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LUCOEX

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Requirements, manufacturing and QC of the buffer components Report LUCOEX – WP2

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For the block production, the constructive collaboration and knowledge of Sébastien Paysan in particular and of the rest of the MPC team in general are acknowledged.

For the GBM productions, constructive discussions with Frank Ohms at Cebo and Martin Holl at JRS are also acknowledged. The working quality of the two companies, the efforts made to adapt their production lines to improve the quality of this novel product and their capability to work together solving some interface problems were highly appreciated. We also want to take the opportunity to mention the detailed and very well documented report of Kennedy on the production of GBM for the EB experiment which was a source of inspiration for the different decisions to be made during the FE production.

In general, the consultation of many detailed and well documented reports of SKB and POSIVA available online were also very helpful in the development of this work.

Executive Summary

A bentonite block wall and three bentonite block pedestals were constructed in the FE-Gallery (Müller et al. 2015) at the Mont Terri underground rock laboratory in St. Ursanne between September 2014 and January 2015 (Fig. 1). Most of the remaining open space of the tunnel was backfilled with a Granulated Bentonite Mixture (GBM) that was also used in several backfilling pre-tests (Fig. 2). The bentonite block construction activities and the GBM backfilling are described in Köhler et al. (2015).

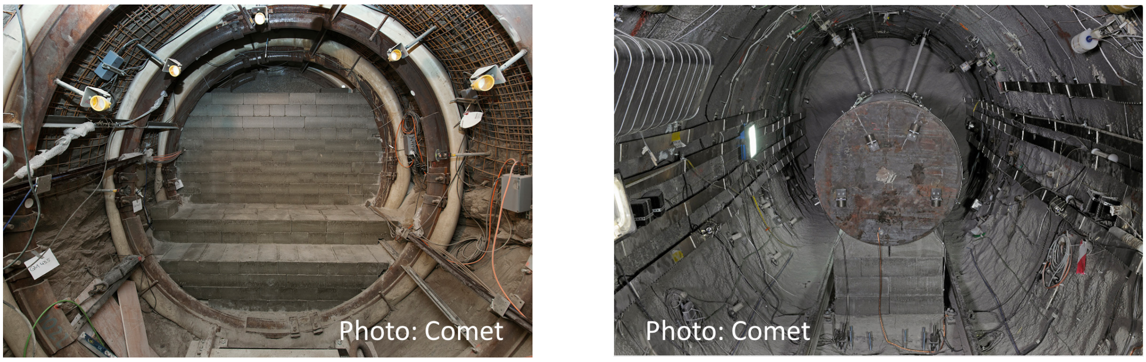

Fig. 1: Emplaced bentonite blocks in the FE tunnel: bentonite block wall in the interjacent sealing section (left) and bentonite block pedestal sustaining a heater (right).

Fig. 2: Emplaced Granulated Bentonite Mixture (GBM) in the FE tunnel (left) and in backfilling pre-test (right).

The present report summarizes the production of 70 tons (March 2014) of bentonite blocks and of 346 tons of GBM (December 2013 – January 2014 and May – June 2014) in the frame of the FE experiment. Derived from long-term safety requirements the bentonite backfill was required to equal or exceed a minimum and homogeneous dry density of 1.45 g/cm^3 anywhere. From a manufacturing engineering point of view, this requirements means that the dry density of mined bentonite, coming at 0.9 g/cm^3, had to be increased by at least 60 % by industrial processes and by proper backfilling technique. The hereby developed Quality Control (QC) procedure had to prove that the properties of the resulting material varied in an acceptable range.

The first section of this report tackles the requirements for the raw bentonite. There are two additional sections about the produced blocks (section 2) and the produced GBM 3 mixture.

State of the art and block pre-production are described in sections 2.1 and 2.2 where the scientific base for setting up the block production requirements (section 2.3) is given. Section (2.4) reports the technical issues of block production and implementation of the requirements into quantifiable QC measures. QC repeated just before emplacement in the FE tunnel showed that the bentonite blocks did not suffer from storage and operational conditions (section 2.5).

The description of the production of the granulated bentonite is summarized in chapter 3. Four different bentonite mixtures were produced in 2 full cycle productions. The first production cycle (mixtures 1 and 2) was to produce material for the backfill pre-tests (about 120 t) and the second cycle (about 260 t) was to produce the granulated bentonite (mixtures 3 and 4) foreseen for backfilling the FE-gallery.

Each of the two production sections is concluded with lessons learnt and open investigation issues.

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1 Requirements for the raw material

Bentonite is usually considered as potential sealing and backfill material in most concepts for geologic radioactive waste disposals. In the FE project at the underground rock laboratory of Mont Terri, no other material was therefore considered for the backfill of the emplacement tunnel.

Bentonite is essentially an impure clay mixture consisting mostly of montmorillonite of volcanic origin and hydrothermally altered. Different potential bentonite providers and bentonite resources worldwide were identified (see appendix A, bentonite resources) and needed to be assessed for their suitability to be used as backfill material.

Tab. 1 summarizes the raw material specification that needed to be fulfilled in order to be considered as backfill material in the FE experiment. A detailed discussion of these specifications and how they relate to safety related requirements follows further down.

Water content and grain size distribution of the raw material were not included in Tab. 1 as those two specifications are different for blocks and Granulated Bentonite Mixture.

Tab. 1: Required raw material specification.

Criterion	**Requirements**
Material	Natural (non-activated) sodium bentonite
Smectite content by dried weight Measured by X-ray diffraction using a dried sample	> 75 %
Additives (such as Magnetite, Baryte, binders or others)	No additives allowed
CEC (Cation Exchange Capacity) Measured by Cu(II)- triethylenetetramine method)	> 70 meq/100 g
Pyrite content by dried weight Measured by X-ray diffraction using a dried sample	< 1 %
Sulphur content by dried weight Measured by emission or mass spectroscopy	< 0.5 % (corresponds to approx. 1 % of pyrite)
Organic carbon by dried weight Measured by emission or mass spectroscopy	< 1 %

Natural (non-activated) sodium bentonite

This material specification supports the buffer requirement to resist mineral transfomation. This requirement supports the buffer safety functions "attenuate releases" and "protect the canister". Mineralogical interactions occurring over time due to elevated temperatures and chemical interactions with other components of the disposal system should not lead to significant alteration and /or loss of the buffer functions (Leupin et al. 2015).

There are two main commercial types of bentonite on the market: sodium rich bentonite and calcium rich bentonite depending on the dominant interlayer cation. Although calcium bentonite has been initially considered a potential raw material for the production of bentonite blocks (compacted calcium bentonite blocks might be more stable as blocks manufactured with sodium bentonite due to the different swelling mechanism), only sodium bentonite was considered at the end. There are two main reasons for this:

- Pore water in Opalinus Clay is of marine origin and hence sodium chloride dominated. By selecting sodium bentonite, we avoid any potential mineralogical structure change of the bentonite by incoming sodium rich water and avoid any additional chemical gradient in the nearfield.
- Sodium bentonite is sometimes called swelling bentonite because it presents two types of swelling mechanisms: crystalline (hydration of the interlayer cation) and osmotic water uptake (calcium bentonite only swells by taking up water to hydrate the interlayer cation). Osmotic swelling only takes place during free swelling (non-constant volume swelling), but might contribute to closing (small) cavities left open because of a non-perfect backfilling process.

Smectite content

This material specification supports the buffer requirements to provide enough swelling pressure, a low hydraulic conductivity, and to minimize microbial corrosion. These requirements support the buffer safety functions "attenuate release" and "protect the canister".

A high content of swelling minerals such as smectite is usually desired to maximize the swelling potential and thus to swelling pressure and to lower the hydraulic conductivity at full saturation. Although the requirement for the swelling potential does not apply directly to the FE as full saturation is not likely to happen within the 10 – 15 years planned for the experiments duration, nonetheless the emplaced material has to comply with the safety related requirements (Leupin & Johnson 2013). The reason for this is that in the FE we will investigate the Thermo-Hydro-Mechanical (THM) behaviour of the buffer, which should be as close as possible to the one expected for real disposal conditions. In general it is accepted that a relatively high smectite content is required, e.g. the range defined in the Swedish concept is between 75 % and 90 % (SKB 2010). Leupin & Johnson (2013) indicate a range between 80 % and 85 %, considering the particular characteristics of MX-80 bentonite as a reference.

Karnland (2010) and Karnland et al. (2006) investigated the relationship between montmorillonite content and swelling potential in a systematic way using 15 materials characterised by varying montmorillonite content in the range between 21 % and 87 %. Montmorillonite is a dioctahedral smectite. The montmorillonite content is defined as:

$$\boldsymbol{x_{mont}} = \frac{\boldsymbol{m_{mont}}}{\boldsymbol{m_{tot}}} \tag{1}$$

Where m_{mont} is the mass of montmorillonite and m_{tot} is the total mass of minerals (montmorillonite and inert minerals). This parameter directly relates to the swelling potential of the material (Karnland 2010) and to the cation exchange capacity (Leupin & Johnson 2013).

Karnland (2010) showed that swelling pressure correlates to the montmorillonite content and the water content at saturation, where the latter is proportional to dry density as the tests were conducted at constant volume (Fig. 3). Karnland's empirical relationship can thus be used to estimate the influence of varying montmorillonite content on the swelling pressure for different dry density values. This has been done in Fig. 4, where the 75 % limit is indicated by a vertical line.

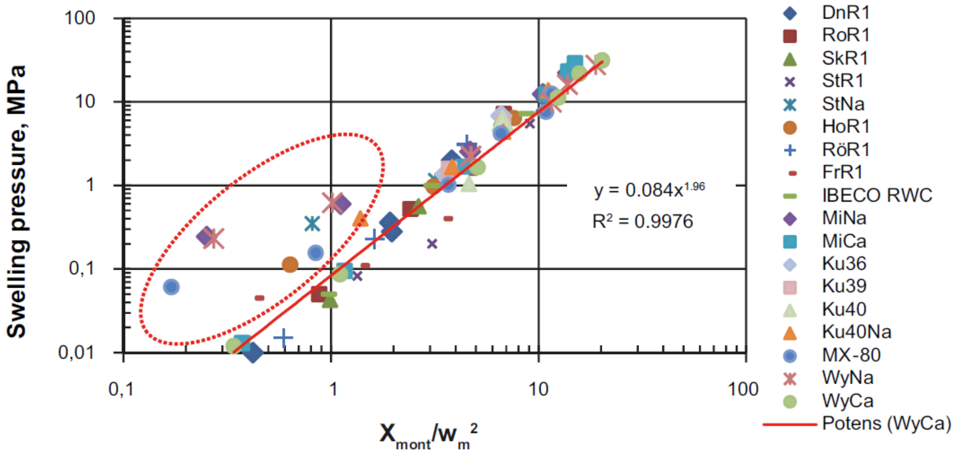


Fig. 3: Measured swelling pressure as a function of montmorillonite content and water content at saturation for a variety of bentonites (Karnland 2010).

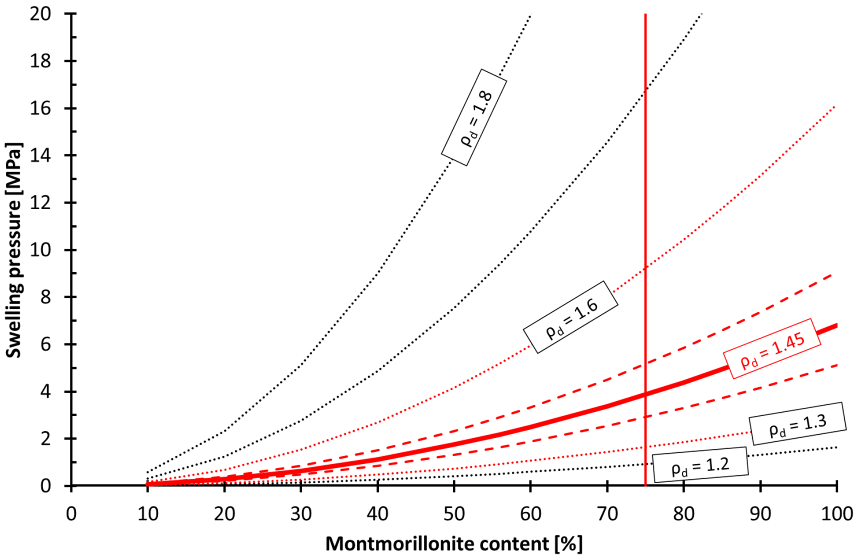


Fig. 4: Swelling pressure as a function of montmorillonite content for different bentonite dry densities derived from the empirical relationship provided by Karnland (2010).

Based on general experience, as described in SKB (2010), and the arguments presented herein, Nagra required a relatively high montmorillonite content (above 75 %) for the raw bentonite. Such a montmorillonite content is believed to ensure an adequate swelling potential (higher than 3 MPa swelling pressure for the target dry density of 1.45). The system is believed to be sufficiently robust, even in the event that mineralogical transformation takes place, e.g. if 25 % of the montmorillonite alters into illite the swelling pressure would still be higher than 1 MPa.

Cation exchange capacity (CEC)

This material specification supports the buffer requirement to provide enough chemical retention of radionuclides. This requirement supports the buffer safety function "attenuate releases" by retarding transport of radionuclides from the buffer.

Most of the research done within the framework of radioactive waste disposal focuses on sodium (Na) and calcium (Ca) bentonites but other bentonite exist with for example Mg in the exchanging position. The cations present in the montmorillonite structure can exchange with cations present in the pore water, resulting in the alteration of the montmorillonite and resulting in altered safety relevant properties such as the swelling pressure properties.

Addition of other components

For many industrial applications, calcium bentonite is converted to sodium bentonite (activated sodium bentonite) to exhibit many sodium bentonite properties by a process known as ion exchange: adding 5–10% of a soluble sodium salt such as sodium carbonate to wet bentonite, mixing well and allowing time for the ion exchange to take place and water to remove the exchanged calcium. As of today, activated bentonites are not considered an option, partly because the structure of the montmorillonite might be altered during the activation process.

The addition of an inert component such as sand or graphite is not desired neither. Wollenberg & Schröder (2006) among others showed that the increase in thermal conductivity or abrasion resistance of pellets when adding sand is not significant. Adding sand would significantly reduce the swelling potential of the mixture as illustrated in Fig. 5. The reduction of swelling pressure corres-ponds in lowering the montmorillonite content (Fig. 4).

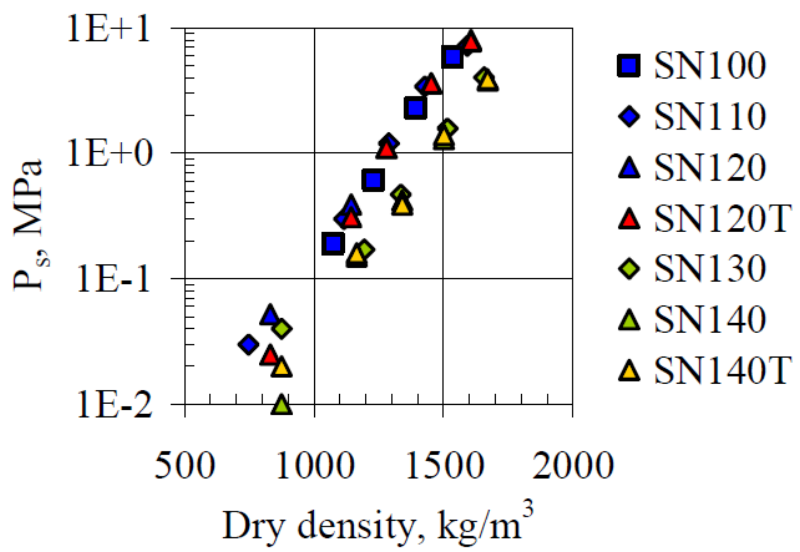


Fig. 5: Measured swelling pressure as a function of dry density for a pure MX-80 bentonite (SN100: raw bentonite; SN110 and SN120: pellet mixtures and SN120T: heated pellet mixture) and for a 70/30 bentonite-sand mixture (SN130 and SN140: pellet mixtures and 140T: heated pellet mixture).

Measurements from Karnland et al. (2007).

Pyrite, Sulphur and Organic carbon content

Apart from unavoidable initial amounts of oxygen, the content sulphide minerals (e.g. pyrite) and organic carbon are required to be low. If not oxidised by initially present or intruding oxygen sulphide might influence the corrosion of carbon steel and copper. There is, however, no absolute criterion placed on this amount. Organic carbon is limited to restrict it's availability to potential micro-organisms.

2 Production of bentonite blocks

2.1 State of the art

The aim of this section is to shortly present the main issues related to the compaction of blocks at the industrial scale based on the available information of block production by sister organizations.

For the FE block production we followed mainly the recommendations given in SKB (2010) summarizing the efforts made since the first industrial production (Johannesson 1999). According to previous bentonite block productions, the quality and strength of bentonite blocks depends on:

- The compaction method (isotropic/isostatic or oedometric/uniaxial compression)
- The compaction pressure
- The water content of the raw material.
- The grain size distribution of the raw material
- The type (mineralogy) of the raw material (Na or Ca bentonite)

The quality of the blocks is not only reflected through their intrinsic properties (e.g. strength, swelling potential, hydraulic conductivity) but also through their suitability to be stored, transported and handled.

Fig. 6 shows the range of dry density obtained in several past productions using uniaxial compression as a function of the water content and the compaction pressure. Optimal Proctor water content is between 10 and 15 % for relatively low compaction pressures (20 MPa to 40 MPa). For higher compaction pressure, Proctor's optimum is not in the investigated range and seems to be inexistent for very high pressures (higher than 150 MPa). For pressures higher than 60 MPa, water content higher than 20 % result in compacted bentonite close to saturation.

The influence of dry density on the uniaxial compression strength (UCS) of saturated bentonite blocks was systematically investigated by Svensson et al. (2011). The results from saturated blocks obtained directly after compaction for different types of bentonite are summarized in Fig. 7. They show an increase of the UCS with dry density, with an exponential correlation. The uniaxial compression strength of the GAST blocks measured by two different laboratories was added for comparison.

Compacted bentonite blocks used in different in-situ experiments were damaged during pre-emplacement handling and emplacement (e.g. Teodori et al. 2011). This damage related to their sensitivity to ambient relative humidity. This is illustrated in Fig. 8 that shows the response of three HE-E bentonite block samples to three different ambient storage conditions (Teodori et al. 2011). The block samples exposed to an environment with high relative humidity deteriorated faster if their water content was relatively low.

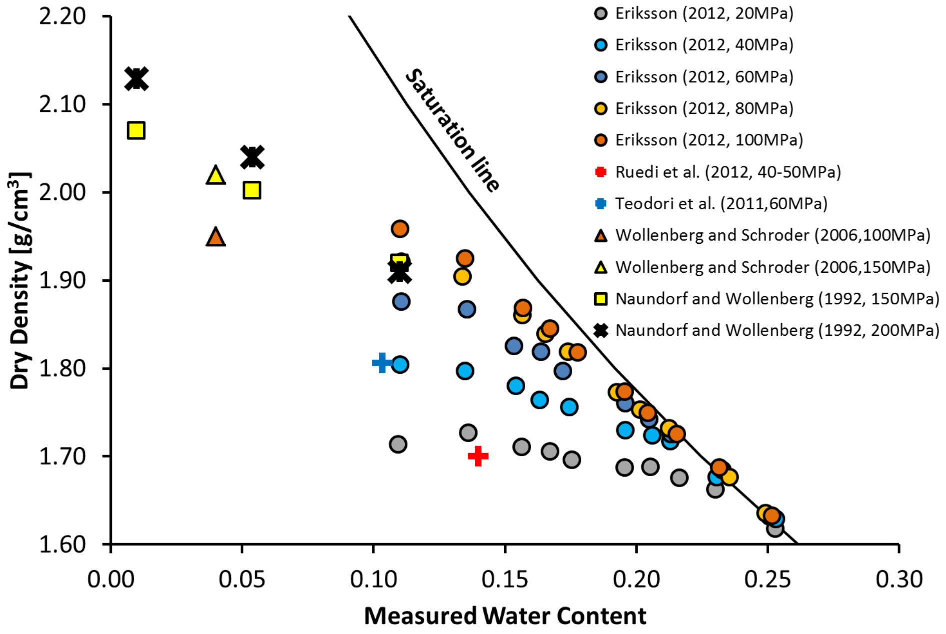


Fig. 6: Dry density as a function of water content and compaction pressure of compacted bentonites.

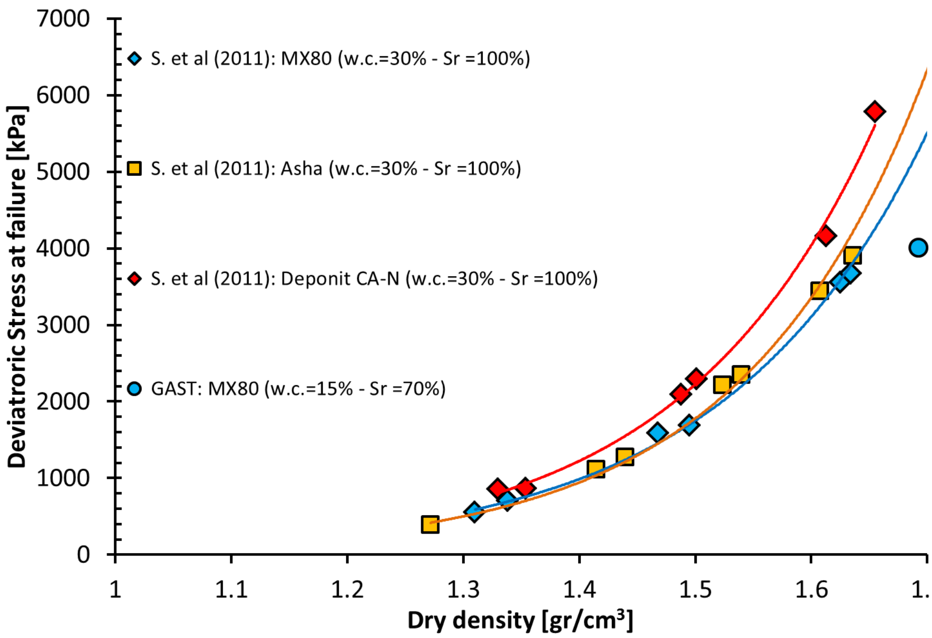


Fig. 7: Uniaxial compression strength as a function of dry density for saturated compacted Na bentonites (MX80 and Asha) and Ca bentonites (Deponit CA-N) (Svensson et al. 2011). GAST blocks were at 70 % degree of saturation (Rueedi et al. 2012).

Fig. 8: Cores from the HE-E bentonite blocks stored at different relative humidity for 6 months. Left ambient condition (50 – 60 % RH), middle 75 % RH, right 99 % RH (Teodori et al. 2011).

As shown in Fig. 9, compacted bentonite has a tendency to disintegrate and this disintegration seemed to be controlled by the original water content of the blocks (i.e. the lower the water content of the raw material used to manufacture the blocks, the faster they start to disintegrate under RH = 100 %).

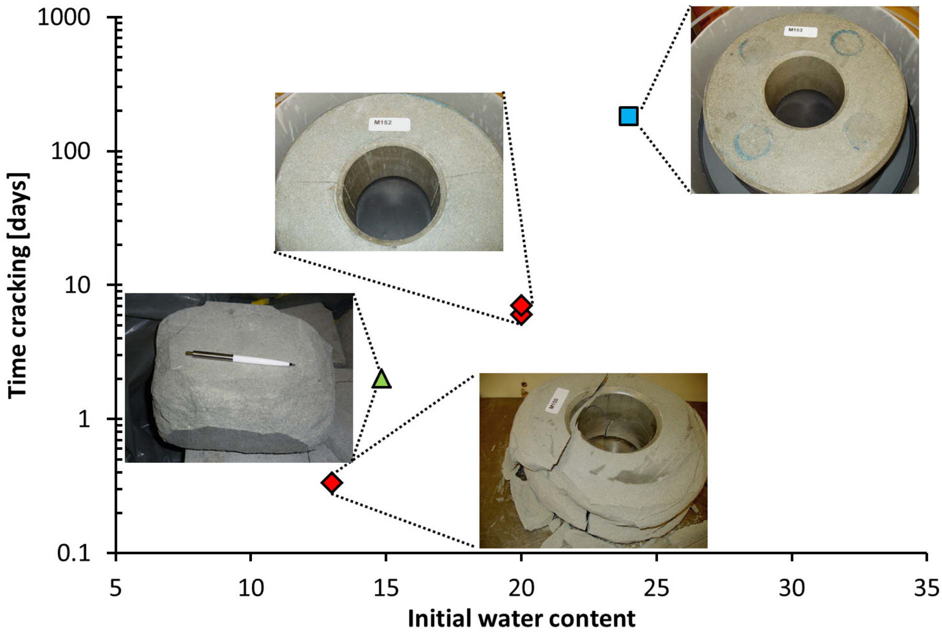


Fig. 9: Time before first cracking measured for blocks at different initial water contents exposed at relative humidity close to 100 % (modified from Sandén et al. 2008 and Teodori et al. 2011).

The target dry density (1.45 g/cm^3) seems easily reachable for compacted bentonite blocks, fulfilling the long term requirements of the FE experiment. The strength of compacted bentonite seems to satisfy the strength structural requirements for the pedestals and the bentonite block wall.

Nevertheless, problems may arise during the emplacement of the FE experiment, related to the block strength degradation. One of the objectives of the FE experiment was to produce bentonite blocks that are capable to resist to the ambient conditions in Mont Terri during storage and operation phases.

2.2 Pre-production

A pre-production of block was decided in order to investigate:

- The water content of the raw bentonite
- The compaction pressure
- The type of raw material

and to acquire the necessary experience at Nagra to launch a larger production.

Two pre-productions of 180 blocks (appendix B.1) and 30 blocks (appendix B.2) were performed by MPC-Laviosa in November 2012 and September 2013, respectively, to identify critical parameters for the FE bentonite blocks. The dimensions of those blocks were 300 mm × 200 mm × 110 mm. In the first pre-production, 90 blocks were produced using Bentosund WH2 (formerly: Gelclay WH2 and also called Bentosund A100), a natural sodium bentonite and 90 blocks using Bentosund SPK, a calcium bentonite. Because of the poor quality of the calcium bentonite blocks (see appendix B.1) a second pre-production of 30 blocks was organized using another type of calcium bentonite (BC1 N bentonite). The quality of the blocks of this second production was even poorer than the first one[1].

The grain size distribution of the raw material is a factor that influences the compaction behaviour. No special investigations were carried out on this matter and Nagra relies on the experience of MPC-Laviosa and the satisfactory result obtained with Bentosund WH2. The instability of the Bentosund SPK blocks can perhaps be due to the specific grain size distribution of the raw bentonite material. The raw material Bentosund WH2 was characterized by grain sizes distributed uniformly between 0 and 2 mm when the Bentosund SPK raw material was constituted by grains without fines (between 0.5 and 3 mm). There for the Calcium bentonite selected for the second pre-production was chosen with a grain size distribution very close to that of Bentosund WH2 (see Fig. 10), but the resulting blocks were of even poorer quality as that obtained with Bentosund SPK.

[1] Note that the potential use of Ca-bentonite was considered as this raw material may have provided higher mechanical strength and lower sensitivity to changes of relative humidity in the ambient air.

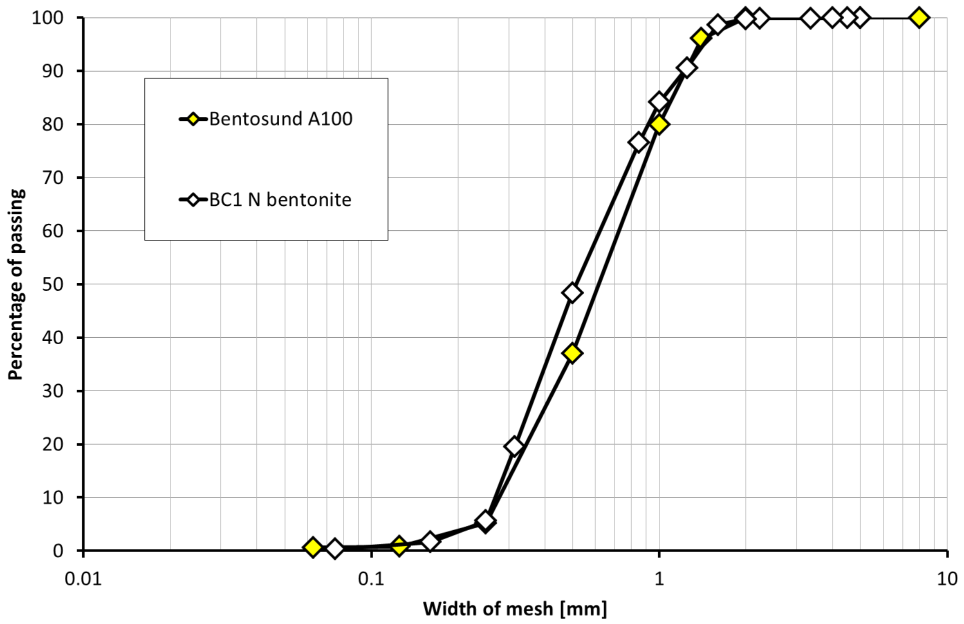


Fig. 10: Grain size distribution of the tested raw materials: Bentosund WH2 (Bentosund A100) and of BC1 N bentonite.

Raw materials at three different water contents were compacted at three different compaction pressures to investigate the influence of those two variables on the behaviour of the blocks. The dry density of the blocks pressed with Bentosund WH2 obtained for the different water contents and compaction pressures is presented in Fig. 11. The results show a pattern consistent with compaction performed at the wet side of the Proctor optimum (increasing dry density with decreasing water content for the same compaction pressure). For the investigated pressure range, at relatively high water content (20 %), the dry density is independent on the compaction pressure, indicating a reduction of the pore space by compaction resulting in a state close to saturation. **In all cases the target dry density criterion is fulfilled (higher than 1.45 g/cm^3)** and the choice of the water content and compaction pressure will thus be governed by the mechanical stability of the blocks.

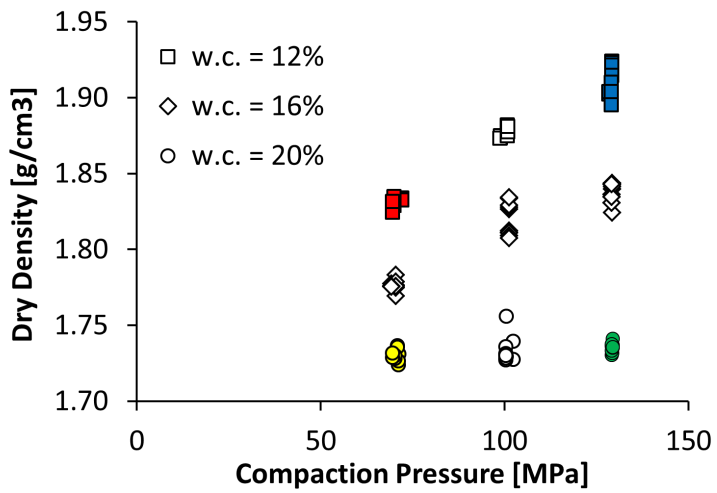


Fig. 11: Dry density as a function of compaction pressure and water content for the blocks pressed with Bentosund WH2.

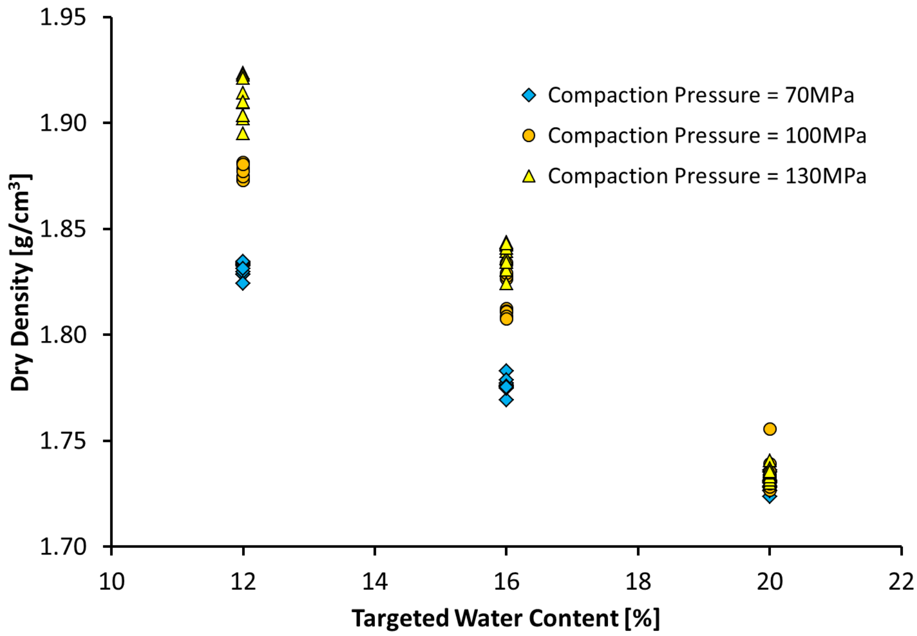


Fig. 12: Dry density as a function of water content and compaction pressure for the blocks pressed with Bentosund WH2.

Results of the tests performed on pre-production blocks

A series of laboratory experiments and a simple in-situ test (BLL) using the Bentosund WH2 blocks of the first pre-production were set up to:

- Confirm that Bentosund WH2 have the expected UCS
- Characterize the deterioration of Bentosund WH2 blocks as a function of initial water content, compaction pressure and ambient conditions
- Select and clear the optimal initial water content and compaction pressure for the production of blocks for the FE experiment as a function of the expected ambient conditions in the emplacement tunnel

The laboratory experiments were performed at the laboratory of CEA. Two blocks out of each water content – compaction pressure group (see Fig. 11) were first emplaced in a sealed plastic bag with a relative humidity sensor in order to determine their equilibrium relative humidity. The equilibrium relative humidity is between 50 % and 70 % and increases with the water content (Fig. 13). For one particular water content value, the equilibrium relative humidity increases with the compaction pressure although this trend is secondary.

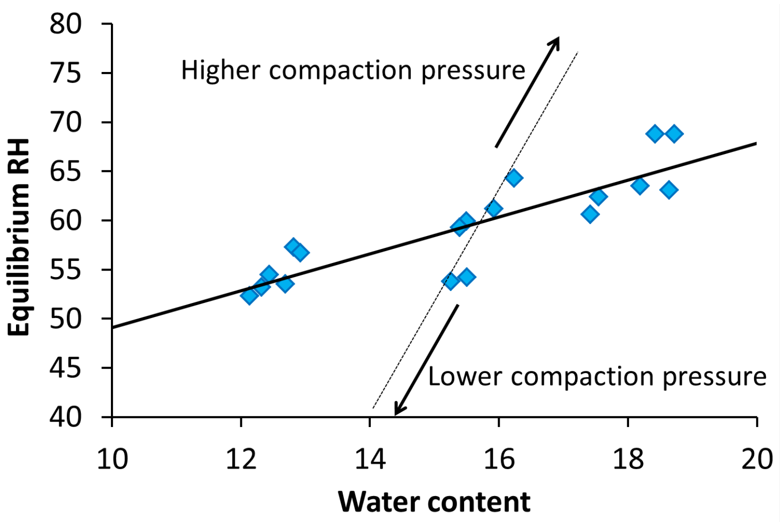


Fig. 13: Equilibrium relative humidity of Bentosund WH2 blocks as a function of their initial water content.

Those 18 blocks were then tested in a uniaxial compression apparatus. The UCS values derived from those tests are plotted in Fig. 14 and are in rough agreement with the extrapolation of the measurements performed by Svensson et al. (2011). All UCS values are **above 6 MPa, which is well above our requirements.**

The remaining blocks were put in a climate chamber in groups of nine blocks (one representtative from each water content – compaction pressure couple) and equilibrated at different relative humidity levels (see Tab. 2). The blocks were left in the climate chamber until reaching a constant weight. They were then tested in the uniaxial compression apparatus.

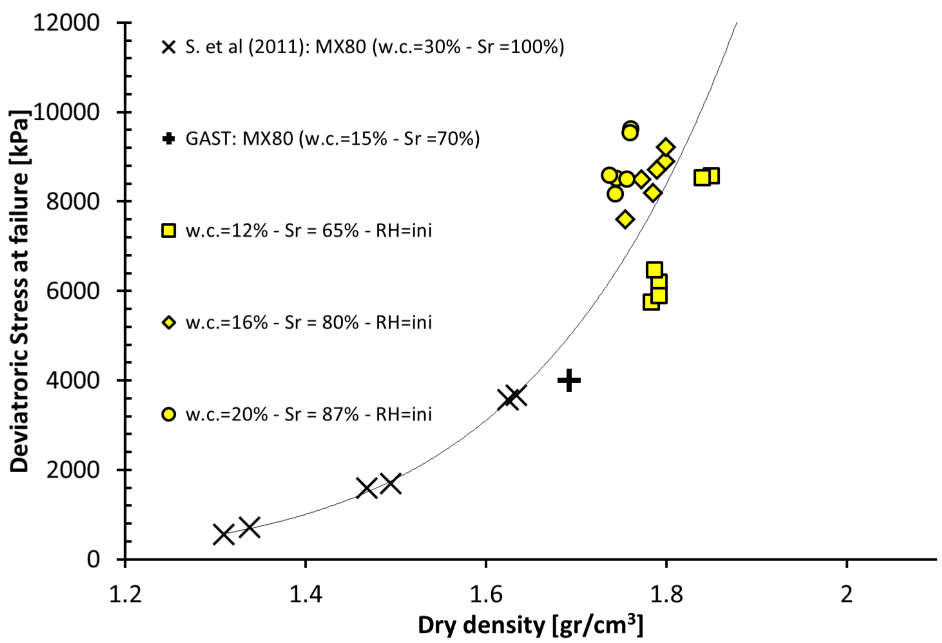


Fig. 14: Task 1-1: UCS of 18 Bentosund WH2 blocks directly after unpacking as a function of dry density.

The measurements by Svensson et al. (2011) and an exponential extrapolation from those results are also shown.

Tab. 2: Description of the relative humidity conditions applied to the blocks before UCS testing and of the loading direction respective to the compaction plane.

Name of the tests	**No. of blocks tested**	**RH in climate chamber before UCS tests**	**Loading direction with respect to compaction plane**
Task 1-1	18	after unpacking	Perpend.
Task 1-2a	9	50%	Perpend.
Task 1-2b	9	50%	Parallel
Task 1-3	9	70%	Perpend.
Task 1-4	9	90%	Perpend.
Task 1-5	9	35%	Perpend.

The UCS values measured in the 63 tests are plotted in Fig. 15. The following observations can be made:

- Task 1-2a: blocks that were equilibrated at 50 % maintain the same strength as blocks tested directly after unpacking
- Task 1-2b: UCS is lower in the direction of the compaction plane
- Task 1-3: blocks that were equilibrated at 70 % and
  - Had an initial water content of 20 % maintain the same strength
  - Had an initial water content of 16 % lost strength
  - Had an initial water content of 12 % were destroyed in the climate chamber and were characterized by a decrease of the dry density associated with water uptake
- Task 1-4: blocks that were equilibrated at 90 % and
  - Had an initial water content of 20 % lost strength and their dry density decreased.
  - Had an initial water content of 12 – 16 % were destroyed in the climate chamber
- Task 1-5: blocks that were equilibrated at 35 % maintain the same strength as blocks tested directly after unpacking and are characterized by an increase of their dry density associated with out coming water

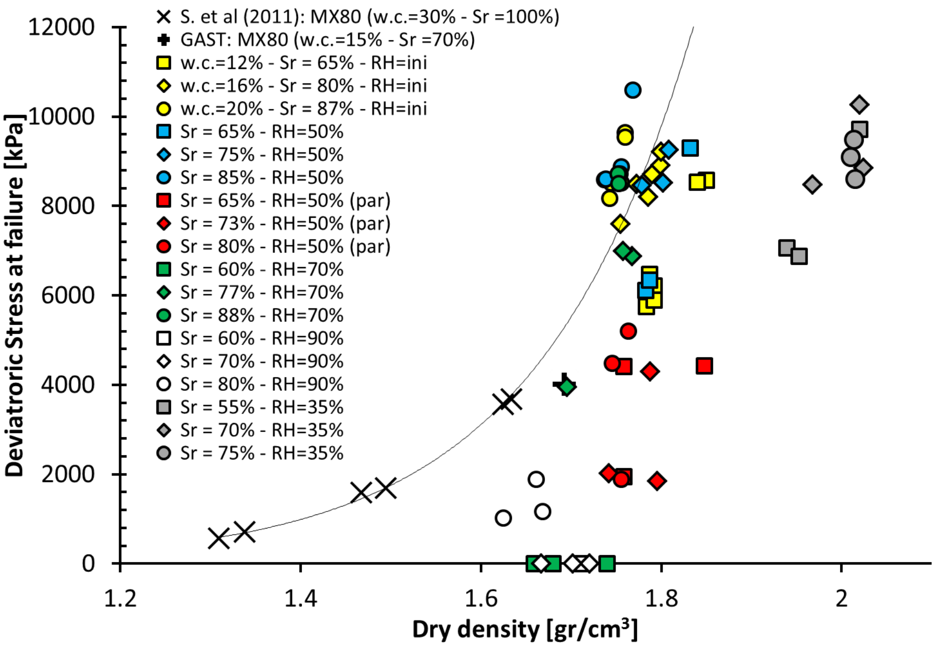


Fig. 15: All tasks: UCS of 63 Bentosund WH2 blocks directly after unpacking and after equilibration in a climate chamber as a function of dry density after equilibration in the chamber.

The deterioration of the blocks can be explained by comparing the equilibrium relative humidity of the bentonite blocks (Fig. 13) and the relative humidity of the climate chamber in each task. **Bentonite blocks in ambient air take up water if the relative humidity of the ambient air is higher than their equilibrium relative humidity.** The water uptake leads to an expansion of the blocks and a strength decrease. The blocks can even be destroyed in case of a large relative humidity difference. In case the ambient air is drier than the blocks, water is lost and the blocks shrink, but no strength reduction was observed.

Finally, some of the remaining 27 blocks were used in a simple in-situ experiment, Bentonite Long term Load test (BLL). 4 groups of 2 blocks with different initial conditions (indicated by coloured dots in Fig. 11) were emplaced in Grimsel and monitored via a dedicated webcam system. The experiment was installed on 19.09.13 at 11:00 (RH at that time =70%). The blocks were loaded with a similar pressure to that induced by a heater on the bentonite blocks in the FE experiment.

The test was set up (1) to verify the previous laboratory test results and (2) to investigate phenomenologically the mechanisms behind those results. Blocks compacted at a low water content disintegrated very fast: support capability was lost only within one month and the first significant fractures appeared in the first days after emplacement (Fig. 16). Cameras set up in front of the blocks and recording a picture every minute allowed following up the block disintegration behaviour. In the low water content blocks the first fractures appeared in the first hours and the videos (see QR codes in Fig. 16) clearly showed the link between fracture development and swelling behaviour. The swelling, caused by water absorption by the relatively dry bentonite from relatively wet air**,** generated cracks that propagated very fast because the relatively wet air penetrates into the fractures and extend the fracture inside the block. Drying cracks were also observed in the blocks equilibrated at 35 % in the laboratory test, but these were shrinkage cracks and they did not penetrate into the blocks. Blocks produced at a high water content and thus characterized by a higher equilibrium RH did nearly not take up water and proved to be very stable over a large time period of approx. 1.5 years.

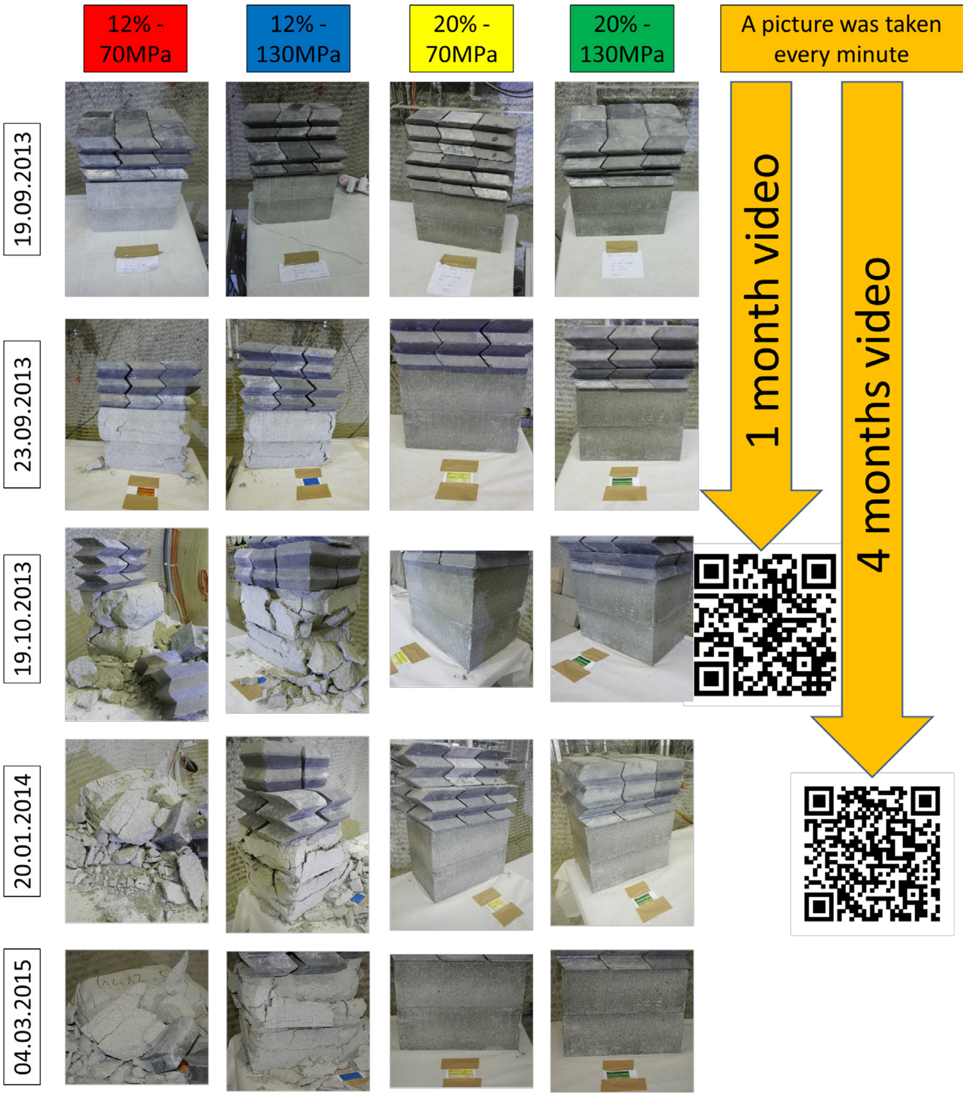


Fig. 16: Resistance of compacted bentonite blocks to exposition time to ambient RH as a function to the production parameters (water content and compaction pressure are indicated on top of the figure).

The QR codes are linked to time-lapse videos of the block evolution.

2.3 Requirements

A **natural sodium bentonite** was selected for the bentonite blocks. The commercial name of this bentonite is Bentosund WH2 (formerly: Gelclay WH2), a brand of the group MPC-Laviosa. This Wyoming bentonite fulfils the same requirement as described in section 1.

The **grain size distribution** selected for the raw material is between 0.5 mm (d5) and 2 mm (d99).

The definition of the **dimensions and shape** comes directly from the required pedestal shape. The dimensions of the bentonite blocks are described in Fig. 17.

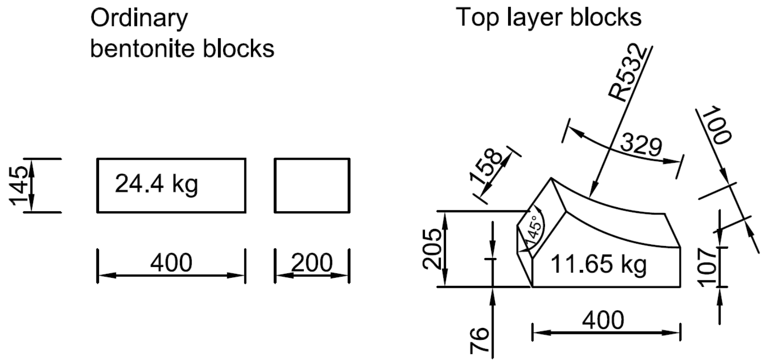


Fig. 17: Dimensions and shape of the bentonite blocks to be used in the FE experiment.

Water content and compaction pressure were selected on the basis of the tests on pre-produced blocks (see previous section):

- The selected water content is 19 % ± 1 %.
- The compaction pressure is 130 MPa.

The selected characteristics aimed at ensuring:

- The stability of the pedestal.
  - The Uniaxial Compression Strength (UCS) of the blocks should be higher than 29 kN/m^2
  - Bentonite blocks have a potential to deteriorate under changing humidity conditions. This feature is taken into account.
- The backfilling function.
  - The block pedestal must have a bulk dry density equal or higher than 1.45 g/cm^3 to ensure appropriate properties in terms of swelling pressure and hydraulic conductivity.

Those requirements were translated in simple QC variables (acting as rejection criteria) for the production:

- Control of the water content during the preparation of the raw material
- The block dimensions, according to Fig. 17 (required precision: 0.85 mm)
- Geometric density (required precision of 0.02 g/cm^3)
- No visible cracks
- Minimum UCS of 6 MPa (checked every 100th block in beginning of production and every 500th block afterwards)

2.4 Manufacturing and Quality Control

About 2500 rectangular and 500 curved "top layer" blocks were produced in March 2014 using a natural sodium bentonite (trade name Bentosund WH2, formerly Gelclay WH2). The production parameters were set according to the tests described above to obtain stable blocks that are capable to support heaters under the expected climatic conditions in Mont Terri:

- water content of the raw material (18 % ± 1 %)
- compaction pressure (130 MPa)

Sequence:

- Preparation of the raw material

- March 3 2014: raw material with adapted water content arrived in Saint-Etienne (Bony SA, local sub-contractor)
- March 4 2014: the rectangular moulds were installed on the hydraulic press and the block pressing tests were performed
- March 5 2014: start of production of 2487 rectangular blocks. Attended by Benoit Garitte.
- March 7 2014: end of production of 2487 rectangular blocks
- March 7 2014: the top layer blocks moulds were installed on the hydraulic press
- March 9 2014: top layer blocks pressing tests were performed and the launch of production of 588 top layer blocks. Attended by Herwig R. Müller and Hanspeter Weber.
- March 10 2014: break in production as MPC got out of stock of raw material. Ordering of 4 additional tons, arrival at 10pm.
- March 11 2014: end of production of 588 top layer blocks
- March 17 2014: truck 1 leaves Saint-Etienne with 17 pallets
- March 18 2014: truck 1 (421 ordinary bentonite blocks, 19 rejected bentonite blocks and 552 top layer blocks) arrives in MT and truck 2 leaves Saint-Etienne with 24 pallets
- March 18 2014: 120 ordinary bentonite blocks and 36 top layer blocks delivered to AITEMIN
- March 19 2014: truck 3 leaves Saint-Etienne with 24 pallets
- March 20 2014: truck 2 (960 ordinary bentonite blocks) and truck 3 (960 ordinary bentonite blocks) arrive in MT

In total, Nagra received thus: 2461 ordinary bentonite blocks and 588 top layer blocks from MPC. The production report from MPC-Laviosa can be found in appendix C.

Raw material preparation

The quality of the raw material Bentosund WH2 (formerly Gelclay WH2) according to the requirements given in section 1 was ensured by MPC. Those requirements were checked beforehand by an external laboratory contracted by MPC (Dorfner Anzaplan, see appendix D) and by ETH contracted by Nagra (sample 13 in appendix E). The quality of the raw material was checked afterwards by BGR (appendix F) and by ETH (appendix G).

The raw material arrives in Europe at a water content of about 10 – 15 %. Nagra required to increase it to 19 % ± 1 %. This work was performed in Limay by MPC. The measurements of the water content (1/ton), performed by MPC, are given in Fig. 18. The average is 18.35 % and the standard deviation is 0.78 %.

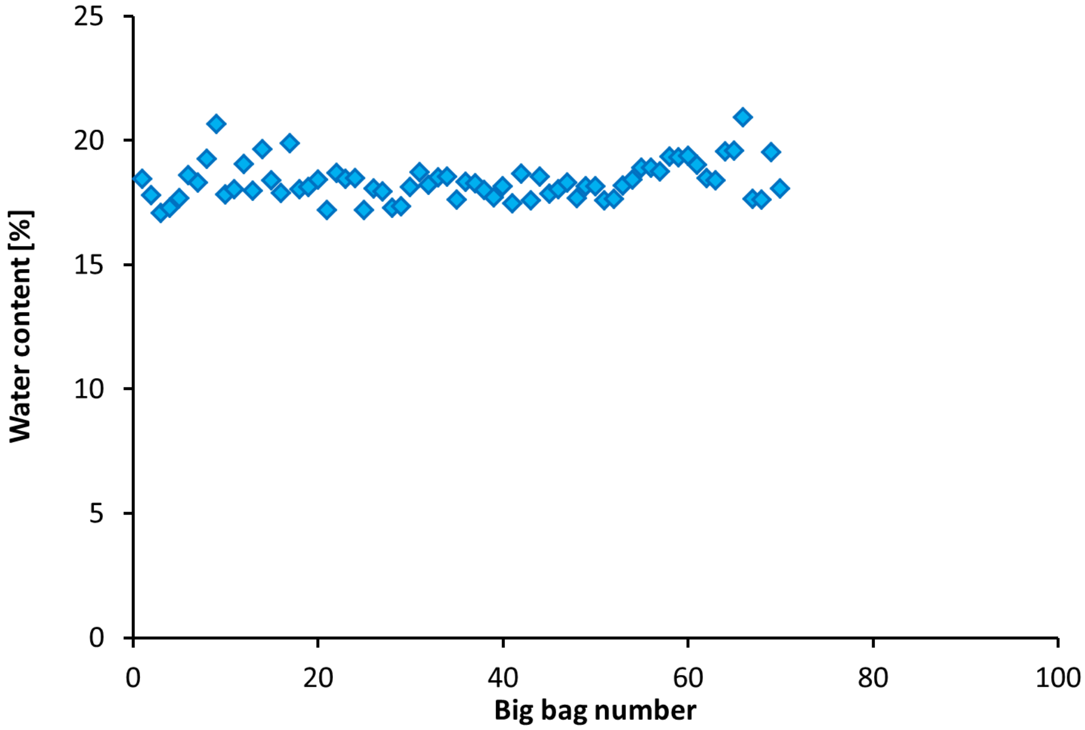


Fig. 18: Water content of the raw material after homogeneous wetting measured by MPC.

Compaction process

Block manufacturing was performed at Bony SA in Saint Etienne on a Laeis Bucher 1600 tons press that operates fully automatically (Fig. 19, Fig. 20 and Fig. 21), starting from the raw material supply (Fig. 22, 10 tons yellow hopper in the background), then conveying the raw material towards the mould (Fig. 22) and mixing the raw material in a pre-mould to obtain an homogeneous block (Fig. 23) and ending at the expulsion of the compacted block on a conveying band (Fig. 24).

The compaction itself was performed in 4 cycles lasting 20 seconds in total.

On the conveying band, superfluous bentonite powder was pushed away using a wooden rule (which also allows for a rough check of the block height, Fig. 24b). At the end of the conveying band an automatized robot picks up the block by suction and the block was emplaced on a pallet (Fig. 25).

This pallet was wrapped in one layer of plastic and brought to the measuring hall (Fig. 26).

Fig. 19: Laeis Bucher press used to compact the blocks.

Fig. 20: Overview of the press and the robot.

Fig. 21: Control board of the press.

Fig. 22: Passage of the material from the supply hopper to the conveying band.

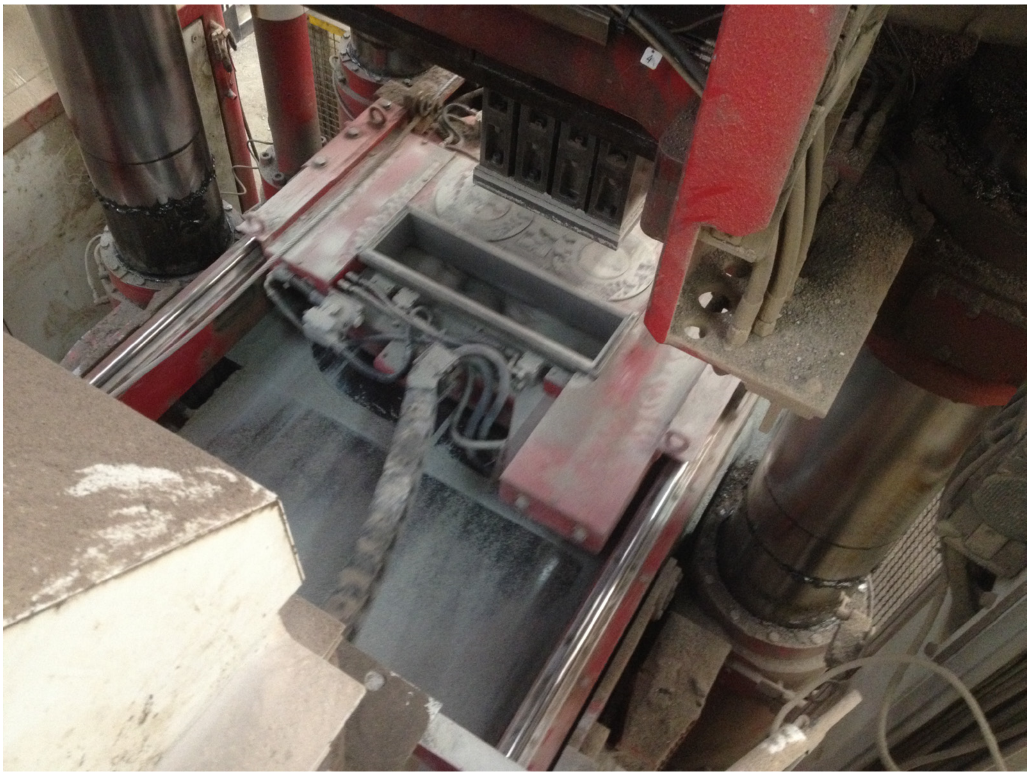


Fig. 23: Homogenisation of the raw material in pre-mould.

(a)

(b)

(c)

Fig. 24: Block expulsed from the mould (a and c) and placed on the conveying band (b).

Fig. 25: Robot taking a block from the conveying band and putting it onto a pallet.

Fig. 26: Pallets ready to be brought to the measurement hall.

QC ordinary bentonite blocks

After some trials to calibrate the press, the production was launched at a rate of 1 block/minute. A photograph of the first production blocks is shown in Fig. 27. Each block was measured, weighted and checked for cracks (Fig. 28 and Fig. 29). Each tenth block was photographed and each 250th block was tested in a uniaxial compression unit. The debris of the uniaxially broken blocks were used to measure the water content. This QC was a little bit slower than the production (40 blocks per hour).

Fig. 27: First accepted blocks.

Fig. 28: Measuring team consisting of 3 persons.

Fig. 29: Measurement of the length of a block.

The measurement of each block was time consuming, mobilized three persons and the many manipulations produced some small damages to the blocks. Additionally, the blocks stay longer in contact with ambient air, increasing the risk of a potential deterioration induced by absorption of humid air. A possible improvement would be to install an automatic laser scanning measurement device on the conveying belt (cheap commercial tools available).

Despite of the disadvantage of the very frequent QC measurements, the authors believe that the information gained in this production was worth the effort. It will allow for defining a better QC strategy in the next production based on sound information.

The QC measurements are summarized in Tab. 3. The average length and width of the blocks is slightly higher than the required one (see Fig. 17). The difference comes from the fact that after unmoulding the blocks experienced an elastic expansion. The elastic expansion was incorporated in the mould design, but underestimated. Taking the mould dimensions and the average dimensions of the blocks, the linear elastic expansion after unmoulding is 0.3 % (for the width and the length), e.g. (Lblock – Lmould)/L = 0.3 %.

As a consequence, Nagra accepted to update the contractual dimension requirements. The average dimensions and density of the first 100 blocks were taken as the new requirement, applying a tolerance of 0.85 mm or 0.02 g/cm^3, to this average. Blocks that did not satisfy the requirements (red lines in the presented graphs or fractures) were rejected.

Tab. 3: Average, standard deviation and minimum and maximum of all measured values for all blocks (including rejected ones).

	Compaction pressure [MPa]	**Weight** [g]	**Length** [mm]	**Width** [mm]	**Height** [mm]	**Density** [g/cm^3]	**Measured water content** [%]
Average	129.6	24'517	401.3	200.6	145.3	2.096	18.00
Std dev.	0.4	93	0.2	0.2	0.3	0.007	0.67
Min	128.7	23'920	400.5	199.9	143.9	2.061	17.27
Max	131.5	25'000	402.1	201.7	146.5	2.119	19.74

We first present the water content of the raw material (Fig. 30), the weight of each block (Fig. 31) and the applied compaction pressure for each block (Fig. 32). The characteristics of the raw material, the amount of raw material in the mould and the applied compaction pressure are the control variables of the block pressing process. The block dimensions and the block density are dependent on those characteristics, on the oedometric conditions (null lateral strain) applied by the mould and on the compaction cycle.

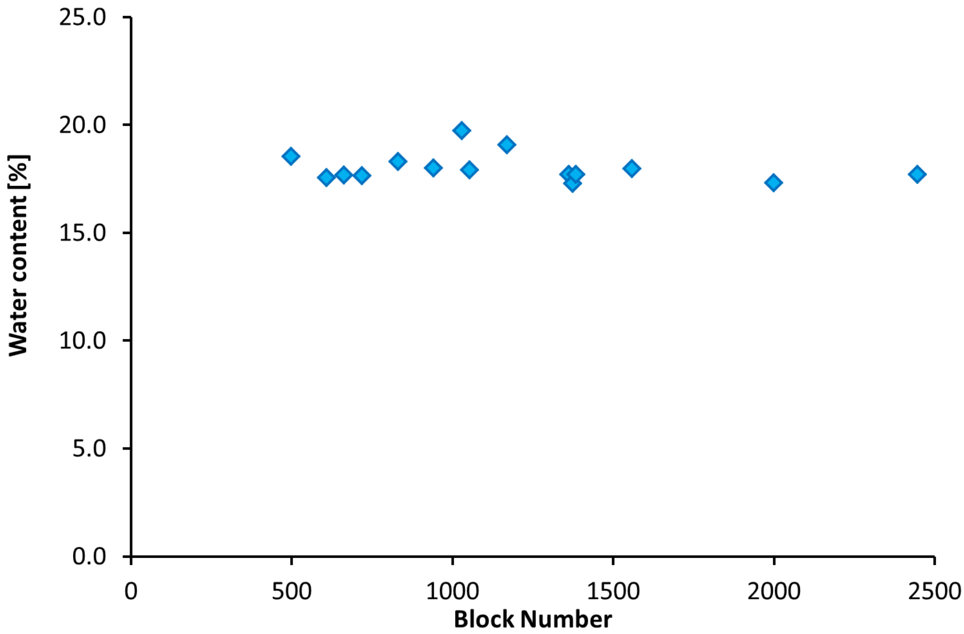


Fig. 30: Water content measured on each 250th block.

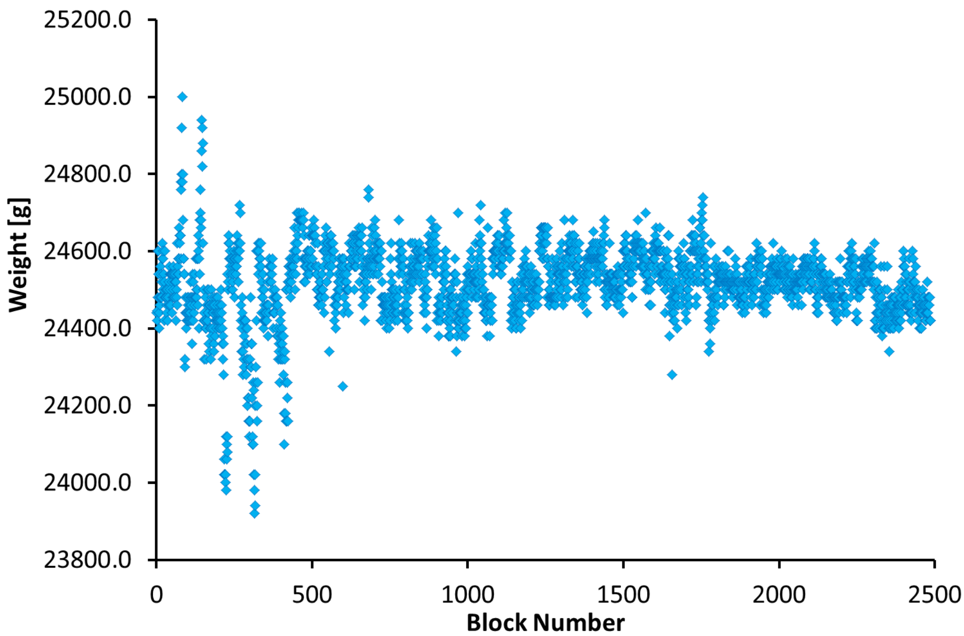


Fig. 31: Weight of the blocks measured for each block.

The applied compaction pressure for each block is given in Fig. 32. Small variations were applied automatically by the machine as a function of the height measured for the previous block.

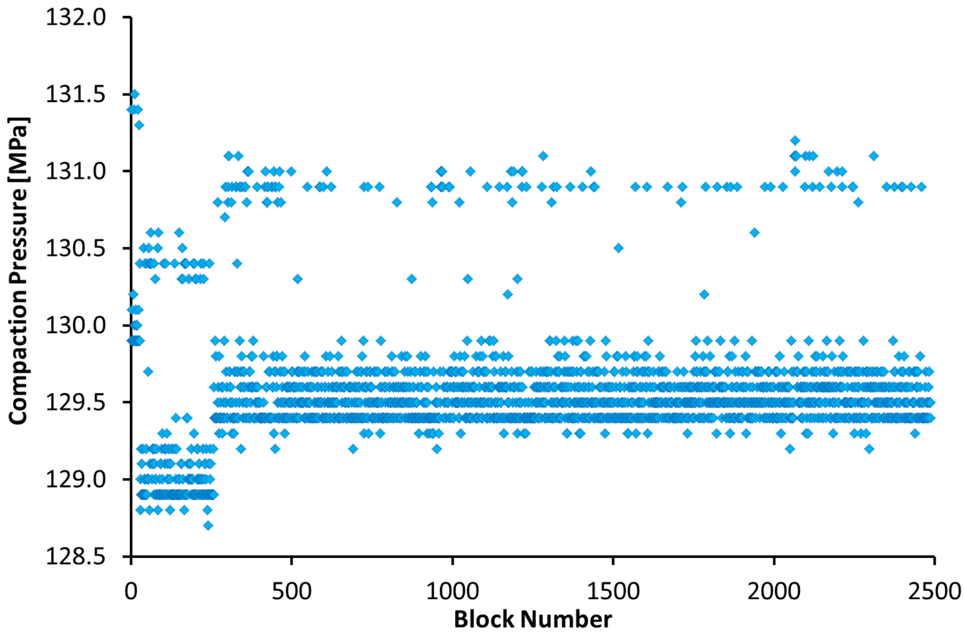


Fig. 32: Compaction pressure applied to each block.

The resulting dimensions and density are given in Fig. 33, Fig. 34, Fig. 35 and Fig. 36.

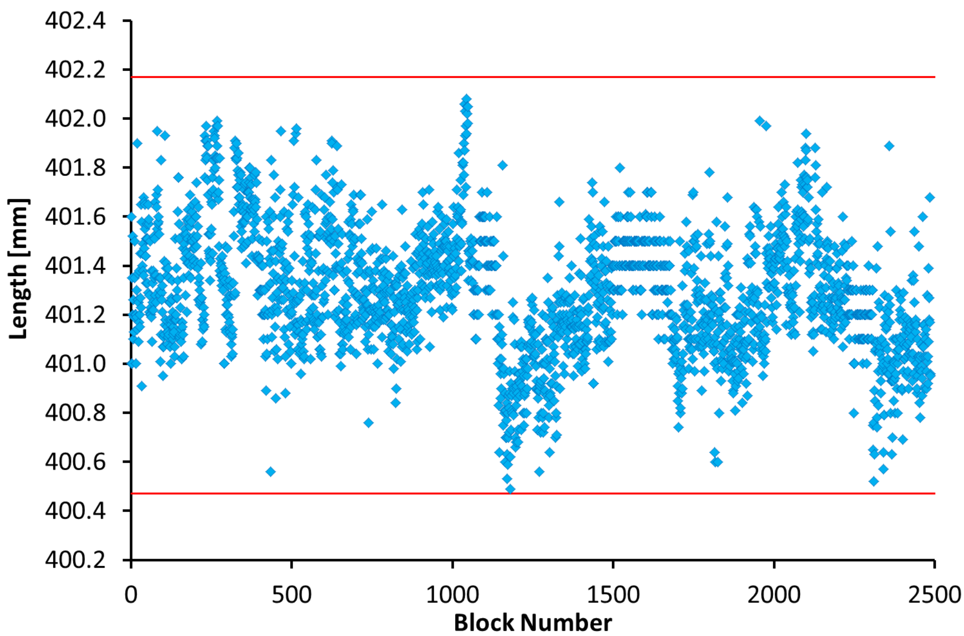


Fig. 33: Length of the blocks measured for each block.

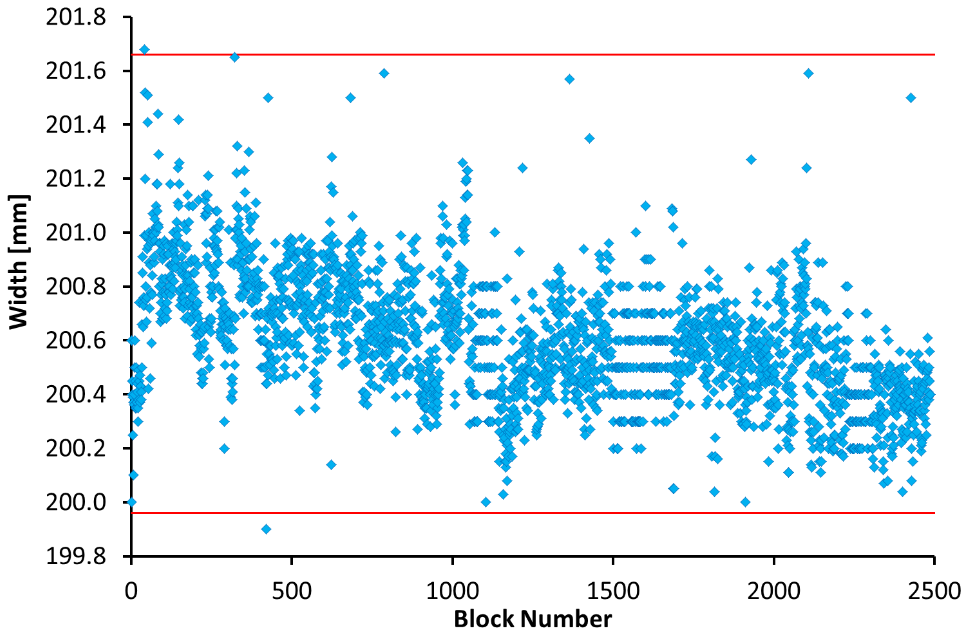


Fig. 34: Width of the blocks measured for each block.

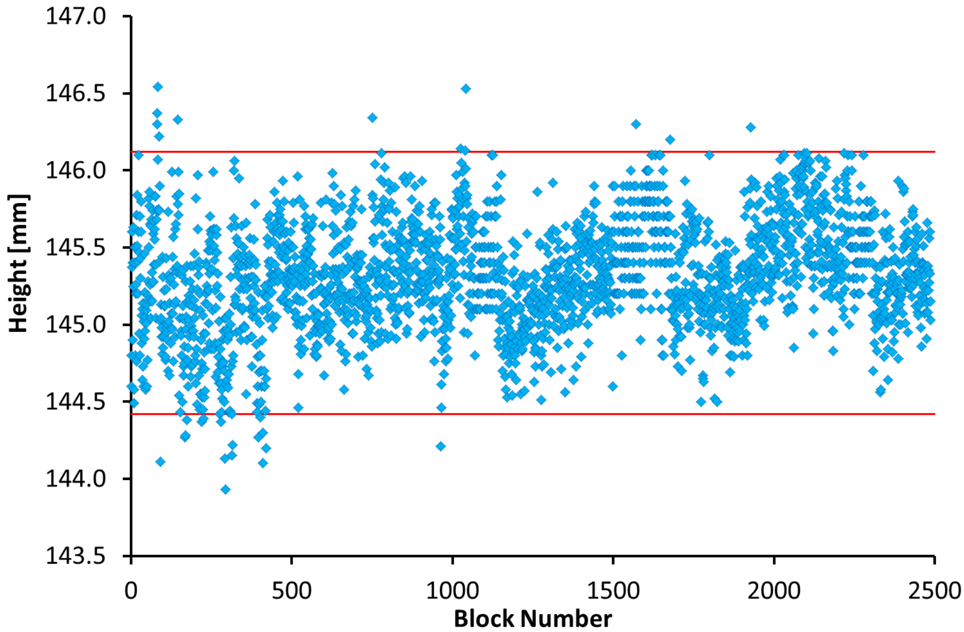


Fig. 35: Height of the blocks measured for each block.

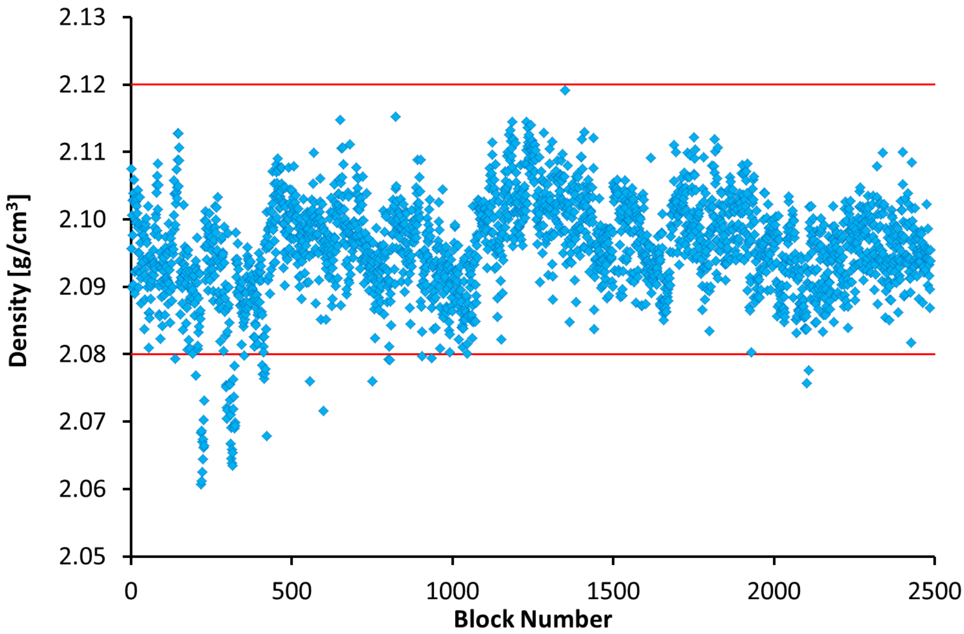


Fig. 36: Density of the blocks measured for each block.

The uniaxial compression strength was measured on rectangular samples of 15 cm x 15 cm x 7 cm cut in the blocks (Fig. 37, Fig. 38, Fig. 39 and Fig. 40). In the ordinary blocks, 2 such a samples were sampled in each block (one in the top part and one in the bottom part to verify the homogeneity of the block). The results are given in Fig. 41. The required minimum UCS was 6MPa. The broken pieces were used to measure the water content. The results are given in Fig. 30. The required range of water content was 19 % ± 1 %.

Fig. 37: Block cutting for the uniaxial compression strength test.

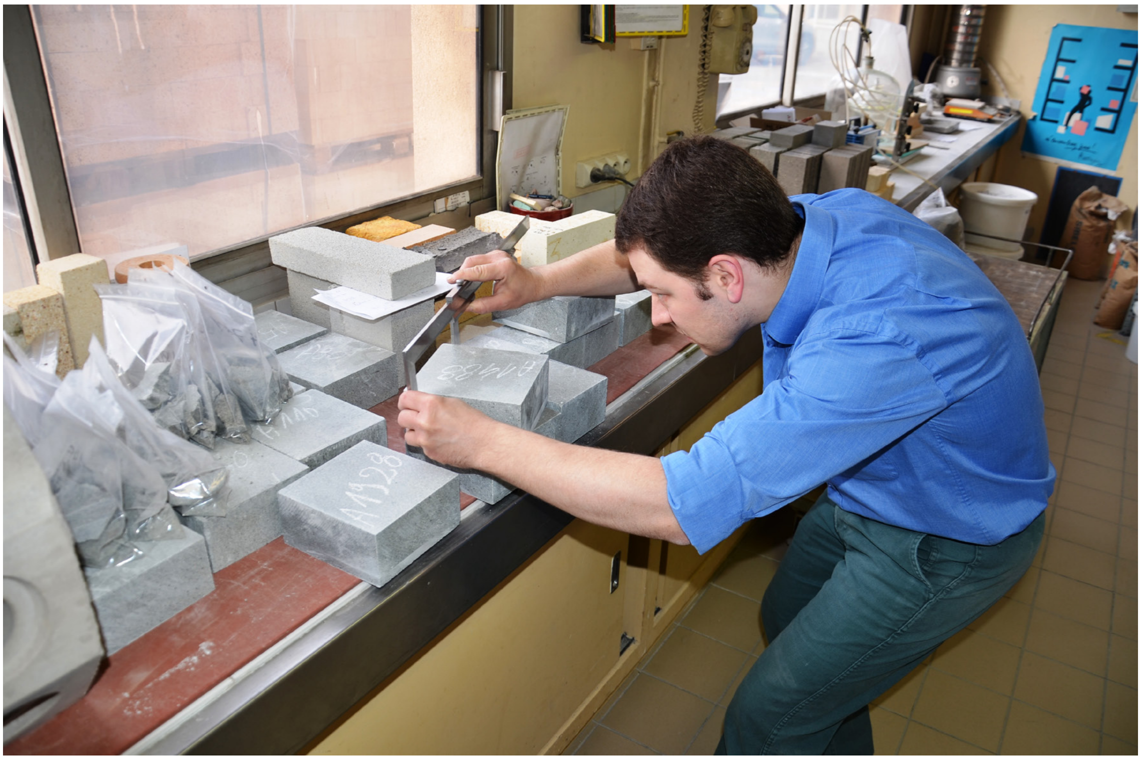


Fig. 38: Measuring the dimensions of the samples to be tested for strength.

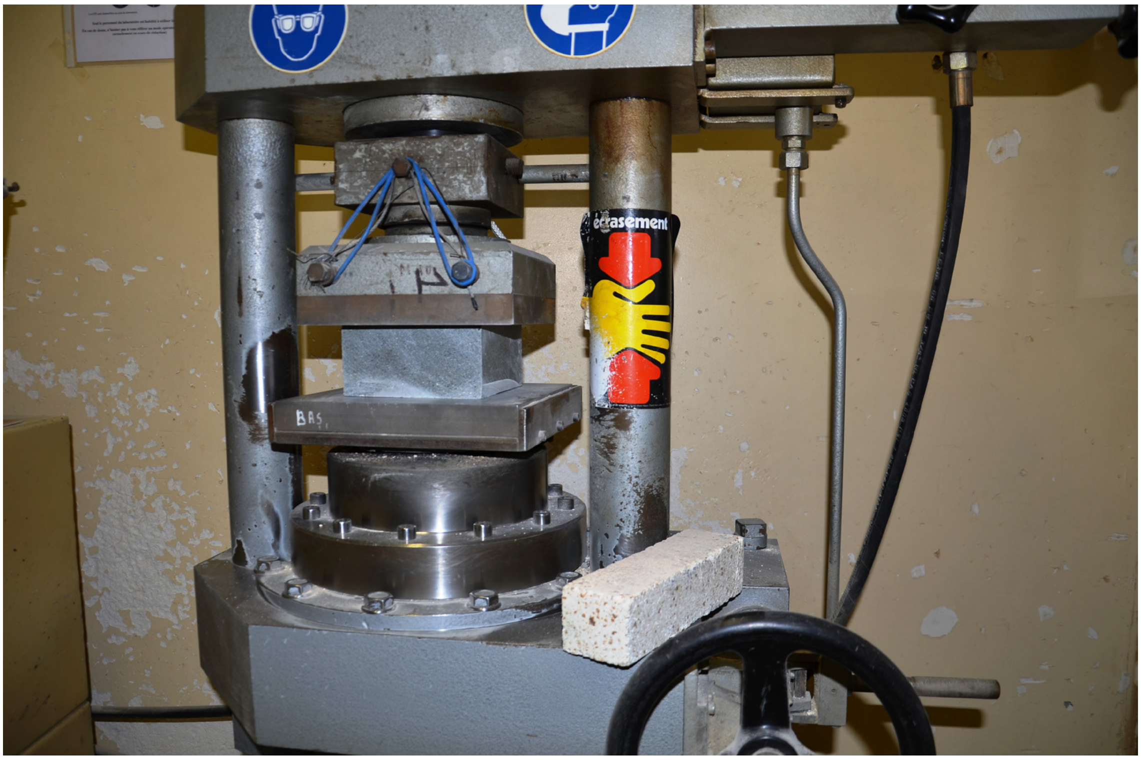


Fig. 39: Uniaxial compression apparatus.

(a)

(b)

Fig. 40: Failed blocks by uniaxial compression strength.

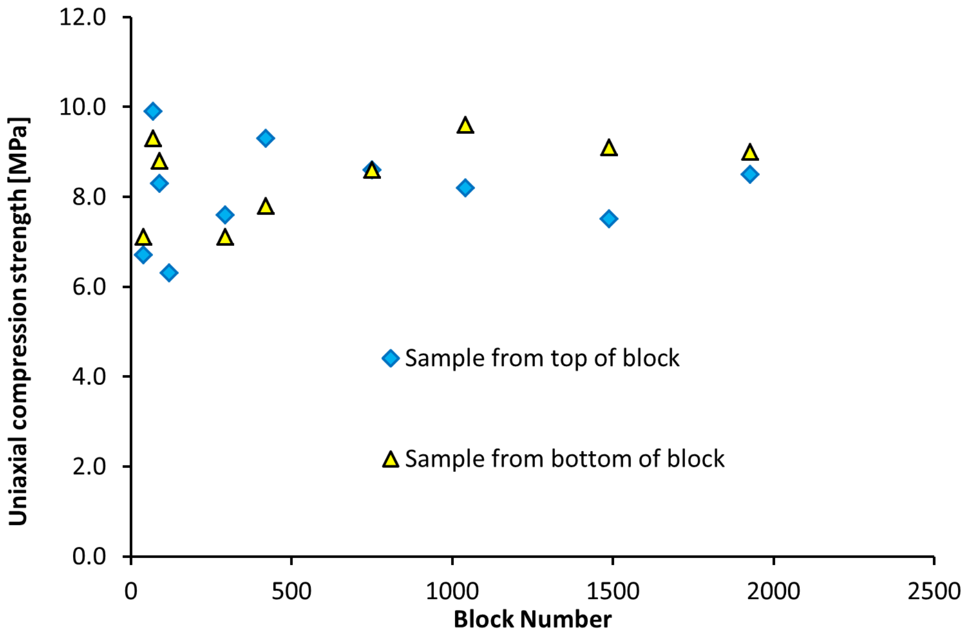


Fig. 41: Uniaxial compression strength measured on each 250th block.

The influence of the small geometric variations of the blocks on a block pedestal was assessed by building one (Fig. 42) and checking visually the height difference on top of the pedestal (Fig. 43).

Fig. 42: Small pedestal built to estimate the influence of the dimension differences of the blocks.

Fig. 43: Height difference observed on top of the pedestal illustrated in Fig. 42.

QC of the top layer bentonite blocks

The same procedure was applied as for the ordinary blocks. The repeatability of the pressing process is illustrated in Fig. 44: three top layer blocks are compared visually showing the very similar dimensions of the three blocks.

Fig. 44: Top layer blocks.

The shape of the top layer blocks was slightly changed compared to the contractual requirements (see

Fig. 45): the top corner was rounded to easy the expulsion of the blocks out of the mould after compaction and to prevent breaking the corner. The dimensions and shape of the produced top layer blocks are given in

Fig. 45.

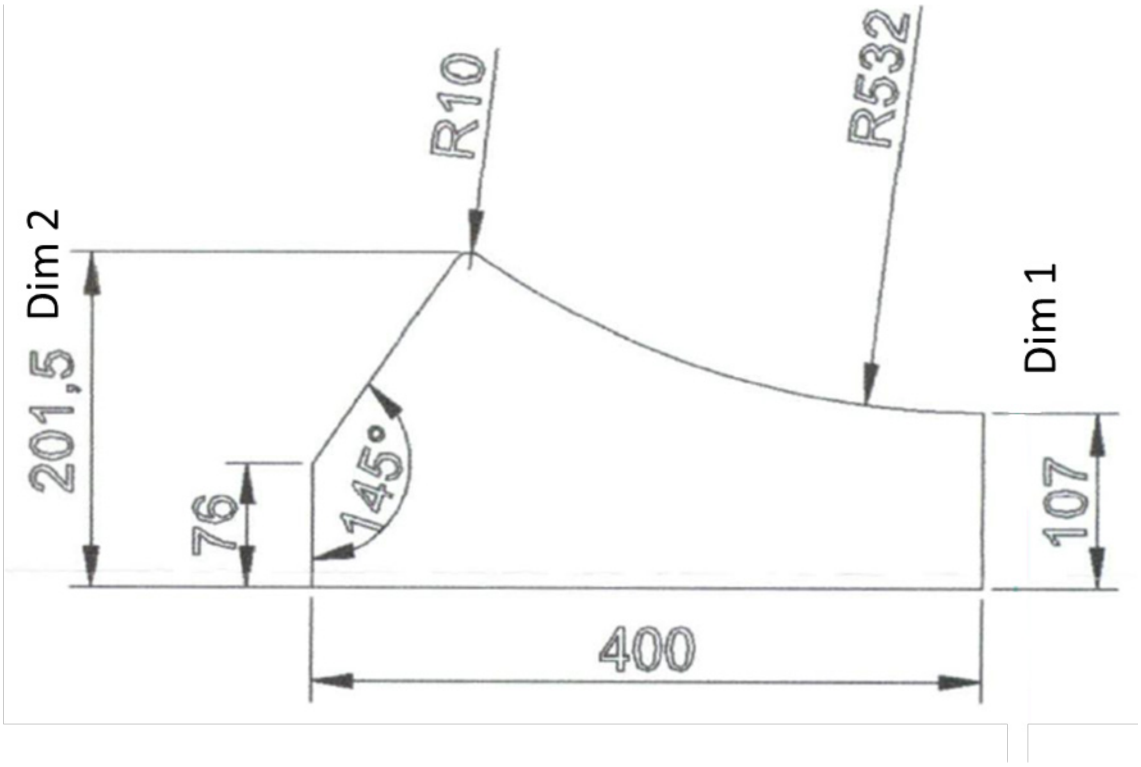


Fig. 45: Dimensions of the compaction plane of the top layer blocks.

The length (400 mm), dim1 and dim 2 as indicated in

Fig. 45, the compaction height and the weight were measured systematically. Those measurements are summarized in Tab. 4. As for the ordinary blocks, the top layer blocks underwent elastic expansion induced by de-moulding. The average length, dim1 and dim2 are slightly higher than the required one (see

Fig. 45). The linear expansion of the length, dim1 and dim2 are 0.3 %, 0.4 % and 0.5 %, respectively.

Tab. 4: Average, standard deviation and minimum and maximum of all measured values for all blocks (including rejected ones).

	Compaction pressure [MPa]	**Weight** [g]	**Length** [mm]	**Dim 1** [mm]	**Dim 2** [mm]	**Height** [mm]	**Density** [g/cm^3]	**Measured water content** [%]
Average	131.1	11'702	401.2	107.5	202.5	99.2	2.100	18.13
Std dev.	0.7	66	0.3	0.3	0.2	0.4	0.009	0.61
Min	130.3	11'500	400.0	106.4	202.0	98.0	2.074	17.68
Max	133.2	11'880	402.0	107.9	203.4	100.4	2.126	19.28

As a consequence, Nagra accepted to update the contractual dimension requirements. The average dimensions and density of the first 100 blocks were taken as the new requirement, applying a tolerance of 0.85 mm or 0.02 g/cm^3, to this average. Blocks that did not satisfy the requirements (red lines in the presented graphs or fractures) were rejected.

We first present the water content of the raw material (Fig. 46), the weight of each block (Fig. 47) and the applied compaction pressure for each block (Fig. 48). The characteristics of the raw material, the amount of raw material in the mould and the applied compaction pressure are the control variables of the block pressing process. The block dimensions and the block density are dependent on those characteristics, on the oedometric conditions (null lateral strain) applied by the mould and on the compaction cycle.

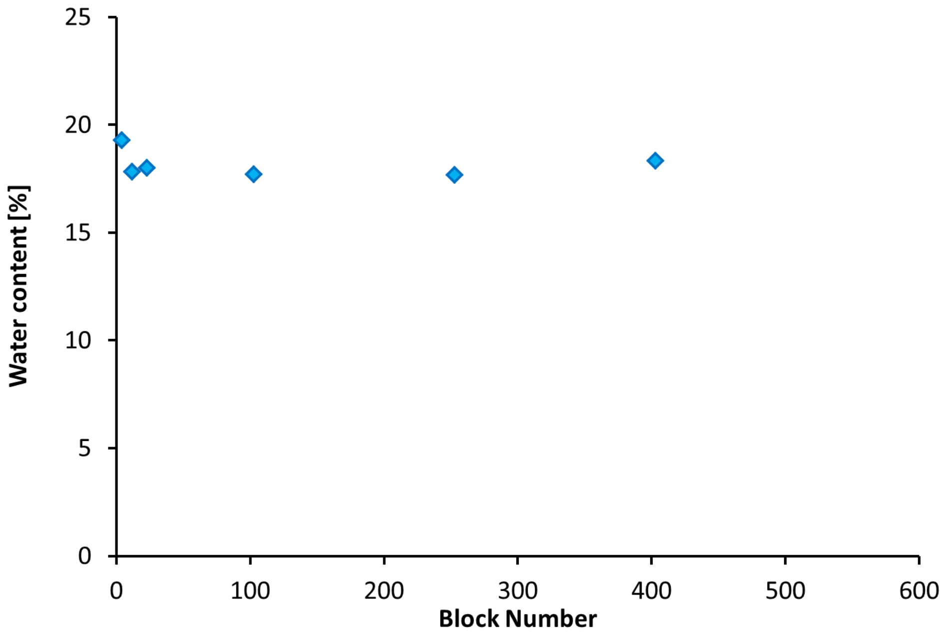


Fig. 46: Water content measured on each 250th block.

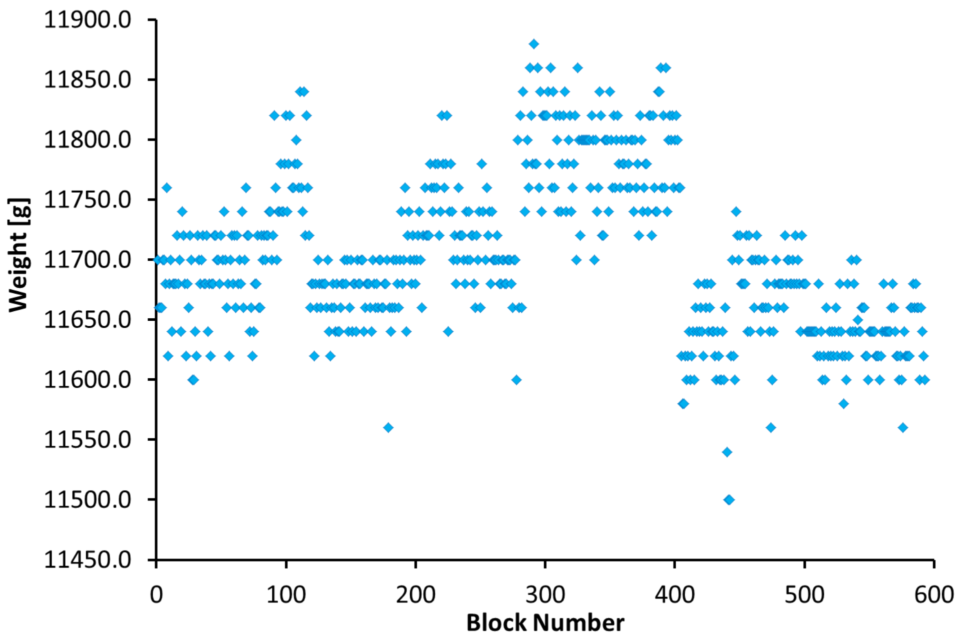


Fig. 47: Weight of the blocks measured for each block.

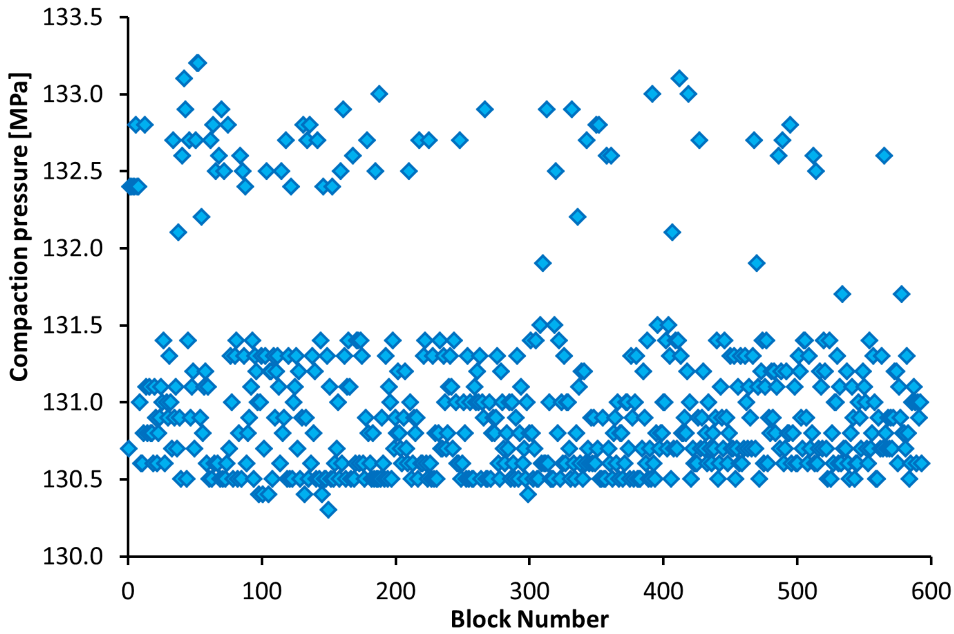


Fig. 48: Compaction pressure used for each block.

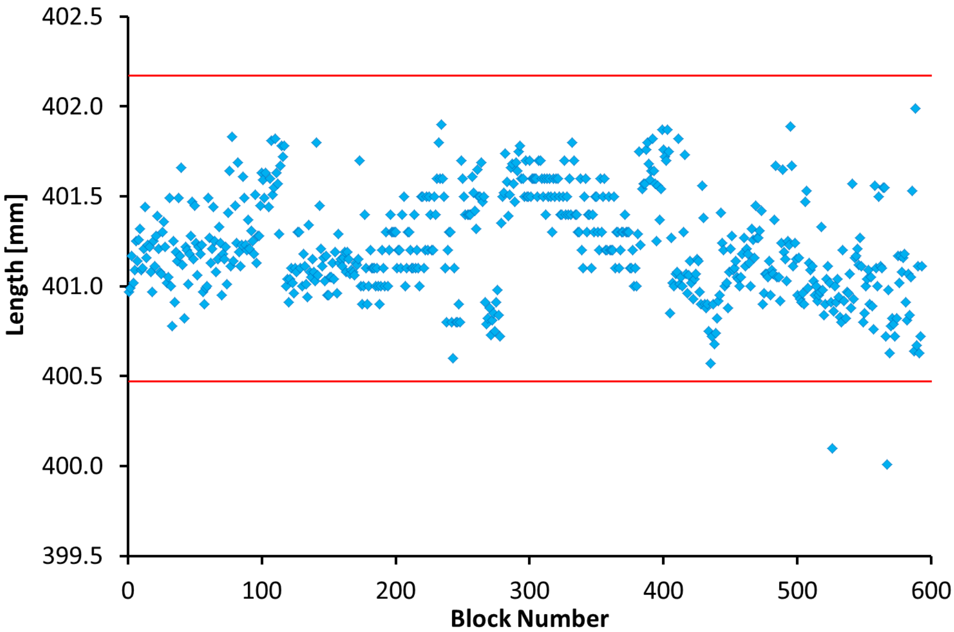


Fig. 49: Length of the blocks measured for each block.

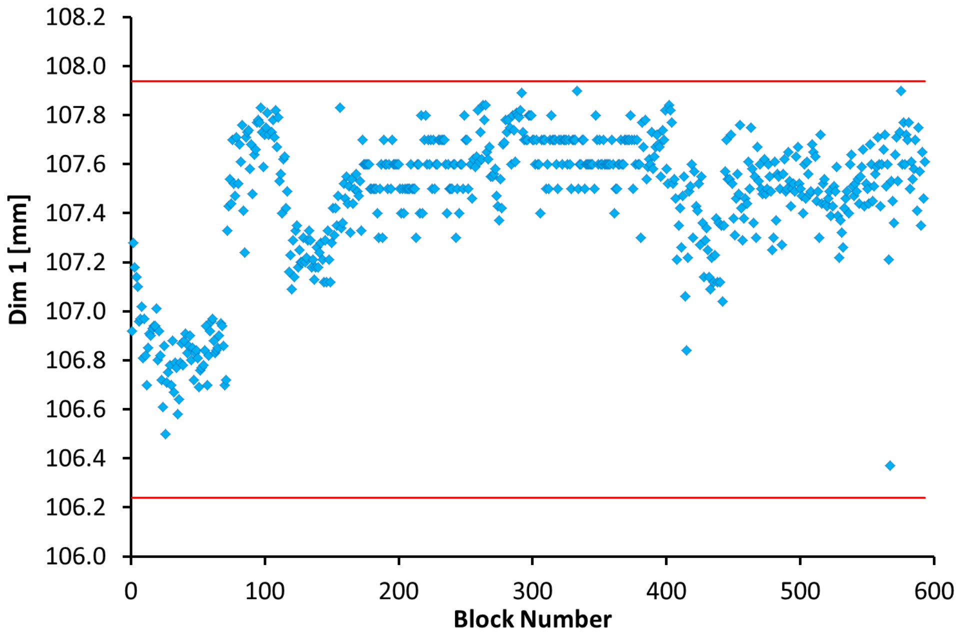


Fig. 50: Dim 1 of the blocks measured for each block.

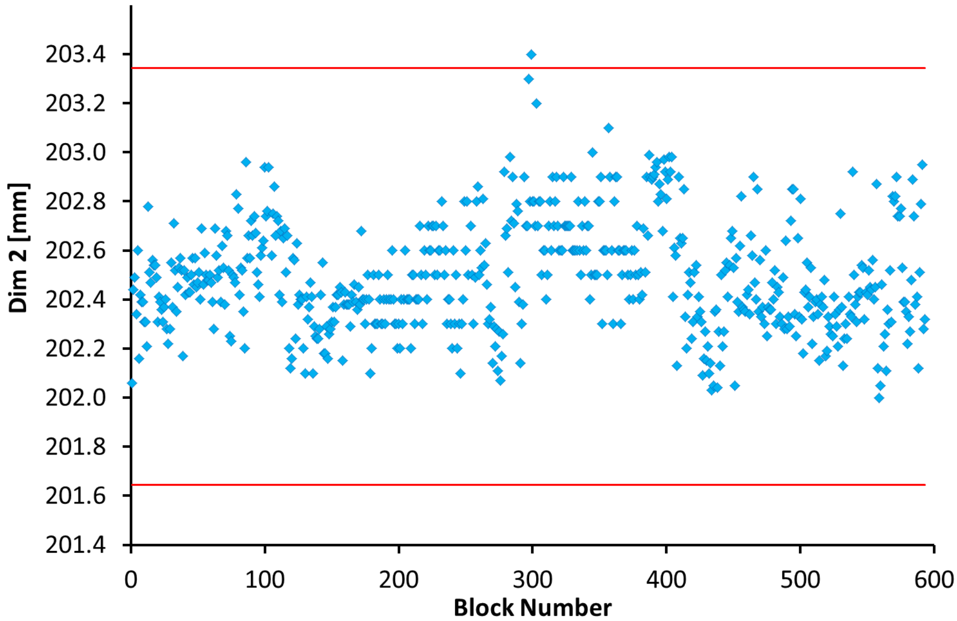


Fig. 51: Dim 2 of the blocks measured for each block.

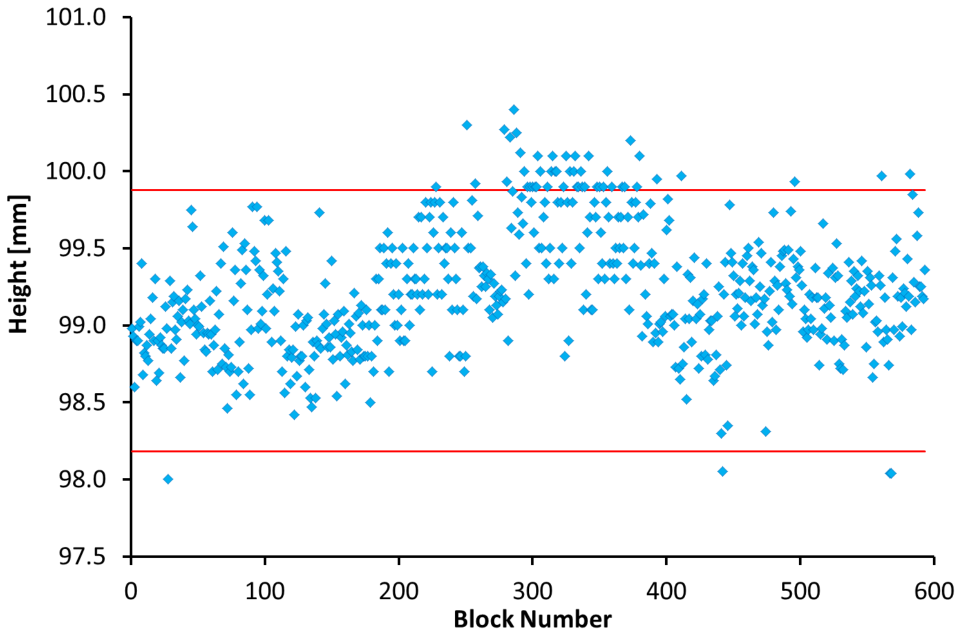


Fig. 52: Height of the blocks measured for each block.

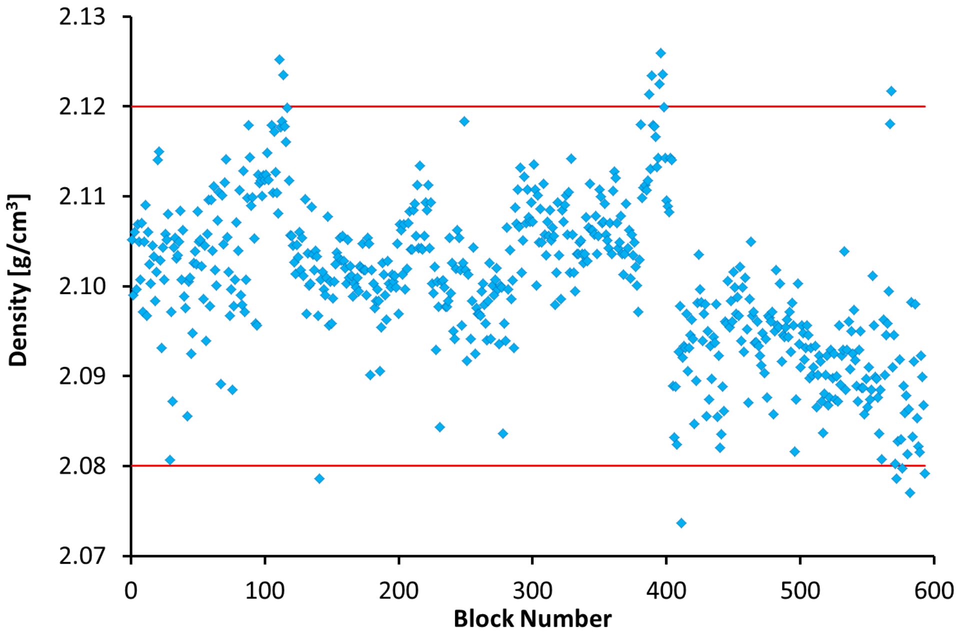


Fig. 53: Density of the blocks measured for each block.

The uniaxial compression strength was measured on rectangular samples of 15 cm x 15 cm x 7 cm cut in a block. The results are given in Fig. 54. The broken pieces were used to measure the water content. The results are given in Fig. 46.

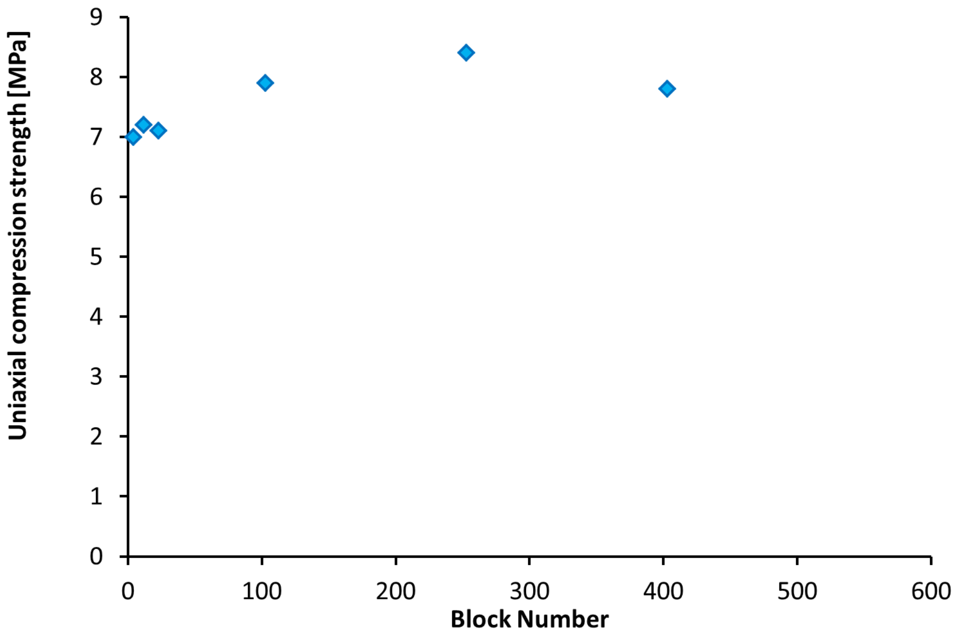


Fig. 54: Uniaxial compression strength measured on each 250th block.

Interpretation of some measurements

The measured water content before and after pressing is depicted in Fig. 55. Pressing has seemingly no influence on the water content.

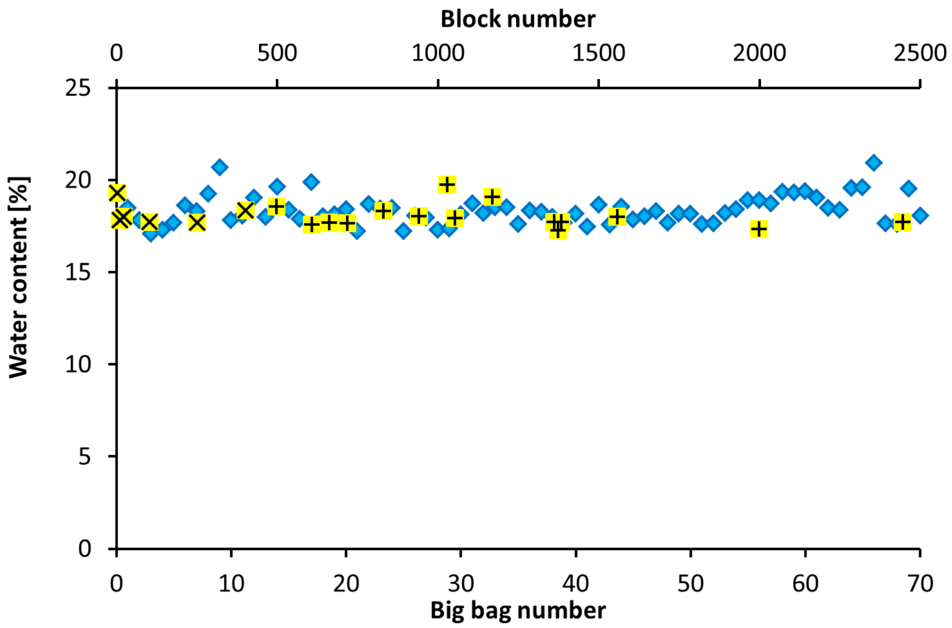


Fig. 55: Water content measurement on raw material (before pressing, blue dots) and on block samples (after pressing, yellow dots).

The degree of saturation of the compacted bentonite in the mould and after expulsion is presented in Fig. 56. The value after expulsion was calculated using the dimensions measured for each block (Fig. 33, Fig. 34 and Fig. 35). The degree of saturation of the bentonite in the mould was calculated using the width and the length of the mould. The height in the mould was estimated from the value measured after expulsion (Fig. 35), multiplying it by 1-α, where α is the linear elastic expansion in the direction of compaction (height). It can be estimated from the stiffness anisotropy ratio which was found equal to 3.1 (laboratory tests on pre-produced blocks, see section 2.2) and the linear elastic expansion in the width and length (0.3 %), resulting in a linear elastic expansion in this direction of about 0.93 %.

The average of the degree of saturation in the mould is 97 % indicating that under compaction, the bentonite is fully saturated. The elastic expansion induced by de-moulding decrease the degree of saturation to an average of 91 %. Producing fully saturated blocks after unmoulding is thus probably not feasible. This suggests that manufacturing blocks with an equilibrium RH higher than 70 % might be impossible.

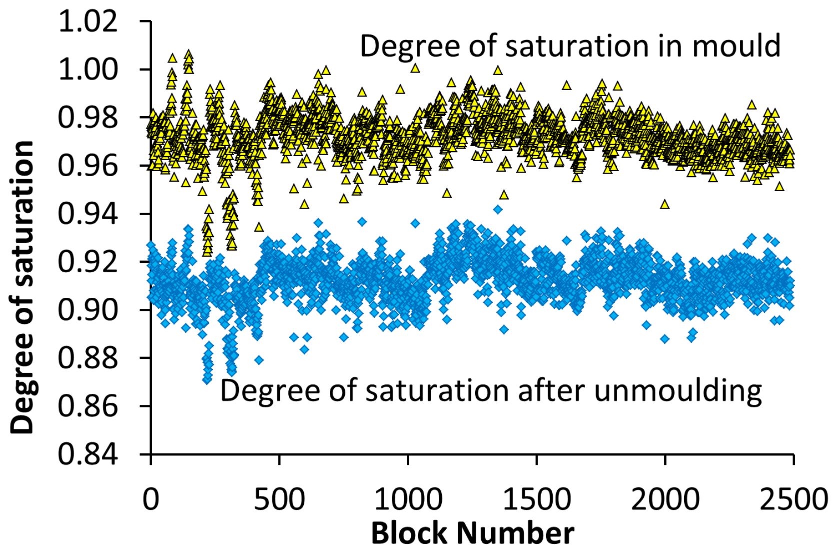


Fig. 56: Degree of saturation assuming the average water content value (=18.34 %) for all blocks in the mould under compaction (yellow dots) and after expulsion (blue dots).

The covariance and correlation coefficient matrix for the QC variables is given in

Tab. 5. The associated scatter plots are given in Tab. 6 for the sake of completeness. The covariance contains information about:

- The existence of a linear relationship between two variables. Values close to 0 indicate that there is no linear trend detected.
- The direction of such a trend (e.g. positive linear relationship if covariance positive)

No more information can be obtained from the covariance. The correlation coefficient varies between -1 and 1. Its magnitude gives information about the strength of the linear relationship.

Tab. 5: Covariance matrix (top triangle) and correlation coefficient (bottom triangle) matrix of the QC variables of the ordinary blocks.

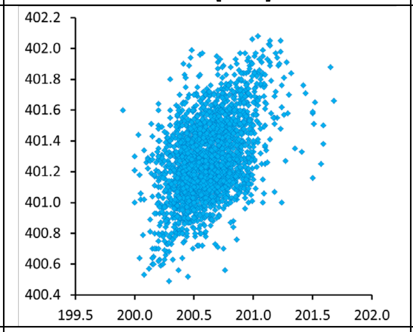
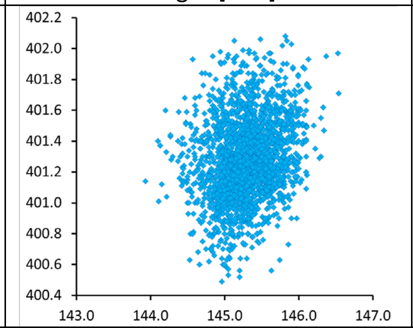
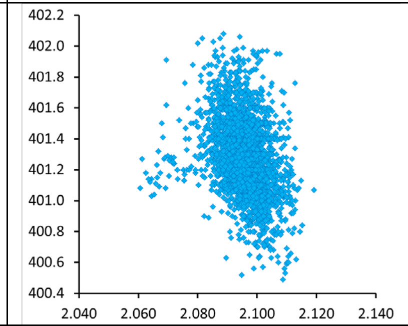
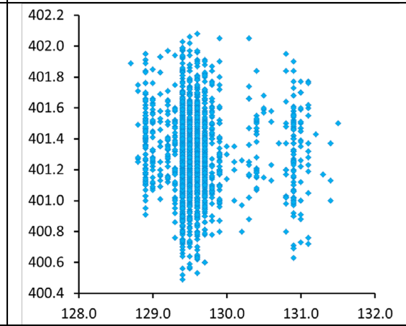
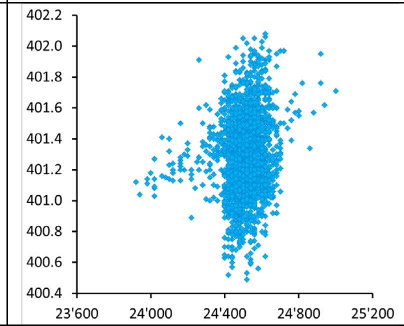
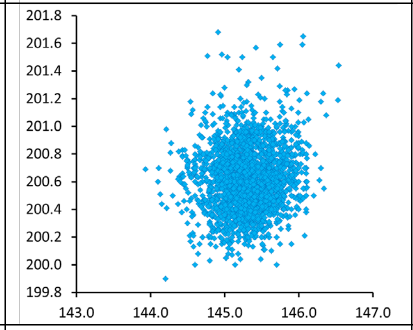
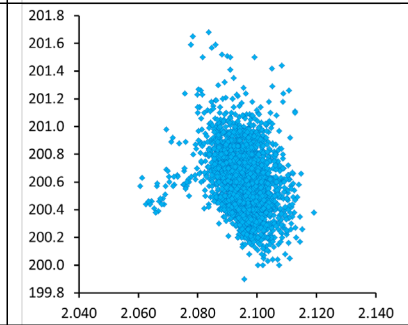
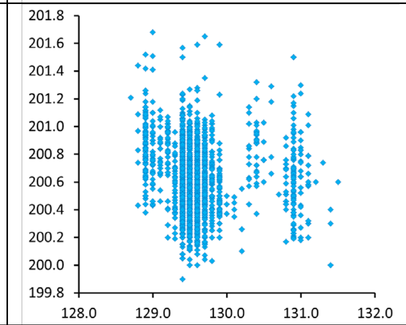
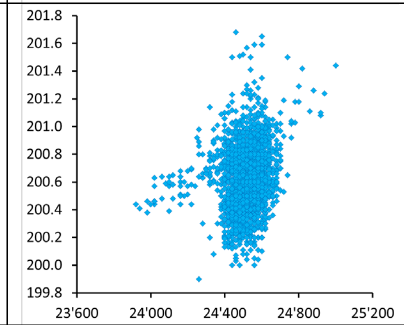
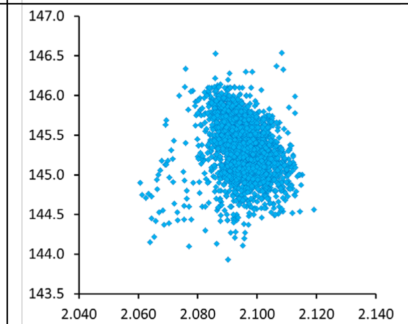
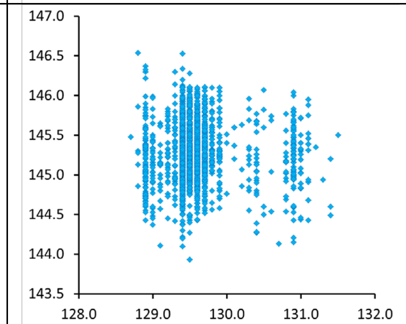
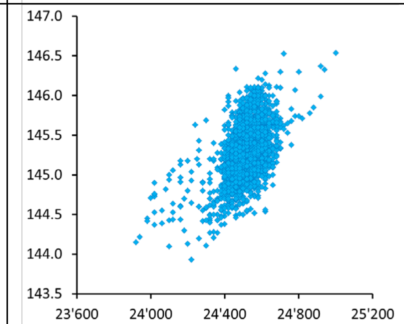
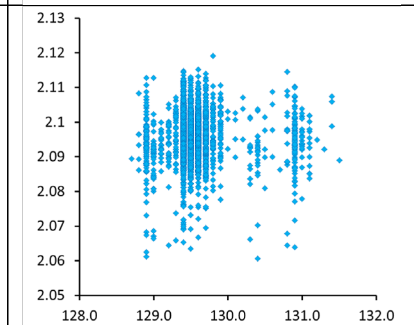
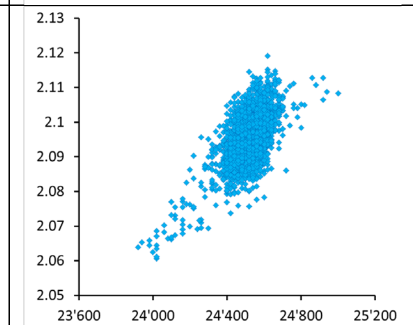
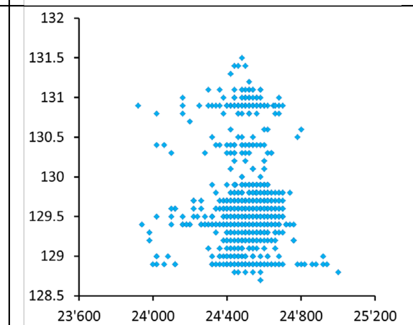
The variance (square of the standard deviation) is given in the diagonal for each variable.

	Length [mm]	**Width** [mm]	**Height** [mm]	**Density** [kg/m^3]	**Compaction pressure** [MPa]	**Weight** [g]
Length [mm]	**0.06**	0.03	0.02	-0.0006	0.00	3.85
Width [mm]	*0.44*	**0.05**	0.01	-0.0005	-0.01	3.75
Height [mm]	*0.24*	*0.09*	**0.12**	-0.0005	-0.01	17.13
Density [kg/m^3]	*-0.32*	*-0.29*	*-0.19*	**0.0001**	0.000005	0.43
Compaction pressure [MPa]	*-0.02*	*-0.07*	*-0.04*	*0.00*		-1.68
Weight [g]	*0.17*	*0.17*	*0.53*	*0.64*	*-0.05*	**8606.97**

The covariance and correlation coefficient of the control variables vs. the other variables indicate that in the weight and compaction pressure range used in this production, the weight has more influence than the compaction pressure. The height and density of the blocks are in particular sensitive to weight variations.

The correlation coefficient between length and width is also relatively high, which highlights the similar elastic expansion in the two directions.

Tab. 6: Scatter plots of the QC variables arranged in a covariance matrix.

	Width [mm]	Height [mm]	Density [kg/m³]	Compaction pressure [MPa]	Weight [g]	
Length [mm]						Length [mm]
Width [mm]						Width [mm]
Height [mm]						Height [mm]
Density [kg/m³]						Density [kg/m³]
Compaction pressure [MPa]						Compaction pressure [MPa]
	Width [mm]	Height [mm]	Density [kg/m³]	Compaction pressure [MPa]	Weight [g]	

Rejected blocks

Some blocks did not satisfy the prescribed criteria and were rejected (Fig. 57, only 20 blocks out of 3000).

Fig. 57: Rejected blocks.

Note that a majority of blocks showed small edge fractures. Blocks with very small such fractures were accepted (Fig. 58), but in some cases, the block had to be rejected (Fig. 59).

(a)

(b)

Fig. 58: Very small edge fracture: (a) at the scale of the block and (b) zoom on the fractured edge of block A1780.

Fig. 59: Extreme case of an edge fracture (in this case, the block was rejected).

Some of the blocks presenting such an edge fracture were cut perpendicularly to the fracture to ensure that the fracture was not propagating far into the block (Fig. 60).

Fig. 60: Edge fracture inside a block.

Packaging

As compacted bentonite blocks are very sensitive to changes of water content and that they could exchange water with ambient air, special care was taken to make the packaging as watertight as possible. The mechanical stability of the pallets was also enhanced by different methods. The different packing steps are given in this section in the form of a photo reportage.

Fig. 61: The pallet is covered with plastic.

Fig. 62: A 2 cm thick polystyrene sheet is put on the plastic and the blocks are centred to ensure mechanical stability.

Fig. 63: Blocks are put in layers of 8 and each layer is separated by a polystyrene sheet.

Fig. 64: Ordinary blocks are palletized in 5 layers of 8 blocks.

Fig. 65: Top layer blocks are palletized in 7 layers of 12 blocks.

Fig. 66: Mechanical stability is improved by 4 vertical angles and 2 horizontal strips.

Fig. 67: The plastic from the bottom pulled to cover the top and closed by heating.

(a)

(b)

Fig. 68: 4 horizontal angles and 4 vertical strips are added.

Fig. 69: Another plastic cover is put and closed by heating. The pallet is labelled and cleared for shipment.

Fig. 70: Pallets waiting for shipment.

Fig. 71: 5 pallets were equipped with wireless relative humidity and temperature sensors.

Quality of the packaging

5 pallets were equipped with wireless relative humidity and temperature sensors. Those sensors arrived in Saint-Etienne on 07.03.14 and were emplaced in the pallets on 11.03.14. The first 5 days of reading, representative of the ambient RH during the production, are depicted in Fig. 72. During the first 3.5 days the sensors were exposed to ambient conditions in the production plant. By coincidence the weather conditions in Saint Etienne during production were optimal: RH was varying between 40 % and 70 %. According to the tests made on the pre-produced blocks, such an ambient RH means that the blocks might lose a little bit of water to the atmosphere, not endangering their mechanical stability.

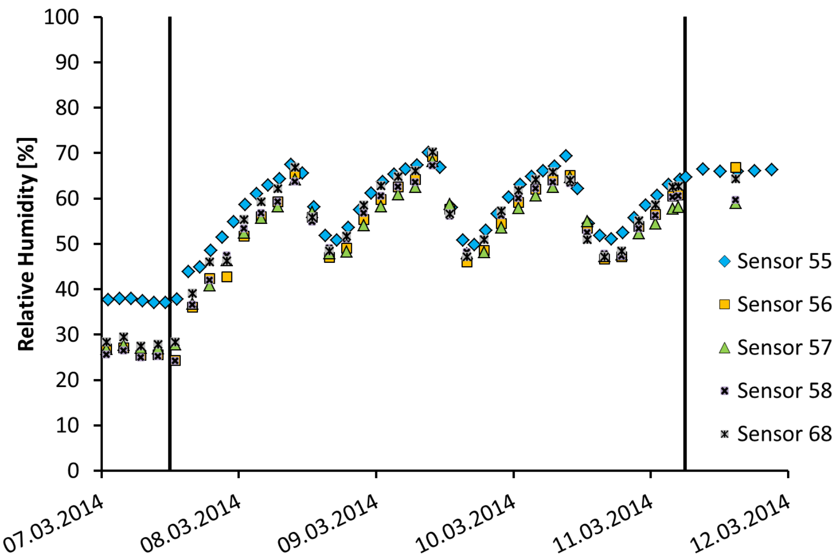


Fig. 72: Readings of Wifi relative humidity sensors.

The sensors arrived in Saint-Etienne on 07.03.14 (first vertical line) and were installed in the pallets on 11.03.14 (second vertical line).

Once installed in the pallet, they stabilize to an RH value close to 70 % (see Fig. 73) as expected from the previous laboratory testing (section 2.2). The relative humidity evolution in the pallets during the storage in Saint-Etienne and transport to Mont Terri was more or less constant (Fig. 73) although (Fig. 74) they show a slight increase towards 70 % and they respond to the daily relative humidity variation in an attenuated manner.

Sensor 60 was in Nagra (Wettingen) until its installation in Mont Terri at the same time as the pallets arrived.

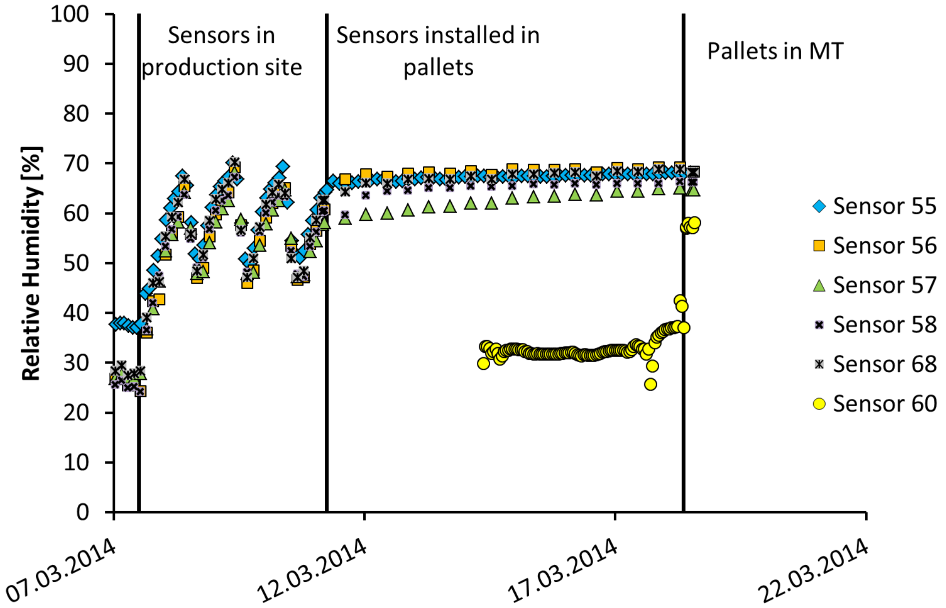


Fig. 73: Readings of Wifi relative humidity sensors.

The sensors arrived in Saint-Etienne on 07.03.14 (first vertical line), were installed in the pallets on 11.03.14 (second vertical line) and arrived in Mont Terri on on 18.03.14 (third vertical line).

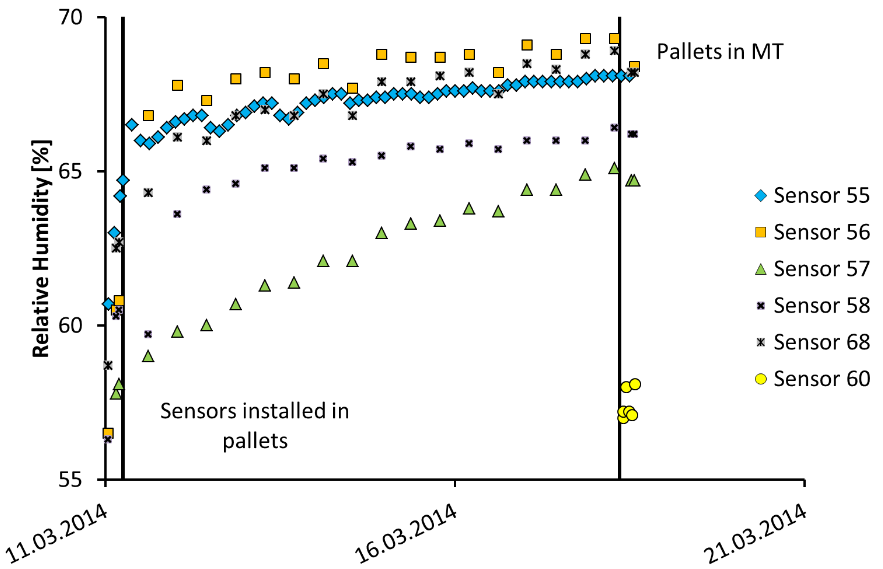


Fig. 74: Readings of Wifi relative humidity sensors. Zoom on the storage time in Saint-Etienne, transport and arrival in Mont Terri.

Between end of March 2014 until the emplacement in the FE tunnel (September 2014 until January 2015), the bentonite block pallets remained in Mont Terri where the RH varied between 60% and 85% (see Fig. 75). The RH inside the pallets was frequently checked. It was found to increase a little bit over the summer, but when the pallets were unpacked for the first emplacement works, the blocks were in a perfect state. Several blocks were weighted after unpacking. Comparison of block weight after production and before emplacement (Fig. 76) shows very small differences.

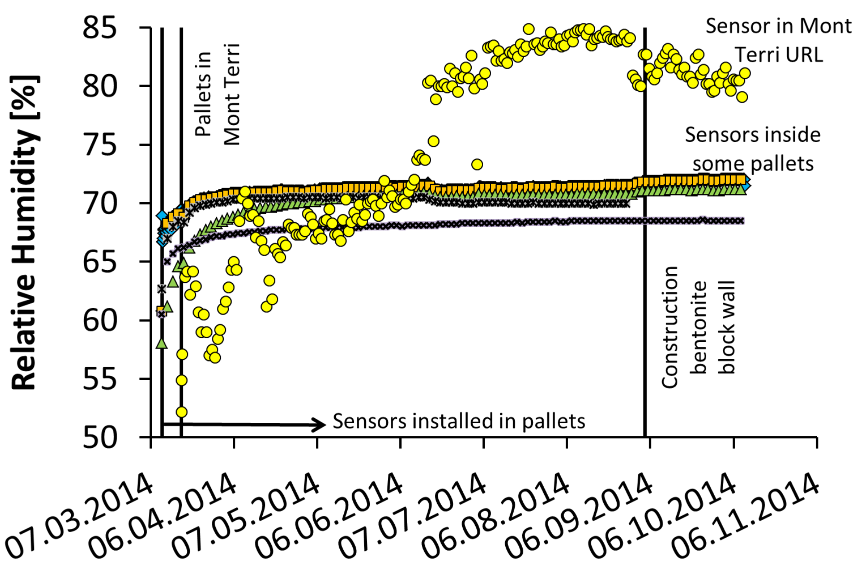


Fig. 75: Readings of Wifi relative humidity sensors between arrival in MT and first emplacement works.

2.5 Emplacement of the bentonite blocks in the FE tunnel

Some of the blocks emplaced in the FE tunnel were weighted before emplacement. Comparison of their weigh to that measured just after production shows that the bentonite blocks were unaffected by the relatively long storage time (Fig. 76).

The construction of the bentonite block wall (Fig. 77, left) took place in early September 2014, when the RH in Mont Terri was still relatively high (see Fig. 75). Even under these harsh RH conditions, the blocks survived the 2 weeks of emplacement without any degradation. Each of the three bentonite block pedestals for the heaters survived not only the ambiental load but also the 5 tons of the heater (Fig. 77, right).

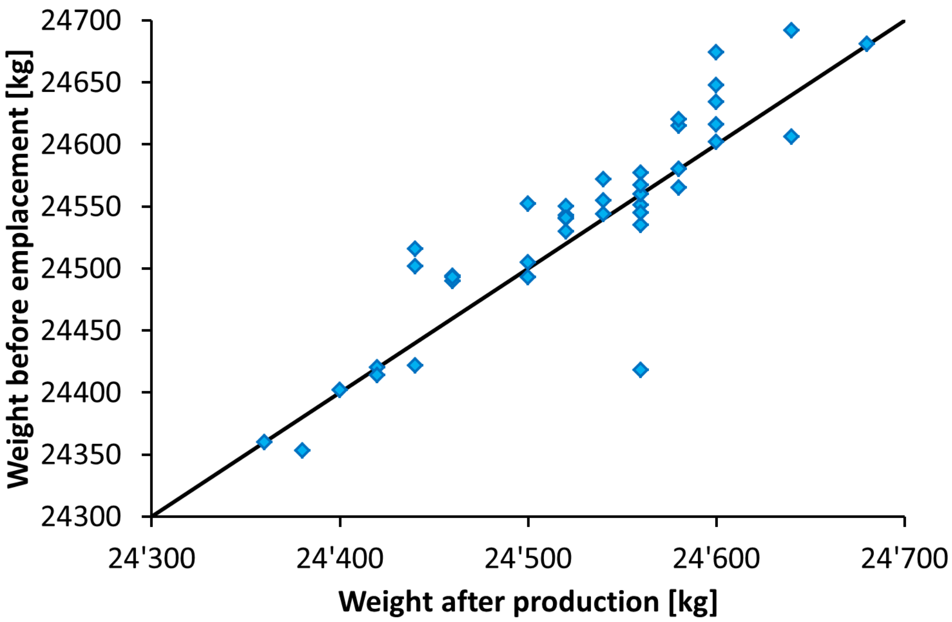


Fig. 76: Comparison of block weight after production and just before emplacement. The black line represents 1:1 correlation.

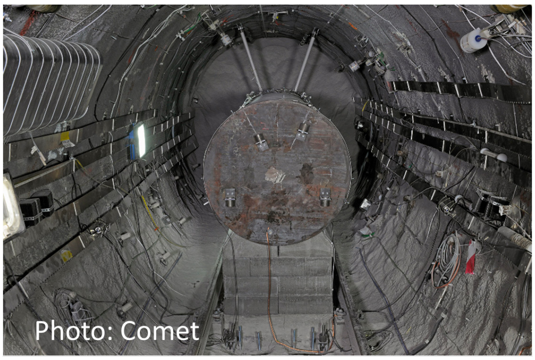


Fig. 77: Emplaced bentonite blocks in the FE tunnel: bentonite block wall in the interjacent sealing section and bentonite block pedestal sustaining a heater.

2.6 Lessons learnt and open questions

From the state of the art, it was clear that the target dry density (1.45 g/cm^3) can be easily achieved for compacted bentonite blocks. For the FE bentonite block production, **an average block dry density of 1.78 g/cm^3** was achieved. All other requirements described in section 2.3 were also fulfilled. The associated strength of the blocks satisfies the strength structural requirements for the pedestals and the bentonite block wall. The achieved dry density is a result of the adjustment of the water content of the raw material and of the compaction pressure to produce bentonite blocks as stable as possible against changing climatic conditions. Higher dry density is possible but with a loss of resistance against climatic condition as a consequence. Lower dry density is probably feasible (increasing the water content), but this was not tested. The achieved block dry density value is relatively low when compared to other block productions, but this is believed to be positive as the value is coming closer to the emplacement dry density of GBM.

Compacted bentonite blocks can disintegrate in contact with ambient air condition. **A novel simple concept was introduced to estimate the resistance of compacted bentonite against changing climatic conditions.** The sensitivity of compacted bentonite blocks to ambient relative humidity was thoroughly and systematically investigated in the framework of the FE experiment to optimize the manufacturing parameters (compaction pressure and water content of the raw material) and to avoid damages to the blocks as experienced in other previous in-situ experiments. Because the damage was mainly due to water absorption of relatively dry compacted bentonite from relatively humid environment, **the concept of equilibrium relative humidity characteristic for each compacted bentonite** was introduced. The equilibrium relative humidity is easy to measure and once known, it allows determining whether or not the compacted bentonite will disintegrate in ambient conditions according to the following simple rule: a bentonite block is stable as long as ambient air relative humidity does not exceed its equilibrium relative humidity by more than 5 % to 10 %. This concept proved to be successful as not bentonite block was affected during the emplacement operations.

Having the equilibrium RH concept in mind and taking high care of the **packaging**, the experience acquired in the FE experiment shows that it is possible to store compacted bentonite blocks for a full year (or more) without affecting them. Nevertheless, it was suggested that it might be impossible to produce blocks with an equilibrium RH higher than 70 %. In case the ambient RH in the repository site is higher than 80 %, this might result in practical problems during the emplacement activities.

The upper limit for the equilibrium RH is a consequence of the elastic rebound taking place during block unmoulding. **Linear rebound coefficient** was estimated between 0.3 % and 0.5 %. This coefficient is important to design the mould dimensions.

The production rate was approximately **60 blocks per hour**.

Homogeneous increase of the water content of the raw bentonite is a difficult but feasible process and was successfully achieved.

Several types of raw bentonites were tested in pre-productions. High quality compaction was only achieved for natural sodium bentonite while the pre-productions with **calcium bentonite failed**, inconsistently with productions performed elsewhere. No explanation was found for this.

The **grain size distribution** of the raw bentonite (and the influence of the wetting process on the grain size distribution) probably affects the compaction results. This was not investigated in details.

Uniaxial compression strength of compacted bentonite blocks is significantly lower in the compaction plane than in the direction perpendicular to it. In the FE experiment, curved top layer blocks are loaded in the compaction plane direction by the heaters.

Production variables were measured for each block (3000 blocks produced in total). Only 20 blocks out of 3000 had to be rejected and no significant outlier was detected; showing that **compaction of bentonite block at the industrial scale is a very stable process**.

It should be noted that producing bentonite blocks close to saturation might affect their swelling potential. This should be investigated in details in the future.

3 Production of Granulated Bentonite Mixture (GBM)

The aim of the production process is to increase the bulk dry density of the raw bentonite material (Fig. 79 left), which approx. equals 0.9 g/cm^3, to an emplacement dry density fitting the requirements specific to each repository site. The mixture density after production is difficult to measure, because it obviously depends on the measurement method. The lower threshold for the target emplacement dry density in the FE experiment was defined as 1.45 g/cm^3 on the basis of the correlations observed between this variable and key parameters as the hydraulic conductivity, the swelling pressure and the thermal conductivity and because 1.45 g/cm^3 was found to be a threshold for microbiological activity (Stroes-Gascoyne 2011).

The design of the manufacturing criteria for the FE experiment aimed at maximizing the dry density. Nevertheless, in the future a robust production scheme should be set-up to control the emplacement dry density (increase it, but also lower it as a function of the site specific conditions).

3.1 State of the art

Blümling & Adams (2008) presented a summary of the work achieved on the use of bentonite pellets as backfilling material in the framework of the borehole sealing project. The authors showed in a very systematic way that the emplaced dry density is dependent on:

- The dry density of individual pellets
- The grain size distribution of the different pellets
- The particle shape of the pellets
- The emplacement method

and successfully emplaced pellet mixtures in 100-1000m long horizontal tubes at dry densities higher than 1.45 g/cm^3. Building further on this experience, Plötze & Weber (2007) showed the feasibility of reaching the target dry density in larger diameter (2 m) circular openings in the framework of the ESDRED project and Teodori et al. (2011), using the same material as Plötze & Weber (2007), back-filled a 1.3 m diameter tunnel at Mont Terri URL in the framework of the HE-E experiment reaching emplacement dry densities higher than 1.4 g/cm^3. Kennedy et al. (2003) achieved the emplacement of a bentonite pellet mixture at a dry density of 1.36g/cm^3 in the framework of the EB experiment. To our knowledge, the production of GBM in the EB, followed up by the ESDRED experiment, was the first industrial intent to increase the emplacement dry density of GBM. Additionally to the criteria defined by Blümling & Adams (2008), the produced bentonite pellets should be stable and strong enough to survive the treatment they will be submitted to during emplacement although, in some cases, shape changes of the pellets associated with emplacement proved useful in terms of emplaced dry density (Plötze & Weber 2007).

The adopted strategy for the EB experiment was described in Hoffmann et al. 2007. The production of a bentonite pellet mixture includes several processing steps illustrated in Fig. 78. The raw material is generally provided at a water content of about 10 – 15 %. It might be dried by heating to obtain a lower water content in the range of 3 – 6 %, generally associated with higher pellet dry density. In this particular case, the pellets were produced by compaction between flat rollers (resulting in flat pellets of irregular shape) but different methods exist (see Pietsch 2005), e.g. extrusion (resulting in cylindrical rods), revolving extrusion machinery or compaction between moulded rollers (resulting in spherical pellets). The aim during the pelletizing process is to increase the pellet dry density, i.e. reducing the intra-pellet porosity. The high density pellets are then crushed and classified by size to be mixed. The aim of the mixing procedure is to reduce the inter-pellet porosity (or increase the bulk dry density of the mixture).

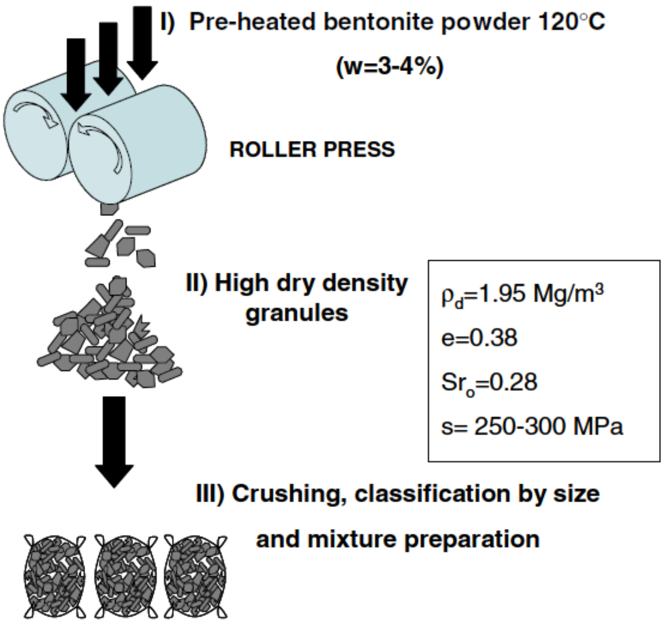


Fig. 78: Illustration of the main steps to produce a bentonite pellet mixture (Hoffmann et al. 2007).

Note that the metrics given in the figure are specific to the bentonite pellet mixture manufactured for the EB.

The process described by Hoffmann et al. (2007) is illustrated in Fig. 79, where the raw material (left) has been transformed in pellets of different sizes that were mixed in different proportions in the framework of the ESDRED experiment.

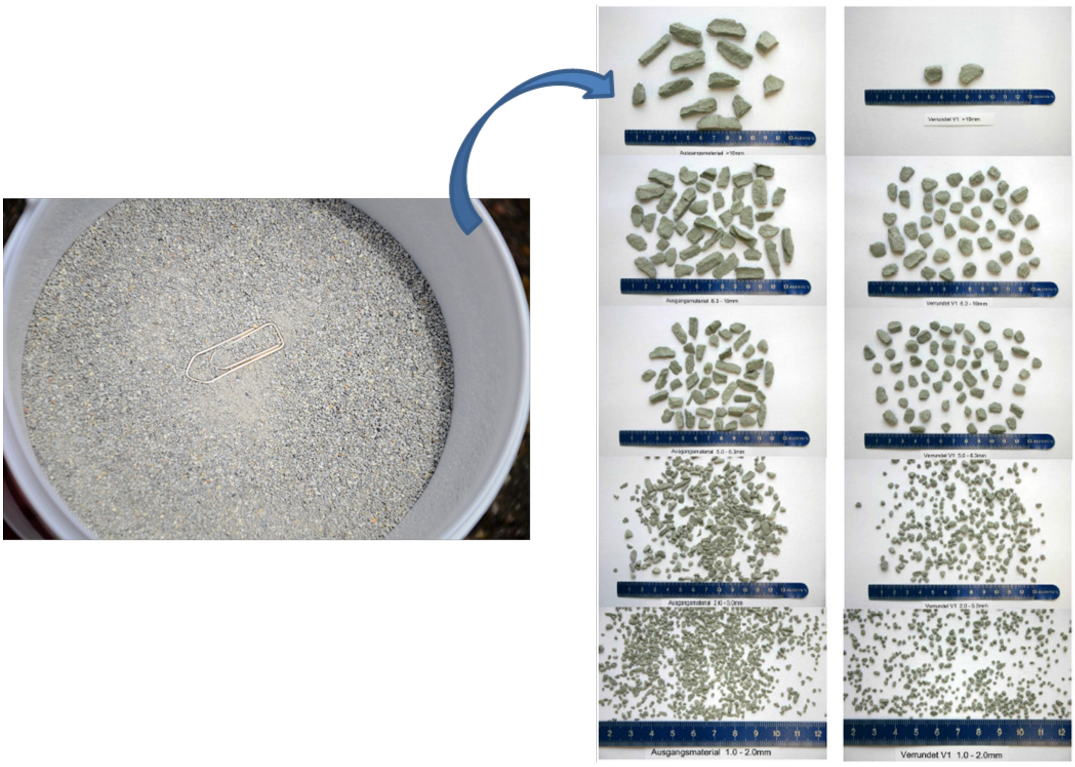


Fig. 79: Raw MX80 bentonite material (left) that has to be transformed in high density pellets (right – produced in the framework of the ESDRED experiment).

To obtain a bentonite mixture with the highest possible dry density on must thus aim at mixing high dry density pellets with the lowest possible porosity between the pellets, considering that those two parameters control the final mixture dry density as:

$$\boldsymbol{\rho_{mixture}} = \left(\mathbf{1} - \boldsymbol{\varphi_{inter-pel}}\right)\boldsymbol{\rho_{dry\,pel}} \tag{1}$$

where $\varphi_{inter\text{-}pel}$ is the porosity between the pellets and $\rho_{dry\ pel}$ is the pellet dry density. Equation 1 is illustrated in Fig. 2 where the target emplacement dry density and target production dry density are indicated.

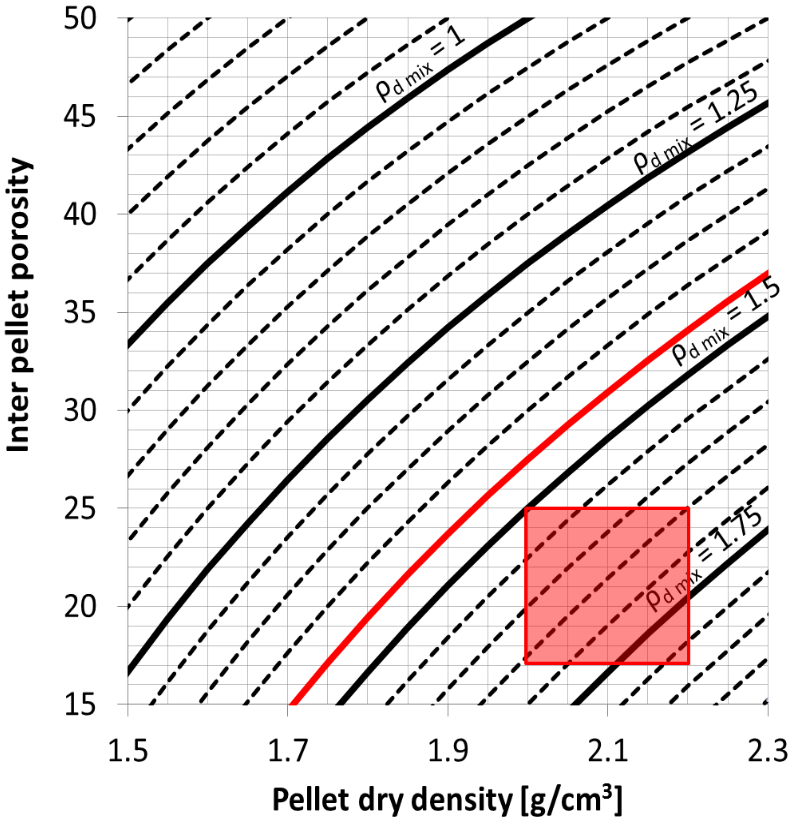


Fig. 80: Theoretical dependency of mixture dry density on pellet dry density and inter pellet porosity.

Target emplacement dry density for FE is indicated by red isoline and target production mixture dry density is indicated by red rectangle.

In the following two sections we present a review of the state of the art on the dry density of pellets and on the porosity between pellets

Dry density of individual pellets

Pellets are manufactured by compaction of raw bentonite material which is the process by which the bulk density of an aggregate of matter is increased by driving out air. For a given amount of compaction energy, the dry density obtained depends on the grain size distribution and the water content of the raw material.

Grain size distribution of the raw material

The grain size distribution of the raw material was found to be a key parameter for the quality (in terms of density, strength and stability) of the pellets (Kennedy et al. 2003 and discussions with different pellet manufacturers). A uniform distribution with grain sizes ranging between very fine and 1 mm is required for the raw material. The presence of fines was found to be fundamental. Note that a wrong grain size distribution would require grinding the raw material before pelletisation, which would be expensive and time-consuming. Grinding had to be applied to the raw material for the EB experiment (Kennedy et al. 2003). The grain size distribution of a raw material that could be used for the production of high quality, stable pellets is illustrated in Fig. 81.

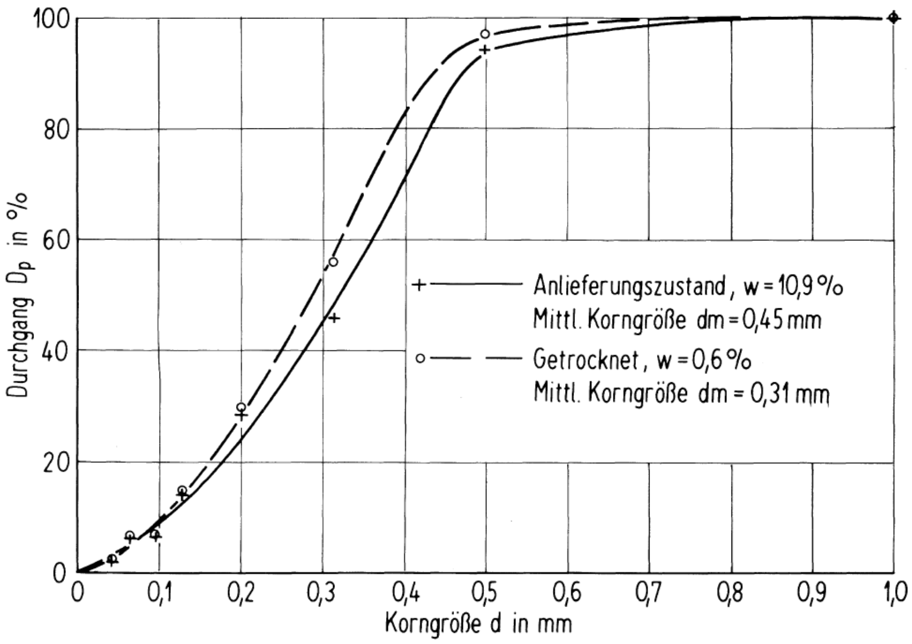


Fig. 81: Grain size distribution of the raw material used by Naundorf & Wollenberg (1992) to produce pellets.

Water content of the raw material

In porous media, the relationship between water content of the material during compaction and the resulting dry density is well-known for a certain compaction energy (Proctor 1933). At relatively high water content, the compaction energy is sufficient to expulse all air and the soil is compacted to full saturation, whereby the highest possible density associated with the water content is reached. At relatively low water content water act as a lubricator and decreasing its content results in lowering the final dry density. Curves expressing the dry density dependency on water content for a given compaction energy are called Proctor curves after the pioneering work of Proctor in the early 1930. Typical ideal Proctor curves are illustrated for sand and clay for two different levels of compaction energy in Fig. 82. The proctor curves indicate an increase of the optimal dry density with increasing compaction energy. For the clay, considering compaction energy level ASTM D1557, the maximum dry density is reached at a water content of about 14 %. For lower water contents, the resulting dry density is less.

Pellets have been produced within the framework of different experiments, using different raw materials. A summary of the different experiments involving pellet production is given in Tab. 7. We focus on experiments where Nagra has had a direct involvement. To the authors' knowledge, these represent all the pellet productions undertaken by Nagra, although ANDRA and SKB have also produced pellets. A detailed review can be found in Dixon et al. (2011).

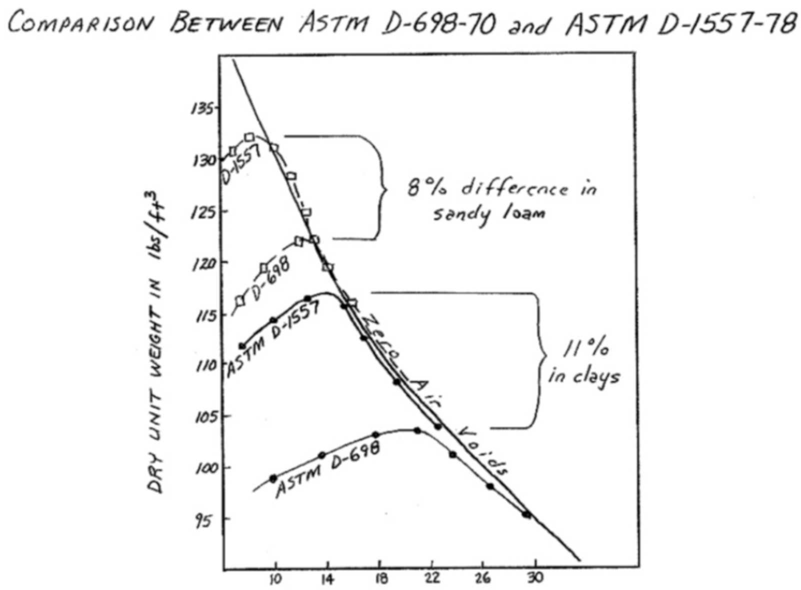


Fig. 82: Proctor curves for a sand and a clay for two levels of compaction energy according to the ASTM standards D698-70 and D1557-78.

Tab. 7: Summary of pellets produced in the two last decades

Description of manufacturing process	**Used in**	**Compres-sion**	**Raw material**	**Pellet dry density** [g/cm^3]	**Water content** [%]	**Production scale**
Naundorf & Wollenberg (1992) = NTB 92-06	Sealing experiment (Blümling & Adams 2008) and laboratory tests (Gloth & Strauss 1995)	Flat rollers	MX-80 (Na)	2.2 – 2.3	1	Lab
			Calcigel (Ca)	2.2	1	
Kennedy et al. (2003) = TN 04-17	EB experiment (García-Siñeriz 2002) and laboratory studies (Hoffmann et al. 2007)	Flat rollers	Calcigel (Ca)	2.15 2.2	6.5 7	Lab and industrial
			Serrata (Ca)	2*	4.2*	Lab and industrial
Plötze & Weber (2007) = NAB 07-24	PEBS – HE-E (Gaus 2011)	Flat rollers	MX-80 (Na)	2*	5*	Industrial
	ESDRED (Plötze & Weber 2007)					
	ABM (Nagra 2011)		MX-80 (Na)**			
Rueedi et al. (2012) = NAB 12-59	GAST (Rueedi et al. 2012)		MX-80 (Na)	1.95	9	
Weber & Gruner (2013)	Briquettes for pretests as part of FE	Moulded rollers	MX-80 (Na)	1.93	10	Industrial

* Dry density and water content values at industrial scale

** Although the ABM experiment was built with a variety of bentonites for the blocks, only MX-80 was used for the pellets.

The pellet dry density values described in Tab. 7 are compared to a data compilation from Kaufhold et al. (2013) in a Proctor-like representation (Fig. 83). The different measurements consider 1) different materials and 2) different compaction methods (and hence different compaction energies), and can thus not be directly use to determine directly Proctor's optimum water content. Nevertheless, considering the (very) high compaction forces applied to small particles, the compaction pressure in most of the pelletization processes are very high and most probably higher than the compaction pressure used for blocks. The Proctor curves of bentonite blocks (see Fig. 6) and the results given in Fig. 83 suggests thus that optimal water content is very low.

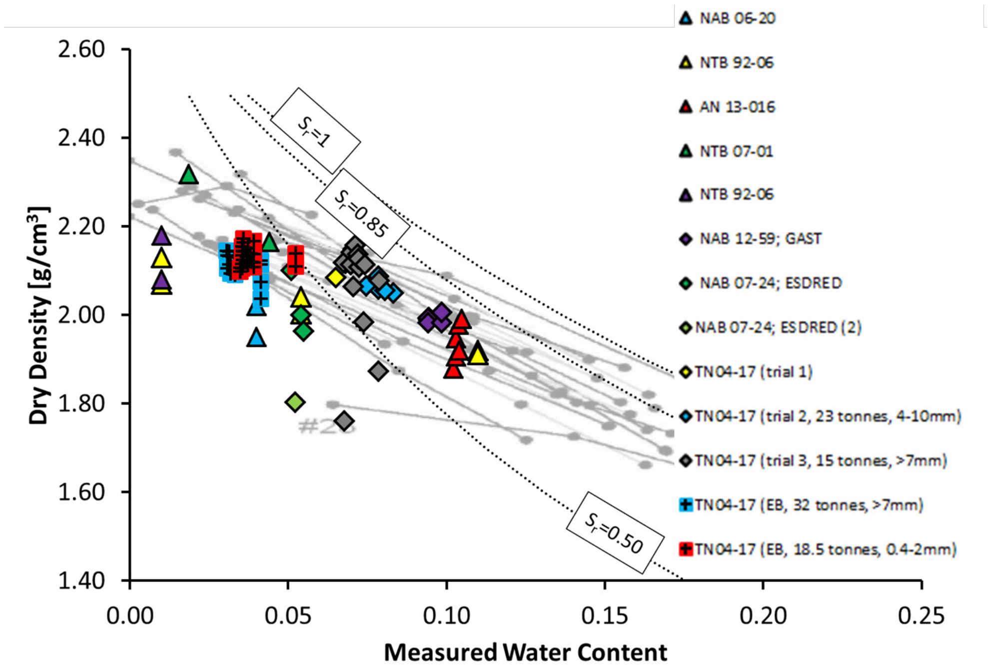


Fig. 83: Dry density – water content curves bentonite pellets from different productions (background grey dots are from Kaufhold et al. 2013 and coloured dots are data from Tab. 7).

Mined bentonite comes at a water content of approx. 30 %. Producers dry the bentonite by layering it out and exposing it to the sun. Generally, the resulting water content of raw bentonite from providers is between 10 % and 15 %, which corresponds roughly to equilibrium with normal climatic conditions (50 – 60 % air relative humidity). Considering the water content values of the providers and the increase of dry density between 10 % and 0 % water content, a drying step must be considered in the manufacturing process. Balancing the gain in pellet dry density and the difficulty to dry bentonite at the industrial scale, a target water content of 5 % was selected in the FE experiment. In addition to the higher quality of pellets obtained with the proposed grain size distribution (Fig. 81), relatively small grains will result in a large effective surface area, facilitating the drying process. The disadvantage of a relatively small grain size is the potential production of dust during the drying process. However, the drying process applied by Naundorf & Wollenberg (1992) does not indicate a significant change in the fine content after drying (Fig. 81).

Dry density of the pellets mixture

The obtained high density pellets will be mixed to obtain the bulk material to be emplaced. The resulting bulk dry density should be higher than 1.45g/cm^3 and as homogeneous as possible. The influence of the grain size distribution and the grain shape on the bulk density of the mixture has been the subject of numerous investigations in the last century. Those works build on the systematic experimental work developed by Fuller & Thomson (1907) who deduced the optimal grain size distribution to maximize the packing density of concrete assemblies referred since then as the Fuller distribution. The Fuller function relates the grain size distribution to the largest grain size (D). The percentage of passing p (in weight) through a sieve of size d is expressed as:

$$\boldsymbol{p = \left(\frac{d_i}{D}\right)^n . 100} \tag{1}$$

where n is a shape parameter typically ranging between 0.4 and 0.7. The validity of the optimal grain size distribution has been confirmed since then by numerous authors in the framework of high density packaging (see Stark & Müller (2004) for a complete state-of-the-art). Those authors proved that in theory, a shape parameter n = 0.5 is associated with maximum mixture bulk density when spherical particles are considered and that lower n values should be used to increase the mixture density in case of elongated particles. Nevertheless, the scientific community has been struggling in finding a unifying theory in relating the porosity of a mixture with grain size distribution (Peronius & Sweeting 1985). According to high density packaging, an additional advantage of Fuller type distributed mixtures is their higher resistance to segregation.

Grain size distribution

Depending on their manufacturing (flat or moulded rollers), pellet mixtures have a relatively smooth (flat rollers) or discrete steps (moulded rollers) grain size distribution. The initially obtained grain size distribution can be further modified by adding a certain percentage of raw material or pellets of different characteristic sizes and/or by applying an energetic abrasive process to the mixture (e.g. shaking the mixture or blowing the mixture through a pipe). Blümling & Adams (2008) and Plötze & Weber (2007) investigated the influence of the grain size distributions of pellets mixtures on the resulting bulk dry density.

Blümling & Adams (2008) measured the bulk dry density of bentonite pellet mixtures emplaced in horizontal boreholes of varying lengths. They also produced the grain size distribution associated with each emplacement. Their results are summarized in Fig. 84. The longer the borehole, in other words the larger the energy transmitted to the mixture during transport, the closer the emplacement grain size distribution to the theoretical Fuller curve. The grain size distribution indicates an initial mixture with no fines (no particles smaller than 1mm) associated with a relatively low bulk dry density (1.1 g/cm^3). During transport through the borehole, some, but not all, of the pellets are broken and the grain size distribution is modified. This process is associated with an increase of the bulk dry density, up to 1.5 g/cm^3 for the longest transport distance which also corresponds to the closest grain size distribution to the Fuller curve.

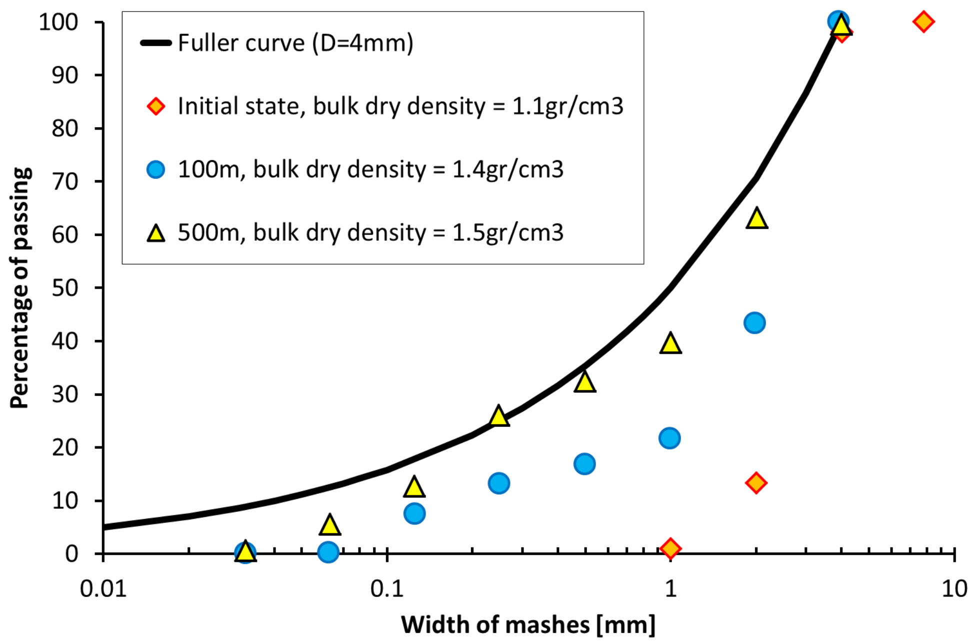


Fig. 84: Grain size distribution of MX80 bentonite pellets mixture in the borehole sealing experiment for different borehole lengths (modified from Blümling & Adams 2008) and associated Fuller curve (n=0.5).

Plötze & Weber (2007) backfilled a 2m diameter pipe containing a dummy abutment and heater using different MX80 bentonite pellets mixtures. The emplacement bulk dry density was calculated for each of the emplaced mixtures considering the total emplaced mass and the volume of emplacement. The different mixtures were prepared using different proportions of three basis preparations: coarse rounded pellets (A), fine bentonite (Z) and coarse briquettes (BR). Preparation A was subjected to a rounding process (blowing the mixture through a 100m long pipe) and has thus already a smooth grain size distribution. The proportions used for preparing the mixtures selected for illustrating the influence of grain size distribution are described in Tab. 8. Only three mixtures out of the eight carried out in ESDRED are considered here.

Tab. 8: Proportions of the basis preparations coarse rounded pellets (A), fine bentonite (Z) and coarse briquettes (BR) used for the mixtures A, D and E.

	Mixture A	**Mixture D**	**Mixture E**
Coarse rounded pellets (A)	100 %	70 %	64 %
Fine bentonite (Z)	0 %	30 %	28 %
Coarse briquettes (BR)	0 %	0 %	8 %

The resulting grain size distributions were plotted in Fig. 85. Emplacement was carried out using an auger system and seems to produce a certain amount of finer material. Fine production is rather limited though in comparison with the blow technique used in the borehole sealing experiment. The Fuller curves corresponding to the different mixtures were added considering the optimal shape parameter of 0.4. Mixture A and D are associated with the same Fuller curve and the addition of briquettes in mixture E increased slightly the maximal size parameter. Mixture A has a clear lack of fine material when compared with the Fuller curve. This is reflected in the relatively low bulk dry density measured after emplacement. Adding 30 % of finer material (mixture D), the obtained grain size distribution agrees better with the Fuller curve resulting in a slightly higher bulk dry density. Increasing the maximum grain size and keeping a similar agreement to the Fuller curve (mixture E) seem to provide an additional improvement in terms of bulk dry density.

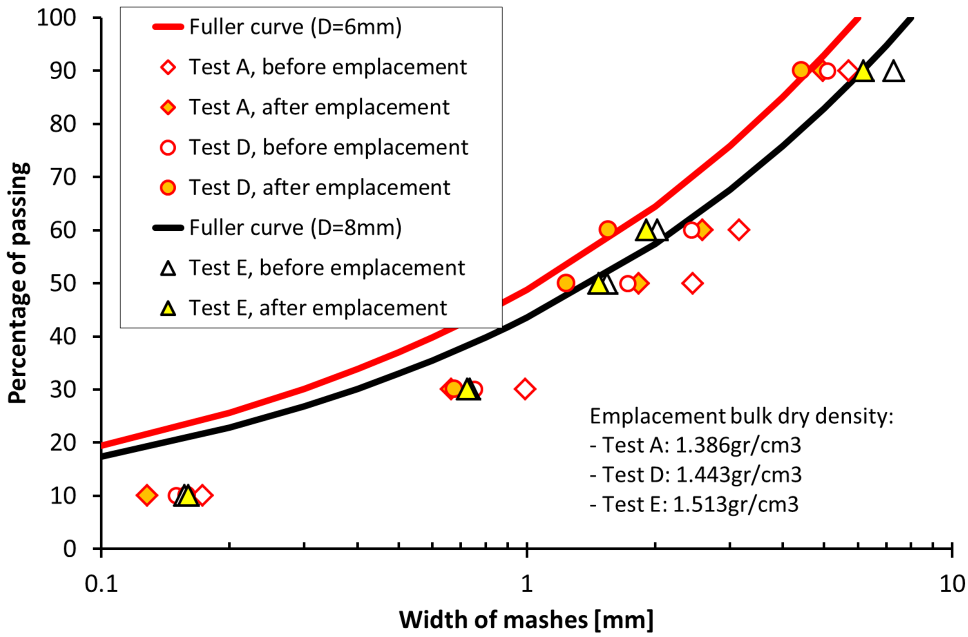


Fig. 85: Grain size distribution of two different MX80 bentonite pellets mixture in the ESDRED experiment (modified from Plötze & Weber 2007) and associated Fuller curves (n = 0.4).

Gloth & Strauss (1995) produced a series of granulated bentonite mixtures with different grain size distributions in the laboratory. The different mixtures were obtained by mixing pellets of different sizes in different proportions. Some of the mixtures aimed at reproducing a mixture with grain size distribution close to a Fuller curve with n = 0.5 and other mixtures deviated from Fuller (Fig. 86). Using the results from this authors, we plotted the pouring drying density they measured as a function of the deviation of each grain size distribution to a Fuller curve n = 0.4 (Fig. 87). The results from some other laboratory and some in-situ experiments were also added to this figure. For each pellet dry density, the decrease of emplacement or pouring mixture dry density with increasing deviation from the Fuller curve is clear.

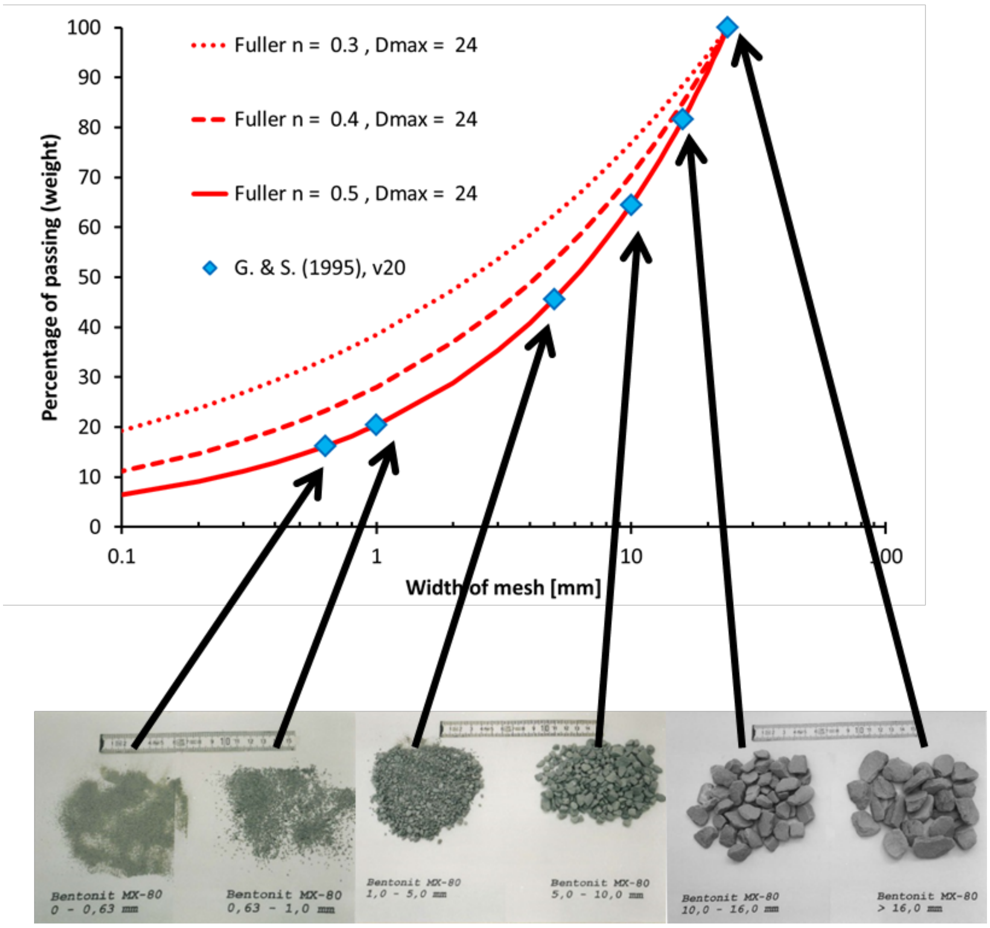


Fig. 86: Mixture 20 prepared by Gloth & Strauss (1995).

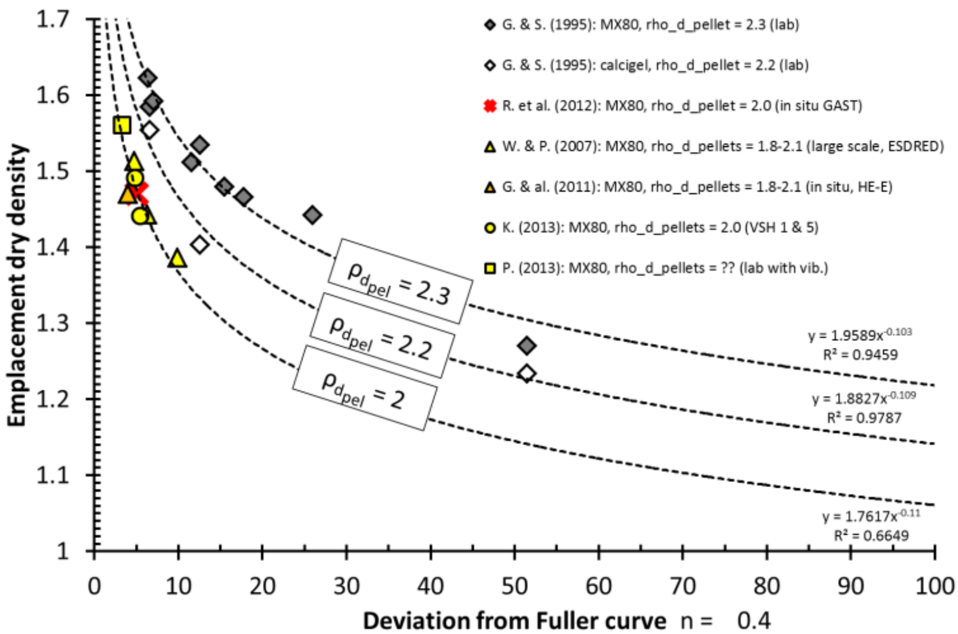


Fig. 87: Emplacement or pouring dry density for different pellet dry density as a function of the deviation (least square methods) of the grain size distribution of several laboratory and in-situ experiments to a Fuller curve n = 0.4.

Note: If the grain size distribution of the GBM is obtained by destruction of pellets and/or addition of non-compacted fines, the particles of the GBM will have a different density as a function of their size.

Pellets shape

Plötze & Weber (2007) investigated the influence of the pellet shape. The pellets they produced had an irregular shape and were elongated (Fig. 79 – right, left column). They noticed that rounding the pellets, i.e. decreasing the elongation (Fig. 79 – right, right column), the resulting dry density of the mixture is higher than using the elongated pellets by 18 %. This is in agreement with other experimental and theoretical observations published in the literature (e.g. Peronius & Sweeting 1985 among many others). Rounding was achieved by blowing the pellets through a 100 m long pipe.

Perfectly rounded pellets have a unique size or produce steep steps in the grain size distribution of the mixture. This was shown to affect the bulk dry density and may also result in segregation during emplacement.

3.2 Requirements and adopted strategy

On the basis of the literature study presented in the previous section a public bidding was organized according to the rules of the World Trade Organization. This procurement called for contractors to deliver the required bentonite pellet mixture (GBM). Targeting this final product, the work was divided into four different work packages with precise technical and production specifications of:

- WP 1 the required raw bentonite
- WP 2 the drying process of the raw bentonite
- WP 3 the required bentonite pellets
- WP 4 the required bentonite pellet mixture, including rounding of the constituents

A company could apply for one or more of the work packages independently.

During each production step, temperature reached by the bentonite was limited to a maximum of 80 °C to avoid mineralogical alteration and all installations were required to be perfectly clean in order to avoid unwanted additives.

The requirements for WP 1 were as defined in section 1 of this report. The grain size distribution of the raw material was required as well distributed between very fine and maximum 2mm, according to the norm ISO 3310-1, BS 410-1.

The requirements for WP 2 were to dry the raw bentonite from WP 1 to a water content between 4% and 6% (according to ASTM D2216 – 10).

The requirements for the process of WP 3 are given in Tab. 9. Bonus points were given to bidders compromising to a higher pellet dry density and/or to bidders proposing to produce separately different sizes of pellets and/or to bidders proposing larger max. grain sizes.

Tab. 9: Technical requirements of WP 3.

Criterion	**Description**
Raw material	From WP 2
Dry density of single pellet measured as: - single pellet weight - volume of single pellet (determined with a pycno-meter by displacement of a medium which does not intrude the sample pores) - dry pellet 72 hours at 105 °C - dried pellet weight - dry density = dried weight/original volume	> 2 g/cm^3
Water content	Between 4 % and 6 % (as close as possible to that of the material from WP 2). Large changes not allowed during the pelletization process
Size of individual pellet (characteristic size)	At least one pellet size with 10 – 15mm
Mechanical restistance of pellet	90 % out of 30 pellets resist to 5 drops of 2 m high on concrete floor Other (equivalent and simple) method can be proposed
Temperature	Max. temperature the bentonite may be submitted to during the pelletizing process: 80 °C

The requirements for the process of WP 4 are given in Tab. 10. Bonus points were given to bidders compromising to control more fractions during the productions to avoid large steps in the grain size distribution but a minimum of 4 controlled fractions were required.

Tab. 10: Technical requirements for WP 4.

Criterion	**Discreption**
Material to be used	Pellets from WP 3
Pellets size distribution (mixture) Grain size distribution of the mixture will be verified according to the norm ISO 3310-1, BS 410-1	Fuller type, with D_{max} = [10 – 15 mm], n = 0.4 (see text for more specific definition)
Shape of the constituents	Rounded and spherical
Water content	Between 4 % and 6 % (as close as possible to that of the material from WP 3). Large changes not allowed during the mixing process.
Mixture	Homogeneous
Temperature	Max. temperature the bentonite may be submitted to during the mixing process: 80 °C

The selection criteria were set according to:

- Prices
- Quality
- Delivery schedule
- Interface management between the different WP

Bidders were also allowed to propose improvements of production process regarding quality.

WP 1 and 2 were finally awarded to CEBO Holland and WP 3 and 4 to JRS.

Due to the need to perform some emplacement pre-tests in the framework of the FE experiment, the production was split in two parts: first production of 120 tons for the pre-tests and second production 220 tons for the material to be backfilled in the FE tunnel. This splitting allowed for refining the production procedures and to decrease the risk of Nagra.

3.3 Production of 120 tons and quality control

WP 1 and WP 2

The raw material proposed by CEBO is a natural sodium bentonite, mined by Bentonite Performance Minerals (BPM) in Wyoming. The commercial name of this bentonite is National ® Standard. The quality of the raw material, according to section 1 of this report, is certified by CEBO, according to their quality certificates (appendix H). A sample of National ® Standard received in the framework of the public tender process was analysed in the laboratory of ETH (appendix E, samples 6, 7 and 8) and the properties measured on these samples fulfil the requirements (Tab. 11).

Tab. 11: Measured characteristics of the raw material proposed by CEBO.

Criterion	**Values measured by ETH**
Material	Natural (non-activated) sodium bentonite
Smectite content by dried weight Measured by X-ray diffraction using a dried sample	77.6 % ± 1 %
Additives (such as Magnetite, Baryte, binders or others)	No additives detected
CEC (Cation Exchange Capacity) (by Cu(II)- triethylenetetramine method)	94.3 meq/100 g
Pyrite content by dried weight Measured by X-ray diffraction using a dried sample	0.2 % ± 0.1 %
Sulphur content by dried weight Measured by emission or mass spectroscopy	Not measured
Organic carbon by dried weight Measured by emission or mass spectroscopy	Not measured

Crude National ® Standard has a grain size distribution between 0.2 and 3 mm as illustrated in Fig. 88 and is characterized by a water content of 15 %. In past productions Nagra used to use MX-80 bentonite characterized by over 50 % of fine material (< 0.5 mm). MX-80 is also a Wyoming bentonite mined and distributed by AMCOL. MX-80 comes at water content around 10 – 12 % and experience shows it is beneficial to dry it before pelletizing.

CEBO disposes of a grinding and sieving unit coupled with a dryer used to adapt the grain size distribution and water content of the crude material. The material is first sent through the grinding and sieving unit and drying is posterior.

CEBO first proposed one of its standard processed materials (here referred to as National ® Standard WP2 beta) that fulfils the tender requirements. The grain size distribution of this material is plotted in Fig. 88. A production of 10 tons was performed to investigate CEBO's capacities to dry the material. Results of this production in terms of obtained water content as a function of dryer's parameters are summarized in Tab. 12.

The 10 tons of material were sent to JRS to be pelletized. JRS expressed concerns about the grain size distribution: according to their experience, the proposed material did not contain enough fines to obtain an optimal pellet dry density. CEBO was thus required to modify the grain size distribution of the processed raw material. After installation of a new sieving unit, CEBO achieved to produce a finer material with a grain size distribution very close to that of MX-80 (National ® Standard WP2 in Fig. 88). After receiving a sample of the modified material JRS confirmed its appropriateness for pelletization. An additional advantage of the modified material is that it is easier to dry as a consequence of the smaller grain size and after only one passage in the dryer a water content between 5 and 6 % is obtained. The production rate of this material is about 1.5 tons/hour.

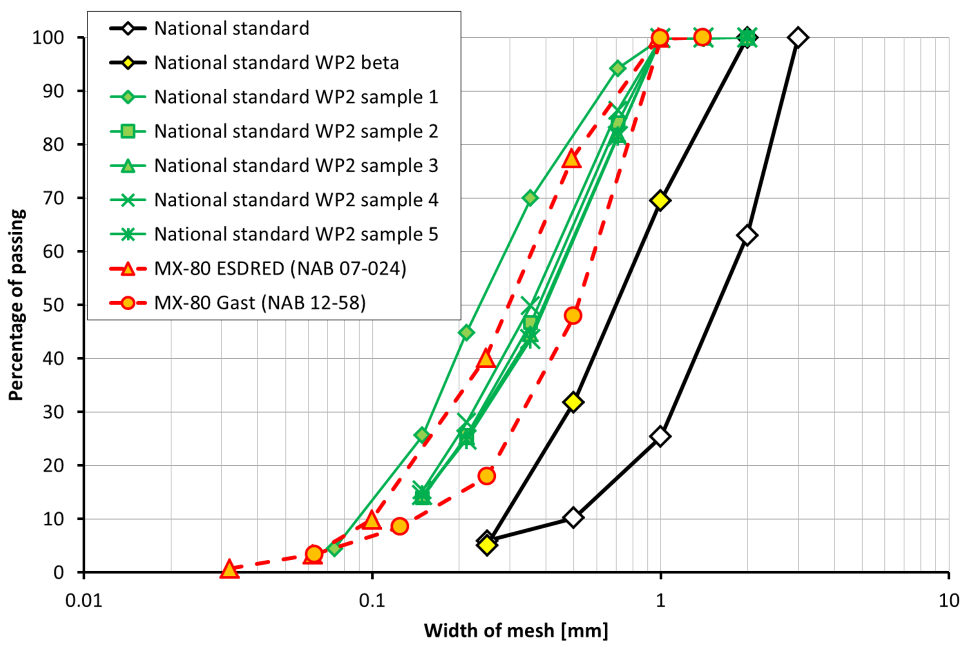


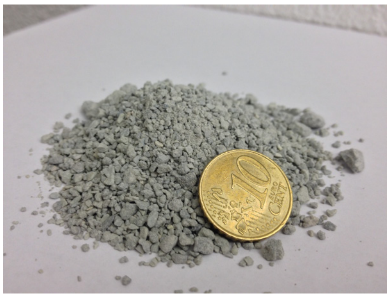
Fig. 88: Grain size distribution (ISO 3310-1, BS 410-1) of the crude material proposed by CEBO and the processed material.

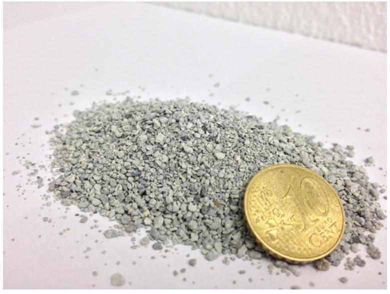
The grain size distribution of MX-80 bentonites (from AMCOL) used in previous pelletization campaigns were added for comparison.

Tab. 12: Water content of the different raw materials proposed by CEBO (measured according to ASTM D2216 – 10).

Name	**Water content** [%]	**Drying parameters**
National ® Standard (crude)	15	
National ® Standard WP2_β1	10 – 11	one passage through drying chamber and heater temperature 80 °C
National ® Standard WP2_ β2	8 – 9	one passage through drying chamber and heater temperature 100 °C (material temperature = 80 °C)
National ® Standard WP2_ β3	3 – 4	two passage through drying chamber and heater temperature 100 °C
National ® Standard WP2	5 – 6	one passage through drying chamber and heater temperature 100 °C (material temperature = 80 °C)

The different grain size distributions of National ® Standard crude, WP2 beta and WP2 are illustrated in the photographs of Fig. 89.


National ® Standard (crude)


National ® Standard WP2 (beta)


National ® Standard WP2

Fig. 89: Photographs of the three characteristic grain size distributions.

After the trial runs, Nagra ordered 120 metric tons of National ® Standard WP2 from CEBO as defined above. The grain size distribution and the water content was measured one time every 3 tons by CEBO (approximately once every two hours during the production). The measurements are depicted in Fig. 90 and Fig. 91, respectively. All measured values fall within the required range.

Additionally to those measurements, CEBO conserved 1 sample/3 tons and sent the samples to Nagra. Measurements performed at BGR on random samples confirmed that the material fulfils the requirements of section 1 (appendix I). The 120 tons were shipped to JRS in five truck loads (24 bigbags of 1 ton in each truck).

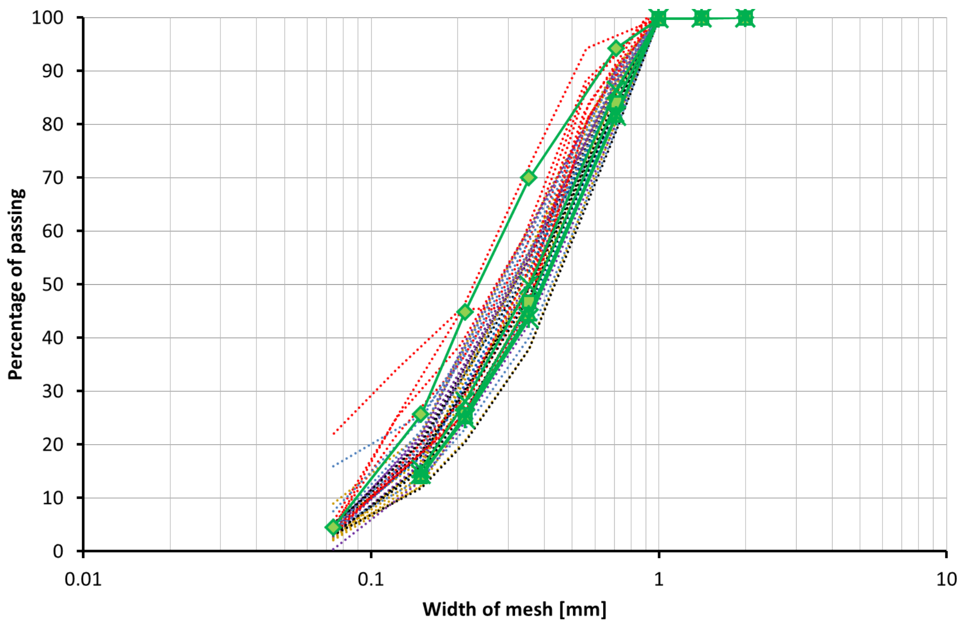


Fig. 90: Grain size distribution of National ® Standard WP2 measured 1/3tons by CEBO during the production of 120 tons.

The required grain size distribution range is indicated by the green lines.

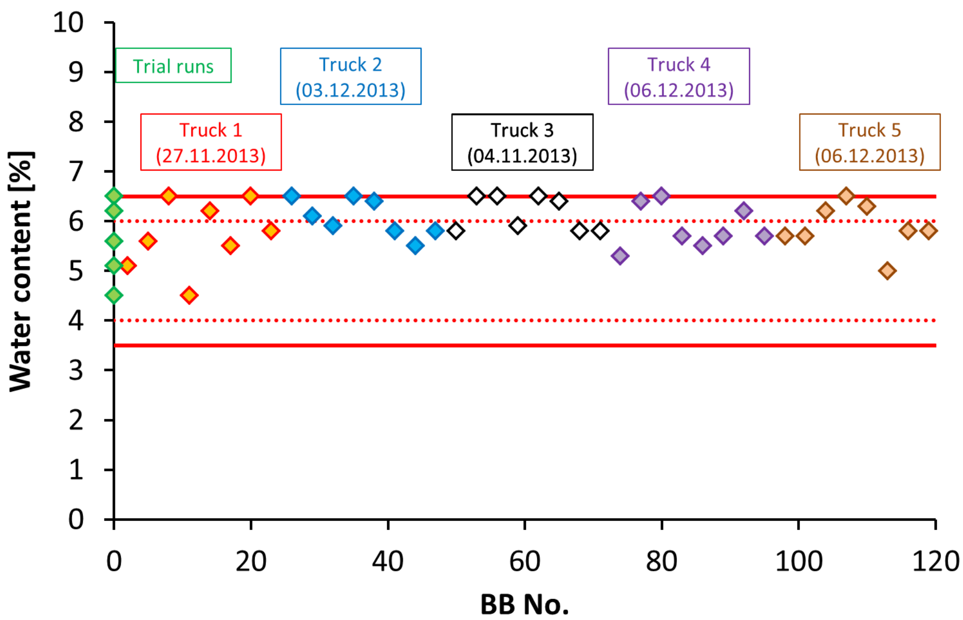


Fig. 91: Water content of National ® Standard WP2 measured 1/3tons by CEBO during the production of 120 tons.

The delivery date at JRS is indicated for each truck. Target and required range is indicated by continuous and dotted red lines, respectively.

The production of the hcGBM for the 1:1 pretests of the FE experiment was done in two steps. The first step is the production of the bentonite pellets between 03.12.2013 and 17.12.2013. The second step, the mixing and rounding of the pellets was performed in January 2014.

WP 3

120 tons of pellets of three characteristic sizes were produced at JRS between 03.12.2013 and 17.12.2013. The pellet fractions of three characteristic sizes are described in Tab. 13. Ideally, the relative amount of each fraction would have been determined by running mixing tests in parallel but unfortunately at the time of the pellet production, the mixer was not available.

Tab. 13: Characterization of the three different fractions produced.

Fraction name	Characteristic size	Relative amount	Amount
A	1 mm to 3 mm	33 %	40 tons
B	3 mm to 6 mm	33 %	40 tons
C	6 mm to 10 mm	33 %	40 tons

The installation was cleaned on 02.12.13 to prevent any form of pollution/unwanted additives. First a basic cleaning operation was performed. Then three tons of National ® Standard WP2β bentonite from a previous CEBO delivery to JRS (10 tons) was run through the installation to finish cleaning and to proceed to a first adjustment of the production line parameters. The three first production days were used to produce a test batch of each fraction (see Tab. 14) to clear the production of the total amount. Pictures of the pellets obtained for the three fractions are presented in Fig. 92. All pellets exhibit a certain elongation. The elongation increases for larger characteristic sizes.

Tab. 14: Production of test batches for each fraction.

	Amount produced	On day
Fraction A	9 tons	03.12.13
Fraction C	4 tons	04.12.13
Fraction B	14 tons	05.12.13

1-3mm fraction 3-6mm fraction 6-10mm fraction

Fig. 92: Pellets of the three different fractions.

After the production of the test batches for each fraction, the remaining quantity of pellets for each fraction was produced in 2 weeks according to the time schedule sketched in Fig. 93.

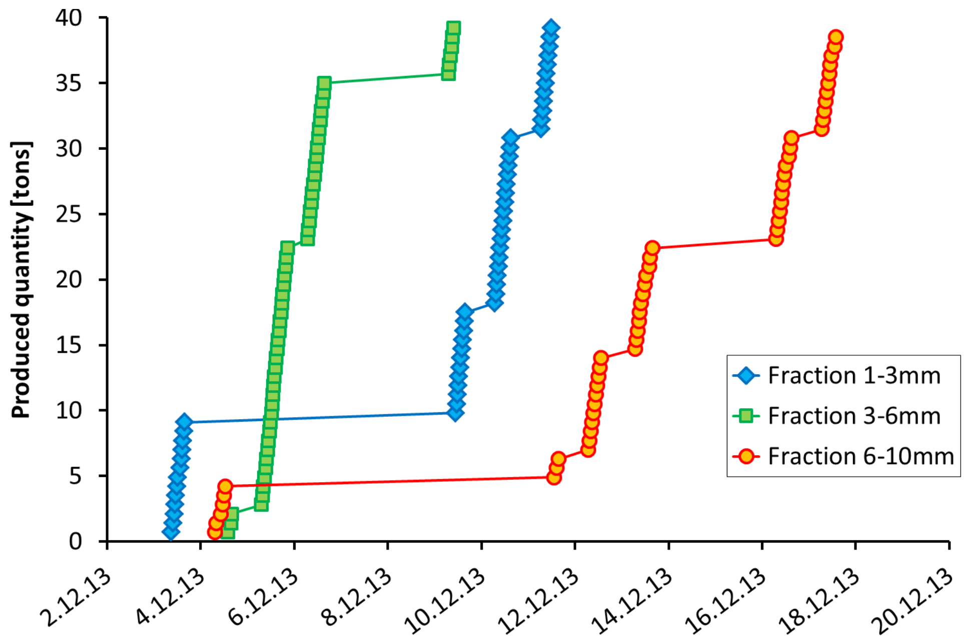


Fig. 93: Produced quantity of bentonite pellets of the different fractions during the two weeks production.

The production flow chart is illustrated in Fig. 94 for the 1 – 3 mm fraction.

- The raw material is introduced (floor 0) in the production line through a mixing hopper (Fig. 95).
- The material is then leaded to floor -1 and undergo a precompaction before it passes between two flat rollers (30 cm diameter steel cylinders). Passage through the compactor is the core part of the production line. Hereby the flow velocity of the material is equal to the circular velocity of an external point of the flat roller cylinder to minimize shear stresses during compaction. One of the axis of the rollers is fixed and the axis of the other one is pushed towards the other one. The applied pressure hereby is about 4 tons/cm^2 (amounting to about 400 MPa). Application of the compaction pressure between the rollers is limited by the power input (150 Ampers). The required power input is correlated to the flow velocity of the material: the slower the material flow the more power is needed.
- The compacted material comes out of the compactor as a cake (Fig. 96) characterized by well visible weaker compaction planes. The cake goes than through a coarse cruncher and is broken into smaller pieces.
- After this step, the material is brought 2 floors up (floor 1) into a sieving unit.
  - Pellets characterized by the characteristic size of the fraction being produced is lead to the bigbags (Fig. 97) on floor 0.
  - Too coarse pellets are grinded and reinjected in the system just after the crushing unit.
  - Too small pellets/particles are reinjected in the system just before the precompaction step.

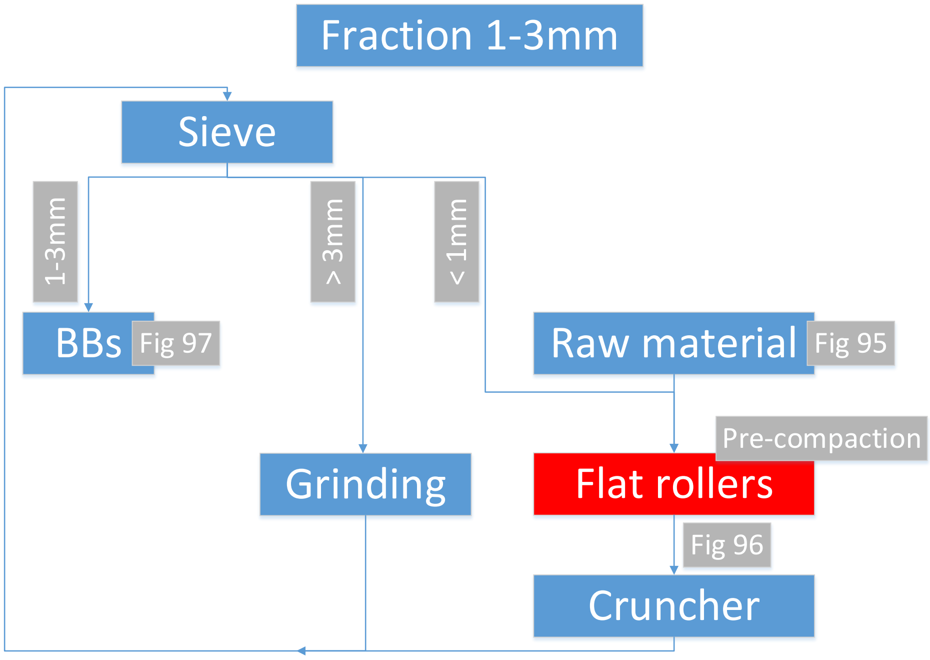


Fig. 94: Production flow chart for fraction of characteristic size between 1 and 3 mm.

(a)

(b)

Fig. 95: Supply of raw material in production line: (a) CEBO bigbag of one ton and mixing hopper and (b) raw material inside the mixer.

Fig. 96: Compacted material as coming out of the compactor, before the crunching unit.

(a) (b)

Fig. 97: (a) Reception of the pellets in 700 kg bigbags and (b) sampling of pellets (beginning middle and end of bigbag).

The reception of the pellets is done in two bigbags working alternatively. Once one bigbag reaches the weight of 700 kg, reception starts in the other one. The filled bigbag is brought to a packaging unit (Fig. 98). Care is taken to make the package water tight. Once packed, the big bag is labelled and brought to its storing place (Fig. 99), waiting for the mixing operations in January. The bigbags for each fraction are labelled from 1 to 57 (amounting to approximately 40 tons for each fraction).

(a) (b)

(c) (d)

Fig. 98: Packaging of the 700 kg pellet bigbags: (a) bigbag is installed on packaging unit, (b) bigbag is separated from the pallet by an impermeable and solid coated carton layer (to avoid water uptake and penetration of wooden needles), (c) wrapping of the bigbag by several plastic layers and (d) wrapped bigbag is labelled for further identification.

Fig. 99: Bigbags are stored in an automated dry store house in the same building as the pelletizing and mixing units.

The quality control during the pellet production consisted of:

- Measuring the production rate (at production line)
- Measuring the water content once every second 700 kg bigbag (at production line)
- Measuring the grain size distribution of the pellets once every second 700 kg bigbag (at production line)
- Measuring the pellet dry density every 700 kg bigbag (done at JRS laboratory according to the pellet dry density measurement protocol given by Nagra, see appendix J)
- Measuring the water content on the same sample as the pellet dry density every 700 kg bigbag (done at JRS laboratory)
- Conserving three samples every 700 kg bigbag (beginning, middle and end) individually packed in airthight bags indicating the provenance for each sample.

The production rate is presented in Fig. 100. The average production speed is larger for the smaller fractions. The explanation of JRS for this is that more energy is required to press larger pellets and as the material flow velocity is inversely proportional to the input power, larger pellets are produced at a slower rate.

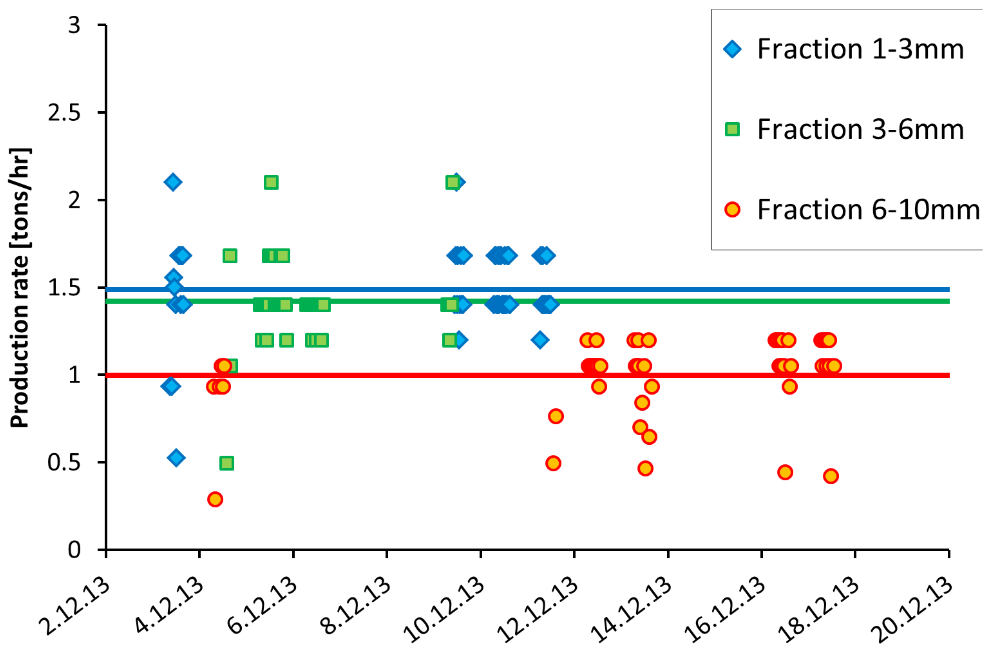


Fig. 100: Production rate of the pellets of the three fractions.

The pellet dry density measured in the middle of every 700 kg bigbag is plotted in Fig. 101 for each fraction. The average pellet dry density is 2.18 g/cm^3. The measurement method of the pellet dry density can be found in appendix J. Some pellets samples were also sent to the laboratory of ETH to have an independent check of density measurement protocol presented in appendix G.

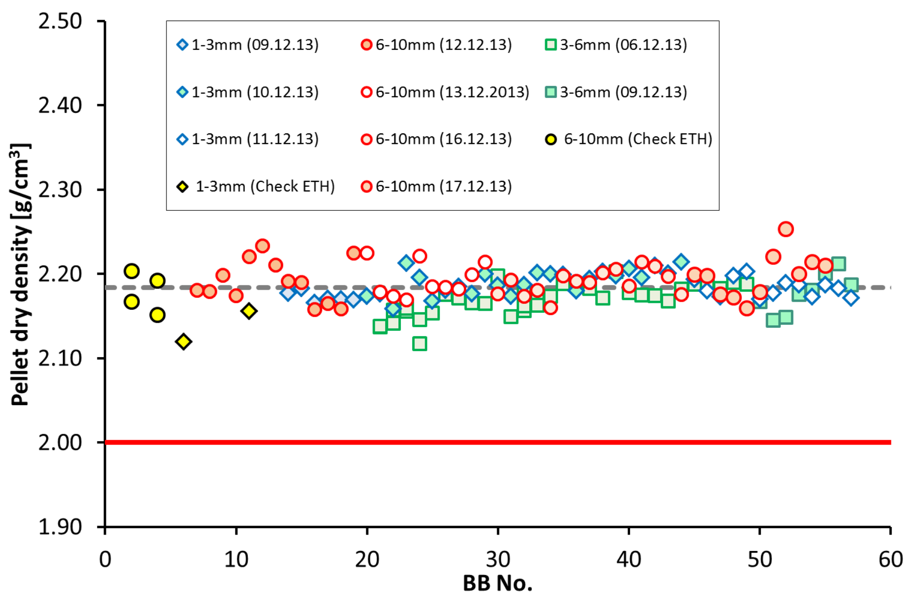


Fig. 101: Pellet dry density measured on the sample in the middle of each 700 kg bigbag during production.

The water content measured:

- by CEBO
- at the production line
- in JRS laboratory

has been plotted in Fig. 102. The values at the production line and in the laboratory of JRS were measured on crushed pellets taken from the 700 kg bigbags and show a satisfactory agreement. The water content measured at CEBO is clearly higher than that measured after pelletization at JRS. This difference is believed to be a consequence of the temperature increase produced during the compaction.

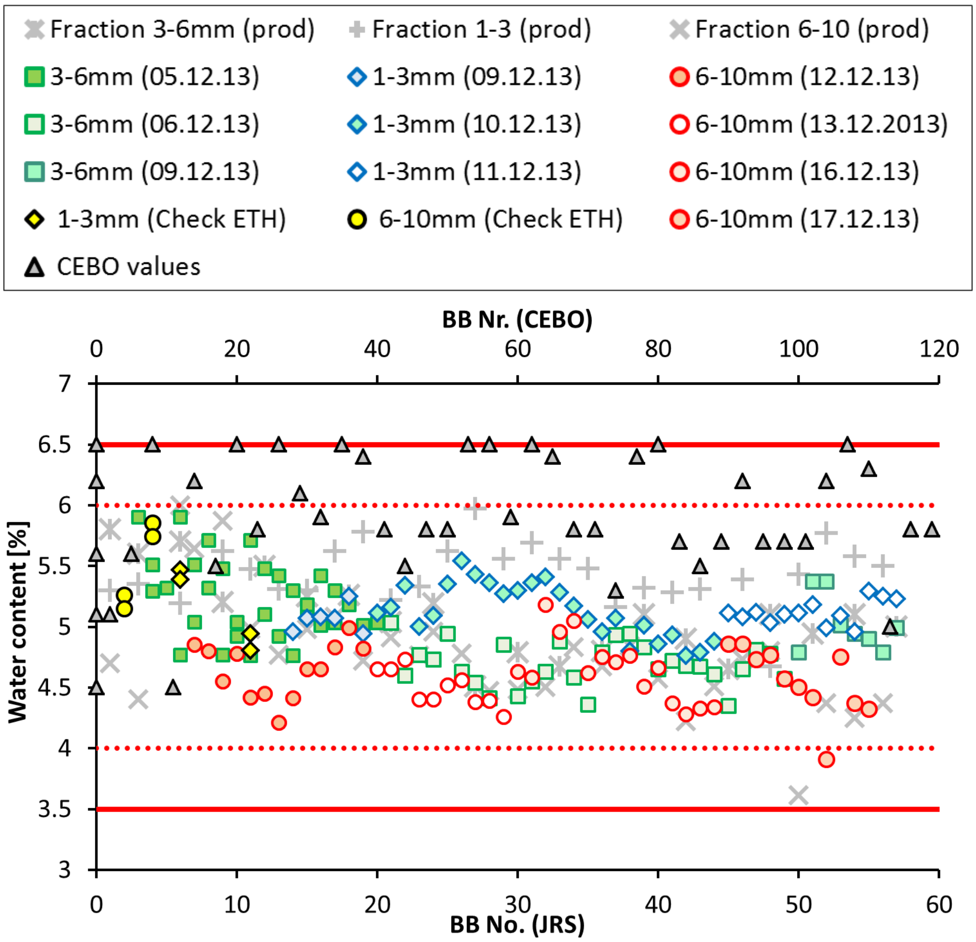


Fig. 102: Water content measured on the sample in the middle of each 700 kg bigbag in JRS laboratory at the same time as the pellet dry density (green, blue and red dots), water content measured at the production line (grey crosses) (referenced to the outcoming 700 kg bigbags, lower axis) and water content measured on the raw material by CEBO (referenced to the incoming 1 tons bigbag, upper axis).

The statistical distribution of the measured values of pellet dry density and water content (only considering the values measured in JRS laboratory) are presented in Fig. 103 and Fig. 104, respectively. The normalized density of the measured pellet dry density and water content were plotted for a class width of 0.005 and 0.05, respectively. The measured distribution appears to be normally distributed as they compare well with the theoretical normal distribution calculated as:

$$f_g(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(x-a)^2}{2\sigma^2}} \quad (2)$$

with a is the average and σ is the standard deviation.

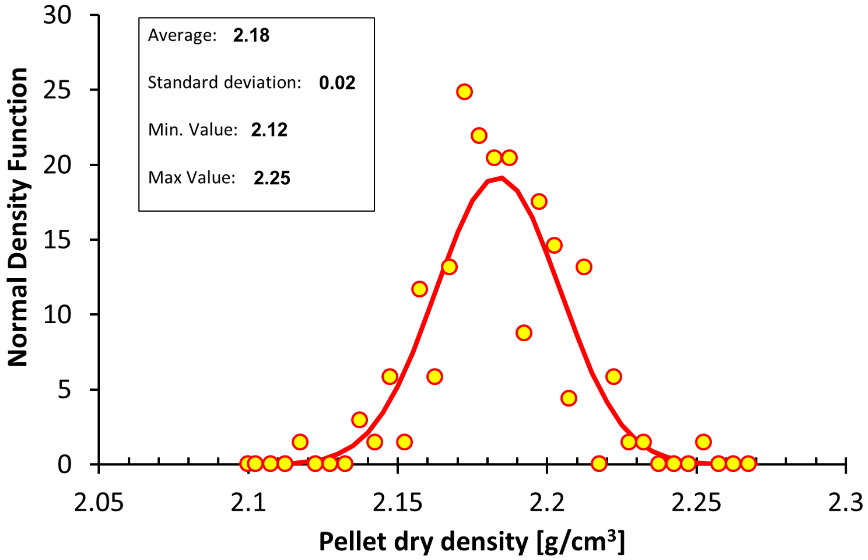


Fig. 103: Statistical distribution of the measured values of pellet dry density considering a class width of 0.005.

Dots: measurement density normalized to agree with a normalized Gaussian distribution with an area of 1 below the Gauss curve. Line: theoretical Gauss curve (equation 1) considering the average (2.18) and standard deviation (0.02) of the measurements.

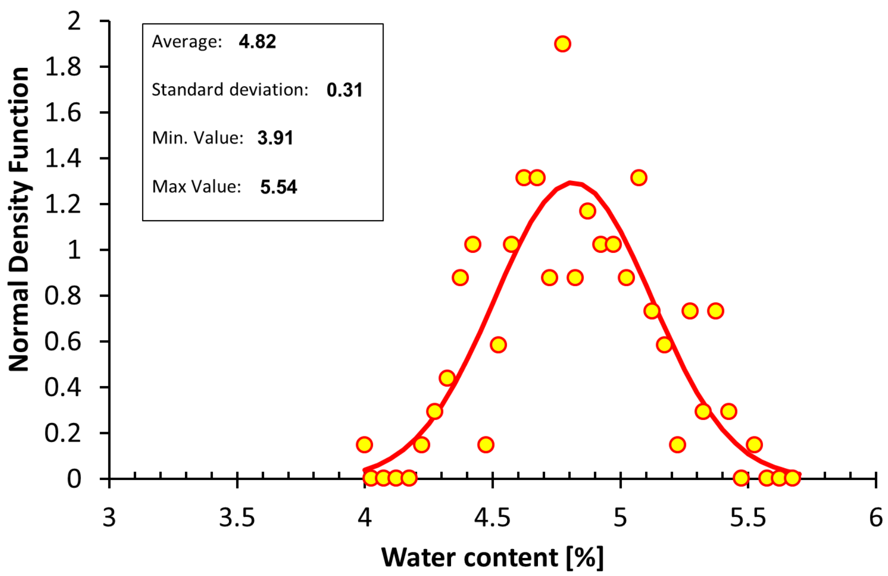


Fig. 104: Statistical distribution of the measured values of water content (green, blue and red dots in Fig. 102) considering a class width of 0.05.

Dots: measurement density normalized to agree with a normalized Gaussian distribution with an area of 1 below the Gauss curve. Line: theoretical Gauss curve (equation (2) considering the average (4.82) and standard deviation (0.31) of the measurements.

The grain size distribution measured for each of the fractions in every second 700 kg bigbag is presented in Fig. 105. The measured grain size distributions do not perfectly match the prescribed characteristic sizes of the fractions, mainly because of the sieving units used in the production process. The deviation is made explicit in Tab. 15 where the prescribed characteristic sizes of the fractions are compared to really obtained sieving values. The deviation from the characteristic size is inexistent for fraction 1 – 3 mm and increases for bigger fractions.

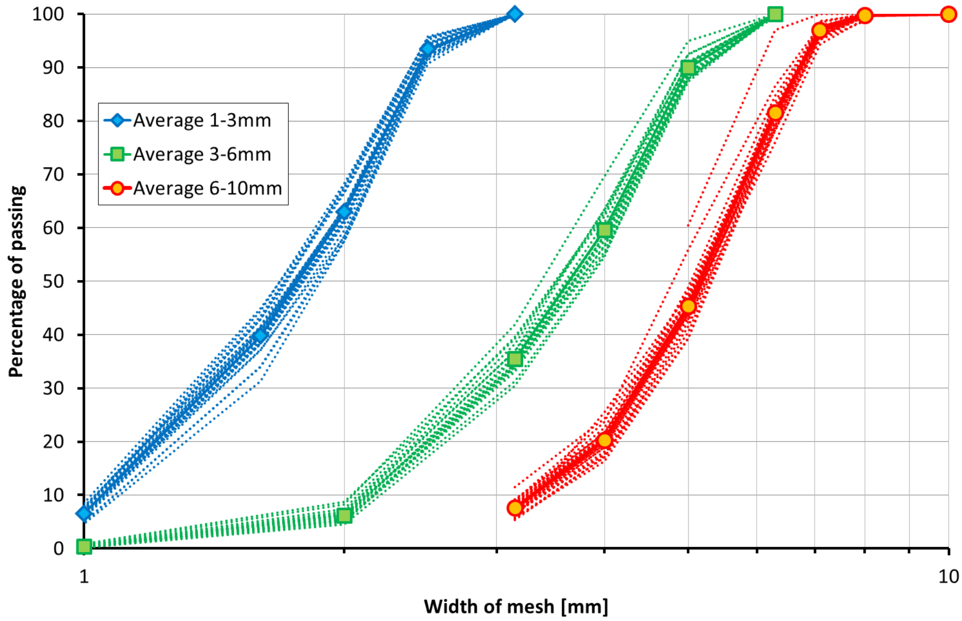


Fig. 105: Grain size distribution measured in every second bigbag at the production line for each fraction (dotted lines).

The average has been calculated for each fraction and is indicated by the diamonds (fraction 1 – 3 mm), the squares (fraction 3 – 6 mm) and the circles (fraction 6 – 10 mm).

Tab. 15: Characterization of the three different fractions produced: prescribed characteristic size and really obtained sieving values (d10, d90 and d100).

Fraction name	Characteristic size		Sieving values		
	MIN	MAX	d10	d90	d100
A	1 mm	3 mm	1.1 mm	2.4 mm	3.1 mm
B	3 mm	6 mm	2.1 mm	5 mm	6.1 mm
C	6 mm	10 mm	3.2 mm	6.8 mm	8 mm

WP 3: some investigations

Compaction energy input given by the flat rollers is approx. equivalent to a compression pressure of 400 MPa. Several pellet productions have been performed on the same production line (Kompactor 2 at JRS). The pellet dry density obtained in the different productions is plotted in Fig. 106 as a function of the water content. Although the raw material was not the same in each production (see Tab. 7), this representation is closer to a Proctor curve than the figure presented in Fig. 83 and it suggest that the Proctor's optimum is between 4 % and 6 %. Nevertheless, no final conclusions can be drawn. Considering only the measurements of this production (Fig. 107), the trend for the very restricted water content range would rather indicate that we are still on the wet side of Proctor.

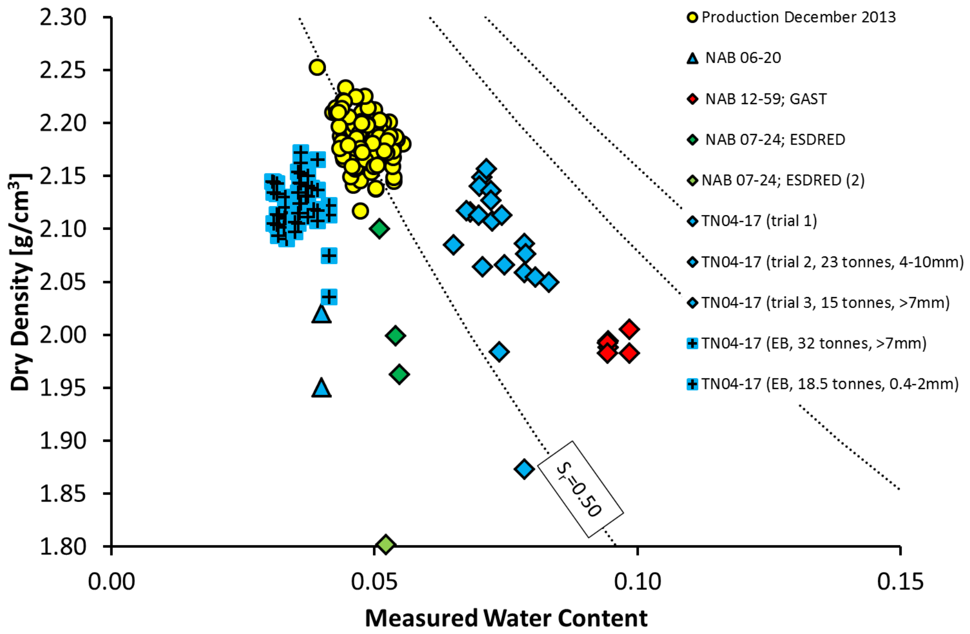


Fig. 106: Measured pellet dry density as a function of associated water content for different productions.

Red dots: GAST experiment, green dots: ESDRED; blue dots: EB and yellow: this production.

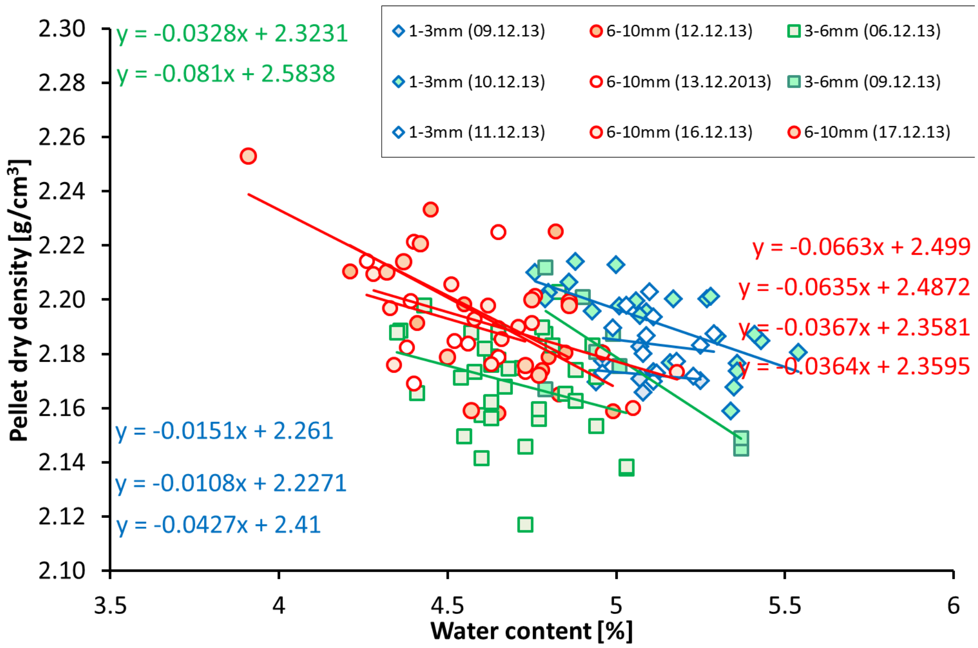


Fig. 107: Measured pellet dry density as a function of associated water content for this production.

Obviously, when using a roller press, the compaction pressure is not the only energy input. The flow velocity of the material through the press also influence the compaction energy input. The pellet dry density was thus plotted as a function of the production rate (Fig. 108). If any influence of the production rate, it is rather low. One should also notice that the production of bigger pellets was also more expensive in terms of energy than the production of small pellets.

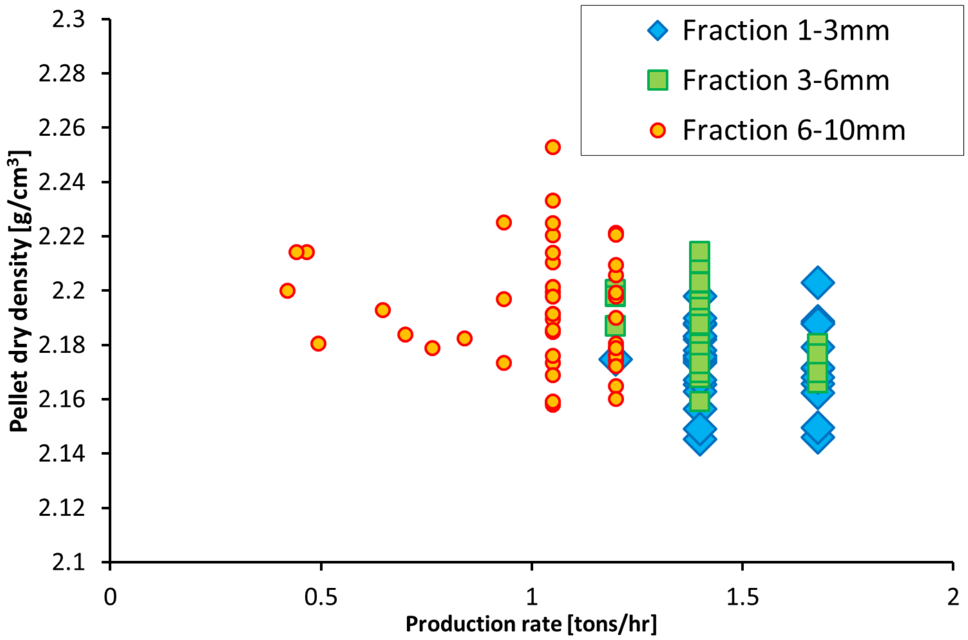


Fig. 108: Pellet dry density measured on the sample in the middle of each 700 kg bigbag as a function of the production rate.

WP 4: preparation

The objective of the mixing procedure is illustrated in Fig. 108: it consists in filling the larger pores between larger particles with high density particles. Ideally this larger pore filling is repeated at as many scales as possible as in a fractal. To reach this objective, the rules of the games were to:

1. mix the pellet fractions of Fig. 105 in the right proportions
2. produce high density fines as a by-product of the mixing process to fill the smallest pores

The targeted grain size distribution is a Fuller-type distribution with a shape parameter n = 0.4 (see appendix L).

Fig. 109: Schematic objective representation of the mixing procedure in 2D (left) and in 3D (right).

The mixing procedure was defined in accordance with JRS. The choice of the mixer (between black share mixer and Kniele mixer) was done on the basis of the expected mixture density and its abrasion potential. The lighter Kniele mixer was finally selected. The concept of such an inversed cone mixer is illustrated in Fig. 110 . The material to be mixed is introduced from the top and follows a cyclic process. It first falls down on the external faces of the mixing cone. Hereby the material is tossed by 4 external mixing arms. When arriving in the bottom of the inversed cone, the material is lifted up along the central axis and then ejected at the top to repeat the process.

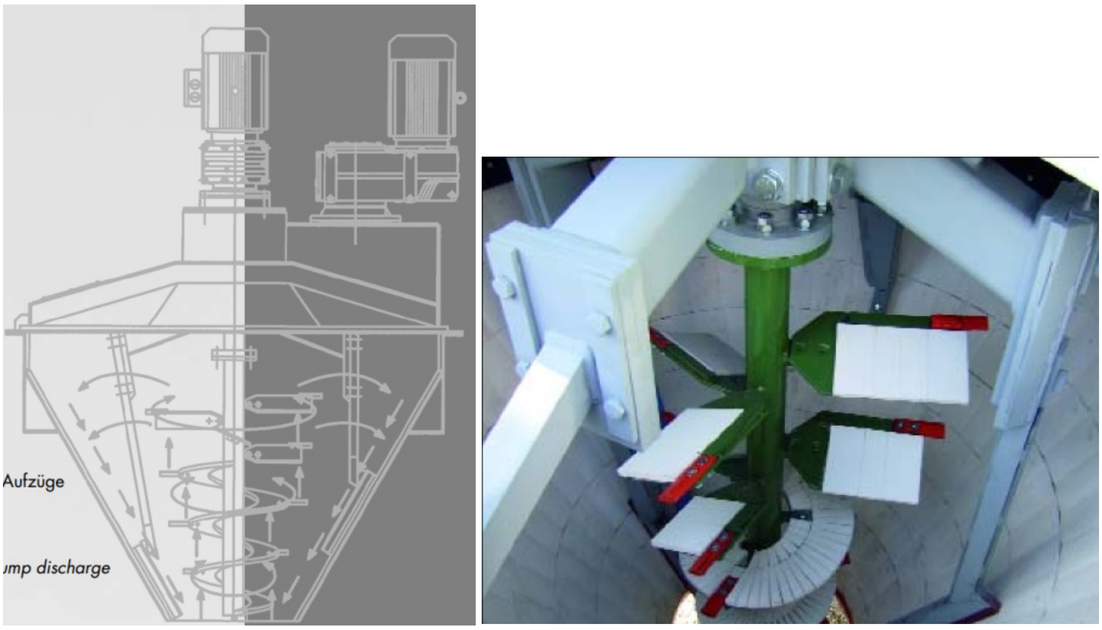


Fig. 110: Schematic representation of a Kniele mixer (left) and internal view picture from top perspective of a Kniele mixing cone (right).

Different mixing velocities can be adopted. They are described in Tab. 16.

Tab. 16: Characteristics of the mixer revolutions as a function of the motors.

Revolutions/min Motor (RPM)	Revolutions/min central axis	Revolutions/min outer mixing branches
1000	92	26
1500	138	39
2000	184	52
2500	230	65
2700	248	70

A series of basic mixing tests were performed using the pellet fractions only to find the optimal mixing procedure through an iterative and empirical process (proportion of pellet fractions to be introduced, mixing speed and time). The test characteristics are described in Tab. 17. In each test, the mixer was stopped every 10 min to sample the mixture and:

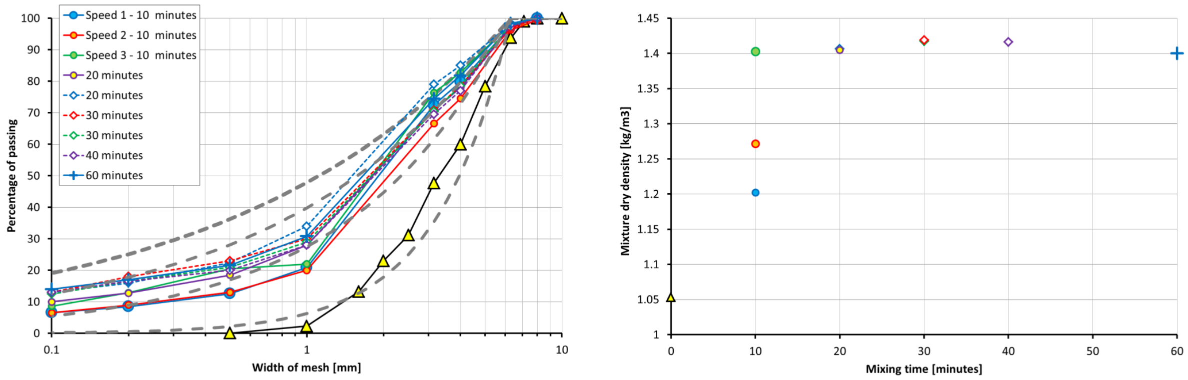
- the grain size distribution
- mixture pouring dry density (see appendix K for the measurement protocol)

were measured. Note that as the mixture density depends on the measurement method, from the values presented herein no conclusions can be drawn on the emplacement dry density. The measurement protocol was set up to have the possibility to compare the produced mixture between themselves.

Tab. 17: Description of the basic industrial mixing tests (each test was sampled every 10 min).

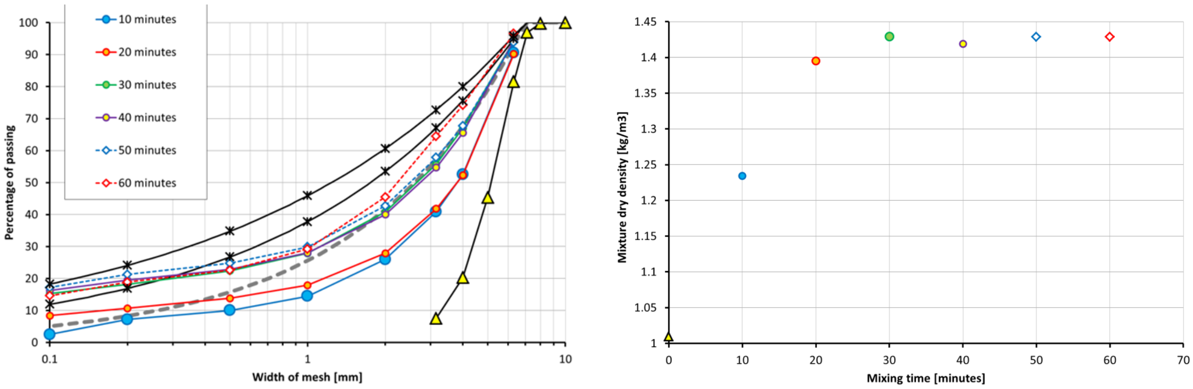
		kg of fractions introduced in mixer			**Mixing time at X RPM** [min]				
	Date	A	B	C	1000	1500	2000	2500	2700
Test 1	08.01.2014	700	700	700	10	10	60		
Test 2	21.01.2014			2100	10	10	10	10	20
Test 3	21.01.2014		2100		10	10	10	10	10
Test 4	21.01.2014	2100			20	10	10	10	20

The results of the tests is given in Fig. 111 until Fig. 114 in terms of evolution of grain size distribution and mixture pouring density as a function of mixing time. Generally, when a sufficient mixing energy (= mixing velocity) is applied, after a threshold residence time in the mixer, the grain size distribution does not change any more. The mixture reaches kind of steady state whereby fine particles bump the tossing of bigger particles that cannot be destroyed anymore. A Fuller-type grain size distribution was never reached. In each test, when the grain size distribution reaches its closest point to a Fuller-type distribution, the pouring mixture dry density stabilizes to its highest level.



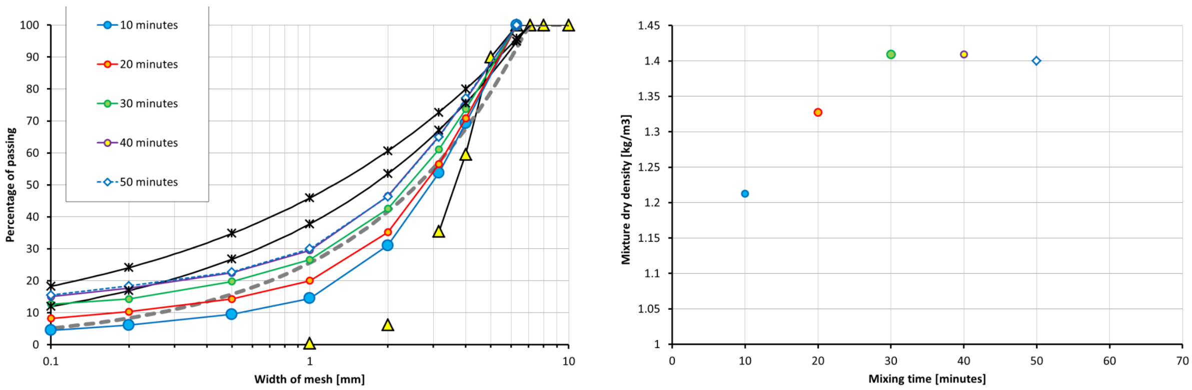
(a) (b)

Fig. 111: Industrial mixing test 1 (a) Evolution of the grain size distribution of the GBM, the grey background dashed line represents Fuller curves with max. grain size = 6 mm and n = 1.5, 0.7, 0.5 and 0.4 (from bottom to top), (b) evolution of the mixture pouring dry density at corresponding mixing time and grain size distribution.



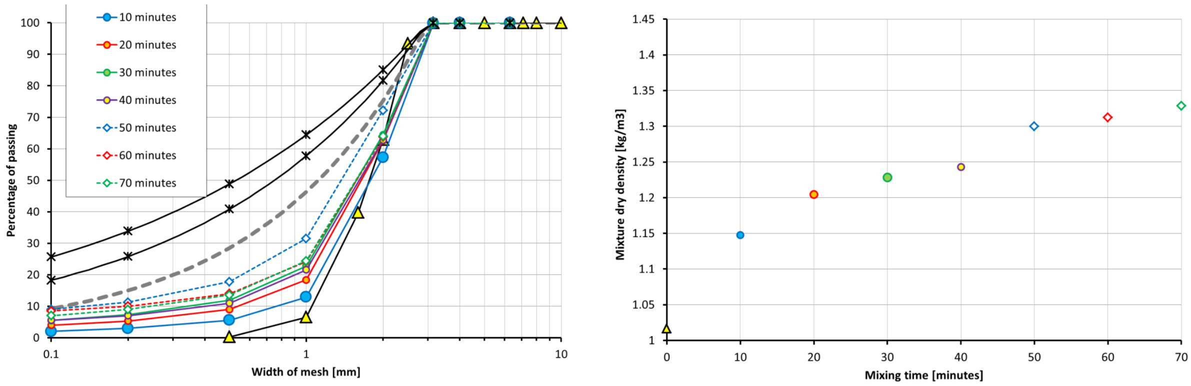
(a) (b)

Fig. 112: Industrial mixing test 2 (a) Evolution of the grain size distribution of the GBM, the grey background dashed line represents Fuller curves with max. grain size = 6 mm and n = 0.7, 0.5 and 0.4 (from bottom to top), (b) evolution of the mixture pouring dry density at corresponding mixing time and grain size distribution.



(a) (b)

Fig. 113: Industrial mixing test 3 (a) Evolution of the grain size distribution of the GBM, the grey background dashed line represents Fuller curves with max. grain size = 6 mm and n = 0.7, 0.5 and 0.4 (from bottom to top), (b) evolution of the mixture pouring dry density at corresponding mixing time and grain size distribution.



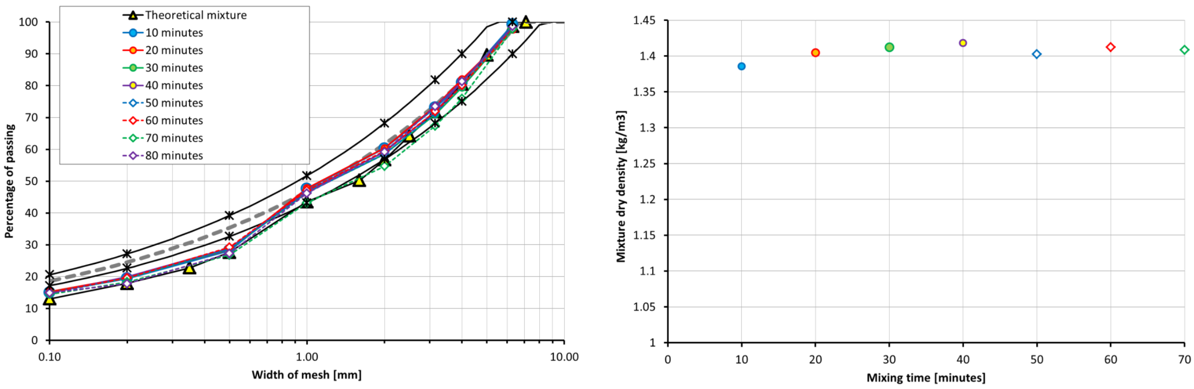
(a) (b)

Fig. 114: Industrial mixing test 4 (a) Evolution of the grain size distribution of the GBM, the grey background dashed line represents Fuller curves with max. grain size = 3 mm and n = 0.7, 0.5 and 0.4 (from bottom to top), (b) evolution of the mixture pouring dry density at corresponding mixing time and grain size distribution.

In an attempt to obtain a grain size distribution closer to Fuller, the mixture products from test 2 and 3 (originating from pellet fractions C and B, respectively) where mixed with raw material in proportions indicated in Tab. 18. With those mixing products, the obtained grain size distribution is very close to the targeted Fuller-type distribution. As expected, longer mixing time does not change the intrinsic characteristic of the material due to the buffer effect of fine particles.

Tab. 18: Description of the improved industrial mixing test (each test was sampled every 10 minutes). X denotes raw material.

		kg of fractions introduced in mixer			**Mixing time at X RPM** [min]				
	Date	X	test 3 (B)	test 2 (C)	1000	1500	2000	2500	2700
Test 5	22.01.2014	400	800	800	20	20	10		20



(a) (b)

Fig. 115: Industrial mixing test 5 (a) Evolution of the grain size distribution of the GBM, the grey background dashed line represents Fuller curves with max. grain size = 5, 6 and 7 mm (from top to bottom)and n = 0.4, (b) evolution of the mixture pouring dry density at corresponding mixing time and grain size distribution.

The mixture dry density of the different tests is compared in Fig. 116 and Fig. 117 as a function of the motor rotation velocity and the mixing time, respectively.

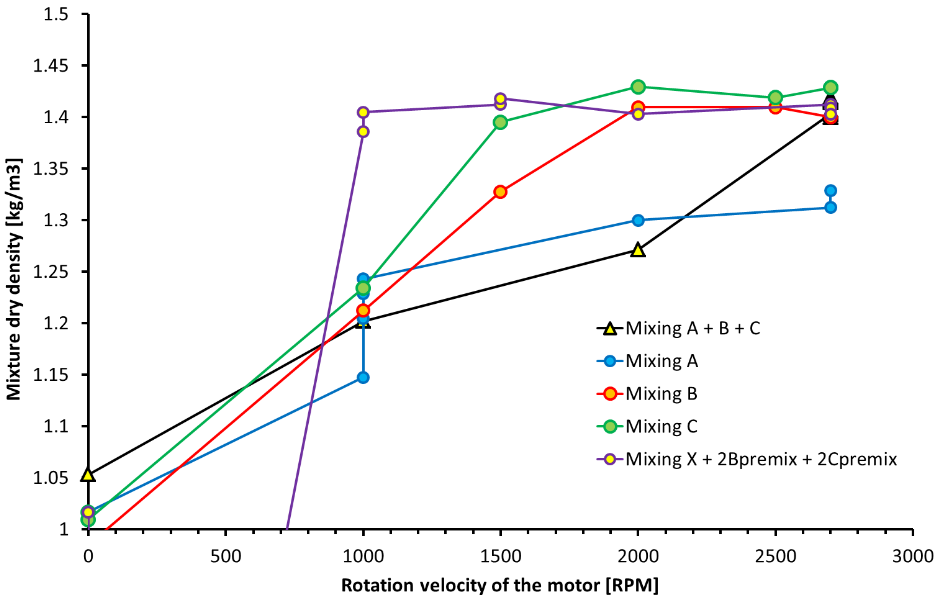


Fig. 116: Evolution of the mixture dry density measured during industrial mixing tests 1, 2, 3, 4 and 5 as a function of the rotation velocity of the mixer's motor.

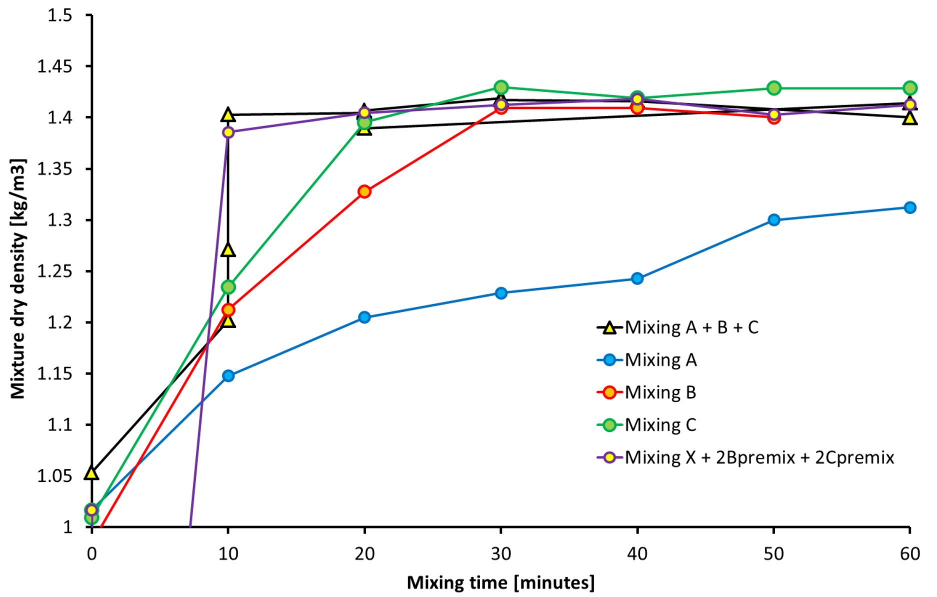


Fig. 117: Evolution of the mixture dry density measured during industrial mixing tests 1, 2, 3, 4 and 5 as a function of the residence time in the mixer.

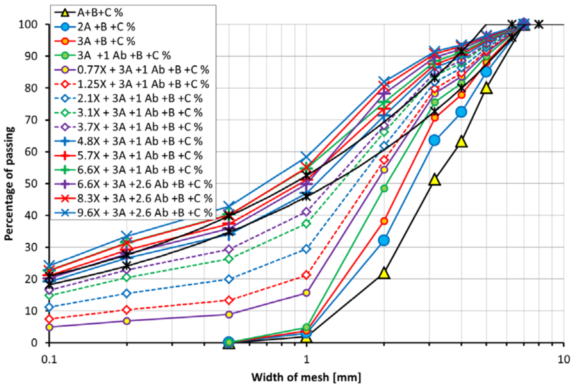
Mixing tests were also performed in the laboratory. Fractions of different materials were mixed in the proportions indicated in the legend of Fig. 118:

- Fraction A: pellet fraction A
- Fraction B: pellet fraction B

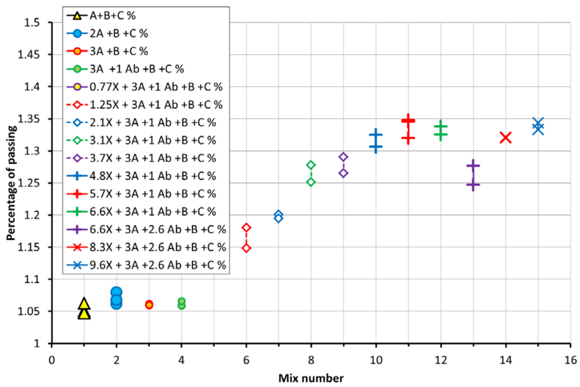
- Fraction C: pellet fraction C
- Fraction Ab: pellet fraction A, all pellets > than 2mm sieved out
- Fraction X: material from industrial mixing test 1, all particles > than 1mm sieved out

For each mixture obtained the mixture pouring dry density was measured twice. Grain size distribution and associated pouring dry density are presented in Fig. 118. The following observations can be made:

- Mixing pellets only does not increase the mixture density. This probably reflects that in the pellet size range is too small. The same exercise with pellets between 1 and 30 mm would probably show an improvement of the pellet mixture dry density.
- As soon as fines are added the mixture density increases, until a maximum value (from mixture 11
- For some reason (unknown, by might relate to mixing energy input), industrial mixing seems more efficient than laboratory mixing. E.g. the grain size distribution of laboratory mixture 7is very similar to the final grain size distribution of industrial mixing test 1 (Fig. 111), but the laboratory mixed mixture pouring density is significantly lower.
- From mixture 11 on, the grain size distribution is very close a Fuller type one with n = 0.4, from that moment on, the pouring dry density stops increasing
- A very small perturbation of this Fuller type distribution (depicted in detail in Fig. 119) creating a step in the grain size distribution (mixture 12 → 13) has a direct influence on the pouring dry density.



(a)



(b)

Fig. 118: Laboratory tests performed on 21 and 22.01.2014: Mixing by hand (a) Evolution of the grain size distribution of the GBM, the grey background dashed line represents Fuller curves with max. grain size = 5, 6 and 7 mm (from top to bottom) and n = 0.4, (b) evolution of the mixture pouring dry density at corresponding mixing time and grain size distribution.

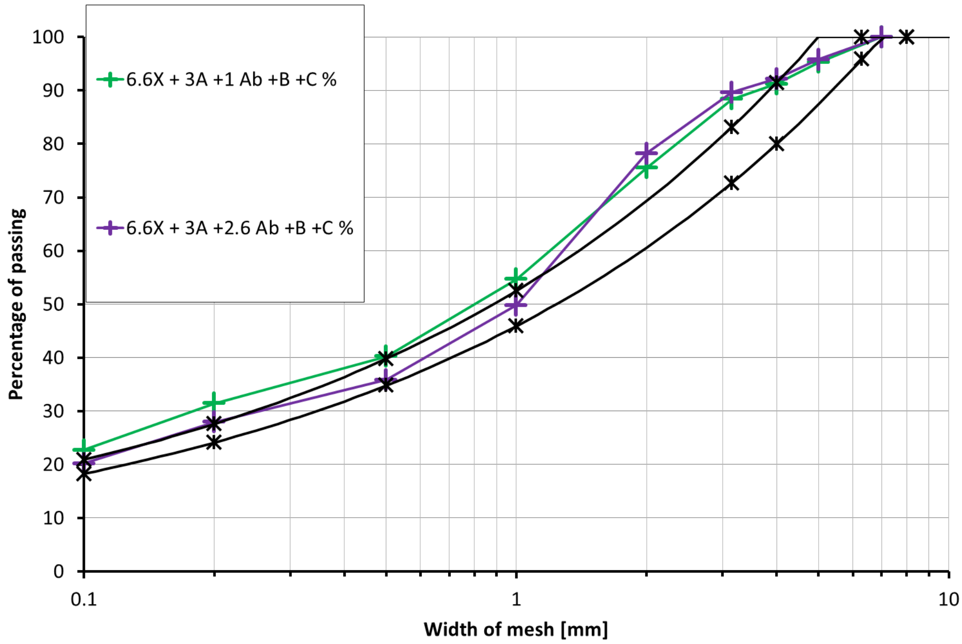


Fig. 119: Grain size distribution of a laboratory prepared mixture very close to Fuller n = 0.4 (green curve) and slightly perturbed mixture (purple curve).

WP 4

On the basis of the mixing tests presented in the previous section and taking into account the amounts of material that were already pelletized, we decided to create 2 different mixtures during this first production.

Mixture 1: 24 tons, Close to FE

Mixture 1 was produced on 28.01.2014 and 29.01.2014 according to the following mixing procedure:

- Product 1: Mix 9.3 tons of pellet fraction B at 2700RPM for 30 minutes. Take product out of the mixer.
- Product 2: Mix 9.3 tons of pellet fraction C at 2700RPM for 30 minutes. Take product out of the mixer.
- Final product: Mix the resulting product from the two previous bullets with left over raw material in proportion 2 x Product 1 + 2 x Product 2 + 1 x raw material. This mixing step was done at 1500RPM for 20 minutes

Quality control: grain size distribution and mixture density of the final mixture every 2 tons.

Production rate was 1 tons per hour.

The measured grain size distribution is given in Fig. 120.

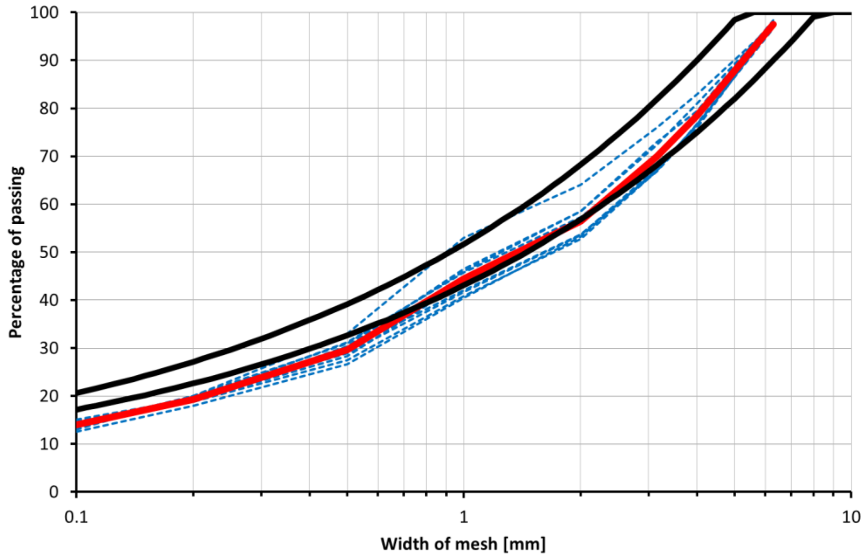


Fig. 120: Grain size distribution of FE mixture 1, measured every 2 tons during production.

Black curves indicate targeted grain size distribution range and red line indicates average of all QC measurements.

Later on, this mixture was used in machinery calibration pre-tests (machine calibration at Wirtech, glass wall test at VSH, etc) and was never emplaced in the FE tunnel or in Grono (see Köhler et al. 2015).

Mixture 2: 106 tons

Mixture 2 was produced on 30.01.2014 and 31.01.2014, 03.02.2014, 04.02.2014, 05.02.2014, 06.02.2014, 07.02.2014, 10.02.2014, 11.02.2014, 12.02.2014 and 13.02.2014 using raw material, and pre-mixed A, B and C pellet fractions in the following proportions:

7X + 35.8A + 25.8B + 25.8C

This second mixture (and especially its proportions) wasdesigned to use up all the material left over at JRS, not deviating too much from a A + B +C mixture. Production rate was 2tons/hour.

The 3 pellet fractions were mixed together during 30 minutes at 2700 RPM in the proportions 35.8A + 25.8B + 25.8C. After that 7 of raw material was added and mixed for 10 minutes at 1500 RPM.

QC: measurement of the grain size distribution and mixture density of the final mixture every 2 tons.

The measured grain size distribution is given in Fig. 121.

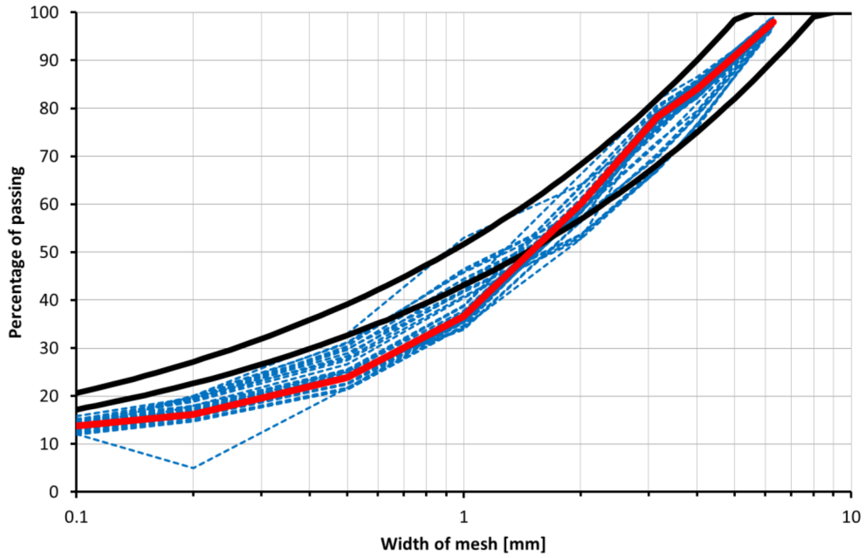


Fig. 121: Grain size distribution of FE mixture 2, measured every 2 tons during production.

Black curves indicate targeted grain size distribution range and red line indicates average of all QC measurements.

Mixture 2 was packed in pink bigbags and was used later on in Grono 1 mock-up, for backfilling of the ISS section and the last tunnel part close to retaining wall. The remaining material is stored at GTS (48 tons).

The grain size distribution of mixture 1 and 2 are compared in Fig. 122.

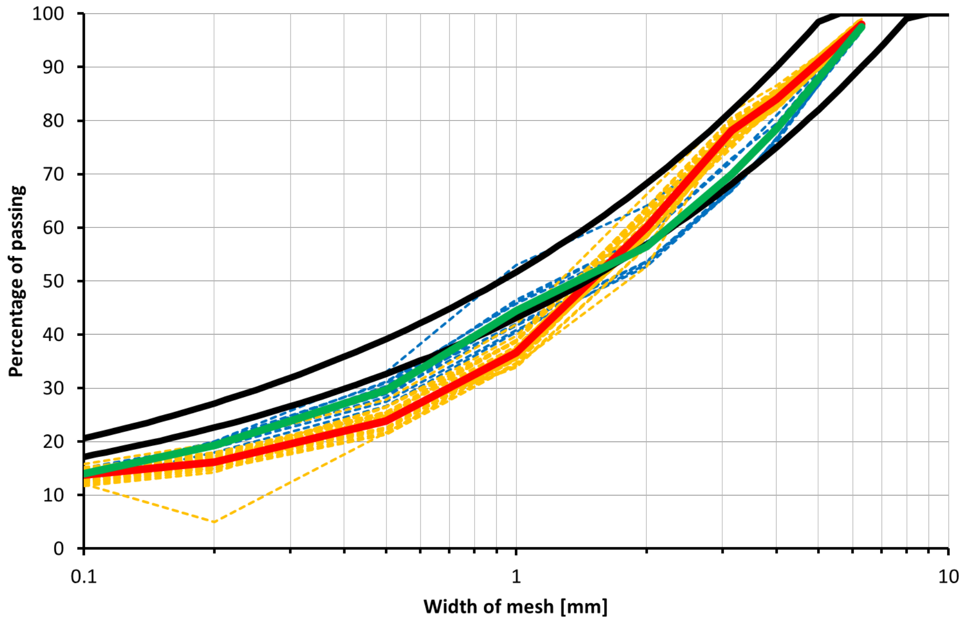


Fig. 122: Comparison of grain size distribution of FE mixture 1 and 2, measured every 2 tons during production.

Black curves indicate targeted grain size distribution range, green curve is the average of all QC measurements of mixture 1 and red line indicates average of all QC measurements of mixture 2.

The mixture pouring dry density of the two mixtures are compared in Fig. 123.

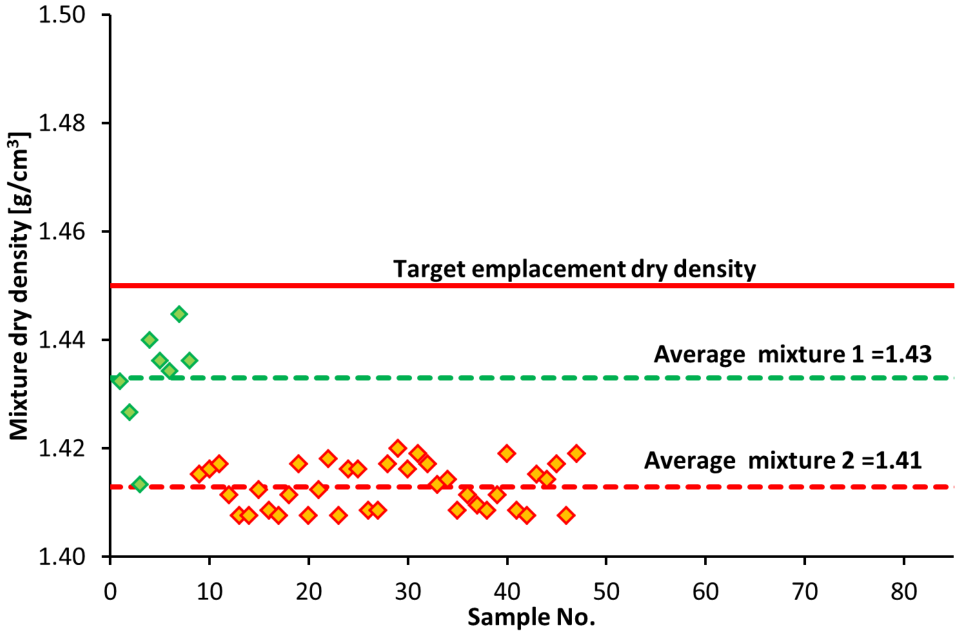


Fig. 123: Mixture pouring dry density for FE mixture 1 and 2, measured every 2 tons during production.

Mixture 1 was also used in an external laboratory (TFB, see appendix L) to investigate the influence of perturbations of the grain size distribution relative to Fuller n = 0.4 on the mixture pouring dry density. Note the measurement of the mixture pouring dry density in this investigation was not done according to the protocol defined in appendix K. One of the main outcomes of this study is that it suggests that Fuller type n = 0.4 mixtures have a higher capability than perturbed mixtures to be compressed. The influence of the maximum grain size and the control of the shape of the grain size distribution at the side of very small particles were also addressed here.

3.4 Production of 216 tons and Quality Control

WP 1 and 2

192 tons of National ® Standard WP2 and 24 tons of National ® Standard were produced at CEBO Holland. QC results from this production did not deviate from the first production. They are not repeated herein.

WP 3

JRS tried to dry 2 batches of 8 tons each of National ® Standard down to 2 % and 7 % in order to better characterize the pelletization Proctor curve, but the drying operations were not successful.

Pelletization of 138 tons of National ® Standard WP2 and 24 tons of National ® Standard was performed from 22.05.2014 until 04.06.2014. Only one pellet fraction, mimicking softly mixed pellet fractions B and C from the previous production, was ordered. The required grain size distribution of the ordered pellet fraction is depicted in Fig. 124. Measurement of pellet density, water content and grain size distribution of the pelletized material according to the procedure developed in the previous production was required at a sampling rate of once per ton for the 24 tons of pellets produced with National ® Standard and of once per 3 tons in the last 138 tons was carried out. In total 70 samples were taken during the pelletization operations and 100 g of material from each of the 70 samples was conserved and packed individually in airtight bags and sent to Nagra.

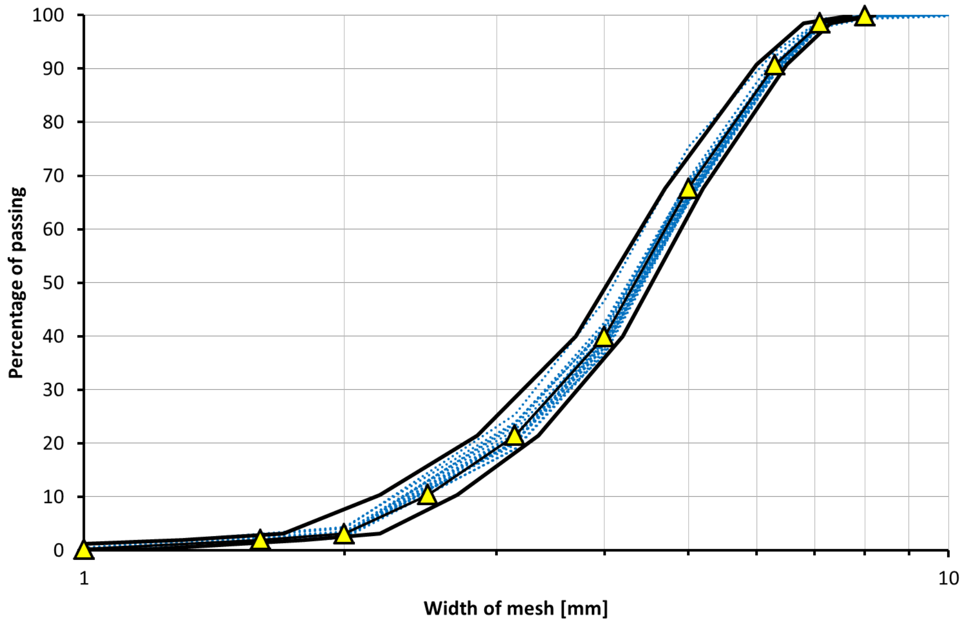


Fig. 124: Required pellet grain size distribution for the second pelletization campaign.

The QC of the pellet dry density performed at JRS is depicted in Fig. 125 for pellets produced with National ® Standard WP2. The average pellet dry density measured immediately after production was 2.14 g/cm^3. The QC value performed at JRS were confirmed by an independent analysis at ETH (see appendix L).

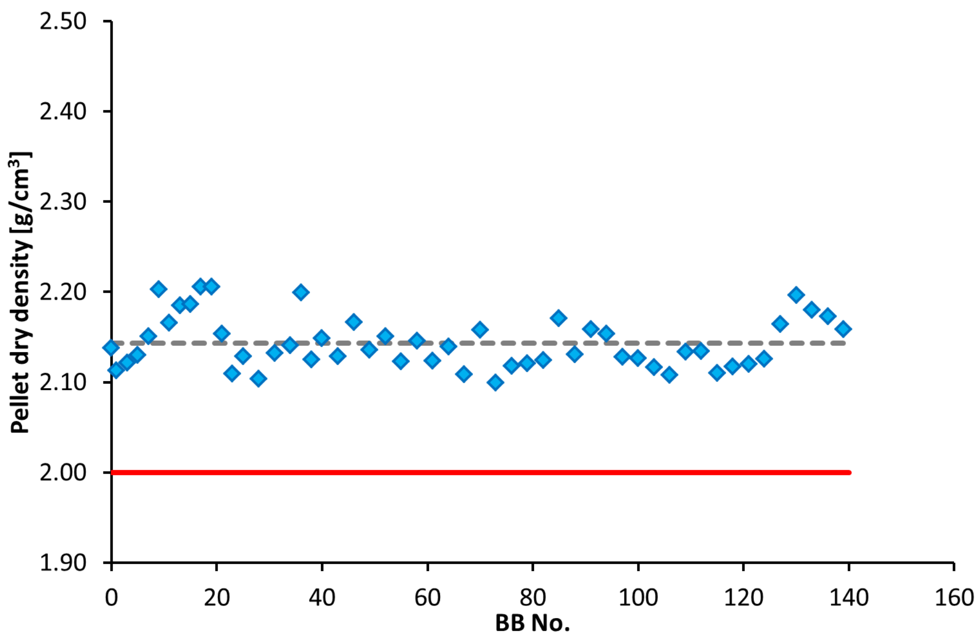


Fig. 125: Pellet dry density measured every 3 tons during the second pelletization campaign.

The pellet dry density measured on pellets of National ® Standard WP2 and of National ® Standard is compared in Fig. 126.

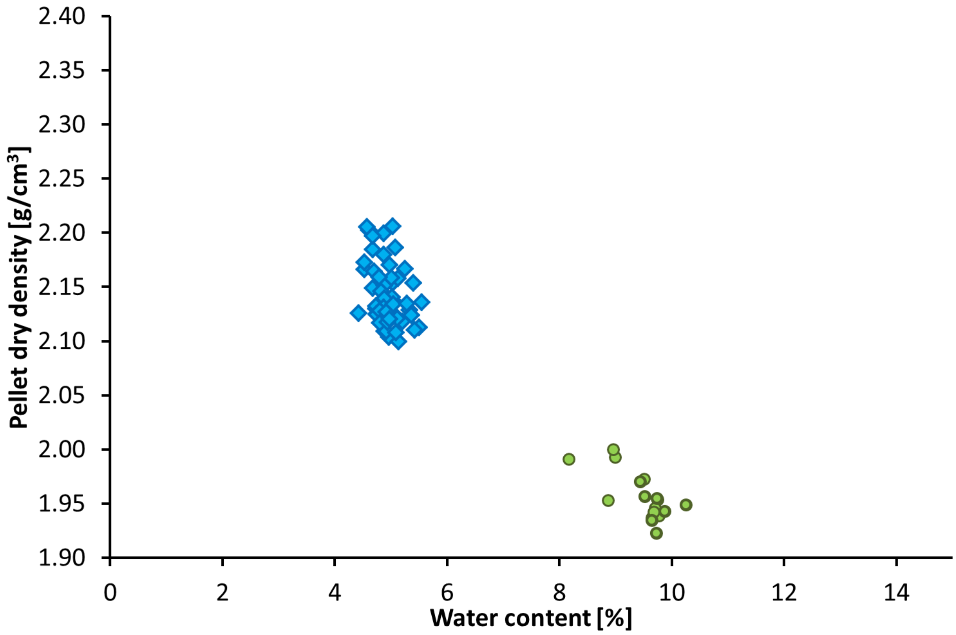


Fig. 126: Pellet dry density for mixture 3 and 4 as a function of the water content.

The QC of the water content performed at JRS is depicted in Fig. 127 for pellets produced with National ® Standard WP2. The average water content measured immediately after production was 4.95 %.

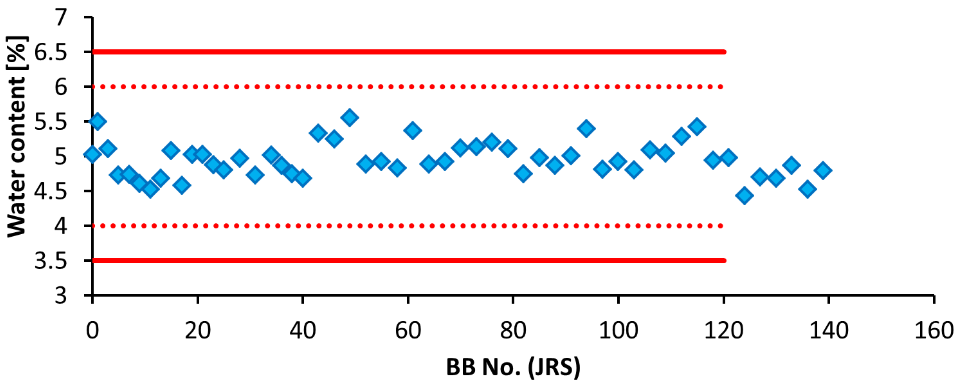


Fig. 127: Water content of the pellets measured every 3 tons during the second pelletization campaign.

Target grain size distribution for the pellets could not be achieved in the second campaign because the 8 mm sieve required for this process (see Fig. 94) was not available and a 6.3 mm sieve had to be used instead. The QC results of the grain size distribution are given in Fig. 128.

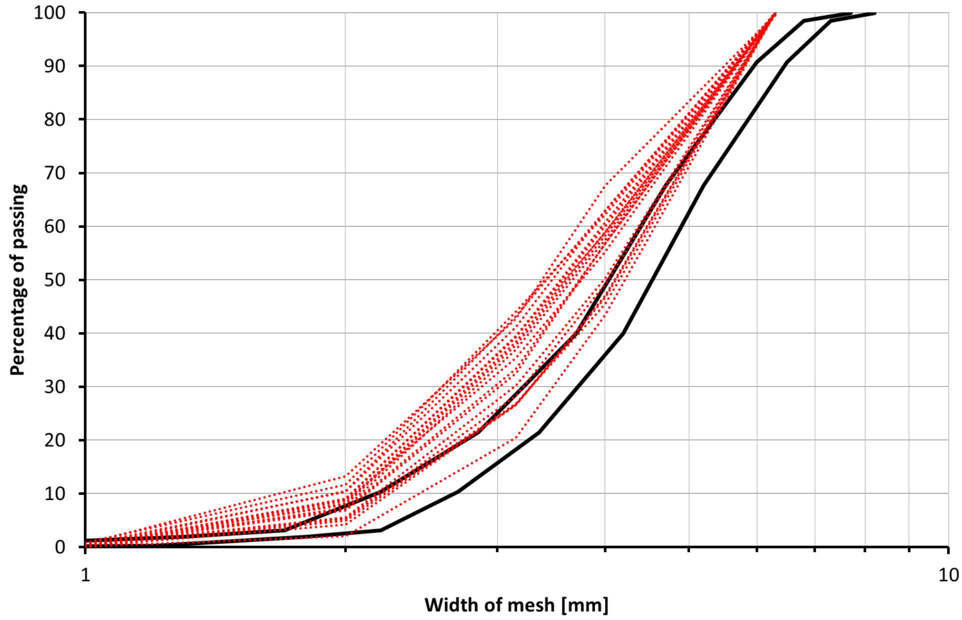


Fig. 128: Grain size distribution distribution of the pellets measured every 3 tons during the second pelletization campaign. Target grain size distribution range is indicated by black curves.

WP 4

Mixture 3

184 tons of mixture 3 were produced from 22.05.2014 until 16.06.2014 in batches of 4 tons according to the following procedure:

- Step 1: a batch of 3 tons of the previously produced bentonite pellets (National ® Standard WP2) is introduced in the Kniele mixer and mixed during 20 minutes at a motor rotation speed of 2700 RPM.
- Step 2: 1 ton of National ® Standard WP2 was added to the pre-mixture and the 4 tons were mixed during 20 minutes at a motor rotation speed of 1500 RPM.

JRS measured the grain size distribution, the water content and the pouring dry density of the final mixture at a sampling rate of once per 2 tons. 200 g of material from each of the samples was conserved and packed individually in airtight bags.

The grain size distribution of mixture 3 and its pouring dry density measured by JRS are depicted in Fig. 129 and Fig. 130.

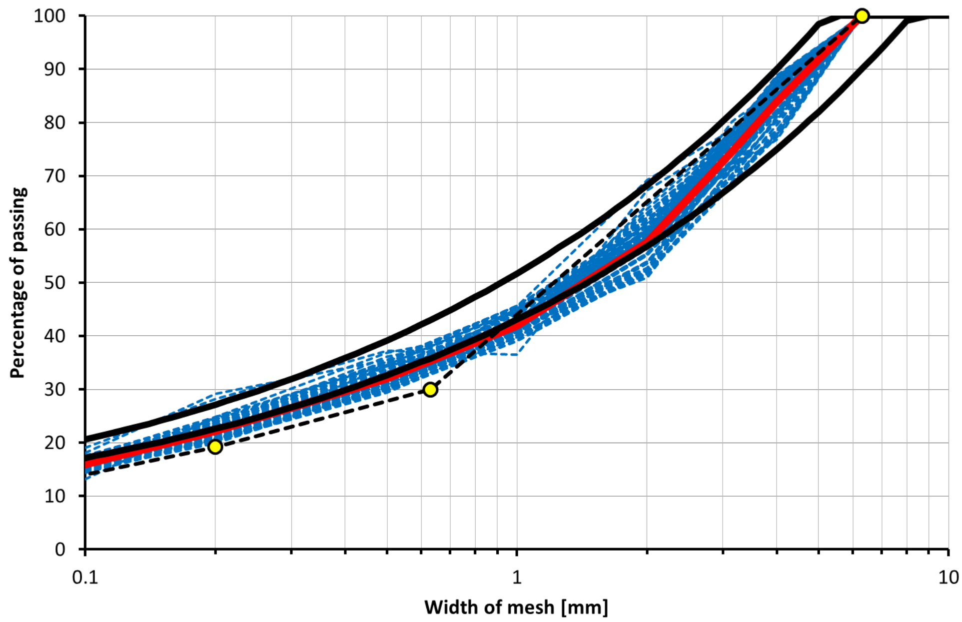


Fig. 129: Grain size distribution of FE mixture 3, measured every 2 tons during production.

Black curves indicate targeted grain size distribution range and red line indicates average of all QC measurements.

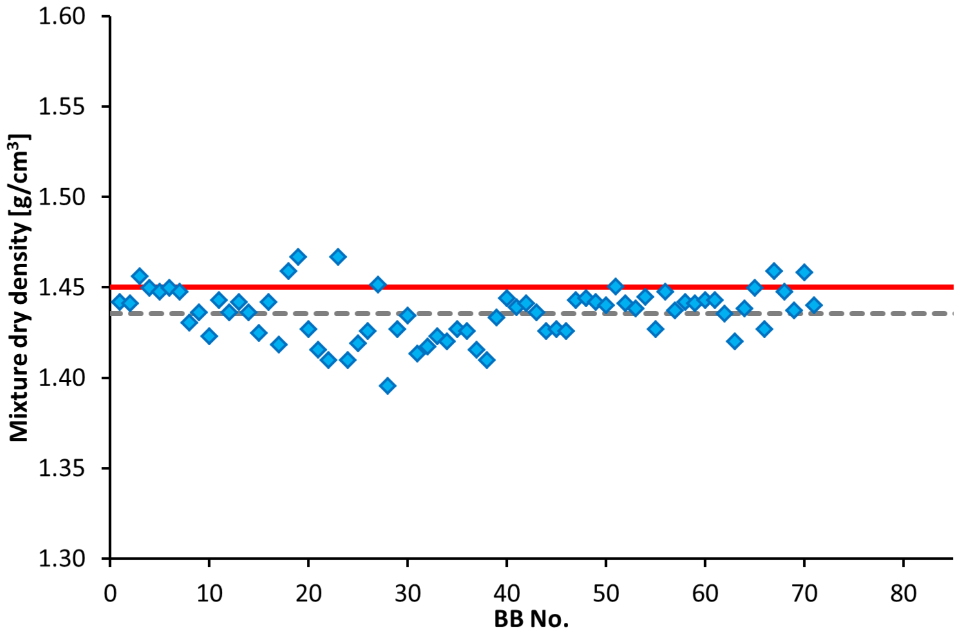


Fig. 130: Mixture pouring dry density for FE mixture 3, measured every 2 tons during production.

Mixture 3 was packed in blue bigbags and was used later on for the second mock-up test in Grono and to backfill the heated section of the FE tunnel. 5 tons of this mixture was conserved and will be used as retain material and to perform some further laboratory testing.

Mixture 4

32 tons of mixture 4 were produced from 17.06.2014 in batches of 4 tons in a similar way to mixture 3 and according to the following procedure:

- Step 1: a batch of 3 tons of the previously produced bentonite pellets (National ® Standard) is introduced in the Kniele mixer and mixed during 20 minutes at a motor rotation speed of 2700 RPM.
- Step 2: 1 ton of National ® Standard WP2 was added to the pre-mixture and the 4 tons were mixed during 20 minutes at a motor rotation speed of 1500 RPM.

The pellets of mixture 4 are thus characterized by a relatively high water content and a relatively low pellet dry density and the raw material add mixture by the same water content as in the other mixtures.

JRS measured the grain size distribution, the water content and the pouring dry density of the final mixture at a sampling rate of once per 2 tons. 200 g of material from each of the samples was conserved and packed individually in airtight bags.

The grain size distribution of mixture 4 is very similar to that of mixture 3 (Fig. 131). The effect of the pellet dry density on the mixture dry density can thus be compared directly. This is done in the next section.

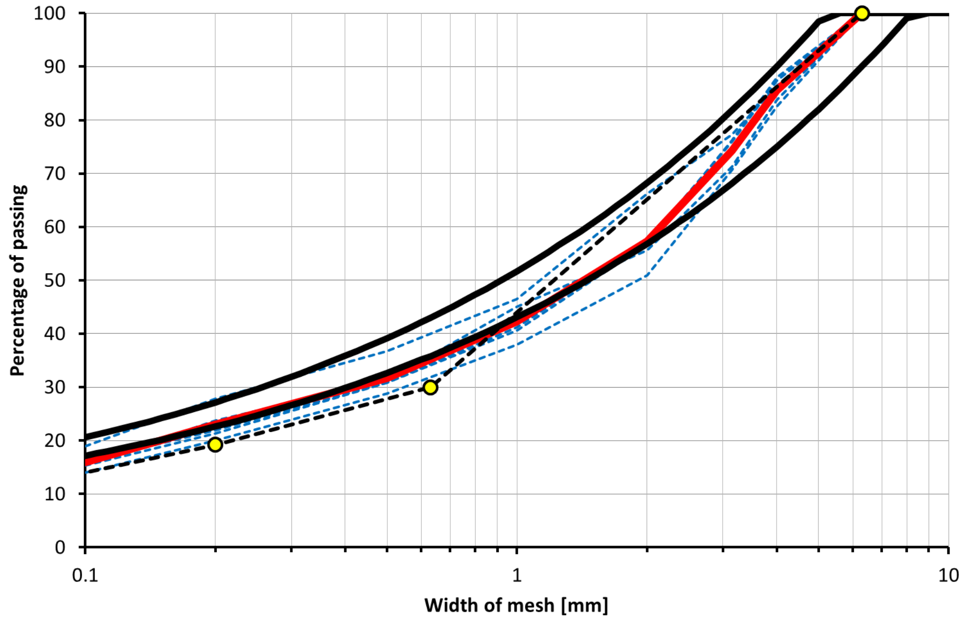


Fig. 131: Grain size distribution of FE mixture 4, measured every 2 tons during production.

Black curves indicate targeted grain size distribution range and red line indicates average of all QC measurements.

Mixture 4 was packed in Green and red bigbags and was not used in the FE experiment. This mixture is currently still in Mont Terri and is planned to be used as sealing material for water pounds near to the Transjura highway.

Comparison of the 4 mixtures

The grain size distribution of the 4 different mixtures are compared in Fig. 132. The main mixture, mainly used in the FE tunnel is within the targeted Fuller range and is characterized by a simple receipt, consisting of only one pellet fraction that is pre-mixed at full force to which an add mixture of 33 % additional raw material is finally smoothly mixed.

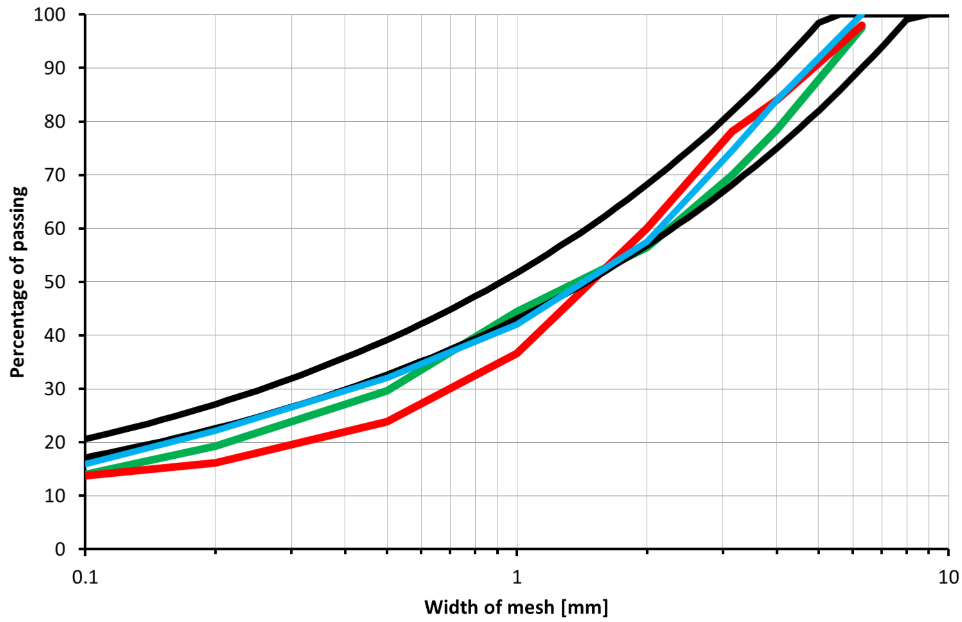


Fig. 132: Comparison of average grain size distribution of FE mixture 1 (green curve), 2 (red curve) and 3 (blue curve, mixture 4 is very similar to 3), measured every 2 tons during production.

Black curves indicate targeted grain size distribution range and red line indicates average of all QC measurements.

The pouring dry density of the 4 different mixtures are compared in Fig. 133. It is interesting to note that:

- Mixture 1 and 3 are characterized by a similar grain size distribution and a similar pellet dry density and that they have a similar pouring dry density
- Mixture 3 and 4 are characterized by a similar grain size distribution but that the pellet dry density of mixture 3 is approx. 10 % higher than that of mixture 4. The higher pellet dry density of mixture 3 results in a 4 % higher pouring dry density for this mixture.
- Mixture 1 and 2 are characterized by a similar pellet dry density but mixture 2 deviates more from Fuller and this results in a loss of pouring dry density for mixture 2.

Pellets are damaged during the mixing process this might result in a loss of pellet dry density. This potential loss was estimated by measuring the pellet dry density of different size classes (Fig. 134). Seemingly big particles do not suffer degradation, whereas smaller pellets (that were obtained as a result of splitting larger particles) have pellet dry density loss of approx. 10 %.

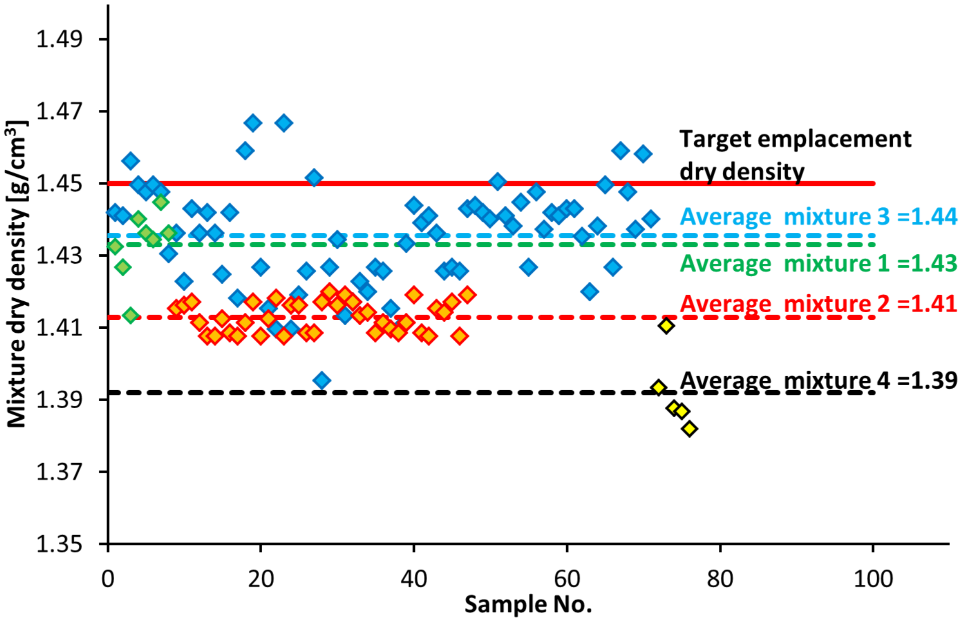


Fig. 133: Comparison of the mixture pouring dry density for FE mixture 1 (green dots), 2 (red dots), 3 (blue dots) and 4 (yellow dots), measured every 2 tons during production.

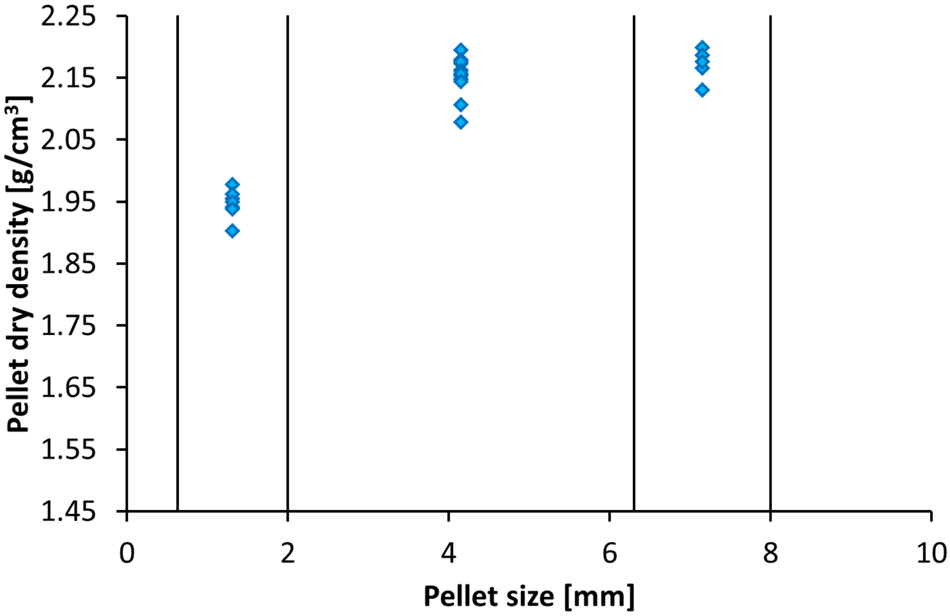


Fig. 134: Pellet dry density measured at ETH using a GeoPyc, for three different sizes of pellets (1, between 0.63mm and 2 mm; 2, between 2mm and 6.3 mm and 3, between 6.3 mm and 8 mm).

10 measurements for class 1 and 2 and 5 measurements for class 3 (each measurement was performed twice).

It is interesting to mention that the mixer was damaged during the production. The wings of the central screw presented signs of damage through abrasion. This can be observed in Fig. 135.

Fig. 135: Inside view of the mixer after producing 216 tons.
Damage is visible on the lower screw wings.

MPC did compare the mixture pouring dry density of mixture 3 and crushed pellet mixture from ANDRA's FSS experiment (appendix H). Note that the measurement of the mixture pouring dry density in this investigation was not done according to the protocol defined in appendix L.

The mineralogy of the produced GBM was also checked by two independent laboratories (BGR and ETH) by random sampling (n = 20 for each laboratory). The results of this QC are given in appendix F and appendix G.

3.5 Emplacement of the GBM in the FE tunnel

The GBM was also characterized before emplacement in the FE tunnel. Water content values measured during emplacement were slightly higher than those measured by JRS (Fig. 136). Nevertheless, the difference is not significant and can easily be explained by the different measurement techniques. During emplacement the water content was measured by oven drying.

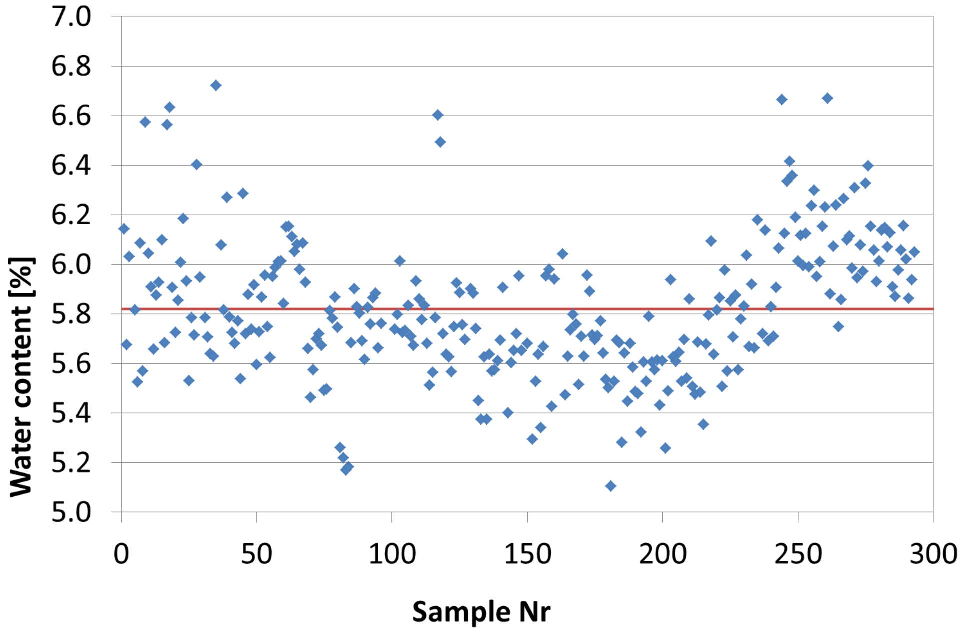


Fig. 136: Water content measured by oven drying (110 °C, 72 hours) on samples taken during the emplacement.

Pellet dry density measured during emplacement is slightly lower than after production (Fig. 137), but as the pellet bulk density was equal after production and during emplacement, the difference in pellet dry density is fully attributed to the different measurement of water content. GBM was thus probably unaffected by storage.

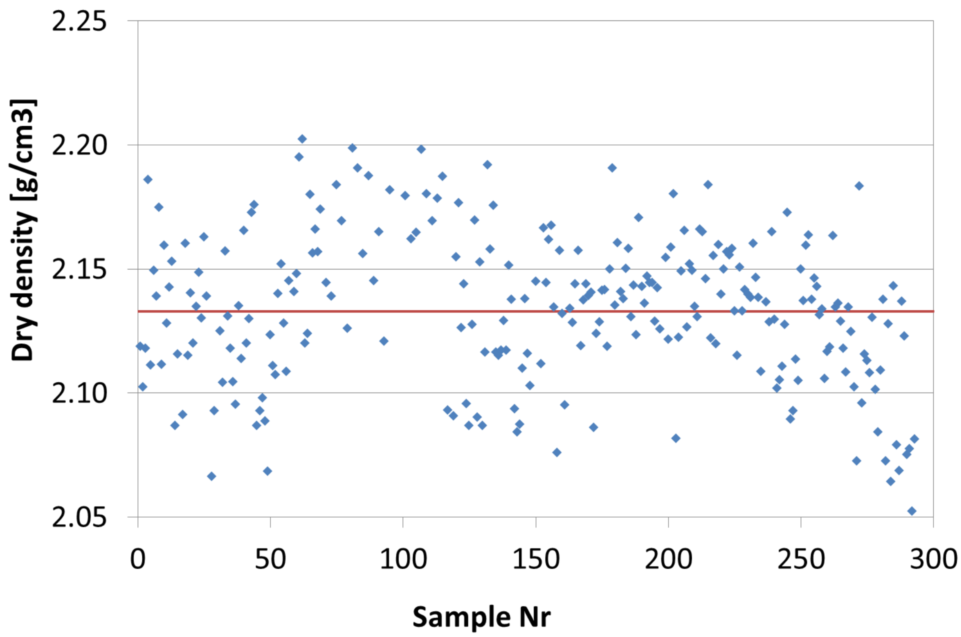


Fig. 137: Pellet dry density on samples taken during the emplacement.

Note some samples of mixture 4 were sieved in February 2015 and the water content of the different fractions was measured. Fines are characterized by lower water content as pellets (water exchange between pellets and fines still ongoing, equilibrium not reached after 8 months!).

3.6 Lessons learnt and open questions

The splitting of the production processes in 4 work processes proved to result in a satisfactory end product. **A clear and simple receipt** (Mixture 3) **was established to produce a GBM at industrial scale** that was emplaced in the FE tunnel at an emplacement dry density of approx. 1.5 g/cm^3, with a potential to be further compressed. Furthermore, the material is robust and supports well storage and many handling steps.

The requirements described in section 3.2 had to be slightly adapted for practical reasons during production (maximum grain size of the pellets was smaller than desired and the mixture characteristics had to be optimized; final mixture characteristics were within requirements).

The procedure was defined on the basis of an extended analysis of existing literature. The main control parameters (water content, pellet dry density, grain size distribution of mixture) were proven to have a low variation, in favour of a homogeneous emplacement. The production of a mixture with a Fuller-type distribution is also believed to provide a segregation resistant material.

The lessons learnt in the different work processes are:

WP 1 the required raw bentonite

MX 80 is not the only natural sodium bentonite from Wyoming that can be used to produce a GBM. The bentonite used in this production (National ® Standard WP 2) has similar characteristics and is cheaper.

WP 2 the drying process of the raw bentonite

Production rate: 1.5 tons/hour

It is possible to dry raw bentonite at the industrial scale without overheating the material (material temperature < 80 °C). A second passage through the dryer might decrease the water content even more.

WP 3 the required bentonite pellets

Production rate: 1 to 2 tons/hour

A raw bentonite dried at a water content in the range 4 % to 6 % and characterized by a grain size distribution between very fine and 1mm in combination with the flat roller compaction technology proved to be a convenient choice to produce high density bentonite pellets at the industrial scale.

Precise and systematic determination of Proctor's optimum at high compaction pressures for different types of bentonite and also different raw material grain size distributions would probably help decision making in future productions. This could be carried out by performing simple laboratory compaction experiments. Determination of Proctor’s optimum at industrial scale would also be very helpful. Note that an increase of 10 % of the pellet dry density was shown to result in an increase of nearly 5 % of the GBM pouring dry density.

The targeted maximum grain size of the pellets was impossible to reach with flat rollers.

The pellet dry density was slightly smaller in the second production. The reason is unclear although the ambient temperature (first production in winter and second production in spring-summer) might have played a role.

WP 4 the required bentonite pellet mixture, including rounding of the constituents Production rate: 2 tons/hour.

It is very important to fill the large pores between large particles, by smaller particles, even if the smaller particles have a smaller particle density. This filling can follow a fractal scheme and hence, the broader the grain size distribution, the better. A broader grain size distribution could be obtained by an increase of the maximum grain size of the pellets, resulting in a higher emplacement dry density. Nevertheless, an increase of the maximum grain size might lead to severe grain size distribution changes during the emplacement process (breakage of larger particles). In fact, for FE smaller maximum grain size as originally planned had to be accepted for cost reasons. If further increase of GBM dry density is desired, this is probably the most promising way.

Heavy energy input during industrial mixing has a positive impact on the GBM pouring dry density compared to laboratory scale. Nevertheless, a systematic laboratory exploration of the influence of grain size distribution of bentonite mixtures on pouring density, similarly to the work of Gloth & Strauss (1995), but in a broader range and also considering the influence of particle density of different sizes would also improve decision making in future productions.

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Appendix A: Bentonite Ressources

Bentonite mines are found all over the world. The world reserves of bentonite are presented in Tab. A-1 The USA accounts for almost half of the reserves, but also of the world production (Virta 2005). Roskill (2005) gives a more detailed overview, including the different production companies.

Tab. A-1: Bentonite reserves in thousand metric tons as estimated by the U.S. Geological Survey in 2013 (minerals.usgs.gov).

	Bentonite	
	2011	2012[e]
United States (sales)	4,810	4,800
Brazil (beneficiated)	532	540
Czech Republic (crude)	160	180
Germany (sales)	350	350
Greece (crude)	850	900
Italy	110	110
Mexico	54	54
Spain	155	160
Turkey	1,000	1,000
Ukraine (crude)	185	210
United Kingdom (sales)	—	—
Uzbekistan (crude)	—	—
Other countries	2,100	2,000
World total (rounded)	10,300	10,000

There are two main types of bentonite: Sodium bentonite (also called swelling bentonite) and Calcium bentonite, each named after the respective dominant element in solution in the clay platelets. Herein we focus on Sodium bentonite.

The Cretaceous 'Wyoming' or 'western' bentonite deposits of the USA are the world's principal source of high-swelling capacity sodium-bentonite[2]. Major mines are located in Wyoming, Montana and South Dakota. The major mining companies present in Wyoming and Montana are (http://active-mines.findthedata.org/d/c/Bentonite):

- AMCOL (American Colloid Co – http://www.amcolspecialtyminerals.com/): 8 mines
- Bentonite Corp: 2 mines
- Bentonite Performance Minerals LLC (www.bentonite.com/): 1 mine
- Black Hills Bentonite LLC (http://www.bhbentonite.com/): 7 mines
- M-I LLC: 1 mine
- Wyo-Ben (we are Wyoming bentonite - www.wyoben.com): 1 mine

[2] In fact, the name "bentonite" comes from Wyoming, from the Benton Shale outcropping in Wyoming; Benton Shale is named after Fort Benton, one of the oldest American settlements in the West on the banks of the Missouri (Montana). Synonyms: Montmorillonite clay, fuller's earth, bleaching earth, etc. Sodium bentonite (also called swelling bentonite) and Calcium bentonite.

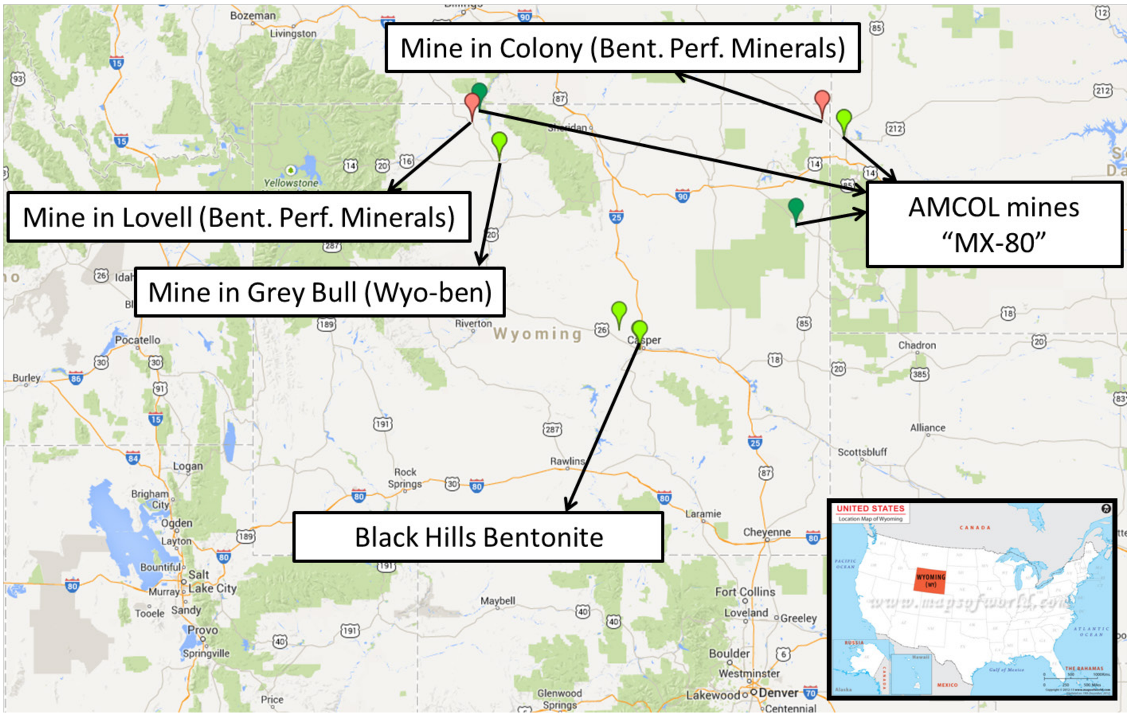

Fig. A-1: Location of some bentonite mines in Wyoming.

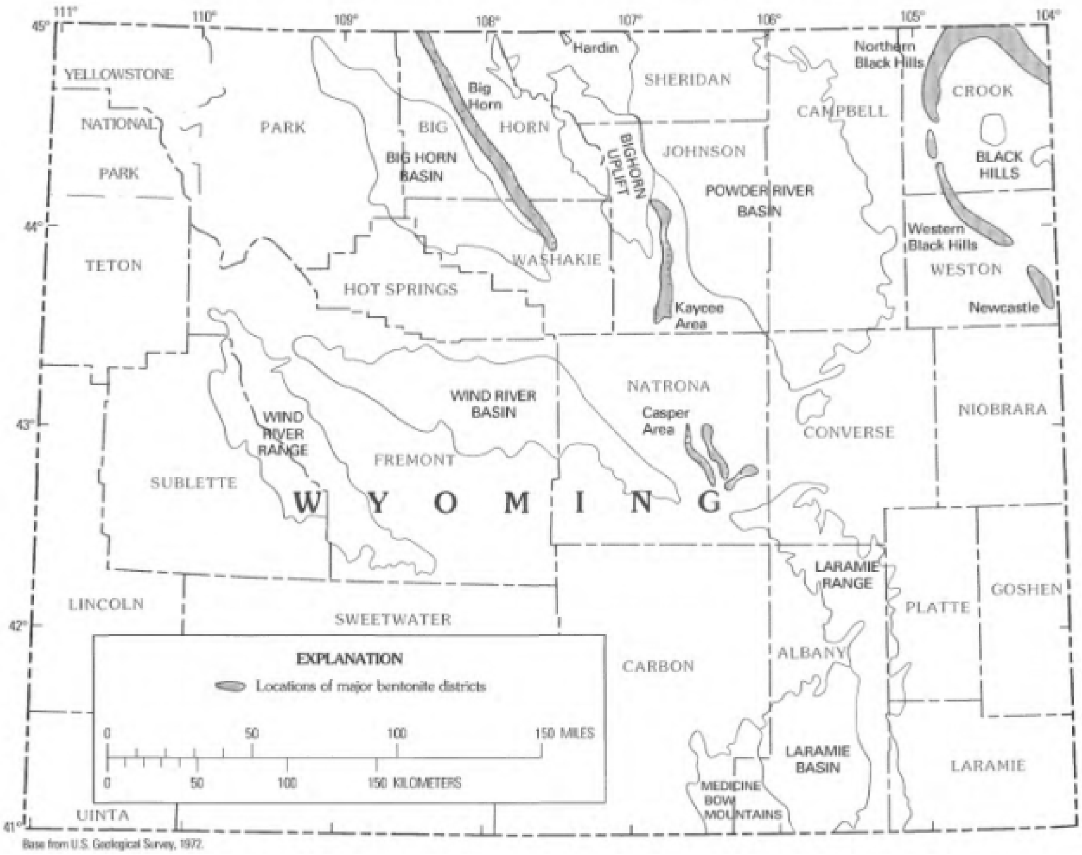

Fig. A-2: Location of major bentonite districts in Wyoming. (U.S. Geological Survey, minerals.usgs.gov).

BENTONITE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE[1]

(Metric tons)

Use	2003	2004
Domestic:		
Absorbents:		
Pet waste absorbents	888,000 [r]	944,000
Other absorbents	W	W
Adhesives	5,560 [r]	2,240
Animal feed	49,600 [r]	44,500
Ceramics (except refractories)[2]	W	W
Drilling mud	772,000 [r]	776,000
Filler and extender applications[3]	41,300	39,000
Filtering, clarifying, decolorizing	W	W
Foundry sand	761,000 [r]	745,000
Pelletizing (iron ore)[4]	511,000 [r]	526,000
Miscellaneous refractories	W	--
Miscellaneous[5]	356,000 [r]	560,000
Waterproofing and sealing	W	W
Total	3,380,000 [r]	3,640,000
Exports:		
Drilling mud	56,700 [r]	58,200
Foundry sand	217,000 [r]	217,000
Other[6]	108,000	149,000
Total	382,000 [r]	424,000
Grand total	3,770,000 [r]	4,060,000

Fig. A-3: Usage of bentonite in the US (U.S. Geological Survey, minerals.usgs.gov).

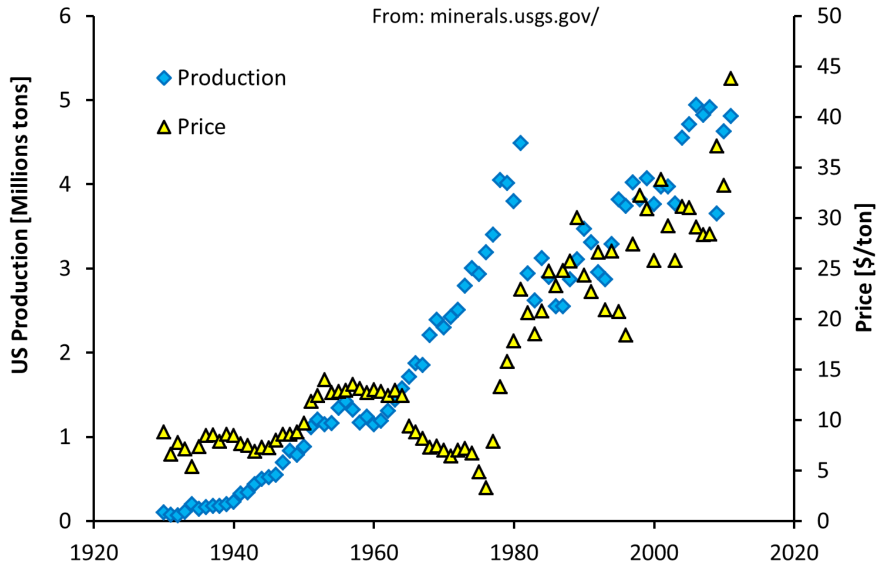

Fig. A-4: Production and price of bentonite in the US (U.S. Geological Survey (minerals.usgs.gov)).

Other natural sodium bentonite mines worldwide are scarce. Some are located in China, but the material is not well known and the available documentation is poor (some producer websites available only in Chinese):

- Fu Yuan Enterprise PTE LTD (China, http://www.fuyuanww.com.sg)
- Weifang Huawei bentonite group (China, http://www.bentonite-hw.com/english/ zuanjing.htm)

- Zheijang Fenghong new material Co., Ltd (http://www.zjfenghong.com)
- Changsha Green Mountain Chemical Co., Ltd. http://changshamayshine.en.made-in-china.com/product/YMQmEuKTuVhl/China-Bentonite-Na-Sodium-Base-.html

Others are located in India. The available documentation is better than for Chinese bentonites:

- Ashapura Minechem Pvt. Ltd (http://www.ashapura.com/) (connected to AMCOL through Volclay International)
- Gex-Min Co. (http://gexmin.com/)
- Gimpex Ltd. (http://www.gimpex.com/)
- Kutch minerals (http://www.kutchminerals.com/)
- http://www.monaexim.com (reseller)

In Italy:

- Laviosa (http://www.laviosa.it/index.php?environment-natural-sodium-bentonite)

In Brasil:

- Bentonit União Nordeste (http://www.bentonit.com.br/bentonitas.asp)

In Germany, all mined bentonite is calcium bentonite, part of which is then converted into activated sodium bentonite (Roskill 2005). They are thus not listed here.

More providers of natural sodium bentonite can obviously be found (see Roskill 2005), but the list given above is judged to cover a range of providers significant enough to obtain an overview of possibilities and refine our selection criteria.

Materials from some of the providers mentioned above have been tested by SKB (mostly focusing on mineralogy and swelling potential). Their findings are described in Karnland (2010) and Savage & Arthur (2012), among others. Nagra engaged Cuevas et al. (2014) to establish a similar comparison basis for different bentonites. They also discuss the stability of the smectite content observed over the two last decades for MX-80 bentonite. The results are summarized in terms of smectite content and CEC in Tab. 19 to enable Nagra to make a first selection when asking for offers for the bentonite material for the FE experiment.

Tab. A-2: Compilation of smectite content and cation exchange capacity of different bentonites from Savage & Arthur (2012), Koch (2008) and Cuevas et al. (2014).

A more extended study from Karnland (2010) show results similar to Savage & Arthur (2012).

		Smectite content [%]	**% of exchange sites**		**CEC** [eq/kg]
			Na	Ca	
Savage & Arthur (2012)	ABM MX-80	83.7	71	20	0.84
	WyMX-80	76.3	69	23	0.85
	Volclay	76.3	69	21	0.89
	ABM DepCaN	68	29	38	0.82
	AC200	76.8	84	6	0.95
	ABGM Asha	55.1	76	13	0.90
	Basic Star	73	51	30	0.92
	HLM Star	65.6	76	13	1.00
	Ca-Star	81.3	55	29	1.00
	ABM Friedland	19.2	76	4	0.26
	SH Friedland	23.9	83	2	0.31
Cuevas et al. (2014)	Newgel	72			0.84
	GWB	89			0.82
	TZZ	87			0.73
	BC	76			0.79
	BLZ	82			0.82
	RYS	93			0.84
	MMT	90			0.95
	MX-80 CETCO	87			0.87
	MX-80 Amcol	84			
	FEBEX	94	4	27	0.98
	China	62			0.80
	Milos TK-FG	79			0.81
	Milos SB&B	90			0.87
	GMZ	83			0.75
	Expangel SP7-D5	89			0.77
	Grezza	98			0.94
	India 5	90			0.88
	India 20	88			0.84
	India 40	86			0.82
Koch (2008)	Ibeco RWC	75-85		x	0.8-0.9
	Ibeco RWN	85-95	x		0.95 – 1.05
	MX-80	65 – 75 (??)	x		0.7 – 0.8

Appendix B: Bentonite Blocks pre-production

B.1 Bentonite blocks pre-production 1

Trial production of 180 Na and Ca bentonite blocks (November 2012)

B.1.1 General context

For nuclear wastes repository design, Nagra needs to build a bed of compacted clay, around 70 cm high that will support a canister of 80 cm in diameter and 4.5 m long.

To build this bed of compacted clay, Nagra thinks to assembly series of blocks of compacted clay.

B.1.2 Key datas

B.1.2.1 Clay to compact

Nagra asked Laviosa MPC to press natural sodic bentonite from Wyoming, Bentosund WH2, at 3 water contents and using 3 compaction forces.

Nagra was also looking for a non-activated calcium bentonite, pressed with the same conditions that Bentosund WH2 to compare.

Laviosa MPC proposed its Bentosund SPK.

B.1.2.2 Program of the trials

Clay	**Number of parts to do**	**Target mass of one block** [kg]	**Target of water content** [%]	**Compaction force** [MPa]
Bentosund WH2	10 10 10	14 14 14	12 12 12	70 10 130
	10 10 10	14 14 14	16 16 16	70 10 130
	10 10 10	14 14 14	20 20 20	70 10 130
Bentosund SBK	10 10 10	14 14 14	12 12 12	70 10 130
	10 10 10	14 14 14	16 16 16	70 10 130
	10 10 10	14 14 14	20 20 20	70 10 130

B.1.3 Material preparation

Water content of the 2 clays has been adjusted in Laviosa MPC factory of Limay (France – 78520).

Because of the small quantities to process (140 kg per batch), industrial mixer with water spray nozzles has not been used. The 2 equipements at Laviosa MPC's are design for quantities from 800 to 1200 kg.

A concrete mixer has been prefered, using a pressurized hand pray gun.

Average water content has been controlled by Laviosa MPC's lab control and is reported in appendixes.

Due to the pressing mode (manual mode for small quantities – 180 blocks in total), each mass necessary to press one block has been weighted and packed in one single airproof and waterproof bucket.

B.1.4 Pressing conditions

The production has been made on a LAEIS press of 1600T using uniaxial compaction, with 4 columns of guidance, a locked lower press plate and a moving upper plate, and a flotting mould coupled with the movement of the upper plate to simulate double effect.

The mold is composed of 2 holes to press 2 blocks in one cycle.

Each hole has been filled with one bucket, manually, at each cycle.

The production has been done in the following order:

1. 10 blocks of Bentosund WH2 at w = 12 % pressed at 70 MPa
2. 10 blocks of Bentosund WH2 at w = 16 % pressed at 70 MPa
3. 10 blocks of Bentosund WH2 at w = 20 % pressed at 70 MPa
4. 10 blocks of Bentosund WH2 at w = 12 % pressed at 100 MPa
5. 10 blocks of Bentosund WH2 at w = 16 % pressed at 100 MPa
6. 10 blocks of Bentosund WH2 at w = 20 % pressed at 100 MPa
7. 10 blocks of Bentosund WH2 at w = 12 % pressed at 130 MPa
8. 10 blocks of Bentosund WH2 at w = 16 % pressed at 130 MPa
9. 10 blocks of Bentosund WH2 at w = 20 % pressed at 130 MPa
10. 10 blocks of Bentosund SPK at w = 12 % pressed at 70 MPa
11. 10 blocks of Bentosund SPK at w = 16 % pressed at 70 MPa
12. 10 blocks of Bentosund SPK at w = 20 % pressed at 70 MPa
13. 10 blocks of Bentosund SPK at w = 12 % pressed at 100 MPa
14. 10 blocks of Bentosund SPK at w = 16 % pressed at 100 MPa
15. 10 blocks of Bentosund SPK at w = 20 % pressed at 100 MPa
16. 10 blocks of Bentosund SPK at w = 12 % pressed at 130 MPa
17. 10 blocks of Bentosund SPK at w = 16 % pressed at 130 MPa
18. 10 blocks of Bentosund SPK at w = 20 % pressed at 130 MPa

Production started on Wednesday 14 November 2012 at 8h15 and finished on the same day at 12h55. Logs of production are available in appendixes.

B.1.5 Storage

The 180 blocks have been packed on 3 palettes (80cm x 120cm), according to the following descript-tion:

Palette 1: 60 blocks (6 layers of 10 blocks)

Top - Layer 6: 10 blocks of Bentosund WH2 at w = 20 % pressed at 100 MPa

- Layer 5: 10 blocks of Bentosund WH2 at w = 16 % pressed at 100 MPa

↑ - Layer 4: 10 blocks of Bentosund WH2 at w = 12 % pressed at 100 MPa

↓ - Layer 3: 10 blocks of Bentosund WH2 at w = 20 % pressed at 70 MPa

- Layer 2: 10 blocks of Bentosund WH2 at w = 16 % pressed at 70 MPa

Bottom - Layer 1: 10 blocks of Bentosund WH2 at w = 12 % pressed at 70 MPa

Palette 2: 60 blocks (6 layers of 10 blocks)

Top - Layer 6: 10 blocks of Bentosund WH2 at w = 20 % pressed at 130 MPa

- Layer 5: 10 blocks of Bentosund WH2 at w = 16 % pressed at 130 MPa

↑ - Layer 4: 10 blocks of Bentosund WH2 at w = 12 % pressed at 130 MPa

↓ - Layer 3: 10 blocks of Bentosund SPK at w =2 0 % pressed at 70 MPa

- Layer 2: 10 blocks of Bentosund SPK at w = 16 % pressed at 70 MPa

Bottom - Layer 1: 10 blocks of Bentosund SPK at w = 12 % pressed at 70 MPa

Palette 3: 60 blocks (6 layers of 10 blocks)

Top - Layer 6: 10 blocks of Bentosund SPK at w = 20 % pressed at 130 MPa

- Layer 5: 10 blocks of Bentosund SPK at w = 16 % pressed at 130 MPa

↑ - Layer 4: 10 blocks of Bentosund SPK at w = 12 % pressed at 130 MPa

↓ - Layer 3: 10 blocks of Bentosund SPK at w = 20 % pressed at 100 MPa

- Layer 2: 10 blocks of Bentosund SPK at w = 16 % pressed at 100 MPa

Bottom - Layer 1: 10 blocks of Bentosund SPK at w = 12 % pressed at 100 MPa

These 2 palettes have been sent back to Laviosa MPC (France/Limay – 78520) on Monday 19 November 2012. They are kept in Laviosa MPC's warehouse until Nagra ask to send them to CEA to perform test on the blocks.

Changing the particle size distribution could be a way of improvement in an industrial process and to have blocks with perfect edges.

B.2 Bentonite blocks pre-production 2

On September 25 2013, 30 bentonite blocks were pressed by MPC-Laviosa using Calcium-Bentonite BC1 N as raw material. The compaction pressure used was 130 MPa and the raw material was prepared at three different water contents:

- 10 Blocks with 12 % w.c. (weight % per dry weight
- 10 Blocks with 16 % w.c. (weight % per dry weight)
- 10 Blocks with 20 % w.c. (weight % per dry weight)

The production QC sheet and pictures of the blocks directly after production are given in annexe. The measurements are summarized in Tab. as a function of the water content of the material prepared for the three groups. An important number of blocks broke in piece directly after production and the rest of the blocks were of poor quality.

Tab. B-1: Average water content, density, dry density and no. of broken blocks in each group of 10 blocks.

Average water content [%]	**Average density** [kg/m^3]	**Average dry density** [kg/m^3]	**No. of broken blocks**
11.1	1.56	1.41	3
14.5	1.65	1.44	1
18.7	1.73	1.46	0

NAGRA - BC1N compaction trials of September 25th, 2013

Water content	Part ref.	Force	Mass of powder	Mass of block	Length		Width		Height		Geometric density
%		MPa	g	g	mm		mm		mm		g/cm3
16	16-01	129,0	14 000	13 720	300,84	300,92	200,69	200,84	133,04	133,07	1,71
	16-02	129,0	14 000	13 680	300,75	301,05	200,57	200,86	132,87	132,56	1,71
	16-03	129,0	14 000	13 560	301,30	300,87	200,46	200,49	137,08	135,59	1,65
	16-04	129,0	14 000	13 520	301,18	299,81	200,37	200,48	136,79	136,38	1,64
	16-05	129,0	14 000	13 480	300,90	301,16	200,95	200,71	136,41	136,28	1,64
	16-06	129,0	14 000	13 480	300,29	301,32	Non measurable : broken in pieces				
	16-07	129,1	12 000	11 880	301,35	301,16	200,63	201,03	116,79	116,93	1,68
	16-08	129,1	12 000	11 780	300,85	301,19	200,52	201,36	116,13	116,12	1,68
	16-09	129,1	12 000	11 700	300,63	300,71	200,54	200,83	116,88	116,70	1,66
	16-10	129,1	12 000	11 700	302,35	301,27	200,42	200,47	119,93	120,09	1,61
	16-11	129,1	12 000	11 760	300,55	300,54	200,32	200,11	117,94	118,37	1,65
	16-12	129,1	12 000	11 860	300,91	300,28	200,74	200,15	118,58	117,92	1,66
12	12-13	129,1	12 000	11 560	301,60	301,55	201,54	201,60	121,55	121,75	1,56
	12-14	129,1	12 000	11 640	302,27	301,34	200,79	202,22	122,43	122,17	1,57
	12-15	129,1	11 000	10 640	301,63	301,47	201,69	201,07	113,38	113,55	1,54
	12-16	129,1	11 000	10 080	Non measurable : broken in pieces						
	12-17	129,1	10 000	9 840	301,05	301,28	201,03	200,01	102,14	102,37	1,59
	12-18	129,1	10 000	10 000	Non measurable : broken in pieces						
	12-19	129,1	10 000	9 720	301,13	300,72	200,81	200,83	102,31	102,93	1,57
	12-20	129,1	10 000	9 800	301,48	301,15	200,64	200,85	105,48	105,53	1,54
	12-21	129,0	10 000	9 880	Non measurable : broken in pieces						
	12-22	129,0	10 000	9 780	300,58	301,03	200,92	200,98	102,87	103,25	1,57
20	20-25	129,2	14 000	13 760	300,54	300,73	200,63	200,66	133,04	134,09	1,71
	20-26	129,2	14 000	13 540	300,35	300,52	200,81	201,05	134,48	134,64	1,67
	20-27	129,2	14 000	13 760	300,36	300,57	200,03	200,45	133,50	133,56	1,71
	20-28	129,2	14 000	13 800	300,44	300,37	200,13	200,32	133,74	133,50	1,72
	20-29	129,2	14 000	13 760	299,95	300,32	200,17	200,05	130,43	130,49	1,76
	20-30	129,2	14 000	13 620	300,11	300,14	200,03	200,34	132,38	130,92	1,72
	20-31	130,3	14 000	13 840	299,97	300,26	199,82	199,70	132,46	133,12	1,74
	20-32	130,3	14 000	13 860	300,03	300,13	200,01	200,12	132,90	132,69	1,74
	20-33	129,2	12 000	11 860	300,14	300,02	200,04	200,10	113,86	113,60	1,74
	20-34	129,2	12 000	11 960	300,04	300,25	200,03	200,39	114,34	114,61	1,74
	20-35	129,1	12 000	11 740	300,03	300,36	199,97	200,20	114,15	113,79	1,71
	20-36	129,1	12 000	11 860	300,23	295,52	200,21	200,02	113,84	113,49	1,75


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Appendix C: Bentonite blocks production

Année	Raison sociale	Affaire	Type de document	Rev.
14	**Laviosa MPC**	**Nagra piedestaux**	**CR**	**1**

Rapport de fabrication des briques pour les piedestaux Nagra

Date	5 Mars - 12 Mars 2014	☐ Réunion Laviosa MPC
Lieu : Saint Etienne (F-42000)	Durée : 5 jours	☐ Réunion Laviosa MPC – Partenaire
Objet : RECETTE OUTILLAGE		☐ Entretien téléphonique
Rédacteur : Sébastien PAYSAN - Laviosa MPC		Date de rédaction : 24/03/2014
Vérificateur : Jean Pierre Lopez - Laviosa MPC		Date de vérification :
Approbateur : Serge RESNIKOW - Laviosa MPC		Date de vérification :

Participants					
Laviosa MPC			Partenaire		
Nom / Prénom	Organisme	Fonction	Nom / Prénom	Organisme	Fonction
Sébastien PAYSAN	Laviosa MPC	Ingénieur matériaux			
Jean Pierre LOPEZ	Laviosa MPC	Responsable projet MPC			

Diffusion (participants +)					
Laviosa MPC			Partenaire		
Nom / Prénom	Organisme	Fonction	Nom / Prénom	Organisme	Fonction
Serge RESNIKOW	Laviosa MPC	Directeur technique	Benoit GARITTE	Nagra	Ingénieur projet
Marcel SCHIVY	Laviosa MPC	Président			

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Objet : ce document est le rapport de fabrication des briques nécessaires à la fabrication des piédestaux

1. Contexte

Dans le cadre du projet « Full Experiment / LUCOEX », la Nagra, organisme suisse chargé d'étudier les modes de stockage des déchets radioactifs, souhaite réaliser en conditions réelles et à échelle 1, l'introduction d'un colis de déchets dans une galerie.

1.1. Principe

Le but est de poser le colis de déchets sur un piédestal (support sur Figure 1) pour venir ensuite garnir la galerie avec de l'argile pulvérulente.

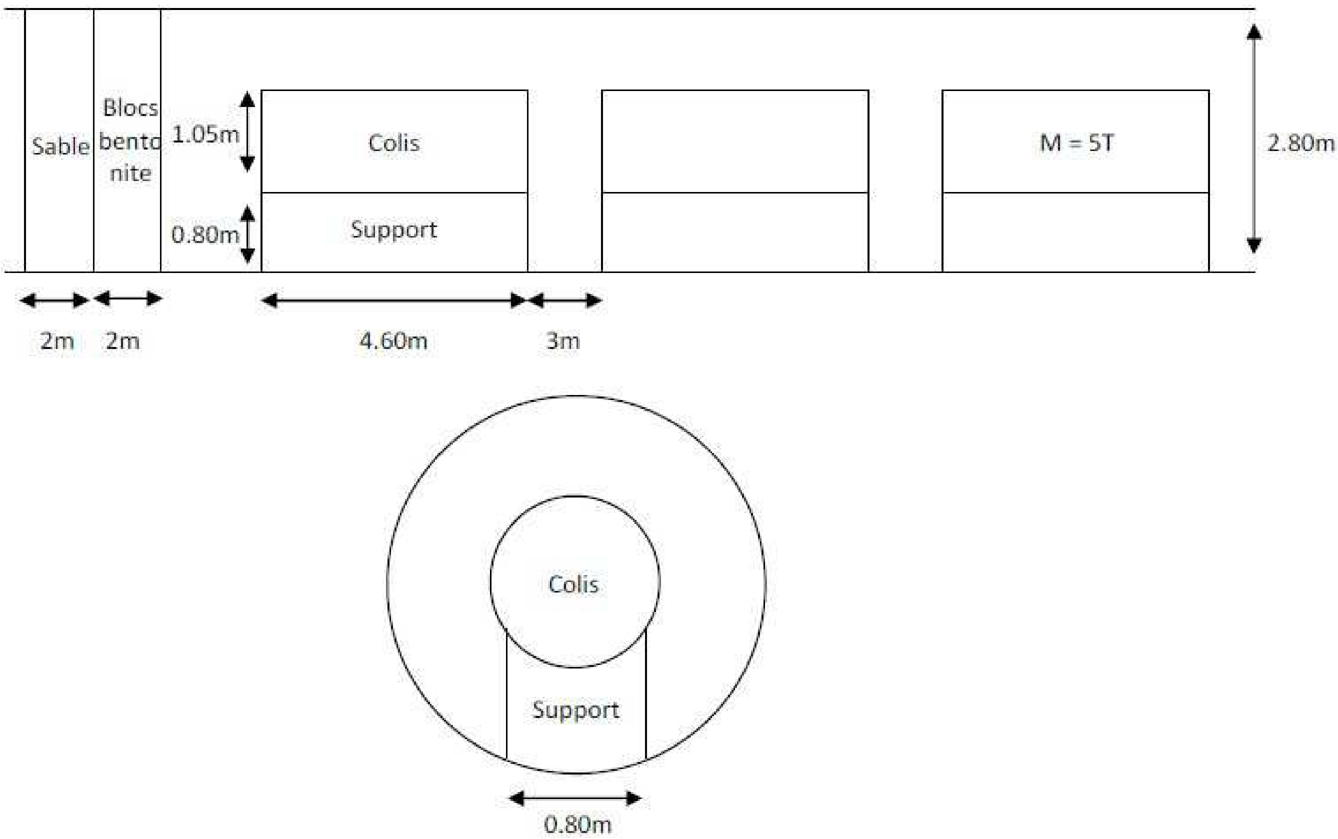

Figure 1 : Principe de stockage des déchets

Le but de la fabrication était de produire les briques d'argile nécessaires à la construction de 3 piédestaux et de 1 mûr fermeture de la galerie.

Cela représente 3100 briques à fabriquer.

1.2. Description des pièces à fabriquer

1.2.1. Géométrie

La même géométrie de briques a été retenue pour la fabrication des piédestaux et celle du mûr.

Cependant compte tenu de la forme du colis, une pièce supplémentaire a été envisagée pour stabiliser le colis sur son piédestal (Figure 2)

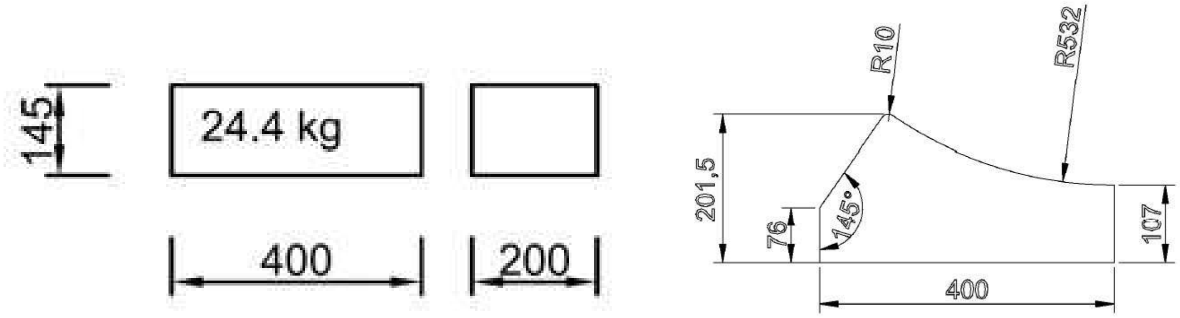

Figure 2 : brique standard et brique arrondie

Les besoins étaient de :

- 2550 briques standards de 24,4kg (62,2T),
- 550 briques arrondies, 11,65kg (6,4T).

1.2.2. Composition

Suite aux essais réalisés en Novembre 2012 selon le même mode de fabrication des briques, il a été déterminé par le Nagra que les briques devaient avoir les caractéristiques suivantes ;

- Composées à 100% de bentonite sodique naturelle du Wyoming, sans aucun autre additif,
- Densité géométriques de 2,08 g/cm^3,
- Teneur en eau de 19%,
- Pression de compactage de 130 MPa.

2. Fabrication des briques

2.1. Préparation des matériaux

L' d'argile Gelclay WH2/ Bentosund A100 a été retenue par Laviosa MPC pour réaliser les briques.

Il s'agit d'une bentonite sodique naturelle sans aucun additif, utilisée depuis plus de 15 ans dans les problématiques de stockage de déchets nucléaires en Europe.

La bentonite se présente sous forme de poudre grise, de granulométrie régulièrement étalée entre 0.2 et 1,8mm et de teneur en eau 12%.

70 BB d'une tonne ont été préparé pour ajuster la teneur en eau de 12 à 19%.
Pour cela, un mélangeur à axe horizontal muni de buse de brumisation a été utilisé.

Chaque tonne ajustée a fait l'objet d'une prise d'échantillon pour vérifier la teneur en eau.

Les résultats sont détaillés au tableau 1.

Tableau 1 : résultats des teneurs en eau après préparation des matériaux

N° BB	Teneur en eau (%)	N° BB	Teneur en eau (%)	N° BB	Teneur en eau (%)
1	18,46	26	18,07	51	17,59
2	17,80	27	17,94	52	17,63
3	17,08	28	17,29	53	18,18
4	17,28	29	17,34	54	18,42
5	17,68	30	18,12	55	18,89
6	18,61	31	18,71	56	18,88
7	18,31	32	18,20	57	18,73
8	19,25	33	18,50	58	19,33
9	20,67	34	18,52	59	19,32
10	17,82	35	17,61	60	19,38
11	18,04	36	18,34	61	19,02
12	19,05	37	18,27	62	18,48
13	17,98	38	17,99	63	18,37
14	19,63	39	17,69	64	19,56
15	18,39	40	18,16	65	19,59
16	17,87	41	17,45	66	20,93
17	19,88	42	18,67	67	17,64
18	18,02	43	17,57	68	17,61
19	18,13	44	18,55	69	19,52
20	18,41	45	17,86	70	18,07
21	17,21	46	18,01		
22	18,70	47	18,30	**Moyenne**	**18,35**
23	18,46	48	17,66	**Ecart type**	**0,78**
24	18,46	49	18,16		
25	17,20	50	18,16		

Chaque tonne de bentonite a été conditionnée en big bags munis d'un liner étanche pour conserver la teneur en eau jusqu'au pressage de l'argile.

2.2. Fabrication des briques

Les briques ont été fabriquées par pressage uni axial, sur une presse Laeis de 1600T (Figure 3) situé à St Etienne chez le partenaire habituel de Laviosa MPC.

Figure 3 : photo de la presse et de son environnement

La presse est assistée d'un robot, qui permet par dépression, d'évacuer les briques de l'emprise de la presse pour les palettiser.

La presse munie de son robot permet la production de briques avec un moule mono alvéole au rythme de 60 pièces par heure.

Un enregistrement de chaque pièce pressée est consigné par la presse, avec, outre la date et l'heure, la hauteur de la pièce et la force de compactage.

Le listing complet des pièces fabriquées est disponible en annexe 1.

2.3. Contrôle des briques

2.3.1. Contrôle dimensionnel et massique

Pour cette fabrication, Nagra a demandé que 100% des briques fabriquées soient contrôlées en densité géométrique (masse et dimensions).

Le listing complet des relevés réalisés est disponible en annexe 2.

- Briques type A (rectangulaires) :

Les spécifications contractuelles initiales des briques type A (rectangulaires) étaient L x l x h = 400 mm x 200 mm x 145 mm (Tableau 2).

Un point d'arrêt a été fait après 160 briques pressées pour évaluer le centrage et la dispersion des valeurs (Tableau 2)

Si la dispersion des valeurs est très correcte (0,2 à 0,4 mm selon la dimension, voir annexe 2), le centrage de la longueur était hors spécifications contractuelles.

Compte tenu de l'utilisation finale des briques, seules la hauteur a besoin de respecter le centrage de la spécification.

Aussi de nouvelles spécifications ont été prises en compte avec accord de la Nagra, sur la base des statistiques obtenues après 160 pressages (Tableau 2).

Tableau 2 : spécifications dimensionnelles des briques type A (rectangulaires)

Dimensions (mm)	**L**	**l**	**h**
Spécifications contractuelles	400 ± 0,85	200 ± 0,85	145 ± 0,85
Spécifications actualisées en accord avec Nagra après 160 briques pressées	401,32 ± 0,85	200,81 ± 0,85	145,27 ± 0,85

Les statistiques de fabrication de l'ensemble des pièces est disponible au tableau 3 :

Tableau 3 : statistiques sur l'ensemble des briques A fabriquées

	Masse (g)	L (mm)	l (mm)	h (mm)
Moyenne	24 517	401,3	200,6	145,3
Ecart type	93	0,3	0,2	0,3

Il est à noter que la densité géométrique visée était de 2,08 ± 0,02.

La moyenne de l'ensemble des briques type A fabriquées est de 2,097 avec une dispersion de 0,007 (voir annexe 2)

- Briques type B (arrondies) :

Dans ce cas aussi, la grande longueur présente un centrage en dehors des spécifications contractuelles (Tableau 4).

Dans la mesure où l'écart à la spécification est équivalent à celui des briques type A, Nagra a validé cet écart, qui sera compensé au montage des piédestaux.

Tableau 4 : statistiques sur l'ensemble des briques B fabriquées

	Masse (g)	L (mm)	h (mm)	H (mm)	Ep (mm)
Spécifications	11 650	400 ± 0,85	107 ± 0,85	202 ± 0,85	100 ± 0,85
Moyenne de l'ensemble des pièces fabriquées	11 702	401,2	107,5	202,5	99,2
Ecart type de l'ensemble des pièces fabriquées	66	0,3	0,3	0,2	0,4

2.3.2. Contrôle des résistances à la compression

Au fil de la production, des pièces ont été prélevées pour analyse de la résistance à la compression.

Des échantillons de section 15cm x 15cm sur 7 cm d'épaisseur ont été débités à la scie sur table pour être testé à la vitesse de 2 MPa/s.

La spécification Nagra indiquait Rc > 6 Mpa.

Le tableau 5 indique l'ensemble des résultats obtenus, qui respectent tous la demande Nagra.
2 mesures par brique A ont été faites, la première sur la haut de la brique, la seconde, sur le bas.

Tableau 5 : résultats des mesures de résistance à la compression

N° brique	Rc (Mpa)
A40	6,7 - 7,1
A70	9,9 - 9,3
A90	8,3 - 8,8
A120	6,3 - /
A295	7,6 - 7,1
A421	9,3 - 7,8
A751	8,6 - 8,6
A1041	8,2 - 9,6
A1488	7,5 - 9,1
A1928	8,5 - 9,0

N° brique	Rc (Mpa)
B3	7,0
B10	7,2
B20	7,1
B100	7,9
B250	8,4
B400	7,8

2.3.3. Contrôle de la teneur en eau

Chaque brique testée en compression a fait l'objet d'un prélèvement pour analyse de la teneur en eau.

Les résultats des analyses réalisées sont disponibles dans le tableau 5.

Tableau 6 : résultats des teneurs en eau

N° brique	Teneur en eau (%)
A40	17,90
A50	17,70
A60	17,27
A70	17,71
A80	17,31
A90	17,70
A100	18,54
A110	17,66
A120	17,63
A295	19,74
A421	19,06
A751	17,97
A1041	17,55
A1488	18,29
A1928	18,01

N° brique	Teneur en eau (%)
B3	19,28
B10	17,82
B20	17,99
B100	17,69
B250	17,68
B400	18,34

Numéro de presse	78
Date d'enregistrement	05/03/2014
Type de briques	mpc 400x200x145
Numéro de personnel	
Début de poste de travail	05/03/2014 08:37
Fin de poste de travail	

Heure	Temps de cycle	Hauteur de remplissage [mm]	Epaisseur de brique [mm]	Pression de pressage [kN/cm²]
			144,80	12,80
8:37:52		729,86	145,10	13,14
8:38:33	0:00:41	729,45	144,70	12,99
8:39:17	0:00:44	729,55	144,90	13,01
8:40:02	0:00:45	729,34	145,00	13,01
8:40:45	0:00:43	729,12	144,50	12,99
8:41:30	0:00:45	729,58	144,80	12,99
8:42:13	0:00:43	729,65	145,00	13,02
8:43:00	0:00:47	729,29	144,60	12,99
8:43:43	0:00:43	729,56	144,90	12,99
8:44:59	0:01:16	729,46	145,10	13,14
8:45:43	0:00:44	729,03	144,50	13,00
8:46:28	0:00:45	729,55	145,20	13,15
8:47:11	0:00:43	728,94	144,60	12,99
8:47:55	0:00:44	729,22	144,80	12,99
8:48:38	0:00:43	729,16	145,00	13,01
8:49:21	0:00:43	728,83	144,70	12,99
8:50:03	0:00:42	728,96	144,90	13,00
8:50:47	0:00:44	728,90	144,60	12,99
8:51:28	0:00:41	729,22	144,80	13,00
8:52:09	0:00:41	729,16	144,90	12,99
8:52:50	0:00:41	729,00	144,70	12,99
8:53:34	0:00:44	729,12	145,30	13,14
8:54:20	0:00:46	728,40	144,50	12,99
8:55:04	0:00:44	728,91	145,00	13,01
8:55:45	0:00:41	728,61	144,60	12,99
8:56:26	0:00:41	728,93	145,20	13,13
8:57:08	0:00:42	728,23	144,50	12,99
8:58:59	0:01:51	728,68	145,50	13,04
8:59:39	0:00:40	727,65	144,50	12,88
9:00:20	0:00:41	728,12	144,80	12,90
9:01:02	0:00:42	728,02	144,80	12,92
9:01:43	0:00:41	727,99	144,90	12,89
9:02:24	0:00:41	727,51	144,20	12,89
9:03:05	0:00:41	728,43	145,00	12,91
9:03:47	0:00:42	728,59	144,50	12,89
9:04:27	0:00:40	729,19	144,70	12,89
9:05:08	0:00:41	729,26	144,70	12,89
9:05:50	0:00:42	729,37	145,00	12,92
9:06:30	0:00:40	729,03	144,50	12,89
9:07:11	0:00:41	729,43	145,20	13,05
9:07:52	0:00:41	728,86	144,50	12,89
9:08:34	0:00:42	729,34	144,90	12,90
9:09:14	0:00:40	729,14	145,00	13,04
9:09:55	0:00:41	728,81	144,80	12,89
9:10:36	0:00:41	728,54	144,60	12,89
9:11:17	0:00:41	729,30	144,90	12,90
9:11:58	0:00:41	729,09	145,00	12,92
9:12:39	0:00:41	728,63	144,40	12,89
9:13:21	0:00:42	729,35	145,20	13,04
9:14:01	0:00:40	728,63	144,60	12,89
9:14:42	0:00:41	728,94	144,80	12,90
9:15:23	0:00:41	729,11	144,70	12,90
9:16:04	0:00:41	729,17	144,90	12,90
9:18:01	0:01:57	729,03	145,00	12,97
9:19:40	0:01:39	729,07	144,60	12,90
9:20:22	0:00:42	729,53	145,20	13,05
9:21:02	0:00:40	728,34	144,70	12,88

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9:21:43	0:00:41	728,97	145,00	13,04
9:25:39	0:03:56	728,59	142,40	12,91
9:26:22	0:00:43	732,48	145,10	13,04
9:27:03	0:00:41	732,02	145,80	13,04
9:27:43	0:00:40	730,57	145,20	13,06
9:28:24	0:00:41	730,04	145,20	13,04
9:29:06	0:00:42	728,40	145,20	13,04
9:29:46	0:00:40	727,82	144,80	12,90
9:30:27	0:00:41	728,73	145,00	12,91
9:31:07	0:00:40	728,31	144,90	12,92
9:31:49	0:00:42	728,13	145,00	12,92
9:32:29	0:00:40	727,74	144,80	12,91
9:33:10	0:00:41	727,74	144,90	12,92
9:33:52	0:00:42	728,72	144,50	12,89
9:34:32	0:00:40	728,06	145,00	13,04
9:35:13	0:00:41	727,74	144,90	12,91
9:35:54	0:00:41	727,53	144,90	12,92
9:36:35	0:00:41	727,41	144,50	12,90
9:37:16	0:00:41	727,79	145,30	13,03
9:37:57	0:00:41	726,92	144,60	12,89
9:38:37	0:00:40	727,27	144,80	12,90
9:39:19	0:00:42	727,23	144,80	12,92
9:39:59	0:00:40	727,20	144,60	12,89
9:41:21	0:01:22	727,14	144,90	12,89
9:42:02	0:00:41	727,06	144,50	12,89
9:42:43	0:00:41	727,53	145,10	13,05
9:43:24	0:00:41	727,06	144,50	12,88
9:46:32	0:03:08	727,45	145,40	13,06
9:47:13	0:00:41	726,48	144,50	12,89
9:47:53	0:00:40	726,97	144,50	12,89
9:48:35	0:00:42	727,46	144,70	12,89
9:49:16	0:00:41	727,63	144,70	12,90
9:49:56	0:00:40	727,75	144,70	12,89
9:50:37	0:00:41	727,90	144,90	12,91
9:51:19	0:00:42	727,71	144,80	12,89
9:51:59	0:00:40	727,09	144,70	12,91
9:52:40	0:00:41	727,95	144,70	12,89
9:53:20	0:00:40	727,44	145,10	12,92
9:54:02	0:00:42	727,44	144,60	12,89
9:54:42	0:00:40	727,75	144,60	12,90
9:55:23	0:00:41	728,15	145,10	12,93
9:56:05	0:00:42	727,65	144,70	12,89
9:56:45	0:00:40	728,80	144,40	12,89
9:57:26	0:00:41	728,44	145,20	13,04
9:58:06	0:00:40	727,81	144,60	12,89
9:58:48	0:00:42	728,12	145,00	12,92
9:59:29	0:00:41	727,82	144,60	12,89
10:00:09	0:00:40	728,23	144,90	12,92
10:00:50	0:00:41	728,01	144,90	12,91
10:06:25	0:05:35	727,91	145,30	13,04
10:07:05	0:00:40	726,28	144,30	12,89
10:07:47	0:00:42	727,82	145,00	12,92
10:08:27	0:00:40	727,72	144,60	12,89
10:09:08	0:00:41	727,97	145,00	12,93
10:09:49	0:00:41	727,56	144,90	12,89
10:10:30	0:00:41	727,37	145,00	12,91
10:11:11	0:00:41	726,34	144,60	12,90
10:11:51	0:00:40	726,69	144,80	12,89
10:12:32	0:00:41	728,31	144,50	12,90
10:13:13	0:00:41	727,62	145,10	12,92
10:13:54	0:00:41	727,04	144,90	12,92
10:14:34	0:00:40	727,27	144,60	12,89
10:15:15	0:00:41	727,61	144,90	12,91
10:15:56	0:00:41	727,38	144,80	12,90
10:16:37	0:00:41	727,12	144,70	12,88
10:17:17	0:00:40	727,71	144,70	12,89
10:17:59	0:00:42	727,73	145,10	12,91

10:18:39	0:00:40	727,25	144,50	12,89
10:19:20	0:00:41	727,77	145,00	12,92
10:20:01	0:00:41	727,44	144,80	12,89
10:20:42	0:00:41	727,44	144,60	12,89
10:21:23	0:00:41	727,79	144,80	12,89
10:22:03	0:00:40	727,55	144,70	12,89
10:22:44	0:00:41	728,06	144,70	12,89
10:23:26	0:00:42	728,05	144,90	12,92
10:24:06	0:00:40	727,94	144,70	12,89
10:24:47	0:00:41	728,11	144,70	12,89
10:25:27	0:00:40	728,24	145,10	13,04
10:26:09	0:00:42	727,70	144,80	12,89
10:26:50	0:00:41	727,72	144,60	12,89
10:27:30	0:00:40	728,05	144,90	12,92
10:28:12	0:00:42	727,82	145,10	12,94
10:28:53	0:00:41	727,32	144,60	12,90
10:29:34	0:00:41	727,83	144,90	12,89
10:30:15	0:00:41	727,60	144,80	12,92
10:30:57	0:00:42	727,60	144,90	12,89
10:31:38	0:00:41	727,44	144,70	12,89
10:32:19	0:00:41	727,65	144,90	12,89
10:33:01	0:00:42	727,47	144,80	12,89
10:33:42	0:00:41	727,47	144,90	12,90
10:34:23	0:00:41	728,54	144,50	12,89
10:35:04	0:00:41	727,94	145,30	13,06
10:35:46	0:00:42	727,11	144,60	12,89
10:36:27	0:00:41	727,39	144,90	12,89
10:37:08	0:00:41	727,21	144,70	12,90
10:37:50	0:00:42	727,43	144,70	12,89
10:38:31	0:00:41	727,55	144,90	12,89
10:39:12	0:00:41	727,36	144,90	12,91
10:39:53	0:00:41	728,34	144,10	12,89
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10:41:15	0:00:41	728,33	145,20	13,03
10:41:56	0:00:41	728,65	144,30	12,89
10:42:38	0:00:42	728,52	145,30	13,05
10:43:19	0:00:41	727,76	144,00	12,90
10:44:00	0:00:41	729,10	145,60	13,03
10:44:42	0:00:42	727,75	144,60	12,89
10:45:23	0:00:41	729,25	144,70	12,89
10:46:04	0:00:41	728,32	145,10	13,04
10:46:44	0:00:40	729,04	144,50	12,88
10:47:26	0:00:42	728,26	145,00	13,04
10:48:07	0:00:41	729,12	144,30	12,89
10:48:48	0:00:41	729,99	144,90	12,89
10:49:29	0:00:41	728,58	145,00	13,04
10:50:10	0:00:41	728,24	144,70	12,89
10:50:51	0:00:41	728,40	145,20	13,04
10:51:31	0:00:40	727,76	144,60	12,89
10:52:13	0:00:42	728,11	145,00	12,94
10:52:54	0:00:41	727,75	144,60	12,89
10:53:35	0:00:41	728,13	145,10	12,94
10:54:17	0:00:42	727,64	144,60	12,90
10:54:57	0:00:40	727,91	144,90	12,91
10:55:38	0:00:41	728,86	144,20	12,90
10:56:19	0:00:41	728,63	145,30	13,03
10:57:00	0:00:41	727,83	144,70	12,90
10:57:41	0:00:41	727,96	144,80	12,90
10:58:22	0:00:41	727,94	144,90	12,91
10:59:03	0:00:41	727,72	144,80	12,90
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11:00:25	0:00:41	727,72	144,90	12,91
11:01:06	0:00:41	728,81	144,40	12,90
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11:02:29	0:00:42	727,87	144,80	12,90
11:03:09	0:00:40	727,86	144,80	12,90
11:03:50	0:00:41	727,83	144,70	12,89

11:04:32	0:00:42	728,03	144,50	12,90
11:05:12	0:00:40	729,54	144,70	12,89
11:05:53	0:00:41	729,79	145,00	13,04
11:06:34	0:00:41	728,34	145,00	12,93
11:07:15	0:00:41	728,02	144,70	12,89
11:07:56	0:00:41	728,14	144,80	12,89
11:08:37	0:00:41	728,06	145,10	13,04
11:09:17	0:00:40	727,59	144,80	12,89
11:09:59	0:00:42	727,59	145,00	13,03
11:10:40	0:00:41	728,34	144,20	12,89
11:11:20	0:00:40	729,42	144,80	12,89
11:12:02	0:00:42	728,23	145,10	13,03
11:12:42	0:00:40	727,65	144,60	12,89
11:13:24	0:00:42	727,96	145,00	12,92
11:14:04	0:00:40	727,59	144,80	12,90
11:14:46	0:00:42	727,54	144,60	12,90
11:15:26	0:00:40	727,84	145,00	12,92
11:16:08	0:00:42	727,54	144,80	12,89
11:16:49	0:00:41	727,54	144,70	12,89
11:18:26	0:01:37	727,64	144,90	12,90
11:22:07	0:03:41	727,64	144,90	12,91
11:22:49	0:00:42	728,48	144,20	12,89
11:23:29	0:00:40	729,58	144,90	12,90
11:24:10	0:00:41	728,32	145,10	13,03
11:24:51	0:00:41	727,75	144,90	12,90
11:25:32	0:00:41	728,75	144,40	12,89
11:26:13	0:00:41	728,40	145,10	13,04
11:26:54	0:00:41	727,88	144,50	12,90
11:27:35	0:00:41	728,28	144,90	12,89
11:28:17	0:00:42	728,14	144,70	12,90
11:28:57	0:00:40	728,29	144,90	12,89
11:29:38	0:00:41	729,39	144,30	12,89
11:30:18	0:00:40	729,93	145,00	12,92
11:39:02	0:08:44	728,56	145,40	13,04
11:39:44	0:00:42	728,57	144,90	13,03
11:40:24	0:00:40	728,43	144,80	12,90
11:41:05	0:00:41	728,44	144,80	12,89
11:41:47	0:00:42	728,44	144,90	12,91
11:42:28	0:00:41	728,24	144,70	12,89
11:43:09	0:00:41	728,47	144,90	12,91
11:43:49	0:00:40	728,31	144,50	12,89
11:44:31	0:00:42	728,81	145,10	12,92
11:45:12	0:00:41	728,35	144,80	12,90
11:45:52	0:00:40	728,35	144,60	12,89
11:46:33	0:00:41	728,70	144,70	12,89
11:47:15	0:00:42	728,70	145,00	12,89
11:47:56	0:00:41	728,47	144,70	12,88
11:48:37	0:00:41	728,72	144,70	12,87
11:49:19	0:00:42	728,87	144,60	12,89
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11:50:41	0:00:41	729,05	144,90	12,89
11:51:23	0:00:42	728,89	144,60	12,89
11:52:04	0:00:41	730,26	144,60	12,89
11:52:44	0:00:40	730,80	145,00	13,04
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11:58:54	0:00:42	729,29	144,80	12,89
11:59:35	0:00:41	729,35	144,50	12,89
12:00:16	0:00:41	729,89	144,60	12,89
12:00:58	0:00:42	730,18	145,00	12,92
12:01:38	0:00:40	729,95	144,80	12,89

12:26:35	0:24:57	729,89	144,90	12,96
12:27:17	0:00:42	729,69	144,70	12,94
12:27:58	0:00:41	729,84	144,40	12,94
12:28:39	0:00:41	730,56	145,00	12,94
12:29:20	0:00:41	730,25	144,90	12,99
12:30:02	0:00:42	731,22	144,40	12,94
12:30:43	0:00:41	730,78	145,00	12,98
12:31:23	0:00:40	730,48	144,90	12,94
12:32:05	0:00:42	730,37	144,60	12,94
12:32:46	0:00:41	730,77	144,70	12,94
12:33:27	0:00:41	731,01	144,70	12,94
12:34:08	0:00:41	732,13	144,80	12,95
12:34:50	0:00:42	731,06	145,10	13,08
12:35:30	0:00:40	730,48	144,80	12,94
12:36:11	0:00:41	730,49	144,90	12,96
12:36:53	0:00:42	730,35	144,80	12,93
12:37:34	0:00:41	730,44	145,00	12,98
12:38:15	0:00:41	730,12	144,70	12,94
12:38:56	0:00:41	730,26	144,90	12,94
12:39:38	0:00:42	731,18	144,70	12,94
12:40:19	0:00:41	730,35	144,90	12,95
12:41:00	0:00:41	730,26	144,80	12,94
12:41:42	0:00:42	730,35	144,90	12,94
12:42:22	0:00:40	731,32	144,30	12,94
12:43:03	0:00:41	732,05	145,00	12,96
12:43:44	0:00:41	731,80	144,60	12,93
12:44:25	0:00:41	732,10	144,90	12,96
12:45:06	0:00:41	732,12	144,70	12,94
12:45:47	0:00:41	731,07	144,90	12,96
12:46:30	0:00:43	730,96	144,90	12,94
12:47:10	0:00:40	730,89	144,90	12,95
12:47:51	0:00:41	730,77	145,10	12,99
12:48:32	0:00:41	730,37	144,50	12,94
12:49:15	0:00:43	730,87	145,10	13,07
12:49:56	0:00:41	730,39	144,60	12,94
12:50:37	0:00:41	730,68	145,10	13,09
12:51:19	0:00:42	730,27	144,90	12,95
12:52:00	0:00:41	730,15	144,70	12,95
12:52:42	0:00:42	730,24	145,00	12,97
12:53:24	0:00:42	729,95	145,10	12,96
12:54:05	0:00:41	730,65	144,10	12,94
13:25:22	0:31:17	730,68	144,10	12,94
14:08:09	0:42:47	731,79	145,00	12,94
14:08:51	0:00:42	731,51	145,90	13,09
14:09:31	0:00:40	730,92	145,40	13,08
14:10:12	0:00:41	728,70	145,30	13,11
14:10:53	0:00:41	727,97	145,20	13,11
14:11:35	0:00:42	727,35	145,00	12,97
14:12:16	0:00:41	727,07	145,00	12,97
14:12:57	0:00:41	726,79	144,50	12,95
14:13:38	0:00:41	727,22	144,80	12,96
14:15:53	0:02:15	727,21	145,00	12,96
14:16:34	0:00:41	726,93	144,60	12,94
14:17:49	0:01:15	727,33	144,10	12,95
14:18:31	0:00:42	728,38	145,10	13,08
14:19:11	0:00:40	727,85	144,20	12,93
14:24:12	0:05:01	728,87	145,30	13,09
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14:25:33	0:00:41	728,13	144,10	12,94
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14:26:55	0:00:41	729,73	144,80	12,94
14:27:36	0:00:41	729,73	144,80	12,94
14:28:16	0:00:40	729,77	144,70	12,93
14:28:57	0:00:41	729,88	144,90	12,97
14:29:38	0:00:41	729,78	144,70	12,94
14:30:20	0:00:42	729,88	144,80	12,94
14:31:00	0:00:40	729,88	145,00	12,97

14:31:41	0:00:41	729,56	145,00	13,09
14:32:22	0:00:41	730,49	144,00	12,95
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14:34:25	0:00:41	729,40	145,00	13,04
14:35:07	0:00:42	729,08	144,90	12,97
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14:36:28	0:00:41	729,93	144,80	12,94
14:37:09	0:00:41	728,85	145,20	13,11
14:37:50	0:00:41	728,31	144,70	12,94
14:38:31	0:00:41	728,53	145,00	12,95
14:39:12	0:00:41	728,23	144,80	12,95
14:39:54	0:00:42	728,25	145,20	13,09
14:40:34	0:00:40	727,66	145,00	12,99
14:41:15	0:00:41	727,38	144,90	12,97
14:41:56	0:00:41	728,31	144,50	12,96
14:42:37	0:00:41	727,72	145,20	13,09
14:43:18	0:00:41	728,12	144,60	12,92
14:43:58	0:00:40	727,49	145,00	12,98
14:44:39	0:00:41	727,24	144,80	12,96
14:45:21	0:00:42	727,22	145,00	13,09
14:52:35	0:07:14	726,90	145,00	12,97
14:53:16	0:00:41	726,57	144,70	12,95
14:53:57	0:00:41	726,76	144,70	12,94
14:54:38	0:00:41	726,96	144,90	12,97
14:55:20	0:00:42	726,83	144,80	12,96
14:56:00	0:00:40	726,76	144,90	12,97
14:56:41	0:00:41	726,63	144,60	12,94
14:59:17	0:02:36	726,86	145,20	13,09
14:59:58	0:00:41	726,24	144,80	12,96
15:00:38	0:00:40	727,43	144,00	12,95
15:01:20	0:00:42	727,54	145,60	13,09
15:02:01	0:00:41	726,32	144,40	12,95
15:02:40	0:00:39	727,00	144,50	12,94
15:03:21	0:00:41	727,42	145,10	13,08
15:04:02	0:00:41	727,03	144,80	12,94
15:04:52	0:00:50	727,05	145,10	13,10
15:05:33	0:00:41	727,71	144,40	12,95
15:10:28	0:04:55	727,30	145,00	13,10
15:11:09	0:00:41	726,91	144,80	12,96
15:11:51	0:00:42	727,98	144,40	12,94
15:12:32	0:00:41	727,66	145,20	13,10
15:14:05	0:01:33	727,04	145,10	12,97
15:14:45	0:00:40	726,61	144,60	12,94
15:15:26	0:00:41	726,91	145,10	12,97
15:16:07	0:00:41	726,44	144,80	12,96
15:16:49	0:00:42	726,50	144,70	12,94
15:17:30	0:00:41	726,64	144,80	12,95
15:18:10	0:00:40	726,54	145,00	12,98
15:18:52	0:00:42	726,28	144,90	12,96
15:19:33	0:00:41	726,20	144,90	12,96
15:20:14	0:00:41	726,02	144,90	12,96
15:20:56	0:00:42	725,92	145,00	12,96
15:21:37	0:00:41	725,64	145,10	12,98
15:22:18	0:00:41	725,24	144,50	12,96
15:22:59	0:00:41	725,71	145,00	12,99
15:23:40	0:00:41	725,41	144,60	12,94
15:24:21	0:00:41	725,71	145,00	12,94
15:25:02	0:00:41	725,42	144,50	12,94
15:25:44	0:00:42	725,87	144,70	12,94
15:26:24	0:00:40	726,07	144,90	12,96
15:27:05	0:00:41	725,99	144,80	12,94
15:27:46	0:00:41	726,08	144,70	12,95
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15:29:09	0:00:41	726,07	144,60	12,94
15:29:50	0:00:41	726,44	144,90	12,96
15:30:30	0:00:40	727,34	144,30	12,95

15:31:12	0:00:42	727,12	145,30	13,09
15:31:52	0:00:40	727,45	144,40	12,96
15:32:33	0:00:41	727,05	144,90	12,96
15:33:15	0:00:42	726,93	144,50	12,95
15:33:56	0:00:41	727,44	144,70	12,95
15:34:37	0:00:41	727,65	144,70	12,94
15:35:17	0:00:40	729,01	144,20	12,95
15:35:58	0:00:41	728,79	144,70	12,94
15:36:41	0:00:43	728,98	144,60	12,94
15:37:22	0:00:41	729,45	144,40	12,95
15:38:03	0:00:41	729,99	144,50	12,94
15:38:45	0:00:42	730,43	144,50	12,94
15:39:27	0:00:42	730,92	144,60	12,94
15:40:08	0:00:41	731,23	144,50	12,94
15:40:50	0:00:42	731,77	144,60	12,94
15:41:32	0:00:42	732,04	144,60	12,94
15:47:14	0:05:42	732,31	144,70	12,94
15:47:56	0:00:42	732,48	144,50	12,94
15:48:38	0:00:42	732,98	144,60	12,94
15:49:19	0:00:41	734,39	144,50	12,95
15:50:00	0:00:41	733,90	145,00	12,98
15:50:41	0:00:41	734,60	144,80	12,94
15:51:23	0:00:42	734,49	144,60	12,94
15:52:04	0:00:41	733,97	145,20	13,09
15:52:45	0:00:41	733,38	144,90	12,94
15:53:26	0:00:41	734,53	144,60	12,94
15:54:08	0:00:42	733,60	145,20	13,10
15:54:50	0:00:42	732,88	144,80	12,96
15:55:31	0:00:41	734,04	144,80	12,94
15:56:13	0:00:42	732,89	145,30	13,08
15:56:54	0:00:41	732,15	145,00	12,96
15:57:35	0:00:41	731,86	145,10	13,09
15:58:16	0:00:41	731,39	145,10	13,08
16:02:17	0:04:01	730,99	145,20	13,09
16:02:58	0:00:41	730,40	144,60	12,94
16:03:39	0:00:41	730,85	145,00	12,97
16:04:21	0:00:42	730,57	145,10	12,94
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16:06:26	0:00:42	732,00	144,40	12,94
16:07:07	0:00:41	731,46	144,90	12,97
16:07:48	0:00:41	731,37	144,70	12,94
16:08:30	0:00:42	731,48	144,50	12,94
16:09:12	0:00:42	731,90	144,90	12,94
16:09:53	0:00:41	731,75	145,10	13,09
16:10:35	0:00:42	731,30	144,80	12,94
16:11:16	0:00:41	732,45	144,70	12,94
16:11:57	0:00:41	731,48	145,10	13,09
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16:14:42	0:00:41	731,43	144,50	12,93
16:15:24	0:00:42	730,77	145,40	13,10
16:16:05	0:00:41	729,78	144,80	12,94
16:16:46	0:00:41	729,77	145,00	12,97
16:20:08	0:03:22	729,46	145,10	13,09
16:20:49	0:00:41	730,62	144,50	12,92
16:21:30	0:00:41	729,90	145,30	13,09
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16:24:16	0:00:41	728,43	144,60	12,94
16:24:58	0:00:42	728,73	145,20	12,98
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16:27:02	0:00:41	728,23	144,90	12,95
16:27:43	0:00:41	728,13	144,80	12,94

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16:31:53	0:00:41	727,64	145,00	12,97
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16:51:45	0:19:11	727,16	145,10	13,08
16:52:27	0:00:42	726,82	144,70	12,95
16:53:08	0:00:41	727,02	144,60	12,94
16:53:50	0:00:42	727,26	145,00	12,98
16:54:32	0:00:42	727,02	144,90	12,96
16:55:13	0:00:41	726,87	144,90	12,97
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16:57:18	0:00:41	726,84	144,70	12,94
16:57:59	0:00:41	727,07	144,70	12,95
16:58:40	0:00:41	727,31	144,80	12,94
16:59:22	0:00:42	727,36	144,50	12,93
17:00:03	0:00:41	727,74	145,00	12,97
17:00:45	0:00:42	727,44	144,70	12,95
17:01:27	0:00:42	727,64	144,70	12,94
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17:11:49	0:00:43	728,64	144,90	12,96
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17:24:13	0:00:41	728,66	144,90	12,96
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17:26:18	0:00:42	728,63	144,60	12,94
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18:00:42	0:00:42	728,24	145,00	12,94
18:01:23	0:00:41	727,96	144,80	12,96
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19:29:55	0:00:41	728,04	144,50	12,95

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19:31:18	0:00:42	728,34	144,60	12,94
19:31:59	0:00:41	728,76	144,90	12,94
19:32:40	0:00:41	728,65	145,00	12,97
19:33:22	0:00:42	728,27	145,10	13,09
19:34:03	0:00:41	727,85	144,50	12,94
19:34:43	0:00:40	728,42	144,90	12,95
19:35:24	0:00:41	728,32	144,70	12,94
19:36:06	0:00:42	728,53	145,00	12,96
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19:40:55	0:00:42	728,84	145,10	13,10
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19:42:17	0:00:41	728,45	144,60	12,95
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22:27:11	0:00:45	728,75	144,30	12,95
22:33:36	0:06:25	729,26	145,40	13,09
22:34:18	0:00:42	728,25	144,70	12,96
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22:38:39	0:00:45	728,88	144,70	12,96
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22:41:35	0:00:44	729,46	144,70	12,95
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22:51:17	0:08:14	729,51	145,00	12,96
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23:01:15	0:00:41	729,96	144,70	12,94
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23:05:23	0:00:41	729,77	145,00	12,97
23:06:04	0:00:41	729,46	144,50	12,94
23:06:46	0:00:42	729,94	145,00	12,97
23:07:27	0:00:41	729,64	144,80	12,96

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23:13:40	0:00:42	729,69	144,90	12,95
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0:11:32	0:00:41	730,17	144,80	12,93
0:12:14	0:00:42	730,48	145,10	13,09
0:12:55	0:00:41	730,02	144,70	12,96

0:13:36	0:00:41	730,16	144,90	12,94
0:14:18	0:00:42	730,08	144,90	12,96
0:14:59	0:00:41	729,93	144,80	12,95
0:15:41	0:00:42	730,02	145,00	12,97
0:16:22	0:00:41	729,72	145,10	12,96
0:17:04	0:00:42	729,32	144,60	12,96
0:17:45	0:00:41	729,66	144,80	12,94
0:18:26	0:00:41	729,57	145,00	12,97
0:19:08	0:00:42	729,36	144,50	12,94
0:19:49	0:00:41	729,76	144,90	12,95
0:21:03	0:01:14	729,65	145,20	13,09
0:21:44	0:00:41	729,08	144,70	12,93
0:22:24	0:00:40	729,36	144,60	12,94
0:23:06	0:00:42	729,58	144,80	12,95
0:23:47	0:00:41	729,55	144,50	12,95
0:24:30	0:00:43	729,98	144,90	12,97
0:25:11	0:00:41	729,76	145,00	12,96
0:25:52	0:00:41	729,55	144,60	12,95
0:26:33	0:00:41	729,88	145,10	12,97
0:27:15	0:00:42	729,46	144,60	12,95
0:27:56	0:00:41	729,74	144,90	12,96
0:28:37	0:00:41	729,67	144,70	12,94
0:29:19	0:00:42	729,76	145,00	12,96
0:30:00	0:00:41	729,47	144,80	12,94
0:30:41	0:00:41	729,56	144,70	12,94
0:31:22	0:00:41	729,67	145,00	12,94
0:32:04	0:00:42	729,44	144,70	12,95
0:32:45	0:00:41	729,58	145,00	12,95
0:33:26	0:00:41	729,35	144,80	12,94
0:34:08	0:00:42	729,41	144,80	12,97
0:34:49	0:00:41	729,46	145,10	12,97
0:35:30	0:00:41	728,98	144,60	12,94
0:36:11	0:00:41	729,36	145,00	12,97
0:36:54	0:00:43	729,04	144,70	12,95
0:37:35	0:00:41	729,14	144,80	12,94
0:38:16	0:00:41	729,22	144,80	12,95
0:38:58	0:00:42	729,28	144,80	12,95
0:39:39	0:00:41	729,38	144,80	12,95
0:40:21	0:00:42	729,46	145,00	12,97
0:41:03	0:00:42	729,22	144,60	12,94
0:41:44	0:00:41	729,58	144,90	12,95
0:42:26	0:00:42	729,40	144,70	12,95
0:43:08	0:00:42	729,57	145,10	12,97
0:43:49	0:00:41	729,15	144,60	12,95
0:44:30	0:00:41	729,56	144,80	12,94
0:48:08	0:03:38	729,58	145,00	13,09
0:48:50	0:00:42	729,60	144,60	12,94
0:49:31	0:00:41	729,86	144,80	12,93
0:50:13	0:00:42	729,88	144,90	12,96
0:52:31	0:02:18	729,72	144,90	12,99
0:53:12	0:00:41	729,55	144,60	12,95
0:53:55	0:00:43	729,78	144,70	12,94
0:54:36	0:00:41	729,97	144,80	12,96
0:55:18	0:00:42	730,05	144,90	12,95
0:56:00	0:00:42	729,95	144,70	12,94
0:56:41	0:00:41	730,09	144,80	12,94
0:57:23	0:00:42	730,07	144,80	12,94
0:58:04	0:00:41	729,97	144,60	12,94
0:58:45	0:00:41	730,38	144,70	12,94
1:34:31	0:35:46	730,47	144,90	12,96
1:35:13	0:00:42	730,51	144,50	12,94
1:35:54	0:00:41	730,96	145,00	12,97
1:36:35	0:00:41	730,70	144,70	12,96
1:37:16	0:00:41	730,96	144,90	12,95
1:37:59	0:00:43	730,82	144,80	12,94
1:38:40	0:00:41	730,79	145,00	12,97
1:39:21	0:00:41	730,54	144,80	12,96

1:40:03	0:00:42	730,65	144,80	12,94
1:40:44	0:00:41	730,58	144,70	12,94
1:41:25	0:00:41	730,72	145,10	12,94
1:42:06	0:00:41	730,27	144,50	12,94
1:42:48	0:00:42	730,80	144,90	12,97
1:43:29	0:00:41	730,58	144,80	12,95
1:44:10	0:00:41	730,62	144,70	12,94
1:44:51	0:00:41	730,76	144,70	12,94
1:45:33	0:00:42	730,85	144,90	12,96
1:46:15	0:00:42	730,74	144,90	12,94
1:46:56	0:00:41	730,65	144,90	12,96
1:47:38	0:00:42	730,49	144,80	12,95
1:48:20	0:00:42	730,51	144,80	12,95
1:49:01	0:00:41	730,59	144,70	12,95
1:49:42	0:00:41	730,76	144,80	12,95
1:50:23	0:00:41	730,79	144,80	12,94
1:51:05	0:00:42	730,93	144,80	12,97
1:51:47	0:00:42	730,96	145,10	12,98
1:52:28	0:00:41	730,47	144,60	12,94
1:53:10	0:00:42	730,76	144,90	12,95
1:53:51	0:00:41	730,68	145,00	12,97
1:54:32	0:00:41	730,37	144,70	12,96
1:55:14	0:00:42	730,53	144,90	12,96
1:55:55	0:00:41	730,38	144,80	12,94
1:56:36	0:00:41	730,37	144,70	12,94
1:57:17	0:00:41	730,59	144,80	12,95
1:57:59	0:00:42	730,65	145,10	12,97
1:58:40	0:00:41	730,20	144,70	12,95
1:59:21	0:00:41	730,47	144,90	12,96
2:00:04	0:00:43	730,30	144,80	12,95
2:12:08	0:12:04	730,31	144,70	12,94
2:12:48	0:00:40	730,37	144,30	12,96
2:13:29	0:00:41	731,20	144,80	12,95
2:14:11	0:00:42	731,24	145,10	13,08
2:14:52	0:00:41	730,76	144,70	12,94
2:15:33	0:00:41	730,98	144,90	12,95
2:16:15	0:00:42	730,87	144,80	12,96
2:16:56	0:00:41	730,85	144,80	12,96
2:17:37	0:00:41	730,89	144,80	12,96
2:18:18	0:00:41	730,88	144,80	12,96
2:18:59	0:00:41	730,97	144,90	12,95
2:19:40	0:00:41	730,87	144,60	12,94
2:20:22	0:00:42	731,18	144,90	12,94
2:21:03	0:00:41	731,06	144,80	12,95
2:21:44	0:00:41	731,10	144,90	12,96
2:22:26	0:00:42	730,98	144,60	12,95
2:23:08	0:00:42	731,30	145,00	12,98
2:23:49	0:00:41	730,99	144,50	12,94
2:24:31	0:00:42	731,43	144,90	12,95
2:25:12	0:00:41	731,33	144,70	12,95
2:25:53	0:00:41	731,56	144,80	12,95
2:26:34	0:00:41	731,54	144,90	12,96
2:27:17	0:00:43	731,47	144,70	12,95
2:27:58	0:00:41	731,72	144,90	12,96
2:28:39	0:00:41	731,49	144,70	12,95
2:29:21	0:00:42	731,75	144,90	12,96
2:30:02	0:00:41	731,65	144,70	12,94
2:30:43	0:00:41	731,91	145,00	12,97
2:31:25	0:00:42	731,64	144,90	12,96
2:32:08	0:00:43	731,54	144,90	12,98
2:32:49	0:00:41	731,36	144,60	12,94
2:33:30	0:00:41	731,62	144,90	12,95
2:34:12	0:00:42	731,50	144,80	12,96
2:44:50	0:10:38	731,51	144,90	12,96
2:45:32	0:00:42	731,48	144,40	12,95
2:46:13	0:00:41	732,08	145,00	12,98
2:46:54	0:00:41	731,71	144,90	12,97

2:47:35	0:00:41	731,57	144,80	12,94
2:48:17	0:00:42	731,58	144,80	12,95
2:48:59	0:00:42	731,65	144,80	12,94
2:49:40	0:00:41	731,69	144,80	12,95
2:50:22	0:00:42	731,66	144,90	12,96
2:51:03	0:00:41	731,57	144,70	12,94
2:51:44	0:00:41	731,79	145,00	12,96
2:52:26	0:00:42	731,47	145,00	12,95
2:53:07	0:00:41	731,21	144,70	12,97
2:53:48	0:00:41	731,47	144,70	12,94
2:54:29	0:00:41	731,68	144,80	12,95
2:55:11	0:00:42	731,78	144,90	13,03
2:55:52	0:00:41	731,56	144,50	12,94
2:56:33	0:00:41	731,98	144,90	12,95
2:57:16	0:00:43	731,90	144,80	12,94
2:57:57	0:00:41	731,98	144,70	12,94
2:58:38	0:00:41	732,20	145,10	12,96
2:59:20	0:00:42	731,78	144,70	12,94
3:00:01	0:00:41	731,99	144,90	12,96
3:00:43	0:00:42	731,89	144,90	12,97
3:01:24	0:00:41	731,69	144,80	12,95
3:02:06	0:00:42	731,62	144,80	12,94
3:02:47	0:00:41	731,67	144,80	12,94
3:03:28	0:00:41	731,71	145,00	12,97
3:07:12	0:03:44	731,39	144,70	12,94
3:07:54	0:00:42	731,61	145,00	12,95
3:08:38	0:00:44	731,33	144,60	12,94
3:09:19	0:00:41	731,74	144,70	12,95
3:10:00	0:00:41	731,99	144,80	12,95
3:10:39	0:00:39	732,05	144,80	12,94
3:11:19	0:00:40	732,13	144,60	12,94
3:12:02	0:00:43	732,49	145,00	12,94
3:12:43	0:00:41	732,19	144,80	12,96
3:13:24	0:00:41	732,20	144,60	12,93
3:14:06	0:00:42	732,63	144,80	12,94
3:14:48	0:00:42	732,70	144,80	12,94
3:15:29	0:00:41	732,60	144,80	12,94
3:16:10	0:00:41	732,67	144,90	12,97
3:16:53	0:00:43	732,55	144,50	12,94
3:17:34	0:00:41	733,00	145,10	12,98
3:18:16	0:00:42	732,50	144,80	12,96
3:18:58	0:00:42	732,54	144,90	12,96
3:19:39	0:00:41	732,40	144,90	12,96
3:20:21	0:00:42	732,19	144,80	12,94
3:21:02	0:00:41	732,27	144,80	12,94
3:21:44	0:00:42	732,33	144,80	12,94
3:22:26	0:00:42	732,31	144,60	12,94
3:23:07	0:00:41	732,71	144,80	12,94
3:23:50	0:00:43	732,77	144,80	12,95
3:24:31	0:00:41	732,88	145,00	12,97
3:34:35	0:10:04	732,64	144,80	12,97
3:35:17	0:00:42	732,51	144,90	12,95
3:35:58	0:00:41	732,47	144,40	12,94
3:36:40	0:00:42	733,10	145,00	12,98
3:37:23	0:00:43	732,79	144,80	12,94
3:38:04	0:00:41	732,86	144,80	12,97
3:38:45	0:00:41	732,80	144,70	12,95
3:39:28	0:00:43	733,09	144,60	12,94
3:40:09	0:00:41	733,41	145,10	12,96
3:40:50	0:00:41	732,98	144,50	12,95
3:41:33	0:00:43	733,46	144,80	12,93
3:42:14	0:00:41	733,48	145,00	12,97
3:42:56	0:00:42	733,19	144,80	12,94
3:43:37	0:00:41	733,27	144,70	12,96
3:44:20	0:00:43	733,32	144,80	12,94
3:45:01	0:00:41	733,29	144,90	12,94
3:45:43	0:00:42	733,16	144,60	12,94

3:46:25	0:00:42	733,59	144,90	12,94
3:47:07	0:00:42	733,50	144,80	12,93
3:47:48	0:00:41	733,55	144,70	12,94
3:48:30	0:00:42	734,93	144,50	12,94
3:49:10	0:00:40	734,93	145,20	13,09
3:49:52	0:00:42	733,59	144,60	12,94
3:50:33	0:00:41	734,96	144,50	12,94
3:51:14	0:00:41	734,42	145,10	13,09
3:51:56	0:00:42	735,33	144,40	12,93
3:52:39	0:00:43	734,72	145,10	13,08
3:53:20	0:00:41	734,25	144,80	12,94
3:54:02	0:00:42	734,39	144,70	12,94
3:54:44	0:00:42	734,60	145,00	12,97
3:55:25	0:00:41	734,28	144,80	12,93
3:56:07	0:00:42	734,33	144,80	12,94
3:56:49	0:00:42	734,27	144,90	12,94
3:57:30	0:00:41	734,19	144,80	12,94
3:58:11	0:00:41	734,19	144,70	12,94
3:58:52	0:00:41	734,31	144,90	12,95
3:59:35	0:00:43	734,20	144,90	12,95
4:00:16	0:00:41	735,15	144,50	12,94
4:00:57	0:00:41	734,61	144,80	12,96
4:01:38	0:00:41	734,52	144,50	12,92
4:02:21	0:00:43	734,97	145,00	12,95
4:03:02	0:00:41	734,70	144,50	12,94
4:03:43	0:00:41	735,13	144,90	12,95
4:04:24	0:00:41	735,04	144,60	12,94
4:05:06	0:00:42	735,43	144,60	12,94
4:05:48	0:00:42	735,85	144,30	12,94
4:06:29	0:00:41	736,79	144,50	12,93
4:07:12	0:00:43	737,38	144,20	12,94
4:07:53	0:00:41	739,44	144,20	12,94
4:08:34	0:00:41	739,50	145,00	12,97

Nombre de pressées (Unités)	961
Plage horaire de pressage (hr:min:sec)	19:30:42
Cumul des temps d'arrêt > 5min (hr:min:sec)	8:00:43
Temps de pressage effectif (hr:min:sec)	11:29:59
Temps moyen de cycle (hr:min:sec)	0:00:43
Productivité (unités/hr)	84
Productivité réelle (unités/hr)	60

Numéro de presse	78			
Date d'enregistrement	06/03/2014			
Type de briques	mpc 400x200x145			
Numéro de personnel				
Début de poste de travail	06/03/2014 04:29			
Fin de poste de travail				
		144,80	12,75	1105

Heure	Temps de cycle	Hauteur de remplissage [mm]	Epaisseur de brique [mm]	Pression de pressage [kN/cm²]
6:25:26		739,16	144,70	12,95
6:26:12	0:00:46	739,23	145,90	13,09
6:26:55	0:00:43	737,35	146,10	13,10
6:27:39	0:00:44	735,21	146,10	13,10
6:28:21	0:00:42	733,00	144,90	13,09
6:29:03	0:00:42	732,89	145,50	13,10
6:29:49	0:00:46	731,78	145,30	13,10
6:30:31	0:00:42	730,94	145,10	13,09
6:31:28	0:00:57	730,38	145,10	13,09
6:34:53	0:03:25	729,85	145,10	12,97
6:35:36	0:00:43	729,46	144,60	12,94
6:36:21	0:00:45	729,78	144,80	12,96
6:37:04	0:00:43	729,83	144,70	12,96
6:37:47	0:00:43	729,92	144,70	12,95
6:38:30	0:00:43	730,02	144,80	12,95
6:39:14	0:00:44	730,22	144,70	12,95
6:39:55	0:00:41	730,36	144,80	12,94
6:40:39	0:00:44	730,31	144,80	12,94
6:41:24	0:00:45	730,28	144,80	12,94
6:42:07	0:00:43	730,37	144,70	12,96
6:42:51	0:00:44	730,47	144,80	12,96
6:43:35	0:00:44	730,48	144,80	12,96
6:44:19	0:00:44	730,48	144,70	12,95
6:45:02	0:00:43	730,66	144,70	12,95
6:45:45	0:00:43	732,12	144,90	12,96
6:46:30	0:00:45	730,74	145,10	13,09
6:47:11	0:00:41	730,36	144,80	12,95
6:47:55	0:00:44	730,41	144,90	12,94
6:49:34	0:01:39	730,27	145,00	12,97
6:54:04	0:04:30	730,28	145,20	13,09
6:54:45	0:00:41	729,62	144,80	12,94
6:55:26	0:00:41	729,69	144,80	12,96
6:56:11	0:00:45	729,77	144,90	12,97
6:56:55	0:00:44	729,65	144,80	12,94
6:57:41	0:00:46	729,59	144,80	12,97
6:58:22	0:00:41	729,59	145,10	12,97
6:59:03	0:00:41	729,22	144,90	12,97
6:59:45	0:00:42	729,05	144,70	12,95
7:00:26	0:00:41	729,29	145,00	12,97
7:01:11	0:00:45	728,96	144,50	12,94
7:01:58	0:00:47	729,46	144,80	12,96
7:02:39	0:00:41	729,57	144,80	12,96
7:03:22	0:00:43	729,58	144,80	12,94
7:07:58	0:04:36	729,62	144,20	12,96
7:09:21	0:01:23	730,10	144,90	12,98
7:10:02	0:00:41	729,96	144,90	12,97
7:10:43	0:00:41	729,75	144,80	12,95
7:11:25	0:00:42	729,76	144,90	12,97
7:12:06	0:00:41	729,67	144,70	12,95
7:12:47	0:00:41	729,88	144,90	12,96
7:13:29	0:00:42	729,73	144,70	12,95
7:14:11	0:00:42	729,84	144,80	12,95
7:14:51	0:00:40	729,90	144,90	12,97
7:15:33	0:00:42	729,70	144,70	12,95
7:16:14	0:00:41	729,96	144,90	12,95
7:16:55	0:00:41	729,87	144,90	12,96
7:17:36	0:00:41	729,78	144,80	12,95
7:18:19	0:00:43	729,86	144,80	12,94
7:19:00	0:00:41	731,13	144,60	12,95
7:19:41	0:00:41	730,27	145,10	13,08
7:20:23	0:00:42	729,80	144,50	12,94

7:21:04	0:00:41	730,20	144,90	12,96
7:21:45	0:00:41	730,06	144,90	12,98
7:22:25	0:00:40	729,95	144,90	12,93
7:23:08	0:00:43	729,88	144,90	12,97
7:23:49	0:00:41	729,77	144,70	12,95
7:24:30	0:00:41	729,94	144,80	12,95
7:25:12	0:00:42	729,91	144,70	12,95
7:25:53	0:00:41	730,17	145,00	12,96
7:26:34	0:00:41	729,91	144,70	12,96
7:27:16	0:00:42	729,97	145,00	12,97
7:27:58	0:00:42	729,71	144,90	12,96
7:51:22	0:23:24	729,57	144,90	12,97
7:52:03	0:00:41	729,47	144,70	12,95
7:52:44	0:00:41	729,57	144,70	12,96
7:53:33	0:00:49	729,77	144,90	12,95
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7:55:46	0:00:46	729,72	144,80	12,94
7:56:31	0:00:45	729,76	144,70	12,94
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7:57:58	0:00:46	729,82	144,60	12,94
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8:02:00	0:00:42	729,57	144,50	12,95
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8:04:45	0:00:41	729,87	144,90	12,96
8:05:26	0:00:41	729,79	144,80	12,94
8:06:07	0:00:41	729,87	144,90	12,96
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8:34:53	0:00:41	729,56	144,70	12,94
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13:16:50	0:00:41	730,20	144,90	12,97
13:17:31	0:00:41	729,98	144,60	12,94
13:18:14	0:00:43	730,27	144,80	12,95
13:34:01	0:15:47	730,30	145,10	13,09
13:34:42	0:00:41	729,80	144,50	12,95
13:36:11	0:01:29	730,24	144,80	12,96
13:36:52	0:00:41	730,19	144,90	12,97
13:37:34	0:00:42	729,99	144,70	12,94
13:38:14	0:00:40	730,10	144,70	12,94
13:38:56	0:00:42	730,22	145,10	12,97
13:39:37	0:00:41	729,82	144,60	12,94
13:40:18	0:00:41	730,11	144,90	12,99
13:41:00	0:00:42	729,89	144,80	12,94
13:41:41	0:00:41	729,91	144,70	12,94
13:42:23	0:00:42	730,07	144,90	12,97

13:43:04	0:00:41	729,90	144,70	12,94
13:43:44	0:00:40	729,98	144,80	12,95
13:44:25	0:00:41	729,91	144,80	12,96
13:45:07	0:00:42	729,88	144,80	12,95
13:45:48	0:00:41	729,97	144,70	12,95
13:46:29	0:00:41	730,07	144,80	12,94
13:47:11	0:00:42	730,06	144,90	12,94
13:52:44	0:05:33	729,83	145,00	12,99
13:53:26	0:00:42	729,47	144,40	12,95
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13:56:50	0:00:41	729,98	145,10	12,99
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13:59:34	0:00:41	730,08	144,70	12,95
14:00:15	0:00:41	730,21	144,70	12,95
14:00:57	0:00:42	730,36	144,80	12,96
14:01:38	0:00:41	730,32	145,00	12,97
14:02:19	0:00:41	730,08	144,70	12,93
14:03:00	0:00:41	730,28	144,90	12,97
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14:09:12	0:00:43	730,42	144,80	12,95
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14:21:33	0:00:43	730,57	144,50	12,94
14:22:14	0:00:41	731,02	144,90	12,94
14:22:55	0:00:41	730,90	145,00	12,99
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14:37:10	0:13:33	730,60	145,10	13,10
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14:39:23	0:00:41	730,36	144,70	12,95
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14:46:55	0:00:41	730,17	145,00	12,97
14:47:36	0:00:41	729,92	144,70	12,94
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14:53:47	0:00:41	730,19	145,00	12,97
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14:55:10	0:00:42	729,95	144,80	12,94
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15:08:14	0:00:41	730,40	144,90	12,96
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15:34:29	0:00:42	731,80	144,80	12,95
15:35:11	0:00:42	731,78	144,80	12,94
15:35:52	0:00:41	731,80	145,00	12,98
15:36:34	0:00:42	731,47	144,70	12,95
15:37:15	0:00:41	731,60	145,10	13,05
15:37:57	0:00:42	731,09	144,80	12,94
15:38:38	0:00:41	731,16	144,80	12,94

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15:44:52	0:00:41	731,29	144,50	12,94
15:45:34	0:00:42	731,78	145,00	12,97
15:46:15	0:00:41	731,38	144,60	12,95
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15:56:38	0:00:41	731,81	144,80	12,95
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16:18:39	0:00:41	732,15	144,70	12,94
16:19:20	0:00:41	732,38	145,00	12,96
16:20:02	0:00:42	732,01	144,90	12,96
16:20:43	0:00:41	731,83	144,70	12,95
16:21:24	0:00:41	731,99	144,80	12,96
16:22:05	0:00:41	731,99	144,70	12,94
16:22:47	0:00:42	732,12	144,70	12,95
16:23:28	0:00:41	732,36	145,00	12,97
16:24:09	0:00:41	732,01	145,00	12,98
16:24:51	0:00:42	731,66	144,80	12,96
16:25:32	0:00:41	731,59	145,00	12,96
16:26:14	0:00:42	731,28	144,90	12,98
16:26:55	0:00:41	731,09	144,80	12,94
16:27:36	0:00:41	731,10	145,10	13,09
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16:29:41	0:00:42	730,77	145,00	12,97
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16:44:24	0:00:40	731,50	144,70	12,94
16:45:06	0:00:42	731,59	144,90	12,96
16:45:48	0:00:42	731,39	144,80	12,94
16:46:28	0:00:40	731,51	144,80	12,95
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16:47:52	0:00:43	731,20	144,60	12,95
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16:51:58	0:00:41	731,19	144,80	12,95
16:52:40	0:00:42	731,20	145,00	12,98
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16:54:02	0:00:41	731,01	145,00	12,97
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16:56:47	0:00:41	730,26	145,00	12,98
16:57:29	0:00:42	729,94	144,70	12,94
16:58:09	0:00:40	730,10	144,90	12,96
16:58:50	0:00:41	729,99	145,10	13,09
16:59:32	0:00:42	729,58	144,70	12,93
17:00:13	0:00:41	729,80	144,90	12,97
17:00:54	0:00:41	729,57	145,10	12,99
17:01:35	0:00:41	729,17	144,70	12,94
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17:17:23	0:00:41	729,46	145,00	12,97
17:18:04	0:00:41	729,20	144,70	12,95
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17:33:12	0:00:42	729,77	144,80	12,96
17:33:53	0:00:41	729,68	144,90	12,95
17:34:35	0:00:42	729,51	144,70	12,95
17:35:17	0:00:42	729,68	144,90	12,95
17:35:57	0:00:40	729,47	144,80	12,96
17:36:38	0:00:41	729,48	144,80	12,94
17:37:19	0:00:41	729,42	144,90	12,97
17:38:01	0:00:42	729,25	144,90	12,96
17:38:42	0:00:41	729,02	144,70	12,95
17:39:23	0:00:41	729,16	144,90	12,97
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17:41:26	0:00:41	729,35	144,70	12,96
17:42:07	0:00:41	729,48	144,80	12,96
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17:43:29	0:00:41	729,44	144,80	12,95

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18:17:49	0:00:41	729,22	144,90	12,95
18:18:30	0:00:41	729,04	144,80	12,96
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18:24:45	0:00:41	729,21	144,60	12,94
18:25:26	0:00:41	729,47	144,70	12,94
18:26:07	0:00:41	729,60	144,70	12,94
18:26:49	0:00:42	729,77	144,70	12,94
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18:30:05	0:00:43	729,89	144,90	12,96
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18:32:50	0:00:41	729,68	144,60	12,94
18:33:32	0:00:42	730,03	144,80	12,95
18:34:14	0:00:42	730,01	144,80	12,94
18:34:55	0:00:41	729,99	144,70	12,95
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18:41:50	0:00:41	730,46	144,90	12,96
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18:45:17	0:00:41	731,17	145,10	13,08
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18:46:40	0:00:42	730,72	144,90	12,96
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18:48:02	0:00:41	730,75	145,10	13,09
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18:50:49	0:00:42	730,45	145,00	12,97
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18:52:52	0:00:41	730,07	145,00	12,96
18:53:34	0:00:42	729,68	144,80	12,96
18:54:15	0:00:41	729,74	144,80	12,95
18:54:56	0:00:41	729,71	144,80	12,94
18:55:38	0:00:42	729,72	144,80	12,96
18:56:19	0:00:41	729,73	144,90	12,95
18:57:00	0:00:41	729,55	144,70	12,95
18:57:42	0:00:42	729,66	144,70	12,94
18:58:23	0:00:41	729,76	144,70	12,93
18:59:05	0:00:42	729,94	144,90	12,95

18:59:46	0:00:41	729,75	144,60	12,94
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19:41:00	0:00:42	731,50	144,90	12,96
19:41:42	0:00:42	731,36	144,70	12,96
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22:38:47	0:00:46	729,68	144,60	12,94
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22:59:02	0:00:40	728,90	144,60	12,95
22:59:44	0:00:42	729,19	145,10	12,99
23:00:25	0:00:41	728,75	144,60	12,94
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23:08:00	0:00:41	729,17	144,80	12,95
23:08:42	0:00:42	729,17	144,90	12,96
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23:12:52	0:00:41	729,11	144,70	12,96
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23:15:38	0:00:41	729,26	144,90	12,97
23:16:19	0:00:41	729,02	144,80	12,96
23:17:02	0:00:43	728,97	145,00	12,97
23:17:45	0:00:43	728,75	144,70	12,95
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23:19:49	0:00:43	729,27	145,10	13,09
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23:41:57	0:00:41	729,59	144,70	12,95
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23:44:44	0:00:42	729,29	144,60	12,94
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23:46:47	0:00:41	729,47	144,70	12,95
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0:39:34	0:00:42	729,44	145,00	12,96
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2:21:03	0:00:44	731,16	144,80	12,94
2:21:42	0:00:39	731,06	145,00	12,97
2:22:23	0:00:41	730,80	144,80	12,94
2:23:04	0:00:41	730,77	144,70	12,95
2:23:45	0:00:41	730,90	144,90	12,97
2:24:27	0:00:42	730,71	144,60	12,94
2:25:08	0:00:41	730,99	144,90	12,96
2:25:49	0:00:41	730,77	144,60	12,94
2:26:31	0:00:42	731,03	144,80	12,96
2:27:12	0:00:41	731,14	144,60	12,95

2:27:53	0:00:41	731,47	145,00	12,98
2:28:35	0:00:42	731,15	144,70	12,95
2:29:16	0:00:41	731,26	144,70	12,96
2:29:57	0:00:41	731,40	144,60	12,94
2:30:38	0:00:41	731,75	144,80	12,93
2:31:20	0:00:42	731,75	144,70	12,95
2:32:01	0:00:41	731,84	144,80	12,94
2:32:42	0:00:41	731,80	144,50	12,94
2:33:24	0:00:42	732,27	145,00	12,96
2:34:05	0:00:41	732,01	144,90	12,96
2:34:45	0:00:40	733,14	144,40	12,96
2:44:24	0:09:39	732,61	145,30	13,09
2:45:04	0:00:40	731,89	144,60	12,94
2:45:46	0:00:42	732,28	144,70	12,95
2:46:27	0:00:41	732,40	144,70	12,95
2:47:08	0:00:41	732,49	144,90	12,97
2:47:49	0:00:41	732,42	145,00	12,96
2:48:31	0:00:42	732,10	144,70	12,95
2:49:12	0:00:41	732,20	144,70	12,95
2:49:53	0:00:41	732,37	144,90	12,94
2:50:35	0:00:42	732,28	144,70	12,94
2:51:16	0:00:41	732,48	144,90	12,96
2:51:57	0:00:41	732,41	144,70	12,95
2:52:39	0:00:42	732,66	144,90	12,96
2:53:20	0:00:41	732,58	144,80	12,95
2:54:01	0:00:41	732,62	144,70	12,95
2:54:42	0:00:41	732,77	144,90	12,96
2:56:05	0:01:23	732,85	144,70	12,96
2:56:46	0:00:41	733,10	144,60	12,96
2:57:28	0:00:42	733,31	144,70	12,95
2:58:09	0:00:41	733,48	144,70	12,94
2:58:50	0:00:41	733,70	144,80	12,96
2:59:31	0:00:41	733,60	144,60	12,95
3:00:13	0:00:42	734,00	144,60	12,92
3:00:54	0:00:41	735,50	144,60	12,95
3:01:35	0:00:41	734,55	144,70	12,94
3:02:17	0:00:42	734,71	145,00	12,99
3:02:58	0:00:41	734,46	144,80	12,94
3:03:39	0:00:41	734,51	144,90	12,97
3:04:21	0:00:42	734,40	144,70	12,94
3:05:02	0:00:41	734,53	144,80	12,94
3:05:43	0:00:41	734,57	144,50	12,95
3:06:24	0:00:41	734,99	144,50	12,94
3:07:05	0:00:41	735,58	144,50	12,94
3:07:47	0:00:42	737,15	144,10	12,95

Nombre de pressées (Unités)	1 100
Plage horaire de pressage (hr:min:sec)	20:42:21
Cumul des temps d'arrêt > 5min (hr:min:sec)	7:36:17
Temps de pressage effectif (hr:min:sec)	13:06:04
Temps moyen de cycle (hr:min:sec)	0:00:43
Productivité (unités/hr)	84
Productivité réelle (unités/hr)	64

Numéro de presse	78				
Date d'enregistrement	07/03/2014				
Type de briques	mpc 400x200x145				
Numéro de personnel					
Début de poste de travail	07/03/2014 04:30				
Fin de poste de travail	10/03/2014 06:32				
			144,80	12,75	420

Heure	Temps de cycle	Hauteur de remplissage [mm]	Epaisseur de brique [mm]	Pression de pressage [kN/cm²]
6:27:40		737,30	143,60	12,97
6:28:27	0:00:47	739,26	146,70	13,11
6:29:14	0:00:47	736,06	146,50	13,11
6:29:55	0:00:41	733,21	145,90	13,12
6:30:43	0:00:48	731,46	145,30	13,10
6:31:24	0:00:41	730,66	145,30	13,11
6:32:05	0:00:41	729,94	145,30	13,11
6:32:47	0:00:42	729,15	145,20	13,11
6:33:31	0:00:44	728,59	145,00	12,97
6:34:12	0:00:41	728,32	144,90	12,97
6:34:53	0:00:41	728,14	144,90	12,96
6:35:36	0:00:43	728,01	144,90	12,97
6:36:18	0:00:42	727,92	144,50	12,96
6:37:01	0:00:43	728,44	145,00	12,98
6:38:27	0:01:26	728,15	144,50	12,95
6:40:30	0:02:03	728,15	144,80	12,95
6:41:12	0:00:42	728,25	144,40	12,95
6:41:54	0:00:42	728,92	144,80	12,95
6:42:37	0:00:43	728,98	144,50	12,95
6:43:20	0:00:43	729,46	144,70	12,96
6:44:03	0:00:43	729,59	144,50	12,95
6:44:46	0:00:43	730,11	144,80	12,94
6:45:30	0:00:44	730,17	144,90	12,96
6:46:12	0:00:42	730,06	144,60	12,95
6:46:55	0:00:43	730,44	144,90	12,96
6:47:44	0:00:49	730,34	144,60	12,95
6:48:27	0:00:43	730,70	144,90	12,94
6:49:11	0:00:44	730,60	144,60	12,94
6:49:54	0:00:43	730,92	144,90	12,96
6:50:38	0:00:44	730,76	144,90	12,96
6:51:22	0:00:44	730,67	145,00	12,97
6:52:07	0:00:45	730,44	144,70	12,96
6:52:51	0:00:44	730,65	145,00	12,97
6:53:37	0:00:46	730,37	145,10	13,09
6:54:21	0:00:44	729,86	144,80	12,96
6:55:06	0:00:45	729,90	145,10	12,97
6:55:51	0:00:45	729,47	145,10	13,11
6:56:36	0:00:45	729,05	144,70	12,95
6:57:17	0:00:41	729,16	144,70	12,96
6:58:03	0:00:46	729,40	144,60	12,93
6:58:44	0:00:41	729,73	144,60	12,94
6:59:30	0:00:46	730,00	145,10	12,97
7:00:15	0:00:45	729,57	144,60	12,95
7:01:00	0:00:45	729,88	144,90	12,96
7:01:46	0:00:46	729,80	144,70	12,95
7:03:06	0:01:20	729,99	144,60	12,93
7:03:51	0:00:45	730,38	145,10	12,99
7:04:37	0:00:46	729,84	144,60	12,95
7:05:18	0:00:41	730,17	144,80	12,95
7:08:25	0:03:07	730,17	145,20	13,11
7:09:13	0:00:48	730,17	144,90	12,94
7:09:54	0:00:41	730,12	144,70	12,96
7:10:40	0:00:46	730,32	144,90	12,95
7:11:21	0:00:41	730,17	144,70	12,96
7:12:02	0:00:41	730,28	144,60	12,95
7:12:45	0:00:43	730,57	144,90	12,96
7:13:26	0:00:41	730,38	145,00	12,97
7:14:14	0:00:48	730,11	144,80	12,94
7:18:47	0:04:33	730,14	143,60	12,95
7:19:29	0:00:42	732,05	145,40	13,09
7:20:11	0:00:42	731,15	145,20	13,11
7:20:53	0:00:42	730,49	145,00	12,96

7:21:34	0:00:41	730,18	144,80	12,95
7:22:17	0:00:43	730,23	144,90	12,97
7:23:03	0:00:46	729,94	144,80	12,94
7:23:51	0:00:48	730,03	144,80	12,95
8:03:35	0:39:44	730,07	145,10	12,98
8:04:22	0:00:47	730,07	144,60	12,95
8:05:05	0:00:43	730,37	145,10	12,97
8:05:50	0:00:45	729,94	144,60	12,96
8:06:34	0:00:44	730,28	144,90	12,97
8:08:48	0:02:14	730,17	144,90	12,96
8:09:34	0:00:46	730,16	145,00	12,98
8:10:18	0:00:44	729,77	144,70	12,96
8:11:02	0:00:44	729,92	144,80	12,94
8:11:47	0:00:45	729,95	144,80	12,96
8:12:32	0:00:45	729,94	144,80	12,95
8:13:16	0:00:44	729,95	144,70	12,95
8:13:58	0:00:42	730,09	144,80	12,96
8:14:43	0:00:45	730,07	144,60	12,95
8:15:29	0:00:46	730,48	145,10	13,09
8:16:14	0:00:45	730,06	144,60	12,94
8:16:57	0:00:43	730,42	145,00	12,97
8:17:43	0:00:46	730,17	144,70	12,95
8:18:24	0:00:41	730,37	144,80	12,95
8:19:09	0:00:45	730,35	145,00	12,96
8:19:54	0:00:45	730,08	144,80	12,96
8:20:40	0:00:46	730,16	144,90	12,96
8:21:28	0:00:48	730,07	144,60	12,94
8:22:09	0:00:41	730,37	145,00	12,96
8:22:50	0:00:41	730,07	144,80	12,96
8:31:35	0:08:45	730,04	145,00	12,98
8:32:17	0:00:42	730,08	145,10	12,96
8:32:58	0:00:41	729,58	144,30	12,94
8:33:40	0:00:42	730,39	145,00	12,97
8:34:22	0:00:42	730,17	144,80	12,96
8:35:02	0:00:40	730,08	144,80	12,96
8:35:43	0:00:41	730,08	144,60	12,95
8:36:25	0:00:42	730,35	145,00	12,97
8:37:07	0:00:42	730,07	144,80	12,96
8:37:48	0:00:41	730,09	144,70	12,94
8:38:29	0:00:41	730,37	144,80	12,95
8:39:11	0:00:42	730,39	145,10	12,99
8:39:53	0:00:42	729,91	144,70	12,96
8:40:34	0:00:41	730,18	144,90	12,97
8:41:16	0:00:42	730,09	144,80	12,96
8:41:57	0:00:41	730,14	144,90	12,97
8:42:38	0:00:41	730,06	144,60	12,96
8:43:19	0:00:41	730,36	145,20	13,10
8:44:01	0:00:42	729,77	144,80	12,96
8:44:42	0:00:41	729,72	144,90	12,95
8:45:23	0:00:41	729,50	144,80	12,96
8:46:05	0:00:42	729,57	144,80	12,94
8:46:46	0:00:41	729,58	145,00	12,96
8:47:27	0:00:41	729,26	144,70	12,96
8:48:10	0:00:43	729,40	144,80	12,94
8:48:51	0:00:41	729,48	145,00	13,09
8:49:32	0:00:41	729,19	144,70	12,94
8:50:13	0:00:41	729,40	144,90	12,96
8:50:55	0:00:42	729,29	145,00	12,98
8:51:37	0:00:42	728,99	144,80	12,95
8:52:18	0:00:41	729,03	144,80	12,95
8:53:00	0:00:42	729,04	144,80	12,96
8:53:41	0:00:41	729,00	144,80	12,93
8:54:22	0:00:41	729,02	144,50	12,95
8:55:05	0:00:43	729,47	144,90	12,96
8:55:45	0:00:40	729,37	144,90	12,97
8:56:26	0:00:41	729,17	144,70	12,94
8:57:08	0:00:42	729,27	145,00	12,96
8:57:50	0:00:42	729,01	144,60	12,95
8:58:31	0:00:41	729,29	144,70	12,96
8:59:12	0:00:41	729,44	144,80	12,94
8:59:55	0:00:43	729,37	144,70	12,94
9:00:36	0:00:41	729,48	144,40	12,94

9:01:17	0:00:41	730,08	145,20	13,10
9:01:59	0:00:42	729,50	144,70	12,96
9:02:41	0:00:42	729,75	145,00	12,97
9:03:22	0:00:41	729,47	144,60	12,94
9:04:03	0:00:41	729,71	144,70	12,95
9:04:44	0:00:41	729,87	144,90	12,97
9:05:27	0:00:43	729,62	144,80	12,95
9:06:08	0:00:41	729,56	144,80	12,94
9:06:49	0:00:41	729,64	145,10	12,99
9:07:31	0:00:42	729,23	144,50	12,96
9:08:12	0:00:41	729,68	144,80	12,96
9:08:53	0:00:41	729,68	145,00	12,97
9:09:35	0:00:42	729,30	144,70	12,96
9:10:16	0:00:41	729,46	144,70	12,94
9:13:55	0:03:39	729,57	143,60	12,96
9:14:36	0:00:41	731,57	144,90	12,97
9:15:19	0:00:43	731,37	145,30	13,10
9:16:00	0:00:41	730,55	145,30	13,09
9:16:42	0:00:42	729,75	144,80	12,96
9:17:24	0:00:42	729,69	144,90	12,98
9:18:05	0:00:41	729,48	144,80	12,94
9:18:47	0:00:42	729,56	145,00	12,97
9:19:29	0:00:42	729,16	144,70	12,95
9:20:10	0:00:41	729,36	144,80	12,95
9:20:51	0:00:41	729,29	144,70	12,94
9:21:32	0:00:41	729,45	144,80	12,95
9:22:14	0:00:42	729,51	144,80	12,95
9:22:55	0:00:41	729,54	144,80	12,95
9:23:36	0:00:41	729,57	144,70	12,94
9:24:19	0:00:43	729,66	144,80	12,95
9:24:58	0:00:39	729,75	144,90	12,97
9:25:41	0:00:43	729,53	144,80	12,95
9:26:22	0:00:41	729,46	144,70	12,95
9:27:03	0:00:41	729,67	144,90	12,96
9:27:44	0:00:41	729,55	144,90	12,97
9:28:26	0:00:42	729,37	144,80	12,94
9:29:08	0:00:42	729,37	144,80	12,94
9:29:49	0:00:41	729,38	144,50	12,94
9:30:31	0:00:42	729,89	144,80	12,95
9:31:12	0:00:41	729,89	145,00	12,97
9:32:21	0:01:09	729,54	144,70	12,95
9:33:03	0:00:42	729,77	144,90	12,94
9:33:44	0:00:41	729,62	144,80	12,95
9:34:26	0:00:42	729,67	144,80	12,97
9:35:07	0:00:41	729,60	145,00	12,97
9:35:49	0:00:42	729,26	144,70	12,95
9:36:30	0:00:41	729,26	144,80	12,96
9:37:11	0:00:41	729,46	144,90	12,95
9:37:53	0:00:42	729,35	145,10	13,09
9:38:35	0:00:42	728,97	144,80	12,95
9:39:17	0:00:42	728,97	145,10	13,09
9:39:58	0:00:41	728,47	144,60	12,94
9:40:40	0:00:42	728,77	144,90	12,96
9:41:21	0:00:41	728,64	144,70	12,94
9:42:02	0:00:41	728,75	144,80	12,93
9:42:45	0:00:43	728,68	145,00	12,97
9:43:25	0:00:40	728,37	144,70	12,94
9:44:07	0:00:42	728,56	144,70	12,95
9:48:27	0:04:20	728,67	145,00	12,97
9:49:08	0:00:41	728,42	144,70	12,96
9:49:50	0:00:42	728,55	144,90	12,94
9:50:31	0:00:41	728,44	144,70	12,94
9:51:12	0:00:41	728,62	145,00	12,97
9:51:55	0:00:43	728,35	144,70	12,94
9:52:36	0:00:41	728,52	144,80	12,96
9:53:17	0:00:41	728,50	144,80	12,95
9:54:00	0:00:43	728,50	145,00	12,97
9:58:53	0:04:53	728,14	145,30	13,08
9:59:34	0:00:41	728,21	144,70	12,96
10:00:15	0:00:41	728,33	144,80	12,94
10:00:58	0:00:43	728,24	145,00	12,97
10:01:39	0:00:41	728,00	144,60	12,94

10:02:21	0:00:42	728,25	144,70	12,95
10:03:03	0:00:42	728,35	144,60	12,94
10:03:44	0:00:41	728,66	144,80	12,95
10:04:26	0:00:42	728,67	144,70	12,93
10:05:08	0:00:42	728,87	144,60	12,95
10:05:49	0:00:41	729,17	144,80	12,94
10:06:31	0:00:42	729,25	144,50	12,95
10:07:13	0:00:42	729,68	144,80	12,95
10:14:10	0:06:57	729,68	144,80	12,96
10:14:51	0:00:41	729,64	145,10	12,97
10:15:33	0:00:42	729,25	144,30	12,95
10:16:14	0:00:41	730,05	145,10	12,99
10:16:56	0:00:42	729,57	144,70	12,94
10:17:38	0:00:42	729,69	144,80	12,94
10:20:53	0:03:15	729,76	144,90	12,96
10:21:34	0:00:41	729,68	144,80	12,95
10:22:17	0:00:43	729,68	144,80	12,94
10:22:58	0:00:41	729,66	144,80	12,94
10:23:39	0:00:41	729,68	144,90	12,97
10:24:21	0:00:42	729,47	144,80	12,93
10:25:03	0:00:42	729,55	145,00	12,97
10:25:44	0:00:41	729,24	144,80	12,96
10:26:26	0:00:42	729,25	144,90	12,97
10:27:08	0:00:42	729,07	144,70	12,94
10:27:49	0:00:41	729,26	144,80	12,96
10:28:30	0:00:41	729,26	144,80	12,95
10:29:12	0:00:42	729,17	144,70	12,95
10:29:54	0:00:42	729,41	144,70	12,95
10:30:35	0:00:41	729,58	144,90	12,97
10:31:16	0:00:41	729,47	144,80	12,92
10:31:58	0:00:42	729,43	144,90	12,96
10:32:39	0:00:41	729,26	144,80	12,96
10:33:21	0:00:42	729,26	144,80	12,96
10:34:02	0:00:41	729,27	144,80	12,96
10:34:44	0:00:42	729,26	144,80	12,96
10:35:24	0:00:40	729,29	144,70	12,94
10:36:05	0:00:41	729,47	145,00	12,97
10:36:48	0:00:43	729,12	144,70	12,94
10:37:29	0:00:41	729,33	144,90	12,97
10:38:10	0:00:41	729,14	144,90	12,96
10:38:50	0:00:40	728,99	144,80	12,96
10:39:33	0:00:43	728,97	144,60	12,94
10:40:14	0:00:41	729,36	145,10	13,11
10:40:55	0:00:41	728,83	144,80	12,94
10:41:36	0:00:41	728,90	144,90	12,96
10:42:18	0:00:42	728,73	144,90	12,95
10:42:59	0:00:41	728,54	144,90	12,97
10:43:40	0:00:41	728,36	144,70	12,96
10:44:23	0:00:43	728,52	144,80	12,95
10:45:04	0:00:41	728,46	144,70	12,94
10:45:45	0:00:41	728,73	145,00	12,96
10:46:28	0:00:43	728,40	144,50	12,95
10:47:09	0:00:41	728,92	144,60	12,94
10:47:50	0:00:41	729,21	145,00	12,97
10:48:32	0:00:42	728,95	144,70	12,95
10:49:13	0:00:41	729,06	145,00	12,97
10:54:02	0:04:49	728,81	144,80	12,95
10:54:43	0:00:41	728,81	144,90	12,96
10:55:24	0:00:41	728,67	144,90	12,94
10:56:06	0:00:42	728,49	144,60	12,94
10:56:48	0:00:42	728,77	144,90	12,95
10:57:29	0:00:41	728,59	144,70	12,94
10:58:10	0:00:41	728,77	144,70	12,96
10:58:52	0:00:42	728,97	144,90	12,96
10:59:33	0:00:41	728,82	144,70	12,95
11:00:14	0:00:41	729,06	145,00	12,97
11:00:56	0:00:42	728,72	144,80	12,95
11:01:38	0:00:42	728,68	144,70	12,95
11:02:19	0:00:41	728,85	144,90	12,97
11:03:00	0:00:41	728,68	144,60	12,96
11:03:42	0:00:42	729,01	144,80	12,96
11:04:23	0:00:41	728,95	144,70	12,94

11:05:05	0:00:42	729,06	144,50	12,94
11:05:46	0:00:41	729,48	144,90	12,95
11:06:27	0:00:41	729,37	144,90	12,96
11:07:08	0:00:41	729,17	144,90	12,97
11:07:50	0:00:42	729,00	144,90	12,95
11:08:31	0:00:41	728,88	144,60	12,94
11:09:12	0:00:41	729,11	144,70	12,94
11:09:54	0:00:42	729,27	144,90	12,96
11:10:35	0:00:41	729,07	144,90	12,96
11:11:16	0:00:41	728,95	144,80	12,95
11:11:58	0:00:42	729,02	144,70	12,95
11:12:40	0:00:42	729,16	145,10	13,09
11:13:21	0:00:41	728,70	144,80	12,95
11:14:02	0:00:41	728,75	144,80	12,94
11:14:44	0:00:42	728,77	144,80	12,94
11:15:26	0:00:42	728,76	144,80	12,95
11:16:07	0:00:41	728,86	144,70	12,94
11:16:49	0:00:42	729,00	144,80	12,96
11:17:30	0:00:41	728,97	144,80	12,95
11:18:12	0:00:42	728,98	145,00	12,96
11:24:39	0:06:27	728,64	144,70	12,96
11:25:20	0:00:41	728,66	144,60	12,94
11:26:02	0:00:42	728,97	144,70	12,95
11:26:43	0:00:41	729,16	144,80	12,94
11:27:24	0:00:41	729,17	144,70	12,94
11:28:07	0:00:43	729,28	144,90	12,95
11:28:48	0:00:41	729,21	144,80	12,95
11:29:29	0:00:41	729,17	144,80	12,96
11:30:10	0:00:41	729,16	144,80	12,95
11:30:52	0:00:42	729,18	144,70	12,94
11:31:33	0:00:41	729,34	145,00	12,99
11:32:13	0:00:40	728,98	144,60	12,94
11:32:56	0:00:43	729,30	145,00	12,96
11:36:20	0:03:24	728,95	143,40	12,96
11:37:01	0:00:41	731,28	145,30	13,09
11:37:44	0:00:43	730,47	145,00	12,97
11:38:25	0:00:41	730,10	144,90	12,97
11:39:06	0:00:41	729,93	144,80	12,94
11:39:46	0:00:40	729,97	144,90	12,96
11:40:28	0:00:42	729,78	144,70	12,94
11:41:10	0:00:42	729,97	144,80	12,95
11:41:51	0:00:41	729,94	144,80	12,94
11:42:34	0:00:43	729,89	144,80	12,94
11:43:15	0:00:41	729,98	144,90	12,95
11:43:56	0:00:41	729,77	144,80	12,94
11:44:37	0:00:41	729,86	144,60	12,94
11:45:20	0:00:43	730,18	144,80	12,94
11:46:01	0:00:41	730,18	144,80	12,96
11:46:42	0:00:41	730,11	144,70	12,95
11:47:24	0:00:42	730,36	145,00	12,98
11:48:06	0:00:42	729,96	144,60	12,95
11:48:47	0:00:41	730,26	144,80	12,95
11:49:29	0:00:42	730,18	144,80	12,96
11:50:10	0:00:41	730,17	144,60	12,94
11:50:50	0:00:40	730,44	144,90	12,97
11:51:31	0:00:41	730,34	144,90	12,96
11:52:14	0:00:43	730,19	144,80	12,94
12:33:07	0:40:53	730,11	145,10	13,09
12:33:48	0:00:41	729,68	144,40	12,96
12:34:29	0:00:41	730,28	145,00	12,96
12:35:12	0:00:43	729,99	144,90	13,09
12:35:52	0:00:40	729,88	144,90	12,97
12:36:33	0:00:41	729,67	144,60	12,94
12:37:14	0:00:41	729,98	145,00	12,97
12:37:57	0:00:43	729,69	144,60	12,95
12:38:38	0:00:41	730,00	145,00	12,98
12:39:19	0:00:41	729,67	144,60	12,94
12:40:02	0:00:43	729,98	144,90	12,96
12:40:42	0:00:40	729,86	144,70	12,95
12:41:24	0:00:42	730,01	144,80	12,94
12:42:06	0:00:42	730,09	144,80	12,95
12:42:47	0:00:41	730,13	144,70	12,94

12:43:29	0:00:42	730,30	144,70	12,94
12:44:11	0:00:42	730,49	145,00	12,96
12:44:52	0:00:41	730,27	144,70	12,95
12:45:34	0:00:42	730,39	144,80	12,96
12:46:16	0:00:42	730,39	144,70	12,94
12:46:58	0:00:42	730,55	144,90	12,95
12:47:39	0:00:41	730,45	145,00	12,97
12:48:21	0:00:42	730,15	144,70	12,94
12:49:03	0:00:42	730,38	144,70	12,94
12:49:45	0:00:42	730,47	145,00	12,96
12:50:26	0:00:41	730,21	144,90	12,94
12:51:09	0:00:43	730,09	145,00	12,97
12:51:50	0:00:41	729,88	144,60	12,94
12:52:32	0:00:42	730,18	144,80	12,94
12:54:34	0:02:02	730,20	145,10	13,09
12:55:16	0:00:42	730,24	144,90	12,94
12:55:58	0:00:42	730,09	144,80	12,96
12:56:39	0:00:41	730,09	144,70	12,94
12:57:21	0:00:42	730,28	144,80	12,95
12:58:02	0:00:41	730,37	144,70	12,95
12:58:45	0:00:43	730,55	144,80	12,94
12:59:26	0:00:41	730,57	144,70	12,95
13:00:08	0:00:42	730,70	144,50	12,95
13:00:50	0:00:42	731,23	145,00	12,97
13:01:31	0:00:41	730,89	144,70	12,95
13:02:14	0:00:43	731,04	144,90	12,95
13:02:55	0:00:41	730,95	144,70	12,93
13:03:37	0:00:42	731,02	144,90	12,97
13:04:18	0:00:41	730,88	144,60	12,94
13:05:01	0:00:43	731,14	144,90	12,97
13:05:42	0:00:41	731,00	144,70	12,94
13:06:24	0:00:42	731,17	144,90	12,96
13:07:06	0:00:42	731,01	144,70	12,96
13:07:48	0:00:42	731,17	144,90	12,97
13:08:29	0:00:41	730,99	144,70	12,96
13:09:12	0:00:43	731,26	144,60	12,94
13:09:53	0:00:41	731,49	145,00	12,97
13:10:34	0:00:41	731,26	144,70	12,94
13:11:16	0:00:42	731,38	144,80	12,94
13:11:58	0:00:42	731,38	144,50	12,95
13:12:40	0:00:42	731,81	144,90	12,94
13:13:21	0:00:41	731,58	144,70	12,95
13:14:04	0:00:43	731,78	144,50	12,96
13:14:45	0:00:41	732,29	145,10	12,98
13:15:26	0:00:41	731,88	144,60	12,95
13:16:08	0:00:42	732,29	144,50	12,94
13:16:50	0:00:42	732,80	145,10	13,09
13:17:31	0:00:41	732,33	144,60	12,95
13:18:13	0:00:42	732,69	144,70	12,94
13:18:54	0:00:41	732,90	144,60	12,94
13:19:35	0:00:41	733,20	144,80	12,95
13:20:16	0:00:41	733,19	144,50	12,94
13:21:02	0:00:46	733,77	144,80	12,94
13:21:43	0:00:41	733,72	144,70	12,95
13:22:25	0:00:42	733,96	144,70	12,94
13:23:07	0:00:42	734,13	144,70	12,94
13:23:48	0:00:41	734,26	144,80	12,94
13:24:30	0:00:42	734,31	144,60	12,94
13:25:11	0:00:41	734,62	144,70	12,96
13:25:53	0:00:42	734,82	144,60	12,94
13:26:34	0:00:41	736,42	144,70	12,95
13:27:15	0:00:41	735,36	144,90	12,97
13:27:58	0:00:43	735,20	144,70	12,94
13:28:39	0:00:41	735,42	144,60	12,94
13:29:20	0:00:41	735,76	144,60	12,94
13:30:02	0:00:42	736,14	144,40	12,95
13:30:44	0:00:42	736,83	144,70	12,94
13:31:25	0:00:41	737,10	144,30	12,95
13:32:06	0:00:41	738,06	144,60	12,94
13:32:48	0:00:42	738,37	143,80	12,96

Nombre de pressées (Unités)	420
Plage horaire de pressage (hr:min:sec)	7:05:08
Cumul des temps d'arrêt > 5min (hr:min:sec)	1:42:46
Temps de pressage effectif (hr:min:sec)	5:22:22
Temps moyen de cycle (hr:min:sec)	0:00:46
Productivité (unités/hr)	79
Productivité réelle (unités/hr)	66

Numéro de presse	78
Date d'enregistrement	10/03/2014
Type de briques	mpc piece arrondie
Numéro de personnel	
Début de poste de travail	10/03/2014 07:59
Fin de poste de travail	
	99,90 12,75 417

Heure	Temps de cycle	Hauteur de remplissage [mm]	Epaisseur de brique [mm]	Pression de pressage [kN/cm²]
8:23:05		646,52	87,10	13,07
8:24:00	0:00:55	668,53	103,80	13,24
8:28:25	0:04:25	662,11	101,00	13,24
8:32:11	0:03:46	660,42	100,70	13,24
8:37:24	0:05:13	659,02	103,30	13,28
8:39:10	0:01:46	654,85	100,20	13,24
8:42:40	0:03:30	653,23	100,20	13,24
9:09:19	0:26:39	652,84	99,90	13,10
9:11:35	0:02:16	652,77	99,50	13,06
9:14:19	0:02:44	653,34	98,90	13,06
9:16:31	0:02:12	654,99	100,50	13,28
9:17:50	0:01:19	654,00	100,00	13,11
9:19:21	0:01:31	653,89	99,80	13,08
9:20:48	0:01:27	654,10	99,90	13,11
9:28:09	0:07:21	654,10	99,50	13,08
11:30:20	2:02:11	654,69	100,30	13,08
11:35:18	0:04:58	654,02	98,90	13,06
11:36:05	0:00:47	655,54	100,10	13,11
11:37:49	0:01:44	655,30	99,70	13,09
11:44:47	0:06:58	655,64	100,30	13,06
11:45:30	0:00:43	655,11	99,50	13,09
11:46:12	0:00:42	655,72	100,00	13,11
11:46:52	0:00:40	655,60	100,10	13,10
11:47:32	0:00:40	655,39	100,10	13,14
11:48:13	0:00:41	655,11	99,20	13,06
11:48:53	0:00:40	656,26	100,10	13,10
11:49:33	0:00:40	656,01	100,00	13,09
11:50:13	0:00:40	655,80	99,90	13,13
11:50:54	0:00:41	655,72	99,80	13,10
11:51:34	0:00:40	655,90	99,30	13,07
11:52:14	0:00:40	656,80	100,20	13,27
11:52:54	0:00:40	656,24	100,00	13,09
11:53:34	0:00:40	656,01	99,70	13,11
11:54:54	0:01:20	656,10	99,40	13,07
11:55:35	0:00:41	656,93	100,10	13,21
11:56:15	0:00:40	656,58	100,00	13,09
11:59:07	0:02:52	656,47	99,70	13,05
12:00:29	0:01:22	656,83	100,40	13,26
12:27:38	0:27:09	656,83	101,70	13,31
12:28:24	0:00:46	654,00	100,10	13,29
12:29:32	0:01:08	653,75	99,30	13,05
12:31:53	0:02:21	654,80	100,00	13,14
12:36:26	0:04:33	654,68	101,00	13,27
12:37:15	0:00:49	653,05	99,40	13,09
12:37:57	0:00:42	653,88	100,10	13,11
12:38:47	0:00:50	653,50	100,00	13,12
12:40:09	0:01:22	653,30	99,50	13,07
12:41:21	0:01:12	653,93	100,60	13,27
12:42:35	0:01:14	652,77	101,70	13,32
12:43:58	0:01:23	649,96	100,40	13,32
12:45:49	0:01:51	649,12	98,50	13,09
12:47:05	0:01:16	651,28	96,10	13,22
12:47:45	0:00:40	657,45	99,40	13,08
12:48:25	0:00:40	658,28	100,30	13,11
12:49:06	0:00:41	657,62	99,70	13,12
12:49:46	0:00:40	658,04	99,70	13,06
12:50:26	0:00:40	658,35	100,10	13,11
12:51:06	0:00:40	658,04	99,70	13,05
12:51:45	0:00:39	658,33	100,10	13,27
12:52:26	0:00:41	658,02	99,70	13,05
12:53:07	0:00:41	658,31	100,10	13,28

12:53:47	0:00:40	658,11	100,20	13,06
12:54:27	0:00:40	657,53	100,20	13,25
12:55:07	0:00:40	657,13	99,20	13,06
12:55:48	0:00:41	658,24	100,10	13,26
12:56:28	0:00:40	658,03	99,70	13,05
12:57:08	0:00:40	658,28	100,70	13,29
12:57:49	0:00:41	656,91	99,10	13,05
12:58:30	0:00:41	658,14	100,00	13,25
12:59:10	0:00:40	657,94	99,80	13,05
12:59:50	0:00:40	658,04	99,60	13,06
13:00:30	0:00:40	658,60	100,30	13,28
13:01:10	0:00:40	657,93	99,80	13,07
13:01:50	0:00:40	658,08	100,10	13,13
13:02:31	0:00:41	657,73	100,30	13,10
13:03:10	0:00:39	657,12	99,20	13,05
13:03:50	0:00:40	658,25	99,90	13,13
13:04:31	0:00:41	658,30	100,20	13,14
13:05:11	0:00:40	657,70	99,70	13,05
13:05:51	0:00:40	658,02	100,10	13,08
13:06:31	0:00:40	657,63	99,90	13,26
13:07:12	0:00:41	657,63	99,80	13,05
13:07:52	0:00:40	657,83	100,00	13,25
13:08:32	0:00:40	657,70	100,00	13,13
13:09:12	0:00:40	657,47	100,30	13,24
13:09:53	0:00:41	656,80	99,30	13,06
13:10:33	0:00:40	657,83	99,80	13,08
13:11:13	0:00:40	657,94	100,30	13,09
13:11:53	0:00:40	657,44	99,80	13,11
13:12:33	0:00:40	657,53	100,50	13,14
13:13:15	0:00:42	656,53	99,10	13,05
13:13:55	0:00:40	657,93	100,10	13,13
13:14:36	0:00:41	657,63	100,00	13,12
13:15:16	0:00:40	657,47	100,00	13,10
13:15:56	0:00:40	657,32	99,60	13,04
13:16:36	0:00:40	657,74	100,40	13,10
13:17:16	0:00:40	656,94	99,50	13,13
13:17:57	0:00:41	657,53	99,50	13,04
13:18:37	0:00:40	658,16	99,90	13,07
13:19:17	0:00:40	658,24	99,90	13,13
13:19:57	0:00:40	658,15	100,60	13,25
13:20:39	0:00:42	656,94	99,10	13,04
13:21:19	0:00:40	658,22	100,40	13,12
13:21:59	0:00:40	657,38	99,70	13,12
13:22:39	0:00:40	657,73	100,00	13,05
13:23:20	0:00:41	657,54	99,70	13,13
13:24:00	0:00:40	657,92	99,80	13,09
13:24:40	0:00:40	658,12	100,10	13,12
13:25:24	0:00:44	657,72	100,00	13,13
13:26:26	0:01:02	657,53	99,70	13,11
13:27:06	0:00:40	657,92	100,00	13,06
13:27:47	0:00:41	657,71	100,00	13,25
13:28:27	0:00:40	657,54	100,10	13,08
13:29:06	0:00:39	657,21	99,40	13,09
13:29:46	0:00:40	657,97	100,20	13,27
13:30:26	0:00:40	657,52	99,40	13,05
13:31:06	0:00:40	658,31	100,20	13,13
13:31:49	0:00:43	657,73	99,70	13,05
13:32:31	0:00:42	658,04	100,30	13,24
13:33:16	0:00:45	657,33	99,60	13,05
13:34:02	0:00:46	657,81	99,90	13,10
13:34:50	0:00:48	657,84	100,20	13,11
13:35:34	0:00:44	657,33	99,90	13,13
13:36:18	0:00:44	657,30	99,50	13,07
13:40:05	0:03:47	657,95	100,10	13,12
13:41:16	0:01:11	657,70	100,30	13,05
13:41:55	0:00:39	657,12	99,50	13,09
13:42:35	0:00:40	657,75	100,20	13,28
13:43:16	0:00:41	657,23	99,40	13,04
13:43:57	0:00:41	658,01	100,20	13,09
13:44:37	0:00:40	657,42	100,20	13,27
13:45:17	0:00:40	656,93	99,30	13,05

13:45:58	0:00:41	657,93	100,30	13,28
13:46:38	0:00:40	657,22	99,50	13,06
13:47:18	0:00:40	657,88	100,00	13,13
13:47:58	0:00:40	657,67	99,80	13,08
13:48:38	0:00:40	657,82	100,10	13,12
13:49:19	0:00:41	657,53	99,60	13,05
13:49:59	0:00:40	658,08	100,30	13,27
13:50:39	0:00:40	657,43	99,50	13,05
13:51:19	0:00:40	658,02	100,20	13,14
13:52:00	0:00:41	657,54	99,50	13,04
13:52:40	0:00:40	658,15	100,20	13,24
13:53:20	0:00:40	657,64	99,70	13,05
13:54:00	0:00:40	658,04	99,60	13,05
13:54:41	0:00:41	658,55	100,30	13,13
13:55:21	0:00:40	657,87	99,40	13,03
13:56:01	0:00:40	658,67	100,00	13,11
13:56:41	0:00:40	658,54	99,60	13,05
13:57:22	0:00:41	659,11	100,30	13,24
14:07:48	0:10:26	658,45	98,90	13,05
14:08:29	0:00:41	658,45	99,50	13,06
14:09:09	0:00:40	659,10	99,70	13,07
14:09:49	0:00:40	659,55	100,00	13,10
14:10:29	0:00:40	659,28	99,80	13,05
14:11:10	0:00:41	659,53	100,10	13,25
14:11:50	0:00:40	659,23	99,70	13,06
14:12:31	0:00:41	659,54	100,30	13,29
14:13:11	0:00:40	658,87	99,90	13,13
14:13:52	0:00:41	658,95	99,70	13,05
14:14:32	0:00:40	659,28	100,10	13,11
14:15:13	0:00:41	658,91	100,00	13,14
14:15:53	0:00:40	658,77	99,80	13,11
14:16:33	0:00:40	658,98	99,50	13,05
14:17:14	0:00:41	659,60	100,20	13,26
14:17:54	0:00:40	659,12	99,80	13,05
14:18:34	0:00:40	659,28	99,70	13,06
14:19:14	0:00:40	659,67	100,40	13,14
14:19:54	0:00:40	658,81	99,80	13,14
14:20:35	0:00:41	659,01	100,00	13,06
14:21:15	0:00:40	658,78	100,00	13,14
14:21:55	0:00:40	658,63	100,00	13,13
14:22:35	0:00:40	658,50	99,80	13,06
14:23:56	0:01:21	658,41	99,90	13,05
14:24:37	0:00:41	658,36	99,80	13,09
14:25:17	0:00:40	658,54	100,20	13,27
14:25:57	0:00:40	658,02	99,80	13,08
14:26:37	0:00:40	658,21	99,90	13,06
14:27:17	0:00:40	658,19	99,70	13,05
14:27:58	0:00:41	658,52	100,00	13,08
14:28:38	0:00:40	658,34	99,70	13,05
14:29:18	0:00:40	658,74	100,10	13,25
14:29:58	0:00:40	658,34	99,80	13,05
14:30:39	0:00:41	658,65	99,70	13,05
14:31:19	0:00:40	658,89	100,40	13,30
14:31:59	0:00:40	658,08	100,00	13,05
14:32:39	0:00:40	657,98	99,60	13,09
14:33:21	0:00:42	658,46	100,20	13,06
14:34:01	0:00:40	657,98	99,50	13,05
14:34:41	0:00:40	658,78	100,10	13,13
14:35:21	0:00:40	658,46	99,80	13,05
14:36:01	0:00:40	658,63	100,10	13,11
14:36:41	0:00:40	658,26	99,80	13,10
14:37:22	0:00:41	658,45	99,90	13,05
14:38:02	0:00:40	658,47	100,10	13,14
14:38:42	0:00:40	658,16	99,50	13,07
14:39:22	0:00:40	658,88	99,90	13,09
14:40:04	0:00:42	658,89	99,90	13,08
14:40:43	0:00:39	658,87	100,20	13,12
14:41:24	0:00:41	658,38	99,90	13,08
14:42:04	0:00:40	658,43	99,80	13,07
14:42:45	0:00:41	658,56	99,60	13,06
14:43:25	0:00:40	658,98	99,90	13,09

14:44:05	0:00:40	658,99	100,10	13,12
14:44:45	0:00:40	658,67	99,70	13,07
14:45:26	0:00:41	659,04	99,90	13,06
14:46:06	0:00:40	659,08	100,40	13,25
14:46:46	0:00:40	658,26	99,90	13,10
14:47:26	0:00:40	658,29	99,40	13,05
14:48:07	0:00:41	659,08	100,10	13,06
14:48:47	0:00:40	658,75	99,90	13,09
14:49:27	0:00:40	658,75	99,70	13,08
14:50:07	0:00:40	659,03	100,20	13,09
14:50:47	0:00:40	658,57	99,40	13,05
14:51:28	0:00:41	659,31	100,20	13,27
14:52:08	0:00:40	658,82	99,90	13,06
14:52:49	0:00:41	658,86	99,70	13,06
14:53:29	0:00:40	659,26	100,10	13,13
14:54:10	0:00:41	659,00	100,40	13,14
14:54:50	0:00:40	658,19	99,40	13,06
14:55:30	0:00:40	658,97	100,10	13,05
14:56:10	0:00:40	658,66	99,80	13,27
14:56:51	0:00:41	658,83	100,20	13,06
14:57:31	0:00:40	658,38	99,50	13,05
14:58:12	0:00:41	658,38	100,30	13,13
14:58:52	0:00:40	658,32	99,60	13,05
14:59:32	0:00:40	658,80	99,90	13,08
15:00:13	0:00:41	658,82	99,80	13,05
15:00:53	0:00:40	658,98	99,90	13,08
15:01:34	0:00:41	658,98	100,20	13,14
15:02:14	0:00:40	658,51	99,70	13,07
15:02:55	0:00:41	658,88	99,90	13,07
15:03:35	0:00:40	658,88	100,10	13,13
15:04:15	0:00:40	658,66	100,10	13,10
15:04:55	0:00:40	658,35	100,00	13,07
15:05:35	0:00:40	658,22	99,70	13,08
15:06:16	0:00:41	658,58	100,00	13,11
15:06:56	0:00:40	658,46	100,20	13,13
15:07:36	0:00:40	657,96	100,30	13,11
15:08:16	0:00:40	657,40	99,20	13,07
15:08:57	0:00:41	658,46	100,20	13,14
15:09:37	0:00:40	657,99	99,80	13,10
15:10:18	0:00:41	658,18	100,00	13,06
15:10:58	0:00:40	658,04	99,90	13,06
15:11:39	0:00:41	657,95	99,90	13,27
15:12:19	0:00:40	657,94	99,90	13,05
15:12:59	0:00:40	658,00	99,80	13,06
15:13:39	0:00:40	658,19	100,20	13,10
15:14:20	0:00:41	657,65	99,70	13,08
15:15:00	0:00:40	658,04	99,80	13,05
15:15:40	0:00:40	658,19	100,20	13,13
15:16:20	0:00:40	657,72	99,70	13,05
15:17:00	0:00:40	658,00	100,00	13,10
15:17:41	0:00:41	657,84	99,90	13,05
15:18:21	0:00:40	657,89	99,70	13,05
15:19:01	0:00:40	658,14	99,90	13,11
15:19:41	0:00:40	658,08	100,00	13,10
15:20:22	0:00:41	657,98	100,00	13,12
15:21:02	0:00:40	657,87	99,90	13,10
15:21:43	0:00:41	657,90	100,30	13,13
15:22:24	0:00:41	657,23	99,90	13,05
15:23:04	0:00:40	657,24	99,60	13,10
15:23:44	0:00:40	657,74	100,00	13,09
15:24:24	0:00:40	657,62	100,40	13,29
15:25:04	0:00:40	656,83	99,70	13,05
15:25:45	0:00:41	657,20	99,80	13,05
15:26:26	0:00:41	657,42	100,00	13,10
15:27:06	0:00:40	657,33	99,70	13,05
15:27:46	0:00:40	657,58	99,90	13,08
15:28:27	0:00:41	657,57	99,90	13,09
15:29:07	0:00:40	657,53	99,90	13,08
15:29:47	0:00:40	657,55	100,00	13,09
15:30:27	0:00:40	657,43	100,20	13,13
15:31:08	0:00:41	656,94	99,80	13,06

15:31:48	0:00:40	657,14	99,60	13,05
15:32:27	0:00:39	657,64	100,20	13,12
15:33:07	0:00:40	657,15	99,80	13,10
15:33:49	0:00:42	657,30	99,90	13,07
15:34:29	0:00:40	657,33	100,00	13,06
15:35:09	0:00:40	657,24	99,80	13,08
15:35:49	0:00:40	657,36	99,90	13,07
15:36:30	0:00:41	657,42	100,00	13,10
15:37:10	0:00:40	657,24	99,80	13,05
15:37:50	0:00:40	657,39	100,00	13,10
15:38:30	0:00:40	657,24	100,30	13,06
15:39:11	0:00:41	656,65	99,50	13,05
15:39:51	0:00:40	657,33	99,90	13,09
15:40:31	0:00:40	657,33	100,40	13,13
15:41:11	0:00:40	656,53	99,50	13,05
15:41:51	0:00:40	657,14	99,90	13,08
15:42:32	0:00:41	657,16	100,00	13,11
15:43:12	0:00:40	657,03	100,00	13,06
15:43:52	0:00:40	656,92	100,00	13,07
15:44:32	0:00:40	656,72	99,60	13,05
15:45:13	0:00:41	657,14	100,30	13,10
16:13:39	0:28:26	656,52	98,80	13,04
16:14:20	0:00:41	656,54	99,50	13,08
16:15:00	0:00:40	657,23	99,80	13,14
16:15:40	0:00:40	657,36	99,90	13,08
16:16:20	0:00:40	657,36	100,00	13,05
16:17:01	0:00:41	657,19	99,80	13,07
16:17:41	0:00:40	657,34	100,00	13,14
16:18:22	0:00:41	657,16	99,70	13,05
16:19:02	0:00:40	657,44	99,70	13,05
16:19:43	0:00:41	657,83	100,30	13,15
16:20:23	0:00:40	657,14	99,50	13,06
16:21:03	0:00:40	657,75	100,10	13,19
16:21:43	0:00:40	657,43	99,60	13,06
16:22:24	0:00:41	657,86	99,90	13,06
16:23:04	0:00:40	657,92	100,40	13,29
16:23:44	0:00:40	657,12	99,60	13,06
16:24:24	0:00:40	657,61	100,30	13,10
16:25:04	0:00:40	656,90	99,50	13,05
16:25:45	0:00:41	657,65	99,80	13,05
16:26:25	0:00:40	657,82	100,00	13,05
16:36:24	0:09:59	657,59	100,00	13,15
16:37:04	0:00:40	657,64	100,20	13,25
16:37:44	0:00:40	657,16	99,90	13,08
16:38:25	0:00:41	657,08	100,00	13,14
16:39:05	0:00:40	656,97	99,50	13,05
16:39:45	0:00:40	657,63	100,00	13,10
16:40:25	0:00:40	657,50	99,80	13,06
16:41:05	0:00:40	657,63	99,90	13,13
16:41:46	0:00:41	657,57	99,90	13,06
16:42:26	0:00:40	657,62	100,30	13,10
16:43:06	0:00:40	656,94	99,90	13,10
16:43:46	0:00:40	656,94	99,70	13,07
16:44:28	0:00:42	657,32	99,90	13,05
16:45:08	0:00:40	657,33	100,00	13,29
16:45:48	0:00:40	657,24	100,00	13,06
16:47:09	0:01:21	657,03	99,60	13,05
16:47:48	0:00:39	657,56	99,90	13,08
16:48:28	0:00:40	657,71	100,10	13,22
16:49:08	0:00:40	657,25	99,90	13,11
16:49:49	0:00:41	657,24	99,80	13,06
16:50:29	0:00:40	657,35	100,10	13,12
16:51:09	0:00:40	657,07	99,60	13,05
16:51:49	0:00:40	657,54	100,10	13,12
16:52:29	0:00:40	657,23	99,70	13,06
16:53:09	0:00:40	657,54	100,50	13,27
16:53:51	0:00:42	656,61	99,40	13,07
16:54:31	0:00:40	657,35	99,80	13,06
16:55:11	0:00:40	657,56	99,90	13,09
16:55:51	0:00:40	657,61	99,90	13,06
16:56:32	0:00:41	657,54	99,90	13,09

16:57:12	0:00:40	657,53	99,90	13,06
16:57:51	0:00:39	657,58	100,60	13,28
16:58:32	0:00:41	656,43	99,30	13,07
16:59:13	0:00:41	657,46	100,30	13,28
16:59:53	0:00:40	656,82	99,70	13,05
17:00:33	0:00:40	657,15	99,90	13,05
17:01:13	0:00:40	657,22	99,90	13,09
17:01:54	0:00:41	657,22	99,70	13,05
17:02:34	0:00:40	657,53	99,90	13,05
17:03:14	0:00:40	657,55	100,20	13,26
17:03:54	0:00:40	657,10	100,00	13,07
17:04:35	0:00:41	656,93	99,50	13,06
17:05:15	0:00:40	657,55	100,10	13,26
17:05:55	0:00:40	657,22	99,80	13,05
17:06:35	0:00:40	657,42	100,30	13,08
17:07:15	0:00:40	656,79	99,60	13,09
17:07:56	0:00:41	657,33	99,70	13,06
17:08:36	0:00:40	657,61	100,00	13,10
17:09:16	0:00:40	657,53	99,90	13,05
17:09:57	0:00:41	657,54	99,90	13,08
17:10:38	0:00:41	657,54	100,10	13,08
17:11:18	0:00:40	657,25	99,70	13,05
17:11:58	0:00:40	657,71	100,00	13,06
17:12:38	0:00:40	657,51	100,10	13,10
17:13:19	0:00:41	657,23	99,70	13,10
17:13:59	0:00:40	657,55	99,90	13,07
17:14:39	0:00:40	657,54	99,80	13,05
17:15:19	0:00:40	657,75	100,40	13,13
17:16:00	0:00:41	656,99	99,60	13,09
17:16:40	0:00:40	657,41	99,80	13,05
17:17:20	0:00:40	657,55	99,90	13,10
17:18:00	0:00:40	657,54	100,10	13,13
17:18:41	0:00:41	657,22	99,70	13,05
17:19:21	0:00:40	657,46	99,80	13,05
17:20:01	0:00:40	657,66	99,80	13,05
17:20:41	0:00:40	657,89	100,20	13,07
17:21:21	0:00:40	657,47	99,80	13,12
17:22:02	0:00:41	657,64	100,00	13,09
17:22:42	0:00:40	657,52	99,90	13,06
17:23:22	0:00:40	657,54	100,10	13,14
17:24:02	0:00:40	657,26	99,60	13,05
17:24:43	0:00:41	657,75	99,90	13,07
17:25:23	0:00:40	657,76	99,80	13,05
22:15:06	4:49:43	657,92	100,40	13,30
22:15:50	0:00:44	657,20	99,60	13,06
22:16:35	0:00:45	657,72	99,70	13,05
22:17:17	0:00:42	658,07	99,90	13,08
22:17:59	0:00:42	658,01	99,90	13,15
22:18:43	0:00:44	657,95	99,80	13,07
22:19:25	0:00:42	658,14	99,80	13,08
22:20:06	0:00:41	658,24	99,90	13,08
22:20:51	0:00:45	658,33	99,80	13,10
22:21:33	0:00:42	658,44	99,80	13,10
22:22:22	0:00:49	658,61	100,10	13,14
22:23:05	0:00:43	658,30	99,60	13,07
22:23:48	0:00:43	658,84	100,10	13,15
22:24:30	0:00:42	658,44	100,00	13,13
22:25:15	0:00:45	658,25	99,70	13,05
22:25:57	0:00:42	658,61	100,10	13,21
22:26:43	0:00:46	658,25	99,80	13,07
22:27:28	0:00:45	658,46	100,10	13,14
22:28:11	0:00:43	658,13	99,50	13,07
22:28:54	0:00:43	658,73	100,10	13,14
22:29:36	0:00:42	658,33	100,30	13,31
22:30:18	0:00:42	657,72	100,30	13,13
22:31:04	0:00:46	657,20	99,10	13,08
22:31:46	0:00:42	658,43	100,00	13,08
22:32:33	0:00:47	658,24	99,70	13,09
22:33:15	0:00:42	658,62	99,80	13,08
22:33:59	0:00:44	658,89	100,10	13,12

Nombre de pressées (Unités)	415
Plage horaire de pressage (hr:min:sec)	14:10:54
Cumul des temps d'arrêt > 5min (hr:min:sec)	8:54:05
Temps de pressage effectif (hr:min:sec)	5:16:49
Temps moyen de cycle (hr:min:sec)	0:00:46
Productivité (unités/hr)	79
Productivité réelle (unités/hr)	61

Numéro de presse	78
Date d'enregistrement	11/03/2014
Type de briques	mpc piece arrondie
Numéro de personnel	
Début de poste de travail	11/03/2014 22:33
Fin de poste de travail	
	99,90 · 12,75 · 206

Heure	Temps de cycle	Hauteur de remplissage [mm]	Epaisseur de brique [mm]	Pression de pressage [kN/cm²]
23:16:44		660,16	105,70	13,30
23:17:36	0:00:52	651,23	97,20	13,10
23:18:49	0:01:13	655,49	99,30	13,05
23:20:03	0:01:14	656,41	99,80	13,07
23:20:46	0:00:43	656,62	99,90	13,06
23:21:28	0:00:42	656,62	99,80	13,06
23:22:09	0:00:41	656,82	99,40	13,06
23:29:27	0:07:18	657,59	99,10	13,09
23:30:08	0:00:41	658,90	100,20	13,27
23:32:11	0:02:03	658,52	99,80	13,07
23:33:56	0:01:45	658,66	99,10	13,09
23:34:38	0:00:42	660,07	100,10	13,12
23:35:21	0:00:43	659,78	99,70	13,07
23:36:07	0:00:46	660,08	99,90	13,08
23:36:54	0:00:47	660,16	99,90	13,06
23:37:34	0:00:40	660,15	99,70	13,10
23:38:17	0:00:43	660,51	99,80	13,07
23:39:00	0:00:43	660,78	99,80	13,06
23:39:42	0:00:42	660,99	100,00	13,08
23:40:26	0:00:44	660,87	99,90	13,07
23:41:08	0:00:42	660,79	99,80	13,09
23:41:53	0:00:45	661,08	100,10	13,14
23:42:36	0:00:43	660,78	99,80	13,05
23:43:22	0:00:46	661,01	99,90	13,06
23:44:04	0:00:42	661,09	100,00	13,11
23:44:50	0:00:46	661,01	99,90	13,09
23:45:31	0:00:41	660,98	99,90	13,07
23:46:15	0:00:44	660,90	99,90	13,14
23:46:58	0:00:43	660,96	100,00	13,09
23:47:38	0:00:40	660,78	99,60	13,06
23:48:20	0:00:42	661,21	100,10	13,08
23:49:04	0:00:44	660,94	99,80	13,13
23:49:46	0:00:42	661,17	100,00	13,07
23:50:28	0:00:42	660,98	99,60	13,07
23:51:08	0:00:40	661,44	100,10	13,13
23:51:48	0:00:40	661,10	99,80	13,05
23:52:28	0:00:40	661,33	99,70	13,07
23:53:10	0:00:42	661,73	100,00	13,11
23:53:50	0:00:40	661,63	99,80	13,06
23:54:30	0:00:40	661,76	100,20	13,13
23:55:10	0:00:40	661,19	99,60	13,06
23:55:51	0:00:41	661,62	99,80	13,07
23:56:32	0:00:41	661,91	100,20	13,13
23:57:12	0:00:40	661,35	99,80	13,10
23:57:52	0:00:40	661,61	99,90	13,07
23:58:33	0:00:41	661,62	100,00	13,11
23:59:13	0:00:40	661,58	100,10	13,09
23:59:53	0:00:40	661,32	99,70	13,07
0:00:34	0:00:41	661,59	100,50	13,13
0:01:15	0:00:41	660,67	99,80	13,27
0:01:55	0:00:40	660,76	99,90	13,07
0:02:36	0:00:41	660,70	100,00	13,19
0:03:16	0:00:40	660,60	100,00	13,11
0:03:57	0:00:41	660,49	99,80	13,05
0:04:37	0:00:40	660,66	100,00	13,12
0:05:17	0:00:40	660,55	100,10	13,14
0:05:58	0:00:41	660,29	99,80	13,06
0:06:38	0:00:40	660,48	100,00	13,11
0:07:19	0:00:41	660,39	100,40	13,14
0:08:00	0:00:41	659,63	99,50	13,06
0:08:40	0:00:40	660,19	99,90	13,09

0:09:20	0:00:40	660,15	100,20	13,08
0:10:01	0:00:41	659,64	99,70	13,12
0:10:41	0:00:40	659,98	100,00	13,09
0:11:21	0:00:40	659,84	100,00	13,12
0:12:01	0:00:40	659,73	99,80	13,08
0:12:43	0:00:42	659,95	100,00	13,11
0:13:23	0:00:40	659,87	100,20	13,26
0:14:03	0:00:40	659,46	99,60	13,07
0:14:43	0:00:40	659,88	100,00	13,12
0:15:24	0:00:41	659,65	100,30	13,27
0:16:04	0:00:40	658,93	99,70	13,06
0:16:45	0:00:41	659,26	99,80	13,07
0:17:25	0:00:40	659,49	100,00	13,12
0:18:06	0:00:41	659,27	99,90	13,08
0:18:46	0:00:40	659,31	100,10	13,08
0:19:26	0:00:40	659,09	99,90	13,28
0:20:06	0:00:40	659,05	99,80	13,06
0:20:47	0:00:41	659,18	99,90	13,08
0:21:28	0:00:41	659,16	99,90	13,11
0:22:08	0:00:40	659,08	99,80	13,06
0:26:22	0:04:14	659,16	99,60	13,06
0:27:02	0:00:40	659,60	99,90	13,13
0:27:43	0:00:41	659,56	100,00	13,12
0:28:23	0:00:40	659,56	99,90	13,09
0:29:04	0:00:41	659,47	100,20	13,07
0:29:44	0:00:40	658,98	99,60	13,14
0:30:24	0:00:40	659,41	100,00	13,14
0:31:04	0:00:40	659,27	99,90	13,09
0:31:44	0:00:40	659,18	99,70	13,06
0:32:25	0:00:41	659,53	100,00	13,13
0:33:05	0:00:40	659,36	99,80	13,07
0:33:45	0:00:40	659,48	99,80	13,08
0:34:25	0:00:40	659,57	100,10	13,26
0:35:06	0:00:41	659,24	99,70	13,06
0:35:46	0:00:40	659,47	100,10	13,25
0:36:26	0:00:40	659,08	99,80	13,06
0:37:06	0:00:40	659,28	99,80	13,07
0:37:48	0:00:42	659,48	100,00	13,12
0:38:28	0:00:40	659,23	99,90	13,11
0:39:08	0:00:40	659,16	99,90	13,07
0:39:48	0:00:40	659,27	100,20	13,14
0:40:29	0:00:41	658,71	99,80	13,12
0:41:09	0:00:40	658,90	99,90	13,07
0:41:49	0:00:40	658,95	99,80	13,05
0:42:30	0:00:41	659,12	100,20	13,14
0:43:11	0:00:41	658,61	99,70	13,05
0:43:51	0:00:40	658,93	99,70	13,08
0:44:31	0:00:40	659,17	99,90	13,06
0:45:11	0:00:40	659,15	99,90	13,10
0:45:52	0:00:41	659,17	100,00	13,10
0:46:33	0:00:41	659,02	100,20	13,13
0:47:13	0:00:40	658,50	99,60	13,06
0:47:53	0:00:40	658,92	100,00	13,11
0:48:33	0:00:40	658,80	99,90	13,06
0:49:14	0:00:41	658,86	100,20	13,17
0:49:54	0:00:40	658,44	99,70	13,07
0:50:35	0:00:41	658,84	99,80	13,07
0:51:15	0:00:40	659,07	100,30	13,12
0:51:56	0:00:41	658,51	99,60	13,06
0:52:36	0:00:40	659,06	99,90	13,05
0:53:16	0:00:40	659,13	99,90	13,08
0:53:56	0:00:40	659,09	99,90	13,11
0:54:38	0:00:42	659,07	99,90	13,09
0:55:18	0:00:40	659,04	99,80	13,05
0:55:58	0:00:40	659,17	99,90	13,06
0:56:38	0:00:40	659,25	99,80	13,06
0:57:19	0:00:41	659,38	99,90	13,10
0:57:59	0:00:40	659,33	99,80	13,09
1:39:47	0:41:48	659,41	99,80	13,07
1:40:27	0:00:40	659,65	100,00	13,12
1:41:07	0:00:40	659,40	100,00	13,11

1:41:48	0:00:41	659,33	99,90	13,10
1:42:29	0:00:41	659,26	99,90	13,07
1:43:09	0:00:40	659,26	99,80	13,06
1:43:49	0:00:40	659,37	100,00	13,14
1:44:30	0:00:41	659,27	99,80	13,07
1:45:11	0:00:41	659,53	99,80	13,08
1:45:51	0:00:40	659,68	99,90	13,13
1:46:31	0:00:40	659,60	100,00	13,10
1:47:13	0:00:42	659,38	99,80	13,05
1:47:53	0:00:40	659,56	99,70	13,05
1:48:33	0:00:40	659,85	100,00	13,09
1:49:14	0:00:41	659,68	99,60	13,07
1:49:54	0:00:40	660,09	100,10	13,13
1:50:34	0:00:40	659,71	99,70	13,07
1:51:15	0:00:41	660,07	100,20	13,26
1:51:55	0:00:40	659,54	99,80	13,08
1:52:36	0:00:41	659,75	99,80	13,07
1:53:16	0:00:40	659,86	99,80	13,09
2:04:11	0:10:55	659,97	99,60	13,07
2:04:51	0:00:40	659,99	99,80	13,09
2:05:32	0:00:41	660,08	99,70	13,07
2:06:12	0:00:40	660,44	99,90	13,09
2:06:53	0:00:41	660,48	100,40	13,12
2:07:33	0:00:40	659,67	99,70	13,12
2:08:14	0:00:41	660,07	99,50	13,06
2:08:55	0:00:41	660,64	100,00	13,11
2:09:35	0:00:40	660,45	99,80	13,09
2:10:15	0:00:40	660,59	100,10	13,17
2:10:57	0:00:42	660,19	99,80	13,08
2:11:37	0:00:40	660,32	99,80	13,08
2:12:17	0:00:40	660,41	100,10	13,07
2:12:57	0:00:40	660,07	99,90	13,13
2:13:39	0:00:42	660,10	99,90	13,08
2:14:19	0:00:40	660,08	99,60	13,05
2:15:00	0:00:41	660,56	100,00	13,06
2:15:40	0:00:40	660,32	99,70	13,10
2:16:21	0:00:41	660,69	100,00	13,11
2:17:01	0:00:40	660,48	99,90	13,10
2:17:42	0:00:41	660,50	99,90	13,06
2:18:22	0:00:40	660,55	99,90	13,10
2:19:03	0:00:41	660,52	100,00	13,09
2:19:43	0:00:40	660,43	99,90	13,10
2:20:24	0:00:41	660,44	99,60	13,06
2:21:04	0:00:40	660,92	100,20	13,24
2:21:45	0:00:41	660,44	99,60	13,07
2:22:25	0:00:40	660,89	99,90	13,10
2:23:06	0:00:41	660,84	100,00	13,11
2:23:46	0:00:40	660,74	100,10	13,13
2:24:26	0:00:40	660,41	99,70	13,06
2:25:08	0:00:42	660,71	99,90	13,08
2:25:48	0:00:40	660,72	99,90	13,07
2:26:28	0:00:40	660,66	99,90	13,10
2:27:09	0:00:41	660,71	100,00	13,12
2:27:50	0:00:41	660,58	99,90	13,08
2:28:31	0:00:41	660,52	99,70	13,07
2:29:11	0:00:40	660,80	99,90	13,09
2:29:51	0:00:40	660,77	99,80	13,06
2:30:32	0:00:41	660,95	100,10	13,14
2:31:13	0:00:41	660,62	100,00	13,09
2:31:53	0:00:40	660,48	100,00	13,06
2:35:39	0:03:46	660,23	99,50	13,08
2:36:19	0:00:40	660,25	99,60	13,08
2:36:59	0:00:40	660,82	100,00	13,09
2:37:39	0:00:40	660,68	99,60	13,06
2:38:19	0:00:40	661,12	100,00	13,13
2:39:00	0:00:41	660,90	100,00	13,10
2:40:42	0:01:42	660,72	100,30	13,11
2:41:27	0:00:45	660,07	99,60	13,04
2:42:11	0:00:44	660,53	99,10	13,05
2:42:56	0:00:45	661,91	98,70	13,06
2:43:40	0:00:44	663,92	100,40	13,24

2:44:25	0:00:45	663,03	98,00	13,16
2:45:08	0:00:43	666,33	99,00	13,05
2:45:52	0:00:44	667,88	98,20	13,14

Nombre de pressées (Unités)	206
Plage horaire de pressage (hr:min:sec)	3:29:08
Cumul des temps d'arrêt > 5min (hr:min:sec)	1:00:01
Temps de pressage effectif (hr:min:sec)	2:29:07
Temps moyen de cycle (hr:min:sec)	0:00:43
Productivité (unités/hr)	82
Productivité réelle (unités/hr)	73

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
Spécifications contractuelles	-	130 ± 5	24 400	400 ± 0,85	200 ± 0,85	145 ± 0,85	-	2,080 ± 0,020	19 ± 1	19 ± 1	-	-	> 6
Spécifications ajustées par Nagra après 160 pièces				401,32 ± 0,85	200,81 ± 0,85	145,27							
Mini	-	125	-	400,47	199,96	144,42	-	2,060	18	18	-	-	6
Maxi	-	135	-	402,17	201,66	146,12	-	2,100	20	20	-	-	-
05/03/2014	**A1**	131,4	24 440	401,0	200,0	144,6		**2,107**	19,0		1,77	97,79%	
05/03/2014	**A10**	131,4	24 460	401,1	200,4	144,5		**2,106**	19,0		1,77	97,58%	
05/03/2014	**A100**	128,9	24 480	401,0	200,7	145,3		**2,094**	19,0	18,54	1,76	95,96%	
06/03/2014	**A1000**	129,7	24 440	401,3	201,0	145,3		**2,086**	19,0		1,75	95,00%	
06/03/2014	**A1001**	129,4	24 560	401,4	200,8	145,7		**2,092**	19,0		1,76	95,73%	
06/03/2014	**A1002**	129,6	24 540	401,6	200,6	145,7		**2,091**	19,0		1,76	95,64%	
06/03/2014	**A1003**	129,6	24 500	401,6	200,6	145,6		**2,089**	19,0		1,76	95,40%	
06/03/2014	**A1004**	129,4	24 500	401,4	200,7	145,6		**2,089**	19,0		1,76	95,39%	
06/03/2014	**A1005**	129,6	24 520	401,4	200,7	145,2		**2,097**	19,0		1,76	96,33%	
06/03/2014	**A1006**	129,8	24 540	401,5	200,7	145,3		**2,096**	19,0		1,76	96,21%	
06/03/2014	**A1007**	129,7	24 540	401,3	200,4	145,4		**2,099**	19,0		1,76	96,64%	
06/03/2014	**A1008**	129,5	24 540	401,5	200,4	145,3		**2,099**	19,0		1,76	96,69%	
06/03/2014	**A1009**	129,7	24 540	401,5	200,6	145,7		**2,091**	19,0		1,76	95,62%	
05/03/2014	**A101**	130,4	24 440	401,1	201,0	144,9	Léger collage supérieur	**2,092**	19,0		1,76	95,78%	
06/03/2014	**A1010**	129,5	24 520	401,4	200,7	145,5		**2,093**	19,0		1,76	95,80%	
06/03/2014	**A1011**	129,6	24 600	401,4	200,7	146,0		**2,092**	19,0		1,76	95,79%	
06/03/2014	**A1012**	129,5	24 480	401,3	200,8	145,5		**2,088**	19,0		1,75	95,17%	
06/03/2014	**A1013**	129,5	24 580	401,5	200,6	145,9		**2,092**	19,0		1,76	95,77%	
06/03/2014	**A1014**	129,7	24 540	401,7	200,7	145,6		**2,091**	19,0		1,76	95,54%	
06/03/2014	**A1015**	129,5	24 580	401,6	200,7	145,8		**2,091**	19,0		1,76	95,59%	
06/03/2014	**A1016**	129,5	24 540	401,6	200,8	145,6		**2,089**	19,0		1,76	95,36%	
06/03/2014	**A1017**	129,6	24 540	401,6	200,7	145,5		**2,092**	19,0		1,76	95,72%	
06/03/2014	**A1018**	129,5	24 540	401,6	200,7	145,3		**2,096**	19,0		1,76	96,28%	
06/03/2014	**A1019**	129,4	24 520	401,4	200,7	145,7	Léger collage supérieur	**2,089**	19,0		1,76	95,33%	
05/03/2014	**A102**	128,9	24 460	401,1	200,9	144,9	Léger collage supérieur	**2,094**	19,0		1,76	96,04%	
06/03/2014	**A1020**	129,5	24 500	401,9	200,9	145,8	Léger collage supérieur	**2,082**	19,0		1,75	94,46%	
06/03/2014	**A1021**	130,8	24 520	401,5	200,6	145,8	Léger collage supérieur	**2,089**	19,0		1,76	95,31%	
06/03/2014	**A1022**	129,4	24 540	401,5	200,8	145,8	Léger collage supérieur	**2,087**	19,0		1,75	95,09%	
06/03/2014	**A1023**	129,6	24 520	401,6	200,7	145,6	Léger collage supérieur	**2,089**	19,0		1,76	95,40%	
06/03/2014	**A1024**	129,8	24 480	401,6	200,6	145,2	Léger collage supérieur	**2,093**	19,0		1,76	95,87%	
06/03/2014	**A1025**	129,3	24 620	401,8	200,9	146,1	Pièce écartée	**2,088**	19,0		1,75	95,17%	
06/03/2014	**A1026**	129,7	24 520	401,6	200,8	145,5	Léger collage supérieur	**2,090**	19,0		1,76	95,41%	
06/03/2014	**A1027**	129,5	24 520	401,5	200,8	145,8	Léger collage supérieur	**2,086**	19,0		1,75	95,00%	
06/03/2014	**A1028**	129,5	24 560	401,4	200,8	146,1	Léger collage supérieur	**2,086**	19,0		1,75	94,97%	
06/03/2014	**A1029**	129,5	24 520	401,6	200,8	145,9	Léger collage supérieur	**2,084**	19,0		1,75	94,70%	
05/03/2014	**A103**	129,2	24 480	401,1	201,0	145,2	Léger collage supérieur	**2,091**	19,0		1,76	95,62%	
06/03/2014	**A1030**	129,6	24 480	401,6	201,0	145,5	Léger collage supérieur	**2,084**	19,0		1,75	94,69%	
06/03/2014	**A1031**	129,6	24 540	401,8	201,3	145,8	Léger collage supérieur	**2,081**	19,0		1,75	94,31%	
06/03/2014	**A1032**	129,7	24 580	401,8	201,0	146,0	Léger collage supérieur	**2,084**	19,0		1,75	94,74%	
06/03/2014	**A1033**	129,6	24 480	401,7	201,0	145,4	Léger collage supérieur	**2,085**	19,0		1,75	94,82%	
06/03/2014	**A1034**	129,7	24 520	401,8	201,0	145,7	Léger collage supérieur	**2,084**	19,0		1,75	94,67%	
06/03/2014	**A1035**	129,5	24 540	401,8	201,0	145,3	Léger collage supérieur	**2,091**	19,0		1,76	95,58%	
06/03/2014	**A1036**	129,6	24 500	401,9	200,9	145,0	Léger collage supérieur	**2,094**	19,0		1,76	95,97%	
06/03/2014	**A1037**	129,5	24 620	402,1	201,0	145,5	Léger collage supérieur	**2,094**	19,0		1,76	96,03%	
06/03/2014	**A1038**	129,8	24 680	401,9	201,0	145,9	Léger collage supérieur	**2,094**	19,0		1,76	96,02%	
06/03/2014	**A1039**	129,4	24 640	401,9	201,1	146,1	Pièce écartée	**2,087**	19,0		1,75	95,04%	
05/03/2014	**A104**	128,9	24 420	401,4	200,7	145,1	Léger collage supérieur	**2,089**	19,0		1,76	95,32%	
06/03/2014	**A1040**	129,4	24 600	402,0	201,1	145,9	Léger collage supérieur	**2,085**	19,0		1,75	94,85%	
06/03/2014	**A1041**	129,4	24 720	402,0	201,2	146,5	Pièce écartée pour Rc	**2,086**	19,0	17,55	1,75	94,96%	8,2 - 9,6
06/03/2014	**A1042**	129,6	24 620	401,7	201,2	146,0	Léger collage supérieur	**2,086**	19,0		1,75	94,99%	
06/03/2014	**A1043**	129,4	24 580	401,9	201,2	145,5	Léger collage supérieur	**2,088**	19,0		1,75	95,26%	
06/03/2014	**A1044**	129,6	24 620	402,1	201,0	145,8	Léger collage supérieur	**2,089**	19,0		1,76	95,30%	
06/03/2014	**A1045**	129,9	24 560	402,1	201,2	145,8	Léger collage supérieur	**2,082**	19,0		1,75	94,37%	
06/03/2014	**A1046**	129,5	24 520	402,0	201,1	145,8	Léger collage supérieur	**2,080**	19,0		1,75	94,19%	
06/03/2014	**A1047**	129,4	24 540	402,0	201,2	144,9	Léger collage supérieur	**2,093**	19,0		1,76	95,88%	
06/03/2014	**A1048**	130,3	24 500	402,1	201,1	145,1	Léger collage supérieur	**2,088**	19,0		1,75	95,15%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1049**	129,5	24 460	401,3	200,6	145,6	Léger collage supérieur	**2,086**	19,0		1,75	94,93%	
05/03/2014	**A105**	129,2	24 440	401,2	200,8	145,1	Léger collage supérieur	**2,090**	19,0		1,76	95,52%	
06/03/2014	**A1050**	129,6	24 480	401,5	200,7	145,7	Léger collage supérieur	**2,086**	19,0		1,75	94,90%	
06/03/2014	**A1051**	129,4	24 440	401,5	200,5	145,1	Léger collage supérieur	**2,093**	19,0		1,76	95,84%	
06/03/2014	**A1052**	129,6	24 500	401,5	200,4	145,3	Léger collage supérieur	**2,095**	19,0		1,76	96,18%	
06/03/2014	**A1053**	129,4	24 440	401,4	200,3	145,1	Léger collage supérieur	**2,095**	19,0		1,76	96,10%	
06/03/2014	**A1054**	129,5	24 440	401,4	200,5	145,2	Léger collage supérieur	**2,092**	19,0		1,76	95,72%	
06/03/2014	**A1055**	129,4	24 480	401,4	200,4	145,4	Léger collage supérieur	**2,092**	19,0		1,76	95,78%	
06/03/2014	**A1056**	131,0	24 440	401,5	200,4	145,3	Léger collage supérieur	**2,090**	19,0		1,76	95,46%	
06/03/2014	**A1057**	129,4	24 460	401,3	200,4	145,4		**2,092**	19,0		1,76	95,71%	
06/03/2014	**A1058**	129,5	24 420	401,5	200,6	145,1		**2,091**	19,0		1,76	95,58%	
06/03/2014	**A1059**	129,6	24 440	401,4	200,7	145,4		**2,085**	19,0		1,75	94,89%	
05/03/2014	**A106**	129,1	24 420	401,9	200,7	145,1	Léger collage supérieur	**2,086**	19,0		1,75	94,93%	
06/03/2014	**A1060**	129,6	24 480	401,5	200,8	145,6		**2,086**	19,0		1,75	94,93%	
06/03/2014	**A1061**	129,5	24 420	401,5	200,5	145,7		**2,082**	19,0		1,75	94,49%	
06/03/2014	**A1062**	129,4	24 460	401,4	200,6	145,7	Léger collage supérieur	**2,085**	19,0		1,75	94,80%	
06/03/2014	**A1063**	129,7	24 380	401,4	200,4	145,2		**2,087**	19,0		1,75	95,11%	
06/03/2014	**A1064**	129,6	24 660	401,3	200,7	145,7		**2,102**	19,0		1,77	97,06%	
06/03/2014	**A1065**	129,6	24 460	401,3	200,8	145,6		**2,085**	19,0		1,75	94,80%	
06/03/2014	**A1066**	129,6	24 460	401,2	200,4	145,3		**2,094**	19,0		1,76	95,97%	
06/03/2014	**A1067**	129,6	24 460	401,5	200,3	145,3		**2,093**	19,0		1,76	95,90%	
06/03/2014	**A1068**	129,6	24 460	401,2	200,4	145,3		**2,094**	19,0		1,76	95,97%	
06/03/2014	**A1069**	129,5	24 480	401,3	200,5	145,1		**2,097**	19,0		1,76	96,37%	
05/03/2014	**A107**	130,4	24 440	401,2	200,8	144,8	Léger collage supérieur	**2,096**	19,0		1,76	96,24%	
06/03/2014	**A1070**	129,6	24 380	401,3	200,3	144,8		**2,095**	19,0		1,76	96,09%	
06/03/2014	**A1071**	129,4	24 480	401,1	200,4	145,7		**2,090**	19,0		1,76	95,51%	
06/03/2014	**A1072**	129,5	24 420	401,3	200,6	145,5		**2,085**	19,0		1,75	94,81%	
06/03/2014	**A1073**	129,4	24 440	401,1	200,6	145,5		**2,088**	19,0		1,75	95,17%	
06/03/2014	**A1074**	129,8	24 480	401,4	200,4	145,7		**2,089**	19,0		1,76	95,30%	
06/03/2014	**A1075**	129,4	24 460	401,3	200,4	145,1		**2,096**	19,0		1,76	96,28%	
06/03/2014	**A1076**	129,5	24 460	401,2	200,3	145,1		**2,098**	19,0		1,76	96,49%	
06/03/2014	**A1077**	129,7	24 480	401,3	200,3	145,2		**2,097**	19,0		1,76	96,46%	
06/03/2014	**A1078**	129,4	24 420	401,2	200,3	145,1		**2,094**	19,0		1,76	96,04%	
06/03/2014	**A1079**	129,7	24 580	401,4	200,6	145,2		**2,102**	19,0		1,77	97,11%	
05/03/2014	**A108**	128,9	24 460	401,2	200,8	144,8	Léger collage supérieur	**2,097**	19,0		1,76	96,45%	
06/03/2014	**A1080**	129,5	24 580	401,3	200,6	145,2		**2,103**	19,0		1,77	97,18%	
06/03/2014	**A1081**	129,7	24 540	401,2	200,5	145,2		**2,101**	19,0		1,77	96,93%	
06/03/2014	**A1082**	129,4	24 600	401,4	200,7	145,3		**2,102**	19,0		1,77	97,00%	
06/03/2014	**A1083**	129,7	24 600	401,6	200,7	145,5		**2,098**	19,0		1,76	96,48%	
06/03/2014	**A1084**	129,6	24 580	401,4	200,7	145,1		**2,103**	19,0		1,77	97,16%	
06/03/2014	**A1085**	129,8	24 560	401,5	200,6	145,1		**2,102**	19,0		1,77	97,00%	
06/03/2014	**A1086**	129,5	24 600	401,5	200,8	145,3		**2,100**	19,0		1,76	96,79%	
06/03/2014	**A1087**	129,5	24 580	401,5	200,5	145,4		**2,100**	19,0		1,76	96,79%	
06/03/2014	**A1088**	129,5	24 600	401,6	200,6	145,3		**2,102**	19,0		1,77	97,00%	
06/03/2014	**A1089**	129,4	24 600	401,5	200,6	145,4		**2,101**	19,0		1,77	96,88%	
05/03/2014	**A109**	129,2	24 480	401,4	201,0	145,2		**2,090**	19,0		1,76	95,43%	
06/03/2014	**A1090**	129,9	24 600	401,5	200,7	145,2		**2,102**	19,0		1,77	97,13%	
06/03/2014	**A1091**	129,4	24 600	401,7	200,8	145,3		**2,099**	19,0		1,76	96,65%	
06/03/2014	**A1092**	129,5	24 620	401,6	200,7	145,5		**2,099**	19,0		1,76	96,71%	
06/03/2014	**A1093**	129,8	24 620	401,6	200,6	145,6		**2,099**	19,0		1,76	96,65%	
06/03/2014	**A1094**	129,4	24 620	401,6	200,8	145,4		**2,100**	19,0		1,76	96,76%	
06/03/2014	**A1095**	129,7	24 600	401,6	200,8	145,3		**2,099**	19,0		1,76	96,72%	
06/03/2014	**A1096**	129,5	24 640	401,6	200,8	145,6		**2,099**	19,0		1,76	96,60%	
06/03/2014	**A1097**	129,7	24 600	401,6	200,6	145,3		**2,102**	19,0		1,77	97,00%	
06/03/2014	**A1098**	129,5	24 640	401,5	200,6	145,5		**2,103**	19,0		1,77	97,14%	
06/03/2014	**A1099**	129,6	24 580	401,5	200,5	145,4		**2,100**	19,0		1,76	96,79%	
05/03/2014	**A11**	130,0	24 480	401,4	200,5	145,4		**2,092**	19,0		1,76	95,77%	
05/03/2014	**A110**	128,9	24 520	401,4	200,7	145,4		**2,093**	19,0	17,66	1,76	95,87%	
06/03/2014	**A1100**	129,6	24 620	401,6	200,7	145,6		**2,098**	19,0		1,76	96,51%	
06/03/2014	**A1101**	129,5	24 640	401,5	200,7	145,5		**2,102**	19,0		1,77	97,00%	
06/03/2014	**A1102**	129,7	24 560	401,6	200,7	145,1		**2,100**	19,0		1,76	96,79%	
06/03/2014	**A1103**	129,6	24 560	401,3	200,0	145,7		**2,100**	19,0		1,76	96,82%	
06/03/2014	**A1104**	129,6	24 560	401,5	200,8	145,3		**2,097**	19,0		1,76	96,34%	
06/03/2014	**A1105**	129,7	24 560	401,5	200,6	145,3		**2,099**	19,0		1,76	96,62%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1106**	129,4	24 540	401,4	200,8	145,1		**2,098**	19,0		1,76	96,57%	
06/03/2014	**A1107**	130,9	24 600	401,5	200,8	145,8		**2,093**	19,0		1,76	95,84%	
06/03/2014	**A1108**	129,4	24 540	401,7	200,5	145,1		**2,100**	19,0		1,76	96,77%	
06/03/2014	**A1109**	129,5	24 560	401,3	200,6	145,2		**2,101**	19,0		1,77	96,95%	
05/03/2014	**A111**	129,3	24 420	401,4	200,7	145,0		**2,091**	19,0		1,76	95,65%	
06/03/2014	**A1110**	129,4	24 560	401,4	200,4	145,7		**2,096**	19,0		1,76	96,20%	
06/03/2014	**A1111**	129,6	24 560	401,3	200,3	145,5		**2,100**	19,0		1,76	96,79%	
06/03/2014	**A1112**	129,6	24 580	401,4	200,3	145,5		**2,101**	19,0		1,77	96,95%	
06/03/2014	**A1113**	129,5	24 580	401,3	200,5	145,4		**2,101**	19,0		1,77	96,93%	
06/03/2014	**A1114**	129,9	24 580	401,3	200,3	145,3		**2,105**	19,0		1,77	97,40%	
06/03/2014	**A1115**	129,6	24 600	401,4	200,4	145,1		**2,108**	19,0		1,77	97,81%	
06/03/2014	**A1116**	129,4	24 680	401,6	200,5	145,8		**2,102**	19,0		1,77	97,09%	
06/03/2014	**A1117**	129,4	24 600	401,5	200,4	145,2		**2,106**	19,0		1,77	97,55%	
06/03/2014	**A1118**	129,9	24 620	401,3	200,3	145,4		**2,107**	19,0		1,77	97,67%	
06/03/2014	**A1119**	129,6	24 600	401,4	200,4	145,5		**2,102**	19,0		1,77	97,04%	
05/03/2014	**A112**	128,9	24 460	401,2	200,7	145,0		**2,095**	19,0		1,76	96,15%	
06/03/2014	**A1120**	129,5	24 620	401,4	200,8	145,7		**2,096**	19,0		1,76	96,32%	
06/03/2014	**A1121**	129,6	24 700	401,5	200,7	146,1		**2,098**	19,0		1,76	96,53%	
06/03/2014	**A1122**	129,5	24 620	401,4	200,5	145,2		**2,107**	19,0		1,77	97,71%	
06/03/2014	**A1123**	129,6	24 640	401,4	200,4	145,2		**2,110**	19,0		1,77	98,08%	
06/03/2014	**A1124**	129,6	24 620	401,2	200,3	145,1		**2,111**	19,0		1,77	98,33%	
06/03/2014	**A1125**	129,4	24 660	401,5	200,6	145,5		**2,104**	19,0		1,77	97,37%	
06/03/2014	**A1126**	129,8	24 700	401,5	200,7	146,1		**2,098**	19,0		1,76	96,53%	
06/03/2014	**A1127**	129,9	24 620	401,5	200,8	145,4		**2,100**	19,0		1,76	96,83%	
06/03/2014	**A1128**	129,4	24 640	401,5	200,6	145,5		**2,103**	19,0		1,77	97,14%	
06/03/2014	**A1129**	129,7	24 600	401,5	200,5	145,2		**2,105**	19,0		1,77	97,41%	
05/03/2014	**A113**	129,1	24 480	401,1	200,9	145,0		**2,095**	19,0		1,76	96,10%	
06/03/2014	**A1130**	129,4	24 620	401,4	200,4	145,3		**2,106**	19,0		1,77	97,58%	
06/03/2014	**A1131**	129,5	24 640	401,4	200,8	145,8		**2,097**	19,0		1,76	96,36%	
06/03/2014	**A1132**	129,4	24 600	401,4	201,0	145,7		**2,093**	19,0		1,76	95,82%	
06/03/2014	**A1133**	129,5	24 600	401,2	200,8	145,7		**2,096**	19,0		1,76	96,24%	
06/03/2014	**A1134**	129,8	24 640	401,4	200,4	145,3		**2,108**	19,0		1,77	97,88%	
06/03/2014	**A1135**	129,4	24 580	401,4	200,6	145,1		**2,104**	19,0		1,77	97,30%	
06/03/2014	**A1136**	129,8	24 600	401,4	200,8	145,7		**2,095**	19,0		1,76	96,10%	
06/03/2014	**A1137**	129,4	24 600	401,2	200,7	145,8		**2,095**	19,0		1,76	96,18%	
06/03/2014	**A1138**	129,4	24 600	401,6	200,6	145,9		**2,093**	19,0		1,76	95,86%	
06/03/2014	**A1139**	129,4	24 420	401,2	200,6	145,3		**2,088**	19,0		1,75	95,25%	
05/03/2014	**A114**	129,0	24 420	401,1	201,0	144,9		**2,091**	19,0		1,76	95,61%	
06/03/2014	**A1140**	129,5	24 440	401,1	200,8	145,5		**2,086**	19,0		1,75	94,90%	
06/03/2014	**A1141**	129,6	24 400	401,0	200,4	144,9		**2,095**	19,0		1,76	96,19%	
06/03/2014	**A1142**	129,5	24 520	401,1	200,3	145,4		**2,099**	19,0		1,76	96,67%	
06/03/2014	**A1143**	129,6	24 460	401,2	200,3	145,2		**2,096**	19,0		1,76	96,30%	
06/03/2014	**A1144**	129,4	24 460	400,8	200,4	144,9		**2,103**	19,0		1,77	97,14%	
06/03/2014	**A1145**	129,6	24 420	400,6	200,2	145,0		**2,101**	19,0		1,77	96,90%	
06/03/2014	**A1146**	130,9	24 480	401,2	200,3	145,4		**2,096**	19,0		1,76	96,27%	
06/03/2014	**A1147**	129,6	24 480	401,1	200,4	145,4		**2,095**	19,0		1,76	96,18%	
06/03/2014	**A1148**	129,4	24 440	401,0	200,4	145,0		**2,097**	19,0		1,76	96,38%	
06/03/2014	**A1149**	129,5	24 500	401,0	200,4	145,8		**2,091**	19,0		1,76	95,59%	
05/03/2014	**A115**	128,9	24 360	401,4	200,9	144,7		**2,087**	19,0		1,75	95,14%	
06/03/2014	**A1150**	129,7	24 440	400,9	200,3	145,1		**2,098**	19,0		1,76	96,50%	
06/03/2014	**A1151**	129,5	24 420	400,9	200,4	146,0		**2,082**	19,0		1,75	94,46%	
06/03/2014	**A1152**	129,6	24 500	401,0	200,6	145,2		**2,097**	19,0		1,76	96,44%	
06/03/2014	**A1153**	129,6	24 460	401,1	200,5	145,2		**2,095**	19,0		1,76	96,08%	
06/03/2014	**A1154**	129,4	24 500	401,1	200,4	145,3		**2,099**	19,0		1,76	96,59%	
06/03/2014	**A1155**	129,4	24 400	401,0	200,5	144,7		**2,098**	19,0		1,76	96,50%	
06/03/2014	**A1156**	129,4	24 400	401,8	200,4	145,0		**2,089**	19,0		1,76	95,35%	
06/03/2014	**A1157**	129,8	24 460	401,4	200,0	144,8		**2,104**	19,0		1,77	97,28%	
06/03/2014	**A1158**	129,6	24 440	400,8	200,3	145,4		**2,094**	19,0		1,76	95,99%	
06/03/2014	**A1159**	129,4	24 520	401,0	200,4	145,4		**2,100**	19,0		1,76	96,79%	
05/03/2014	**A116**	129,0	24 540	401,1	200,8	145,7		**2,091**	19,0		1,76	95,57%	
06/03/2014	**A1160**	129,3	24 520	401,0	200,2	145,1		**2,104**	19,0		1,77	97,39%	
06/03/2014	**A1161**	129,6	24 440	400,8	200,2	144,9		**2,102**	19,0		1,77	97,11%	
06/03/2014	**A1162**	129,4	24 460	400,8	200,4	144,9		**2,102**	19,0		1,77	97,02%	
06/03/2014	**A1163**	129,6	24 480	400,9	200,3	145,3		**2,099**	19,0		1,76	96,64%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	A1164	129,7	24 440	400,6	200,2	144,7		2,107	19,0		1,77	97,74%	
06/03/2014	A1165	129,6	24 480	400,7	200,2	145,1		2,104	19,0		1,77	97,33%	
06/03/2014	A1166	129,7	24 420	400,8	200,1	144,6		2,106	19,0		1,77	97,55%	
06/03/2014	A1167	129,6	24 460	400,8	200,3	145,0		2,101	19,0		1,77	96,91%	
06/03/2014	A1168	129,4	24 440	400,7	200,2	144,8		2,104	19,0		1,77	97,38%	
06/03/2014	A1169	130,9	24 400	400,6	200,2	144,5		2,105	19,0		1,77	97,43%	
05/03/2014	A117	129,2	24 480	401,4	200,8	145,3		2,090	19,0		1,76	95,53%	
06/03/2014	A1170	129,4	24 460	400,8	200,8	144,9	Léger collage supérieur	2,097	19,0		1,76	96,43%	
06/03/2014	A1171	129,6	24 520	400,5	200,1	145,1	Léger collage supérieur	2,109	19,0		1,77	98,06%	
06/03/2014	A1172	129,5	24 540	400,6	200,2	145,0	Léger collage supérieur	2,110	19,0		1,77	98,13%	
06/03/2014	A1173	130,2	24 500	400,8	200,3	144,9	Léger collage supérieur	2,107	19,0		1,77	97,75%	
06/03/2014	A1174	129,5	24 420	400,7	200,2	145,0	Léger collage supérieur	2,100	19,0		1,76	96,79%	
06/03/2014	A1175	129,8	24 480	400,9	200,3	145,2	Léger collage supérieur	2,101	19,0		1,77	96,88%	
06/03/2014	A1176	129,5	24 560	400,8	200,4	144,8	Léger collage supérieur	2,113	19,0		1,78	98,48%	
06/03/2014	A1177	129,4	24 480	400,7	200,5	144,8	Léger collage supérieur	2,103	19,0		1,77	97,23%	
06/03/2014	A1178	129,4	24 500	401,0	200,3	144,9	Léger collage supérieur	2,105	19,0		1,77	97,51%	
06/03/2014	A1179	129,4	24 560	400,9	200,3	145,0	Léger collage supérieur	2,110	19,0		1,77	98,08%	
05/03/2014	A118	129,2	24 520	401,1	200,8	145,0		2,099	19,0		1,76	96,71%	
06/03/2014	A1180	129,6	24 540	400,6	200,2	144,8	Léger collage supérieur	2,113	19,0		1,78	98,57%	
06/03/2014	A1181	129,4	24 520	400,5	200,3	145,0	Léger collage supérieur	2,109	19,0		1,77	97,96%	
06/03/2014	A1182	129,4	24 580	400,9	200,4	144,9	Léger collage supérieur	2,112	19,0		1,77	98,35%	
06/03/2014	A1183	131,0	24 480	400,7	200,3	145,1	Léger collage supérieur	2,103	19,0		1,77	97,13%	
06/03/2014	A1184	129,4	24 520	400,9	200,4	144,7	Léger collage supérieur	2,109	19,0		1,77	98,06%	
06/03/2014	A1185	129,7	24 560	400,8	200,3	144,9	Léger collage supérieur	2,111	19,0		1,77	98,21%	
06/03/2014	A1186	129,4	24 600	400,9	200,3	145,3	Léger collage supérieur	2,108	19,0		1,77	97,83%	
06/03/2014	A1187	130,8	24 520	400,8	200,2	144,5	Léger collage supérieur	2,114	19,0		1,78	98,75%	
06/03/2014	A1188	129,6	24 480	401,2	200,6	145,1	Léger collage supérieur	2,096	19,0		1,76	96,27%	
06/03/2014	A1189	129,5	24 560	401,3	200,5	145,5	Léger collage supérieur	2,097	19,0		1,76	96,44%	
05/03/2014	A119	128,9	24 420	401,2	200,8	144,7		2,095	19,0		1,76	96,18%	
06/03/2014	A1190	129,4	24 560	400,8	200,4	144,8	Léger collage supérieur	2,112	19,0		1,77	98,39%	
06/03/2014	A1191	131,0	24 520	400,9	200,4	145,3	Léger collage supérieur	2,101	19,0		1,77	96,92%	
06/03/2014	A1192	129,6	24 520	401,2	200,4	145,5	Léger collage supérieur	2,097	19,0		1,76	96,39%	
06/03/2014	A1193	129,4	24 540	400,9	200,4	145,4	Léger collage supérieur	2,101	19,0		1,77	96,93%	
06/03/2014	A1194	129,6	24 480	401,0	200,4	144,8	Léger collage supérieur	2,104	19,0		1,77	97,28%	
06/03/2014	A1195	129,6	24 480	401,1	200,5	145,1	Léger collage supérieur	2,098	19,0		1,76	96,57%	
06/03/2014	A1196	129,4	24 480	400,7	200,8	144,8	Léger collage supérieur	2,102	19,0		1,77	97,11%	
06/03/2014	A1197	129,4	24 540	400,7	200,3	144,9	Léger collage supérieur	2,111	19,0		1,77	98,32%	
06/03/2014	A1198	129,4	24 440	400,7	200,3	144,6	Léger collage supérieur	2,106	19,0		1,77	97,53%	
06/03/2014	A1199	129,5	24 540	400,8	200,5	144,9	Léger collage supérieur	2,107	19,0		1,77	97,72%	
05/03/2014	A12	131,5	24 480	401,5	200,6	145,5		2,089	19,0		1,76	95,34%	
05/03/2014	A120	129,1	24 480	401,3	200,9	145,1	Pièce écartée pour Rc	2,093	19,0	17,63	1,76	95,81%	6,3 - /
06/03/2014	A1200	129,7	24 480	400,9	200,4	144,9	Léger collage supérieur	2,103	19,0		1,77	97,21%	
06/03/2014	A1201	129,4	24 500	400,9	200,3	145,2	Léger collage supérieur	2,101	19,0		1,77	96,93%	
06/03/2014	A1202	130,3	24 520	400,9	200,4	145,2	Léger collage supérieur	2,101	19,0		1,77	96,93%	
06/03/2014	A1203	129,3	24 560	400,9	200,3	145,5	Léger collage supérieur	2,102	19,0		1,77	97,12%	
06/03/2014	A1204	129,6	24 460	400,7	200,3	144,8	Léger collage supérieur	2,105	19,0		1,77	97,40%	
06/03/2014	A1205	129,4	24 480	400,7	200,3	145,3	Léger collage supérieur	2,099	19,0		1,76	96,72%	
06/03/2014	A1206	129,5	24 500	400,9	200,4	144,9	Léger collage supérieur	2,104	19,0		1,77	97,28%	
06/03/2014	A1207	129,7	24 500	401,0	200,5	145,2	Léger collage supérieur	2,099	19,0		1,76	96,62%	
06/03/2014	A1208	129,4	24 540	401,0	200,9	145,1	Léger collage supérieur	2,099	19,0		1,76	96,65%	
06/03/2014	A1209	129,6	24 460	400,9	200,6	144,9	Léger collage supérieur	2,099	19,0		1,76	96,66%	
05/03/2014	A121	129,0	24 440	401,1	201,2	145,3		2,085	19,0		1,75	94,78%	
06/03/2014	A1210	129,4	24 520	400,9	200,6	145,1	Léger collage supérieur	2,101	19,0		1,77	96,93%	
06/03/2014	A1211	129,5	24 460	400,9	200,5	145,1	Léger collage supérieur	2,098	19,0		1,76	96,48%	
06/03/2014	A1212	129,7	24 520	401,1	200,6	144,6	Léger collage supérieur	2,108	19,0		1,77	97,87%	
06/03/2014	A1213	129,4	24 540	401,1	200,4	145,3	Léger collage supérieur	2,101	19,0		1,77	96,97%	
06/03/2014	A1214	129,6	24 460	401,1	200,5	144,9	Léger collage supérieur	2,099	19,0		1,76	96,72%	
06/03/2014	A1215	129,5	24 500	400,7	200,7	145,3	Léger collage supérieur	2,097	19,0		1,76	96,40%	
06/03/2014	A1216	131,0	24 500	400,9	200,6	144,8	Léger collage supérieur	2,104	19,0		1,77	97,31%	
06/03/2014	A1217	130,9	24 500	401,1	200,5	145,0	Léger collage supérieur	2,101	19,0		1,77	96,95%	
06/03/2014	A1218	131,0	24 500	401,0	201,2	144,8	Léger collage supérieur	2,096	19,0		1,76	96,28%	
06/03/2014	A1219	129,6	24 480	401,0	200,6	145,0	Léger collage supérieur	2,100	19,0		1,76	96,75%	
05/03/2014	A122	128,8	24 460	401,3	200,8	145,3		2,089	19,0		1,76	95,39%	
06/03/2014	A1220	129,4	24 540	400,8	200,4	145,3	Léger collage supérieur	2,102	19,0		1,77	97,10%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	A1221	129,4	24 520	401,0	200,5	145,0	Léger collage supérieur	2,103	19,0		1,77	97,16%	
06/03/2014	A1222	129,3	24 500	401,0	200,6	145,0	Léger collage supérieur	2,101	19,0		1,77	96,97%	
06/03/2014	A1223	129,4	24 500	400,8	200,4	144,9	Léger collage supérieur	2,105	19,0		1,77	97,40%	
06/03/2014	A1224	129,4	24 460	400,8	200,2	144,6	Léger collage supérieur	2,108	19,0		1,77	97,90%	
06/03/2014	A1225	129,4	24 520	400,9	200,5	145,0	Léger collage supérieur	2,105	19,0		1,77	97,45%	
06/03/2014	A1226	129,4	24 480	400,9	200,4	144,9	Léger collage supérieur	2,103	19,0		1,77	97,16%	
06/03/2014	A1227	129,5	24 520	400,9	200,5	145,3	Léger collage supérieur	2,100	19,0		1,76	96,83%	
06/03/2014	A1228	129,4	24 500	401,0	200,5	144,9	Léger collage supérieur	2,104	19,0		1,77	97,27%	
06/03/2014	A1229	129,3	24 520	401,0	200,6	145,0	Léger collage supérieur	2,101	19,0		1,77	96,96%	
05/03/2014	A123	128,9	24 540	401,0	200,8	145,3		2,098	19,0		1,76	96,50%	
06/03/2014	A1230	130,9	24 600	401,0	200,5	145,0	Léger collage supérieur	2,110	19,0		1,77	98,17%	
06/03/2014	A1231	129,4	24 620	400,8	200,4	145,0	Léger collage supérieur	2,114	19,0		1,78	98,74%	
06/03/2014	A1232	129,4	24 620	400,9	200,6	145,6	Léger collage supérieur	2,102	19,0		1,77	97,10%	
06/03/2014	A1233	129,4	24 600	401,0	200,5	145,2		2,108	19,0		1,77	97,89%	
06/03/2014	A1234	129,4	24 640	401,0	200,3	145,3		2,111	19,0		1,77	98,25%	
06/03/2014	A1235	129,4	24 640	401,1	200,5	145,0		2,114	19,0		1,78	98,62%	
06/03/2014	A1236	129,5	24 660	401,2	200,6	145,2		2,111	19,0		1,77	98,33%	
06/03/2014	A1237	129,5	24 660	401,2	200,5	145,2		2,112	19,0		1,77	98,43%	
06/03/2014	A1238	129,7	24 640	401,2	200,6	145,2		2,109	19,0		1,77	98,02%	
06/03/2014	A1239	129,4	24 660	401,1	200,5	145,1		2,113	19,0		1,78	98,48%	
05/03/2014	A124	129,1	24 480	401,2	200,8	144,9		2,097	19,0		1,76	96,42%	
06/03/2014	A1240	129,4	24 600	401,1	200,6	145,2		2,107	19,0		1,77	97,69%	
06/03/2014	A1241	129,4	24 580	401,2	200,5	145,0		2,108	19,0		1,77	97,82%	
06/03/2014	A1242	129,4	24 620	401,2	200,5	145,0		2,110	19,0		1,77	98,19%	
06/03/2014	A1243	129,4	24 660	401,2	200,6	145,2		2,111	19,0		1,77	98,28%	
06/03/2014	A1244	129,4	24 580	401,3	200,6	144,9		2,108	19,0		1,77	97,81%	
06/03/2014	A1245	129,7	24 660	401,1	200,6	145,0		2,114	19,0		1,78	98,68%	
06/03/2014	A1246	129,5	24 660	401,1	200,6	145,2		2,111	19,0		1,77	98,22%	
06/03/2014	A1247	129,4	24 620	401,2	200,5	145,0		2,110	19,0		1,77	98,19%	
06/03/2014	A1248	129,7	24 620	401,2	200,8	145,1		2,106	19,0		1,77	97,60%	
06/03/2014	A1249	129,4	24 660	401,3	200,6	145,1		2,112	19,0		1,77	98,37%	
05/03/2014	A125	128,9	24 480	401,2	200,8	145,0		2,096	19,0		1,76	96,23%	
06/03/2014	A1250	129,4	24 640	401,1	200,6	145,2		2,109	19,0		1,77	98,00%	
06/03/2014	A1251	129,4	24 660	401,0	200,8	145,3		2,109	19,0		1,77	97,95%	
06/03/2014	A1252	129,4	24 620	401,1	200,7	144,9		2,110	19,0		1,77	98,20%	
06/03/2014	A1253	129,4	24 640	401,0	200,6	145,2		2,109	19,0		1,77	98,05%	
06/03/2014	A1254	129,4	24 480	401,0	200,5	144,6		2,106	19,0		1,77	97,53%	
06/03/2014	A1255	129,6	24 580	401,2	200,4	144,8		2,111	19,0		1,77	98,29%	
06/03/2014	A1256	129,4	24 660	401,0	200,4	145,3		2,111	19,0		1,77	98,28%	
06/03/2014	A1257	129,4	24 580	401,1	200,5	145,1		2,107	19,0		1,77	97,74%	
06/03/2014	A1258	129,4	24 560	401,1	200,5	144,7		2,110	19,0		1,77	98,18%	
06/03/2014	A1259	129,5	24 560	401,0	200,5	144,9		2,109	19,0		1,77	97,98%	
05/03/2014	A126	129,2	24 480	401,3	200,9	145,1		2,093	19,0		1,76	95,92%	
06/03/2014	A1260	129,6	24 460	400,9	200,3	144,8	Léger collage supérieur	2,103	19,0		1,77	97,26%	
06/03/2014	A1261	129,7	24 500	401,0	200,4	145,1	Léger collage supérieur	2,101	19,0		1,77	96,95%	
06/03/2014	A1262	129,6	24 480	400,9	200,3	145,2	Léger collage supérieur	2,100	19,0		1,76	96,78%	
06/03/2014	A1263	129,5	24 500	400,9	200,3	145,3	Léger collage supérieur	2,100	19,0		1,76	96,79%	
06/03/2014	A1264	129,5	24 460	400,9	200,3	144,9	Léger collage supérieur	2,102	19,0		1,77	97,08%	
06/03/2014	A1265	129,5	24 540	400,7	200,3	145,9	Léger collage supérieur	2,096	19,0		1,76	96,30%	
06/03/2014	A1266	129,6	24 480	401,1	200,3	145,2	Léger collage supérieur	2,099	19,0		1,76	96,64%	
06/03/2014	A1267	129,4	24 480	400,9	200,4	145,1	Léger collage supérieur	2,100	19,0		1,76	96,82%	
06/03/2014	A1268	129,6	24 520	400,9	200,5	145,0	Léger collage supérieur	2,104	19,0		1,77	97,36%	
06/03/2014	A1269	129,4	24 480	400,8	200,3	145,1	Léger collage supérieur	2,101	19,0		1,77	96,97%	
05/03/2014	A127	128,9	24 580	401,3	201,0	146,0		2,088	19,0		1,75	95,21%	
06/03/2014	A1270	129,4	24 480	400,9	200,4	145,1	Léger collage supérieur	2,101	19,0		1,77	96,90%	
06/03/2014	A1271	129,5	24 580	400,6	200,4	145,2	Léger collage supérieur	2,109	19,0		1,77	98,02%	
06/03/2014	A1272	129,6	24 540	400,9	200,5	145,5	Léger collage supérieur	2,098	19,0		1,76	96,49%	
06/03/2014	A1273	129,7	24 480	401,1	200,6	145,5	Léger collage supérieur	2,091	19,0		1,76	95,57%	
06/03/2014	A1274	129,6	24 480	400,9	200,7	144,9	Léger collage supérieur	2,099	19,0		1,76	96,67%	
06/03/2014	A1275	129,5	24 480	400,7	200,5	145,1	Léger collage supérieur	2,099	19,0		1,76	96,66%	
06/03/2014	A1276	129,6	24 480	400,8	200,3	144,8	Léger collage supérieur	2,106	19,0		1,77	97,57%	
06/03/2014	A1277	129,4	24 480	400,9	200,5	144,5	Léger collage supérieur	2,107	19,0		1,77	97,74%	
06/03/2014	A1278	129,7	24 460	401,1	200,4	144,7	Léger collage supérieur	2,103	19,0		1,77	97,19%	
06/03/2014	A1279	130,9	24 480	401,0	200,5	144,8	Léger collage supérieur	2,103	19,0		1,77	97,14%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	A128	128,9	24 500	401,3	200,9	145,0		2,096	19,0		1,76	96,29%	
06/03/2014	A1280	129,5	24 560	400,8	200,4	145,2	Léger collage supérieur	2,106	19,0		1,77	97,58%	
06/03/2014	A1281	129,5	24 460	401,2	200,6	145,1	Léger collage supérieur	2,095	19,0		1,76	96,13%	
06/03/2014	A1282	131,1	24 480	400,7	200,6	144,9	Léger collage supérieur	2,102	19,0		1,77	97,04%	
06/03/2014	A1283	129,5	24 480	400,8	200,6	145,1	Léger collage supérieur	2,099	19,0		1,76	96,67%	
06/03/2014	A1284	129,6	24 520	401,0	200,5	145,1	Léger collage supérieur	2,102	19,0		1,77	97,00%	
06/03/2014	A1285	129,7	24 580	400,9	200,5	144,7	Léger collage supérieur	2,113	19,0		1,78	98,52%	
06/03/2014	A1286	129,4	24 500	400,9	200,5	145,0	Léger collage supérieur	2,102	19,0		1,77	97,09%	
06/03/2014	A1287	129,5	24 560	400,7	200,4	145,3	Léger collage supérieur	2,105	19,0		1,77	97,51%	
06/03/2014	A1288	129,6	24 540	400,9	200,6	145,2	Léger collage supérieur	2,103	19,0		1,77	97,16%	
06/03/2014	A1289	129,4	24 540	401,0	200,7	145,0	Léger collage supérieur	2,104	19,0		1,77	97,32%	
05/03/2014	A129	128,9	24 480	401,1	200,8	145,4		2,090	19,0		1,76	95,47%	
06/03/2014	A1290	129,7	24 480	401,2	200,4	145,2	Léger collage supérieur	2,096	19,0		1,76	96,32%	
06/03/2014	A1291	129,5	24 560	401,1	200,4	145,4	Léger collage supérieur	2,102	19,0		1,77	97,06%	
06/03/2014	A1292	129,7	24 540	401,1	200,5	145,5	Léger collage supérieur	2,098	19,0		1,76	96,47%	
06/03/2014	A1293	129,4	24 520	401,1	200,7	145,3	Léger collage supérieur	2,097	19,0		1,76	96,40%	
06/03/2014	A1294	129,4	24 540	400,9	200,8	145,4		2,097	19,0		1,76	96,44%	
06/03/2014	A1295	129,6	24 520	401,0	200,6	145,1		2,101	19,0		1,77	96,97%	
06/03/2014	A1296	129,6	24 600	401,1	200,6	145,2		2,105	19,0		1,77	97,49%	
06/03/2014	A1297	129,7	24 540	401,4	200,5	145,2		2,101	19,0		1,77	96,95%	
06/03/2014	A1298	129,7	24 500	401,3	200,5	145,6		2,092	19,0		1,76	95,71%	
06/03/2014	A1299	129,7	24 560	400,9	200,4	145,5		2,102	19,0		1,77	97,01%	
05/03/2014	A13	129,9	24 560	401,2	200,4	145,5		2,100	19,0		1,76	96,79%	
05/03/2014	A130	128,9	24 500	401,2	200,9	145,1		2,096	19,0		1,76	96,21%	
06/03/2014	A1300	129,4	24 480	400,8	200,4	145,0		2,102	19,0		1,77	97,03%	
06/03/2014	A1301	129,6	24 500	400,8	200,5	145,1		2,101	19,0		1,77	96,89%	
06/03/2014	A1302	129,6	24 620	400,6	200,4	145,3		2,110	19,0		1,77	98,19%	
06/03/2014	A1303	129,9	24 560	401,0	200,5	144,9		2,108	19,0		1,77	97,90%	
06/03/2014	A1304	129,4	24 560	400,9	200,5	145,2		2,104	19,0		1,77	97,26%	
06/03/2014	A1305	129,9	24 540	400,9	200,5	145,2		2,103	19,0		1,77	97,16%	
06/03/2014	A1306	129,5	24 580	401,0	200,5	145,2		2,106	19,0		1,77	97,64%	
06/03/2014	A1307	129,7	24 460	400,9	200,6	144,7		2,102	19,0		1,77	97,00%	
06/03/2014	A1308	129,4	24 540	401,2	200,8	145,2		2,098	19,0		1,76	96,53%	
06/03/2014	A1309	130,8	24 520	401,2	200,7	145,2		2,098	19,0		1,76	96,46%	
05/03/2014	A131	128,9	24 580	401,1	200,9	145,6		2,095	19,0		1,76	96,12%	
06/03/2014	A1310	129,4	24 520	401,2	200,6	145,6		2,093	19,0		1,76	95,91%	
06/03/2014	A1311	129,5	24 680	400,9	200,6	145,4		2,111	19,0		1,77	98,34%	
06/03/2014	A1312	129,4	24 540	401,1	200,8	145,9		2,088	19,0		1,75	95,23%	
06/03/2014	A1313	129,6	24 540	401,2	200,8	145,6		2,092	19,0		1,76	95,68%	
06/03/2014	A1314	129,4	24 580	401,2	200,5	145,1		2,106	19,0		1,77	97,62%	
06/03/2014	A1315	130,9	24 480	401,1	200,4	145,0		2,101	19,0		1,77	96,91%	
06/03/2014	A1316	129,5	24 540	401,0	200,6	145,4		2,098	19,0		1,76	96,50%	
06/03/2014	A1317	129,5	24 520	400,9	200,6	145,4		2,098	19,0		1,76	96,49%	
06/03/2014	A1318	129,4	24 580	401,1	200,6	145,3		2,102	19,0		1,77	97,08%	
06/03/2014	A1319	129,6	24 560	401,0	200,5	145,3		2,102	19,0		1,77	97,09%	
05/03/2014	A132	129,2	24 460	401,2	201,0	144,8		2,096	19,0		1,76	96,21%	
06/03/2014	A1320	129,7	24 500	401,0	200,5	145,1		2,101	19,0		1,77	96,94%	
06/03/2014	A1321	129,6	24 480	400,7	200,5	145,1		2,100	19,0		1,76	96,80%	
06/03/2014	A1322	129,5	24 620	400,8	200,6	145,4		2,107	19,0		1,77	97,67%	
06/03/2014	A1323	129,9	24 600	400,8	200,6	145,2		2,107	19,0		1,77	97,75%	
06/03/2014	A1324	129,4	24 600	400,9	200,7	145,6		2,100	19,0		1,76	96,75%	
06/03/2014	A1325	130,9	24 580	400,7	200,7	145,4		2,102	19,0		1,77	97,12%	
06/03/2014	A1326	129,5	24 600	401,3	200,7	144,9		2,109	19,0		1,77	97,96%	
06/03/2014	A1327	129,7	24 600	401,2	200,7	145,0		2,106	19,0		1,77	97,62%	
06/03/2014	A1328	129,5	24 640	401,1	200,9	145,5		2,102	19,0		1,77	97,07%	
06/03/2014	A1329	129,8	24 620	401,1	200,7	145,3		2,105	19,0		1,77	97,51%	
05/03/2014	A133	128,9	24 580	401,2	201,0	145,1		2,101	19,0		1,77	96,87%	
06/03/2014	A1330	129,7	24 600	401,3	200,7	145,5		2,099	19,0		1,76	96,70%	
06/03/2014	A1331	129,4	24 620	401,4	200,9	145,0		2,106	19,0		1,77	97,62%	
06/03/2014	A1332	129,4	24 600	401,5	200,8	145,1		2,104	19,0		1,77	97,26%	
06/03/2014	A1333	129,7	24 560	401,7	200,6	145,2		2,099	19,0		1,76	96,63%	
06/03/2014	A1334	129,4	24 600	401,2	200,8	145,2		2,104	19,0		1,77	97,36%	
06/03/2014	A1335	129,8	24 600	400,9	200,7	145,3		2,104	19,0		1,77	97,35%	
06/03/2014	A1336	129,4	24 640	401,1	200,5	145,4		2,107	19,0		1,77	97,68%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	A1337	129,6	24 680	401,3	200,8	145,4		2,106	19,0		1,77	97,65%	
06/03/2014	A1338	129,4	24 580	401,1	200,8	144,7		2,109	19,0		1,77	97,96%	
06/03/2014	A1339	129,5	24 560	401,2	200,9	145,3		2,098	19,0		1,76	96,54%	
05/03/2014	A134	128,9	24 640	401,1	200,8	145,3		2,106	19,0		1,77	97,56%	
06/03/2014	A1340	129,5	24 560	401,3	200,8	145,0		2,102	19,0		1,77	97,05%	
06/03/2014	A1341	129,6	24 640	401,2	200,8	145,3		2,106	19,0		1,77	97,56%	
06/03/2014	A1342	129,6	24 640	401,2	200,6	145,1		2,110	19,0		1,77	98,09%	
06/03/2014	A1343	129,5	24 600	401,1	200,7	145,3		2,103	19,0		1,77	97,18%	
06/03/2014	A1344	129,5	24 620	401,0	200,6	145,3		2,106	19,0		1,77	97,64%	
06/03/2014	A1345	129,5	24 480	401,2	200,5	145,3		2,095	19,0		1,76	96,13%	
06/03/2014	A1346	129,7	24 520	401,2	200,6	145,2		2,098	19,0		1,76	96,57%	
06/03/2014	A1347	129,6	24 520	401,3	200,5	145,0		2,102	19,0		1,77	97,11%	
06/03/2014	A1348	129,9	24 560	401,0	200,6	145,0		2,106	19,0		1,77	97,64%	
06/03/2014	A1349	129,5	24 540	401,2	200,4	145,2		2,102	19,0		1,77	97,08%	
05/03/2014	A135	130,4	24 600	401,1	200,9	145,1		2,104	19,0		1,77	97,30%	
06/03/2014	A1350	129,8	24 620	401,1	200,4	144,6		2,119	19,0		1,78	99,39%	
06/03/2014	A1351	129,4	24 560	401,3	200,5	145,5		2,098	19,0		1,76	96,57%	
06/03/2014	A1352	129,6	24 540	401,2	200,4	145,3		2,101	19,0		1,77	96,90%	
06/03/2014	A1353	129,7	24 560	401,3	200,5	145,6		2,096	19,0		1,76	96,29%	
06/03/2014	A1354	129,6	24 600	401,3	200,5	145,5		2,102	19,0		1,77	96,99%	
06/03/2014	A1355	129,5	24 480	401,2	200,7	145,2		2,093	19,0		1,76	95,92%	
06/03/2014	A1356	129,3	24 580	401,2	200,5	145,5		2,101	19,0		1,77	96,86%	
06/03/2014	A1357	129,3	24 540	401,1	200,5	145,1		2,102	19,0		1,77	97,12%	
06/03/2014	A1358	129,4	24 580	401,3	200,5	145,4		2,102	19,0		1,77	97,02%	
06/03/2014	A1359	129,7	24 620	401,1	200,3	145,3		2,108	19,0		1,77	97,87%	
05/03/2014	A136	128,9	24 580	401,0	200,9	145,4		2,099	19,0		1,76	96,60%	
06/03/2014	A1360	129,4	24 540	401,0	200,5	145,3		2,101	19,0		1,77	96,90%	
06/03/2014	A1361	129,6	24 540	401,2	200,6	144,9		2,104	19,0		1,77	97,39%	
06/03/2014	A1362	129,5	24 500	401,3	200,5	145,2		2,097	19,0		1,76	96,39%	
06/03/2014	A1363	129,7	24 540	401,3	200,4	145,1		2,102	19,0		1,77	97,09%	
06/03/2014	A1364	129,4	24 520	401,3	201,6	145,4		2,085	19,0		1,75	94,79%	
06/03/2014	A1365	129,5	24 500	401,4	200,7	145,2		2,094	19,0		1,76	95,98%	
06/03/2014	A1366	130,9	24 520	401,3	200,5	145,0		2,101	19,0		1,77	96,97%	
06/03/2014	A1367	129,5	24 500	401,2	200,7	145,4		2,094	19,0		1,76	95,96%	
06/03/2014	A1368	129,6	24 500	401,2	200,8	145,2		2,095	19,0		1,76	96,13%	
06/03/2014	A1369	129,7	24 460	401,2	200,6	145,0		2,096	19,0		1,76	96,29%	
05/03/2014	A137	128,9	24 400	401,2	200,9	145,6		2,079	19,0		1,75	94,09%	
06/03/2014	A1370	129,4	24 540	401,4	200,5	145,4		2,097	19,0		1,76	96,44%	
06/03/2014	A1371	129,4	24 480	401,2	200,8	145,2		2,094	19,0		1,76	95,94%	
06/03/2014	A1372	129,7	24 540	401,2	200,5	145,3		2,100	19,0		1,76	96,82%	
06/03/2014	A1373	129,4	24 480	401,2	200,6	145,0		2,098	19,0		1,76	96,54%	
06/03/2014	A1374	129,9	24 540	401,1	200,5	145,1		2,104	19,0		1,77	97,35%	
06/03/2014	A1375	129,4	24 560	401,0	200,5	145,1		2,105	19,0		1,77	97,50%	
06/03/2014	A1376	129,4	24 560	401,0	200,6	145,2		2,103	19,0		1,77	97,17%	
06/03/2014	A1377	129,7	24 500	401,2	200,6	144,6		2,104	19,0		1,77	97,36%	
06/03/2014	A1378	129,4	24 580	401,0	200,5	145,3		2,105	19,0		1,77	97,43%	
06/03/2014	A1379	129,5	24 560	401,1	200,6	145,3		2,101	19,0		1,77	96,94%	
05/03/2014	A138	129,2	24 540	401,5	200,9	144,9		2,099	19,0		1,76	96,68%	
06/03/2014	A1380	129,6	24 580	401,3	200,4	145,3		2,104	19,0		1,77	97,29%	
06/03/2014	A1381	129,5	24 480	401,2	200,4	145,6		2,091	19,0		1,76	95,60%	
06/03/2014	A1382	129,5	24 520	401,2	200,6	145,3		2,098	19,0		1,76	96,46%	
06/03/2014	A1383	129,4	24 540	401,1	200,5	145,5		2,097	19,0		1,76	96,41%	
06/03/2014	A1384	129,4	24 440	401,1	200,7	145,4		2,088	19,0		1,75	95,18%	
06/03/2014	A1385	129,9	24 540	401,1	200,7	144,7		2,106	19,0		1,77	97,65%	
06/03/2014	A1386	129,5	24 520	401,2	200,4	145,3		2,099	19,0		1,76	96,65%	
06/03/2014	A1387	129,7	24 580	401,2	200,5	145,6		2,099	19,0		1,76	96,63%	
06/03/2014	A1388	129,6	24 560	401,2	200,6	145,4		2,098	19,0		1,76	96,58%	
06/03/2014	A1389	129,5	24 540	401,2	200,4	145,7		2,095	19,0		1,76	96,18%	
05/03/2014	A139	129,4	24 620	401,2	201,0	145,2		2,104	19,0		1,77	97,31%	
06/03/2014	A1390	129,4	24 560	401,1	200,4	145,0		2,107	19,0		1,77	97,71%	
06/03/2014	A1391	129,9	24 600	401,0	200,6	145,2		2,106	19,0		1,77	97,63%	
06/03/2014	A1392	129,6	24 580	401,2	200,4	145,3		2,105	19,0		1,77	97,43%	
06/03/2014	A1393	129,4	24 600	401,1	200,7	145,6		2,099	19,0		1,76	96,67%	
06/03/2014	A1394	129,3	24 580	401,4	200,4	145,4		2,102	19,0		1,77	97,06%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	A1395	129,5	24 600	401,2	200,7	145,6		2,098	19,0		1,76	96,59%	
06/03/2014	A1396	129,5	24 540	401,2	200,7	145,5		2,095	19,0		1,76	96,08%	
06/03/2014	A1397	129,6	24 580	401,1	200,5	145,4		2,103	19,0		1,77	97,20%	
06/03/2014	A1398	129,7	24 580	401,2	200,4	145,6		2,099	19,0		1,76	96,61%	
06/03/2014	A1399	129,3	24 600	401,5	200,6	145,6		2,099	19,0		1,76	96,61%	
05/03/2014	A14	129,9	24 480	401,2	200,5	144,8		2,102	19,0		1,77	97,09%	
05/03/2014	A140	129,0	24 680	401,2	200,9	145,7		2,102	19,0		1,77	97,10%	
06/03/2014	A1400	129,7	24 580	401,4	200,5	144,8		2,109	19,0		1,77	98,03%	
06/03/2014	A1401	129,5	24 620	401,2	200,4	145,2		2,109	19,0		1,77	98,04%	
06/03/2014	A1402	129,5	24 580	401,2	200,7	145,2		2,103	19,0		1,77	97,24%	
06/03/2014	A1403	129,4	24 620	401,0	200,4	145,1		2,112	19,0		1,77	98,39%	
06/03/2014	A1404	130,9	24 650	401,0	200,5	145,5		2,107	19,0		1,77	97,79%	
06/03/2014	A1405	129,5	24 600	401,1	200,8	145,5		2,100	19,0		1,76	96,80%	
06/03/2014	A1406	129,6	24 580	401,3	200,7	145,2		2,102	19,0		1,77	97,06%	
06/03/2014	A1407	129,4	24 580	401,1	200,5	145,3		2,105	19,0		1,77	97,45%	
06/03/2014	A1408	129,8	24 580	401,2	200,9	145,5		2,096	19,0		1,76	96,25%	
06/03/2014	A1409	129,5	24 580	401,3	200,6	145,2		2,102	19,0		1,77	97,06%	
05/03/2014	A141	128,9	24 700	401,3	201,0	145,3		2,107	19,0		1,77	97,78%	
06/03/2014	A1410	129,4	24 560	401,1	200,5	145,7		2,096	19,0		1,76	96,23%	
06/03/2014	A1411	129,5	24 620	401,0	200,3	145,1		2,113	19,0		1,78	98,54%	
06/03/2014	A1412	129,6	24 540	401,1	200,6	145,2		2,101	19,0		1,77	96,86%	
06/03/2014	A1413	129,8	24 520	401,0	200,3	145,2		2,103	19,0		1,77	97,13%	
06/03/2014	A1414	129,4	24 600	401,1	200,4	145,7		2,100	19,0		1,76	96,80%	
06/03/2014	A1415	129,4	24 580	401,0	200,7	145,6		2,098	19,0		1,76	96,53%	
06/03/2014	A1416	129,8	24 620	401,1	200,5	145,5		2,104	19,0		1,77	97,29%	
06/03/2014	A1417	129,5	24 580	401,1	200,3	145,5		2,102	19,0		1,77	97,06%	
06/03/2014	A1418	129,5	24 580	401,1	200,5	145,3		2,103	19,0		1,77	97,22%	
06/03/2014	A1419	129,5	24 560	401,2	200,6	145,5		2,097	19,0		1,76	96,44%	
05/03/2014	A142	129,2	24 760	401,4	201,0	145,8		2,104	19,0		1,77	97,33%	
06/03/2014	A1420	129,7	24 580	401,1	200,6	145,5		2,100	19,0		1,76	96,78%	
06/03/2014	A1421	129,4	24 540	401,1	200,4	145,0		2,105	19,0		1,77	97,48%	
06/03/2014	A1422	129,6	24 520	401,2	200,4	144,9		2,105	19,0		1,77	97,41%	
06/03/2014	A1423	129,5	24 580	401,2	200,5	145,1		2,106	19,0		1,77	97,58%	
06/03/2014	A1424	129,6	24 560	401,6	200,7	145,4		2,095	19,0		1,76	96,17%	
06/03/2014	A1425	129,4	24 620	401,3	200,4	145,6		2,103	19,0		1,77	97,22%	
06/03/2014	A1426	129,7	24 600	401,4	201,4	145,5		2,092	19,0		1,76	95,76%	
06/03/2014	A1427	129,4	24 580	401,5	200,5	145,5		2,100	19,0		1,76	96,73%	
06/03/2014	A1428	129,4	24 580	401,4	200,3	145,3		2,105	19,0		1,77	97,44%	
06/03/2014	A1429	129,9	24 600	401,3	200,4	145,6		2,100	19,0		1,76	96,81%	
05/03/2014	A143	128,9	24 660	401,3	201,0	145,4		2,103	19,0		1,77	97,21%	
06/03/2014	A1430	129,5	24 580	401,4	200,4	145,4		2,101	19,0		1,77	96,96%	
06/03/2014	A1431	131,0	24 560	401,5	200,5	145,2		2,101	19,0		1,77	96,93%	
06/03/2014	A1432	129,5	24 580	401,4	200,7	145,5		2,096	19,0		1,76	96,29%	
06/03/2014	A1433	129,5	24 560	401,6	200,5	145,5		2,097	19,0		1,76	96,33%	
06/03/2014	A1434	129,6	24 620	401,7	200,6	145,1		2,105	19,0		1,77	97,43%	
06/03/2014	A1435	129,5	24 600	401,3	200,5	145,5		2,100	19,0		1,76	96,83%	
06/03/2014	A1436	129,7	24 640	401,7	200,5	145,7		2,100	19,0		1,76	96,73%	
06/03/2014	A1437	129,5	24 620	401,4	200,7	145,3		2,103	19,0		1,77	97,24%	
06/03/2014	A1438	129,4	24 680	400,9	200,7	145,3		2,112	19,0		1,77	98,42%	
06/03/2014	A1439	130,9	24 660	400,9	200,4	145,7		2,108	19,0		1,77	97,81%	
05/03/2014	A144	128,9	24 680	401,3	201,0	145,4		2,105	19,0		1,77	97,42%	
06/03/2014	A1440	129,5	24 500	401,5	200,7	145,9		2,084	19,0		1,75	94,65%	
06/03/2014	A1441	129,4	24 480	401,5	200,5	145,8		2,087	19,0		1,75	95,03%	
06/03/2014	A1442	130,9	24 540	401,4	200,5	145,8		2,091	19,0		1,76	95,66%	
06/03/2014	A1443	129,5	24 500	401,3	200,5	145,5		2,093	19,0		1,76	95,88%	
06/03/2014	A1444	129,7	24 520	401,4	200,6	145,4		2,094	19,0		1,76	96,00%	
06/03/2014	A1445	129,4	24 520	401,3	200,7	145,2		2,096	19,0		1,76	96,29%	
06/03/2014	A1446	129,5	24 460	401,3	200,4	145,3		2,094	19,0		1,76	95,98%	
06/03/2014	A1447	129,5	24 540	401,2	200,4	145,8		2,094	19,0		1,76	96,03%	
06/03/2014	A1448	129,7	24 460	401,1	200,4	145,1		2,098	19,0		1,76	96,51%	
06/03/2014	A1449	129,4	24 520	401,5	200,6	145,5		2,093	19,0		1,76	95,80%	
05/03/2014	A145	128,9	24 940	401,6	201,2	146,3		2,109	19,0		1,77	97,97%	
06/03/2014	A1450	129,7	24 520	401,2	200,3	145,4		2,098	19,0		1,76	96,59%	
06/03/2014	A1451	129,5	24 520	401,2	200,5	145,4		2,096	19,0		1,76	96,32%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1452**	129,4	24 500	401,1	200,8	145,2		**2,096**	19,0		1,76	96,25%	
06/03/2014	**A1453**	129,4	24 480	401,3	200,7	145,1		**2,095**	19,0		1,76	96,16%	
06/03/2014	**A1454**	129,7	24 520	401,3	200,6	145,4		**2,095**	19,0		1,76	96,18%	
06/03/2014	**A1455**	129,7	24 540	401,4	200,7	145,3		**2,098**	19,0		1,76	96,49%	
06/03/2014	**A1456**	129,4	24 620	401,1	200,9	145,3		**2,103**	19,0		1,77	97,21%	
06/03/2014	**A1457**	129,6	24 520	401,5	200,7	145,3		**2,094**	19,0		1,76	95,96%	
06/03/2014	**A1458**	129,5	24 540	401,1	200,7	145,3		**2,098**	19,0		1,76	96,55%	
06/03/2014	**A1459**	129,4	24 540	401,6	200,7	145,5		**2,093**	19,0		1,76	95,82%	
05/03/2014	**A146**	128,9	24 860	401,3	201,1	145,8		**2,113**	19,0		1,78	98,51%	
06/03/2014	**A1460**	129,6	24 520	401,3	200,5	145,2		**2,099**	19,0		1,76	96,67%	
06/03/2014	**A1461**	129,4	24 500	401,1	200,9	145,2		**2,094**	19,0		1,76	95,96%	
06/03/2014	**A1462**	129,4	24 540	401,3	200,7	145,3		**2,097**	19,0		1,76	96,40%	
06/03/2014	**A1463**	129,4	24 520	401,4	200,9	145,5		**2,090**	19,0		1,76	95,45%	
06/03/2014	**A1464**	129,5	24 540	401,4	200,6	145,6		**2,092**	19,0		1,76	95,78%	
06/03/2014	**A1465**	129,6	24 520	401,3	200,5	145,5		**2,095**	19,0		1,76	96,10%	
06/03/2014	**A1466**	129,4	24 500	401,2	200,6	145,3		**2,094**	19,0		1,76	96,00%	
06/03/2014	**A1467**	129,4	24 480	401,5	200,6	145,4		**2,090**	19,0		1,76	95,50%	
06/03/2014	**A1468**	129,5	24 520	401,3	200,7	145,4		**2,094**	19,0		1,76	95,98%	
06/03/2014	**A1469**	129,5	24 520	401,5	200,5	145,2		**2,098**	19,0		1,76	96,51%	
05/03/2014	**A147**	129,0	24 920	401,8	201,1	146,0		**2,113**	19,0		1,78	98,51%	
06/03/2014	**A1470**	129,5	24 480	401,1	200,6	145,1		**2,097**	19,0		1,76	96,44%	
06/03/2014	**A1471**	129,4	24 500	401,2	200,4	145,3		**2,097**	19,0		1,76	96,40%	
06/03/2014	**A1472**	129,5	24 480	401,2	200,6	145,6		**2,090**	19,0		1,76	95,53%	
06/03/2014	**A1473**	129,7	24 520	401,7	200,6	145,2		**2,096**	19,0		1,76	96,29%	
06/03/2014	**A1474**	129,3	24 500	401,4	200,8	145,4		**2,091**	19,0		1,76	95,63%	
06/03/2014	**A1475**	129,6	24 480	401,1	200,7	145,4		**2,092**	19,0		1,76	95,76%	
06/03/2014	**A1476**	129,5	24 500	401,4	200,5	145,3		**2,096**	19,0		1,76	96,29%	
06/03/2014	**A1477**	129,9	24 540	401,2	200,6	145,3		**2,099**	19,0		1,76	96,62%	
06/03/2014	**A1478**	129,4	24 500	401,3	200,9	145,2		**2,094**	19,0		1,76	95,96%	
06/03/2014	**A1479**	129,8	24 540	401,4	200,6	145,6		**2,093**	19,0		1,76	95,91%	
05/03/2014	**A148**	128,9	24 820	401,8	201,4	145,7		**2,105**	19,0		1,77	97,45%	
06/03/2014	**A1480**	129,4	24 460	401,3	200,6	145,5		**2,088**	19,0		1,75	95,25%	
06/03/2014	**A1481**	129,4	24 540	401,1	200,9	145,2		**2,097**	19,0		1,76	96,40%	
06/03/2014	**A1482**	129,5	24 540	401,3	200,5	145,3		**2,099**	19,0		1,76	96,60%	
06/03/2014	**A1483**	129,6	24 560	401,1	200,5	145,6		**2,098**	19,0		1,76	96,49%	
06/03/2014	**A1484**	129,4	24 500	401,5	200,5	145,3		**2,095**	19,0		1,76	96,09%	
06/03/2014	**A1485**	129,5	24 540	401,0	200,6	145,5		**2,097**	19,0		1,76	96,33%	
06/03/2014	**A1486**	129,6	24 480	401,1	200,8	145,1		**2,095**	19,0		1,76	96,13%	
06/03/2014	**A1487**	129,4	24 460	401,1	201,0	145,3		**2,089**	19,0		1,76	95,30%	
06/03/2014	**A1488**	129,6	24 500	401,1	200,6	145,1	Pièce écartée pour Rc	**2,099**	19,0	18,29	1,76	96,60%	7,5 - 9,1
06/03/2014	**A1489**	129,5	24 500	401,3	200,4	145,2		**2,098**	19,0		1,76	96,53%	
05/03/2014	**A149**	130,6	24 620	401,5	201,2	144,5		**2,109**	19,0		1,77	97,96%	
06/03/2014	**A1490**	129,4	24 500	401,3	200,6	145,3		**2,095**	19,0		1,76	96,18%	
06/03/2014	**A1491**	129,5	24 540	401,2	200,9	145,4		**2,094**	19,0		1,76	96,02%	
06/03/2014	**A1492**	129,6	24 480	401,3	200,8	145,1		**2,094**	19,0		1,76	96,03%	
06/03/2014	**A1493**	129,4	24 500	401,1	200,5	145,1		**2,099**	19,0		1,76	96,60%	
06/03/2014	**A1494**	129,5	24 500	401,4	200,4	145,4		**2,094**	19,0		1,76	96,02%	
06/03/2014	**A1495**	129,5	24 520	401,1	200,6	145,5		**2,094**	19,0		1,76	96,06%	
06/03/2014	**A1496**	129,5	24 540	401,2	200,5	145,6		**2,095**	19,0		1,76	96,16%	
06/03/2014	**A1497**	129,5	24 500	401,4	200,5	145,6		**2,091**	19,0		1,76	95,58%	
06/03/2014	**A1498**	129,4	24 560	401,3	200,7	145,9		**2,090**	19,0		1,76	95,48%	
06/03/2014	**A1499**	129,6	24 440	401,4	200,7	144,6		**2,098**	19,0		1,76	96,53%	
05/03/2014	**A15**	130,1	24 540	401,2	200,4	145,2		**2,103**	19,0		1,77	97,14%	
05/03/2014	**A150**	128,9	24 880	401,6	201,3	145,9		**2,111**	19,0		1,77	98,23%	
06/03/2014	**A1500**	129,4	24 600	401,4	200,2	145,4		**2,105**	19,0		1,77	97,51%	
06/03/2014	**A1501**	129,4	24 600	401,3	200,3	145,4		**2,105**	19,0		1,77	97,44%	
06/03/2014	**A1502**	129,7	24 560	401,3	200,4	145,2		**2,103**	19,0		1,77	97,23%	
06/03/2014	**A1503**	129,5	24 620	401,3	200,4	145,6		**2,103**	19,0		1,77	97,14%	
06/03/2014	**A1504**	129,7	24 560	401,4	200,7	145,7		**2,092**	19,0		1,76	95,79%	
06/03/2014	**A1505**	129,4	24 600	401,5	200,7	145,9		**2,092**	19,0		1,76	95,79%	
06/03/2014	**A1506**	129,4	24 620	401,5	200,4	145,4		**2,104**	19,0		1,77	97,39%	
06/03/2014	**A1507**	129,4	24 600	401,5	200,5	145,2		**2,105**	19,0		1,77	97,41%	
06/03/2014	**A1508**	129,6	24 640	401,5	200,6	145,4		**2,104**	19,0		1,77	97,34%	
06/03/2014	**A1509**	129,4	24 640	401,6	200,4	145,5		**2,104**	19,0		1,77	97,35%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Resistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	A151	128,9	24 420	401,1	200,8	145,0		2,091	19,0		1,76	95,56%	
06/03/2014	A1510	129,4	24 600	401,4	200,4	145,4		2,103	19,0		1,77	97,23%	
06/03/2014	A1511	129,8	24 600	401,5	200,5	145,2		2,105	19,0		1,77	97,41%	
06/03/2014	A1512	129,5	24 580	401,3	200,5	145,2		2,104	19,0		1,77	97,32%	
06/03/2014	A1513	129,5	24 560	401,2	200,2	145,2		2,106	19,0		1,77	97,58%	
06/03/2014	A1514	129,4	24 580	401,3	200,2	145,4		2,104	19,0		1,77	97,35%	
06/03/2014	A1515	129,8	24 560	401,6	200,2	145,2		2,104	19,0		1,77	97,30%	
06/03/2014	A1516	129,5	24 560	401,5	200,5	145,8		2,093	19,0		1,76	95,80%	
06/03/2014	A1517	130,5	24 540	401,6	200,6	145,6		2,092	19,0		1,76	95,75%	
06/03/2014	A1518	129,4	24 520	401,3	200,3	145,2		2,101	19,0		1,77	96,91%	
06/03/2014	A1519	129,4	24 540	401,4	200,5	145,2		2,100	19,0		1,76	96,79%	
05/03/2014	A152	129,0	24 500	401,1	200,7	145,3		2,094	19,0		1,76	95,97%	
06/03/2014	A1520	129,6	24 580	401,8	200,3	145,7		2,096	19,0		1,76	96,29%	
06/03/2014	A1521	129,6	24 540	401,4	200,5	145,1		2,101	19,0		1,77	96,98%	
06/03/2014	A1522	129,4	24 520	401,3	200,8	145,7		2,088	19,0		1,76	95,27%	
06/03/2014	A1523	129,6	24 520	401,6	200,6	145,7		2,089	19,0		1,76	95,34%	
06/03/2014	A1524	129,5	24 560	401,3	200,4	145,4		2,100	19,0		1,77	96,84%	
06/03/2014	A1525	129,4	24 540	401,3	200,3	145,5		2,098	19,0		1,76	96,56%	
06/03/2014	A1526	129,5	24 540	401,4	200,3	145,3		2,101	19,0		1,77	96,88%	
06/03/2014	A1527	129,4	24 480	401,3	200,5	144,8		2,101	19,0		1,77	96,95%	
06/03/2014	A1528	129,4	24 480	401,2	200,5	145,7		2,089	19,0		1,76	95,30%	
06/03/2014	A1529	129,7	24 520	401,4	200,5	145,8		2,090	19,0		1,76	95,43%	
05/03/2014	A153	128,9	24 320	401,2	200,8	144,4		2,090	19,0		1,76	95,49%	
06/03/2014	A1530	129,5	24 620	401,5	200,7	145,9		2,094	19,0		1,76	96,01%	
06/03/2014	A1531	129,5	24 560	401,5	200,8	145,6		2,092	19,0		1,76	95,77%	
06/03/2014	A1532	129,4	24 600	401,5	200,4	145,4		2,103	19,0		1,77	97,16%	
06/03/2014	A1533	129,4	24 560	401,5	200,3	145,2		2,103	19,0		1,77	97,23%	
06/03/2014	A1534	129,6	24 600	401,4	200,3	145,4		2,104	19,0		1,77	97,37%	
06/03/2014	A1535	129,4	24 580	401,5	200,7	145,3		2,099	19,0		1,76	96,71%	
06/03/2014	A1536	129,5	24 600	401,4	200,3	145,3		2,106	19,0		1,77	97,56%	
06/03/2014	A1537	129,5	24 620	401,5	200,5	145,5		2,102	19,0		1,77	97,05%	
06/03/2014	A1538	129,8	24 600	401,5	200,4	145,4		2,103	19,0		1,77	97,16%	
06/03/2014	A1539	129,4	24 640	401,4	200,6	145,6		2,102	19,0		1,77	97,02%	
05/03/2014	A154	128,9	24 440	401,1	201,0	145,4	Léger collage supérieur	2,086	19,0		1,75	94,95%	
06/03/2014	A1540	129,7	24 560	401,4	200,7	145,6		2,094	19,0		1,76	95,98%	
06/03/2014	A1541	129,4	24 620	401,4	200,5	145,4		2,104	19,0		1,77	97,32%	
06/03/2014	A1542	129,4	24 600	401,5	200,7	145,7		2,095	19,0		1,76	96,17%	
06/03/2014	A1543	129,4	24 640	401,6	200,8	145,9		2,094	19,0		1,76	96,03%	
06/03/2014	A1544	129,3	24 620	401,5	200,7	145,5		2,100	19,0		1,76	96,77%	
06/03/2014	A1545	129,5	24 620	401,6	200,5	145,6		2,100	19,0		1,76	96,79%	
06/03/2014	A1546	129,3	24 680	401,6	200,6	145,7		2,103	19,0		1,77	97,14%	
06/03/2014	A1547	129,4	24 600	401,7	200,7	145,4		2,099	19,0		1,76	96,60%	
06/03/2014	A1548	129,6	24 600	401,4	200,8	145,3		2,101	19,0		1,77	96,86%	
06/03/2014	A1549	129,6	24 620	401,5	200,7	145,5		2,100	19,0		1,76	96,77%	
05/03/2014	A155	129,1	24 420	401,1	200,8	145,0	Léger collage supérieur	2,092	19,0		1,76	95,76%	
06/03/2014	A1550	129,4	24 600	401,4	200,6	145,3		2,103	19,0		1,77	97,14%	
06/03/2014	A1551	129,6	24 600	401,5	200,7	145,3		2,101	19,0		1,77	96,93%	
06/03/2014	A1552	129,4	24 620	401,4	200,5	145,8		2,098	19,0		1,76	96,55%	
06/03/2014	A1553	129,4	24 620	401,7	200,5	145,9		2,095	19,0		1,76	96,15%	
06/03/2014	A1554	129,4	24 600	401,5	200,6	146,0		2,092	19,0		1,76	95,74%	
06/03/2014	A1555	129,5	24 560	401,6	200,6	145,8		2,091	19,0		1,76	95,60%	
06/03/2014	A1556	129,4	24 560	401,5	200,3	145,2		2,103	19,0		1,77	97,23%	
06/03/2014	A1557	129,6	24 620	401,4	200,4	145,6		2,102	19,0		1,77	97,07%	
06/03/2014	A1558	129,6	24 560	401,4	200,3	145,2		2,104	19,0		1,77	97,30%	
06/03/2014	A1559	129,5	24 620	401,4	200,3	145,5		2,105	19,0		1,77	97,41%	
05/03/2014	A156	128,9	24 420	401,1	200,9	144,9	Léger collage supérieur	2,091	19,0		1,76	95,65%	
06/03/2014	A1560	129,6	24 580	401,4	200,6	145,5		2,098	19,0		1,76	96,53%	
06/03/2014	A1561	129,4	24 560	401,3	200,3	145,3		2,103	19,0		1,77	97,18%	
06/03/2014	A1562	129,5	24 580	401,4	200,3	145,4		2,103	19,0		1,77	97,14%	
06/03/2014	A1563	129,7	24 620	401,3	200,5	145,5		2,103	19,0		1,77	97,19%	
06/03/2014	A1564	129,8	24 560	401,4	200,6	145,8		2,092	19,0		1,76	95,74%	
06/03/2014	A1565	129,6	24 580	401,5	200,7	145,9		2,091	19,0		1,76	95,57%	
06/03/2014	A1566	129,6	24 540	401,5	200,4	145,2		2,101	19,0		1,77	96,86%	
06/03/2014	A1567	129,8	24 600	401,5	200,4	145,7		2,098	19,0		1,76	96,58%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1568**	129,4	24 560	401,5	200,3	145,3		**2,102**	19,0		1,77	97,04%	
06/03/2014	**A1569**	130,9	24 580	401,4	200,4	145,5		**2,100**	19,0		1,76	96,81%	
05/03/2014	**A157**	129,1	24 400	401,2	200,9	144,8	Léger collage supérieur	**2,091**	19,0		1,76	95,56%	
06/03/2014	**A1570**	129,6	24 580	401,5	201,0	145,9		**2,088**	19,0		1,75	95,16%	
06/03/2014	**A1571**	129,3	24 700	401,3	200,7	146,3	Pièce écartée	**2,096**	19,0		1,76	96,29%	
06/03/2014	**A1572**	129,7	24 500	401,5	200,5	145,2		**2,096**	19,0		1,76	96,27%	
06/03/2014	**A1573**	129,4	24 540	401,5	200,2	145,3		**2,101**	19,0		1,77	96,95%	
06/03/2014	**A1574**	129,5	24 580	401,5	200,3	145,5		**2,101**	19,0		1,77	96,88%	
06/03/2014	**A1575**	129,8	24 540	401,5	200,3	145,3		**2,100**	19,0		1,76	96,81%	
06/03/2014	**A1576**	129,4	24 540	401,4	200,4	145,8		**2,092**	19,0		1,76	95,79%	
06/03/2014	**A1577**	129,7	24 520	401,4	200,6	145,6		**2,091**	19,0		1,76	95,67%	
06/03/2014	**A1578**	129,4	24 540	401,5	200,3	145,6		**2,096**	19,0		1,76	96,23%	
06/03/2014	**A1579**	129,5	24 500	401,5	200,3	145,3		**2,097**	19,0		1,76	96,35%	
05/03/2014	**A158**	130,3	24 480	401,0	200,9	145,3	Léger collage supérieur	**2,091**	19,0		1,76	95,65%	
06/03/2014	**A1580**	129,4	24 500	401,4	200,3	145,2		**2,099**	19,0		1,76	96,61%	
06/03/2014	**A1581**	129,5	24 560	401,4	200,3	145,5		**2,099**	19,0		1,76	96,72%	
06/03/2014	**A1582**	129,6	24 520	401,6	200,3	145,3		**2,098**	19,0		1,76	96,51%	
06/03/2014	**A1583**	129,5	24 560	401,3	200,4	145,4		**2,100**	19,0		1,77	96,84%	
06/03/2014	**A1584**	129,4	24 460	401,3	200,3	144,9		**2,100**	19,0		1,76	96,80%	
06/03/2014	**A1585**	129,6	24 520	401,4	200,4	145,3		**2,098**	19,0		1,76	96,51%	
06/03/2014	**A1586**	129,4	24 500	401,3	200,5	145,2		**2,097**	19,0		1,76	96,41%	
06/03/2014	**A1587**	129,5	24 520	401,3	200,2	145,1		**2,103**	19,0		1,77	97,24%	
06/03/2014	**A1588**	129,7	24 520	401,2	200,7	145,9		**2,087**	19,0		1,75	95,10%	
06/03/2014	**A1589**	129,5	24 460	401,5	200,6	145,5		**2,087**	19,0		1,75	95,12%	
05/03/2014	**A159**	128,9	24 400	401,2	200,9	145,0	Léger collage supérieur	**2,088**	19,0		1,75	95,15%	
06/03/2014	**A1590**	129,6	24 600	401,5	200,6	145,8		**2,095**	19,0		1,76	96,12%	
06/03/2014	**A1591**	129,4	24 560	401,4	200,5	145,7		**2,094**	19,0		1,76	96,06%	
06/03/2014	**A1592**	129,4	24 560	401,4	200,3	145,2		**2,104**	19,0		1,77	97,30%	
06/03/2014	**A1593**	129,7	24 600	401,4	200,8	145,5		**2,098**	19,0		1,76	96,48%	
06/03/2014	**A1594**	129,5	24 580	401,5	200,5	145,2		**2,103**	19,0		1,77	97,18%	
06/03/2014	**A1595**	129,5	24 600	401,5	200,5	145,4		**2,102**	19,0		1,77	97,02%	
06/03/2014	**A1596**	129,8	24 580	401,5	200,6	145,7		**2,095**	19,0		1,76	96,08%	
06/03/2014	**A1597**	129,4	24 620	401,5	200,6	145,8		**2,097**	19,0		1,76	96,34%	
06/03/2014	**A1598**	129,7	24 580	401,5	200,7	145,7		**2,094**	19,0		1,76	95,94%	
06/03/2014	**A1599**	129,7	24 600	401,4	200,9	145,8		**2,092**	19,0		1,76	95,77%	
05/03/2014	**A16**	129,9	24 520	401,0	200,5	145,3		**2,099**	19,0		1,76	96,73%	
05/03/2014	**A160**	130,5	24 320	401,2	200,8	144,5	Léger collage supérieur	**2,090**	19,0		1,76	95,45%	
06/03/2014	**A1600**	129,6	24 540	401,5	200,8	145,5		**2,092**	19,0		1,76	95,74%	
06/03/2014	**A1601**	129,6	24 580	401,6	201,1	145,8		**2,087**	19,0		1,75	95,14%	
06/03/2014	**A1602**	129,8	24 620	401,6	200,6	145,9		**2,095**	19,0		1,76	96,08%	
06/03/2014	**A1603**	129,4	24 640	401,6	200,7	146,0		**2,094**	19,0		1,76	95,98%	
06/03/2014	**A1604**	129,6	24 620	401,7	200,9	145,9		**2,091**	19,0		1,76	95,60%	
06/03/2014	**A1605**	130,9	24 660	401,6	200,5	146,0		**2,098**	19,0		1,76	96,48%	
06/03/2014	**A1606**	129,3	24 600	401,5	200,7	145,8		**2,094**	19,0		1,76	95,98%	
06/03/2014	**A1607**	129,7	24 600	401,7	200,7	145,8		**2,093**	19,0		1,76	95,84%	
06/03/2014	**A1608**	129,9	24 620	401,4	200,4	146,0		**2,096**	19,0		1,76	96,31%	
06/03/2014	**A1609**	129,4	24 560	401,4	200,4	145,7		**2,096**	19,0		1,76	96,20%	
05/03/2014	**A161**	129,0	24 460	401,1	200,7	145,1	Léger collage supérieur	**2,093**	19,0		1,76	95,93%	
06/03/2014	**A1610**	129,7	24 620	401,4	200,4	146,0		**2,096**	19,0		1,76	96,31%	
06/03/2014	**A1611**	129,5	24 600	401,5	200,9	145,8		**2,092**	19,0		1,76	95,70%	
06/03/2014	**A1612**	129,4	24 620	401,4	200,8	145,9		**2,094**	19,0		1,76	95,94%	
06/03/2014	**A1613**	129,7	24 600	401,5	200,5	145,8		**2,096**	19,0		1,76	96,25%	
06/03/2014	**A1614**	129,6	24 540	401,4	200,6	145,8		**2,090**	19,0		1,76	95,51%	
06/03/2014	**A1615**	129,6	24 600	401,4	200,7	145,9		**2,093**	19,0		1,76	95,86%	
06/03/2014	**A1616**	129,4	24 520	401,4	200,9	145,4		**2,091**	19,0		1,76	95,63%	
06/03/2014	**A1617**	129,4	24 660	401,7	200,6	145,1		**2,109**	19,0		1,77	98,01%	
06/03/2014	**A1618**	129,5	24 600	401,7	200,6	145,9		**2,092**	19,0		1,76	95,79%	
06/03/2014	**A1619**	129,5	24 600	401,6	200,7	146,1		**2,089**	19,0		1,76	95,35%	
05/03/2014	**A162**	130,3	24 420	401,5	200,8	145,4	Léger collage supérieur	**2,084**	19,0		1,75	94,65%	
06/03/2014	**A1620**	129,4	24 520	401,2	200,5	145,6		**2,094**	19,0		1,76	95,94%	
06/03/2014	**A1621**	129,4	24 600	401,2	200,7	146,1		**2,091**	19,0		1,76	95,62%	
06/03/2014	**A1622**	129,6	24 560	401,4	200,7	145,8		**2,091**	19,0		1,76	95,60%	
06/03/2014	**A1623**	129,4	24 540	401,2	200,7	145,7		**2,092**	19,0		1,76	95,70%	
06/03/2014	**A1624**	129,7	24 540	401,4	200,5	145,7		**2,093**	19,0		1,76	95,84%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1625**	129,5	24 540	401,5	200,5	145,7		**2,092**	19,0		1,76	95,77%	
06/03/2014	**A1626**	129,4	24 560	401,3	200,7	145,8		**2,091**	19,0		1,76	95,67%	
06/03/2014	**A1627**	129,5	24 540	401,4	200,5	145,5		**2,096**	19,0		1,76	96,22%	
06/03/2014	**A1628**	129,5	24 600	401,6	200,5	145,9		**2,094**	19,0		1,76	96,00%	
06/03/2014	**A1629**	129,6	24 540	401,5	200,7	145,6		**2,092**	19,0		1,76	95,68%	
05/03/2014	**A163**	128,9	24 500	401,0	200,8	144,7	Léger collage supérieur	**2,102**	19,0		1,77	97,08%	
06/03/2014	**A1630**	129,4	24 600	401,5	200,6	146,1		**2,091**	19,0		1,76	95,55%	
06/03/2014	**A1631**	129,5	24 540	401,3	200,6	145,6		**2,094**	19,0		1,76	95,96%	
06/03/2014	**A1632**	129,4	24 520	401,3	200,3	145,6		**2,095**	19,0		1,76	96,15%	
06/03/2014	**A1633**	129,5	24 500	401,4	200,4	145,4		**2,095**	19,0		1,76	96,09%	
06/03/2014	**A1634**	129,5	24 440	401,4	200,4	145,2		**2,092**	19,0		1,76	95,80%	
06/03/2014	**A1635**	129,5	24 500	401,5	200,5	145,6		**2,090**	19,0		1,76	95,51%	
06/03/2014	**A1636**	129,4	24 540	401,2	200,6	145,7		**2,093**	19,0		1,76	95,84%	
06/03/2014	**A1637**	129,5	24 580	401,4	200,6	145,9		**2,092**	19,0		1,76	95,77%	
06/03/2014	**A1638**	129,5	24 580	401,3	200,6	145,9		**2,093**	19,0		1,76	95,84%	
06/03/2014	**A1639**	129,5	24 600	401,2	200,5	145,8		**2,098**	19,0		1,76	96,46%	
05/03/2014	**A164**	128,9	24 420	401,4	200,8	144,7	Léger collage supérieur	**2,095**	19,0		1,76	96,12%	
06/03/2014	**A1640**	129,4	24 560	401,3	200,8	145,7		**2,092**	19,0		1,76	95,72%	
06/03/2014	**A1641**	129,4	24 560	401,1	200,4	145,8		**2,096**	19,0		1,76	96,22%	
06/03/2014	**A1642**	129,7	24 520	401,2	200,6	145,5		**2,094**	19,0		1,76	95,99%	
06/03/2014	**A1643**	129,7	24 580	401,5	200,6	145,7		**2,095**	19,0		1,76	96,08%	
06/03/2014	**A1644**	129,5	24 640	401,5	200,5	146,1		**2,095**	19,0		1,76	96,13%	
06/03/2014	**A1645**	129,8	24 540	401,5	200,5	145,6		**2,094**	19,0		1,76	95,96%	
06/03/2014	**A1646**	129,6	24 560	401,6	200,8	145,9		**2,087**	19,0		1,75	95,14%	
06/03/2014	**A1647**	129,5	24 640	401,5	200,6	146,1		**2,094**	19,0		1,76	96,00%	
06/03/2014	**A1648**	129,5	24 460	401,4	200,8	145,4		**2,087**	19,0		1,75	95,10%	
06/03/2014	**A1649**	129,5	24 380	401,3	200,5	145,1		**2,088**	19,0		1,75	95,25%	
05/03/2014	**A165**	130,4	24 440	401,5	201,0	144,8	Léger collage supérieur	**2,092**	19,0		1,76	95,70%	
06/03/2014	**A1650**	129,6	24 520	401,4	200,6	145,6		**2,091**	19,0		1,76	95,67%	
06/03/2014	**A1651**	129,4	24 460	401,3	200,5	144,9		**2,098**	19,0		1,76	96,53%	
06/03/2014	**A1652**	129,7	24 480	401,3	200,4	145,1		**2,098**	19,0		1,76	96,51%	
06/03/2014	**A1653**	129,6	24 440	401,2	200,6	144,9		**2,096**	19,0		1,76	96,23%	
06/03/2014	**A1654**	129,5	24 500	401,3	200,7	144,8		**2,101**	19,0		1,77	96,90%	
06/03/2014	**A1655**	129,7	24 520	401,4	200,7	145,9		**2,086**	19,0		1,75	94,97%	
06/03/2014	**A1656**	129,6	24 540	401,3	200,6	146,0		**2,088**	19,0		1,75	95,21%	
06/03/2014	**A1657**	129,4	24 280	401,1	200,3	144,8		**2,087**	19,0		1,75	95,10%	
06/03/2014	**A1658**	129,6	24 480	401,5	200,7	145,7		**2,085**	19,0		1,75	94,83%	
06/03/2014	**A1659**	129,6	24 460	401,4	200,7	145,5		**2,087**	19,0		1,75	95,05%	
05/03/2014	**A166**	128,8	24 440	401,5	200,7	144,9	Léger collage supérieur	**2,093**	19,0		1,76	95,91%	
06/03/2014	**A1660**	129,6	24 420	401,4	200,4	145,4		**2,088**	19,0		1,75	95,20%	
06/03/2014	**A1661**	129,5	24 440	401,1	200,4	145,5		**2,090**	19,0		1,76	95,44%	
06/03/2014	**A1662**	129,7	24 440	401,3	200,6	145,4		**2,088**	19,0		1,75	95,22%	
06/03/2014	**A1663**	129,4	24 480	401,4	200,5	145,8		**2,086**	19,0		1,75	94,98%	
06/03/2014	**A1664**	129,5	24 460	401,3	200,6	145,6		**2,087**	19,0		1,75	95,07%	
06/03/2014	**A1665**	129,7	24 420	401,3	200,6	145,4		**2,086**	19,0		1,75	94,99%	
06/03/2014	**A1666**	129,5	24 480	401,3	200,4	145,6		**2,091**	19,0		1,76	95,56%	
06/03/2014	**A1667**	129,5	24 520	401,4	200,4	145,8		**2,091**	19,0		1,76	95,56%	
06/03/2014	**A1668**	129,4	24 480	401,3	200,3	145,6		**2,092**	19,0		1,76	95,70%	
06/03/2014	**A1669**	129,6	24 500	401,3	200,5	145,8		**2,088**	19,0		1,76	95,27%	
05/03/2014	**A167**	130,4	24 360	401,4	200,7	144,3	Léger collage supérieur	**2,096**	19,0		1,76	96,26%	
06/03/2014	**A1670**	130,9	24 500	401,3	200,6	145,7		**2,089**	19,0		1,76	95,36%	
06/03/2014	**A1671**	129,4	24 480	401,5	200,4	145,6		**2,090**	19,0		1,76	95,42%	
06/03/2014	**A1672**	129,6	24 460	401,3	200,5	145,6		**2,088**	19,0		1,75	95,20%	
06/03/2014	**A1673**	129,4	24 400	401,2	200,4	145,2		**2,090**	19,0		1,76	95,49%	
06/03/2014	**A1674**	129,5	24 500	401,4	200,4	145,7		**2,090**	19,0		1,76	95,53%	
06/03/2014	**A1675**	129,5	24 520	401,4	200,4	145,7		**2,092**	19,0		1,76	95,75%	
06/03/2014	**A1676**	129,6	24 460	401,4	200,4	145,4		**2,091**	19,0		1,76	95,64%	
06/03/2014	**A1677**	129,4	24 600	401,5	200,5	146,2	Pièce écartée	**2,090**	19,0		1,76	95,50%	
06/03/2014	**A1678**	129,6	24 580	401,2	200,7	145,7		**2,095**	19,0		1,76	96,15%	
06/03/2014	**A1679**	129,6	24 580	401,3	200,7	145,5		**2,098**	19,0		1,76	96,46%	
05/03/2014	**A168**	128,9	24 460	401,6	200,8	145,0	Léger collage supérieur	**2,092**	19,0		1,76	95,71%	
06/03/2014	**A1680**	129,5	24 500	401,2	200,5	145,1		**2,099**	19,0		1,76	96,67%	
06/03/2014	**A1681**	129,5	24 560	401,1	200,6	145,3		**2,101**	19,0		1,77	96,90%	
06/03/2014	**A1682**	129,5	24 540	401,2	200,4	145,2		**2,102**	19,0		1,77	97,07%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1683**	129,5	24 560	401,2	200,6	145,4		**2,099**	19,0		1,76	96,63%	
06/03/2014	**A1684**	129,5	24 580	401,1	201,1	145,1		**2,101**	19,0		1,77	96,87%	
06/03/2014	**A1685**	129,4	24 560	401,2	201,1	145,1		**2,099**	19,0		1,76	96,60%	
06/03/2014	**A1686**	129,4	24 500	401,0	201,1	145,0		**2,095**	19,0		1,76	96,14%	
06/03/2014	**A1687**	129,4	24 560	401,1	201,0	144,9		**2,103**	19,0		1,77	97,17%	
06/03/2014	**A1688**	129,4	24 460	401,1	200,1	145,0		**2,102**	19,0		1,77	97,09%	
06/03/2014	**A1689**	129,4	24 560	401,0	200,1	145,0		**2,111**	19,0		1,77	98,28%	
05/03/2014	**A169**	128,9	24 500	401,5	200,9	145,3	Léger collage supérieur	**2,091**	19,0		1,76	95,54%	
06/03/2014	**A1690**	129,6	24 560	401,1	200,3	145,2		**2,106**	19,0		1,77	97,55%	
06/03/2014	**A1691**	129,6	24 540	401,1	200,6	145,1		**2,101**	19,0		1,77	96,97%	
06/03/2014	**A1692**	129,4	24 480	401,1	200,6	144,8		**2,101**	19,0		1,77	96,98%	
06/03/2014	**A1693**	129,5	24 620	401,1	200,5	145,6		**2,103**	19,0		1,77	97,17%	
06/03/2014	**A1694**	129,4	24 520	401,1	200,4	145,1		**2,102**	19,0		1,77	97,13%	
06/03/2014	**A1695**	129,5	24 580	401,2	200,4	145,3		**2,104**	19,0		1,77	97,27%	
06/03/2014	**A1696**	129,4	24 580	401,0	200,5	144,9		**2,110**	19,0		1,77	98,13%	
06/03/2014	**A1697**	129,5	24 560	401,0	200,6	145,2		**2,103**	19,0		1,77	97,19%	
06/03/2014	**A1698**	129,4	24 560	401,2	200,5	145,2		**2,103**	19,0		1,77	97,13%	
06/03/2014	**A1699**	129,4	24 440	401,1	200,6	145,0		**2,095**	19,0		1,76	96,14%	
05/03/2014	**A17**	130,0	24 480	401,3	200,4	144,8		**2,103**	19,0		1,77	97,21%	
05/03/2014	**A170**	130,4	24 340	401,3	200,9	144,3	Léger collage supérieur	**2,093**	19,0		1,76	95,84%	
06/03/2014	**A1700**	129,7	24 540	401,1	200,6	145,1		**2,102**	19,0		1,77	97,00%	
06/03/2014	**A1701**	129,5	24 480	400,9	200,6	145,0		**2,100**	19,0		1,76	96,74%	
06/03/2014	**A1702**	129,6	24 420	400,9	200,4	144,7		**2,100**	19,0		1,77	96,85%	
06/03/2014	**A1703**	129,4	24 540	400,7	200,4	145,5		**2,101**	19,0		1,77	96,88%	
06/03/2014	**A1704**	129,5	24 540	401,0	200,4	145,2		**2,104**	19,0		1,77	97,35%	
06/03/2014	**A1705**	129,5	24 500	401,0	200,7	145,4		**2,093**	19,0		1,76	95,91%	
06/03/2014	**A1706**	129,5	24 460	400,9	200,5	145,1		**2,097**	19,0		1,76	96,37%	
06/03/2014	**A1707**	129,6	24 500	401,0	200,5	145,4		**2,096**	19,0		1,76	96,28%	
06/03/2014	**A1708**	129,4	24 500	401,5	200,4	144,9		**2,101**	19,0		1,77	96,97%	
06/03/2014	**A1709**	129,4	24 560	400,8	200,5	145,2		**2,105**	19,0		1,77	97,44%	
05/03/2014	**A171**	128,9	24 460	401,5	200,8	145,0	Léger collage supérieur	**2,092**	19,0		1,76	95,77%	
06/03/2014	**A1710**	129,5	24 520	400,8	200,4	145,1		**2,103**	19,0		1,77	97,24%	
06/03/2014	**A1711**	129,4	24 480	400,9	200,5	144,9		**2,101**	19,0		1,77	96,97%	
06/03/2014	**A1712**	130,8	24 520	401,0	200,8	144,9		**2,102**	19,0		1,77	97,03%	
06/03/2014	**A1713**	129,6	24 460	400,9	200,7	144,7		**2,101**	19,0		1,77	96,98%	
06/03/2014	**A1714**	129,6	24 600	401,0	200,6	145,2		**2,106**	19,0		1,77	97,61%	
06/03/2014	**A1715**	129,4	24 560	400,9	200,5	145,2		**2,104**	19,0		1,77	97,34%	
06/03/2014	**A1716**	130,9	24 600	401,3	201,0	145,5		**2,097**	19,0		1,76	96,35%	
06/03/2014	**A1717**	129,4	24 540	401,2	200,6	145,1		**2,102**	19,0		1,77	97,07%	
06/03/2014	**A1718**	129,6	24 640	401,0	200,7	145,6		**2,102**	19,0		1,77	97,12%	
06/03/2014	**A1719**	129,5	24 560	401,0	200,6	145,2		**2,103**	19,0		1,77	97,20%	
05/03/2014	**A172**	130,4	24 400	401,5	201,0	145,1	Léger collage supérieur	**2,085**	19,0		1,75	94,77%	
06/03/2014	**A1720**	129,7	24 640	401,2	200,6	145,5		**2,105**	19,0		1,77	97,40%	
06/03/2014	**A1721**	129,5	24 540	401,2	200,5	145,2		**2,101**	19,0		1,77	96,96%	
06/03/2014	**A1722**	129,5	24 680	401,2	200,6	145,6		**2,107**	19,0		1,77	97,72%	
06/03/2014	**A1723**	129,6	24 600	401,4	200,8	145,5		**2,098**	19,0		1,76	96,52%	
06/03/2014	**A1724**	129,6	24 640	401,5	200,8	145,9		**2,095**	19,0		1,76	96,09%	
06/03/2014	**A1725**	129,5	24 520	401,1	200,7	145,3		**2,096**	19,0		1,76	96,29%	
06/03/2014	**A1726**	129,4	24 600	401,2	200,6	145,2		**2,105**	19,0		1,77	97,43%	
06/03/2014	**A1727**	129,6	24 620	401,2	200,6	145,7		**2,099**	19,0		1,76	96,67%	
06/03/2014	**A1728**	129,5	24 600	401,6	200,6	145,2		**2,104**	19,0		1,77	97,32%	
06/03/2014	**A1729**	129,5	24 640	401,5	200,7	145,8		**2,098**	19,0		1,76	96,49%	
05/03/2014	**A173**	128,9	24 460	401,2	201,0	145,4	Léger collage supérieur	**2,087**	19,0		1,75	95,06%	
06/03/2014	**A1730**	129,4	24 640	401,4	200,6	145,6		**2,101**	19,0		1,77	96,98%	
06/03/2014	**A1731**	129,3	24 600	401,2	200,8	145,0		**2,106**	19,0		1,77	97,63%	
06/03/2014	**A1732**	129,5	24 620	401,2	200,5	145,1		**2,110**	19,0		1,77	98,12%	
06/03/2014	**A1733**	129,4	24 460	401,1	200,6	145,1		**2,095**	19,0		1,76	96,18%	
06/03/2014	**A1734**	129,6	24 600	401,2	200,6	145,5		**2,101**	19,0		1,77	96,88%	
06/03/2014	**A1735**	129,4	24 480	401,0	200,7	145,1		**2,097**	19,0		1,76	96,41%	
06/03/2014	**A1736**	129,5	24 540	401,5	200,6	145,2		**2,099**	19,0		1,76	96,68%	
06/03/2014	**A1737**	129,5	24 520	401,1	200,8	145,0		**2,100**	19,0		1,76	96,83%	
06/03/2014	**A1738**	129,6	24 560	401,1	200,5	145,0		**2,106**	19,0		1,77	97,62%	
06/03/2014	**A1739**	129,6	24 540	401,1	200,4	144,8		**2,109**	19,0		1,77	98,06%	
05/03/2014	**A174**	129,4	24 400	401,6	200,8	144,4	Léger collage supérieur	**2,096**	19,0		1,76	96,20%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	A1740	129,5	24 600	401,1	200,6	145,7		2,098	19,0		1,76	96,57%	
06/03/2014	A1741	129,5	24 580	401,1	200,7	145,6		2,098	19,0		1,76	96,56%	
06/03/2014	A1742	129,6	24 520	401,2	200,6	145,2		2,098	19,0		1,76	96,58%	
06/03/2014	A1743	129,6	24 560	401,1	200,7	145,4		2,099	19,0		1,76	96,66%	
06/03/2014	A1744	129,5	24 600	401,4	200,6	145,7		2,097	19,0		1,76	96,45%	
06/03/2014	A1745	129,5	24 660	401,2	200,5	145,7		2,105	19,0		1,77	97,42%	
06/03/2014	A1746	129,4	24 660	401,1	200,5	145,8		2,104	19,0		1,77	97,34%	
06/03/2014	A1747	129,6	24 600	401,0	200,6	145,7		2,099	19,0		1,76	96,67%	
06/03/2014	A1748	129,5	24 580	401,7	200,6	145,6		2,094	19,0		1,76	96,02%	
06/03/2014	A1749	129,4	24 520	401,5	200,7	145,3		2,095	19,0		1,76	96,14%	
05/03/2014	A175	128,9	24 320	401,4	201,1	144,8	Léger collage supérieur	2,081	19,0		1,75	94,26%	
06/03/2014	A1750	129,5	24 620	401,7	200,6	145,4		2,101	19,0		1,77	96,94%	
06/03/2014	A1751	129,6	24 700	401,4	200,5	145,7		2,107	19,0		1,77	97,70%	
06/03/2014	A1752	129,7	24 680	401,1	200,6	145,2		2,112	19,0		1,77	98,43%	
06/03/2014	A1753	129,5	24 680	401,0	200,6	145,7		2,107	19,0		1,77	97,66%	
06/03/2014	A1754	129,4	24 720	401,5	200,5	145,6		2,109	19,0		1,77	98,00%	
06/03/2014	A1755	129,8	24 740	401,5	200,7	145,5		2,110	19,0		1,77	98,18%	
06/03/2014	A1756	129,5	24 640	401,5	200,8	145,6		2,099	19,0		1,76	96,67%	
06/03/2014	A1757	129,5	24 600	401,3	200,7	145,6		2,098	19,0		1,76	96,55%	
06/03/2014	A1758	129,9	24 580	401,1	200,6	145,2		2,104	19,0		1,77	97,37%	
06/03/2014	A1759	129,7	24 640	401,5	200,7	145,7		2,100	19,0		1,76	96,78%	
05/03/2014	A176	129,4	24 500	401,5	200,7	145,2	Léger collage supérieur	2,095	19,0		1,76	96,09%	
06/03/2014	A1760	129,6	24 580	401,3	200,8	145,7		2,094	19,0		1,76	96,01%	
06/03/2014	A1761	129,6	24 560	401,3	200,7	145,6		2,094	19,0		1,76	96,05%	
06/03/2014	A1762	129,7	24 520	401,3	200,8	145,2		2,096	19,0		1,76	96,30%	
06/03/2014	A1763	129,6	24 540	401,5	200,5	145,1		2,100	19,0		1,77	96,85%	
06/03/2014	A1764	129,6	24 560	401,2	200,6	145,3		2,101	19,0		1,77	96,89%	
06/03/2014	A1765	129,5	24 580	401,1	200,7	145,4		2,100	19,0		1,77	96,85%	
06/03/2014	A1766	129,4	24 580	401,3	200,6	145,3		2,101	19,0		1,77	96,98%	
06/03/2014	A1767	129,6	24 560	401,1	200,5	145,7		2,096	19,0		1,76	96,23%	
06/03/2014	A1768	129,5	24 520	401,3	200,6	145,0		2,101	19,0		1,77	96,91%	
06/03/2014	A1769	129,6	24 540	401,3	200,7	145,2		2,099	19,0		1,76	96,64%	
05/03/2014	A177	129,0	24 380	401,6	200,7	144,6	Léger collage supérieur	2,091	19,0		1,76	95,65%	
06/03/2014	A1770	129,4	24 500	401,3	200,6	145,1		2,097	19,0		1,76	96,40%	
06/03/2014	A1771	129,7	24 520	401,3	200,7	145,2		2,098	19,0		1,76	96,47%	
06/03/2014	A1772	129,5	24 520	401,1	200,7	145,0		2,102	19,0		1,77	97,07%	
06/03/2014	A1773	129,6	24 540	401,4	200,6	145,3		2,097	19,0		1,76	96,37%	
06/03/2014	A1774	129,4	24 340	401,2	200,7	144,5		2,092	19,0		1,76	95,73%	
06/03/2014	A1775	129,6	24 420	400,9	200,6	145,1		2,093	19,0		1,76	95,82%	
06/03/2014	A1776	129,6	24 440	401,1	200,6	145,1		2,094	19,0		1,76	96,00%	
06/03/2014	A1777	129,6	24 420	401,1	200,7	145,2		2,090	19,0		1,76	95,49%	
06/03/2014	A1778	129,5	24 400	401,2	200,6	145,3		2,087	19,0		1,75	95,02%	
06/03/2014	A1779	129,4	24 360	401,1	200,6	144,7		2,093	19,0		1,76	95,85%	
05/03/2014	A178	129,1	24 480	401,6	200,8	144,9	Léger collage supérieur	2,095	19,0		1,76	96,19%	
06/03/2014	A1780	129,8	24 480	401,2	200,5	144,7		2,104	19,0		1,77	97,39%	
06/03/2014	A1781	129,7	24 620	401,0	200,6	145,1		2,109	19,0		1,77	98,03%	
06/03/2014	A1782	129,4	24 480	401,2	200,6	144,6		2,103	19,0		1,77	97,14%	
06/03/2014	A1783	130,2	24 440	401,0	200,6	145,1		2,095	19,0		1,76	96,13%	
06/03/2014	A1784	129,6	24 420	401,3	200,5	145,0		2,093	19,0		1,76	95,86%	
06/03/2014	A1785	129,4	24 460	401,1	200,7	145,5		2,088	19,0		1,75	95,23%	
06/03/2014	A1786	129,7	24 460	401,3	200,5	145,0		2,096	19,0		1,76	96,31%	
06/03/2014	A1787	129,7	24 460	401,2	200,5	145,2		2,095	19,0		1,76	96,10%	
06/03/2014	A1788	130,9	24 560	401,2	200,5	145,2		2,104	19,0		1,77	97,31%	
06/03/2014	A1789	129,5	24 480	401,2	200,6	145,2		2,096	19,0		1,76	96,24%	
05/03/2014	A179	129,0	24 460	401,4	201,0	145,0	Léger collage supérieur	2,090	19,0		1,76	95,46%	
06/03/2014	A1790	129,6	24 480	401,3	200,4	145,3		2,095	19,0		1,76	96,17%	
06/03/2014	A1791	129,7	24 440	401,1	200,7	145,1		2,093	19,0		1,76	95,83%	
06/03/2014	A1792	129,6	24 420	401,5	200,6	145,1		2,090	19,0		1,76	95,48%	
06/03/2014	A1793	129,5	24 500	401,2	200,4	145,6		2,093	19,0		1,76	95,90%	
06/03/2014	A1794	129,9	24 480	401,2	200,5	145,7		2,090	19,0		1,76	95,42%	
06/03/2014	A1795	129,4	24 480	401,1	200,5	145,2		2,096	19,0		1,76	96,32%	
06/03/2014	A1796	129,6	24 560	401,1	200,4	145,7		2,098	19,0		1,76	96,49%	
06/03/2014	A1797	129,5	24 540	401,5	200,5	145,6		2,093	19,0		1,76	95,90%	
06/03/2014	A1798	129,4	24 580	401,2	200,7	145,2		2,102	19,0		1,77	97,00%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1799**	129,6	24 500	401,8	200,9	145,3		**2,089**	19,0		1,76	95,39%	
05/03/2014	**A18**	129,9	24 620	401,2	200,4	145,7		**2,102**	19,0		1,77	97,05%	
05/03/2014	**A180**	130,3	24 400	401,4	201,1	145,2	Léger collage supérieur	**2,082**	19,0		1,75	94,45%	
06/03/2014	**A1800**	129,5	24 540	401,5	200,8	146,1		**2,083**	19,0		1,75	94,62%	
06/03/2014	**A1801**	129,8	24 520	401,1	200,5	145,1		**2,102**	19,0		1,77	97,06%	
06/03/2014	**A1802**	129,5	24 480	401,5	200,5	145,0		**2,098**	19,0		1,76	96,48%	
06/03/2014	**A1803**	129,4	24 480	401,2	200,6	144,9		**2,099**	19,0		1,76	96,61%	
06/03/2014	**A1804**	129,4	24 460	401,4	200,6	145,3		**2,090**	19,0		1,76	95,48%	
06/03/2014	**A1805**	129,4	24 540	401,2	200,7	145,4		**2,096**	19,0		1,76	96,27%	
06/03/2014	**A1806**	129,5	24 520	401,3	200,8	145,0		**2,098**	19,0		1,76	96,56%	
06/03/2014	**A1807**	129,6	24 560	401,2	200,2	145,1		**2,108**	19,0		1,77	97,86%	
06/03/2014	**A1808**	129,5	24 520	401,2	200,7	144,8		**2,103**	19,0		1,77	97,18%	
06/03/2014	**A1809**	129,5	24 520	401,2	200,7	145,1		**2,099**	19,0		1,76	96,63%	
05/03/2014	**A181**	129,0	24 440	401,6	200,8	145,1	Léger collage supérieur	**2,088**	19,0		1,75	95,23%	
06/03/2014	**A1810**	129,6	24 540	401,2	200,6	145,1		**2,102**	19,0		1,77	97,04%	
06/03/2014	**A1811**	129,4	24 520	401,1	200,7	145,1		**2,099**	19,0		1,76	96,65%	
06/03/2014	**A1812**	129,6	24 540	401,3	200,6	145,1		**2,101**	19,0		1,77	96,88%	
06/03/2014	**A1813**	129,6	24 540	401,1	200,6	145,2		**2,100**	19,0		1,77	96,84%	
06/03/2014	**A1814**	129,5	24 540	401,1	200,4	144,9		**2,108**	19,0		1,77	97,84%	
06/03/2014	**A1815**	129,7	24 560	401,0	200,7	144,5		**2,112**	19,0		1,77	98,39%	
06/03/2014	**A1816**	129,5	24 520	400,6	200,0	145,2		**2,107**	19,0		1,77	97,72%	
06/03/2014	**A1817**	129,7	24 540	400,6	200,2	145,0		**2,110**	19,0		1,77	98,15%	
06/03/2014	**A1818**	129,6	24 540	401,1	200,2	145,2		**2,105**	19,0		1,77	97,50%	
06/03/2014	**A1819**	129,7	24 520	401,2	200,6	145,5		**2,094**	19,0		1,76	95,98%	
05/03/2014	**A182**	129,0	24 440	401,4	200,8	144,9	Léger collage supérieur	**2,092**	19,0		1,76	95,77%	
06/03/2014	**A1820**	129,5	24 560	401,2	200,7	145,3		**2,099**	19,0		1,76	96,70%	
06/03/2014	**A1821**	129,5	24 460	401,6	200,6	145,1		**2,092**	19,0		1,76	95,72%	
06/03/2014	**A1822**	129,3	24 460	401,0	200,5	145,1		**2,097**	19,0		1,76	96,37%	
06/03/2014	**A1823**	130,9	24 520	401,0	200,5	145,4		**2,097**	19,0		1,76	96,38%	
06/03/2014	**A1824**	129,5	24 500	401,1	200,7	144,5		**2,106**	19,0		1,77	97,61%	
06/03/2014	**A1825**	129,7	24 540	400,6	200,2	145,0		**2,111**	19,0		1,77	98,22%	
06/03/2014	**A1826**	129,5	24 480	401,1	200,8	145,3		**2,091**	19,0		1,76	95,63%	
06/03/2014	**A1827**	129,5	24 520	401,4	200,8	145,2		**2,095**	19,0		1,76	96,19%	
06/03/2014	**A1828**	129,5	24 520	401,2	200,5	145,2		**2,099**	19,0		1,76	96,62%	
06/03/2014	**A1829**	129,5	24 560	401,2	200,6	145,1		**2,102**	19,0		1,77	97,09%	
05/03/2014	**A183**	129,1	24 460	401,7	200,7	145,2	Léger collage supérieur	**2,090**	19,0		1,76	95,43%	
06/03/2014	**A1830**	129,6	24 540	400,8	200,6	145,4		**2,099**	19,0		1,76	96,66%	
06/03/2014	**A1831**	129,6	24 520	401,2	200,6	145,2		**2,099**	19,0		1,76	96,60%	
06/03/2014	**A1832**	129,7	24 500	401,3	200,4	145,1		**2,100**	19,0		1,76	96,80%	
06/03/2014	**A1833**	129,9	24 520	401,3	200,7	145,3		**2,095**	19,0		1,76	96,17%	
06/03/2014	**A1834**	129,5	24 540	401,3	200,6	145,2		**2,100**	19,0		1,76	96,76%	
06/03/2014	**A1835**	129,6	24 600	400,9	200,6	145,4		**2,104**	19,0		1,77	97,35%	
06/03/2014	**A1836**	129,6	24 520	401,1	200,6	145,4		**2,096**	19,0		1,76	96,30%	
06/03/2014	**A1837**	129,4	24 520	401,2	200,6	145,0		**2,102**	19,0		1,77	97,05%	
06/03/2014	**A1838**	129,6	24 520	401,0	200,5	145,0		**2,104**	19,0		1,77	97,31%	
06/03/2014	**A1839**	129,6	24 600	401,0	200,7	145,4		**2,102**	19,0		1,77	97,06%	
05/03/2014	**A184**	129,0	24 360	401,6	200,7	145,3	Léger collage supérieur	**2,081**	19,0		1,75	94,29%	
06/03/2014	**A1840**	129,5	24 540	401,0	200,6	145,3		**2,100**	19,0		1,76	96,73%	
06/03/2014	**A1841**	129,5	24 540	401,2	200,4	145,3		**2,101**	19,0		1,77	96,91%	
06/03/2014	**A1842**	129,6	24 500	401,0	200,5	145,3		**2,098**	19,0		1,76	96,49%	
06/03/2014	**A1843**	129,6	24 520	401,1	200,7	145,1		**2,099**	19,0		1,76	96,64%	
06/03/2014	**A1844**	129,5	24 520	401,0	200,7	145,3		**2,097**	19,0		1,76	96,40%	
06/03/2014	**A1845**	129,5	24 540	401,1	200,7	145,1		**2,102**	19,0		1,77	97,06%	
06/03/2014	**A1846**	129,5	24 520	401,2	200,6	145,3		**2,098**	19,0		1,76	96,47%	
06/03/2014	**A1847**	129,5	24 500	401,4	200,5	145,4		**2,093**	19,0		1,76	95,92%	
06/03/2014	**A1848**	129,5	24 500	401,6	200,7	145,2		**2,094**	19,0		1,76	95,99%	
06/03/2014	**A1849**	129,6	24 520	401,4	200,5	145,5		**2,093**	19,0		1,76	95,91%	
05/03/2014	**A185**	128,9	24 340	401,4	200,8	144,7	Léger collage supérieur	**2,088**	19,0		1,75	95,20%	
06/03/2014	**A1850**	129,6	24 480	401,2	200,6	145,5	Léger collage supérieur	**2,091**	19,0		1,76	95,60%	
06/03/2014	**A1851**	129,5	24 500	401,1	200,7	145,4	Léger collage supérieur	**2,094**	19,0		1,76	95,96%	
06/03/2014	**A1852**	129,4	24 500	401,5	200,5	145,4	Léger collage supérieur	**2,094**	19,0		1,76	95,94%	
06/03/2014	**A1853**	129,4	24 500	401,4	200,7	145,3	Léger collage supérieur	**2,094**	19,0		1,76	95,93%	
06/03/2014	**A1854**	130,9	24 520	401,2	200,6	145,3	Léger collage supérieur	**2,097**	19,0		1,76	96,34%	
06/03/2014	**A1855**	129,5	24 500	401,5	200,7	145,2	Léger collage supérieur	**2,095**	19,0		1,76	96,16%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Resistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1856**	129,7	24 500	401,7	200,7	145,0	Léger collage supérieur	**2,096**	19,0		1,76	96,23%	
06/03/2014	**A1857**	129,5	24 520	401,4	200,5	145,5	Léger collage supérieur	**2,094**	19,0		1,76	96,04%	
06/03/2014	**A1858**	129,7	24 520	401,3	200,5	144,9		**2,103**	19,0		1,77	97,14%	
06/03/2014	**A1859**	129,4	24 580	401,1	200,5	145,3		**2,104**	19,0		1,77	97,38%	
05/03/2014	**A186**	129,1	24 480	401,4	200,9	145,4	Léger collage supérieur	**2,088**	19,0		1,76	95,27%	
06/03/2014	**A1860**	129,4	24 540	401,0	200,5	145,3		**2,101**	19,0		1,77	96,89%	
06/03/2014	**A1861**	129,8	24 560	401,1	200,5	145,5		**2,098**	19,0		1,76	96,57%	
06/03/2014	**A1862**	129,5	24 520	401,0	200,6	145,1		**2,101**	19,0		1,77	96,92%	
06/03/2014	**A1863**	129,3	24 500	401,1	200,7	144,7		**2,104**	19,0		1,77	97,29%	
06/03/2014	**A1864**	129,4	24 520	401,0	200,5	144,8		**2,106**	19,0		1,77	97,62%	
06/03/2014	**A1865**	130,9	24 460	401,1	200,6	145,2		**2,094**	19,0		1,76	96,00%	
06/03/2014	**A1866**	129,5	24 540	401,1	200,4	145,0		**2,106**	19,0		1,77	97,54%	
06/03/2014	**A1867**	129,6	24 520	401,0	200,5	145,1		**2,102**	19,0		1,77	97,06%	
06/03/2014	**A1868**	129,4	24 520	401,0	200,6	144,9		**2,104**	19,0		1,77	97,27%	
06/03/2014	**A1869**	129,8	24 520	401,0	200,7	145,2		**2,099**	19,0		1,76	96,68%	
05/03/2014	**A187**	129,0	24 460	401,5	200,9	145,0	Léger collage supérieur	**2,091**	19,0		1,76	95,67%	
06/03/2014	**A1870**	129,5	24 480	401,0	200,5	144,8		**2,103**	19,0		1,77	97,14%	
06/03/2014	**A1871**	129,5	24 480	400,9	200,5	145,2		**2,098**	19,0		1,76	96,58%	
06/03/2014	**A1872**	129,6	24 520	401,0	200,4	145,0		**2,104**	19,0		1,77	97,38%	
06/03/2014	**A1873**	129,4	24 480	400,9	200,7	145,1		**2,097**	19,0		1,76	96,41%	
06/03/2014	**A1874**	129,4	24 480	400,9	200,5	145,0		**2,101**	19,0		1,77	96,95%	
06/03/2014	**A1875**	129,4	24 480	401,1	200,5	144,8		**2,102**	19,0		1,77	97,06%	
06/03/2014	**A1876**	129,5	24 500	401,0	200,6	144,9		**2,102**	19,0		1,77	97,01%	
06/03/2014	**A1877**	129,4	24 480	401,0	200,6	144,9		**2,101**	19,0		1,77	96,94%	
06/03/2014	**A1878**	129,9	24 520	401,1	200,5	145,0		**2,102**	19,0		1,77	97,05%	
06/03/2014	**A1879**	129,4	24 460	401,2	200,7	145,0		**2,095**	19,0		1,76	96,18%	
05/03/2014	**A188**	129,2	24 380	401,6	200,7	144,7	Léger collage supérieur	**2,090**	19,0		1,76	95,44%	
06/03/2014	**A1880**	129,7	24 500	400,8	200,6	145,5		**2,095**	19,0		1,76	96,07%	
06/03/2014	**A1881**	129,6	24 440	400,9	200,6	145,1		**2,095**	19,0		1,76	96,11%	
06/03/2014	**A1882**	129,5	24 460	401,0	200,7	145,1		**2,094**	19,0		1,76	95,99%	
06/03/2014	**A1883**	129,6	24 480	401,2	200,6	144,9		**2,099**	19,0		1,76	96,64%	
06/03/2014	**A1884**	129,6	24 520	401,1	200,7	145,3		**2,097**	19,0		1,76	96,39%	
06/03/2014	**A1885**	129,5	24 460	401,1	200,6	145,0		**2,097**	19,0		1,76	96,40%	
06/03/2014	**A1886**	130,9	24 520	401,0	200,6	145,1		**2,102**	19,0		1,77	96,99%	
06/03/2014	**A1887**	129,4	24 480	401,2	200,4	145,1		**2,099**	19,0		1,76	96,65%	
06/03/2014	**A1888**	129,6	24 480	400,9	200,3	145,0		**2,102**	19,0		1,77	97,10%	
06/03/2014	**A1889**	129,7	24 480	401,0	200,4	145,3		**2,097**	19,0		1,76	96,33%	
05/03/2014	**A189**	129,0	24 420	401,6	200,7	145,0	Léger collage supérieur	**2,090**	19,0		1,76	95,49%	
06/03/2014	**A1890**	129,5	24 440	400,9	200,4	144,9		**2,099**	19,0		1,76	96,69%	
06/03/2014	**A1891**	129,5	24 480	401,2	200,4	145,2		**2,097**	19,0		1,76	96,41%	
06/03/2014	**A1892**	129,4	24 520	401,2	200,4	145,0		**2,103**	19,0		1,77	97,21%	
06/03/2014	**A1893**	129,4	24 520	401,1	200,4	145,1		**2,102**	19,0		1,77	97,11%	
06/03/2014	**A1894**	129,5	24 540	401,2	200,6	145,0		**2,104**	19,0		1,77	97,30%	
06/03/2014	**A1895**	129,5	24 560	401,1	200,3	145,4		**2,102**	19,0		1,77	97,12%	
06/03/2014	**A1896**	129,5	24 500	401,1	200,5	145,0		**2,101**	19,0		1,77	96,91%	
06/03/2014	**A1897**	129,4	24 520	401,1	200,5	145,3		**2,098**	19,0		1,76	96,59%	
06/03/2014	**A1898**	129,6	24 460	401,3	200,7	145,0		**2,094**	19,0		1,76	96,04%	
06/03/2014	**A1899**	129,4	24 560	401,0	200,5	145,4		**2,102**	19,0		1,77	97,02%	
05/03/2014	**A19**	130,0	24 580	401,1	200,4	145,5		**2,101**	19,0		1,77	96,91%	
05/03/2014	**A190**	129,0	24 440	401,5	200,8	145,1	Léger collage supérieur	**2,089**	19,0		1,76	95,38%	
06/03/2014	**A1900**	129,7	24 560	401,0	200,3	145,1		**2,107**	19,0		1,77	97,71%	
06/03/2014	**A1901**	129,4	24 520	400,8	200,5	145,2		**2,101**	19,0		1,77	96,91%	
06/03/2014	**A1902**	129,5	24 520	401,1	200,3	144,8		**2,108**	19,0		1,77	97,87%	
06/03/2014	**A1903**	129,7	24 520	401,0	200,5	145,0		**2,104**	19,0		1,77	97,28%	
06/03/2014	**A1904**	129,6	24 540	401,3	200,4	145,4		**2,099**	19,0		1,76	96,63%	
06/03/2014	**A1905**	129,5	24 520	401,1	200,3	144,9		**2,107**	19,0		1,77	97,68%	
06/03/2014	**A1906**	129,6	24 560	401,0	200,5	145,4		**2,101**	19,0		1,77	96,96%	
06/03/2014	**A1907**	129,5	24 560	401,2	200,5	145,9		**2,094**	19,0		1,76	95,99%	
06/03/2014	**A1908**	129,5	24 580	401,1	200,5	145,1		**2,107**	19,0		1,77	97,72%	
06/03/2014	**A1909**	129,5	24 580	401,2	200,4	145,7		**2,098**	19,0		1,76	96,55%	
05/03/2014	**A191**	128,9	24 420	401,5	201,1	144,7	Léger collage supérieur	**2,090**	19,0		1,76	95,42%	
06/03/2014	**A1910**	129,6	24 500	401,1	200,3	145,0		**2,103**	19,0		1,77	97,19%	
06/03/2014	**A1911**	129,5	24 480	401,2	200,0	145,1		**2,102**	19,0		1,77	97,05%	
06/03/2014	**A1912**	129,8	24 460	401,0	200,4	145,3		**2,096**	19,0		1,76	96,24%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1913**	129,3	24 520	400,9	200,3	144,9		**2,107**	19,0		1,77	97,74%	
06/03/2014	**A1914**	129,6	24 520	401,1	200,3	144,9		**2,106**	19,0		1,77	97,57%	
06/03/2014	**A1915**	129,5	24 520	401,0	200,3	145,1		**2,104**	19,0		1,77	97,31%	
06/03/2014	**A1916**	129,7	24 500	401,1	200,4	145,3		**2,098**	19,0		1,76	96,49%	
06/03/2014	**A1917**	129,4	24 520	400,9	200,4	144,8		**2,108**	19,0		1,77	97,89%	
06/03/2014	**A1918**	129,4	24 520	401,4	200,6	145,8	Léger collage supérieur	**2,089**	19,0		1,76	95,40%	
06/03/2014	**A1919**	129,7	24 480	401,4	200,4	145,3	Léger collage supérieur	**2,095**	19,0		1,76	96,09%	
05/03/2014	**A192**	129,0	24 400	401,7	201,1	145,2	Léger collage supérieur	**2,080**	19,0		1,75	94,18%	
06/03/2014	**A1920**	129,5	24 540	401,3	200,6	145,4	Léger collage supérieur	**2,097**	19,0		1,76	96,37%	
06/03/2014	**A1921**	129,5	24 540	401,4	200,5	145,3	Léger collage supérieur	**2,097**	19,0		1,76	96,46%	
06/03/2014	**A1922**	129,5	24 540	401,1	200,5	145,2	Léger collage supérieur	**2,101**	19,0		1,77	96,93%	
06/03/2014	**A1923**	129,4	24 520	401,2	200,6	145,3	Léger collage supérieur	**2,097**	19,0		1,76	96,33%	
06/03/2014	**A1924**	129,4	24 500	401,5	200,9	145,6	Léger collage supérieur	**2,087**	19,0		1,75	95,08%	
06/03/2014	**A1925**	129,4	24 500	401,5	200,6	145,8	Léger collage supérieur	**2,087**	19,0		1,75	95,02%	
06/03/2014	**A1926**	129,6	24 580	401,6	200,6	145,9	Léger collage supérieur	**2,091**	19,0		1,76	95,64%	
06/03/2014	**A1927**	129,4	24 560	401,4	200,5	145,5	Léger collage supérieur	**2,097**	19,0		1,76	96,38%	
06/03/2014	**A1928**	129,5	24 620	401,3	200,6	146,3	Pièce écartée pour Rc	**2,091**	19,0	18,01	1,76	95,57%	8,5 - 9,0
06/03/2014	**A1929**	129,5	24 520	401,3	201,3	145,9		**2,080**	19,0		1,75	94,22%	
05/03/2014	**A193**	128,9	24 480	401,5	200,9	145,4	Léger collage supérieur	**2,088**	19,0		1,75	95,24%	
06/03/2014	**A1930**	129,4	24 580	401,2	200,5	145,6		**2,099**	19,0		1,76	96,69%	
06/03/2014	**A1931**	129,9	24 560	401,3	200,7	145,2		**2,100**	19,0		1,76	96,83%	
06/03/2014	**A1932**	129,5	24 560	401,2	200,4	145,3		**2,103**	19,0		1,77	97,21%	
06/03/2014	**A1933**	129,6	24 600	401,0	200,4	145,4		**2,105**	19,0		1,77	97,40%	
06/03/2014	**A1934**	129,4	24 580	401,3	200,4	145,4		**2,102**	19,0		1,77	97,11%	
06/03/2014	**A1935**	129,4	24 580	401,3	200,4	145,3		**2,103**	19,0		1,77	97,18%	
06/03/2014	**A1936**	129,5	24 580	401,1	200,5	145,2		**2,106**	19,0		1,77	97,58%	
06/03/2014	**A1937**	129,5	24 580	401,1	200,3	145,3		**2,106**	19,0		1,77	97,65%	
06/03/2014	**A1938**	129,5	24 460	401,6	200,6	145,4		**2,088**	19,0		1,75	95,26%	
06/03/2014	**A1939**	130,6	24 600	401,1	200,7	145,7		**2,098**	19,0		1,76	96,50%	
05/03/2014	**A194**	130,4	24 440	401,4	200,7	145,0	Léger collage supérieur	**2,092**	19,0		1,76	95,79%	
06/03/2014	**A1940**	129,5	24 560	401,3	200,6	145,3		**2,100**	19,0		1,76	96,74%	
06/03/2014	**A1941**	129,7	24 540	401,5	200,7	145,4		**2,095**	19,0		1,76	96,15%	
06/03/2014	**A1942**	129,7	24 540	401,5	200,6	145,9	Léger collage latéral	**2,088**	19,0		1,75	95,18%	
06/03/2014	**A1943**	129,4	24 560	401,6	200,7	145,6		**2,094**	19,0		1,76	95,96%	
06/03/2014	**A1944**	129,5	24 500	401,5	200,6	145,2		**2,095**	19,0		1,76	96,10%	
06/03/2014	**A1945**	129,7	24 600	401,2	200,6	145,5		**2,101**	19,0		1,77	96,97%	
06/03/2014	**A1946**	129,5	24 580	401,6	200,7	145,9	Léger collage supérieur	**2,090**	19,0		1,76	95,44%	
06/03/2014	**A1947**	129,5	24 580	401,6	200,8	145,8	Léger collage supérieur	**2,091**	19,0		1,76	95,63%	
06/03/2014	**A1948**	129,6	24 460	401,3	200,7	145,5		**2,088**	19,0		1,76	95,28%	
06/03/2014	**A1949**	129,7	24 480	401,2	200,4	145,6		**2,091**	19,0		1,76	95,58%	
05/03/2014	**A195**	129,3	24 420	401,4	200,7	144,9	Léger collage supérieur	**2,092**	19,0		1,76	95,68%	
06/03/2014	**A1950**	129,5	24 500	401,3	200,5	145,6		**2,092**	19,0		1,76	95,67%	
06/03/2014	**A1951**	129,7	24 440	401,1	200,4	145,4		**2,091**	19,0		1,76	95,61%	
06/03/2014	**A1952**	129,7	24 460	401,2	200,5	145,6		**2,089**	19,0		1,76	95,29%	
06/03/2014	**A1953**	129,7	24 460	401,6	200,4	145,3		**2,091**	19,0		1,76	95,62%	
06/03/2014	**A1954**	129,5	24 500	401,1	200,6	145,2		**2,097**	19,0		1,76	96,33%	
06/03/2014	**A1955**	129,4	24 460	402,0	200,5	145,3		**2,088**	19,0		1,75	95,27%	
06/03/2014	**A1956**	129,5	24 480	401,2	200,5	145,4		**2,095**	19,0		1,76	96,07%	
06/03/2014	**A1957**	129,6	24 500	401,1	200,6	145,3		**2,096**	19,0		1,76	96,27%	
06/03/2014	**A1958**	129,6	24 440	401,6	200,5	145,0		**2,093**	19,0		1,76	95,83%	
06/03/2014	**A1959**	129,5	24 460	401,1	200,5	145,6		**2,090**	19,0		1,76	95,41%	
05/03/2014	**A196**	128,9	24 480	401,5	200,8	145,2	Léger collage supérieur	**2,092**	19,0		1,76	95,69%	
06/03/2014	**A1960**	129,7	24 540	401,2	200,5	145,8		**2,092**	19,0		1,76	95,79%	
06/03/2014	**A1961**	129,7	24 540	401,1	200,6	145,5		**2,096**	19,0		1,76	96,33%	
06/03/2014	**A1962**	129,5	24 500	401,2	200,7	145,3		**2,095**	19,0		1,76	96,11%	
06/03/2014	**A1963**	129,6	24 520	401,0	200,5	145,6		**2,095**	19,0		1,76	96,08%	
06/03/2014	**A1964**	129,5	24 520	401,1	200,6	145,5		**2,096**	19,0		1,76	96,22%	
06/03/2014	**A1965**	129,6	24 480	401,0	200,5	145,3		**2,096**	19,0		1,76	96,28%	
06/03/2014	**A1966**	129,5	24 520	401,1	200,3	145,6		**2,096**	19,0		1,76	96,27%	
06/03/2014	**A1967**	129,6	24 480	401,1	200,6	145,4		**2,093**	19,0		1,76	95,81%	
06/03/2014	**A1968**	129,4	24 500	401,0	200,6	145,0		**2,100**	19,0		1,76	96,78%	
06/03/2014	**A1969**	129,6	24 500	401,1	200,5	145,3		**2,097**	19,0		1,76	96,33%	
05/03/2014	**A197**	128,9	24 460	401,4	200,9	145,5	Léger collage supérieur	**2,086**	19,0		1,75	94,92%	
06/03/2014	**A1970**	129,5	24 520	401,0	200,5	145,0		**2,104**	19,0		1,77	97,32%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A1971**	129,4	24 560	401,1	200,5	145,2		**2,104**	19,0		1,77	97,30%	
06/03/2014	**A1972**	130,9	24 540	401,2	200,6	145,6		**2,094**	19,0		1,76	96,05%	
06/03/2014	**A1973**	129,5	24 560	401,1	200,6	145,6		**2,097**	19,0		1,76	96,43%	
06/03/2014	**A1974**	129,5	24 520	401,1	200,4	145,6		**2,095**	19,0		1,76	96,09%	
06/03/2014	**A1975**	129,4	24 540	401,5	200,5	145,6		**2,093**	19,0		1,76	95,92%	
06/03/2014	**A1976**	129,6	24 560	402,0	200,6	145,6		**2,092**	19,0		1,76	95,76%	
06/03/2014	**A1977**	129,6	24 580	401,2	200,5	145,7		**2,097**	19,0		1,76	96,42%	
06/03/2014	**A1978**	129,6	24 520	401,3	200,3	145,2		**2,100**	19,0		1,76	96,83%	
06/03/2014	**A1979**	129,6	24 500	401,4	200,5	145,4		**2,094**	19,0		1,76	96,06%	
05/03/2014	**A198**	130,4	24 420	401,5	200,9	145,0		**2,087**	19,0		1,75	95,15%	
06/03/2014	**A1980**	129,4	24 560	401,5	200,7	145,9		**2,089**	19,0		1,76	95,40%	
06/03/2014	**A1981**	129,7	24 520	401,3	200,4	145,6		**2,094**	19,0		1,76	96,02%	
06/03/2014	**A1982**	129,5	24 620	401,4	200,5	145,5		**2,102**	19,0		1,77	97,10%	
06/03/2014	**A1983**	129,5	24 560	401,5	200,5	145,4		**2,099**	19,0		1,76	96,62%	
06/03/2014	**A1984**	129,7	24 560	401,4	200,2	145,9		**2,095**	19,0		1,76	96,15%	
06/03/2014	**A1985**	129,7	24 540	401,5	200,5	145,3		**2,097**	19,0		1,76	96,46%	
06/03/2014	**A1986**	129,4	24 500	401,3	200,5	145,2		**2,098**	19,0		1,76	96,54%	
06/03/2014	**A1987**	129,6	24 560	401,5	200,6	145,6		**2,095**	19,0		1,76	96,10%	
06/03/2014	**A1988**	129,4	24 560	401,4	200,3	145,5		**2,099**	19,0		1,76	96,65%	
06/03/2014	**A1989**	130,9	24 560	401,6	200,4	145,8		**2,093**	19,0		1,76	95,90%	
05/03/2014	**A199**	128,9	24 420	401,5	200,7	144,8		**2,093**	19,0		1,76	95,88%	
06/03/2014	**A1990**	129,5	24 520	401,4	200,6	145,7		**2,090**	19,0		1,76	95,42%	
06/03/2014	**A1991**	129,6	24 560	401,4	200,9	145,5		**2,093**	19,0		1,76	95,93%	
06/03/2014	**A1992**	129,5	24 540	401,3	200,5	145,3		**2,100**	19,0		1,76	96,76%	
06/03/2014	**A1993**	129,5	24 580	401,2	200,5	145,7		**2,098**	19,0		1,76	96,55%	
06/03/2014	**A1994**	129,4	24 500	401,4	200,4	145,2		**2,098**	19,0		1,76	96,52%	
06/03/2014	**A1995**	129,4	24 500	401,2	200,5	145,3		**2,096**	19,0		1,76	96,30%	
06/03/2014	**A1996**	129,5	24 540	401,2	200,7	145,7		**2,093**	19,0		1,76	95,87%	
06/03/2014	**A1997**	129,4	24 540	401,4	200,5	145,3		**2,099**	19,0		1,76	96,62%	
06/03/2014	**A1998**	129,6	24 540	401,3	200,4	145,5		**2,098**	19,0		1,76	96,51%	
06/03/2014	**A1999**	129,6	24 540	401,3	200,4	145,3		**2,100**	19,0		1,76	96,80%	
05/03/2014	**A2**	129,9	24 446	401,6	200,6	144,8		**2,096**	19,0		1,76	96,21%	
05/03/2014	**A20**	129,9	24 580	401,9	200,4	145,8		**2,093**	19,0		1,76	95,80%	
05/03/2014	**A200**	130,3	24 440	401,7	200,8	144,8		**2,093**	19,0		1,76	95,86%	
06/03/2014	**A2000**	129,4	24 560	401,4	200,4	145,6		**2,096**	19,0		1,76	96,31%	
06/03/2014	**A2001**	129,5	24 540	401,3	200,5	145,5		**2,096**	19,0		1,76	96,23%	
06/03/2014	**A2002**	129,5	24 520	401,4	200,5	145,4		**2,097**	19,0		1,76	96,33%	
06/03/2014	**A2003**	129,7	24 540	401,4	200,5	145,4		**2,098**	19,0		1,76	96,50%	
06/03/2014	**A2004**	129,5	24 580	401,4	200,4	145,6		**2,099**	19,0		1,76	96,68%	
06/03/2014	**A2005**	129,7	24 540	401,4	200,5	145,4		**2,097**	19,0		1,76	96,43%	
06/03/2014	**A2006**	129,4	24 580	401,5	200,4	145,5		**2,100**	19,0		1,77	96,85%	
06/03/2014	**A2007**	129,4	24 540	401,1	200,8	145,8		**2,091**	19,0		1,76	95,58%	
06/03/2014	**A2008**	129,7	24 600	401,2	200,7	146,0		**2,094**	19,0		1,76	95,94%	
06/03/2014	**A2009**	129,4	24 560	401,5	200,6	145,9		**2,090**	19,0		1,76	95,53%	
05/03/2014	**A201**	128,9	24 400	401,6	200,6	144,6		**2,094**	19,0		1,76	95,98%	
06/03/2014	**A2010**	129,5	24 540	401,5	200,9	145,9		**2,086**	19,0		1,75	94,90%	
06/03/2014	**A2011**	129,7	24 540	401,5	200,9	145,8		**2,087**	19,0		1,75	95,09%	
06/03/2014	**A2012**	129,4	24 540	401,3	200,4	145,4		**2,098**	19,0		1,76	96,51%	
06/03/2014	**A2013**	129,6	24 560	401,6	200,2	145,4		**2,101**	19,0		1,77	96,87%	
06/03/2014	**A2014**	129,4	24 520	401,6	200,4	145,3		**2,097**	19,0		1,76	96,41%	
06/03/2014	**A2015**	129,6	24 500	401,5	200,3	145,3		**2,097**	19,0		1,76	96,39%	
06/03/2014	**A2016**	129,5	24 540	401,4	200,6	145,9		**2,089**	19,0		1,76	95,36%	
06/03/2014	**A2017**	129,8	24 556	401,4	200,6	146,0		**2,090**	19,0		1,76	95,43%	
06/03/2014	**A2018**	129,5	24 500	401,4	200,8	145,6		**2,087**	19,0		1,75	95,14%	
06/03/2014	**A2019**	129,6	24 540	401,4	200,8	145,8		**2,089**	19,0		1,76	95,30%	
05/03/2014	**A202**	128,9	24 400	401,6	200,6	145,8		**2,077**	19,0		1,75	93,77%	
06/03/2014	**A2020**	129,4	24 580	401,5	200,6	146,1		**2,090**	19,0		1,76	95,49%	
06/03/2014	**A2021**	129,3	24 500	401,5	200,8	145,7		**2,086**	19,0		1,75	95,00%	
06/03/2014	**A2022**	129,5	24 560	401,5	200,7	145,9		**2,088**	19,0		1,75	95,24%	
06/03/2014	**A2023**	129,4	24 520	401,5	200,8	145,8		**2,086**	19,0		1,75	94,95%	
06/03/2014	**A2024**	129,4	24 540	401,7	200,7	145,5		**2,093**	19,0		1,76	95,87%	
06/03/2014	**A2025**	129,6	24 520	401,6	200,5	145,4		**2,095**	19,0		1,76	96,07%	
06/03/2014	**A2026**	129,6	24 480	401,6	200,9	145,2		**2,090**	19,0		1,76	95,50%	
06/03/2014	**A2027**	129,6	24 580	401,5	200,7	145,8		**2,093**	19,0		1,76	95,81%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
06/03/2014	**A2028**	130,9	24 500	401,6	200,8	145,6	Léger collage supérieur	**2,087**	19,0		1,75	95,03%	
06/03/2014	**A2029**	129,4	24 560	401,7	200,6	146,1	Léger collage supérieur	**2,087**	19,0		1,75	95,07%	
05/03/2014	**A203**	130,3	24 440	401,7	200,7	144,8		**2,092**	19,0		1,76	95,79%	
06/03/2014	**A2030**	129,5	24 500	401,4	200,7	145,7	Léger collage supérieur	**2,087**	19,0		1,75	95,05%	
06/03/2014	**A2031**	129,5	24 540	401,5	200,6	145,9	Léger collage supérieur	**2,089**	19,0		1,76	95,28%	
06/03/2014	**A2032**	129,7	24 560	401,4	200,9	146,1	Léger collage supérieur	**2,085**	19,0		1,75	94,79%	
06/03/2014	**A2033**	129,6	24 520	401,5	200,7	145,8	Léger collage supérieur	**2,086**	19,0		1,75	94,97%	
06/03/2014	**A2034**	129,5	24 540	401,7	200,7	145,9	Léger collage supérieur	**2,086**	19,0		1,75	94,89%	
06/03/2014	**A2035**	129,5	24 560	401,5	200,6	145,6	Léger collage supérieur	**2,094**	19,0		1,76	95,94%	
06/03/2014	**A2036**	129,4	24 520	401,6	200,6	145,5	Léger collage supérieur	**2,092**	19,0		1,76	95,75%	
06/03/2014	**A2037**	129,4	24 500	401,6	200,4	145,3	Léger collage supérieur	**2,094**	19,0		1,76	96,02%	
06/03/2014	**A2038**	129,6	24 540	401,2	200,5	145,7		**2,094**	19,0		1,76	96,04%	
06/03/2014	**A2039**	129,5	24 500	401,5	200,4	145,7		**2,090**	19,0		1,76	95,49%	
05/03/2014	**A204**	128,9	24 420	401,5	200,7	145,1		**2,089**	19,0		1,76	95,31%	
06/03/2014	**A2040**	129,6	24 480	401,3	200,2	145,3		**2,097**	19,0		1,76	96,39%	
06/03/2014	**A2041**	129,5	24 480	401,4	200,3	145,1		**2,099**	19,0		1,76	96,63%	
06/03/2014	**A2042**	129,5	24 540	401,4	200,3	145,6		**2,097**	19,0		1,76	96,41%	
06/03/2014	**A2043**	129,6	24 460	401,3	200,4	145,1		**2,096**	19,0		1,76	96,31%	
06/03/2014	**A2044**	129,6	24 540	401,3	200,2	145,6		**2,098**	19,0		1,76	96,54%	
06/03/2014	**A2045**	129,6	24 500	401,3	200,1	145,1		**2,103**	19,0		1,77	97,15%	
06/03/2014	**A2046**	129,5	24 580	401,3	200,1	145,5		**2,103**	19,0		1,77	97,24%	
06/03/2014	**A2047**	129,4	24 520	401,4	200,3	145,5		**2,097**	19,0		1,76	96,43%	
06/03/2014	**A2048**	129,6	24 520	401,2	200,4	145,8		**2,092**	19,0		1,76	95,72%	
06/03/2014	**A2049**	129,5	24 500	401,2	200,4	145,5		**2,094**	19,0		1,76	95,98%	
05/03/2014	**A205**	129,2	24 460	401,4	200,7	145,2		**2,091**	19,0		1,76	95,55%	
06/03/2014	**A2050**	129,2	24 500	401,3	200,2	145,3		**2,099**	19,0		1,76	96,68%	
06/03/2014	**A2051**	129,5	24 520	401,2	200,3	145,5		**2,097**	19,0		1,76	96,46%	
06/03/2014	**A2052**	129,4	24 500	401,3	200,3	145,2		**2,099**	19,0		1,76	96,67%	
06/03/2014	**A2053**	129,9	24 500	401,3	200,3	145,3		**2,098**	19,0		1,76	96,55%	
06/03/2014	**A2054**	129,4	24 540	401,1	200,5	145,8		**2,094**	19,0		1,76	95,96%	
06/03/2014	**A2055**	129,7	24 500	401,2	200,5	145,5		**2,093**	19,0		1,76	95,81%	
06/03/2014	**A2056**	129,4	24 520	401,3	200,4	145,6		**2,094**	19,0		1,76	96,05%	
06/03/2014	**A2057**	129,4	24 500	401,2	200,3	145,1		**2,101**	19,0		1,77	96,89%	
06/03/2014	**A2058**	129,5	24 520	401,3	200,4	145,1		**2,101**	19,0		1,77	96,96%	
06/03/2014	**A2059**	129,4	24 480	401,2	200,3	145,1		**2,100**	19,0		1,76	96,78%	
05/03/2014	**A206**	129,0	24 400	401,5	200,6	144,5		**2,097**	19,0		1,76	96,43%	
06/03/2014	**A2060**	129,4	24 520	401,2	200,5	146,0		**2,088**	19,0		1,75	95,26%	
06/03/2014	**A2061**	129,5	24 520	401,1	200,6	145,7		**2,092**	19,0		1,76	95,70%	
07/03/2013	**A2062**	129,7	24 460	401,4	200,4	144,9		**2,100**	19,0		1,76	96,76%	
07/03/2013	**A2063**	131,1	24 540	401,2	200,6	145,4		**2,097**	19,0		1,76	96,43%	
07/03/2013	**A2064**	131,1	24 520	401,6	200,3	145,3		**2,098**	19,0		1,76	96,53%	
07/03/2013	**A2065**	131,2	24 520	401,4	200,6	145,4		**2,095**	19,0		1,76	96,12%	
07/03/2013	**A2066**	131,0	24 540	401,1	200,6	145,7		**2,092**	19,0		1,76	95,80%	
07/03/2013	**A2067**	131,1	24 520	401,3	200,6	145,5		**2,094**	19,0		1,76	95,98%	
07/03/2013	**A2068**	131,1	24 520	401,6	200,7	145,9	Léger collage supérieur	**2,085**	19,0		1,75	94,84%	
07/03/2013	**A2069**	131,1	24 540	401,6	200,8	146,0	Léger collage supérieur	**2,085**	19,0		1,75	94,83%	
05/03/2014	**A207**	129,0	24 500	401,6	200,9	146,0		**2,081**	19,0		1,75	94,27%	
07/03/2013	**A2070**	129,7	24 540	401,6	200,9	146,0	Léger collage supérieur	**2,083**	19,0		1,75	94,58%	
07/03/2013	**A2071**	129,7	24 520	401,5	200,8	145,8	Léger collage supérieur	**2,086**	19,0		1,75	94,91%	
07/03/2013	**A2072**	129,6	24 460	401,6	200,5	145,3	Léger collage supérieur	**2,091**	19,0		1,76	95,64%	
07/03/2013	**A2073**	129,7	24 520	401,8	200,5	145,4	Léger collage supérieur	**2,093**	19,0		1,76	95,84%	
07/03/2013	**A2074**	129,6	24 520	401,6	200,5	145,6	Léger collage supérieur	**2,091**	19,0		1,76	95,60%	
07/03/2013	**A2075**	129,8	24 560	401,6	200,6	145,7	Léger collage supérieur	**2,092**	19,0		1,76	95,78%	
07/03/2013	**A2076**	129,5	24 560	401,5	200,7	146,1	Léger collage supérieur	**2,087**	19,0		1,75	95,03%	
07/03/2013	**A2077**	129,5	24 500	401,5	200,9	145,6	Léger collage supérieur	**2,086**	19,0		1,75	95,00%	
07/03/2013	**A2078**	129,5	24 540	401,5	200,8	145,9	Léger collage supérieur	**2,086**	19,0		1,75	94,99%	
07/03/2013	**A2079**	129,5	24 580	401,2	200,7	146,0	Léger collage supérieur	**2,092**	19,0		1,76	95,68%	
05/03/2014	**A208**	129,2	24 420	401,4	200,7	145,6		**2,081**	19,0		1,75	94,34%	
07/03/2013	**A2080**	129,5	24 560	401,5	200,7	146,0		**2,087**	19,0		1,75	95,15%	
07/03/2013	**A2081**	129,6	24 580	401,6	200,8	146,0		**2,087**	19,0		1,75	95,13%	
07/03/2013	**A2082**	129,5	24 540	401,4	200,8	145,9		**2,088**	19,0		1,75	95,15%	
07/03/2013	**A2083**	129,4	24 560	401,6	200,7	145,9		**2,088**	19,0		1,76	95,27%	
07/03/2013	**A2084**	129,6	24 520	401,8	200,5	145,3		**2,095**	19,0		1,76	96,07%	
07/03/2013	**A2085**	129,5	24 580	401,7	200,6	145,7		**2,094**	19,0		1,76	96,00%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
07/03/2013	**A2086**	129,6	24 540	401,6	200,6	145,6		**2,092**	19,0		1,76	95,79%	
07/03/2013	**A2087**	129,5	24 560	401,7	200,9	145,7		**2,090**	19,0		1,76	95,42%	
07/03/2013	**A2088**	129,4	24 560	401,5	200,7	146,0		**2,088**	19,0		1,75	95,18%	
07/03/2013	**A2089**	129,4	24 560	401,7	200,8	146,0		**2,086**	19,0		1,75	94,98%	
05/03/2014	**A209**	128,9	24 460	401,6	200,7	145,3		**2,088**	19,0		1,75	95,25%	
07/03/2013	**A2090**	129,6	24 580	401,6	200,9	146,0		**2,087**	19,0		1,75	95,10%	
07/03/2013	**A2091**	129,6	24 580	401,6	200,7	146,0		**2,088**	19,0		1,75	95,21%	
07/03/2013	**A2092**	129,7	24 580	401,6	200,9	146,0		**2,087**	19,0		1,75	95,09%	
07/03/2013	**A2093**	129,6	24 540	401,6	200,8	145,9		**2,085**	19,0		1,75	94,88%	
07/03/2013	**A2094**	129,7	24 580	401,8	200,8	146,1		**2,086**	19,0		1,75	94,90%	
07/03/2013	**A2095**	130,9	24 560	401,7	200,9	146,0		**2,084**	19,0		1,75	94,67%	
07/03/2013	**A2096**	129,6	24 560	401,5	200,8	146,1		**2,086**	19,0		1,75	94,92%	
07/03/2013	**A2097**	129,7	24 540	401,8	200,6	145,5		**2,093**	19,0		1,76	95,85%	
07/03/2013	**A2098**	131,1	24 500	401,8	200,8	145,8	Léger collage supérieur	**2,084**	19,0		1,75	94,66%	
07/03/2013	**A2099**	129,5	24 560	401,9	200,8	146,1	Léger collage supérieur	**2,084**	19,0		1,75	94,64%	
05/03/2014	**A21**	129,9	24 600	401,3	200,4	145,4		**2,104**	19,0		1,77	97,38%	
05/03/2014	**A210**	128,9	24 440	401,3	201,1	145,4		**2,083**	19,0		1,75	94,60%	
07/03/2013	**A2100**	129,6	24 580	401,9	200,7	146,1	Léger collage supérieur	**2,086**	19,0		1,75	94,98%	
07/03/2013	**A2101**	129,3	24 500	401,9	201,0	145,4	Léger collage supérieur	**2,086**	19,0		1,75	94,91%	
07/03/2013	**A2102**	129,4	24 520	401,8	201,2	146,1	Léger collage supérieur	**2,076**	19,0		1,74	93,63%	
07/03/2013	**A2103**	129,7	24 520	401,7	200,8	145,9	Léger collage supérieur	**2,084**	19,0		1,75	94,65%	
07/03/2013	**A2104**	129,5	24 560	401,7	200,6	145,8		**2,091**	19,0		1,76	95,55%	
07/03/2013	**A2105**	129,6	24 520	401,8	200,4	145,4		**2,094**	19,0		1,76	96,04%	
07/03/2013	**A2106**	129,5	24 520	401,6	200,6	145,5		**2,092**	19,0		1,76	95,78%	
07/03/2013	**A2107**	129,3	24 560	401,6	200,6	145,7		**2,092**	19,0		1,76	95,75%	
07/03/2013	**A2108**	129,9	24 560	401,5	201,6	146,1		**2,078**	19,0		1,75	93,88%	
07/03/2013	**A2109**	129,5	24 540	401,7	200,6	145,7		**2,090**	19,0		1,76	95,51%	
05/03/2014	**A211**	129,0	24 400	401,3	200,6	145,4		**2,084**	19,0		1,75	94,71%	
07/03/2013	**A2110**	129,5	24 560	401,4	200,3	145,6		**2,099**	19,0		1,76	96,60%	
07/03/2013	**A2111**	131,1	24 580	401,4	200,3	145,5		**2,102**	19,0		1,77	97,05%	
07/03/2013	**A2112**	129,4	24 580	401,5	200,6	146,1		**2,090**	19,0		1,76	95,46%	
07/03/2013	**A2113**	129,6	24 600	401,4	200,3	145,8		**2,100**	19,0		1,76	96,74%	
07/03/2013	**A2114**	129,5	24 620	401,2	200,5	146,0		**2,096**	19,0		1,76	96,32%	
07/03/2013	**A2115**	129,6	24 500	401,4	200,4	145,9		**2,088**	19,0		1,75	95,24%	
07/03/2013	**A2116**	129,5	24 500	401,3	200,2	145,4		**2,098**	19,0		1,76	96,47%	
07/03/2013	**A2117**	129,6	24 560	401,2	200,1	145,5		**2,102**	19,0		1,77	97,05%	
07/03/2013	**A2118**	129,7	24 500	401,1	200,3	145,5		**2,097**	19,0		1,76	96,37%	
07/03/2013	**A2119**	129,4	24 460	401,3	200,1	145,4		**2,095**	19,0		1,76	96,14%	
05/03/2014	**A212**	129,1	24 360	401,4	200,5	144,7		**2,092**	19,0		1,76	95,74%	
07/03/2013	**A2120**	129,5	24 540	401,3	200,6	145,9		**2,090**	19,0		1,76	95,49%	
07/03/2013	**A2121**	130,9	24 540	401,3	200,5	145,8		**2,093**	19,0		1,76	95,81%	
07/03/2013	**A2122**	131,1	24 440	401,1	200,2	144,9		**2,100**	19,0		1,76	96,81%	
07/03/2013	**A2123**	129,6	24 480	401,1	200,4	145,2		**2,097**	19,0		1,76	96,36%	
07/03/2013	**A2124**	129,5	24 480	401,2	200,3	145,3	Léger collage supérieur	**2,097**	19,0		1,76	96,39%	
07/03/2013	**A2125**	129,7	24 460	401,1	200,3	145,1	Léger collage supérieur	**2,098**	19,0		1,76	96,54%	
07/03/2013	**A2126**	129,4	24 480	401,2	200,5	145,7	Léger collage supérieur	**2,088**	19,0		1,75	95,24%	
07/03/2013	**A2127**	129,5	24 440	401,3	200,5	145,4	Léger collage supérieur	**2,089**	19,0		1,76	95,40%	
07/03/2013	**A2128**	129,8	24 520	401,8	200,6	145,4		**2,092**	19,0		1,76	95,78%	
07/03/2013	**A2129**	129,5	24 540	401,9	200,7	145,9		**2,085**	19,0		1,75	94,78%	
05/03/2014	**A213**	128,9	24 380	401,3	200,6	145,2		**2,086**	19,0		1,75	94,95%	
07/03/2013	**A2130**	129,7	24 540	401,8	200,7	145,7		**2,088**	19,0		1,75	95,18%	
07/03/2013	**A2131**	129,6	24 540	401,6	200,6	145,9		**2,087**	19,0		1,75	95,13%	
07/03/2013	**A2132**	129,7	24 500	401,4	200,7	145,9		**2,085**	19,0		1,75	94,79%	
07/03/2013	**A2133**	129,6	24 560	401,5	200,7	145,9		**2,088**	19,0		1,76	95,28%	
07/03/2013	**A2134**	129,8	24 560	401,6	200,6	145,7		**2,093**	19,0		1,76	95,81%	
07/03/2013	**A2135**	129,6	24 580	401,4	200,6	145,5		**2,098**	19,0		1,76	96,57%	
07/03/2013	**A2136**	129,4	24 580	401,5	200,6	145,6		**2,097**	19,0		1,76	96,33%	
07/03/2013	**A2137**	129,6	24 560	401,5	200,5	145,6		**2,096**	19,0		1,76	96,23%	
07/03/2013	**A2138**	129,5	24 540	401,5	200,9	145,8		**2,087**	19,0		1,75	95,05%	
07/03/2013	**A2139**	129,5	24 540	401,6	200,7	145,7		**2,090**	19,0		1,76	95,44%	
05/03/2014	**A214**	129,0	24 320	401,2	200,6	144,5		**2,092**	19,0		1,76	95,73%	
07/03/2013	**A2140**	129,6	24 500	401,2	200,3	145,5		**2,096**	19,0		1,76	96,24%	
07/03/2013	**A2141**	129,5	24 540	401,4	200,2	146,1	Léger collage supérieur	**2,090**	19,0		1,76	95,52%	
07/03/2013	**A2142**	130,9	24 520	401,5	200,2	145,4	Léger collage supérieur	**2,098**	19,0		1,76	96,55%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
07/03/2013	A2143	129,4	24 520	401,3	200,2	145,5	Léger collage supérieur	2,098	19,0		1,76	96,52%	
07/03/2013	A2144	129,7	24 540	401,3	200,6	146,0		2,089	19,0		1,76	95,30%	
07/03/2013	A2145	129,5	24 540	401,3	200,4	145,8		2,094	19,0		1,76	96,01%	
07/03/2013	A2146	129,5	24 540	401,2	200,1	145,5	Léger collage supérieur	2,100	19,0		1,76	96,81%	
07/03/2013	A2147	129,6	24 500	401,1	200,2	145,5		2,096	19,0		1,76	96,28%	
07/03/2013	A2148	129,6	24 480	401,3	200,2	145,3		2,098	19,0		1,76	96,54%	
07/03/2013	A2149	129,6	24 520	401,3	200,2	145,4		2,099	19,0		1,76	96,61%	
05/03/2014	A215	130,3	24 280	401,3	200,6	144,6		2,087	19,0		1,75	95,02%	
07/03/2013	A2150	129,4	24 540	401,1	200,5	146,0		2,091	19,0		1,76	95,55%	
07/03/2013	A2151	129,6	24 520	401,7	200,5	145,4		2,095	19,0		1,76	96,11%	
07/03/2013	A2152	129,6	24 500	401,2	200,5	145,7		2,090	19,0		1,76	95,42%	
07/03/2013	A2153	129,8	24 480	401,2	200,9	145,8	Léger collage supérieur	2,083	19,0		1,75	94,61%	
07/03/2013	A2154	129,6	24 500	401,2	200,7	145,8	Léger collage supérieur	2,086	19,0		1,75	94,93%	
07/03/2013	A2155	129,4	24 480	401,3	200,6	145,6	Léger collage supérieur	2,088	19,0		1,76	95,27%	
07/03/2013	A2156	129,7	24 480	401,4	200,5	145,2		2,095	19,0		1,76	96,17%	
07/03/2013	A2157	129,6	24 500	401,2	200,2	145,3		2,099	19,0		1,76	96,69%	
07/03/2013	A2158	129,6	24 520	401,2	200,3	145,9	Léger collage supérieur	2,092	19,0		1,76	95,67%	
07/03/2013	A2159	129,5	24 480	401,4	200,5	145,7	Léger collage supérieur	2,088	19,0		1,75	95,25%	
05/03/2014	A216	129,0	24 360	401,3	200,7	145,1		2,085	19,0		1,75	94,85%	
07/03/2013	A2160	129,7	24 520	401,4	200,5	146,1	Léger collage supérieur	2,086	19,0		1,75	94,97%	
07/03/2013	A2161	129,6	24 480	401,5	200,5	145,8	Léger collage supérieur	2,086	19,0		1,75	94,93%	
07/03/2013	A2162	129,4	24 480	401,3	200,6	145,5	Léger collage supérieur	2,090	19,0		1,76	95,49%	
07/03/2013	A2163	129,5	24 540	401,1	200,5	146,0	Léger collage supérieur	2,090	19,0		1,76	95,42%	
07/03/2013	A2164	129,9	24 520	401,7	200,6	145,8	Léger collage supérieur	2,087	19,0		1,75	95,05%	
07/03/2013	A2165	129,6	24 460	401,4	200,7	145,5	Léger collage supérieur	2,087	19,0		1,75	95,11%	
07/03/2013	A2166	129,7	24 500	401,5	200,4	145,4	Léger collage supérieur	2,095	19,0		1,76	96,08%	
07/03/2013	A2167	129,6	24 500	401,5	200,5	145,4	Léger collage supérieur	2,094	19,0		1,76	95,95%	
07/03/2013	A2168	129,7	24 480	401,5	200,5	145,4	Léger collage supérieur	2,092	19,0		1,76	95,75%	
07/03/2013	A2169	129,6	24 520	401,4	200,4	145,6	Léger collage supérieur	2,094	19,0		1,76	95,97%	
05/03/2014	A217	128,9	24 060	401,4	200,5	144,6		2,068	19,0		1,74	92,69%	
07/03/2013	A2170	131,0	24 500	401,4	200,2	145,5	Léger collage supérieur	2,096	19,0		1,76	96,21%	
07/03/2013	A2171	129,6	24 480	401,2	200,3	145,2	Léger collage supérieur	2,097	19,0		1,76	96,45%	
07/03/2013	A2172	129,5	24 480	401,4	200,6	145,4	Léger collage supérieur	2,091	19,0		1,76	95,57%	
07/03/2013	A2173	129,6	24 460	401,3	200,4	145,5	Léger collage supérieur	2,091	19,0		1,76	95,55%	
07/03/2013	A2174	129,4	24 460	401,4	200,6	145,5	Léger collage supérieur	2,088	19,0		1,75	95,20%	
07/03/2013	A2175	129,6	24 480	401,2	200,6	145,8	Léger collage supérieur	2,087	19,0		1,75	95,04%	
07/03/2013	A2176	129,6	24 440	401,2	200,4	145,5	Léger collage supérieur	2,089	19,0		1,76	95,41%	
07/03/2013	A2177	129,4	24 480	401,1	200,5	145,7	Léger collage supérieur	2,089	19,0		1,76	95,35%	
07/03/2013	A2178	130,9	24 480	401,2	200,3	145,4	Léger collage supérieur	2,095	19,0		1,76	96,19%	
07/03/2013	A2179	129,4	24 440	401,2	200,2	145,2	Léger collage supérieur	2,096	19,0		1,76	96,24%	
05/03/2014	A218	130,4	24 020	401,1	200,6	144,9		2,061	19,0		1,73	91,74%	
07/03/2013	A2180	129,6	24 440	401,3	200,2	145,3	Léger collage supérieur	2,094	19,0		1,76	95,96%	
07/03/2013	A2181	129,8	24 480	401,2	200,3	145,5		2,094	19,0		1,76	96,01%	
07/03/2013	A2182	129,5	24 460	401,1	200,6	145,0		2,097	19,0		1,76	96,41%	
07/03/2013	A2183	129,5	24 520	401,3	200,4	145,3		2,099	19,0		1,76	96,64%	
07/03/2013	A2184	129,6	24 420	401,3	200,4	144,8		2,097	19,0		1,76	96,39%	
07/03/2013	A2185	129,3	24 480	401,3	200,2	145,0		2,102	19,0		1,77	97,05%	
07/03/2013	A2186	129,5	24 440	401,2	200,2	145,3		2,095	19,0		1,76	96,10%	
07/03/2013	A2187	129,6	24 420	401,1	200,5	145,6		2,085	19,0		1,75	94,80%	
07/03/2013	A2188	129,7	24 520	401,2	200,3	145,4	Léger collage supérieur	2,099	19,0		1,76	96,66%	
07/03/2013	A2189	129,4	24 480	401,5	200,2	145,3	Léger collage supérieur	2,097	19,0		1,76	96,34%	
05/03/2014	A219	129,0	24 020	401,3	200,4	144,4		2,069	19,0		1,74	92,73%	
07/03/2013	A2190	129,6	24 480	401,2	200,4	145,4	Léger collage supérieur	2,095	19,0		1,76	96,08%	
07/03/2013	A2191	129,5	24 480	401,3	200,3	145,3	Léger collage supérieur	2,097	19,0		1,76	96,34%	
07/03/2013	A2192	129,6	24 520	401,3	200,5	145,9	Léger collage supérieur	2,089	19,0		1,76	95,32%	
07/03/2013	A2193	129,4	24 440	401,2	200,5	145,5	Léger collage supérieur	2,089	19,0		1,76	95,29%	
07/03/2013	A2194	129,4	24 520	401,3	200,4	145,4	Léger collage supérieur	2,098	19,0		1,76	96,54%	
07/03/2013	A2195	129,4	24 520	401,4	200,4	145,4	Léger collage supérieur	2,096	19,0		1,76	96,24%	
07/03/2013	A2196	131,0	24 500	401,5	200,4	145,2	Léger collage supérieur	2,098	19,0		1,76	96,51%	
07/03/2013	A2197	129,6	24 580	401,4	200,6	145,9	Léger collage supérieur	2,092	19,0		1,76	95,76%	
07/03/2013	A2198	129,7	24 500	401,2	200,7	145,4	Léger collage supérieur	2,093	19,0		1,76	95,85%	
07/03/2013	A2199	129,4	24 520	401,2	200,6	145,8	Léger collage supérieur	2,089	19,0		1,76	95,37%	
05/03/2014	A22	131,4	24 500	401,4	200,3	145,2		2,099	19,0		1,76	96,63%	
05/03/2014	A220	128,9	24 020	401,3	200,6	144,8		2,061	19,0		1,73	91,80%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
07/03/2013	A2200	129,5	24 480	401,3	200,4	145,4		2,095	19,0		1,76	96,08%	
07/03/2013	A2201	129,7	24 500	401,3	200,5	145,5		2,093	19,0		1,76	95,82%	
07/03/2013	A2202	129,5	24 480	401,3	200,4	145,4		2,095	19,0		1,76	96,09%	
07/03/2013	A2203	129,4	24 520	401,3	200,5	145,7		2,092	19,0		1,76	95,72%	
07/03/2013	A2204	129,9	24 480	401,4	200,5	145,3		2,094	19,0		1,76	95,98%	
07/03/2013	A2205	129,6	24 480	401,2	200,5	145,4		2,093	19,0		1,76	95,89%	
07/03/2013	A2206	129,6	24 440	401,3	200,2	145,2		2,095	19,0		1,76	96,18%	
07/03/2013	A2207	129,7	24 460	401,2	200,3	145,3		2,094	19,0		1,76	96,00%	
07/03/2013	A2208	129,6	24 480	401,2	200,2	145,3		2,098	19,0		1,76	96,51%	
07/03/2013	A2209	129,4	24 480	401,1	200,5	145,4		2,092	19,0		1,76	95,79%	
05/03/2014	A221	129,0	24 020	401,1	200,5	144,5		2,067	19,0		1,74	92,53%	
07/03/2013	A2210	129,6	24 480	401,3	200,4	145,6		2,090	19,0		1,76	95,51%	
07/03/2013	A2211	129,7	24 480	401,2	200,5	145,7		2,089	19,0		1,76	95,29%	
07/03/2013	A2212	131,0	24 480	401,3	200,2	145,3		2,097	19,0		1,76	96,40%	
07/03/2013	A2213	130,9	24 480	401,5	200,3	145,2		2,097	19,0		1,76	96,41%	
07/03/2013	A2214	129,6	24 460	401,6	200,4	145,4		2,091	19,0		1,76	95,61%	
07/03/2013	A2215	129,8	24 480	401,1	200,3	145,5		2,094	19,0		1,76	96,06%	
07/03/2013	A2216	129,4	24 460	401,2	200,2	145,1		2,099	19,0		1,76	96,72%	
07/03/2013	A2217	129,7	24 440	401,2	200,2	145,1		2,097	19,0		1,76	96,46%	
07/03/2013	A2218	129,5	24 520	401,3	200,5	145,8		2,090	19,0		1,76	95,52%	
07/03/2013	A2219	129,5	24 560	401,5	200,6	146,1		2,087	19,0		1,75	95,10%	
05/03/2014	A222	128,9	24 000	401,2	200,4	144,7		2,062	19,0		1,73	91,96%	
07/03/2013	A2220	129,4	24 520	401,3	200,4	146,0		2,089	19,0		1,76	95,31%	
07/03/2013	A2221	129,5	24 540	401,2	200,4	145,2		2,102	19,0		1,77	97,00%	
07/03/2013	A2222	129,5	24 540	401,2	200,4	146,0		2,092	19,0		1,76	95,72%	
07/03/2013	A2223	129,5	24 600	401,3	200,3	145,6		2,103	19,0		1,77	97,14%	
07/03/2013	A2224	129,4	24 560	401,4	200,6	145,9		2,092	19,0		1,76	95,71%	
07/03/2013	A2225	129,5	24 560	401,5	200,8	145,9		2,088	19,0		1,75	95,20%	
07/03/2013	A2226	129,7	24 600	401,3	200,5	145,8		2,096	19,0		1,76	96,27%	
07/03/2013	A2227	129,5	24 560	401,4	200,4	145,4		2,100	19,0		1,76	96,77%	
07/03/2013	A2228	129,5	24 520	401,2	200,6	145,7		2,091	19,0		1,76	95,61%	
07/03/2013	A2229	129,6	24 580	401,3	200,7	146,0	Léger collage supérieur	2,090	19,0		1,76	95,52%	
05/03/2014	A223	128,9	24 120	401,2	200,5	145,1		2,067	19,0		1,74	92,58%	
07/03/2013	A2230	129,7	24 480	401,4	200,7	145,6	Léger collage supérieur	2,087	19,0		1,75	95,08%	
07/03/2013	A2231	129,4	24 540	401,4	200,8	146,1	Léger collage supérieur	2,084	19,0		1,75	94,68%	
07/03/2013	A2232	129,4	24 600	401,2	200,7	145,6	Léger collage supérieur	2,098	19,0		1,76	96,57%	
07/03/2013	A2233	129,4	24 580	401,3	200,6	145,3	Léger collage supérieur	2,101	19,0		1,77	96,98%	
07/03/2013	A2234	129,5	24 620	401,1	200,4	145,8	Léger collage supérieur	2,101	19,0		1,77	96,90%	
07/03/2013	A2235	129,7	24 500	401,2	200,4	145,0	Léger collage supérieur	2,102	19,0		1,77	97,00%	
07/03/2013	A2236	129,5	24 580	401,2	200,4	145,7	Léger collage supérieur	2,098	19,0		1,76	96,56%	
07/03/2013	A2237	129,4	24 520	401,2	200,3	145,5	Léger collage supérieur	2,097	19,0		1,76	96,41%	
07/03/2013	A2238	129,5	24 580	401,3	200,2	145,5	Léger collage supérieur	2,103	19,0		1,77	97,16%	
07/03/2013	A2239	129,7	24 540	401,3	200,3	145,5	Léger collage supérieur	2,098	19,0		1,76	96,56%	
05/03/2014	A224	129,2	23 980	401,1	200,5	144,5		2,064	19,0		1,73	92,21%	
07/03/2013	A2240	129,7	24 520	401,3	200,4	145,5	Léger collage supérieur	2,096	19,0		1,76	96,20%	
07/03/2013	A2241	129,5	24 560	401,2	200,3	145,6	Léger collage supérieur	2,099	19,0		1,76	96,67%	
07/03/2013	A2242	129,6	24 580	401,2	200,4	146,1	Léger collage supérieur	2,093	19,0		1,76	95,81%	
07/03/2013	A2243	129,5	24 560	401,5	200,4	146,0	Léger collage supérieur	2,091	19,0		1,76	95,57%	
07/03/2013	A2244	130,9	24 540	401,3	200,2	145,5	Léger collage supérieur	2,099	19,0		1,76	96,70%	
07/03/2013	A2245	129,5	24 540	401,3	200,3	145,5	Léger collage supérieur	2,098	19,0		1,76	96,56%	
07/03/2013	A2246	130,9	24 580	401,4	200,3	145,6	Léger collage supérieur	2,100	19,0		1,76	96,76%	
07/03/2013	A2247	129,4	24 500	401,3	200,2	145,3	Léger collage supérieur	2,099	19,0		1,76	96,63%	
07/03/2013	A2248	129,6	24 420	401,0	200,2	145,3		2,093	19,0		1,76	95,93%	
07/03/2013	A2249	129,4	24 440	400,8	200,2	145,2		2,098	19,0		1,76	96,49%	
05/03/2014	A225	130,4	24 060	401,2	200,6	144,4		2,070	19,0		1,74	92,94%	
07/03/2013	A2250	129,3	24 420	401,0	200,4	145,2		2,093	19,0		1,76	95,85%	
07/03/2013	A2251	129,7	24 420	401,0	200,2	145,1		2,096	19,0		1,76	96,31%	
07/03/2013	A2252	129,4	24 420	401,1	200,4	145,5		2,088	19,0		1,75	95,21%	
07/03/2013	A2253	129,5	24 480	401,1	200,5	145,7		2,089	19,0		1,76	95,37%	
07/03/2013	A2254	129,7	24 520	401,2	200,3	145,4		2,099	19,0		1,76	96,60%	
07/03/2013	A2255	129,6	24 520	401,3	200,4	145,5		2,096	19,0		1,76	96,20%	
07/03/2013	A2256	129,4	24 500	401,3	200,4	145,3		2,097	19,0		1,76	96,35%	
07/03/2013	A2257	129,4	24 500	401,3	200,3	145,4		2,096	19,0		1,76	96,30%	
07/03/2013	A2258	129,7	24 480	401,2	200,3	145,3		2,097	19,0		1,76	96,33%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
07/03/2013	**A2259**	129,4	24 500	401,2	200,5	145,5		**2,093**	19,0		1,76	95,90%	
05/03/2014	**A226**	130,3	24 100	401,2	200,6	144,9		**2,066**	19,0		1,74	92,43%	
07/03/2013	**A2260**	129,6	24 500	401,2	200,2	145,4		**2,098**	19,0		1,76	96,51%	
07/03/2013	**A2261**	129,5	24 520	401,2	200,2	145,4		**2,100**	19,0		1,76	96,74%	
07/03/2013	**A2262**	129,7	24 500	401,1	200,3	145,2		**2,100**	19,0		1,76	96,82%	
07/03/2013	**A2263**	130,8	24 520	401,2	200,4	145,4		**2,097**	19,0		1,76	96,46%	
07/03/2013	**A2264**	129,6	24 500	401,1	200,4	145,6		**2,093**	19,0		1,76	95,92%	
07/03/2013	**A2265**	129,4	24 560	401,1	200,4	145,8		**2,096**	19,0		1,76	96,22%	
07/03/2013	**A2266**	129,7	24 540	401,2	200,2	145,2		**2,104**	19,0		1,77	97,35%	
07/03/2013	**A2267**	129,4	24 580	401,2	200,2	145,6		**2,102**	19,0		1,77	97,04%	
07/03/2013	**A2268**	129,5	24 540	401,1	200,2	145,2		**2,105**	19,0		1,77	97,42%	
07/03/2013	**A2269**	129,4	24 560	401,2	200,3	145,4		**2,102**	19,0		1,77	97,05%	
05/03/2014	**A227**	129,0	24 080	401,2	200,6	144,8	Léger collage supérieur	**2,066**	19,0		1,74	92,45%	
07/03/2013	**A2270**	129,5	24 520	401,2	200,5	145,6		**2,094**	19,0		1,76	95,94%	
07/03/2013	**A2271**	129,3	24 580	401,3	200,4	145,9		**2,095**	19,0		1,76	96,11%	
07/03/2013	**A2272**	129,5	24 560	401,1	200,4	145,5		**2,100**	19,0		1,76	96,79%	
07/03/2013	**A2273**	129,4	24 520	401,1	200,3	145,4		**2,099**	19,0		1,76	96,67%	
07/03/2013	**A2274**	129,5	24 540	401,1	200,2	145,7		**2,097**	19,0		1,76	96,46%	
07/03/2013	**A2275**	129,5	24 560	401,2	200,2	145,5		**2,102**	19,0		1,77	97,00%	
07/03/2013	**A2276**	129,6	24 520	401,0	200,5	145,6		**2,095**	19,0		1,76	96,08%	
07/03/2013	**A2277**	129,7	24 560	401,1	200,5	145,3		**2,102**	19,0		1,77	97,04%	
07/03/2013	**A2278**	129,5	24 520	401,1	200,5	145,7		**2,093**	19,0		1,76	95,82%	
07/03/2013	**A2279**	129,9	24 580	401,3	200,5	146,1		**2,091**	19,0		1,76	95,60%	
05/03/2014	**A228**	128,9	24 120	401,2	200,7	144,5	Léger collage supérieur	**2,073**	19,0		1,74	93,30%	
07/03/2013	**A2280**	129,4	24 560	401,1	200,3	145,6		**2,100**	19,0		1,76	96,74%	
07/03/2013	**A2281**	129,4	24 520	401,2	200,3	145,4		**2,099**	19,0		1,76	96,60%	
07/03/2013	**A2282**	129,6	24 580	401,2	200,4	145,7		**2,098**	19,0		1,76	96,56%	
07/03/2013	**A2283**	129,5	24 540	401,2	200,4	145,5		**2,098**	19,0		1,76	96,49%	
07/03/2013	**A2284**	129,4	24 560	401,2	200,3	145,5		**2,101**	19,0		1,77	96,86%	
07/03/2013	**A2285**	129,4	24 580	401,3	200,3	145,5		**2,102**	19,0		1,77	97,02%	
07/03/2013	**A2286**	129,7	24 540	401,3	200,3	145,4		**2,100**	19,0		1,76	96,75%	
07/03/2013	**A2287**	129,3	24 600	401,2	200,7	145,6		**2,098**	19,0		1,76	96,57%	
07/03/2013	**A2288**	129,7	24 560	401,3	200,5	145,8		**2,094**	19,0		1,76	95,94%	
07/03/2013	**A2289**	129,6	24 540	401,0	200,6	145,8		**2,092**	19,0		1,76	95,79%	
05/03/2014	**A229**	129,1	24 540	401,9	201,1	144,6	Léger collage supérieur	**2,100**	19,0		1,76	96,77%	
07/03/2013	**A2290**	129,7	24 580	401,1	200,7	145,8		**2,094**	19,0		1,76	96,03%	
07/03/2013	**A2291**	129,4	24 520	401,1	200,4	145,6		**2,095**	19,0		1,76	96,15%	
07/03/2013	**A2292**	129,6	24 560	401,1	200,2	145,5		**2,102**	19,0		1,77	97,07%	
07/03/2013	**A2293**	129,5	24 600	401,2	200,2	145,6		**2,104**	19,0		1,77	97,26%	
07/03/2013	**A2294**	129,5	24 580	401,4	200,4	145,5		**2,100**	19,0		1,76	96,81%	
07/03/2013	**A2295**	129,5	24 580	401,1	200,4	145,5		**2,102**	19,0		1,77	97,02%	
07/03/2013	**A2296**	129,7	24 580	401,2	200,5	145,7	Léger collage supérieur	**2,097**	19,0		1,76	96,43%	
07/03/2013	**A2297**	129,2	24 520	401,3	200,4	145,4	Léger collage supérieur	**2,097**	19,0		1,76	96,39%	
07/03/2013	**A2298**	129,6	24 580	401,3	200,3	145,6	Léger collage supérieur	**2,100**	19,0		1,76	96,83%	
07/03/2013	**A2299**	129,6	24 560	401,2	200,3	145,5	Léger collage supérieur	**2,101**	19,0		1,77	96,86%	
05/03/2014	**A23**	129,9	24 540	401,1	200,4	146,1		**2,090**	19,0		1,76	95,46%	
05/03/2014	**A230**	128,9	24 500	401,8	201,1	144,7	Léger collage supérieur	**2,096**	19,0		1,76	96,25%	
07/03/2013	**A2300**	129,6	24 520	401,2	200,5	145,7	Léger collage supérieur	**2,092**	19,0		1,76	95,75%	
07/03/2013	**A2301**	129,6	24 560	401,2	200,6	145,8	Léger collage supérieur	**2,093**	19,0		1,76	95,87%	
07/03/2013	**A2302**	129,6	24 560	401,1	200,5	145,8	Léger collage supérieur	**2,095**	19,0		1,76	96,08%	
07/03/2013	**A2303**	129,4	24 520	401,2	200,5	145,7	Léger collage supérieur	**2,092**	19,0		1,76	95,75%	
07/03/2013	**A2304**	129,7	24 500	401,1	200,3	145,2	Léger collage supérieur	**2,100**	19,0		1,76	96,82%	
07/03/2013	**A2305**	129,4	24 560	401,2	200,4	145,5	Léger collage supérieur	**2,099**	19,0		1,76	96,72%	
07/03/2013	**A2306**	129,7	24 620	401,3	200,3	145,7	Léger collage supérieur	**2,102**	19,0		1,77	97,09%	
07/03/2013	**A2307**	129,6	24 520	401,3	200,2	145,4	Léger collage supérieur	**2,099**	19,0		1,76	96,67%	
07/03/2013	**A2308**	129,6	24 400	400,7	200,2	145,1		**2,097**	19,0		1,76	96,46%	
07/03/2013	**A2309**	129,4	24 420	400,8	200,2	144,7		**2,103**	19,0		1,77	97,26%	
05/03/2014	**A231**	129,1	24 520	401,8	201,1	145,1	Léger collage supérieur	**2,091**	19,0		1,76	95,60%	
07/03/2013	**A2310**	131,1	24 480	400,8	200,3	145,5		**2,095**	19,0		1,76	96,19%	
07/03/2013	**A2311**	129,4	24 420	400,5	200,5	145,2		**2,095**	19,0		1,76	96,11%	
07/03/2013	**A2312**	129,6	24 440	400,6	200,3	145,7		**2,090**	19,0		1,76	95,42%	
07/03/2013	**A2313**	129,5	24 400	400,9	200,1	144,9		**2,099**	19,0		1,76	96,68%	
07/03/2013	**A2314**	129,7	24 400	401,1	200,4	145,0		**2,094**	19,0		1,76	95,98%	
07/03/2013	**A2315**	129,6	24 520	400,9	200,6	145,7		**2,093**	19,0		1,76	95,90%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Resistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
07/03/2013	**A2316**	129,5	24 480	401,1	200,5	145,2		**2,097**	19,0		1,76	96,37%	
07/03/2013	**A2317**	129,4	24 440	401,1	200,5	145,3		**2,092**	19,0		1,76	95,72%	
07/03/2013	**A2318**	129,6	24 440	401,4	200,5	145,0		**2,094**	19,0		1,76	96,04%	
07/03/2013	**A2319**	129,5	24 460	401,1	200,3	145,4		**2,094**	19,0		1,76	96,06%	
05/03/2014	**A232**	128,9	24 620	401,9	201,1	144,9	Léger collage supérieur	**2,101**	19,0		1,77	96,96%	
07/03/2013	**A2320**	129,4	24 480	400,7	200,3	145,0		**2,103**	19,0		1,77	97,23%	
07/03/2013	**A2321**	129,7	24 500	400,8	200,2	144,8		**2,108**	19,0		1,77	97,85%	
07/03/2013	**A2322**	129,5	24 500	401,1	200,3	145,2		**2,101**	19,0		1,77	96,90%	
07/03/2013	**A2323**	129,7	24 400	401,5	200,5	145,2		**2,087**	19,0		1,75	95,14%	
07/03/2013	**A2324**	129,5	24 500	401,0	200,5	145,3		**2,099**	19,0		1,76	96,61%	
07/03/2013	**A2325**	129,6	24 440	400,8	200,5	145,1		**2,096**	19,0		1,76	96,28%	
07/03/2013	**A2326**	129,4	24 560	401,3	200,4	145,3		**2,102**	19,0		1,77	97,09%	
07/03/2013	**A2327**	129,4	24 420	401,1	200,5	145,0		**2,094**	19,0		1,76	96,04%	
07/03/2013	**A2328**	129,5	24 460	401,1	200,5	145,3		**2,094**	19,0		1,76	96,01%	
07/03/2013	**A2329**	129,4	24 480	401,2	200,4	145,4		**2,094**	19,0		1,76	96,00%	
05/03/2014	**A233**	129,2	24 640	402,0	200,9	145,4	Léger collage supérieur	**2,099**	19,0		1,76	96,60%	
07/03/2013	**A2330**	129,6	24 480	401,1	200,4	145,4		**2,096**	19,0		1,76	96,21%	
07/03/2013	**A2331**	129,6	24 380	401,0	200,4	144,6		**2,099**	19,0		1,76	96,66%	
07/03/2013	**A2332**	129,5	24 460	400,9	200,3	145,0		**2,101**	19,0		1,77	96,89%	
07/03/2013	**A2333**	129,7	24 400	400,9	200,2	144,6		**2,102**	19,0		1,77	97,12%	
07/03/2013	**A2334**	129,5	24 400	401,1	200,3	145,0		**2,094**	19,0		1,76	95,97%	
07/03/2013	**A2335**	129,5	24 400	401,1	200,3	145,1		**2,093**	19,0		1,76	95,85%	
07/03/2013	**A2336**	129,7	24 420	401,0	200,3	145,1		**2,095**	19,0		1,76	96,18%	
07/03/2013	**A2337**	129,6	24 400	401,0	200,3	145,3		**2,091**	19,0		1,76	95,59%	
07/03/2013	**A2338**	129,6	24 560	401,0	200,3	144,9		**2,110**	19,0		1,77	98,11%	
07/03/2013	**A2339**	129,4	24 500	401,0	200,3	145,6	Léger collage supérieur	**2,095**	19,0		1,76	96,11%	
05/03/2014	**A234**	129,0	24 620	401,9	201,0	145,2	Léger collage supérieur	**2,100**	19,0		1,76	96,75%	
07/03/2013	**A2340**	129,4	24 440	400,6	200,2	145,1	Léger collage supérieur	**2,101**	19,0		1,77	96,92%	
07/03/2013	**A2341**	129,5	24 440	400,6	200,1	145,1	Léger collage supérieur	**2,102**	19,0		1,77	97,05%	
07/03/2013	**A2342**	129,6	24 420	400,8	200,2	144,8	Léger collage supérieur	**2,102**	19,0		1,77	97,04%	
07/03/2013	**A2343**	129,7	24 460	400,8	200,1	145,1	Léger collage supérieur	**2,102**	19,0		1,77	97,10%	
07/03/2013	**A2344**	129,5	24 420	401,3	200,5	145,1	Léger collage supérieur	**2,093**	19,0		1,76	95,80%	
07/03/2013	**A2345**	129,4	24 440	401,2	200,4	145,4	Léger collage supérieur	**2,091**	19,0		1,76	95,55%	
07/03/2013	**A2346**	129,4	24 440	401,2	200,5	145,7	Léger collage supérieur	**2,085**	19,0		1,75	94,88%	
07/03/2013	**A2347**	129,6	24 500	401,1	200,5	145,6	Léger collage supérieur	**2,093**	19,0		1,76	95,88%	
07/03/2013	**A2348**	129,6	24 560	401,1	200,6	145,4	Léger collage supérieur	**2,099**	19,0		1,76	96,62%	
07/03/2013	**A2349**	129,5	24 460	401,2	200,5	145,6	Léger collage supérieur	**2,089**	19,0		1,76	95,38%	
05/03/2014	**A235**	128,9	24 580	401,9	201,1	145,3	Léger collage supérieur	**2,094**	19,0		1,76	96,01%	
07/03/2013	**A2350**	129,5	24 420	401,2	200,5	145,2	Léger collage supérieur	**2,092**	19,0		1,76	95,74%	
07/03/2013	**A2351**	130,9	24 400	401,0	200,4	145,0	Léger collage supérieur	**2,094**	19,0		1,76	95,95%	
07/03/2013	**A2352**	129,5	24 440	401,1	200,5	145,2	Léger collage supérieur	**2,094**	19,0		1,76	95,94%	
07/03/2013	**A2353**	129,4	24 460	401,0	200,3	145,4	Léger collage supérieur	**2,094**	19,0		1,76	96,01%	
07/03/2013	**A2354**	129,4	24 340	401,0	200,1	144,6	Léger collage supérieur	**2,097**	19,0		1,76	96,44%	
07/03/2013	**A2355**	129,5	24 400	401,0	200,2	144,8	Léger collage supérieur	**2,098**	19,0		1,76	96,55%	
07/03/2013	**A2356**	129,4	24 440	401,3	200,6	145,2	Léger collage supérieur	**2,091**	19,0		1,76	95,59%	
07/03/2013	**A2357**	129,6	24 420	401,2	200,4	145,3	Léger collage supérieur	**2,091**	19,0		1,76	95,55%	
07/03/2013	**A2358**	129,5	24 400	401,0	200,5	145,6		**2,085**	19,0		1,75	94,83%	
07/03/2013	**A2359**	129,6	24 460	401,9	200,5	145,3		**2,090**	19,0		1,76	95,47%	
05/03/2014	**A236**	128,9	24 600	401,8	200,9	145,4	Léger collage supérieur	**2,096**	19,0		1,76	96,25%	
07/03/2013	**A2360**	129,6	24 460	401,2	200,5	145,6		**2,088**	19,0		1,75	95,23%	
07/03/2013	**A2361**	129,4	24 460	401,2	200,5	145,2		**2,094**	19,0		1,76	96,01%	
07/03/2013	**A2362**	129,5	24 480	401,5	200,5	145,1		**2,096**	19,0		1,76	96,30%	
07/03/2013	**A2363**	129,4	24 480	400,8	200,4	145,3		**2,097**	19,0		1,76	96,40%	
07/03/2013	**A2364**	129,4	24 400	400,9	200,4	145,4		**2,088**	19,0		1,75	95,22%	
07/03/2013	**A2365**	129,5	24 420	401,0	200,4	145,3		**2,092**	19,0		1,76	95,79%	
07/03/2013	**A2366**	129,5	24 460	400,9	200,2	145,0		**2,101**	19,0		1,77	96,98%	
07/03/2013	**A2367**	129,6	24 440	400,6	200,3	145,0		**2,101**	19,0		1,77	96,86%	
07/03/2013	**A2368**	129,5	24 480	400,9	200,2	145,3	Léger collage supérieur	**2,099**	19,0		1,76	96,64%	
07/03/2013	**A2369**	129,4	24 400	400,7	200,2	144,8	Léger collage supérieur	**2,100**	19,0		1,76	96,83%	
05/03/2014	**A237**	128,9	24 560	401,9	201,1	145,2	Léger collage supérieur	**2,092**	19,0		1,76	95,76%	
07/03/2013	**A2370**	129,9	24 440	401,0	200,4	145,3	Léger collage supérieur	**2,093**	19,0		1,76	95,93%	
07/03/2013	**A2371**	129,4	24 480	401,1	200,3	145,5	Léger collage supérieur	**2,094**	19,0		1,76	96,05%	
07/03/2013	**A2372**	129,6	24 480	400,9	200,2	145,4	Léger collage supérieur	**2,098**	19,0		1,76	96,47%	
07/03/2013	**A2373**	129,6	24 420	400,9	200,2	144,9	Léger collage supérieur	**2,099**	19,0		1,76	96,71%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
07/03/2013	**A2374**	130,9	24 440	401,0	200,4	145,0	Léger collage supérieur	**2,099**	19,0		1,76	96,61%	
07/03/2013	**A2375**	129,7	24 440	401,0	200,3	145,3	Léger collage supérieur	**2,094**	19,0		1,76	95,98%	
07/03/2013	**A2376**	129,7	24 420	400,9	200,5	145,2	Léger collage supérieur	**2,092**	19,0		1,76	95,76%	
07/03/2013	**A2377**	129,4	24 420	400,8	200,4	145,4	Léger collage supérieur	**2,091**	19,0		1,76	95,58%	
07/03/2013	**A2378**	129,6	24 460	401,0	200,3	145,1	Léger collage supérieur	**2,098**	19,0		1,76	96,56%	
07/03/2013	**A2379**	129,4	24 440	401,1	200,4	145,1	Léger collage supérieur	**2,096**	19,0		1,76	96,22%	
05/03/2014	**A238**	128,8	24 580	401,8	201,1	145,1	Léger collage supérieur	**2,096**	19,0		1,76	96,32%	
07/03/2013	**A2380**	129,5	24 460	401,1	200,4	145,1	Léger collage supérieur	**2,098**	19,0		1,76	96,47%	
07/03/2013	**A2381**	129,4	24 420	401,3	200,5	145,2	Léger collage supérieur	**2,091**	19,0		1,76	95,55%	
07/03/2013	**A2382**	129,4	24 460	400,9	200,4	145,3	Léger collage supérieur	**2,096**	19,0		1,76	96,27%	
07/03/2013	**A2383**	129,5	24 500	401,1	200,3	145,3	Léger collage supérieur	**2,099**	19,0		1,76	96,64%	
07/03/2013	**A2384**	129,4	24 460	400,8	200,4	145,1	Léger collage supérieur	**2,099**	19,0		1,76	96,61%	
07/03/2013	**A2385**	129,4	24 440	401,0	200,5	145,2	Léger collage supérieur	**2,094**	19,0		1,76	96,00%	
07/03/2013	**A2386**	129,4	24 400	401,0	200,4	144,8		**2,097**	19,0		1,76	96,37%	
07/03/2013	**A2387**	129,6	24 480	401,1	200,5	145,9		**2,086**	19,0		1,75	94,98%	
07/03/2013	**A2388**	129,5	24 420	401,1	200,4	145,0		**2,096**	19,0		1,76	96,23%	
07/03/2013	**A2389**	129,8	24 460	401,1	200,4	145,3		**2,094**	19,0		1,76	96,04%	
05/03/2014	**A239**	128,7	24 580	401,9	201,2	145,5	Léger collage supérieur	**2,089**	19,0		1,76	95,40%	
07/03/2013	**A2390**	129,5	24 420	401,2	200,5	145,2		**2,092**	19,0		1,76	95,69%	
07/03/2013	**A2391**	129,5	24 480	401,3	200,5	145,4		**2,093**	19,0		1,76	95,85%	
07/03/2013	**A2392**	129,6	24 420	401,2	200,6	145,1		**2,091**	19,0		1,76	95,61%	
07/03/2013	**A2393**	129,4	24 440	401,1	200,4	145,2		**2,094**	19,0		1,76	95,97%	
07/03/2013	**A2394**	129,7	24 520	401,3	200,4	145,0		**2,103**	19,0		1,77	97,16%	
07/03/2013	**A2395**	129,6	24 460	401,2	200,4	145,2		**2,095**	19,0		1,76	96,18%	
07/03/2013	**A2396**	129,4	24 500	401,1	200,2	145,2		**2,101**	19,0		1,77	96,97%	
07/03/2013	**A2397**	130,9	24 460	400,9	200,4	145,2		**2,097**	19,0		1,76	96,39%	
07/03/2013	**A2398**	129,6	24 500	400,9	200,3	145,2		**2,101**	19,0		1,77	96,97%	
07/03/2013	**A2399**	129,6	24 600	400,9	200,5	145,9		**2,098**	19,0		1,76	96,48%	
05/03/2014	**A24**	130,1	24 540	401,3	200,5	145,6		**2,095**	19,0		1,76	96,14%	
05/03/2014	**A240**	128,9	24 540	401,7	201,1	144,8	Léger collage supérieur	**2,098**	19,0		1,76	96,46%	
07/03/2013	**A2400**	130,9	24 560	400,7	200,3	145,1		**2,110**	19,0		1,77	98,13%	
07/03/2013	**A2401**	129,7	24 580	401,2	200,0	145,5	Léger collage supérieur	**2,105**	19,0		1,77	97,49%	
07/03/2013	**A2402**	129,4	24 560	401,0	200,3	145,9	Léger collage supérieur	**2,097**	19,0		1,76	96,39%	
07/03/2013	**A2403**	129,7	24 560	401,3	200,5	145,4	Léger collage supérieur	**2,100**	19,0		1,76	96,75%	
07/03/2013	**A2404**	129,5	24 480	401,0	200,4	145,9	Léger collage supérieur	**2,089**	19,0		1,76	95,29%	
07/03/2013	**A2405**	129,8	24 540	401,1	200,4	145,6	Léger collage supérieur	**2,097**	19,0		1,76	96,44%	
07/03/2013	**A2406**	129,4	24 460	401,1	200,4	145,7	Léger collage supérieur	**2,089**	19,0		1,76	95,33%	
07/03/2013	**A2407**	129,6	24 480	401,0	200,4	145,5	Léger collage supérieur	**2,094**	19,0		1,76	95,96%	
07/03/2013	**A2408**	129,5	24 460	401,2	200,4	145,3	Léger collage supérieur	**2,094**	19,0		1,76	96,06%	
07/03/2013	**A2409**	129,4	24 520	401,1	200,4	145,0	Léger collage supérieur	**2,103**	19,0		1,77	97,21%	
05/03/2014	**A241**	129,1	24 540	401,5	200,7	145,2	Léger collage supérieur	**2,098**	19,0		1,76	96,50%	
07/03/2013	**A2410**	129,5	24 540	401,2	200,2	145,5	Léger collage supérieur	**2,099**	19,0		1,76	96,71%	
07/03/2013	**A2411**	129,4	24 460	401,1	200,4	145,3	Léger collage supérieur	**2,095**	19,0		1,76	96,08%	
07/03/2013	**A2412**	129,4	24 500	401,0	200,4	145,5	Léger collage supérieur	**2,095**	19,0		1,76	96,09%	
07/03/2013	**A2413**	129,6	24 460	401,0	200,5	145,3	Léger collage supérieur	**2,094**	19,0		1,76	95,97%	
07/03/2013	**A2414**	129,5	24 500	401,1	200,3	145,3	Léger collage supérieur	**2,099**	19,0		1,76	96,66%	
07/03/2013	**A2415**	129,6	24 460	401,1	200,4	145,3	Léger collage supérieur	**2,093**	19,0		1,76	95,92%	
07/03/2013	**A2416**	129,4	24 520	401,2	200,4	145,0	Léger collage supérieur	**2,104**	19,0		1,77	97,31%	
07/03/2013	**A2417**	129,5	24 500	401,0	200,4	145,6	Léger collage supérieur	**2,094**	19,0		1,76	96,04%	
07/03/2013	**A2418**	129,7	24 440	401,0	200,4	145,2	Léger collage supérieur	**2,094**	19,0		1,76	96,01%	
07/03/2013	**A2419**	129,4	24 580	400,9	200,4	145,5	Léger collage supérieur	**2,102**	19,0		1,77	97,09%	
05/03/2014	**A242**	128,9	24 500	401,5	200,5	145,0	Léger collage supérieur	**2,098**	19,0		1,76	96,57%	
07/03/2013	**A2420**	129,4	24 440	401,1	200,4	145,3	Léger collage supérieur	**2,092**	19,0		1,76	95,76%	
07/03/2013	**A2421**	129,6	24 520	401,0	200,3	145,4	Léger collage supérieur	**2,099**	19,0		1,76	96,72%	
07/03/2013	**A2422**	129,4	24 440	401,1	200,3	145,2	Léger collage supérieur	**2,094**	19,0		1,76	96,03%	
07/03/2013	**A2423**	129,7	24 460	401,2	200,3	145,5	Léger collage supérieur	**2,091**	19,0		1,76	95,63%	
07/03/2013	**A2424**	129,4	24 440	401,2	200,6	145,3	Léger collage supérieur	**2,091**	19,0		1,76	95,64%	
07/03/2013	**A2425**	129,4	24 420	401,1	200,4	145,4	Léger collage supérieur	**2,089**	19,0		1,76	95,37%	
07/03/2013	**A2426**	130,9	24 440	401,2	201,5	145,2	Léger collage supérieur	**2,082**	19,0		1,75	94,40%	
07/03/2013	**A2427**	129,4	24 480	401,1	200,3	145,3	Léger collage supérieur	**2,097**	19,0		1,76	96,35%	
07/03/2013	**A2428**	129,6	24 600	401,0	200,2	145,3	Léger collage supérieur	**2,108**	19,0		1,77	97,92%	
07/03/2013	**A2429**	129,4	24 500	401,3	200,1	145,2	Léger collage supérieur	**2,102**	19,0		1,77	97,00%	
05/03/2014	**A243**	128,9	24 580	401,5	200,7	145,3	Léger collage supérieur	**2,099**	19,0		1,76	96,65%	
07/03/2013	**A2430**	129,5	24 540	400,9	200,3	145,7	Léger collage supérieur	**2,097**	19,0		1,76	96,42%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
07/03/2013	**A2431**	129,5	24 580	401,0	200,3	145,7	Léger collage supérieur	**2,100**	19,0		1,76	96,76%	
07/03/2013	**A2432**	129,4	24 520	401,0	200,2	145,8	Léger collage supérieur	**2,096**	19,0		1,76	96,25%	
07/03/2013	**A2433**	129,5	24 520	401,4	200,3	145,7	Léger collage supérieur	**2,093**	19,0		1,76	95,86%	
07/03/2013	**A2434**	129,5	24 500	401,3	200,3	145,3	Léger collage supérieur	**2,099**	19,0		1,76	96,61%	
07/03/2013	**A2435**	129,7	24 520	401,0	200,3	145,5	Léger collage supérieur	**2,099**	19,0		1,76	96,63%	
07/03/2013	**A2436**	129,5	24 520	401,5	200,5	145,5	Léger collage supérieur	**2,094**	19,0		1,76	95,98%	
07/03/2013	**A2437**	129,5	24 440	401,3	200,3	145,3	Léger collage supérieur	**2,093**	19,0		1,76	95,86%	
07/03/2013	**A2438**	129,3	24 560	401,2	200,3	145,4	Léger collage supérieur	**2,102**	19,0		1,77	97,02%	
07/03/2013	**A2439**	129,7	24 480	401,2	200,4	145,6	Léger collage supérieur	**2,092**	19,0		1,76	95,71%	
05/03/2014	**A244**	128,9	24 500	401,5	200,5	144,9	Léger collage supérieur	**2,101**	19,0		1,77	96,92%	
07/03/2013	**A2440**	129,4	24 500	401,1	200,3	145,3	Léger collage supérieur	**2,098**	19,0		1,76	96,50%	
07/03/2013	**A2441**	129,7	24 480	401,2	200,5	145,1	Léger collage supérieur	**2,097**	19,0		1,76	96,39%	
07/03/2013	**A2442**	129,4	24 500	401,2	200,4	145,5	Léger collage supérieur	**2,094**	19,0		1,76	96,04%	
07/03/2013	**A2443**	129,6	24 500	401,0	200,4	145,6	Léger collage supérieur	**2,094**	19,0		1,76	95,93%	
07/03/2013	**A2444**	129,6	24 480	400,9	200,3	145,6	Léger collage supérieur	**2,095**	19,0		1,76	96,13%	
07/03/2013	**A2445**	129,7	24 460	400,9	200,4	145,6	Léger collage supérieur	**2,092**	19,0		1,76	95,68%	
07/03/2013	**A2446**	129,6	24 460	401,1	200,4	145,1	Léger collage supérieur	**2,097**	19,0		1,76	96,42%	
07/03/2013	**A2447**	129,4	24 480	401,0	200,4	145,4	Léger collage supérieur	**2,095**	19,0		1,76	96,19%	
07/03/2013	**A2448**	129,7	24 420	401,0	200,5	145,1		**2,094**	19,0		1,76	95,94%	
07/03/2013	**A2449**	129,4	24 460	401,0	200,4	145,3		**2,095**	19,0		1,76	96,10%	
05/03/2014	**A245**	130,4	24 520	401,4	200,7	145,5	Léger collage supérieur	**2,091**	19,0		1,76	95,66%	
07/03/2013	**A2450**	129,4	24 500	401,0	200,5	145,3		**2,097**	19,0		1,76	96,39%	
07/03/2013	**A2451**	129,5	24 400	401,5	200,6	145,1		**2,088**	19,0		1,75	95,24%	
07/03/2013	**A2452**	129,4	24 460	400,8	200,3	145,2		**2,098**	19,0		1,76	96,53%	
07/03/2013	**A2453**	129,5	24 440	401,0	200,3	145,3		**2,094**	19,0		1,76	95,95%	
07/03/2013	**A2454**	129,6	24 460	401,0	200,4	145,3		**2,095**	19,0		1,76	96,18%	
07/03/2013	**A2455**	129,8	24 440	400,8	200,3	145,4		**2,094**	19,0		1,76	95,96%	
07/03/2013	**A2456**	129,5	24 400	401,0	200,2	145,0		**2,096**	19,0		1,76	96,24%	
07/03/2013	**A2457**	129,4	24 440	401,1	200,4	145,2		**2,095**	19,0		1,76	96,10%	
07/03/2013	**A2458**	130,9	24 400	401,0	200,2	144,9		**2,098**	19,0		1,76	96,57%	
07/03/2013	**A2459**	129,5	24 480	401,0	200,2	145,4		**2,098**	19,0		1,76	96,50%	
05/03/2014	**A246**	129,2	24 560	401,3	200,9	145,7	Léger collage supérieur	**2,091**	19,0		1,76	95,60%	
07/03/2013	**A2460**	129,4	24 460	400,9	200,2	145,4		**2,095**	19,0		1,76	96,19%	
07/03/2013	**A2461**	129,4	24 500	400,9	200,2	145,6		**2,097**	19,0		1,76	96,35%	
07/03/2013	**A2462**	129,5	24 440	401,6	200,5	145,4		**2,088**	19,0		1,75	95,16%	
07/03/2013	**A2463**	129,4	24 460	401,1	200,4	145,4		**2,093**	19,0		1,76	95,85%	
07/03/2013	**A2464**	129,4	24 460	401,2	200,4	145,4		**2,092**	19,0		1,76	95,77%	
07/03/2013	**A2465**	129,5	24 480	401,1	200,4	145,5		**2,093**	19,0		1,76	95,86%	
07/03/2013	**A2466**	129,4	24 480	401,0	200,5	145,2		**2,096**	19,0		1,76	96,29%	
07/03/2013	**A2467**	129,4	24 460	401,2	200,5	145,4		**2,092**	19,0		1,76	95,75%	
07/03/2013	**A2468**	129,4	24 460	400,9	200,3	145,3		**2,096**	19,0		1,76	96,22%	
07/03/2013	**A2469**	129,4	24 420	401,1	200,3	145,1		**2,095**	19,0		1,76	96,13%	
05/03/2014	**A247**	129,0	24 540	401,4	200,8	145,5	Léger collage supérieur	**2,093**	19,0		1,76	95,81%	
07/03/2013	**A2470**	129,6	24 440	400,9	200,4	145,2		**2,095**	19,0		1,76	96,17%	
07/03/2013	**A2471**	129,4	24 420	401,1	200,4	145,2		**2,092**	19,0		1,76	95,80%	
07/03/2013	**A2472**	129,5	24 440	401,0	200,4	145,2		**2,094**	19,0		1,76	96,04%	
07/03/2013	**A2473**	129,7	24 460	401,1	200,3	145,4		**2,094**	19,0		1,76	96,01%	
07/03/2013	**A2474**	129,4	24 460	401,0	200,3	144,9		**2,102**	19,0		1,77	97,09%	
07/03/2013	**A2475**	129,4	24 440	400,9	200,5	145,1		**2,095**	19,0		1,76	96,19%	
07/03/2013	**A2476**	129,4	24 440	401,3	200,5	145,1		**2,094**	19,0		1,76	96,00%	
07/03/2013	**A2477**	129,5	24 520	401,0	200,5	145,7		**2,094**	19,0		1,76	96,01%	
07/03/2013	**A2478**	129,4	24 480	401,0	200,5	145,1		**2,099**	19,0		1,76	96,61%	
07/03/2013	**A2479**	129,5	24 440	400,9	200,6	145,4		**2,090**	19,0		1,76	95,50%	
05/03/2014	**A248**	128,9	24 580	401,4	200,6	145,5	Léger collage supérieur	**2,097**	19,0		1,76	96,44%	
07/03/2013	**A2480**	129,4	24 460	401,1	200,4	145,2		**2,095**	19,0		1,76	96,18%	
07/03/2013	**A2481**	129,6	24 480	401,4	200,4	145,4		**2,094**	19,0		1,76	95,98%	
07/03/2013	**A2482**	129,7	24 480	401,3	200,4	145,6		**2,092**	19,0		1,76	95,68%	
07/03/2013	**A2483**	129,5	24 460	401,2	200,5	145,3		**2,093**	19,0		1,76	95,90%	
07/03/2013	**A2484**	129,5	24 420	401,7	200,5	145,3		**2,087**	19,0		1,75	95,07%	
07/03/2013	**A2485**	129,5	24 480	401,2	200,6	145,6		**2,090**	19,0		1,76	95,43%	
07/03/2013	**A2486**	129,5	24 420	401,0	200,4	145,0		**2,096**	19,0		1,76	96,20%	
07/03/2013	**A2487**	129,4	24 420	401,0	200,4	145,2		**2,094**	19,0		1,76	95,98%	
05/03/2014	**A249**	129,1	24 600	401,5	200,7	145,6	Léger collage supérieur	**2,097**	19,0		1,76	96,36%	
05/03/2014	**A25**	129,9	24 520	401,4	200,5	145,5		**2,095**	19,0		1,76	96,13%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A250**	128,9	24 480	401,6	200,7	144,8	Léger collage supérieur	**2,097**	19,0		1,76	96,45%	
05/03/2014	**A251**	128,9	24 580	401,7	200,8	145,6	Léger collage supérieur	**2,093**	19,0		1,76	95,93%	
05/03/2014	**A252**	128,9	24 560	401,7	200,8	145,4	Léger collage supérieur	**2,095**	19,0		1,76	96,18%	
05/03/2014	**A253**	128,9	24 580	401,7	200,8	145,6	Léger collage supérieur	**2,094**	19,0		1,76	95,95%	
05/03/2014	**A254**	128,9	24 540	401,5	200,8	145,5	Léger collage supérieur	**2,093**	19,0		1,76	95,81%	
05/03/2014	**A255**	128,9	24 540	401,8	200,8	145,1	Léger collage supérieur	**2,097**	19,0		1,76	96,34%	
05/03/2014	**A256**	128,9	24 600	401,8	200,8	146,0	Léger collage supérieur	**2,088**	19,0		1,75	95,21%	
05/03/2014	**A257**	129,2	24 560	401,7	201,0	145,6	Léger collage supérieur	**2,089**	19,0		1,76	95,39%	
05/03/2014	**A258**	128,9	24 560	402,0	201,0	144,8	Léger collage supérieur	**2,099**	19,0		1,76	96,62%	
05/03/2014	**A259**	129,6	24 640	401,8	201,0	145,5	Léger collage supérieur	**2,097**	19,0		1,76	96,39%	
05/03/2014	**A26**	131,3	24 420	401,2	200,7	144,9		**2,092**	19,0		1,76	95,76%	
05/03/2014	**A260**	129,4	24 580	401,9	200,9	145,4	Léger collage supérieur	**2,094**	19,0		1,76	95,97%	
05/03/2014	**A261**	129,4	24 600	401,9	201,0	145,6	Léger collage supérieur	**2,092**	19,0		1,76	95,69%	
05/03/2014	**A262**	129,4	24 620	401,9	201,0	145,2		**2,099**	19,0		1,76	96,64%	
05/03/2014	**A263**	129,9	24 580	401,8	200,9	144,9		**2,102**	19,0		1,77	97,06%	
05/03/2014	**A264**	129,4	24 520	401,7	200,9	144,7		**2,100**	19,0		1,76	96,79%	
05/03/2014	**A265**	129,8	24 600	401,8	201,1	145,1		**2,098**	19,0		1,76	96,53%	
05/03/2014	**A266**	129,4	24 620	401,8	200,9	145,6		**2,094**	19,0		1,76	96,06%	
05/03/2014	**A267**	129,4	24 720	402,0	200,9	145,6		**2,102**	19,0		1,77	97,03%	
05/03/2014	**A268**	129,4	24 600	402,0	201,1	145,3		**2,095**	19,0		1,76	96,16%	
05/03/2014	**A269**	129,4	24 620	401,9	201,0	145,5		**2,095**	19,0		1,76	96,19%	
05/03/2014	**A27**	129,9	24 600	401,2	200,5	145,7		**2,099**	19,0		1,76	96,69%	
05/03/2014	**A270**	129,5	24 700	402,0	201,0	145,3		**2,103**	19,0		1,77	97,24%	
05/03/2014	**A271**	130,8	24 460	401,8	200,9	144,7		**2,094**	19,0		1,76	95,98%	
05/03/2014	**A272**	129,4	24 420	401,7	200,9	144,9		**2,089**	19,0		1,76	95,32%	
05/03/2014	**A273**	129,6	24 400	401,7	200,8	144,8		**2,089**	19,0		1,76	95,37%	
05/03/2014	**A274**	129,3	24 340	401,5	200,8	144,6		**2,088**	19,0		1,75	95,19%	
05/03/2014	**A275**	129,8	24 440	401,8	201,0	145,0		**2,087**	19,0		1,75	95,06%	
05/03/2014	**A276**	129,4	24 480	401,8	201,0	144,7		**2,094**	19,0		1,76	95,94%	
05/03/2014	**A277**	129,4	24 280	401,4	200,6	144,4		**2,088**	19,0		1,75	95,17%	
05/03/2014	**A278**	129,4	24 340	401,4	200,6	145,2		**2,082**	19,0		1,75	94,42%	
05/03/2014	**A279**	129,5	24 420	401,4	200,7	144,8		**2,093**	19,0		1,76	95,86%	
05/03/2014	**A28**	130,4	24 480	401,2	200,4	144,8		**2,103**	19,0		1,77	97,23%	
05/03/2014	**A280**	129,4	24 320	401,4	200,6	144,6		**2,088**	19,0		1,75	95,21%	
05/03/2014	**A281**	129,4	24 380	401,4	200,6	144,4		**2,097**	19,0		1,76	96,40%	
05/03/2014	**A282**	129,4	24 300	401,4	200,7	144,6		**2,087**	19,0		1,75	95,07%	
05/03/2014	**A283**	129,6	24 360	401,3	200,8	144,4		**2,093**	19,0		1,76	95,89%	
05/03/2014	**A284**	129,3	24 420	401,4	200,7	144,7		**2,094**	19,0		1,76	96,05%	
05/03/2014	**A285**	129,6	24 420	401,3	200,7	144,5		**2,097**	19,0		1,76	96,44%	
05/03/2014	**A286**	129,4	24 420	401,4	200,6	144,8		**2,095**	19,0		1,76	96,14%	
05/03/2014	**A287**	129,6	24 420	401,3	200,7	144,8		**2,095**	19,0		1,76	96,10%	
05/03/2014	**A288**	129,4	24 400	401,4	200,7	145,0		**2,089**	19,0		1,76	95,37%	
05/03/2014	**A289**	129,5	24 280	401,4	200,7	144,9		**2,080**	19,0		1,75	94,24%	
05/03/2014	**A29**	128,8	24 500	401,3	200,4	145,3		**2,097**	19,0		1,76	96,33%	
05/03/2014	**A290**	129,9	24 320	401,0	200,2	144,7	Nettoyage pied à coulisse	**2,094**	19,0		1,76	95,94%	
05/03/2014	**A291**	129,4	24 360	401,0	200,3	144,5		**2,099**	19,0		1,76	96,64%	
05/03/2014	**A292**	130,7	24 200	401,4	200,5	144,1		**2,086**	19,0		1,75	94,99%	
05/03/2014	**A293**	129,4	24 400	401,3	200,7	145,0		**2,088**	19,0		1,75	95,26%	
05/03/2014	**A294**	130,9	24 320	401,5	200,7	145,0		**2,083**	19,0		1,75	94,54%	
05/03/2014	**A295**	129,5	24 220	401,1	200,7	143,9	Pièce écartée pour Rc	**2,090**	19,0	19,74	1,76	95,51%	7,6 - 7,1
05/03/2014	**A296**	129,5	24 160	401,1	200,7	144,6		**2,075**	19,0		1,74	93,59%	
05/03/2014	**A297**	129,7	24 220	401,2	200,6	145,0		**2,075**	19,0		1,74	93,55%	
05/03/2014	**A298**	129,6	24 120	401,2	200,6	144,6		**2,072**	19,0		1,74	93,16%	
05/03/2014	**A299**	129,4	24 160	401,3	200,6	145,0		**2,070**	19,0		1,74	92,96%	
05/03/2014	**A3**	130,1	24 420	401,0	200,5	145,4		**2,090**	19,0		1,76	95,46%	
05/03/2014	**A30**	129,0	24 480	401,5	200,4	145,4		**2,092**	19,0		1,76	95,74%	
05/03/2014	**A300**	129,4	24 160	401,2	200,6	144,9		**2,072**	19,0		1,74	93,12%	
05/03/2014	**A301**	129,4	24 320	401,5	200,7	144,9		**2,083**	19,0		1,75	94,61%	
05/03/2014	**A302**	130,9	24 300	401,3	200,7	144,6		**2,087**	19,0		1,75	95,07%	
05/03/2014	**A303**	130,8	24 480	401,2	200,6	145,0		**2,098**	19,0		1,76	96,51%	
05/03/2014	**A304**	131,1	24 300	401,2	200,7	144,4		**2,090**	19,0		1,76	95,47%	
05/03/2014	**A305**	131,1	24 360	401,3	201,0	144,7		**2,087**	19,0		1,75	95,13%	
05/03/2014	**A306**	129,7	24 360	401,3	200,7	145,1		**2,085**	19,0		1,75	94,78%	
05/03/2014	**A307**	129,7	24 220	401,2	200,7	144,9		**2,076**	19,0		1,74	93,61%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A308**	129,5	24 100	401,1	200,6	144,4		**2,073**	19,0		1,74	93,31%	
05/03/2014	**A309**	129,6	24 120	401,1	200,6	144,4		**2,075**	19,0		1,74	93,60%	
05/03/2014	**A31**	129,2	24 500	401,7	200,4	145,8		**2,088**	19,0		1,75	95,16%	
05/03/2014	**A310**	129,6	24 100	401,3	200,4	145,0		**2,067**	19,0		1,74	92,49%	
05/03/2014	**A311**	129,4	24 260	401,3	200,9	145,3		**2,071**	19,0		1,74	93,04%	
05/03/2014	**A312**	129,5	24 240	401,1	200,6	145,6		**2,069**	19,0		1,74	92,79%	
05/03/2014	**A313**	130,8	24 020	401,0	200,5	144,7		**2,064**	19,0		1,73	92,21%	
05/03/2014	**A314**	129,3	23 980	401,1	200,4	144,4		**2,066**	19,0		1,74	92,39%	
05/03/2014	**A315**	130,9	23 920	401,1	200,4	144,2	Pièce écartée	**2,064**	19,0		1,73	92,14%	
05/03/2014	**A316**	129,5	24 020	401,1	200,5	144,8		**2,063**	19,0		1,73	92,09%	
05/03/2014	**A317**	129,4	23 940	401,0	200,4	144,2	Pièce écartée	**2,065**	19,0		1,74	92,32%	
05/03/2014	**A318**	129,4	24 200	401,3	200,6	144,8		**2,076**	19,0		1,74	93,70%	
05/03/2014	**A319**	129,4	24 260	401,3	200,6	145,4		**2,072**	19,0		1,74	93,15%	
05/03/2014	**A32**	128,9	24 480	401,2	200,4	145,6		**2,091**	19,0		1,76	95,63%	
05/03/2014	**A320**	129,4	24 300	401,6	200,7	145,7		**2,069**	19,0		1,74	92,82%	
05/03/2014	**A321**	129,3	24 420	401,5	200,9	146,0		**2,074**	19,0		1,74	93,38%	
05/03/2014	**A322**	129,7	24 600	401,9	201,7	146,1		**2,078**	19,0		1,75	93,96%	
05/03/2014	**A323**	129,4	24 160	401,3	200,5	145,1		**2,069**	19,0		1,74	92,78%	
05/03/2014	**A324**	129,4	24 200	401,3	200,7	145,2		**2,070**	19,0		1,74	92,89%	
05/03/2014	**A325**	129,7	24 260	401,9	201,0	145,1		**2,069**	19,0		1,74	92,83%	
05/03/2014	**A326**	130,9	24 600	401,8	201,0	145,2	Léger collage supérieur	**2,098**	19,0		1,76	96,53%	
05/03/2014	**A327**	129,5	24 620	401,8	200,9	145,6	Léger collage supérieur	**2,094**	19,0		1,76	96,00%	
05/03/2014	**A328**	130,9	24 540	401,9	201,2	145,0	Léger collage supérieur	**2,093**	19,0		1,76	95,93%	
05/03/2014	**A329**	129,4	24 600	401,8	201,1	145,6	Léger collage supérieur	**2,091**	19,0		1,76	95,66%	
05/03/2014	**A33**	128,9	24 460	400,9	200,5	145,1		**2,098**	19,0		1,76	96,49%	
05/03/2014	**A330**	130,4	24 560	401,8	201,3	145,3	Léger collage supérieur	**2,089**	19,0		1,76	95,36%	
05/03/2014	**A331**	129,7	24 580	401,7	201,0	145,4	Léger collage supérieur	**2,094**	19,0		1,76	96,01%	
05/03/2014	**A332**	129,7	24 620	401,7	200,9	145,5	Léger collage supérieur	**2,096**	19,0		1,76	96,32%	
05/03/2014	**A333**	129,4	24 580	401,8	200,9	145,5	Léger collage supérieur	**2,093**	19,0		1,76	95,92%	
05/03/2014	**A334**	131,1	24 580	401,8	201,1	145,4	Léger collage supérieur	**2,093**	19,0		1,76	95,81%	
05/03/2014	**A335**	129,4	24 560	401,9	201,1	145,5	Léger collage supérieur	**2,089**	19,0		1,76	95,32%	
05/03/2014	**A336**	129,5	24 620	401,7	201,0	146,0	Léger collage supérieur	**2,089**	19,0		1,76	95,41%	
05/03/2014	**A337**	129,5	24 520	401,7	201,0	145,4	Léger collage supérieur	**2,089**	19,0		1,76	95,28%	
05/03/2014	**A338**	130,9	24 440	401,7	200,8	145,0	Léger collage supérieur	**2,091**	19,0		1,76	95,55%	
05/03/2014	**A339**	129,9	24 480	401,8	200,8	145,2	Léger collage supérieur	**2,090**	19,0		1,76	95,46%	
05/03/2014	**A34**	129,1	24 440	401,6	200,7	144,9		**2,093**	19,0		1,76	95,92%	
05/03/2014	**A340**	129,7	24 500	401,6	201,0	145,4	Léger collage supérieur	**2,087**	19,0		1,75	95,12%	
05/03/2014	**A341**	129,6	24 480	401,8	200,9	145,1	Léger collage supérieur	**2,090**	19,0		1,76	95,43%	
05/03/2014	**A342**	130,9	24 540	401,8	201,0	145,4	Léger collage supérieur	**2,090**	19,0		1,76	95,46%	
05/03/2014	**A343**	129,2	24 400	401,6	200,9	144,9	Léger collage supérieur	**2,087**	19,0		1,75	95,10%	
05/03/2014	**A344**	129,8	24 420	401,5	201,0	145,4	Léger collage supérieur	**2,081**	19,0		1,75	94,36%	
05/03/2014	**A345**	129,6	24 500	401,5	200,9	145,6	Léger collage supérieur	**2,086**	19,0		1,75	94,97%	
05/03/2014	**A346**	130,9	24 440	401,5	200,8	145,3	Léger collage supérieur	**2,087**	19,0		1,75	95,07%	
05/03/2014	**A347**	129,7	24 460	401,6	200,8	145,1	Léger collage supérieur	**2,091**	19,0		1,76	95,56%	
05/03/2014	**A348**	129,5	24 420	401,7	200,9	145,1	Léger collage supérieur	**2,086**	19,0		1,75	94,91%	
05/03/2014	**A349**	129,4	24 420	401,6	200,9	145,0	Léger collage supérieur	**2,088**	19,0		1,75	95,16%	
05/03/2014	**A35**	128,9	24 500	401,5	200,9	145,1		**2,093**	19,0		1,76	95,93%	
05/03/2014	**A350**	129,7	24 440	401,6	200,7	145,5	Léger collage supérieur	**2,084**	19,0		1,75	94,71%	
05/03/2014	**A351**	129,6	24 420	401,6	200,8	145,2	Léger collage supérieur	**2,085**	19,0		1,75	94,79%	
05/03/2014	**A352**	129,7	24 420	401,7	200,8	145,0	Léger collage supérieur	**2,088**	19,0		1,75	95,16%	
05/03/2014	**A353**	129,4	24 440	401,5	201,2	145,5	Léger collage supérieur	**2,080**	19,0		1,75	94,16%	
05/03/2014	**A354**	130,9	24 420	401,6	201,2	145,0	Léger collage supérieur	**2,085**	19,0		1,75	94,85%	
05/03/2014	**A355**	129,6	24 460	401,7	200,9	145,3	Léger collage supérieur	**2,086**	19,0		1,75	94,96%	
05/03/2014	**A356**	129,5	24 460	401,7	200,8	145,4	Léger collage supérieur	**2,086**	19,0		1,75	94,94%	
05/03/2014	**A357**	130,9	24 460	401,6	200,8	145,3	Léger collage supérieur	**2,087**	19,0		1,75	95,10%	
05/03/2014	**A358**	129,5	24 520	401,4	201,0	145,7	Léger collage supérieur	**2,087**	19,0		1,75	95,06%	
05/03/2014	**A359**	129,4	24 380	401,5	201,1	144,6	Léger collage supérieur	**2,089**	19,0		1,76	95,35%	
05/03/2014	**A36**	128,9	24 420	401,4	200,9	144,6		**2,094**	19,0		1,76	96,02%	
05/03/2014	**A360**	130,8	24 460	401,6	200,9	145,2	Léger collage supérieur	**2,088**	19,0		1,75	95,17%	
05/03/2014	**A361**	129,4	24 440	401,6	200,8	144,9	Léger collage supérieur	**2,092**	19,0		1,76	95,68%	
05/03/2014	**A362**	131,0	24 580	401,7	200,8	145,4	Léger collage supérieur	**2,096**	19,0		1,76	96,24%	
05/03/2014	**A363**	129,5	24 560	401,6	200,8	145,4	Léger collage supérieur	**2,095**	19,0		1,76	96,08%	
05/03/2014	**A364**	131,0	24 560	401,7	200,9	145,4	Léger collage supérieur	**2,093**	19,0		1,76	95,88%	
05/03/2014	**A365**	129,6	24 560	401,5	200,9	145,4	Léger collage supérieur	**2,094**	19,0		1,76	96,01%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	A366	129,4	24 540	401,7	200,8	145,3	Léger collage supérieur	2,094	19,0		1,76	95,98%	
05/03/2014	A367	131,0	24 520	401,7	201,3	145,3	Léger collage supérieur	2,087	19,0		1,75	95,07%	
05/03/2014	A368	129,7	24 520	401,8	200,9	145,1	Léger collage supérieur	2,093	19,0		1,76	95,93%	
05/03/2014	A369	129,4	24 560	401,7	201,0	145,5	Léger collage supérieur	2,091	19,0		1,76	95,60%	
05/03/2014	A37	128,9	24 480	401,4	200,7	144,7		2,099	19,0		1,76	96,69%	
05/03/2014	A370	129,7	24 540	401,7	201,1	145,6	Léger collage supérieur	2,088	19,0		1,75	95,16%	
05/03/2014	A371	129,6	24 560	401,8	201,1	145,4	Léger collage supérieur	2,091	19,0		1,76	95,61%	
05/03/2014	A372	129,4	24 580	401,8	200,9	145,4	Léger collage supérieur	2,094	19,0		1,76	95,97%	
05/03/2014	A373	129,5	24 500	401,6	201,0	145,2	Léger collage supérieur	2,090	19,0		1,76	95,50%	
05/03/2014	A374	129,8	24 480	401,6	200,7	145,3	Léger collage supérieur	2,090	19,0		1,76	95,41%	
05/03/2014	A375	129,6	24 440	401,7	200,8	144,9	Léger collage supérieur	2,091	19,0		1,76	95,62%	
05/03/2014	A376	129,6	24 400	401,4	200,8	144,7	Léger collage supérieur	2,092	19,0		1,76	95,72%	
05/03/2014	A377	129,6	24 440	401,7	200,9	144,9	Léger collage supérieur	2,090	19,0		1,76	95,45%	
05/03/2014	A378	129,6	24 440	401,5	200,7	145,1	Léger collage supérieur	2,090	19,0		1,76	95,43%	
05/03/2014	A379	129,8	24 440	401,6	200,8	145,1	Léger collage supérieur	2,089	19,0		1,76	95,34%	
05/03/2014	A38	129,2	24 480	401,5	200,7	145,1		2,094	19,0		1,76	95,96%	
05/03/2014	A380	129,6	24 440	401,7	200,8	145,1	Léger collage supérieur	2,088	19,0		1,75	95,22%	
05/03/2014	A381	129,9	24 480	401,6	200,8	145,3	Léger collage supérieur	2,089	19,0		1,76	95,31%	
05/03/2014	A382	129,4	24 500	401,6	200,9	145,3	Léger collage supérieur	2,091	19,0		1,76	95,60%	
05/03/2014	A383	129,4	24 460	401,6	201,0	145,6	Léger collage supérieur	2,083	19,0		1,75	94,51%	
05/03/2014	A384	129,4	24 480	401,5	200,8	145,4	Léger collage supérieur	2,088	19,0		1,75	95,20%	
05/03/2014	A385	129,4	24 400	401,8	201,1	145,1	Léger collage supérieur	2,081	19,0		1,75	94,32%	
05/03/2014	A386	129,6	24 480	401,7	200,8	145,8	Léger collage supérieur	2,083	19,0		1,75	94,50%	
05/03/2014	A387	129,4	24 380	401,7	200,7	145,1	Léger collage supérieur	2,085	19,0		1,75	94,76%	
05/03/2014	A388	129,5	24 480	401,8	200,8	145,4	Léger collage supérieur	2,087	19,0		1,75	95,07%	
05/03/2014	A389	129,5	24 460	401,6	201,1	145,3	Léger collage supérieur	2,084	19,0		1,75	94,73%	
05/03/2014	A39	128,9	24 520	401,4	200,7	145,0		2,099	19,0		1,76	96,62%	
05/03/2014	A390	129,4	24 460	401,7	201,0	145,0	Léger collage supérieur	2,089	19,0		1,76	95,33%	
05/03/2014	A391	129,6	24 380	401,4	200,7	144,9	Léger collage supérieur	2,089	19,0		1,76	95,31%	
05/03/2014	A392	129,5	24 320	401,6	200,8	144,5		2,088	19,0		1,75	95,19%	
05/03/2014	A393	130,9	24 360	401,4	200,8	144,4		2,092	19,0		1,76	95,75%	
05/03/2014	A394	129,6	24 340	401,4	200,8	144,8		2,086	19,0		1,75	94,93%	
05/03/2014	A395	129,6	24 260	401,3	200,9	144,6		2,082	19,0		1,75	94,37%	
05/03/2014	A396	129,5	24 400	401,4	200,6	145,2		2,086	19,0		1,75	94,98%	
05/03/2014	A397	129,5	24 320	401,4	200,8	144,3	Pièce écartée	2,091	19,0		1,76	95,62%	
05/03/2014	A398	129,4	24 420	401,4	200,7	144,7		2,095	19,0		1,76	96,12%	
05/03/2014	A399	129,5	24 380	401,5	200,8	144,5		2,093	19,0		1,76	95,88%	
05/03/2014	A4	130,1	24 600	401,4	200,4	145,6		2,101	19,0		1,77	96,88%	
05/03/2014	A40	130,5	24 460	401,7	200,8	144,6	Pièce écartée pour Rc	2,098	19,0	17,90	1,76	96,48%	6,7 - 7,1
05/03/2014	A400	129,4	24 440	401,4	200,8	145,0		2,091	19,0		1,76	95,59%	
05/03/2014	A401	129,4	24 360	401,3	200,8	144,8		2,088	19,0		1,75	95,18%	
05/03/2014	A402	129,5	24 320	401,3	200,6	144,4	Pièce écartée	2,092	19,0		1,76	95,76%	
05/03/2014	A403	129,4	24 400	401,3	200,7	144,8		2,092	19,0		1,76	95,76%	
05/03/2014	A404	129,4	24 380	401,3	200,5	144,7		2,094	19,0		1,76	96,00%	
05/03/2014	A405	129,4	24 360	401,3	200,7	144,5		2,093	19,0		1,76	95,88%	
05/03/2014	A406	129,4	24 340	401,3	200,6	144,6		2,091	19,0		1,76	95,60%	
05/03/2014	A407	129,4	24 320	401,4	200,7	144,7		2,086	19,0		1,75	94,99%	
05/03/2014	A408	129,4	24 380	401,2	200,8	145,1		2,086	19,0		1,75	94,93%	
05/03/2014	A409	129,4	24 280	401,5	200,8	144,9		2,078	19,0		1,75	93,97%	
05/03/2014	A41	128,9	24 560	401,5	201,0	145,5		2,092	19,0		1,76	95,80%	
05/03/2014	A410	129,4	24 180	401,3	200,5	144,3	Pièce écartée	2,083	19,0		1,75	94,51%	
05/03/2014	A411	129,4	24 100	401,4	200,6	144,1	Pièce écartée	2,077	19,0		1,75	93,80%	
05/03/2014	A412	129,5	24 320	401,2	200,6	145,2		2,081	19,0		1,75	94,33%	
05/03/2014	A413	129,8	24 340	401,1	200,9	145,2		2,080	19,0		1,75	94,21%	
05/03/2014	A414	129,4	24 260	401,2	200,8	144,6		2,083	19,0		1,75	94,51%	
05/03/2014	A415	129,4	24 180	401,2	200,6	144,7		2,076	19,0		1,74	93,71%	
05/03/2014	A416	130,9	24 160	401,2	200,5	144,6		2,077	19,0		1,75	93,80%	
05/03/2014	A417	129,4	24 500	401,3	200,5	145,3		2,096	19,0		1,76	96,31%	
05/03/2014	A418	129,4	24 500	401,0	200,7	145,2		2,097	19,0		1,76	96,35%	
05/03/2014	A419	131,0	24 160	401,2	200,6	144,4		2,078	19,0		1,75	93,90%	
05/03/2014	A42	129,0	24 460	401,7	201,7	144,9		2,084	19,0		1,75	94,66%	
05/03/2014	A420	129,6	24 220	400,9	200,4	144,7		2,084	19,0		1,75	94,66%	
05/03/2014	A421	129,4	24 260	401,6	199,9	144,2	Pièce écartée pour Rc	2,096	19,0	19,06	1,76	96,22%	9,3 - 7,8
05/03/2014	A422	130,8	24 160	401,5	200,4	145,2		2,068	19,0		1,74	92,64%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A423**	129,6	24 520	401,0	200,6	145,1		**2,101**	19,0		1,77	96,94%	
05/03/2014	**A424**	130,9	24 520	401,1	200,7	145,7		**2,091**	19,0		1,76	95,61%	
05/03/2014	**A425**	130,8	24 560	401,2	200,5	145,6		**2,097**	19,0		1,76	96,45%	
05/03/2014	**A426**	130,9	24 540	401,6	201,5	145,0		**2,091**	19,0		1,76	95,60%	
05/03/2014	**A427**	129,4	24 560	401,2	200,5	145,5		**2,098**	19,0		1,76	96,58%	
05/03/2014	**A428**	129,7	24 500	401,3	200,7	145,1		**2,096**	19,0		1,76	96,24%	
05/03/2014	**A429**	129,4	24 580	401,6	200,6	145,4		**2,099**	19,0		1,76	96,63%	
05/03/2014	**A43**	130,4	24 540	401,6	201,2	145,2		**2,092**	19,0		1,76	95,70%	
05/03/2014	**A430**	129,4	24 520	401,2	200,6	145,4		**2,096**	19,0		1,76	96,28%	
05/03/2014	**A431**	129,4	24 480	401,4	200,7	145,3		**2,092**	19,0		1,76	95,68%	
05/03/2014	**A432**	129,4	24 520	401,6	200,6	145,7		**2,089**	19,0		1,76	95,34%	
05/03/2014	**A433**	129,7	24 560	401,4	200,5	145,2		**2,101**	19,0		1,77	96,96%	
05/03/2014	**A434**	129,4	24 560	401,3	200,6	145,3		**2,099**	19,0		1,76	96,72%	
05/03/2014	**A435**	129,4	24 580	400,6	200,8	145,6		**2,099**	19,0		1,76	96,64%	
05/03/2014	**A436**	129,4	24 540	401,8	200,7	145,4		**2,093**	19,0		1,76	95,82%	
05/03/2014	**A437**	130,9	24 560	401,5	200,5	145,3		**2,099**	19,0		1,76	96,68%	
05/03/2014	**A438**	129,4	24 560	401,2	200,7	145,3		**2,100**	19,0		1,76	96,79%	
05/03/2014	**A439**	129,4	24 560	401,1	200,7	145,2		**2,101**	19,0		1,77	96,94%	
05/03/2014	**A44**	128,9	24 500	401,7	201,5	145,0		**2,088**	19,0		1,75	95,23%	
05/03/2014	**A440**	130,9	24 540	401,3	200,5	145,1		**2,102**	19,0		1,77	97,11%	
05/03/2014	**A441**	129,6	24 600	401,2	200,7	145,0		**2,107**	19,0		1,77	97,75%	
05/03/2014	**A442**	129,8	24 580	401,5	200,7	145,3		**2,099**	19,0		1,76	96,64%	
05/03/2014	**A443**	129,6	24 580	401,4	200,5	145,5		**2,098**	19,0		1,76	96,59%	
05/03/2014	**A444**	129,3	24 660	401,6	200,5	145,6		**2,104**	19,0		1,77	97,26%	
05/03/2014	**A445**	131,0	24 500	401,8	200,9	145,0		**2,093**	19,0		1,76	95,92%	
05/03/2014	**A446**	129,4	24 620	401,1	200,7	145,9		**2,097**	19,0		1,76	96,37%	
05/03/2014	**A447**	129,7	24 600	401,2	200,5	145,3		**2,105**	19,0		1,77	97,50%	
05/03/2014	**A448**	130,9	24 540	401,7	200,7	145,4		**2,094**	19,0		1,76	95,96%	
05/03/2014	**A449**	129,2	24 600	401,2	201,0	145,3		**2,100**	19,0		1,76	96,76%	
05/03/2014	**A45**	128,9	24 540	401,4	200,8	145,1		**2,099**	19,0		1,76	96,63%	
05/03/2014	**A450**	130,9	24 580	401,4	200,7	145,7		**2,095**	19,0		1,76	96,14%	
05/03/2014	**A451**	129,7	24 580	400,9	200,6	145,3		**2,104**	19,0		1,77	97,28%	
05/03/2014	**A452**	129,8	24 700	401,1	200,8	145,6		**2,107**	19,0		1,77	97,73%	
05/03/2014	**A453**	129,6	24 620	401,3	200,6	145,1		**2,108**	19,0		1,77	97,89%	
05/03/2014	**A454**	129,4	24 640	401,3	200,5	145,8		**2,100**	19,0		1,76	96,83%	
05/03/2014	**A455**	129,8	24 680	401,2	200,6	145,6		**2,105**	19,0		1,77	97,51%	
05/03/2014	**A456**	130,8	24 660	401,0	200,7	145,3		**2,109**	19,0		1,77	98,00%	
05/03/2014	**A457**	129,5	24 700	401,2	200,9	145,7		**2,103**	19,0		1,77	97,25%	
05/03/2014	**A458**	129,5	24 700	401,5	200,8	145,3		**2,108**	19,0		1,77	97,80%	
05/03/2014	**A459**	129,4	24 680	401,4	200,8	145,5		**2,104**	19,0		1,77	97,38%	
05/03/2014	**A46**	129,0	24 460	401,4	200,8	144,6		**2,099**	19,0		1,76	96,70%	
05/03/2014	**A460**	130,9	24 680	401,3	200,8	145,3		**2,107**	19,0		1,77	97,76%	
05/03/2014	**A461**	129,4	24 680	401,5	200,8	145,5		**2,104**	19,0		1,77	97,33%	
05/03/2014	**A462**	131,0	24 680	401,5	200,8	145,7		**2,102**	19,0		1,77	97,02%	
05/03/2014	**A463**	129,4	24 680	401,5	200,8	145,6		**2,103**	19,0		1,77	97,16%	
05/03/2014	**A464**	129,7	24 680	401,6	200,5	145,8		**2,103**	19,0		1,77	97,24%	
05/03/2014	**A465**	129,7	24 680	401,7	200,8	145,6		**2,102**	19,0		1,77	97,03%	
05/03/2014	**A466**	129,5	24 700	401,3	200,8	145,7		**2,104**	19,0		1,77	97,34%	
05/03/2014	**A467**	130,8	24 680	402,0	200,7	145,2		**2,108**	19,0		1,77	97,82%	
05/03/2014	**A468**	129,5	24 680	401,3	200,9	145,4		**2,105**	19,0		1,77	97,51%	
05/03/2014	**A469**	129,4	24 680	401,5	200,7	145,3		**2,108**	19,0		1,77	97,82%	
05/03/2014	**A47**	129,2	24 540	401,3	200,7	145,1		**2,100**	19,0		1,76	96,81%	
05/03/2014	**A470**	129,8	24 660	401,5	200,6	145,6		**2,103**	19,0		1,77	97,17%	
05/03/2014	**A471**	129,6	24 580	401,3	200,7	145,2		**2,102**	19,0		1,77	97,12%	
05/03/2014	**A472**	129,7	24 700	401,3	200,8	145,7		**2,105**	19,0		1,77	97,41%	
05/03/2014	**A473**	129,4	24 680	401,4	200,7	145,9		**2,099**	19,0		1,76	96,71%	
05/03/2014	**A474**	129,5	24 640	401,3	200,8	145,5		**2,102**	19,0		1,77	97,10%	
05/03/2014	**A475**	129,4	24 520	401,4	200,6	145,5		**2,093**	19,0		1,76	95,84%	
05/03/2014	**A476**	129,5	24 560	401,6	200,5	145,3		**2,099**	19,0		1,76	96,71%	
05/03/2014	**A477**	129,4	24 580	401,1	200,6	145,8		**2,095**	19,0		1,76	96,14%	
05/03/2014	**A478**	129,3	24 580	401,1	200,6	145,6		**2,098**	19,0		1,76	96,55%	
05/03/2014	**A479**	129,7	24 520	401,4	200,9	145,5		**2,090**	19,0		1,76	95,50%	
05/03/2014	**A48**	128,9	24 540	401,5	201,0	145,0		**2,097**	19,0		1,76	96,40%	
05/03/2014	**A480**	129,5	24 560	400,9	200,8	145,1		**2,102**	19,0		1,77	97,04%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Resistance a la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A481**	129,4	24 580	401,0	200,6	145,2		**2,105**	19,0		1,77	97,42%	
05/03/2014	**A482**	129,4	24 580	401,4	200,5	145,4		**2,100**	19,0		1,77	96,86%	
05/03/2014	**A483**	129,6	24 560	401,3	200,5	145,4		**2,098**	19,0		1,76	96,56%	
05/03/2014	**A484**	129,4	24 600	401,2	200,8	145,6		**2,098**	19,0		1,76	96,48%	
05/03/2014	**A485**	129,6	24 540	401,6	201,0	145,2		**2,094**	19,0		1,76	96,05%	
05/03/2014	**A486**	129,6	24 540	401,4	200,9	145,3		**2,094**	19,0		1,76	96,00%	
05/03/2014	**A487**	129,4	24 600	401,3	200,9	145,3		**2,101**	19,0		1,77	96,87%	
05/03/2014	**A488**	129,6	24 580	401,6	200,9	145,1		**2,100**	19,0		1,76	96,78%	
05/03/2014	**A489**	129,5	24 600	401,5	201,0	145,5		**2,095**	19,0		1,76	96,19%	
05/03/2014	**A49**	130,4	24 520	401,5	200,9	145,1		**2,094**	19,0		1,76	96,01%	
05/03/2014	**A490**	129,4	24 640	401,1	200,6	145,3		**2,108**	19,0		1,77	97,82%	
05/03/2014	**A491**	129,6	24 640	401,6	200,8	145,5		**2,100**	19,0		1,76	96,80%	
05/03/2014	**A492**	129,5	24 540	401,4	200,7	145,1		**2,098**	19,0		1,76	96,59%	
05/03/2014	**A493**	129,5	24 560	401,2	201,0	145,4		**2,096**	19,0		1,76	96,21%	
05/03/2014	**A494**	129,5	24 580	401,3	200,7	145,1		**2,102**	19,0		1,77	97,11%	
05/03/2014	**A495**	129,6	24 600	401,2	200,6	145,3		**2,104**	19,0		1,77	97,39%	
05/03/2014	**A496**	129,6	24 600	401,1	201,0	145,3		**2,101**	19,0		1,77	96,91%	
05/03/2014	**A497**	129,4	24 660	401,2	200,9	145,6		**2,101**	19,0		1,77	96,90%	
05/03/2014	**A498**	131,0	24 560	401,0	201,0	145,3		**2,097**	19,0		1,76	96,43%	
05/03/2014	**A499**	129,5	24 560	401,2	200,8	145,4		**2,097**	19,0		1,76	96,41%	
05/03/2014	**A5**	129,9	24 480	401,2	200,3	144,9		**2,103**	19,0		1,77	97,17%	
05/03/2014	**A50**	128,9	24 440	401,6	200,8	144,6		**2,096**	19,0	17,70	1,76	96,33%	
05/03/2014	**A500**	129,7	24 640	401,2	200,6	145,5		**2,104**	19,0		1,77	97,37%	
05/03/2014	**A501**	129,5	24 580	401,3	200,7	145,3		**2,101**	19,0		1,77	96,87%	
05/03/2014	**A502**	129,4	24 640	401,3	201,0	145,4		**2,102**	19,0		1,77	97,08%	
05/03/2014	**A503**	129,7	24 640	401,7	200,9	145,3		**2,102**	19,0		1,77	97,04%	
05/03/2014	**A504**	129,6	24 640	401,7	200,8	145,8		**2,095**	19,0		1,76	96,12%	
05/03/2014	**A505**	129,6	24 680	401,3	201,0	145,5		**2,103**	19,0		1,77	97,23%	
05/03/2014	**A506**	129,6	24 640	401,9	200,7	145,7		**2,097**	19,0		1,76	96,41%	
05/03/2014	**A507**	129,4	24 660	401,3	200,6	145,4		**2,108**	19,0		1,77	97,85%	
05/03/2014	**A508**	129,5	24 640	401,7	200,9	145,3		**2,101**	19,0		1,77	96,98%	
05/03/2014	**A509**	129,6	24 640	401,4	200,9	145,4		**2,102**	19,0		1,77	97,01%	
05/03/2014	**A51**	129,0	24 540	401,3	201,4	145,2		**2,091**	19,0		1,76	95,61%	
05/03/2014	**A510**	129,5	24 620	401,2	200,9	145,4		**2,100**	19,0		1,77	96,84%	
05/03/2014	**A511**	129,6	24 560	401,1	200,7	145,1		**2,102**	19,0		1,77	97,12%	
05/03/2014	**A512**	129,4	24 560	401,1	200,6	145,1		**2,104**	19,0		1,77	97,26%	
05/03/2014	**A513**	129,5	24 540	401,9	200,5	145,0		**2,100**	19,0		1,76	96,76%	
05/03/2014	**A514**	129,6	24 560	402,0	200,6	145,1		**2,100**	19,0		1,77	96,85%	
05/03/2014	**A515**	129,4	24 500	401,3	200,8	145,2		**2,095**	19,0		1,76	96,11%	
05/03/2014	**A516**	129,7	24 540	401,2	200,7	145,0		**2,102**	19,0		1,77	97,02%	
05/03/2014	**A517**	129,4	24 500	401,3	200,8	145,2		**2,095**	19,0		1,76	96,07%	
05/03/2014	**A518**	130,3	24 620	401,2	200,9	146,0		**2,093**	19,0		1,76	95,91%	
05/03/2014	**A519**	129,4	24 560	401,1	200,9	145,3		**2,097**	19,0		1,76	96,43%	
05/03/2014	**A52**	129,0	24 480	401,5	201,5	144,8		**2,090**	19,0		1,76	95,47%	
05/03/2014	**A520**	129,7	24 460	401,2	200,8	144,7		**2,099**	19,0		1,76	96,62%	
05/03/2014	**A521**	129,5	24 460	401,7	200,6	144,5	Léger collage latéral	**2,102**	19,0		1,77	97,00%	
05/03/2014	**A522**	129,7	24 480	401,1	200,7	145,4		**2,091**	19,0		1,76	95,66%	
05/03/2014	**A523**	129,6	24 480	401,3	200,9	144,9		**2,096**	19,0		1,76	96,26%	
05/03/2014	**A524**	129,4	24 520	401,0	200,6	145,8		**2,090**	19,0		1,76	95,48%	
05/03/2014	**A525**	129,7	24 480	401,3	200,3	145,2		**2,098**	19,0		1,76	96,48%	
05/03/2014	**A526**	129,5	24 480	401,3	200,8	145,3		**2,092**	19,0		1,76	95,69%	
05/03/2014	**A527**	129,5	24 520	401,1	200,8	145,0		**2,100**	19,0		1,76	96,80%	
05/03/2014	**A528**	129,5	24 480	401,0	200,8	144,9		**2,099**	19,0		1,76	96,64%	
05/03/2014	**A529**	129,6	24 480	401,2	200,9	144,8		**2,098**	19,0		1,76	96,48%	
05/03/2014	**A53**	129,0	24 540	401,7	201,0	145,2		**2,095**	19,0		1,76	96,07%	
05/03/2014	**A530**	129,5	24 500	401,1	200,9	145,0		**2,098**	19,0		1,76	96,46%	
05/03/2014	**A531**	129,5	24 460	401,1	201,0	145,3		**2,088**	19,0		1,75	95,23%	
05/03/2014	**A532**	129,5	24 540	401,1	200,8	145,4		**2,096**	19,0		1,76	96,27%	
05/03/2014	**A533**	129,7	24 500	401,2	200,7	145,4		**2,094**	19,0		1,76	95,96%	
05/03/2014	**A534**	129,5	24 500	401,1	200,7	145,2		**2,097**	19,0		1,76	96,36%	
05/03/2014	**A535**	129,6	24 500	401,4	200,8	145,0		**2,095**	19,0		1,76	96,18%	
05/03/2014	**A536**	129,5	24 560	401,3	200,5	145,4		**2,098**	19,0		1,76	96,57%	
05/03/2014	**A537**	129,5	24 600	401,1	200,5	145,5		**2,103**	19,0		1,77	97,20%	
05/03/2014	**A538**	129,4	24 620	401,0	200,7	145,8		**2,099**	19,0		1,76	96,63%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A539**	129,7	24 440	401,0	200,8	144,8		**2,095**	19,0		1,76	96,16%	
05/03/2014	**A54**	129,7	24 560	401,3	200,4	145,3		**2,102**	19,0		1,77	97,05%	
05/03/2014	**A540**	129,4	24 480	401,3	200,7	145,3		**2,092**	19,0		1,76	95,73%	
05/03/2014	**A541**	129,8	24 600	401,6	200,7	145,3		**2,101**	19,0		1,77	96,89%	
05/03/2014	**A542**	129,4	24 640	401,6	200,7	145,6		**2,099**	19,0		1,76	96,69%	
05/03/2014	**A543**	129,7	24 600	401,5	200,8	145,7		**2,095**	19,0		1,76	96,08%	
05/03/2014	**A544**	129,5	24 580	401,6	200,9	145,3		**2,096**	19,0		1,76	96,27%	
05/03/2014	**A545**	129,5	24 660	401,2	200,9	145,7		**2,100**	19,0		1,76	96,84%	
05/03/2014	**A546**	129,6	24 520	401,1	200,8	145,0		**2,099**	19,0		1,76	96,61%	
05/03/2014	**A547**	129,4	24 520	401,3	200,9	145,5		**2,091**	19,0		1,76	95,55%	
05/03/2014	**A548**	130,9	24 620	401,5	200,8	145,6		**2,098**	19,0		1,76	96,47%	
05/03/2014	**A549**	129,5	24 620	401,5	200,7	145,5		**2,101**	19,0		1,77	96,94%	
05/03/2014	**A55**	129,0	24 500	401,6	201,0	145,5		**2,086**	19,0		1,75	94,97%	
05/03/2014	**A550**	129,6	24 600	401,2	201,0	145,5		**2,098**	19,0		1,76	96,50%	
05/03/2014	**A551**	129,7	24 620	401,7	200,9	145,4		**2,099**	19,0		1,76	96,61%	
05/03/2014	**A552**	129,5	24 560	401,6	200,9	145,6		**2,091**	19,0		1,76	95,56%	
05/03/2014	**A553**	129,4	24 580	401,5	200,9	145,3		**2,097**	19,0		1,76	96,42%	
05/03/2014	**A554**	129,4	24 580	401,5	200,7	145,4		**2,098**	19,0		1,76	96,47%	
05/03/2014	**A555**	129,5	24 560	401,4	200,7	145,6		**2,095**	19,0		1,76	96,07%	
05/03/2014	**A556**	129,6	24 340	401,4	200,9	145,4		**2,076**	19,0		1,74	93,66%	
05/03/2014	**A557**	129,5	24 540	401,2	200,9	144,9		**2,101**	19,0		1,77	96,93%	
05/03/2014	**A558**	129,6	24 600	401,0	200,8	145,5		**2,099**	19,0		1,76	96,71%	
05/03/2014	**A559**	129,4	24 620	401,2	201,0	145,6		**2,098**	19,0		1,76	96,51%	
05/03/2014	**A56**	130,5	24 480	401,6	200,9	145,8		**2,081**	19,0		1,75	94,30%	
05/03/2014	**A560**	129,6	24 640	401,5	200,7	145,6		**2,100**	19,0		1,76	96,73%	
05/03/2014	**A561**	129,4	24 620	401,4	200,6	145,5		**2,101**	19,0		1,77	96,95%	
05/03/2014	**A562**	129,4	24 640	401,3	200,9	145,7		**2,098**	19,0		1,76	96,56%	
05/03/2014	**A563**	129,7	24 600	401,4	200,7	145,2		**2,103**	19,0		1,77	97,18%	
05/03/2014	**A564**	129,4	24 560	401,6	200,9	145,1		**2,097**	19,0		1,76	96,46%	
05/03/2014	**A565**	129,4	24 600	401,2	200,9	145,3		**2,101**	19,0		1,77	96,99%	
05/03/2014	**A566**	129,6	24 620	401,3	200,4	145,4		**2,105**	19,0		1,77	97,50%	
05/03/2014	**A567**	129,4	24 600	401,2	200,9	145,7		**2,095**	19,0		1,76	96,12%	
05/03/2014	**A568**	129,7	24 620	401,3	200,5	145,1		**2,110**	19,0		1,77	98,11%	
05/03/2014	**A569**	129,4	24 580	401,2	200,9	145,2		**2,100**	19,0		1,76	96,81%	
05/03/2014	**A57**	128,8	24 540	401,3	201,0	145,9		**2,086**	19,0		1,75	94,98%	
05/03/2014	**A570**	129,7	24 600	401,2	200,7	145,3		**2,103**	19,0		1,77	97,13%	
05/03/2014	**A571**	129,5	24 460	401,1	200,5	144,8		**2,100**	19,0		1,76	96,84%	
05/03/2014	**A572**	129,4	24 420	401,6	200,4	144,8		**2,095**	19,0		1,76	96,17%	
05/03/2014	**A573**	129,5	24 480	401,3	200,4	145,0		**2,099**	19,0		1,76	96,72%	
05/03/2014	**A574**	129,4	24 480	401,5	200,4	145,2		**2,096**	19,0		1,76	96,21%	
05/03/2014	**A575**	129,7	24 400	401,7	200,7	145,0		**2,087**	19,0		1,75	95,15%	
05/03/2014	**A576**	129,7	24 440	401,3	200,5	144,8		**2,098**	19,0		1,76	96,48%	
05/03/2014	**A577**	129,4	24 460	401,8	200,4	144,8		**2,098**	19,0		1,76	96,46%	
05/03/2014	**A578**	129,5	24 460	401,2	200,4	144,9		**2,100**	19,0		1,76	96,79%	
05/03/2014	**A579**	129,6	24 480	401,2	200,6	145,0		**2,098**	19,0		1,76	96,50%	
05/03/2014	**A58**	130,4	24 480	401,2	200,7	145,8		**2,085**	19,0		1,75	94,87%	
05/03/2014	**A580**	129,7	24 460	401,1	200,5	144,9		**2,100**	19,0		1,76	96,80%	
05/03/2014	**A581**	129,4	24 500	401,1	200,8	145,0		**2,098**	19,0		1,76	96,51%	
05/03/2014	**A582**	129,6	24 480	401,5	200,6	145,1		**2,095**	19,0		1,76	96,12%	
05/03/2014	**A583**	129,5	24 540	401,4	200,8	145,1		**2,099**	19,0		1,76	96,71%	
05/03/2014	**A584**	129,5	24 480	401,5	200,7	145,3		**2,091**	19,0		1,76	95,60%	
05/03/2014	**A585**	129,4	24 520	401,2	200,6	145,0		**2,101**	19,0		1,77	96,93%	
05/03/2014	**A586**	130,9	24 500	401,1	200,6	144,9		**2,101**	19,0		1,77	96,93%	
05/03/2014	**A587**	130,9	24 520	401,5	200,6	145,0		**2,100**	19,0		1,76	96,81%	
05/03/2014	**A588**	130,9	24 580	401,1	200,7	145,0		**2,106**	19,0		1,77	97,61%	
05/03/2014	**A589**	129,5	24 580	401,5	200,8	145,0		**2,103**	19,0		1,77	97,14%	
05/03/2014	**A59**	129,1	24 520	401,2	200,5	145,7		**2,093**	19,0		1,76	95,90%	
05/03/2014	**A590**	129,7	24 500	401,1	200,9	145,8		**2,085**	19,0		1,75	94,84%	
05/03/2014	**A591**	129,5	24 560	401,0	200,9	145,2		**2,099**	19,0		1,76	96,69%	
05/03/2014	**A592**	129,6	24 540	401,7	200,5	145,3		**2,097**	19,0		1,76	96,34%	
05/03/2014	**A593**	129,5	24 540	401,0	200,8	145,2		**2,099**	19,0		1,76	96,64%	
05/03/2014	**A594**	129,7	24 520	401,2	200,8	145,0		**2,100**	19,0		1,76	96,74%	
05/03/2014	**A595**	129,4	24 560	401,3	200,8	145,0		**2,102**	19,0		1,77	97,09%	
05/03/2014	**A596**	129,4	24 560	401,2	200,7	145,3		**2,099**	19,0		1,76	96,62%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	A597	129,7	24 580	401,4	200,6	145,6		2,096	19,0		1,76	96,22%	
05/03/2014	A598	130,9	24 250	401,3	200,9	145,2		2,072	19,0		1,74	93,11%	
05/03/2014	A599	129,4	24 580	401,4	200,8	145,3		2,099	19,0		1,76	96,62%	
05/03/2014	A6	129,9	24 540	401,5	200,4	145,4		2,098	19,0		1,76	96,48%	
05/03/2014	A60	130,4	24 540	401,5	200,9	145,3		2,095	19,0	17,27	1,76	96,08%	
05/03/2014	A600	129,5	24 540	401,6	200,7	145,1		2,098	19,0		1,76	96,56%	
05/03/2014	A601	129,4	24 440	401,3	200,8	144,7		2,097	19,0		1,76	96,38%	
05/03/2014	A602	129,6	24 580	401,7	200,8	145,3		2,097	19,0		1,76	96,36%	
05/03/2014	A603	129,5	24 480	401,3	200,6	145,1		2,095	19,0		1,76	96,17%	
05/03/2014	A604	129,6	24 540	401,3	200,9	145,3		2,094	19,0		1,76	96,03%	
05/03/2014	A605	129,4	24 560	401,6	200,8	145,4		2,095	19,0		1,76	96,19%	
05/03/2014	A606	129,8	24 520	401,8	200,7	145,8		2,085	19,0		1,75	94,85%	
05/03/2014	A607	129,4	24 520	401,5	201,0	145,2		2,093	19,0		1,76	95,82%	
05/03/2014	A608	129,4	24 460	401,6	200,6	145,1		2,093	19,0		1,76	95,93%	
05/03/2014	A609	131,0	24 500	401,6	200,8	145,0		2,095	19,0		1,76	96,09%	
05/03/2014	A61	130,4	24 520	401,2	201,0	145,6		2,088	19,0		1,75	95,24%	
05/03/2014	A610	129,4	24 520	401,4	200,7	145,2		2,096	19,0		1,76	96,29%	
05/03/2014	A611	129,5					Pièce écartée		19,0		0,00	#DIV/0!	
05/03/2014	A612	129,7	24 540	401,2	200,9	145,2		2,098	19,0		1,76	96,51%	
05/03/2014	A613	129,5	24 500	401,5	201,0	144,9		2,095	19,0		1,76	96,15%	
05/03/2014	A614	129,6	24 500	401,5	200,8	145,0		2,097	19,0		1,76	96,35%	
05/03/2014	A615	129,5	24 500	401,6	200,8	145,0		2,096	19,0		1,76	96,20%	
05/03/2014	A616	129,5	24 500	401,4	200,9	145,2		2,092	19,0		1,76	95,69%	
05/03/2014	A617	129,4	24 440	401,5	200,9	144,9		2,091	19,0		1,76	95,65%	
05/03/2014	A618	129,4	24 500	401,5	200,7	145,0		2,096	19,0		1,76	96,30%	
05/03/2014	A619	129,8	24 620	401,7	201,0	145,2		2,100	19,0		1,76	96,81%	
05/03/2014	A62	130,6	24 420	401,2	200,8	145,0		2,090	19,0		1,76	95,47%	
05/03/2014	A620	129,4	24 560	401,5	200,9	144,9		2,101	19,0		1,77	96,94%	
05/03/2014	A621	129,5	24 560	401,6	200,9	145,2		2,097	19,0		1,76	96,44%	
05/03/2014	A622	129,5	24 560	401,5	200,1	145,3		2,103	19,0		1,77	97,21%	
05/03/2014	A623	130,9	24 580	401,6	201,2	145,3		2,095	19,0		1,76	96,10%	
05/03/2014	A624	129,6	24 580	401,9	201,3	145,0		2,095	19,0		1,76	96,19%	
05/03/2014	A625	129,7	24 580	401,9	201,0	145,8		2,087	19,0		1,75	95,11%	
05/03/2014	A626	129,5	24 600	401,7	200,9	145,6		2,093	19,0		1,76	95,84%	
05/03/2014	A627	129,6	24 600	401,6	201,0	146,0		2,088	19,0		1,75	95,24%	
05/03/2014	A628	129,5	24 600	401,8	201,2	145,4		2,094	19,0		1,76	95,99%	
05/03/2014	A629	129,4	24 640	401,4	200,9	145,5		2,101	19,0		1,77	96,94%	
05/03/2014	A63	130,4	24 520	401,4	200,6	145,7		2,091	19,0		1,76	95,54%	
05/03/2014	A630	129,6	24 620	401,5	200,9	145,6		2,097	19,0		1,76	96,33%	
05/03/2014	A631	129,4	24 620	401,7	200,9	145,9		2,091	19,0		1,76	95,60%	
05/03/2014	A632	129,4	24 620	401,3	200,7	145,8		2,097	19,0		1,76	96,45%	
05/03/2014	A633	129,5	24 640	401,3	200,9	145,2		2,105	19,0		1,77	97,49%	
05/03/2014	A634	129,5	24 580	401,5	200,6	145,1		2,103	19,0		1,77	97,14%	
05/03/2014	A635	129,4	24 500	401,2	200,7	145,1		2,097	19,0		1,76	96,41%	
05/03/2014	A636	129,6	24 560	401,4	200,9	145,7		2,090	19,0		1,76	95,49%	
05/03/2014	A637	129,6	24 560	401,5	200,9	145,4		2,095	19,0		1,76	96,16%	
05/03/2014	A638	129,5	24 640	401,4	200,7	145,5		2,102	19,0		1,77	97,07%	
05/03/2014	A639	129,6	24 560	401,2	200,7	145,2		2,101	19,0		1,77	96,89%	
05/03/2014	A64	130,4	24 500	401,2	201,0	145,2		2,093	19,0		1,76	95,91%	
05/03/2014	A640	129,6	24 620	401,9	200,8	145,3		2,100	19,0		1,76	96,82%	
05/03/2014	A641	129,5	24 600	401,4	200,9	145,3		2,099	19,0		1,76	96,72%	
05/03/2014	A642	129,6	24 560	401,7	200,9	145,2		2,096	19,0		1,76	96,27%	
05/03/2014	A643	129,4	24 580	401,7	201,0	145,6		2,091	19,0		1,76	95,63%	
05/03/2014	A644	129,8	24 640	401,6	200,8	145,3		2,104	19,0		1,77	97,30%	
05/03/2014	A645	129,4	24 640	401,5	200,7	145,5		2,102	19,0		1,77	97,00%	
05/03/2014	A646	129,7	24 580	401,2	200,8	145,2		2,102	19,0		1,77	97,06%	
05/03/2014	A647	129,4	24 640	401,4	200,7	145,4		2,104	19,0		1,77	97,29%	
05/03/2014	A648	129,4	24 620	401,0	200,8	145,2		2,106	19,0		1,77	97,57%	
05/03/2014	A649	129,4	24 600	401,2	200,7	145,1		2,106	19,0		1,77	97,59%	
05/03/2014	A65	129,0	24 480	401,2	200,8	145,3		2,091	19,0		1,76	95,60%	
05/03/2014	A650	129,6	24 640	401,4	200,8	145,5		2,102	19,0		1,77	97,00%	
05/03/2014	A651	129,4	24 660	401,1	200,7	144,9		2,115	19,0		1,78	98,79%	
05/03/2014	A652	129,7	24 520	401,0	200,9	145,8		2,087	19,0		1,75	95,12%	
05/03/2014	A653	129,4	24 620	401,0	200,8	145,2		2,105	19,0		1,77	97,51%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	A654	129,9	24 620	401,4	200,7	144,8		2,111	19,0		1,77	98,21%	
05/03/2014	A655	129,6	24 640	401,7	200,8	145,4		2,101	19,0		1,77	96,96%	
05/03/2014	A656	129,5	24 640	401,5	200,6	145,8		2,099	19,0		1,76	96,66%	
05/03/2014	A657	129,7	24 600	401,1	200,5	145,2		2,106	19,0		1,77	97,63%	
05/03/2014	A658	129,4	24 600	401,1	200,6	145,4		2,103	19,0		1,77	97,25%	
05/03/2014	A659	129,7	24 640	401,1	200,6	145,1		2,111	19,0		1,77	98,23%	
05/03/2014	A66	129,1	24 460	401,1	200,8	145,2		2,092	19,0		1,76	95,73%	
05/03/2014	A660	129,6	24 660	401,3	200,8	145,2		2,108	19,0		1,77	97,89%	
05/03/2014	A661	129,4	24 560	401,4	200,8	145,3		2,097	19,0		1,76	96,35%	
05/03/2014	A662	129,6	24 580	401,2	200,7	145,5		2,098	19,0		1,76	96,49%	
05/03/2014	A663	129,6	24 460	401,1	200,7	144,6		2,101	19,0		1,77	96,99%	
05/03/2014	A664	129,5	24 500	401,1	200,6	145,0		2,100	19,0		1,76	96,77%	
05/03/2014	A665	129,6	24 540	401,2	200,7	145,1		2,100	19,0		1,76	96,81%	
05/03/2014	A666	129,5	24 540	401,2	200,8	145,2		2,099	19,0		1,76	96,64%	
05/03/2014	A667	129,7	24 480	401,2	200,8	144,8		2,099	19,0		1,76	96,68%	
05/03/2014	A668	129,4	24 420	401,2	200,5	144,8		2,096	19,0		1,76	96,28%	
05/03/2014	A669	129,5	24 540	401,3	200,8	145,5		2,093	19,0		1,76	95,91%	
05/03/2014	A67	129,2	24 620	401,3	201,1	145,7		2,094	19,0		1,76	95,98%	
05/03/2014	A670	129,4	24 480	401,4	200,9	145,4		2,089	19,0		1,76	95,32%	
05/03/2014	A671	129,4	24 520	401,2	200,8	145,6		2,090	19,0		1,76	95,43%	
05/03/2014	A672	129,4	24 520	401,2	200,7	145,4		2,094	19,0		1,76	96,00%	
05/03/2014	A673	129,7	24 520	401,1	200,8	145,1		2,098	19,0		1,76	96,53%	
05/03/2014	A674	129,5	24 560	401,3	200,6	145,0		2,104	19,0		1,77	97,32%	
05/03/2014	A675	129,4	24 540	401,4	200,7	145,1		2,099	19,0		1,76	96,70%	
05/03/2014	A676	129,6	24 540	401,6	200,8	145,6		2,091	19,0		1,76	95,60%	
05/03/2014	A677	129,5	24 580	401,1	200,7	145,2		2,103	19,0		1,77	97,25%	
05/03/2014	A678	129,6	24 500	401,5	200,8	145,2		2,093	19,0		1,76	95,85%	
05/03/2014	A679	129,5	24 560	401,3	201,0	145,7		2,091	19,0		1,76	95,55%	
05/03/2014	A68	129,2	24 540	401,3	201,0	145,3		2,094	19,0		1,76	96,01%	
05/03/2014	A680	129,6	24 580	401,5	200,6	145,4		2,098	19,0		1,76	96,54%	
05/03/2014	A681	129,4	24 760	401,5	200,9	145,4		2,111	19,0		1,77	98,29%	
05/03/2014	A682	129,4	24 740	401,6	201,5	145,7		2,099	19,0		1,76	96,67%	
05/03/2014	A683	129,6	24 560	401,1	200,9	145,7		2,092	19,0		1,76	95,72%	
05/03/2014	A684	129,4	24 620	401,2	200,9	145,6		2,097	19,0		1,76	96,46%	
05/03/2014	A685	129,6	24 580	401,7	200,9	145,2		2,098	19,0		1,76	96,49%	
05/03/2014	A686	129,5	24 540	401,5	200,9	145,1		2,097	19,0		1,76	96,33%	
05/03/2014	A687	129,4	24 580	401,6	200,8	145,4		2,097	19,0		1,76	96,37%	
05/03/2014	A688	129,4	24 560	401,5	201,1	144,9		2,099	19,0		1,76	96,68%	
05/03/2014	A689	129,4	24 600	401,3	200,9	145,7		2,095	19,0		1,76	96,16%	
05/03/2014	A69	129,1	24 560	401,4	201,0	145,3		2,095	19,0		1,76	96,19%	
05/03/2014	A690	129,6	24 500	401,6	201,0	144,9		2,094	19,0		1,76	96,04%	
05/03/2014	A691	129,2	24 660	401,6	200,8	145,8		2,098	19,0		1,76	96,46%	
05/03/2014	A692	129,4	24 560	401,7	200,9	145,2		2,097	19,0		1,76	96,34%	
05/03/2014	A693	129,4	24 580	401,5	200,8	145,2		2,100	19,0		1,76	96,75%	
05/03/2014	A694	129,5	24 640	401,2	201,0	145,8		2,096	19,0		1,76	96,26%	
05/03/2014	A695	129,4	24 540	401,2	200,8	145,1		2,100	19,0		1,76	96,75%	
05/03/2014	A696	129,6	24 540	401,3	200,8	145,3		2,096	19,0		1,76	96,30%	
05/03/2014	A697	129,4	24 580	401,5	200,7	145,4		2,097	19,0		1,76	96,45%	
05/03/2014	A698	129,5	24 560	401,2	200,7	145,4		2,098	19,0		1,76	96,47%	
05/03/2014	A699	129,6	24 660	401,3	200,7	145,9		2,099	19,0		1,76	96,69%	
05/03/2014	A7	130,2	24 600	401,3	200,1	145,6		2,104	19,0		1,77	97,30%	
05/03/2014	A70	129,2	24 580	401,2	201,0	145,6	Pièce écartée pour Rc	2,094	19,0	17,71	1,76	95,95%	9,9 - 9,3
05/03/2014	A700	129,7	24 600	401,0	200,7	145,0		2,108	19,0		1,77	97,83%	
05/03/2014	A701	129,4	24 580	401,2	200,8	145,1		2,104	19,0		1,77	97,29%	
05/03/2014	A702	129,4	24 680	401,4	200,8	145,4		2,106	19,0		1,77	97,63%	
05/03/2014	A703	129,6	24 600	401,4	200,9	145,5		2,098	19,0		1,76	96,48%	
05/03/2014	A704	129,4	24 640	401,2	200,8	145,4		2,105	19,0		1,77	97,41%	
05/03/2014	A705	129,5	24 620	401,3	201,0	145,3		2,102	19,0		1,77	97,00%	
05/03/2014	A706	129,4	24 580	401,4	200,8	145,3		2,098	19,0		1,76	96,59%	
05/03/2014	A707	129,5	24 540	401,2	200,6	144,8		2,106	19,0		1,77	97,61%	
05/03/2014	A708	129,7	24 600	401,3	200,8	145,2		2,104	19,0		1,77	97,27%	
05/03/2014	A709	129,6	24 580	401,4	200,8	145,1		2,102	19,0		1,77	97,02%	
05/03/2014	A71	128,9	24 540	401,4	200,9	145,4		2,093	19,0		1,76	95,92%	
05/03/2014	A710	129,6	24 620	401,6	200,5	145,4		2,103	19,0		1,77	97,16%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A711**	129,4	24 580	401,4	200,6	145,3		**2,101**	19,0		1,77	96,98%	
05/03/2014	**A712**	129,6	24 580	401,3	200,7	145,1		**2,103**	19,0		1,77	97,18%	
05/03/2014	**A713**	129,5	24 540	401,6	201,0	145,3		**2,093**	19,0		1,76	95,83%	
05/03/2014	**A714**	129,5	24 620	401,7	201,0	145,5		**2,097**	19,0		1,76	96,35%	
05/03/2014	**A715**	129,4	24 580	401,7	200,9	145,2		**2,098**	19,0		1,76	96,48%	
05/03/2014	**A716**	129,7	24 620	401,4	200,6	145,4		**2,103**	19,0		1,77	97,21%	
05/03/2014	**A717**	129,4	24 580	401,5	200,7	145,3		**2,100**	19,0		1,76	96,75%	
05/03/2014	**A718**	129,7	24 620	401,5	201,0	145,8		**2,094**	19,0		1,76	95,97%	
05/03/2014	**A719**	129,8	24 560	401,2	201,0	145,5		**2,094**	19,0		1,76	96,01%	
05/03/2014	**A72**	130,4	24 580	401,5	200,9	145,7		**2,092**	19,0		1,76	95,70%	
05/03/2014	**A720**	129,4	24 600	401,4	200,8	145,2		**2,102**	19,0		1,77	97,07%	
05/03/2014	**A721**	129,6	24 420	401,3	200,6	144,8		**2,096**	19,0		1,76	96,22%	
05/03/2014	**A722**	129,4	24 600	401,2	200,4	145,2		**2,106**	19,0		1,77	97,65%	
05/03/2014	**A723**	129,9	24 480	401,2	200,4	145,2		**2,097**	19,0		1,76	96,38%	
05/03/2014	**A724**	129,4	24 520	401,2	200,6	145,1		**2,100**	19,0		1,76	96,77%	
05/03/2014	**A725**	129,3	24 420	401,2	200,4	145,3		**2,090**	19,0		1,76	95,53%	
05/03/2014	**A726**	130,9	24 480	401,3	200,5	145,3		**2,094**	19,0		1,76	96,06%	
05/03/2014	**A727**	129,6	24 460	401,4	200,5	145,2		**2,094**	19,0		1,76	95,96%	
05/03/2014	**A728**	129,4	24 460	401,3	200,6	144,9		**2,097**	19,0		1,76	96,38%	
05/03/2014	**A729**	129,6	24 460	401,2	200,4	145,0		**2,098**	19,0		1,76	96,51%	
05/03/2014	**A73**	129,1	24 660	401,5	201,1	145,6		**2,098**	19,0		1,76	96,51%	
05/03/2014	**A730**	129,5	24 440	401,1	200,5	145,1		**2,094**	19,0		1,76	96,06%	
05/03/2014	**A731**	129,7	24 460	401,2	200,6	145,0		**2,096**	19,0		1,76	96,27%	
05/03/2014	**A732**	129,6	24 480	401,3	200,6	145,2		**2,094**	19,0		1,76	95,99%	
05/03/2014	**A733**	129,6	24 480	401,2	200,4	144,7		**2,104**	19,0		1,77	97,30%	
05/03/2014	**A734**	129,4	24 460	401,3	200,5	145,1		**2,096**	19,0		1,76	96,25%	
05/03/2014	**A735**	129,7	24 460	401,4	200,4	145,2		**2,094**	19,0		1,76	96,05%	
05/03/2014	**A736**	129,4	24 480	401,6	200,5	145,1		**2,095**	19,0		1,76	96,13%	
05/03/2014	**A737**	129,5	24 460	401,2	200,7	145,2		**2,092**	19,0		1,76	95,72%	
05/03/2014	**A738**	130,9	24 420	401,1	200,6	145,1		**2,092**	19,0		1,76	95,69%	
05/03/2014	**A739**	129,3	24 400	400,8	200,9	145,0		**2,091**	19,0		1,76	95,63%	
05/03/2014	**A74**	129,2	24 640	401,4	201,0	145,6		**2,099**	19,0		1,76	96,63%	
05/03/2014	**A740**	129,4	24 440	401,1	200,8	144,7		**2,097**	19,0		1,76	96,42%	
05/03/2014	**A741**	129,5	24 440	401,2	200,7	145,3		**2,089**	19,0		1,76	95,40%	
05/03/2014	**A742**	129,5	24 460	401,2	200,7	145,2		**2,093**	19,0		1,76	95,85%	
05/03/2014	**A743**	129,7	24 480	401,4	200,5	145,4		**2,093**	19,0		1,76	95,81%	
05/03/2014	**A744**	129,6	24 480	401,4	200,8	145,2		**2,092**	19,0		1,76	95,76%	
05/03/2014	**A745**	129,5	24 460	401,5	200,6	145,0		**2,095**	19,0		1,76	96,12%	
05/03/2014	**A746**	129,7	24 460	401,2	200,4	145,3		**2,093**	19,0		1,76	95,84%	
05/03/2014	**A747**	129,5	24 440	401,3	200,5	145,1		**2,094**	19,0		1,76	95,97%	
05/03/2014	**A748**	129,6	24 400	401,1	200,6	144,9		**2,093**	19,0		1,76	95,89%	
05/03/2014	**A749**	129,4	24 480	401,2	200,7	145,3		**2,092**	19,0		1,76	95,71%	
05/03/2014	**A75**	129,0	24 620	401,3	201,0	145,8		**2,093**	19,0		1,76	95,87%	
05/03/2014	**A750**	129,6	24 420	401,6	200,7	144,9		**2,091**	19,0		1,76	95,64%	
05/03/2014	**A751**	129,4	24 460	401,5	200,6	146,3	Pièce écartée pour Rc	**2,076**	19,0	17,97	1,74	93,66%	8,6 - 8,6
05/03/2014	**A752**	129,4	24 580	401,2	200,5	145,8		**2,095**	19,0		1,76	96,10%	
05/03/2014	**A753**	129,4	24 620	401,3	200,7	145,8		**2,097**	19,0		1,76	96,33%	
05/03/2014	**A754**	129,5	24 540	401,2	200,7	145,6		**2,094**	19,0		1,76	95,96%	
05/03/2014	**A755**	129,5	24 520	401,3	200,7	145,5		**2,092**	19,0		1,76	95,79%	
05/03/2014	**A756**	129,4	24 500	401,1	200,6	145,8		**2,089**	19,0		1,76	95,33%	
05/03/2014	**A757**	129,7	24 500	401,3	200,4	145,4		**2,095**	19,0		1,76	96,08%	
05/03/2014	**A758**	129,7	24 440	401,2	200,5	145,6		**2,087**	19,0		1,75	95,05%	
05/03/2014	**A759**	129,4	24 480	401,2	200,7	146,0		**2,082**	19,0		1,75	94,48%	
05/03/2014	**A76**	130,3	24 640	401,7	201,0	145,8		**2,093**	19,0		1,76	95,82%	
05/03/2014	**A760**	129,7	24 500	401,2	200,6	145,7		**2,090**	19,0		1,76	95,45%	
05/03/2014	**A761**	129,5	24 440	401,4	200,7	145,3		**2,087**	19,0		1,75	95,14%	
05/03/2014	**A762**	129,4	24 460	401,2	200,9	145,2		**2,091**	19,0		1,76	95,60%	
05/03/2014	**A763**	129,5	24 500	401,2	200,6	145,1		**2,099**	19,0		1,76	96,62%	
05/03/2014	**A764**	129,5	24 460	401,5	200,6	145,3		**2,091**	19,0		1,76	95,56%	
05/03/2014	**A765**	129,5	24 480	401,2	200,6	145,4		**2,092**	19,0		1,76	95,78%	
05/03/2014	**A766**	129,7	24 460	401,2	200,7	145,0		**2,094**	19,0		1,76	96,03%	
05/03/2014	**A767**	129,4	24 420	401,0	200,8	145,1		**2,090**	19,0		1,76	95,53%	
05/03/2014	**A768**	129,5	24 440	401,4	200,9	144,9		**2,092**	19,0		1,76	95,77%	
05/03/2014	**A769**	129,5	24 500	401,2	200,7	145,3		**2,094**	19,0		1,76	95,94%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	A77	128,9	24 640	401,4	201,0	145,4		2,101	19,0		1,77	96,89%	
05/03/2014	A770	129,7	24 440	401,2	200,6	144,9		2,095	19,0		1,76	96,13%	
05/03/2014	A771	129,5	24 460	401,2	201,0	145,3		2,088	19,0		1,75	95,26%	
05/03/2014	A772	129,4	24 480	401,2	200,7	145,7		2,087	19,0		1,75	95,03%	
05/03/2014	A773	130,9	24 460	401,3	200,8	145,3		2,089	19,0		1,76	95,40%	
05/03/2014	A774	129,4	24 440	401,2	200,6	145,0		2,094	19,0		1,76	96,01%	
05/03/2014	A775	129,3	24 420	401,2	200,4	144,9		2,096	19,0		1,76	96,26%	
05/03/2014	A776	129,6	24 480	401,3	200,9	145,4		2,100	19,0		1,77	96,84%	
05/03/2014	A777	129,9	24 580	401,3	200,6	145,9		2,091	19,0		1,76	95,58%	
05/03/2014	A778	129,5	24 540	401,4	200,5	145,2		2,093	19,0		1,76	95,81%	
05/03/2014	A779	129,4	24 680	401,2	200,6	146,1		2,091	19,0		1,76	95,61%	
05/03/2014	A78	129,0	24 580	401,3	201,1	145,0		2,100	19,0		1,76	96,82%	
05/03/2014	A780	129,6	24 500	401,4	200,7	145,0		2,092	19,0		1,76	95,78%	
05/03/2014	A781	129,5	24 620	401,1	200,9	145,8		2,096	19,0		1,76	96,27%	
05/03/2014	A782	129,4	24 580	401,7	200,7	145,6		2,095	19,0		1,76	96,09%	
05/03/2014	A783	129,4	24 600	401,4	200,7	145,7		2,096	19,0		1,76	96,27%	
05/03/2014	A784	129,4	24 560	401,4	200,6	145,7		2,093	19,0		1,76	95,85%	
05/03/2014	A785	129,4	24 560	401,2	200,6	145,3		2,101	19,0		1,77	96,96%	
05/03/2014	A786	129,4	24 620	401,3	200,7	145,8		2,096	19,0		1,76	96,29%	
05/03/2014	A787	129,6	24 600	401,4	201,6	145,8		2,086	19,0		1,75	94,95%	
05/03/2014	A788	129,4	24 580	401,3	200,6	145,9		2,093	19,0		1,76	95,86%	
05/03/2014	A789	129,7	24 560	401,3	200,7	145,4		2,098	19,0		1,76	96,54%	
05/03/2014	A79	129,2	24 760	401,6	201,0	145,7		2,105	19,0		1,77	97,48%	
05/03/2014	A790	129,6	24 600	401,3	200,5	146,0		2,094	19,0		1,76	96,04%	
05/03/2014	A791	129,5	24 440	401,4	200,6	144,9		2,095	19,0		1,76	96,11%	
05/03/2014	A792	129,4	24 540	401,2	200,6	145,5		2,095	19,0		1,76	96,15%	
05/03/2014	A793	129,7	24 580	401,4	200,6	145,3		2,101	19,0		1,77	96,89%	
05/03/2014	A794	129,6	24 560	401,5	200,5	145,2		2,100	19,0		1,77	96,84%	
05/03/2014	A795	129,4	24 460	401,2	200,6	145,4		2,091	19,0		1,76	95,58%	
05/03/2014	A796	129,4	24 500	401,2	200,6	145,5		2,093	19,0		1,76	95,81%	
05/03/2014	A797	129,4	24 440	401,3	200,5	145,3		2,091	19,0		1,76	95,61%	
05/03/2014	A798	129,4	24 500	401,3	200,8	145,7		2,088	19,0		1,75	95,18%	
05/03/2014	A799	129,7	24 420	401,2	200,7	144,9		2,092	19,0		1,76	95,78%	
05/03/2014	A8	129,9	24 400	401,1	200,4	145,2		2,090	19,0		1,76	95,51%	
05/03/2014	A80	128,9	24 780	401,7	201,2	145,7		2,104	19,0	17,31	1,77	97,33%	
05/03/2014	A800	129,5	24 440	401,3	200,7	145,2		2,090	19,0		1,76	95,47%	
05/03/2014	A801	129,4	24 420	401,2	200,6	145,9		2,079	19,0		1,75	94,08%	
05/03/2014	A802	129,4	24 520	401,1	200,6	145,8		2,091	19,0		1,76	95,62%	
05/03/2014	A803	129,6	24 460	401,2	200,6	145,4		2,091	19,0		1,76	95,54%	
05/03/2014	A804	129,4	24 440	401,4	200,8	145,8		2,081	19,0		1,75	94,33%	
05/03/2014	A805	129,6	24 420	401,3	200,7	145,9		2,079	19,0		1,75	94,07%	
05/03/2014	A806	129,5	24 480	401,1	200,6	145,5		2,091	19,0		1,76	95,58%	
05/03/2014	A807	129,5	24 440	401,3	200,5	145,5		2,088	19,0		1,75	95,19%	
05/03/2014	A808	129,5	24 400	401,1	200,7	145,1		2,089	19,0		1,76	95,33%	
05/03/2014	A809	129,5	24 440	401,2	200,5	145,8		2,084	19,0		1,75	94,73%	
05/03/2014	A81	128,9	24 800	401,6	201,2	146,3		2,098	19,0		1,76	96,58%	
05/03/2014	A810	129,4	24 440	401,0	200,7	144,9		2,095	19,0		1,76	96,19%	
05/03/2014	A811	129,7	24 540	401,1	200,6	145,3		2,100	19,0		1,76	96,76%	
05/03/2014	A812	129,8	24 540	401,2	200,6	145,1		2,101	19,0		1,77	96,99%	
05/03/2014	A813	129,4	24 560	401,1	200,7	145,6		2,096	19,0		1,76	96,24%	
05/03/2014	A814	129,5	24 500	401,1	200,6	145,2		2,098	19,0		1,76	96,49%	
05/03/2014	A815	129,7	24 620	401,4	200,5	145,5		2,103	19,0		1,77	97,19%	
05/03/2014	A816	129,6	24 520	401,1	200,5	145,4		2,098	19,0		1,76	96,51%	
05/03/2014	A817	129,6	24 560	401,3	200,7	145,3		2,100	19,0		1,76	96,73%	
05/03/2014	A818	129,4	24 520	401,0	200,5	145,2		2,101	19,0		1,77	96,94%	
05/03/2014	A819	129,4	24 580	401,3	200,5	145,3		2,102	19,0		1,77	97,06%	
05/03/2014	A82	128,9	24 920	402,0	201,1	146,4		2,106	19,0		1,77	97,66%	
05/03/2014	A820	129,5	24 500	401,2	200,8	145,4		2,093	19,0		1,76	95,81%	
05/03/2014	A821	129,7	24 540	401,1	200,6	145,9		2,090	19,0		1,76	95,52%	
05/03/2014	A822	129,5	24 520	401,3	200,7	145,0		2,099	19,0		1,76	96,70%	
05/03/2014	A823	129,6	24 620	400,8	200,3	145,0		2,115	19,0		1,78	98,85%	
05/03/2014	A824	129,5	24 560	401,3	200,4	145,1		2,105	19,0		1,77	97,40%	
05/03/2014	A825	129,4	24 540	401,3	200,5	144,9		2,105	19,0		1,77	97,44%	
05/03/2014	A826	129,6	24 560	400,9	200,6	145,7		2,096	19,0		1,76	96,23%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A827**	129,5	24 560	401,3	200,6	145,3		**2,099**	19,0		1,76	96,61%	
05/03/2014	**A828**	130,8	24 520	401,0	200,5	145,0		**2,103**	19,0		1,77	97,16%	
05/03/2014	**A829**	129,4	24 540	401,3	200,8	145,0		**2,100**	19,0		1,76	96,83%	
05/03/2014	**A83**	130,5	24 780	401,6	201,0	146,1		**2,101**	19,0		1,77	96,99%	
05/03/2014	**A830**	129,5	24 620	401,2	200,8	145,6		**2,099**	19,0		1,76	96,70%	
05/03/2014	**A831**	129,6	24 580	401,2	200,7	145,5		**2,098**	19,0		1,76	96,46%	
05/03/2014	**A832**	129,6	24 540	401,4	200,7	145,1		**2,100**	19,0		1,76	96,80%	
05/03/2014	**A833**	129,6	24 600	401,2	200,7	145,6		**2,099**	19,0		1,76	96,62%	
05/03/2014	**A834**	129,6	24 540	401,1	200,7	145,1		**2,101**	19,0		1,77	96,95%	
05/03/2014	**A835**	129,5	24 600	401,4	200,9	145,5		**2,097**	19,0		1,76	96,43%	
05/03/2014	**A836**	129,4	24 600	401,4	200,6	145,4		**2,101**	19,0		1,77	96,93%	
05/03/2014	**A837**	129,4	24 560	401,3	200,8	145,5		**2,096**	19,0		1,76	96,22%	
05/03/2014	**A838**	129,5	24 560	401,3	200,6	145,4		**2,099**	19,0		1,76	96,62%	
05/03/2014	**A839**	129,6	24 580	401,1	200,7	145,2		**2,103**	19,0		1,77	97,19%	
05/03/2014	**A84**	128,8	25 000	401,7	201,4	146,5		**2,108**	19,0		1,77	97,90%	
05/03/2014	**A840**	129,5	24 600	401,0	201,0	145,3		**2,101**	19,0		1,77	96,87%	
05/03/2014	**A841**	129,8	24 540	401,4	200,9	145,5		**2,091**	19,0		1,76	95,58%	
05/03/2014	**A842**	129,4	24 560	401,2	200,7	145,6		**2,095**	19,0		1,76	96,14%	
05/03/2014	**A843**	129,5	24 580	401,1	200,5	145,6		**2,099**	19,0		1,76	96,61%	
05/03/2014	**A844**	129,5	24 520	401,6	200,6	145,3		**2,095**	19,0		1,76	96,15%	
05/03/2014	**A845**	129,5	24 620	401,1	200,8	145,7		**2,099**	19,0		1,76	96,69%	
05/03/2014	**A846**	129,6	24 540	401,4	200,5	145,6		**2,095**	19,0		1,76	96,11%	
05/03/2014	**A847**	129,5	24 580	401,2	200,7	146,0		**2,092**	19,0		1,76	95,75%	
05/03/2014	**A848**	129,6	24 600	401,3	200,6	145,4		**2,102**	19,0		1,77	97,10%	
05/03/2014	**A849**	129,5	24 580	401,4	200,6	145,4		**2,099**	19,0		1,76	96,70%	
05/03/2014	**A85**	130,6	24 800	401,6	201,3	145,7		**2,105**	19,0		1,77	97,48%	
05/03/2014	**A850**	129,6	24 580	401,2	200,9	145,2		**2,100**	19,0		1,76	96,78%	
05/03/2014	**A851**	129,4	24 600	401,3	200,6	145,5		**2,099**	19,0		1,76	96,70%	
05/03/2014	**A852**	129,7	24 580	401,3	200,9	146,0		**2,089**	19,0		1,76	95,38%	
05/03/2014	**A853**	129,6	24 540	401,5	200,7	145,3		**2,097**	19,0		1,76	96,35%	
05/03/2014	**A854**	129,8	24 540	401,4	200,8	145,1		**2,098**	19,0		1,76	96,54%	
05/03/2014	**A855**	129,4	24 580	401,3	200,5	145,4		**2,101**	19,0		1,77	96,93%	
05/03/2014	**A856**	129,5	24 580	401,1	200,6	145,9		**2,094**	19,0		1,76	95,96%	
05/03/2014	**A857**	129,6	24 480	401,1	200,4	144,9		**2,101**	19,0		1,77	96,93%	
05/03/2014	**A858**	129,6	24 600	401,2	200,6	145,5		**2,101**	19,0		1,77	96,91%	
05/03/2014	**A859**	129,5	24 500	401,3	200,9	145,0		**2,096**	19,0		1,76	96,32%	
05/03/2014	**A86**	128,9	24 680	401,6	201,0	145,8		**2,098**	19,0		1,76	96,46%	
05/03/2014	**A860**	129,8	24 440	401,1	200,5	145,2		**2,093**	19,0		1,76	95,91%	
05/03/2014	**A861**	129,7	24 460	401,2	200,5	145,1		**2,095**	19,0		1,76	96,18%	
05/03/2014	**A862**	129,4	24 480	401,2	200,8	145,3		**2,091**	19,0		1,76	95,58%	
05/03/2014	**A863**	129,5	24 540	401,2	200,8	145,2		**2,098**	19,0		1,76	96,52%	
05/03/2014	**A864**	129,4	24 520	401,2	200,8	145,3		**2,095**	19,0		1,76	96,11%	
05/03/2014	**A865**	129,5	24 480	401,1	200,5	145,1		**2,099**	19,0		1,76	96,62%	
05/03/2014	**A866**	129,6	24 440	401,2	200,5	145,1		**2,094**	19,0		1,76	96,04%	
05/03/2014	**A867**	129,4	24 480	401,2	200,5	145,5		**2,092**	19,0		1,76	95,72%	
05/03/2014	**A868**	129,6	24 400	401,2	200,5	145,4		**2,087**	19,0		1,75	95,07%	
05/03/2014	**A869**	129,5	24 500	401,1	200,8	145,3		**2,093**	19,0		1,76	95,88%	
05/03/2014	**A87**	128,9	24 580	401,5	201,0	145,7		**2,090**	19,0		1,76	95,49%	
05/03/2014	**A870**	129,7	24 500	401,3	200,7	146,0		**2,084**	19,0		1,75	94,75%	
05/03/2014	**A871**	129,4	24 560	401,3	200,9	145,5		**2,094**	19,0		1,76	95,97%	
05/03/2014	**A872**	129,5	24 580	401,4	200,7	145,7		**2,095**	19,0		1,76	96,08%	
05/03/2014	**A873**	130,3	24 640	401,2	200,6	145,7		**2,101**	19,0		1,77	96,98%	
05/03/2014	**A874**	129,4	24 600	401,1	201,0	145,8		**2,093**	19,0		1,76	95,86%	
05/03/2014	**A875**	129,5	24 600	401,3	200,8	145,6		**2,097**	19,0		1,76	96,34%	
05/03/2014	**A876**	129,4	24 600	401,2	200,7	145,6		**2,097**	19,0		1,76	96,45%	
05/03/2014	**A877**	129,4	24 620	401,2	200,8	145,5		**2,100**	19,0		1,76	96,76%	
05/03/2014	**A878**	129,6	24 620	401,4	200,6	145,7		**2,099**	19,0		1,76	96,63%	
05/03/2014	**A879**	129,4	24 600	401,3	200,7	145,6		**2,098**	19,0		1,76	96,54%	
05/03/2014	**A88**	128,9	24 580	401,4	200,8	146,2		**2,086**	19,0		1,75	94,94%	
05/03/2014	**A880**	129,6	24 620	401,2	200,8	145,6		**2,100**	19,0		1,76	96,76%	
05/03/2014	**A881**	129,7	24 600	401,2	200,9	145,5		**2,097**	19,0		1,76	96,34%	
05/03/2014	**A882**	129,5	24 600	401,1	200,9	145,6		**2,097**	19,0		1,76	96,43%	
05/03/2014	**A883**	129,4	24 680	401,3	200,7	145,9		**2,100**	19,0		1,76	96,79%	
05/03/2014	**A884**	129,4	24 600	401,2	200,6	145,6		**2,099**	19,0		1,76	96,72%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A885**	129,7	24 560	401,4	200,7	145,2		**2,100**	19,0		1,76	96,81%	
05/03/2014	**A886**	129,4	24 620	401,5	200,8	145,5		**2,098**	19,0		1,76	96,53%	
05/03/2014	**A887**	129,5	24 640	401,4	200,6	145,4		**2,105**	19,0		1,77	97,42%	
05/03/2014	**A888**	129,4	24 580	401,5	201,0	145,3		**2,097**	19,0		1,76	96,43%	
05/03/2014	**A889**	129,5	24 560	401,2	200,6	145,4		**2,099**	19,0		1,76	96,69%	
05/03/2014	**A89**	129,0	24 540	401,3	200,9	145,4		**2,093**	19,0		1,76	95,88%	
05/03/2014	**A890**	129,5	24 660	401,1	200,5	145,7		**2,104**	19,0		1,77	97,31%	
05/03/2014	**A891**	129,4	24 600	401,1	200,3	145,2		**2,109**	19,0		1,77	97,98%	
05/03/2014	**A892**	129,4	24 580	401,3	200,6	145,2		**2,102**	19,0		1,77	97,10%	
05/03/2014	**A893**	129,4	24 560	401,3	200,6	145,3		**2,100**	19,0		1,76	96,83%	
05/03/2014	**A894**	129,6	24 640	401,5	200,5	145,7		**2,102**	19,0		1,77	97,03%	
05/03/2014	**A895**	129,3	24 660	401,5	200,5	145,7		**2,102**	19,0		1,77	97,12%	
05/03/2014	**A896**	129,4	24 540	401,5	200,5	145,1		**2,101**	19,0		1,77	96,92%	
05/03/2014	**A897**	129,4	24 620	401,6	200,4	145,3		**2,106**	19,0		1,77	97,63%	
05/03/2014	**A898**	129,4	24 600	401,4	200,7	145,8		**2,095**	19,0		1,76	96,11%	
05/03/2014	**A899**	129,7	24 580	401,1	200,9	145,3		**2,100**	19,0		1,76	96,82%	
05/03/2014	**A9**	129,9	24 440	401,2	200,4	144,6		**2,103**	19,0		1,77	97,19%	
05/03/2014	**A90**	128,9	24 540	401,3	201,0	145,9	Pièce écartée pour Rc	**2,086**	19,0	17,70	1,75	94,91%	8,3 - 8,8
05/03/2014	**A900**	129,4	24 660	401,5	200,5	145,6		**2,104**	19,0		1,77	97,35%	
05/03/2014	**A901**	129,8	24 420	401,4	200,5	145,3		**2,088**	19,0		1,75	95,19%	
05/03/2014	**A902**	129,6	24 580	401,4	200,4	144,9		**2,109**	19,0		1,77	97,97%	
05/03/2014	**A903**	129,6	24 440	401,5	200,5	145,5		**2,087**	19,0		1,75	95,09%	
05/03/2014	**A904**	129,6	24 460	401,3	200,4	145,5		**2,090**	19,0		1,76	95,50%	
05/03/2014	**A905**	129,4	24 460	401,6	200,7	145,9		**2,080**	19,0		1,75	94,14%	
05/03/2014	**A906**	129,4	24 380	401,3	200,7	145,3		**2,083**	19,0		1,75	94,61%	
05/03/2014	**A907**	129,4	24 420	401,7	200,4	145,2		**2,090**	19,0		1,76	95,49%	
05/03/2014	**A908**	129,4	24 480	401,5	200,4	145,3		**2,095**	19,0		1,76	96,07%	
05/03/2014	**A909**	129,4	24 460	401,7	200,4	145,3		**2,091**	19,0		1,76	95,58%	
05/03/2014	**A91**	129,1	24 300	401,0	200,7	144,1	Léger collage supérieur	**2,095**	19,0		1,76	96,15%	
05/03/2014	**A910**	129,5	24 440	401,5	200,4	145,2		**2,092**	19,0		1,76	95,71%	
05/03/2014	**A911**	129,7	24 440	401,5	200,4	145,2		**2,093**	19,0		1,76	95,84%	
05/03/2014	**A912**	129,7	24 440	401,4	200,4	145,0		**2,095**	19,0		1,76	96,18%	
05/03/2014	**A913**	129,5	24 440	401,3	200,3	145,2		**2,094**	19,0		1,76	95,98%	
05/03/2014	**A914**	129,4	24 420	401,3	200,4	145,0		**2,095**	19,0		1,76	96,19%	
05/03/2014	**A915**	129,8	24 480	401,3	200,4	145,5		**2,092**	19,0		1,76	95,77%	
05/03/2014	**A916**	129,4	24 460	401,4	200,4	145,5		**2,089**	19,0		1,76	95,38%	
05/03/2014	**A917**	129,7	24 440	401,5	200,4	145,2		**2,093**	19,0		1,76	95,85%	
05/03/2014	**A918**	129,5	24 480	401,4	200,4	145,6		**2,090**	19,0		1,76	95,52%	
05/03/2014	**A919**	129,4	24 540	401,5	200,4	145,4		**2,098**	19,0		1,76	96,54%	
05/03/2014	**A92**	128,9	24 320	401,4	200,7	145,0		**2,082**	19,0		1,75	94,47%	
05/03/2014	**A920**	129,6	24 560	401,4	200,4	145,5		**2,098**	19,0		1,76	96,50%	
05/03/2014	**A921**	129,5	24 520	401,4	200,3	145,2		**2,100**	19,0		1,76	96,81%	
05/03/2014	**A922**	129,3	24 520	401,4	200,5	145,4		**2,095**	19,0		1,76	96,11%	
05/03/2014	**A923**	129,7	24 520	401,6	200,4	145,3		**2,097**	19,0		1,76	96,37%	
05/03/2014	**A924**	129,4	24 500	401,4	200,6	145,3		**2,095**	19,0		1,76	96,07%	
05/03/2014	**A925**	129,6	24 520	401,5	200,4	145,4		**2,097**	19,0		1,76	96,34%	
05/03/2014	**A926**	129,4	24 580	401,4	200,5	145,5		**2,099**	19,0		1,76	96,69%	
05/03/2014	**A927**	129,4	24 600	401,3	200,4	145,5		**2,101**	19,0		1,77	96,99%	
05/03/2014	**A928**	129,4	24 540	401,7	200,5	145,3		**2,097**	19,0		1,76	96,41%	
05/03/2014	**A929**	129,4	24 600	401,5	200,6	145,6		**2,098**	19,0		1,76	96,59%	
05/03/2014	**A93**	129,1	24 480	401,8	200,8	145,1		**2,091**	19,0		1,76	95,58%	
05/03/2014	**A930**	129,3	24 560	401,1	200,5	145,2		**2,103**	19,0		1,77	97,19%	
05/03/2014	**A931**	129,4	24 540	401,4	200,4	145,5	ce coupée pour analyse de cr	**2,097**	19,0		1,76	96,45%	
05/03/2014	**A932**	129,4	24 420	401,3	200,3	145,1		**2,094**	19,0		1,76	95,98%	
05/03/2014	**A933**	130,9	24 460	401,3	200,5	145,6		**2,088**	19,0		1,75	95,26%	
05/03/2014	**A934**	129,4	24 420	401,4	200,3	145,0		**2,094**	19,0		1,76	95,96%	
05/03/2014	**A935**	129,4	24 480	401,2	200,7	145,7		**2,087**	19,0		1,75	95,06%	
05/03/2014	**A936**	130,9	24 440	401,5	200,8	145,8		**2,079**	19,0		1,75	94,11%	
05/03/2014	**A937**	129,3	24 440	401,6	200,4	145,3		**2,090**	19,0		1,76	95,46%	
05/03/2014	**A938**	130,8	24 380	401,4	200,5	145,0		**2,088**	19,0		1,75	95,27%	
05/03/2014	**A939**	129,4	24 480	401,4	200,5	145,4		**2,093**	19,0		1,76	95,85%	
05/03/2014	**A94**	128,9	24 440	401,1	200,7	145,0		**2,093**	19,0		1,76	95,83%	
05/03/2014	**A940**	129,4	24 440	401,5	200,4	145,2		**2,093**	19,0		1,76	95,87%	
05/03/2014	**A941**	129,7	24 380	401,5	200,4	145,4		**2,084**	19,0		1,75	94,66%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
05/03/2014	**A942**	129,3	24 400	401,4	200,8	145,0		**2,088**	19,0		1,75	95,22%	
05/03/2014	**A943**	129,4	24 500	401,4	200,4	145,8		**2,089**	19,0		1,76	95,37%	
05/03/2014	**A944**	129,4	24 380	401,4	200,4	144,8		**2,093**	19,0		1,76	95,90%	
05/03/2014	**A945**	129,4	24 420	401,5	200,4	145,0		**2,094**	19,0		1,76	95,95%	
05/03/2014	**A946**	129,4	24 500	401,4	200,7	145,4		**2,090**	19,0		1,76	95,54%	
05/03/2014	**A947**	129,5	24 480	401,4	200,7	145,6		**2,088**	19,0		1,75	95,27%	
05/03/2014	**A948**	129,5	24 460	401,4	200,6	145,8		**2,084**	19,0		1,75	94,68%	
05/03/2014	**A949**	129,4	24 480	401,4	200,4	145,5		**2,092**	19,0		1,76	95,69%	
05/03/2014	**A95**	129,2	24 400	401,3	200,8	145,0		**2,089**	19,0		1,76	95,28%	
05/03/2014	**A950**	129,6	24 440	401,4	200,3	145,2		**2,094**	19,0		1,76	95,97%	
05/03/2014	**A951**	129,2	24 480	401,4	200,3	145,3		**2,096**	19,0		1,76	96,25%	
05/03/2014	**A952**	129,5	24 480	401,3	200,5	145,2		**2,096**	19,0		1,76	96,20%	
05/03/2014	**A953**	129,4	24 460	401,3	200,4	145,5		**2,092**	19,0		1,76	95,68%	
05/03/2014	**A954**	129,5	24 460	401,6	200,4	145,3		**2,091**	19,0		1,76	95,65%	
05/03/2014	**A955**	129,4	24 520	401,6	200,4	145,3		**2,097**	19,0		1,76	96,36%	
05/03/2014	**A956**	129,4	24 520	401,4	200,4	145,4		**2,096**	19,0		1,76	96,25%	
05/03/2014	**A957**	129,4	24 540	401,4	200,5	145,3		**2,100**	19,0		1,76	96,75%	
05/03/2014	**A958**	129,3	24 580	401,3	200,4	145,4		**2,102**	19,0		1,77	97,13%	
05/03/2014	**A959**	129,4	24 540	401,5	200,5	145,3		**2,098**	19,0		1,76	96,58%	
05/03/2014	**A96**	128,9	24 440	401,3	200,8	144,9	Léger collage supérieur	**2,093**	19,0		1,76	95,83%	
05/03/2014	**A960**	129,4	24 540	401,6	200,7	145,7		**2,090**	19,0		1,76	95,48%	
05/03/2014	**A961**	129,7	24 420	401,3	200,8	145,6	Léger collage supérieur	**2,081**	19,0		1,75	94,29%	
06/03/2014	**A962**	129,5	24 480	401,2	200,9	145,6	Léger collage supérieur	**2,087**	19,0		1,75	95,08%	
06/03/2014	**A963**	130,9	24 340	401,3	201,0	144,2	Pièce écartée	**2,093**	19,0		1,76	95,80%	
06/03/2014	**A964**	131,0	24 520	401,4	201,0	145,3	Léger collage supérieur	**2,092**	19,0		1,76	95,75%	
06/03/2014	**A965**	131,0	24 380	401,4	200,8	144,5	Léger collage supérieur	**2,094**	19,0		1,76	95,95%	
06/03/2014	**A966**	130,9	24 420	401,5	200,7	144,6	Léger collage supérieur	**2,096**	19,0		1,76	96,23%	
06/03/2014	**A967**	131,0	24 440	401,6	200,7	144,8	Léger collage supérieur	**2,094**	19,0		1,76	95,98%	
06/03/2014	**A968**	131,0	24 440	401,5	200,7	144,9	Léger collage supérieur	**2,093**	19,0		1,76	95,87%	
06/03/2014	**A969**	130,9	24 400	401,3	201,1	145,0	Léger collage supérieur	**2,086**	19,0		1,75	94,94%	
05/03/2014	**A97**	129,0	24 440	401,3	200,9	145,4	Léger collage supérieur	**2,084**	19,0		1,75	94,72%	
06/03/2014	**A970**	130,9	24 700	401,4	201,1	145,4	Léger collage supérieur	**2,104**	19,0		1,77	97,39%	
06/03/2014	**A971**	129,7	24 400	401,2	200,7	145,1	Léger collage supérieur	**2,089**	19,0		1,76	95,35%	
06/03/2014	**A972**	129,4	24 420	401,5	201,0	145,1	Léger collage supérieur	**2,085**	19,0		1,75	94,88%	
06/03/2014	**A973**	129,6	24 440	401,5	200,7	145,1	Léger collage supérieur	**2,091**	19,0		1,76	95,56%	
06/03/2014	**A974**	129,6	24 420	401,4	200,7	144,7	Léger collage supérieur	**2,095**	19,0		1,76	96,15%	
06/03/2014	**A975**	129,5	24 440	401,6	200,8	145,0	Léger collage supérieur	**2,091**	19,0		1,76	95,62%	
06/03/2014	**A976**	129,5	24 480	401,5	200,8	145,2		**2,092**	19,0		1,76	95,72%	
06/03/2014	**A977**	129,5	24 460	401,5	200,8	145,1		**2,091**	19,0		1,76	95,66%	
06/03/2014	**A978**	129,4	24 440	401,5	200,6	144,9		**2,095**	19,0		1,76	96,12%	
06/03/2014	**A979**	129,4	24 440	401,5	200,6	144,8		**2,096**	19,0		1,76	96,26%	
05/03/2014	**A98**	129,3	24 420	401,2	200,7	144,8	Léger collage supérieur	**2,094**	19,0		1,76	96,06%	
06/03/2014	**A980**	129,4	24 440	401,5	200,7	144,9		**2,093**	19,0		1,76	95,89%	
06/03/2014	**A981**	129,6	24 460	401,2	201,0	145,3		**2,087**	19,0		1,75	95,09%	
06/03/2014	**A982**	129,6	24 380	401,6	200,9	144,9		**2,086**	19,0		1,75	94,96%	
06/03/2014	**A983**	129,6	24 420	401,3	200,8	145,0		**2,090**	19,0		1,76	95,43%	
06/03/2014	**A984**	129,5	24 480	401,5	200,9	145,4		**2,087**	19,0		1,75	95,05%	
06/03/2014	**A985**	129,5	24 420	401,5	200,8	144,8		**2,093**	19,0		1,76	95,82%	
06/03/2014	**A986**	129,6	24 460	401,4	200,6	145,1		**2,093**	19,0		1,76	95,90%	
06/03/2014	**A987**	130,9	24 460	401,5	200,7	145,0		**2,093**	19,0		1,76	95,89%	
06/03/2014	**A988**	129,5	24 500	401,4	200,7	145,2		**2,095**	19,0		1,76	96,10%	
06/03/2014	**A989**	129,4	24 380	401,4	200,8	145,2		**2,084**	19,0		1,75	94,63%	
05/03/2014	**A99**	128,9	24 420	401,1	200,8	144,9	Léger collage supérieur	**2,094**	19,0		1,76	95,94%	
06/03/2014	**A990**	129,7	24 400	401,4	200,6	145,3		**2,085**	19,0		1,75	94,80%	
06/03/2014	**A991**	130,9	24 420	401,4	200,6	145,6		**2,083**	19,0		1,75	94,56%	
06/03/2014	**A992**	129,4	24 400	401,5	201,0	145,4		**2,080**	19,0		1,75	94,21%	
06/03/2014	**A993**	129,6	24 400	401,3	200,6	145,0		**2,091**	19,0		1,76	95,56%	
06/03/2014	**A994**	129,7	24 460	401,4	200,5	145,4		**2,090**	19,0		1,76	95,52%	
06/03/2014	**A995**	129,4	24 440	401,3	200,6	145,1		**2,093**	19,0		1,76	95,83%	
06/03/2014	**A996**	129,7	24 520	401,4	200,6	145,4		**2,094**	19,0		1,76	96,00%	
06/03/2014	**A997**	129,7	24 480	401,2	200,7	145,6		**2,088**	19,0		1,75	95,26%	
06/03/2014	**A998**	129,7	24 500	401,3	200,7	145,8		**2,087**	19,0		1,75	95,11%	
06/03/2014	**A999**	129,5	24 540	401,2	200,7	145,7		**2,091**	19,0		1,76	95,61%	
05/03/2014	**Exemple**	130,0	24 128	400,0	200,0	145,0		**2,080**	19,0		1,75	94,18%	

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce (mm)	Remarques	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Denisté sèche (g/cm3)	Degré de saturation (%)	Résistance à la compression (Mpa) 15x15x7 Echantillon dessus - échantiloon dessous
Average		129,6	24 517	401,3	200,6	145,3		2,096		18,00			
Std dev.		0,4	93	0,3	0,2	0,3		0,007		0,67			
Min		128,7	23 920	400,0	199,9	143,9		2,061		17,27			
Max		131,5	25 000	402,1	201,7	146,5		2,119		19,74			
Max-Min		2,8	1 080	2,1	1,8	2,6		0,059		2,47			

Spécifications	-	130 ± 5	11 650	400 ± 0,85	107 ± 0,85	202 ± 0,85	100 ± 0,85	2,080 ± 0,020	19 ± 1	19 ± 1	> 6	-	-
Mini	-	125	-	399,15	106,15	201,15	99,15	2,060	18	18	6	-	-
Maxi	-	135	-	400,85	107,85	202,85	100,85	2,100	20	20	-	-	-
Date	**Référence pièce**	**Pression de compactage (MPa)**	**Masse pièce compactée (g)**	**Longueur de pièce (mm)**	**Largeur de pièces (mm)**	**Hauteur de pièce sur la pointe (mm)**	**Epaisseur de pièce (mm)**	**Densité géométrique (g/cm3)**	**Teneur en eau théorique (%)**	**Teneur en eau mesurée (%)**	**Résistance à la compression (Mpa)**	**Agent de démoulage**	**Remarques**
10/03/2014	**Exemple**	130,0	11 544	400,0	107,0	202,0	100,0	2,080	19,0				
10/03/2014	**B1**	130,7	11 700	401,0	106,9	202,1	99,0	2,105	19,0				
10/03/2014	**B2**	132,4	11 660	401,0	107,3	202,4	98,9	2,099	19,0				
10/03/2014	**B3**	132,4	11 660	401,2	107,2	202,5	98,6	2,106	19,0				
10/03/2014	**B3-1**	132,4	11 660	401,0	107,1	202,3	98,9	2,100	19,0	19,28	7,0		Pièce écartée pour Rc
10/03/2014	**B4**	132,4	11 700	401,1	107,1	202,6	98,9	2,107	19,0				
10/03/2014	**B5**	132,8	11 700	401,3	107,0	202,2	99,0	2,105	19,0				
10/03/2014	**B6**	132,4	11 680	401,1	107,0	202,4	99,0	2,101	19,0				
10/03/2014	**B7**	132,4	11 760	401,3	107,0	202,4	99,4	2,107	19,0				
10/03/2014	**B8**	131,0	11 620	401,3	106,8	202,4	98,7	2,097	19,0				
10/03/2014	**B9**	130,6	11 680	401,1	107,0	202,3	98,8	2,105	19,0				
10/03/2014	**B10**	130,6	11 700	401,1	106,8	202,3	98,8	2,109	19,0				
10/03/2014	**B10-1**	130,8	11 640	401,2	106,7	202,2	98,9	2,097	19,0	17,82	7,2		Pièce écartée pour Rc
10/03/2014	**B11**	132,8	11 680	401,4	106,9	202,8	98,8	2,106	19,0				
10/03/2014	**B12**	131,1	11 680	401,2	106,9	202,5	98,9	2,102	19,0				
10/03/2014	**B13**	130,8	11 680	401,2	106,9	202,5	99,0	2,100	19,0				
10/03/2014	**B14**	131,1	11 720	401,2	106,9	202,6	99,2	2,105	19,0				
10/03/2014	**B15**	130,8	11 680	401,1	106,9	202,5	98,9	2,103	19,0				
10/03/2014	**B16**	130,8	11 700	401,0	106,9	202,5	99,3	2,098	19,0				
10/03/2014	**B17**	130,6	11 640	401,3	107,0	202,5	98,6	2,102	19,0				
10/03/2014	**B18**	131,1	11 740	401,1	106,8	202,3	98,9	2,114	19,0				
10/03/2014	**B19**	130,9	11 720	401,3	106,9	202,4	98,7	2,115	19,0				
10/03/2014	**B20**	130,6	11 680	401,4	106,8	202,4	98,9	2,103	19,0				
10/03/2014	**B20-1**	130,8	11 620	401,2	106,7	202,4	98,9	2,093	19,0	17,99	7,1		Pièce écartée pour Rc
10/03/2014	**B21**	130,9	11 680	401,1	106,6	202,3	98,9	2,104	19,0				
10/03/2014	**B22**	131,1	11 660	401,1	106,9	202,4	98,9	2,101	19,0				
10/03/2014	**B23**	131,0	11 720	401,3	106,5	202,4	99,1	2,106	19,0				
10/03/2014	**B24**	131,4	11 700	401,4	106,7	202,3	99,0	2,105	19,0				
10/03/2014	**B25**	130,6	11 600	401,2	106,8	202,2	98,0	2,108	19,0				
10/03/2014	**B26**	131,0	11 600	401,0	106,8	202,3	99,3	2,081	19,0				
10/03/2014	**B27**	130,9	11 640	401,1	106,7	202,6	98,9	2,097	19,0				
10/03/2014	**B28**	131,3	11 620	401,5	106,9	202,4	99,2	2,087	19,0				
10/03/2014	**B29**	131,0	11 720	401,0	106,7	202,7	99,2	2,104	19,0				
10/03/2014	**B30**	130,7	11 700	400,8	106,8	202,5	99,0	2,105	19,0				
10/03/2014	**B31**	132,7	11 680	401,3	106,8	202,4	98,9	2,103	19,0				
10/03/2014	**B32**	130,9	11 700	400,9	106,6	202,5	99,1	2,103	19,0				
10/03/2014	**B33**	131,1	11 720	401,2	106,6	202,5	99,2	2,105	19,0				
10/03/2014	**B34**	130,7	11 680	401,1	106,8	202,6	98,7	2,108	19,0				
10/03/2014	**B35**	132,1	11 680	401,5	106,9	202,5	99,0	2,101	19,0				
10/03/2014	**B36**	130,9	11 720	401,2	106,8	202,2	99,1	2,106	19,0				
10/03/2014	**B37**	130,5	11 640	401,7	106,9	202,5	98,8	2,099	19,0				
10/03/2014	**B38**	132,6	11 680	401,1	106,9	202,4	99,2	2,098	19,0				
10/03/2014	**B39**	133,1	11 620	400,8	106,8	202,5	99,2	2,086	19,0				
10/03/2014	**B40**	132,9	11 680	401,2	106,9	202,4	99,0	2,101	19,0				
10/03/2014	**B41**	130,5	11 680	401,2	106,9	202,4	99,0	2,101	19,0				
10/03/2014	**B42**	131,4	11 720	401,0	106,8	202,5	99,8	2,092	19,0				
10/03/2014	**B43**	132,7	11 720	401,2	106,9	202,6	99,6	2,095	19,0				
10/03/2014	**B44**	130,9	11 700	401,3	106,7	202,5	99,1	2,103	19,0				
10/03/2014	**B45**	131,1	11 700	401,5	106,8	202,6	99,0	2,104	19,0				
10/03/2014	**B46**	131,2	11 680	401,2	106,8	202,5	98,9	2,102	19,0				
10/03/2014	**B47**	130,7	11 720	401,5	106,8	202,5	99,0	2,108	19,0				
10/03/2014	**B48**	132,7	11 700	401,2	106,7	202,5	99,0	2,105	19,0				
10/03/2014	**B49**	133,2	11 740	401,1	106,8	202,4	99,3	2,105	19,0				
10/03/2014	**B50**	133,2	11 700	401,2	106,8	202,7	99,1	2,102	19,0				
10/03/2014	**B51**	130,9	11 660	401,2	106,8	202,5	99,0	2,099	19,0				
10/03/2014	**B52**	132,2	11 680	401,2	106,8	202,6	98,8	2,105	19,0				
10/03/2014	**B53**	130,8	11 620	401,0	106,9	202,5	98,8	2,094	19,0				
10/03/2014	**B54**	131,1	11 700	400,9	106,7	202,5	99,0	2,106	19,0				
10/03/2014	**B55**	131,2	11 720	401,0	106,8	202,5	98,9	2,110	19,0				
10/03/2014	**B56**	130,6	11 680	401,0	106,9	202,5	99,2	2,098	19,0				
10/03/2014	**B57**	131,1	11 720	401,5	107,0	202,5	98,9	2,110	19,0				
10/03/2014	**B58**	130,5	11 660	401,3	107,0	202,4	98,7	2,104	19,0				

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
10/03/2014	**B59**	132,7	11 720	401,1	106,9	202,3	98,9	2,111	19,0				
10/03/2014	**B60**	130,5	11 680	401,2	106,8	202,7	99,0	2,102	19,0				
10/03/2014	**B61**	132,8	11 700	401,4	106,8	202,6	99,2	2,100	19,0				
10/03/2014	**B62**	130,6	11 680	401,3	106,9	202,5	98,7	2,107	19,0				
10/03/2014	**B63**	132,5	11 740	401,1	106,9	202,5	99,1	2,110	19,0				
10/03/2014	**B64**	130,6	11 660	401,2	107,0	202,4	99,4	2,089	19,0				
10/03/2014	**B65**	132,6	11 700	401,3	106,9	202,6	98,8	2,110	19,0				
10/03/2014	**B66**	130,5	11 760	401,2	106,9	202,5	99,5	2,105	19,0				
10/03/2014	**B67**	132,9	11 720	401,0	106,7	202,4	98,9	2,112	19,0				
10/03/2014	**B68**	130,5	11 720	401,2	106,7	202,7	98,7	2,114	19,0				
10/03/2014	**B69**	132,5	11 640	401,2	107,3	202,7	98,5	2,105	19,0				
10/03/2014	**B70**	130,5	11 660	401,2	107,4	202,5	98,8	2,102	19,0				Léger collage
10/03/2014	**B71**	130,6	11 620	401,0	107,5	202,3	98,7	2,097	19,0				Léger collage
10/03/2014	**B72**	132,8	11 640	401,4	107,4	202,2	98,7	2,100	19,0				
10/03/2014	**B73**	130,7	11 680	401,6	107,7	202,5	99,6	2,088	19,0				
10/03/2014	**B74**	131,3	11 680	401,1	107,5	202,5	99,2	2,098	19,0				
10/03/2014	**B75**	131,0	11 720	401,8	107,5	202,5	99,4	2,101	19,0				
10/03/2014	**B76**	130,5	11 660	401,1	107,7	202,8	98,6	2,107	19,0				
10/03/2014	**B77**	131,3	11 660	401,5	107,5	202,8	98,7	2,104	19,0				
10/03/2014	**B78**	131,4	11 720	401,2	107,7	202,4	98,9	2,111	19,0				
10/03/2014	**B79**	130,5	11 700	401,7	107,6	202,5	99,3	2,099	19,0				
10/03/2014	**B80**	130,8	11 720	401,2	107,8	202,5	99,5	2,098	19,0				
10/03/2014	**B81**	132,6	11 700	401,1	107,4	202,4	98,6	2,113	19,0				
10/03/2014	**B82**	130,5	11 720	401,2	107,2	202,2	99,5	2,097	19,0				
10/03/2014	**B83**	132,5	11 720	401,6	107,7	203,0	99,4	2,101	19,0				
10/03/2014	**B84**	131,3	11 740	401,5	107,7	202,6	99,1	2,110	19,0				
10/03/2014	**B85**	132,4	11 740	401,2	107,7	202,7	98,7	2,118	19,0				
10/03/2014	**B86**	130,6	11 700	401,2	107,6	202,6	98,6	2,114	19,0				
10/03/2014	**B87**	130,8	11 720	401,4	107,7	202,7	99,0	2,109	19,0				
10/03/2014	**B88**	130,9	11 820	401,2	107,5	202,7	99,8	2,110	19,0				
10/03/2014	**B89**	131,1	11 760	401,3	107,6	202,7	99,5	2,105	19,0				
10/03/2014	**B90**	131,4	11 700	401,3	107,7	202,7	99,4	2,096	19,0				
10/03/2014	**B91**	130,5	11 740	401,2	107,8	202,5	99,8	2,096	19,0				
10/03/2014	**B92**	131,3	11 740	401,5	107,8	202,5	99,0	2,112	19,0				
10/03/2014	**B93**	131,2	11 780	401,1	107,8	202,4	99,4	2,111	19,0				
10/03/2014	**B94**	131,0	11 740	401,3	107,8	202,6	99,0	2,112	19,0				
10/03/2014	**B95**	130,4	11 740	401,3	107,7	202,6	99,1	2,110	19,0				
10/03/2014	**B96**	131,0	11 780	401,5	107,6	202,6	99,3	2,112	19,0				
10/03/2014	**B97**	131,3	11 820	401,6	107,7	202,9	99,7	2,112	19,0				
10/03/2014	**B98**	130,4	11 740	401,6	107,8	202,7	99,0	2,112	19,0				
10/03/2014	**B99**	130,7	11 780	401,5	107,8	202,8	99,2	2,115	19,0				
10/03/2014	**B100**	131,3	11 820	401,6	107,7	202,9	99,7	2,112	19,0	17,69	7,9		Pièce écartée pour Rc
10/03/2014	**B101**	132,5							19,0				
10/03/2014	**B102**	130,4	11 760	401,4	107,7	202,6	98,9	2,118	19,0				
10/03/2014	**B103**	131,2	11 760	401,6	107,8	202,8	99,2	2,110	19,0				
10/03/2014	**B104**	131,2	11 780	401,8	107,7	202,9	99,1	2,117	19,0				
10/03/2014	**B105**	130,5	11 800	401,5	107,8	202,7	99,5	2,113	19,0				
10/03/2014	**B106**	131,3	11 780	401,6	107,7	202,7	99,4	2,110	19,0				
10/03/2014	**B107**	130,9	11 760	401,8	107,8	202,7	99,4	2,108	19,0				
10/03/2014	**B108**	131,2	11 840	401,6	107,5	202,4	99,2	2,125	19,0				
10/03/2014	**B109**	131,3	11 760	401,6	107,6	202,7	98,9	2,118	19,0				
10/03/2014	**B110**	131,1	11 740	401,3	107,4	202,4	98,7	2,118	19,0				
10/03/2014	**B111**	130,6	11 840	401,7	107,6	202,7	99,3	2,124	19,0				
10/03/2014	**B112**	132,5	11 720	401,8	107,6	202,7	98,6	2,118	19,0				
10/03/2014	**B113**	130,8	11 820	401,7	107,4	202,5	99,5	2,116	19,0				
10/03/2014	**B114**	130,9	11 760	401,8	107,5	202,7	98,8	2,120	19,0				Léger collage
10/03/2014	**B115**	132,7	11 720	401,0	107,2	202,2	98,8	2,112	19,0				Léger collage
10/03/2014	**B116**	130,5	11 660	401,0	107,2	202,1	98,6	2,106	19,0				Léger collage
10/03/2014	**B117**	131,3	11 680	400,9	107,1	202,2	98,8	2,106	19,0				Léger collage
10/03/2014	**B118**	130,5	11 680	401,0	107,3	202,6	98,8	2,105	19,0				Léger collage
10/03/2014	**B119**	132,4	11 620	401,1	107,1	202,6	98,4	2,103	19,0				Léger collage
10/03/2014	**B120**	130,5	11 680	401,0	107,3	202,2	99,0	2,101	19,0				Léger collage
10/03/2014	**B121**	131,0	11 660	401,0	107,4	202,6	98,7	2,105	19,0				Léger collage
10/03/2014	**B122**	131,1	11 700	401,1	107,2	202,4	99,1	2,103	19,0				Léger collage
10/03/2014	**B123**	131,3	11 680	401,1	107,3	202,4	98,8	2,106	19,0				Léger collage
10/03/2014	**B124**	130,7	11 660	401,3	107,2	202,4	98,8	2,102	19,0				Léger collage
10/03/2014	**B125**	131,2	11 680	401,3	107,2	202,4	98,8	2,105	19,0				Léger collage
10/03/2014	**B126**	130,5	11 680	401,1	107,3	202,2	99,0	2,101	19,0				Léger collage

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
10/03/2014	**B127**	130,9	11 680	401,0	107,2	202,1	98,6	2,110	19,0				Léger collage
10/03/2014	**B128**	132,8	11 660	401,2	107,2	202,4	99,0	2,097	19,0				Léger collage
10/03/2014	**B129**	130,4	11 700	401,1	107,3	202,3	99,1	2,104	19,0				Léger collage
10/03/2014	**B130**	130,9	11 640	401,0	107,3	202,4	98,7	2,100	19,0				Léger collage
10/03/2014	**B131**	132,7	11 620	400,9	107,3	202,5	98,5	2,100	19,0				Léger collage
10/03/2014	**B132**	130,5	11 660	401,3	107,2	202,4	98,5	2,109	19,0				Léger collage
10/03/2014	**B133**	132,8	11 680	401,1	107,2	202,1	98,9	2,103	19,0				Léger collage
10/03/2014	**B134**	130,6	11 660	401,1	107,1	202,3	98,8	2,102	19,0				Léger collage
10/03/2014	**B135**	131,3	11 640	401,2	107,2	202,3	98,5	2,104	19,0				Léger collage
10/03/2014	**B136**	130,8	11 680	401,1	107,3	202,2	98,9	2,103	19,0				Léger collage
10/03/2014	**B137**	131,2	11 640	401,0	107,2	202,2	98,9	2,097	19,0				Léger collage
10/03/2014	**B138**	130,5	11 640	401,8	107,2	202,3	99,7	2,079	19,0				Léger collage
10/03/2014	**B139**	132,7	11 660	401,1	107,3	202,4	98,9	2,101	19,0				Léger collage
10/03/2014	**B140**	130,5	11 680	401,5	107,2	202,6	99,0	2,102	19,0				Léger collage
10/03/2014	**B141**	131,4	11 680	401,2	107,1	202,2	99,1	2,100	19,0				Léger collage
10/03/2014	**B142**	130,4	11 700	401,1	107,3	202,2	99,3	2,099	19,0				Léger collage
10/03/2014	**B143**	132,4	11 680	401,2	107,1	202,3	99,0	2,101	19,0				Léger collage
10/03/2014	**B144**	130,5	11 700	401,0	107,3	202,2	98,9	2,108	19,0				Léger collage
10/03/2014	**B145**	130,5	11 640	401,2	107,2	202,3	98,9	2,096	19,0				Léger collage
10/03/2014	**B146**	131,3	11 660	401,0	107,1	202,3	98,9	2,101	19,0				Léger collage
10/03/2014	**B147**	130,3	11 700	401,0	107,3	202,3	99,4	2,096	19,0				Léger collage
10/03/2014	**B148**	131,1	11 640	401,1	107,4	202,4	98,8	2,099	19,0				Léger collage
10/03/2014	**B149**	130,5	11 680	401,1	107,3	202,3	99,0	2,101	19,0				Léger collage
10/03/2014	**B150**	132,4	11 680	401,1	107,4	202,4	98,9	2,102	19,0				Léger collage
10/03/2014	**B151**	130,5	11 640	401,0	107,4	202,4	98,5	2,104	19,0				Léger collage
10/03/2014	**B152**	130,6	11 700	401,2	107,5	202,4	99,1	2,103	19,0				Léger collage
10/03/2014	**B153**	130,7	11 680	401,0	107,8	202,5	98,8	2,105	19,0				Léger collage
10/03/2014	**B154**	131,0	11 680	401,3	107,3	202,4	98,9	2,103	19,0				Léger collage
10/03/2014	**B155**	130,5	11 700	401,1	107,4	202,2	99,0	2,106	19,0				Léger collage
10/03/2014	**B156**	132,5	11 700	401,2	107,5	202,4	99,1	2,103	19,0				Léger collage
10/03/2014	**B157**	130,6	11 640	401,1	107,5	202,4	98,6	2,102	19,0				Léger collage
10/03/2014	**B158**	132,9	11 660	401,2	107,6	202,4	98,9	2,100	19,0				Léger collage
10/03/2014	**B159**	131,3	11 680	401,2	107,4	202,4	98,8	2,105	19,0				Léger collage
10/03/2014	**B160**	130,5	11 680	401,1	107,5	202,4	99,0	2,101	19,0				Léger collage
10/03/2014	**B161**	131,1	11 680	401,2	107,3	202,3	99,0	2,102	19,0				Léger collage
10/03/2014	**B162**	131,4	11 660	401,2	107,5	202,4	98,8	2,101	19,0				Léger collage
10/03/2014	**B163**	131,1	11 640	401,1	107,4	202,4	98,8	2,099	19,0				Léger collage
10/03/2014	**B164**	130,5	11 700	401,1	107,5	202,5	99,2	2,100	19,0				Léger collage
10/03/2014	**B165**	132,6	11 680	401,1	107,6	202,4	99,1	2,100	19,0				Léger collage
10/03/2014	**B166**	130,5	11 660	401,1	107,5	202,4	98,8	2,101	19,0				Léger collage
10/03/2014	**B167**	130,6	11 680	401,1	107,5	202,5	99,1	2,099	19,0				Léger collage
10/03/2014	**B168**	131,4	11 660	401,1	107,5	202,4	98,8	2,102	19,0				Léger collage
10/03/2014	**B169**	131,4	11 700	401,2	107,3	202,7	99,1	2,102	19,0				Léger collage
10/03/2014	**B170**	130,6	11 700	401,7	107,7	202,4	99,0	2,105	19,0				Léger collage
10/03/2014	**B171**	131,4	11 660	401,0	107,6	202,4	98,8	2,102	19,0				Léger collage
10/03/2014	**B172**	131,3	11 660	400,9	107,6	202,3	98,8	2,102	19,0				Léger collage
10/03/2014	**B173**	130,6	11 680	401,0	107,6	202,4	99,1	2,099	19,0				Léger collage
10/03/2014	**B174**	130,5	11 680	401,4	107,6	202,5	98,8	2,105	19,0				Léger collage
10/03/2014	**B175**	130,9	11 700	401,1	107,6	202,4	99,0	2,105	19,0				Léger collage
10/03/2014	**B176**	132,7	11 560	400,9	107,5	202,1	98,5	2,090	19,0				Léger collage
10/03/2014	**B177**	130,8	11 660	401,0	107,5	202,2	98,8	2,102	19,0				Léger collage
10/03/2014	**B178**	130,6	11 640	401,2	107,5	202,5	98,7	2,100	19,0				Léger collage
10/03/2014	**B179**	130,5	11 660	401,1	107,5	202,3	99,0	2,098	19,0				Léger collage
10/03/2014	**B180**	130,8	11 700	401,1	107,5	202,3	99,3	2,098	19,0				Léger collage
10/03/2014	**B181**	130,5	11 660	401,1	107,4	202,3	98,9	2,100	19,0				Léger collage
10/03/2014	**B182**	132,5	11 700	401,0	107,3	202,5	99,3	2,098	19,0				Léger collage
10/03/2014	**B183**	130,5	11 680	401,1	107,5	202,4	99,5	2,091	19,0				Léger collage
10/03/2014	**B184**	130,5	11 660	401,0	107,6	202,3	99,1	2,095	19,0				Léger collage
10/03/2014	**B185**	133,0	11 700	400,9	107,3	202,3	99,1	2,103	19,0				Léger collage
10/03/2014	**B186**	130,5	11 740	401,0	107,7	202,4	99,5	2,101	19,0				Léger collage
10/03/2014	**B187**	130,9	11 680	401,2	107,6	202,3	99,1	2,099	19,0				Léger collage
10/03/2014	**B188**	130,6	11 700	401,1	107,6	202,4	99,4	2,096	19,0				Léger collage
10/03/2014	**B189**	130,5	11 760	401,0	107,5	202,5	99,6	2,103	19,0				Léger collage
10/03/2014	**B190**	131,3	11 640	401,3	107,6	202,4	98,7	2,100	19,0				Léger collage
10/03/2014	**B191**	130,5	11 720	401,0	107,5	202,4	99,4	2,100	19,0				Léger collage
10/03/2014	**B192**	131,1	11 740	401,2	107,7	202,6	99,5	2,101	19,0				Léger collage
10/03/2014	**B193**	131,0	11 700	401,4	107,6	202,4	99,2	2,101	19,0				Léger collage
10/03/2014	**B194**	130,5	11 680	401,3	107,6	202,3	99,0	2,101	19,0				Léger collage

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
10/03/2014	**B195**	131,4	11 720	401,3	107,6	202,3	99,4	2,100	19,0				Léger collage
10/03/2014	**B196**	130,7	11 700	401,3	107,6	202,2	99,0	2,105	19,0				Léger collage
10/03/2014	**B197**	130,9	11 680	401,3	107,6	202,3	99,2	2,097	19,0				
10/03/2014	**B198**	130,8	11 700	401,1	107,5	202,2	98,9	2,107	19,0				
10/03/2014	**B199**	131,2	11 720	401,2	107,4	202,4	99,1	2,106	19,0				
10/03/2014	**B200**	130,8	11 740	401,2	107,5	202,3	99,5	2,101	19,0				
10/03/2014	**B201**	130,7	11 700	401,1	107,4	202,4	98,9	2,107	19,0				
10/03/2014	**B202**	130,6	11 660	401,4	107,5	202,6	98,9	2,100	19,0				
10/03/2014	**B203**	130,9	11 720	401,5	107,5	202,4	99,3	2,102	19,0				
10/03/2014	**B204**	131,2	11 760	401,0	107,5	202,4	99,4	2,107	19,0				
10/03/2014	**B205**	130,7	11 720	401,1	107,5	202,4	99,0	2,108	19,0				
10/03/2014	**B206**	130,6	11 720	401,3	107,6	202,2	99,2	2,104	19,0				
10/03/2014	**B207**	132,5	11 720	401,3	107,5	202,5	99,2	2,104	19,0				
10/03/2014	**B208**	131,0	11 780	401,2	107,5	202,5	99,5	2,108	19,0				Léger collage
10/03/2014	**B209**	130,5	11 760	401,1	107,5	202,3	99,3	2,109	19,0				Léger collage
10/03/2014	**B210**	130,6	11 740	401,1	107,3	202,4	99,3	2,106	19,0				Léger collage
10/03/2014	**B211**	130,9	11 760	401,4	107,6	202,4	99,2	2,111	19,0				Léger collage
10/03/2014	**B212**	130,8	11 780	401,1	107,6	202,4	99,7	2,104	19,0				Léger collage
10/03/2014	**B213**	130,9	11 760	401,2	107,4	202,7	99,1	2,113	19,0				Léger collage
10/03/2014	**B214**	130,5	11 780	401,1	107,8	202,5	99,7	2,104	19,0				Léger collage
10/03/2014	**B215**	132,7	11 720	401,0	107,4	202,3	99,2	2,104	19,0				Léger collage
10/03/2014	**B216**	130,6	11 740	401,5	107,7	202,6	99,3	2,106	19,0				Léger collage
10/03/2014	**B217**	130,6	11 820	401,5	107,8	202,5	99,8	2,109	19,0				Léger collage
10/03/2014	**B218**	131,3	11 780	401,1	107,6	202,4	99,5	2,108	19,0				Léger collage
10/03/2014	**B219**	131,4	11 760	401,2	107,7	202,7	99,2	2,111	19,0				Léger collage
10/03/2014	**B220**	130,6	11 780	401,5	107,6	202,6	99,7	2,104	19,0				Léger collage
10/03/2014	**B221**	130,5	11 820	401,2	107,7	202,6	99,8	2,109	19,0				Léger collage
10/03/2014	**B222**	132,7	11 640	401,5	107,5	202,7	98,7	2,100	19,0				Léger collage
10/03/2014	**B223**	130,6	11 740	401,4	107,7	202,7	99,6	2,099	19,0				Léger collage
10/03/2014	**B224**	130,5	11 780	401,2	107,5	202,5	99,8	2,102	19,0				Léger collage
10/03/2014	**B225**	131,3	11 740	401,2	107,6	202,7	99,9	2,093	19,0				Léger collage
10/03/2014	**B226**	130,5	11 700	401,5	107,6	202,5	99,2	2,101	19,0				Léger collage
10/03/2014	**B227**	130,8	11 720	401,4	107,7	202,6	99,5	2,098	19,0				Léger collage
10/03/2014	**B228**	130,5	11 680	401,6	107,7	202,6	99,8	2,084	19,0				Léger collage
10/03/2014	**B229**	130,8	11 700	401,8	107,7	202,8	99,2	2,101	19,0				Léger collage
10/03/2014	**B230**	131,4	11 760	401,6	107,7	202,7	99,7	2,101	19,0				Léger collage
10/03/2014	**B231**	130,7	11 720	401,9	107,7	202,5	99,4	2,100	19,0				Léger collage
10/03/2014	**B232**	130,7	11 720	401,6	107,6	202,6	99,5	2,098	19,0				Léger collage
10/03/2014	**B233**	131,3	11 720	401,5	107,4	202,3	99,5	2,098	19,0				Léger collage
10/03/2014	**B234**	131,0	11 700	401,1	107,6	202,4	99,3	2,098	19,0				Léger collage
10/03/2014	**B235**	130,7	11 680	400,8	107,5	202,4	98,8	2,105	19,0				Léger collage
10/03/2014	**B236**	130,8	11 740	401,2	107,5	202,3	99,6	2,099	19,0				Léger collage
10/03/2014	**B237**	131,1	11 700	401,3	107,5	202,2	99,1	2,103	19,0				Léger collage
10/03/2014	**B238**	131,3	11 740	401,3	107,6	202,6	99,8	2,095	19,0				Léger collage
10/03/2014	**B239**	131,1	11 700	400,8	107,6	202,3	99,5	2,094	19,0				Léger collage
10/03/2014	**B240**	130,7	11 720	400,6	107,3	202,5	99,3	2,102	19,0				Léger collage
10/03/2014	**B241**	131,4	11 720	401,1	107,5	202,2	99,1	2,106	19,0				Léger collage
10/03/2014	**B242**	131,0	11 680	400,8	107,4	202,3	98,8	2,105	19,0				Léger collage
10/03/2014	**B243**	130,6	11 660	400,8	107,6	202,1	98,8	2,102	19,0				Léger collage
10/03/2014	**B244**	130,6	11 720	400,9	107,6	202,3	99,6	2,096	19,0				Léger collage
10/03/2014	**B245**	132,7	11 700	400,8	107,5	202,4	99,1	2,103	19,0				Léger collage
10/03/2014	**B246**	130,5	11 740	401,7	107,8	202,8	98,7	2,118	19,0				Léger collage
10/03/2014	**B247**	130,6	11 660	401,6	107,7	202,6	98,8	2,102	19,0				Léger collage
10/03/2014	**B248**	131,0	11 780	401,5	107,7	202,8	100,3	2,092	19,0				Pièce écartée arête cassée
10/03/2014	**B249**	130,8	11 740	401,4	107,5	202,5	99,5	2,101	19,0				Léger collage
10/03/2014	**B250**	130,5							19,0	17,68	8,4		Pièce écartée pour Rc
10/03/2014	**B251**	131,3	11 700	401,4	107,6	202,7	99,5	2,094	19,0				
10/03/2014	**B252**	130,5	11 760	401,4	107,5	202,5	99,8	2,098	19,0				
10/03/2014	**B253**	131,0	11 720	401,4	107,6	202,3	99,2	2,104	19,0				
10/03/2014	**B254**	130,5	11 740	401,6	107,6	202,5	99,9	2,093	19,0				
10/03/2014	**B255**	130,5	11 680	401,5	107,6	202,8	99,2	2,098	19,0				
10/03/2014	**B256**	131,1	11 740	401,4	107,8	202,9	99,7	2,097	19,0				
10/03/2014	**B257**	131,0	11 700	401,3	107,6	202,5	99,4	2,097	19,0				
10/03/2014	**B258**	131,2	11 700	401,7	107,7	202,6	99,4	2,097	19,0				
10/03/2014	**B259**	131,0	11 700	401,5	107,6	202,5	99,3	2,099	19,0				
10/03/2014	**B260**	131,3	11 720	401,5	107,8	202,8	99,4	2,100	19,0				
10/03/2014	**B261**	130,5	11 700	401,7	107,8	202,5	99,3	2,098	19,0				
10/03/2014	**B262**	131,0	11 680	401,5	107,8	202,6	99,3	2,096	19,0				

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
10/03/2014	**B263**	130,9	11 680	401,5	107,7	202,5	99,3	2,094	19,0				
10/03/2014	**B264**	132,9	11 700	400,9	107,6	202,3	99,3	2,098	19,0				
10/03/2014	**B265**	130,5	11 700	400,8	107,7	202,3	99,1	2,103	19,0				
10/03/2014	**B266**	130,5	11 680	400,8	107,6	202,4	99,3	2,094	19,0				
10/03/2014	**B267**	131,0	11 680	400,9	107,6	202,1	99,1	2,100	19,0				
10/03/2014	**B268**	130,5	11 700	400,7	107,6	202,3	99,3	2,099	19,0				
10/03/2014	**B269**	130,8	11 700	400,8	107,6	202,2	99,2	2,101	19,0				
10/03/2014	**B270**	130,9	11 700	400,9	107,5	202,3	99,1	2,102	19,0				
10/03/2014	**B271**	130,8	11 680	400,8	107,4	202,1	99,1	2,100	19,0				
10/03/2014	**B272**	130,9	11 660	400,9	107,4	202,3	99,2	2,094	19,0				
10/03/2014	**B273**	131,3	11 700	401,0	107,5	202,1	99,2	2,100	19,0				
10/03/2014	**B274**	130,6	11 700	400,8	107,4	202,2	99,2	2,100	19,0				
10/03/2014	**B275**	130,5	11 600	400,7	107,7	202,3	99,2	2,084	19,0				
10/03/2014	**B276**	131,2	11 800	401,4	107,7	202,9	100,3	2,096	19,0				
10/03/2014	**B277**	131,0	11 660	401,5	107,8	202,7	99,2	2,094	19,0				
10/03/2014	**B278**	130,7	11 820	401,5	107,7	202,7	99,9	2,107	19,0				
10/03/2014	**B279**	130,6	11 660	401,7	107,8	202,5	98,9	2,100	19,0				
10/03/2014	**B280**	130,8	11 840	401,6	107,8	203,0	100,2	2,104	19,0				
10/03/2014	**B281**	130,7	11 740	401,4	107,6	202,7	99,6	2,099	19,0				
10/03/2014	**B282**	131,0	11 780	401,5	107,8	202,9	99,9	2,101	19,0				
10/03/2014	**B283**	130,5	11 800	401,7	107,7	202,7	100,4	2,093	19,0				
10/03/2014	**B284**	131,0	11 760	401,7	107,6	202,5	99,3	2,109	19,0				
10/03/2014	**B285**	130,6	11 860	401,6	107,8	202,8	100,3	2,107	19,0				
10/03/2014	**B286**	130,5	11 820	401,5	107,8	202,8	99,7	2,111	19,0				
10/03/2014	**B287**	130,9	11 780	401,7	107,8	202,4	99,6	2,107	19,0				
10/03/2014	**B288**	131,3	11 880	401,6	107,8	202,1	100,1	2,113	19,0				
10/03/2014	**B289**	130,5	11 780	401,8	107,9	202,3	99,8	2,102	19,0				
10/03/2014	**B290**	130,8	11 780	401,8	107,7	202,4	99,7	2,105	19,0				
10/03/2014	**B291**	131,1	11 860	401,6	107,7	202,9	100,0	2,112	19,0				
10/03/2014	**B292**	130,6	11 760	401,6	107,7	202,7	99,4	2,107	19,0				
10/03/2014	**B293**	130,7	11 840	401,5	107,7	202,7	99,9	2,111	19,0				
10/03/2014	**B294**	130,5	11 740	401,7	107,8	203,3	99,2	2,108	19,0				
10/03/2014	**B295**	131,0	11 820	401,5	107,8	202,8	99,9	2,107	19,0				
10/03/2014	**B296**	130,4	11 820	401,5	107,8	203,4	99,8	2,109	19,0				
10/03/2014	**B297**	130,8	11 820	401,7	107,7	202,8	99,9	2,107	19,0				
10/03/2014	**B298**	131,4	11 820	401,5	107,7	202,8	99,6	2,114	19,0				
10/03/2014	**B299**	130,8	11 840	401,6	107,6	202,7	99,9	2,111	19,0				
10/03/2014	**B300**	130,5	11 780	401,6	107,7	203,2	99,9	2,100	19,0				
10/03/2014	**B301**	130,7	11 860	401,6	107,6	202,7	100,1	2,110	19,0				
10/03/2014	**B302**	131,4	11 760	401,6	107,6	202,8	99,5	2,105	19,0				
10/03/2014	**B303**	130,5	11 840	401,5	107,4	202,8	100,0	2,109	19,0				
10/03/2014	**B304**	130,5	11 760	401,7	107,7	202,5	99,5	2,105	19,0				
10/03/2014	**B305**	131,5	11 820	401,7	107,7	202,6	99,7	2,111	19,0				
10/03/2014	**B306**	130,6	11 800	401,6	107,7	202,6	99,8	2,106	19,0				
10/03/2014	**B307**	131,9	11 740	401,5	107,5	202,4	99,4	2,103	19,0				
10/03/2014	**B308**	130,6	11 820	401,6	107,6	202,5	99,9	2,107	19,0				
10/03/2014	**B309**	130,6	11 740	401,4	107,5	202,7	99,3	2,106	19,0				
10/03/2014	**B310**	132,9	11 780	401,6	107,7	202,8	99,5	2,108	19,0				
10/03/2014	**B311**	130,6	11 820	401,5	107,8	202,6	100,0	2,105	19,0				
10/03/2014	**B312**	131,0	11 840	401,6	107,7	202,9	100,1	2,107	19,0				
10/03/2014	**B313**	130,5	11 740	401,5	107,7	202,7	99,3	2,106	19,0				
10/03/2014	**B314**	130,5	11 780	401,3	107,7	202,8	100,0	2,098	19,0				
10/03/2014	**B315**	130,5	11 800	401,6	107,6	202,9	100,0	2,102	19,0				
10/03/2014	**B316**	131,5	11 820	401,5	107,5	202,7	99,8	2,109	19,0				
10/03/2014	**B317**	132,5	11 740	401,6	107,7	202,6	99,4	2,103	19,0				
10/03/2014	**B318**	130,8	11 760	401,6	107,7	202,6	99,8	2,099	19,0				
10/03/2014	**B319**	131,4	11 780	401,5	107,6	202,6	99,5	2,108	19,0				
10/03/2014	**B320**	130,5	11 820	401,4	107,7	202,9	99,9	2,107	19,0				
10/03/2014	**B321**	131,0	11 700	401,4	107,7	202,7	98,8	2,109	19,0				
10/03/2014	**B322**	130,6	11 860	401,5	107,7	202,7	100,1	2,110	19,0				
10/03/2014	**B323**	131,3	11 800	401,7	107,6	202,7	99,8	2,106	19,0				
10/03/2014	**B324**	130,6	11 720	401,4	107,7	202,7	98,9	2,110	19,0				
10/03/2014	**B325**	131,0	11 800	401,5	107,6	202,7	100,0	2,102	19,0				
10/03/2014	**B326**	131,0	11 800	401,4	107,5	202,9	99,4	2,114	19,0				
10/03/2014	**B327**	130,7	11 800	401,6	107,7	202,6	99,8	2,106	19,0				
10/03/2014	**B328**	130,5	11 800	401,4	107,7	202,6	100,0	2,102	19,0				
10/03/2014	**B329**	132,9	11 800	401,8	107,7	202,6	100,1	2,099	19,0				
10/03/2014	**B330**	130,6	11 800	401,7	107,9	202,6	99,9	2,104	19,0				

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
10/03/2014	**B331**	130,5	11 800	401,4	107,5	202,8	99,9	2,104	19,0				
10/03/2014	**B332**	130,8	11 760	401,4	107,6	202,6	99,5	2,105	19,0				
10/03/2014	**B333**	132,2	11 820	401,3	107,6	202,5	100,0	2,105	19,0				
10/03/2014	**B334**	131,1	11 800	401,3	107,7	202,7	99,9	2,104	19,0				
10/03/2014	**B335**	130,6	11 700	401,6	107,7	202,6	99,1	2,103	19,0				
10/03/2014	**B336**	131,2	11 800	401,2	107,5	202,8	99,9	2,104	19,0				
10/03/2014	**B337**	130,5	11 740	401,1	107,6	202,6	99,2	2,108	19,0				
10/03/2014	**B338**	131,2	11 760	401,5	107,6	202,7	99,6	2,103	19,0				
10/03/2014	**B339**	130,6	11 840	401,6	107,6	202,7	100,1	2,107	19,0				
10/03/2014	**B340**	132,7	11 820	401,3	107,6	202,4	99,7	2,111	19,0				
10/03/2014	**B341**	130,7	11 720	401,4	107,6	202,5	99,1	2,106	19,0				
10/03/2014	**B342**	130,6	11 720	401,4	107,6	203,0	99,1	2,106	19,0				
10/03/2014	**B343**	130,9	11 800	401,1	107,5	202,5	99,8	2,106	19,0				
10/03/2014	**B344**	130,6	11 800	401,4	107,8	202,5	99,7	2,108	19,0				
10/03/2014	**B345**	130,9	11 800	401,3	107,7	202,5	99,9	2,104	19,0				
10/03/2014	**B346**	130,6	11 740	401,5	107,6	202,8	99,3	2,106	19,0				
10/03/2014	**B347**	132,8	11 840	401,5	107,7	202,8	99,9	2,111	19,0				
10/03/2014	**B348**	130,7	11 800	401,3	107,6	202,9	99,6	2,110	19,0				
10/03/2014	**B349**	132,8	11 760	401,2	107,6	202,3	99,4	2,107	19,0				
10/03/2014	**B350**	130,5	11 820	401,6	107,7	202,6	99,9	2,107	19,0				
10/03/2014	**B351**	130,5	11 760	401,3	107,6	202,6	99,3	2,109	19,0				
10/03/2014	**B352**	130,9	11 800	401,5	107,6	202,6	99,8	2,106	19,0				
10/03/2014	**B353**	130,5	11 820	401,6	107,6	202,5	100,0	2,105	19,0				
10/03/2014	**B354**	130,5	11 780	401,2	107,6	203,1	99,7	2,104	19,0				
10/03/2014	**B355**	132,6	11 760	401,2	107,6	202,9	99,4	2,107	19,0				
10/03/2014	**B356**	130,7	11 800	401,5	107,7	202,6	99,9	2,104	19,0				
10/03/2014	**B357**	130,6	11 780	401,2	107,6	202,3	99,4	2,111	19,0				
10/03/2014	**B358**	132,6	11 780	401,2	107,4	202,8	99,3	2,113	19,0				
10/03/2014	**B359**	130,5	11 800	401,2	107,5	202,9	99,5	2,112	19,0				
10/03/2014	**B360**	130,8	11 760	401,5	107,5	202,9	99,4	2,107	19,0				
10/03/2014	**B361**	130,9	11 780	401,1	107,6	202,6	99,7	2,104	19,0				
10/03/2014	**B362**	130,6	11 760	401,3	107,6	202,6	99,5	2,105	19,0				
10/03/2014	**B363**	131,0	11 800	401,3	107,7	202,3	99,7	2,108	19,0				
10/03/2014	**B364**	130,5	11 800	401,1	107,6	202,5	99,9	2,104	19,0				
10/03/2014	**B365**	130,8	11 740	401,2	107,6	202,6	99,5	2,101	19,0				
10/03/2014	**B366**	130,8	11 800	401,3	107,7	202,6	99,9	2,104	19,0				
10/03/2014	**B367**	130,5	11 760	401,3	107,7	202,6	99,3	2,109	19,0				
10/03/2014	**B368**	130,6	11 780	401,4	107,7	202,5	99,7	2,104	19,0				
10/03/2014	**B369**	131,0	11 720	401,3	107,7	202,4	99,1	2,106	19,0				
10/03/2014	**B370**	131,0	11 820	401,3	107,8	202,5	100,2	2,101	19,0				
10/03/2014	**B371**	130,7	11 800	401,3	107,7	202,6	99,8	2,106	19,0				
10/03/2014	**B372**	130,5	11 740	401,1	107,5	202,4	99,4	2,103	19,0				
10/03/2014	**B373**	131,3	11 760	401,1	107,7	202,6	99,5	2,105	19,0				
10/03/2014	**B374**	130,9	11 780	401,2	107,6	202,5	99,8	2,102	19,0				
10/03/2014	**B375**	130,5	11 780	401,0	107,7	202,7	99,9	2,100	19,0				
10/03/2014	**B376**	131,0	11 740	401,1	107,6	202,5	99,7	2,097	19,0				
10/03/2014	**B377**	131,3	11 820	401,0	107,6	202,4	100,1	2,103	19,0				
10/03/2014	**B378**	130,5	11 820	401,3	107,3	202,5	99,4	2,118	19,0				
10/03/2014	**B379**	130,5	11 720	401,8	107,8	202,4	98,9	2,110	19,0				
10/03/2014	**B380**	130,5	11 820	401,2	107,7	202,7	99,7	2,111	19,0				
10/03/2014	**B381**	130,7	11 760	401,5	107,8	202,5	99,2	2,111	19,0				
10/03/2014	**B382**	131,2	11 740	401,6	107,5	202,9	99,1	2,111	19,0				
10/03/2014	**B383**	130,9	11 740	401,6	107,6	202,7	99,0	2,112	19,0				
10/03/2014	**B384**	130,6	11 840	401,8	107,6	203,0	99,4	2,121	19,0				
10/03/2014	**B385**	131,4	11 840	401,8	107,6	202,9	99,8	2,113	19,0				
10/03/2014	**B386**	130,5	11 860	401,7	107,7	202,9	99,5	2,123	19,0				
10/03/2014	**B387**	130,7	11 760	401,6	107,6	202,9	98,9	2,118	19,0				
10/03/2014	**B388**	130,5	11 820	401,6	107,6	202,9	99,4	2,118	19,0				
10/03/2014	**B389**	133,0	11 760	401,8	107,7	202,9	99,0	2,117	19,0				
10/03/2014	**B390**	130,6	11 860	401,6	107,7	203,0	100,0	2,113	19,0				
10/03/2014	**B391**	130,5	11 740	401,6	107,7	202,8	98,9	2,114	19,0				
10/03/2014	**B392**	130,8	11 800	401,3	107,7	202,9	99,0	2,123	19,0				
10/03/2014	**B393**	131,5	11 820	401,6	107,6	202,8	99,0	2,126	19,0				
10/03/2014	**B394**	130,7	11 800	401,4	107,7	202,7	99,0	2,124	19,0				
10/03/2014	**B395**	130,8	11 820	401,5	107,7	203,0	99,3	2,120	19,0				
10/03/2014	**B396**	130,8	11 760	401,9	107,8	202,9	99,1	2,114	19,0				
10/03/2014	**B397**	131,0	11 800	401,8	107,6	202,8	99,6	2,110	19,0				
10/03/2014	**B398**	131,0	11 820	401,7	107,5	202,9	99,8	2,109	19,0				Pièce écartée léger cloquage

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
10/03/2014	**B399**	131,4	11 800	401,7	107,8	203,0	99,7	2,108	19,0				
10/03/2014	**B400**	130,7	11 760	401,9	107,8	202,9	99,1	2,114	19,0	18,34	7,8		Pièce écartée pour Rc
10/03/2014	**B401**	131,5	11 760	401,8	107,8	203,0	99,1	2,114	19,0				
10/03/2014	**B402**	131,3	11 620	400,9	107,5	202,4	99,1	2,089	19,0				
10/03/2014	**B403**	130,5	11 580	401,3	107,5	202,6	99,0	2,083	19,0				
10/03/2014	**B404**	132,1	11 580	401,0	107,5	202,6	98,7	2,089	19,0				
10/03/2014	**B405**	130,7	11 620	401,0	107,2	202,1	99,4	2,082	19,0				
10/03/2014	**B406**	131,4	11 600	401,1	107,4	202,9	98,7	2,093	19,0				
10/03/2014	**B407**	130,7	11 620	401,1	107,4	202,7	98,7	2,098	19,0				
10/03/2014	**B408**	131,4	11 640	401,8	107,3	202,6	100,0	2,074	19,0				
10/03/2014	**B409**	133,1	11 600	401,0	107,5	202,7	98,8	2,092	19,0				
10/03/2014	**B410**	131,3	11 620	401,1	107,6	202,9	98,9	2,093	19,0				
10/03/2014	**B411**	130,8	11 640	401,0	107,1	202,3	99,0	2,093	19,0				
10/03/2014	**B412**	130,8	11 600	401,3	106,8	202,2	98,5	2,097	19,0				
10/03/2014	**B413**	130,9	11 660	401,7	107,2	202,4	99,3	2,091	19,0				
10/03/2014	**B414**	130,8	11 640	401,1	107,5	202,5	99,0	2,093	19,0				
10/03/2014	**B415**	131,2	11 680	401,0	107,5	202,5	99,3	2,095	19,0				
11/03/2014	**B416**	133,0	11 640	401,1	107,6	202,2	98,9	2,096	19,0				
11/03/2014	**B417**	131,0	11 660	401,1	107,3	202,3	99,2	2,094	19,0				
11/03/2014	**B418**	130,5	11 640	401,0	107,6	202,5	99,4	2,085	19,0				
11/03/2014	**B419**	130,7	11 620	400,9	107,4	202,5	99,0	2,090	19,0				
11/03/2014	**B420**	130,6	11 680	401,0	107,4	202,3	99,1	2,098	19,0				
11/03/2014	**B421**	130,6	11 660	401,1	107,5	202,4	98,7	2,104	19,0				
11/03/2014	**B422**	130,6	11 680	401,2	107,3	202,4	99,1	2,100	19,0				
11/03/2014	**B423**	130,9	11 640	401,1	107,6	202,3	98,8	2,098	19,0				
11/03/2014	**B424**	132,7	11 660	401,0	107,4	202,1	99,2	2,094	19,0				
11/03/2014	**B425**	130,7	11 680	400,9	107,1	202,2	99,2	2,097	19,0				Pièce écartée fissures
11/03/2014	**B426**	130,9	11 640	401,6	107,3	202,3	98,8	2,098	19,0				
11/03/2014	**B427**	131,2	11 640	401,4	107,3	202,2	99,4	2,086	19,0				
11/03/2014	**B428**	130,7	11 620	400,9	107,3	202,2	98,8	2,095	19,0				
11/03/2014	**B429**	130,8	11 600	400,9	107,1	202,1	99,0	2,087	19,0				
11/03/2014	**B430**	130,6	11 640	400,9	107,1	202,1	99,0	2,093	19,0				
11/03/2014	**B431**	131,0	11 620	400,8	107,2	202,0	99,0	2,090	19,0				
11/03/2014	**B432**	130,7	11 600	400,6	107,1	202,1	98,6	2,094	19,0				
11/03/2014	**B433**	130,6	11 600	400,7	107,2	202,4	98,7	2,094	19,0				
11/03/2014	**B434**	130,8	11 640	400,9	107,4	202,4	98,8	2,098	19,0				
11/03/2014	**B435**	130,7	11 600	400,7	107,1	202,0	99,1	2,085	19,0				
11/03/2014	**B436**	130,9	11 660	400,7	107,4	202,3	99,3	2,092	19,0				
11/03/2014	**B437**	131,4	11 540	400,8	107,1	202,1	98,7	2,082	19,0				
11/03/2014	**B438**	130,5	11 500	400,9	107,4	202,5	98,3	2,084	19,0				
11/03/2014	**B439**	130,6	11 500	401,0	107,0	202,2	98,1	2,089	19,0				
11/03/2014	**B440**	131,1	11 620	401,4	107,4	202,3	99,2	2,086	19,0				
11/03/2014	**B441**	130,9	11 700	401,2	107,6	202,5	99,4	2,096	19,0				
11/03/2014	**B442**	130,7	11 620	401,2	107,7	202,6	98,7	2,096	19,0				
11/03/2014	**B443**	131,4	11 600	401,0	107,5	202,4	98,4	2,101	19,0				
11/03/2014	**B444**	130,9	11 740	401,0	107,5	202,5	99,8	2,095	19,0				
11/03/2014	**B445**	130,6	11 720	400,9	107,7	202,7	99,5	2,098	19,0				Pièce écartée corps étranger
11/03/2014	**B446**	130,8	11 700	401,1	107,5	202,7	99,4	2,096	19,0				
11/03/2014	**B447**	131,3	11 720	401,2	107,4	202,5	99,3	2,102	19,0				
11/03/2014	**B448**	130,7	11 680	401,3	107,3	202,1	99,1	2,100	19,0				
11/03/2014	**B449**	130,7	11 680	401,1	107,5	202,6	99,2	2,097	19,0				
11/03/2014	**B450**	131,3	11 680	401,1	107,6	202,4	99,1	2,099	19,0				
11/03/2014	**B451**	130,5	11 680	401,1	107,5	202,4	99,2	2,097	19,0				
11/03/2014	**B452**	130,7	11 720	401,1	107,8	202,6	99,3	2,102	19,0				
11/03/2014	**B453**	131,1	11 640	401,0	107,4	202,8	99,0	2,094	19,0				
11/03/2014	**B454**	130,6	11 720	401,0	107,3	202,4	99,4	2,100	19,0				
11/03/2014	**B455**	131,3	11 640	401,1	107,4	202,4	99,1	2,093	19,0				
11/03/2014	**B456**	130,6	11 700	401,2	107,5	202,4	99,2	2,101	19,0				
11/03/2014	**B457**	130,7	11 700	401,3	107,4	202,4	99,5	2,095	19,0				
11/03/2014	**B458**	131,3	11 660	401,1	107,6	202,4	99,5	2,087	19,0				
11/03/2014	**B459**	131,0	11 700	401,2	107,5	202,3	99,3	2,099	19,0				
11/03/2014	**B460**	130,7	11 720	401,2	107,8	202,7	99,2	2,105	19,0				
11/03/2014	**B461**	131,1	11 700	401,1	107,6	202,6	99,4	2,097	19,0				
11/03/2014	**B462**	130,9	11 700	401,0	107,4	202,9	99,4	2,097	19,0				
11/03/2014	**B463**	130,7	11 640	401,3	107,6	202,5	99,0	2,094	19,0				
11/03/2014	**B464**	131,3	11 660	401,3	107,3	202,4	99,2	2,094	19,0				
11/03/2014	**B465**	132,7	11 660	401,2	107,7	202,9	99,1	2,096	19,0				
11/03/2014	**B466**	130,7	11 700	401,5	107,5	202,4	99,5	2,093	19,0				

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
11/03/2014	**B467**	131,9	11 660	401,3	107,6	202,6	99,3	2,092	19,0				
11/03/2014	**B468**	131,1	11 680	401,3	107,5	202,3	99,5	2,091	19,0				
11/03/2014	**B469**	130,5	11 660	401,3	107,5	202,4	99,1	2,095	19,0				
11/03/2014	**B470**	131,2	11 640	401,4	107,6	202,3	99,2	2,090	19,0				
11/03/2014	**B471**	131,4	11 560	400,9	107,5	202,6	98,3	2,094	19,0				
11/03/2014	**B472**	130,6	11 600	401,0	107,5	202,3	99,0	2,088	19,0				
11/03/2014	**B473**	131,1	11 640	401,1	107,6	202,4	98,9	2,097	19,0				
11/03/2014	**B474**	131,4	11 680	401,1	107,6	202,4	99,2	2,096	19,0				
11/03/2014	**B475**	130,6	11 700	401,1	107,5	202,4	99,4	2,096	19,0				
11/03/2014	**B476**	130,9	11 660	401,1	107,3	202,5	99,0	2,097	19,0				
11/03/2014	**B477**	130,8	11 680	401,0	107,3	202,4	99,7	2,086	19,0				
11/03/2014	**B478**	131,2	11 680	401,1	107,6	202,5	99,3	2,095	19,0				
11/03/2014	**B479**	130,9	11 680	401,1	107,4	202,3	99,0	2,102	19,0				
11/03/2014	**B480**	131,2	11 680	401,4	107,6	202,5	99,3	2,096	19,0				
11/03/2014	**B481**	130,8	11 660	401,7	107,6	202,4	99,1	2,095	19,0				
11/03/2014	**B482**	131,1	11 720	401,1	107,5	202,3	99,4	2,100	19,0				
11/03/2014	**B483**	132,6	11 680	401,1	107,3	202,3	99,5	2,092	19,0				
11/03/2014	**B484**	130,7	11 700	400,9	107,6	202,5	99,5	2,095	19,0				
11/03/2014	**B485**	131,2	11 700	401,2	107,6	202,3	99,5	2,094	19,0				
11/03/2014	**B486**	132,7	11 680	401,7	107,5	202,6	99,3	2,095	19,0				
11/03/2014	**B487**	130,6	11 680	401,2	107,5	202,3	99,2	2,096	19,0				
11/03/2014	**B488**	130,7	11 700	401,2	107,7	202,3	99,5	2,094	19,0				
11/03/2014	**B489**	131,2	11 680	401,0	107,5	202,3	99,2	2,097	19,0				
11/03/2014	**B490**	130,8	11 720	401,3	107,4	202,7	99,7	2,093	19,0				
11/03/2014	**B491**	130,8	11 680	401,2	107,5	202,9	99,1	2,098	19,0				
11/03/2014	**B492**	132,8	11 700	401,9	107,5	202,9	99,4	2,096	19,0				
11/03/2014	**B493**	130,6	11 680	401,7	107,5	202,3	99,9	2,082	19,0				
11/03/2014	**B494**	130,8	11 640	401,1	107,6	202,3	99,3	2,087	19,0				
11/03/2014	**B495**	131,1	11 720	401,2	107,7	202,7	99,4	2,100	19,0				
11/03/2014	**B496**	130,6	11 680	401,2	107,5	202,3	99,4	2,094	19,0				
11/03/2014	**B497**	130,6	11 680	401,0	107,5	202,8	99,5	2,091	19,0				
11/03/2014	**B498**	131,3	11 680	401,2	107,5	202,3	99,3	2,096	19,0				
11/03/2014	**B499**	131,2	11 640	400,9	107,4	202,2	99,0	2,095	19,0				
11/03/2014	**B500**	130,9	11 640	400,9	107,6	202,4	99,1	2,092	19,0				
11/03/2014	**B501**	130,7	11 640	401,0	107,5	202,4	99,0	2,093	19,0				
11/03/2014	**B502**	131,4	11 640	400,9	107,6	202,6	98,9	2,096	19,0				
11/03/2014	**B503**	131,4	11 640	401,5	107,6	202,4	99,0	2,095	19,0				
11/03/2014	**B504**	130,9	11 640	401,5	107,5	202,4	99,2	2,090	19,0				
11/03/2014	**B505**	130,6	11 640	401,0	107,5	202,5	99,0	2,093	19,0				
11/03/2014	**B506**	131,3	11 640	401,1	107,7	202,2	99,2	2,090	19,0				
11/03/2014	**B507**	130,7	11 620	401,1	107,7	202,3	99,0	2,091	19,0				
11/03/2014	**B508**	130,8	11 680	401,1	107,6	202,4	99,4	2,093	19,0				
11/03/2014	**B509**	132,6	11 620	401,0	107,5	202,4	99,2	2,087	19,0				
11/03/2014	**B510**	130,6	11 640	401,0	107,5	202,3	99,2	2,090	19,0				
11/03/2014	**B511**	132,5	11 600	401,0	107,3	202,2	98,7	2,092	19,0				
11/03/2014	**B512**	130,6	11 620	400,9	107,7	202,4	98,9	2,092	19,0				
11/03/2014	**B513**	130,7	11 600	401,0	107,4	202,4	99,0	2,087	19,0				
11/03/2014	**B514**	131,2	11 660	401,0	107,5	202,4	99,7	2,084	19,0				
11/03/2014	**B515**	131,1	11 620	401,3	107,5	202,5	99,1	2,088	19,0				
11/03/2014	**B516**	130,7	11 640	401,0	107,4	202,2	99,2	2,090	19,0				
11/03/2014	**B517**	131,4	11 620	400,8	107,4	202,2	98,9	2,092	19,0				
11/03/2014	**B518**	131,2	11 640	400,9	107,5	202,3	99,3	2,087	19,0				
11/03/2014	**B519**	130,7	11 620	401,0	107,5	202,3	99,1	2,088	19,0				
11/03/2014	**B520**	130,5	11 640	401,1	107,4	202,3	99,1	2,093	19,0				
11/03/2014	**B521**	131,4	11 660	401,0	107,4	202,3	99,4	2,090	19,0				
11/03/2014	**B522**	130,5	11 620	400,9	107,5	202,4	98,9	2,092	19,0				
11/03/2014	**B523**	130,8	11 640	400,1	107,5	202,3	99,3	2,087	19,0				
11/03/2014	**B524**	130,6	11 680	400,9	107,6	202,3	99,5	2,090	19,0				
11/03/2014	**B525**	131,0	11 640	401,0	107,4	202,2	99,3	2,087	19,0				
11/03/2014	**B526**	131,0	11 620	400,9	107,2	202,4	98,8	2,096	19,0				
11/03/2014	**B527**	131,3	11 580	401,0	107,4	202,8	98,7	2,089	19,0				
11/03/2014	**B528**	130,6	11 620	400,9	107,3	202,4	98,9	2,092	19,0				
11/03/2014	**B529**	131,1	11 600	400,8	107,3	202,1	98,7	2,093	19,0				
11/03/2014	**B530**	130,6	11 680	400,8	107,4	202,2	98,9	2,104	19,0				
11/03/2014	**B531**	131,7	11 620	401,2	107,5	202,3	99,1	2,088	19,0				
11/03/2014	**B532**	130,7	11 640	400,9	107,5	202,2	99,1	2,093	19,0				
11/03/2014	**B533**	130,7	11 700	400,8	107,4	202,4	99,4	2,096	19,0				
11/03/2014	**B534**	131,2	11 640	401,0	107,6	202,3	99,2	2,091	19,0				

Date	Référence pièce	Pression de compactage (MPa)	Masse pièce compactée (g)	Longueur de pièce (mm)	Largeur de pièces (mm)	Hauteur de pièce sur la pointe (mm)	Epaisseur de pièce (mm)	Densité géométrique (g/cm3)	Teneur en eau théorique (%)	Teneur en eau mesurée (%)	Résistance à la compression (Mpa)	Agent de démoulage	Remarques
11/03/2014	**B535**	130,6	11 680	401,0	107,6	202,3	99,3	2,095	19,0				
11/03/2014	**B536**	130,5	11 640	401,1	107,5	202,9	99,1	2,092	19,0				
11/03/2014	**B537**	130,8	11 700	400,9	107,5	202,5	99,4	2,097	19,0				
11/03/2014	**B538**	131,1	11 650	401,6	107,5	202,4	99,2	2,092	19,0				
11/03/2014	**B539**	130,9	11 640	400,9	107,5	202,3	99,2	2,089	19,0				
11/03/2014	**B540**	130,5	11 640	401,2	107,5	202,4	99,3	2,087	19,0				
11/03/2014	**B541**	130,6	11 660	401,2	107,4	202,4	99,2	2,093	19,0				
11/03/2014	**B542**	130,6	11 660	401,2	107,6	202,4	99,1	2,095	19,0				
11/03/2014	**B543**	131,0	11 660	401,1	107,6	202,5	99,4	2,089	19,0				
11/03/2014	**B544**	130,9	11 620	401,3	107,7	202,5	99,1	2,089	19,0				
11/03/2014	**B545**	130,7	11 620	401,1	107,4	202,3	99,2	2,086	19,0				
11/03/2014	**B546**	131,2	11 600	400,8	107,5	202,4	98,9	2,090	19,0				
11/03/2014	**B547**	131,1	11 640	400,9	107,5	202,4	99,4	2,087	19,0				
11/03/2014	**B548**	131,0	11 640	401,0	107,4	202,5	99,1	2,091	19,0				
11/03/2014	**B549**	130,7	11 640	401,0	107,7	202,5	99,3	2,087	19,0				
11/03/2014	**B550**	130,6	11 640	401,1	107,6	202,4	99,3	2,088	19,0				
11/03/2014	**B551**	131,4	11 640	400,9	107,5	202,6	98,7	2,101					
11/03/2014	**B552**	130,7	11 620	401,1	107,5	202,4	98,8	2,096					
11/03/2014	**B553**	130,8	11 620	400,9	107,6	202,5	99,0	2,090					
11/03/2014	**B554**	131,3	11 620	400,8	107,6	202,9	99,0	2,090					
11/03/2014	**B555**	131,0	11 600	401,6	107,7	202,1	99,0	2,088					
11/03/2014	**B556**	130,5	11 620	401,1	107,6	202,0	99,3	2,084					
11/03/2014	**B557**	130,5	11 640	401,0	107,4	202,1	99,3	2,088					
11/03/2014	**B558**	130,9	11 680	401,5	107,6	202,5	100,0	2,081					
11/03/2014	**B559**	130,7	11 640	401,1	107,7	202,2	98,9	2,096					
11/03/2014	**B560**	131,3	11 640	401,1	107,7	202,3	99,2	2,090					
11/03/2014	**B561**	130,7	11 640	401,6	107,5	202,1	99,0	2,095					
11/03/2014	**B562**	132,6	11 640	401,6	107,6	202,4	98,9	2,096					
11/03/2014	**B563**	130,8	11 640	400,7	107,2	202,3	98,7	2,099					
11/03/2014	**B564**	130,7	11 660	400,0	106,4	202,5	98,0	2,118					
11/03/2014	**B565**	130,9	11 680	401,0	107,5	202,3	98,0	2,122					
11/03/2014	**B566**	130,7	11 660	400,6	107,5	202,8	99,3	2,091					
11/03/2014	**B567**	130,9	11 640	400,8	107,4	202,8	99,0	2,095					
11/03/2014	**B568**	130,7	11 620	400,8	107,6	202,8	99,5	2,080					
11/03/2014	**B569**	130,9	11 620	400,8	107,7	202,9	99,6	2,079					
11/03/2014	**B570**	131,2	11 600	400,7	107,5	202,7	99,2	2,083					
11/03/2014	**B571**	131,2	11 620	400,8	107,7	202,7	98,9	2,092					
11/03/2014	**B572**	130,6	11 600	401,2	107,9	202,8	99,2	2,083					
11/03/2014	**B573**	131,1	11 560	401,0	107,6	202,5	99,0	2,080					
11/03/2014	**B574**	130,9	11 640	401,2	107,8	202,4	99,2	2,089					
11/03/2014	**B575**	131,7	11 620	401,1	107,6	202,4	99,2	2,086					
11/03/2014	**B576**	130,8	11 620	401,2	107,7	202,4	99,1	2,088					
11/03/2014	**B577**	130,8	11 620	401,2	107,7	202,2	99,4	2,081					
11/03/2014	**B578**	130,7	11 620	400,9	107,8	202,3	99,2	2,086					
11/03/2014	**B579**	131,3	11 660	400,8	107,5	202,3	100,0	2,077					
11/03/2014	**B580**	130,8	11 660	401,1	107,6	202,5	99,0	2,098					
11/03/2014	**B581**	130,5	11 680	400,8	107,5	202,9	99,9	2,083					
11/03/2014	**B582**	130,6	11 660	401,1	107,6	202,7	99,3	2,092					
11/03/2014	**B583**	131,0	11 680	401,5	107,7	202,4	99,2	2,098					
11/03/2014	**B584**	131,1	11 660	400,6	107,4	202,4	99,6	2,085					
11/03/2014	**B585**	131,0	11 660	402,0	107,8	202,1	99,7	2,082					
11/03/2014	**B586**	130,6	11 600	400,7	107,6	202,5	99,3	2,082					
11/03/2014	**B587**	131,0	11 660	401,1	107,4	202,8	99,3	2,092					
11/03/2014	**B588**	130,9	11 640	400,6	107,7	203,0	99,2	2,090					
11/03/2014	**B589**	131,0	11 620	400,7	107,5	202,3	99,2	2,087					
11/03/2014	**B590**	130,6	11 600	401,1	107,6	202,3	99,4	2,079					

Average		131,1	11 702	401,2	107,5	202,5	99,2	2,100		18,13
Std dev.		0,7	66	0,3	0,3	0,2	0,4	0,009		0,61
Min		130,3	11 500	400,0	106,4	202,0	98,0	2,074		17,68
Max		133,2	11 880	402,0	107,9	203,4	100,4	2,126		19,28
Max-Min		2,9	380,0	2,0	1,5	1,4	2,4	0,052		1,60

Appendix D: External Quality Control of raw material for bentonite blocks

TÜV MANAGEMENT SERVICE | ISO 9001 | ISO 14001

Zertifiziert von der AQS-Leitstelle des Bayerischen Landesamtes für Wasserwirtschaft

Untersuchungsstelle nach § 15 Abs. 4, Satz 2 der TrinkwV 2001

dorfner ANZAPLAN

DAkkS Deutsche Akkreditierungsstelle D-PL-17744-01-00

Nach DIN EN ISO/IEC 17025:2005 durch die DAkkS Deutsche Akkreditierungsstelle GmbH akkreditiertes Prüflaboratorium

Dorfner Analysenzentrum und Anlagenplanungsgesellschaft mbH
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Laviosa MPC
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Unsere Zeichen: *Our Reference:*	Ansprechpartner: *Contact:*	Fon: 0 96 22/ *Phone: (+49 96 22)*	Datum: *Date:*	**UNTERSUCHUNGSBERICHT NR. TEST REPORT NO.**
Dr. TB-ch	Dr. Thomas Bach	82-185	11.12.2013	**1801697** ***AU-49342***
Sekretariat GL	Christin Held	82-162		

LIMS ID	**Sample**	**Date of Entry**
13-20672	Na Bentonite	25.11.2013

Dorfner
Analysenzentrum und
Anlagenplanungsgesellschaft mbH

i. A. Dr. Thomas Bach
Head of Laboratory

Deutscher Verband unabhängiger Prüflaboratorien e.V. VUP Nr. 1102 Mitglied

Sitz der Gesellschaft: Hirschau,
Registergericht Amberg HRB 820
Geschäftsführer:
PD Dr. rer. nat. Reiner Haus

1801697 *AU-49342*

dorfner ANZAPLAN

Parameter	LIMS ID	13-20672
Parameter	Norm	Na Bentonite
Moisture 105°C	DIN EN ISO 787-2	11,98 | MA.-%
SiO2	DIN EN ISO 12677	62,2 | MA-%
Al2O3	DIN EN ISO 12677	19,5 | MA-%
Fe2O3	DIN EN ISO 12677	4,53 | MA-%
TiO2	DIN EN ISO 12677	0,18 | MA-%
K2O	DIN EN ISO 12677	0,46 | MA-%
Na2O	DIN EN ISO 12677	2,56 | MA-%
CaO	DIN EN ISO 12677	1,60 | MA-%
MgO	DIN EN ISO 12677	2,36 | MA-%
PbO	DIN EN ISO 12677	<0,01 | MA-%
BaO	DIN EN ISO 12677	0,03 | MA-%
SO3	DIN EN ISO 12677	0,44 | MA-%
MnO	DIN EN ISO 12677	0,04 | MA-%
P2O5	DIN EN ISO 12677	0,04 | MA-%
ZrO2	DIN EN ISO 12677	0,03 | MA-%
LOI 1025 °C	DIN EN ISO 26845	6,02 | MA-%
XRD	DIN 13925	s. Attachment
Pyrite	Rietveld	<1 | MA-%
Smectite	Calculated	80 | MA-%
Albite	Standard-Addition	2 | MA-%
Anorthite	Rietveld	8 | MA-%
Quartz	Standard-Addition	4 | MA-%
Muscovite	Rietveld	4 | MA-%
Smectite	VDG-Merkblatt Bindemittelprüfung Prüfung von Bindebetonen P69 1999	81 | MA-%
CEC Capacity	AgTU	98 | meq/100g
Na conversion	AgTU	52 | meq/100g
K conversion	AgTU	1,2 | meq/100g
Mg conversion	AgTU	10 | meq/100g
Ca conversion	AgTU	37 | meq/100g
Sum conversion	AgTU	100 | meq/100g
TOC	ASTM D5373-93	0,21 | MA-%
Sulphur	DIN 51085	0,15 | MA-%

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Appendix E: Quality Control of raw material for bentonite blocks and bentonite pellets (before production) by ETH

Nagra
Hardstrasse 73
CH-5430 Wettingen
Dr. Hanspeter Weber

LUCOEX/FE

Analyses of bentonite materials

IGT Report CL1044, Nagra 11’832
12th December 2013

Content:

1 Introduction

NAGRA assigned the Institute of Geotechnical Engineering of the ETH Zurich (IGT) with the analysis of samples of 14 different Na-bentonite materials in the framework of public tender No. 784573.

The parameters to determine where the water content and from selected samples the pellet/grain density, the grain size distribution, the mineralogical composition, the cation exchange capacity, and the water uptake under free swelling conditions.

2 Samples

Nagra delivered the bags with the material (between 200 g and 1.5 kg) on 17th September (Tab. 1, Fig. 1 - 14). For comparison, a sample of the original MX-80 from AmCol 2012 was included in the sample suite.

Tab. 1: Samples

<table>
<tr><th>Sample ID</th><th>WP</th><th>Type</th></tr>
<tr><td>1</td><td>WP1</td><td>Raw material</td></tr>
<tr><td>2</td><td>WP2</td><td>Dried raw material</td></tr>
<tr><td>3</td><td rowspan="3">WP2</td><td>Dried raw material</td></tr>
<tr><td>4</td><td>Dried raw material</td></tr>
<tr><td>5</td><td>Dried raw material</td></tr>
<tr><td>6</td><td>WP1</td><td>Raw material</td></tr>
<tr><td>7</td><td>WP2</td><td>Dried raw material</td></tr>
<tr><td>8</td><td>WP3</td><td>Pellets</td></tr>
<tr><td>9</td><td>WP1</td><td>Raw material</td></tr>
<tr><td>10</td><td>WP2-3</td><td>Pellets</td></tr>
<tr><td>11</td><td></td><td>Pellets</td></tr>
<tr><td>12</td><td>WP1</td><td>Raw material</td></tr>
<tr><td>13</td><td>WP1</td><td>Raw material</td></tr>
<tr><td>14</td><td>WP3</td><td>Pellets</td></tr>
<tr><td>MX-80</td><td></td><td>Raw material</td></tr>
</table>

Fig. 1: ID1, raw material.

Fig. 2: ID2, raw material.

Fig. 3: ID3, dried raw material.

Fig. 4: ID4, dried raw material.

Fig. 5: ID5, dried raw material..

Fig. 6: ID6, raw material.

Fig. 7: ID7, dried, crushed and sieved.

Fig. 8: ID8, extruded, non-sieved.

Fig. 9: ID9, raw material.

Fig. 10: ID10, Lab muster pellets.

Fig. 11: ID11, industrial muster pellets.

Fig. 12: ID12, raw material.

Fig. 13: ID13, raw material.

Fig. 14: ID14, pellets.

3 Methods

3.1 Water content

The gravimetric water content (w) is defined as the ratio between the weight of water and the weight of dry solid expressed as a percentage. The water content was determined in accordance with SN 670 3406. Approx. 10 g material (moist) were immediately after delivering weighed out and dried at 105–110 °C for one week (until weight constancy).

$$w = \frac{M - M_d}{M_d} \cdot 100$$

w = water content in per cent, M = sample mass in moist state and M_d = sample mass after drying.

3.2 Density of the bentonite pellets

Density is the mass of an object divided by its volume. Bulk density is the mass of an object divided by its volume where the volume includes that of its pores and small cavities. In the case of irregularly formed samples (e.g. the pellets), the volume is determined with a pycnometer by displacement of a medium. The bulk density is determined using a medium, which not intrude the sample pores. The bulk (moist) density ρ of the bentonite pellets was determined as average of 10 measurements usually of at least two different samples. On request, in this study, the number of measured samples was increased to 4 – 10 (sample weight between 5 and 40 g). The measurements were carried out with the Micromeritics GeoPyc 1360. This instrument determines the volume and density of a solid object by displacement of a solid medium (so called DryFlow, a silica nano powder).

The measured bulk density is the moist density. Based on the determined water content w the moist bulk density can be recalculated into dry density ρ_d.

$$\rho_d = \frac{\rho}{1 + \frac{w}{100}}$$

ρ_d = dry density in g/cm^3 (or kg/l), ρ = moist density in g/cm^3 and w = water content in per cent.

3.3 Grain size distribution (sieve analysis)

The grain size distribution of the bentonite material was determined by dry sieving of 200 – 1400 g. Sieving was executed with a 3D sieve shaker Retsch AS450 control (amplitude 1.5 mm, time 3 min with 30 s intervals) and sieves with 2 mm, 1 mm, 0.5 mm, and 0.25 mm opening (high-grade steel of mesh sieves with 440 mm diameter acc. DIN ISO 3310/1). The value Q3 gives the amount passing (mesh minus) and the value p3 the residual amount (mesh plus). The analysis was carried out in replicates and averaged.

The evaluation of particle size distribution permits various conclusions on the compaction behaviour. Thus, the distortion number of C_U and the curvature number of C_C from the particle size distribution are computed. The distortion number of C_U represents thereby the relationship of the values for to the grain diameters at 10% and 60% sieve passage.

$$C_U = d_{60}/d_{10}$$

Values below five show the predomination of a certain grain size (poorly graded), whereas values above are typical for well-graded materials. Since with the computation by C_U a large grain range is not considered, one computes the curvature number C_C.

$$C_C = (d_{30})^2 / (d_{60} \cdot d_{10})$$

3.4 Mineralogical Composition

Mineralogy of the sample was determined on randomly oriented powder specimens with X-ray diffraction analysis. The samples were air dried crushed in a Retsch-jaw breaker <0.4 mm and split representatively. About 5 g of the material was Ca-exchanged using a 4% $CaCl_2$-solution turnover rotating overnight followed by 5 times washing with H_2O_{dest}. An aliquot of about 2 g of the exchanged material was then milled in ethanol to a grain size below 20 µm with a McCrone micronizing mill. For frontloading preparation, about 1.5 g of the powdered dry material was gentle pressed in a sample holder for packing, sample-height adjustment and forming a flat surface. Preferred orientation is to be avoided by using a blade for surface preparation. The second sample preparation for clayey materials produces oriented specimens. This smearing technique enhances the basal reflections from clay minerals thereby facilitating their identification by typical the shift of basal peak position after different treatments. The specimens were measured air dry, after intercalation of ethylene glycol (smectite shift from 14 to 17 Å, illite no change) and after 2 h heating (disappearing kaolinite, basal spacing of smectite shifts to 9.6 Å).

X-ray measurements are made using a Bragg-Brentano diffractometer (Bruker AXS D8 Advance, CoKα with automatic theta compensating divergence and antiscattering slit and SolX solid state detector) in the range of 2 to 80°2Θ with a step width of 0.02°2Θ and a counting time of 4 s per step.

The qualitative phase analysis was carried out with the software package DIFFRACplus (Bruker AXS). The phases were identified according to the position and relative intensity of the peaks in comparison to the ICDD database. The amount of the mineral phases was calculated by Rietveld-analysis of the measured patterns based on the results of the qualitative phase analysis. This full pattern-fitting method consists in the calculation of the X-ray diffraction pattern and its iterative adjustment to the measured diffractogram. In the refinements, the phase specific parameters and the phase content were adapted to minimize the difference between the calculated and the measured X-ray diffractogram. The latter forms the basis for the standardless quantitative analysis. The quantitative phase analysis of the sample was carried out with the Rietveld program AutoQuan (GE SEIFERT).

3.5 Cation exchange capacity (CEC)

The cation-exchange capacity (CEC) was determined using complexes of copper (II) ion with triethylenetetramine and tetraethylenepentamine (Meier & Kahr 1999). The copper complex has a high affinity for clay minerals. 200 mg of clay sample are added to 35 ml of distilled water and dispersed by ultrasonic treatment. The suspension is then diluted to 50 ml and overhead shaken. After 3 min reaction time, the suspension is centrifuged. The supernatant solution is carefully removed and the photometric extinction is measured at 580 nm against a blank. The CEC is then calculated with reference to the dry clay weight.

3.6 Water uptake

The water uptake under free swelling conditions was determined using the Enslin-Neff technique (DIN 18132) on approx. 0.1 g bentonite.

The amount of water and suction time depends from material (grain size for the capillary uptake and content of swellable clay minerals and the ionic form particularly the content of Na for interlayer uptake). The amount and speed of up-taken water under the suction conditions are normally measured up to 24 h. In case of bentonite, the time can be more than 24 h until maximal uptake. The measurements were terminated after three constant data of water uptake. The measurements were carried out in duplicate using desalted and degassed water. The water uptake ability W_b (in % or mg/g) can be calculated as follows:

$$W_b = \frac{W_{\max}}{M_d} \cdot 100$$

where W_{max} = amount of uptaken water and M_d = dry weight of the sample.

4 Results

4.1 Water content

Tab. 2: Gravimetric water content in wt% related to the dry weight.

Sample ID	*w* in wt%
1	13.0
2	5.9
3	5.1
4	6.0
5	7.2
6	15.4
7	11.4
8	14.2
9	14.3
10	17.7
11	9.2
12	9.8
13	7.3
14	4.5

4.2 Density of the bentonite pellets

Tab. 3: Density of the bentonite pellets (average of 10 measurements of each sample)

Sample	Bulk density of pellets ρ	
	moist (g/cm^3)	dry (g/cm^3)
ID 8: extruded pellets (10 samples)	2.10	1.839 (±0.020)
ID 10: lab muster pellets (10 samples)	2.05	1.744 (±0.031)
ID 11: industrial muster pellets (10 samples)	2.03	1.856 (±0.017)
ID 14: pellets (4 samples)	2.18	2.086 (±0.053)

The detailed measurement results for all samples are given in the appendix.

4.3 Sieve analysis

Tab. 4a: Grain size distribution parameters of selected bentonite materials.

Sample	Parameter		
	d30 in mm	d50 in mm	d90 in mm
ID2	0.637	0.992	1.801
ID3	0.228	0.414	0.878
ID6	1.124	1.655	2.73
ID7	0.483	0.741	1.673
ID9	0.673	1.278	2.661
ID12	0.266	0.354	0.709
ID13	0.602	0.848	1.736
MX-80	0.227	0.396	0.870

The sieve curves and the full set of parameters are given in the appendix.

Tab. 4b: Size of selected bentonite pellets (average of 20 pellets).

Sample	Parameter	
	length in mm	diameter in mm
ID8	7.28	6.20
ID10	9.67	12.34

4.4 Mineralogical composition

Tab. 5: Mineralogical composition of selected bentonite materials (data in wt% with 3σ absolute error).

	ID2	ID7	ID9	ID12	ID13	MX-80*
Calcite	1.0 (0.2)	1.1 (0.2)	1.1 (0.2)	1.5 (0.2)	1.3 (0.2)	1.0 (0.2)
Illite+Muscovite	8.2 (1.5)	6.2 (1.2)	7.0 (1.1)	9.3 (1.7)	8.3 (1.6)	4.6 (0.8)
K-Feldspar	4.4 (0.3)	3.8 (0.3)	4.0 (0.3)	3.2 (0.3)	3.7 (0.3)	5.2 (0.8)
Na-plagioclase	3.0 (0.4)	2.3 (0.3)	2.4 (0.3)	3.7 (0.4)	2.6 (0.3)	
Pyrite	0.2 (0.2)	0.2 (0.1)	0.2 (0.1)	0.4 (0.1)	0.3 (0.1)	
Quartz	6.6 (0.3)	7.2 (0.3)	6.3 (0.3)	2.5 (0.3)	6.9 (0.3)	3.4 (0.5)
Cristobalite	0.6 (0.2)	1.0 (0.2)	1.7 (0.3)	2.5 (0.3)	1.6 (0.3)	
Siderite	0.7 (0.2)	0.6 (0.1)	0.5 (0.2)	0.3 (0.1)	0.6 (0.1)	
Clinoptilolite	nn	nn	nn	7.4 (0.5)	nn	
Smectite	75.3 (1.1)	77.6 (1.0)	76.8 (0.9)	69.2 (1.1)	74.7 (1.1)	85.7 (1.2)
Test for interstratified (CV)	0.89 no	0.32 no	0.21 no	0.93 no	0.83 no	

* Plötze, M., Weber, H.P. (2007): ESDRED: Emplacement tests with granular bentonite MX-80. Laboratory results from ETH Zürich. Arbeitsbericht NAB 07-24, nagra.

All samples are Na-bentonites but have a lower smectite content as the MX-80 bentonite. Sample ID12 is the only with a smectite content slightly below the requested 70% limit. Furthermore, this material is characterized by the highest content in muscovite/illite, pyrite and cristobalite but the lowest quartz content. Additionally only in this sample zeolite was found.

4.5 Cation exchange capacity

Tab. 6: Cation exchange capacity of selected bentonite materials (average of two measurements).

	ID2	ID7	ID9	ID12	ID13	MX-80
CEC in cmol(+)/kg	89.3	94.3	93.3	90.8	84.3	85.6

4.6 Water uptake (Enslin-Neff)

Tab. 7: Maximum water uptake capacity of selected bentonite materials (average of two measurements).

	ID2	ID7	ID9	ID12	ID13	MX-80*
W_b in %	656.1	553.5	587.5	550.0	574.5	620

* Plötze, M. (2007): Bentonit als Barrierematerial für die Endlagerung radioaktiver Abfälle. Mineralogisch-chemische und physikalische Untersuchungen an Bentonit. ETH Zürich IGT-Report 4718/1, 20.12.2007

The curves of the water uptake are given in the appendix.

5 Concluding remarks

The investigations were carefully carried out according to current scientific state of the art and to the best of our knowledge. The results exclusively refer to the sample mentioned.

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Zurich, 12th December 2013

ETH Zurich
Institute for Geotechnical Engineering (IGT)

Dr. M. Plötze

Appendix

1) **Density measurements**

2) **Sieve curves**

3) **Enslin-Neff curves**

Density measurements

Pellet/grain density		Micromeritics Geopyc 1360	
		bulk density	**dry bulk density**
	w%		
Sample	related to m_d	ρ (g/cm^3)	**ρ_d (g/cm3)**
ID8			
	14.2		
1, 7.2706 g		2.1077	**1.8450**
		2.1044	**1.8421**
		2.1052	**1.8428**
		2.1028	**1.8407**
		2.1077	**1.8450**
		2.1011	**1.8392**
		2.1044	**1.8421**
		2.1028	**1.8407**
		2.1036	**1.8414**
		2.1036	**1.8414**
2, 7.1085 g		2.1134	**1.8500**
		2.1091	**1.8462**
		2.1134	**1.8500**
		2.1065	**1.8439**
		2.1100	**1.8470**
		2.1006	**1.8388**
		2.1117	**1.8485**
		2.1040	**1.8417**
		2.1142	**1.8507**
		2.1065	**1.8439**
3, 7.0326 g		2.1139	**1.8504**
		2.1139	**1.8504**
		2.1139	**1.8504**
		2.1088	**1.8459**
		2.1096	**1.8466**
		2.1105	**1.8474**
		2.1070	**1.8444**
		2.1079	**1.8452**
		2.1079	**1.8452**
		2.1070	**1.8444**
4, 7.0210 g		2.0242	**1.7719**
		2.0346	**1.7810**
		2.0266	**1.7740**
		2.0362	**1.7824**
		2.0378	**1.7838**
		2.0362	**1.7824**
		2.0386	**1.7845**
		2.0346	**1.7810**
		2.0426	**1.7880**
		2.0451	**1.7902**

5, 7.0466 g		2.1147	**1.8511**
		2.1173	**1.8534**
		2.1147	**1.8511**
		2.1190	**1.8549**
		2.1138	**1.8503**
		2.1130	**1.8496**
		2.1095	**1.8466**
		2.1138	**1.8503**
		2.1112	**1.8480**
		2.1112	**1.8480**
6, 7.0789 g		2.1046	**1.8423**
		2.0986	**1.8370**
		2.0995	**1.8378**
		2.0986	**1.8370**
		2.1012	**1.8393**
		2.1020	**1.8400**
		2.0969	**1.8355**
		2.0986	**1.8370**
		2.0935	**1.8326**
		2.0961	**1.8348**
7, 7.0431 g		2.1016	**1.8396**
		2.1042	**1.8419**
		2.1059	**1.8434**
		2.1042	**1.8419**
		2.1007	**1.8389**
		2.0999	**1.8382**
		2.1007	**1.8389**
		2.0999	**1.8382**
		2.0982	**1.8367**
		2.0931	**1.8322**
8, 7.0624 g		2.1212	**1.8568**
		2.1125	**1.8492**
		2.1142	**1.8507**
		2.1108	**1.8477**
		2.1160	**1.8522**
		2.1091	**1.8462**
		2.1065	**1.8439**
		2.1117	**1.8485**
		2.1142	**1.8507**
		2.1125	**1.8492**
9, 7.0192 g		2.1230	**1.8584**
		2.1221	**1.8576**
		2.1186	**1.8545**
		2.1177	**1.8537**
		2.1151	**1.8515**
		2.1195	**1.8553**
		2.1151	**1.8515**
		2.1125	**1.8492**
		2.1169	**1.8530**

		2.1134	**1.8500**
10, 7.1729 g		2.1103	**1.8473**
		2.1086	**1.8458**
		2.1103	**1.8473**
		2.1061	**1.8436**
		2.1035	**1.8413**
		2.1061	**1.8436**
		2.1069	**1.8443**
		2.1019	**1.8399**
		2.1052	**1.8428**
		2.1002	**1.8384**
average		**2.10**	**1.839**
median			1.8443
Stddev			0.0200
min			1.7719
max			1.8584

Pellet/grain density		Micromeritics Geopyc 1360	
		bulk density	**dry bulk density**
	w%		
Sample	related to m_d	ρ (g/cm^3)	**ρ_d (g/cm3)**
ID10			
	17.7		
1, 7.2043 g		2.0665	**1.7563**
		2.0673	**1.7570**
		2.0689	**1.7583**
		2.0616	**1.7521**
		2.0697	**1.7590**
		2.0640	**1.7542**
		2.0673	**1.7570**
		2.0665	**1.7563**
		2.0649	**1.7549**
		2.0649	**1.7549**
2, 3.2914 g		2.0704	**1.7596**
		2.0722	**1.7611**
		2.0704	**1.7596**
		2.0686	**1.7581**
		2.0704	**1.7596**
		2.0651	**1.7551**
		2.0739	**1.7626**
		2.0615	**1.7520**
		2.0563	**1.7476**
		2.0580	**1.7491**
3, 5.8040 g		1.9957	**1.6961**
		1.9939	**1.6946**
		1.9957	**1.6961**
		1.9995	**1.6994**
		2.0042	**1.7033**
		2.0033	**1.7026**
		2.0051	**1.7041**
		2.0051	**1.7041**
		2.0070	**1.7057**
		2.0014	**1.7010**
5, 3.0456 g		2.0106	**1.7088**
		2.0088	**1.7073**
		2.0052	**1.7042**
		1.9962	**1.6965**
		2.0034	**1.7027**
		1.9980	**1.6981**
		1.9980	**1.6981**
		1.9944	**1.6950**
		1.9944	**1.6950**
		2.0016	**1.7011**
6, 2.5422 g		2.0580	**1.7491**
		2.0512	**1.7433**
		2.0512	**1.7433**

		2.0311	**1.7262**
		2.0445	**1.7376**
		2.0490	**1.7414**
		2.0422	**1.7356**
		2.0378	**1.7319**
		2.0356	**1.7300**
		2.0333	**1.7281**
7, 2.2557 g		2.1211	**1.8027**
		2.1320	**1.8120**
		2.1348	**1.8143**
		2.1238	**1.8050**
		2.1348	**1.8143**
		2.1102	**1.7934**
		2.1211	**1.8027**
		2.1211	**1.8027**
		2.1184	**1.8004**
		2.1129	**1.7957**
8, 2.4500 g		2.0798	**1.7676**
		2.0943	**1.7799**
		2.0895	**1.7758**
		2.0895	**1.7758**
		2.0655	**1.7554**
		2.0607	**1.7514**
		2.0584	**1.7494**
		2.0397	**1.7335**
		2.0655	**1.7554**
		2.0798	**1.7676**
9, 3.1675 g		2.0559	**1.7473**
		2.0487	**1.7412**
		2.0415	**1.7350**
		2.0487	**1.7412**
		2.0290	**1.7244**
		2.0379	**1.7320**
		2.0290	**1.7244**
		2.0290	**1.7244**
		2.0325	**1.7274**
		2.0254	**1.7214**
10, 3.5928 g		2.0491	**1.7415**
		2.0523	**1.7442**
		2.0427	**1.7361**
		2.0587	**1.7497**
		2.0475	**1.7401**
		2.0491	**1.7415**
		2.0539	**1.7456**
		2.0587	**1.7497**
		2.0635	**1.7537**
		2.0555	**1.7469**
average		**2.05**	**1.744**
median			1.7463

Stddev			0.0312
min			1.6946
max			1.8143

Pellet/grain density		Micromeritics Geopyc 1360	
		bulk density	**dry bulk density**
	w%		
Sample	related to m_d	ρ (g/cm^3)	**ρ_d (g/cm3)**
ID11			
	9.2		
1, 7.7855 g		2.0357	**1.8650**
		2.0386	**1.8676**
		2.0357	**1.8650**
		2.0386	**1.8676**
		2.0365	**1.8657**
		2.0365	**1.8657**
		2.0372	**1.8664**
		2.0379	**1.8670**
		2.0314	**1.8611**
		2.0350	**1.8644**
2, 7.2817 g		2.0573	**1.8848**
		2.0589	**1.8862**
		2.0541	**1.8818**
		2.0573	**1.8848**
		2.0510	**1.8790**
		2.0541	**1.8818**
		2.0549	**1.8826**
		2.0510	**1.8790**
		2.0546	**1.8823**
		2.0486	**1.8768**
3, 2.4893 g		2.0152	**1.8462**
		2.0041	**1.8360**
		2.0019	**1.8340**
		1.9997	**1.8320**
		1.9976	**1.8301**
		1.9997	**1.8320**
		1.9997	**1.8320**
		1.9932	**1.8261**
		1.9845	**1.8181**
		1.9997	**1.8320**
4, 5.2467 g		2.0328	**1.8623**
		2.0328	**1.8623**
		2.0286	**1.8585**
		2.0350	**1.8644**
		2.0328	**1.8623**
		2.0296	**1.8594**
		2.0190	**1.8497**
		2.0264	**1.8565**
		2.0211	**1.8516**
		2.0243	**1.8545**
5, 4.4952 g		2.0402	**1.8691**
		2.0440	**1.8726**
		2.0390	**1.8680**
		2.0390	**1.8680**
		2.0390	**1.8680**
		2.0277	**1.8577**
		2.0364	**1.8656**
		2.0339	**1.8633**
		2.0327	**1.8622**

		2.0352	**1.8645**
6, 4.8956 g		1.9959	**1.8285**
		2.0071	**1.8388**
		1.9981	**1.8305**
		1.9993	**1.8316**
		1.9981	**1.8305**
		1.9993	**1.8316**
		2.0026	**1.8347**
		1.9993	**1.8316**
		2.0015	**1.8337**
		1.9970	**1.8295**
7, 5.4621 g		2.0243	**1.8545**
		2.0233	**1.8536**
		2.0254	**1.8556**
		2.0233	**1.8536**
		2.0233	**1.8536**
		2.0243	**1.8545**
		2.0192	**1.8499**
		2.0182	**1.8490**
		2.0213	**1.8518**
		2.0111	**1.8425**
8, 4.8100 g		2.0102	**1.8416**
		2.0056	**1.8374**
		2.0194	**1.8501**
		2.0136	**1.8447**
		2.0194	**1.8501**
		2.0148	**1.8458**
		2.0102	**1.8416**
		2.0045	**1.8364**
		1.9988	**1.8312**
		2.0056	**1.8374**
9, 5.4855 g		2.0258	**1.8559**
		2.0279	**1.8578**
		2.0177	**1.8485**
		2.0228	**1.8532**
		2.0107	**1.8421**
		2.0208	**1.8513**
		2.0096	**1.8411**
		2.0258	**1.8559**
		2.0076	**1.8392**
		2.0218	**1.8523**
10, 5.4407 g		2.0591	**1.8864**
		2.0453	**1.8738**
		2.0591	**1.8864**
		2.0401	**1.8690**
		2.0580	**1.8854**
		2.0412	**1.8700**
		2.0506	**1.8786**
		2.0443	**1.8729**
		2.0422	**1.8709**
		2.0422	**1.8709**
average		**2.03**	**1.856**
median			1.8633

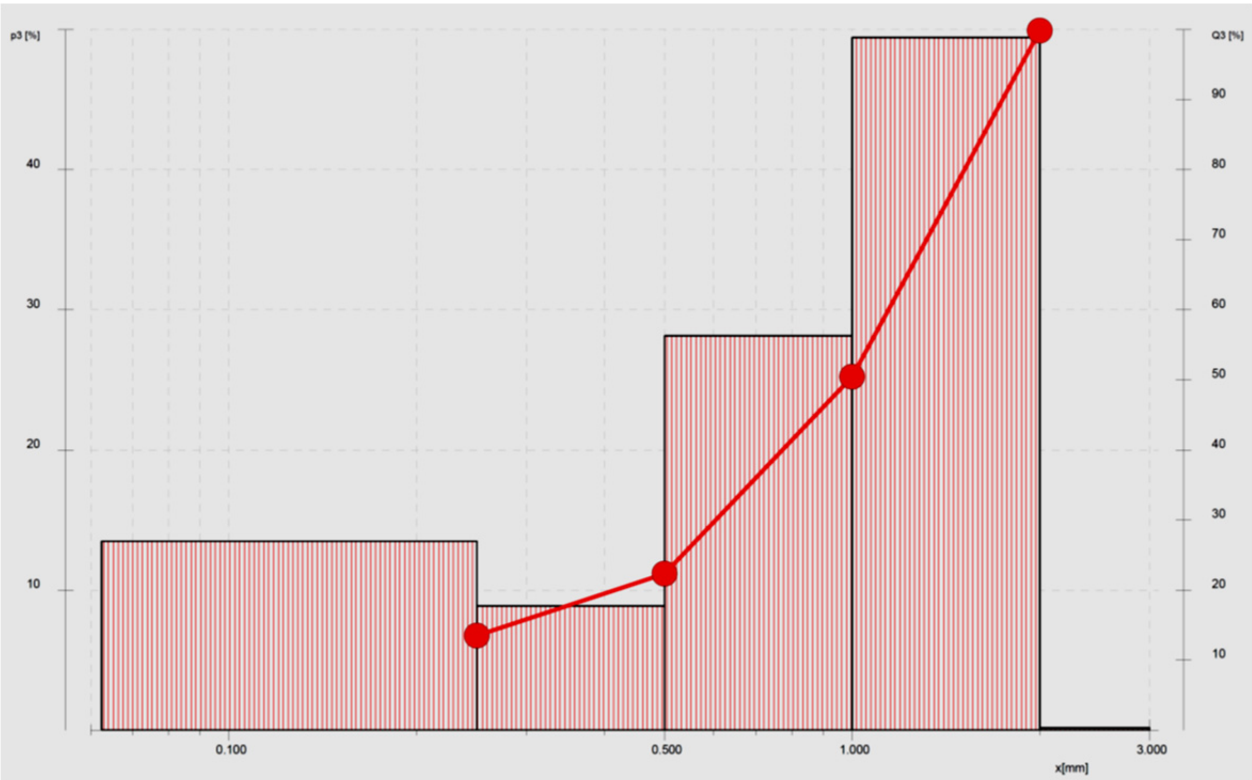
Stddev			0.0172
min			1.8181
max			1.8864

Pellet/grain density		Micromeritics Geopyc 1360	
		bulk density	**dry bulk density**
	w%		
Sample	related to m_d	ρ (g/cm^3)	**ρ_d (g/cm3)**
ID14			
	4.5		
1, 42.0329 g		2.1576	**2.0653**
		2.1546	**2.0625**
		2.1558	**2.0636**
		2.1564	**2.0642**
		2.1552	**2.0630**
		2.1546	**2.0625**
		2.1582	**2.0659**
		2.1582	**2.0659**
		2.1564	**2.0642**
		2.1552	**2.0630**
2, 42.9117 g		2.1010	**2.0112**
		2.0977	**2.0080**
		2.0993	**2.0095**
		2.0966	**2.0070**
		2.0999	**2.0101**
		2.0999	**2.0101**
		2.1021	**2.0122**
		2.1032	**2.0133**
		2.1049	**2.0149**
		2.1066	**2.0165**
3, 42.6926 g		2.2424	**2.1465**
		2.2430	**2.1471**
		2.2411	**2.1453**
		2.2417	**2.1459**
		2.2392	**2.1435**
		2.2411	**2.1453**
		2.2411	**2.1453**
		2.2392	**2.1435**
		2.2411	**2.1453**
		2.2411	**2.1453**
4, 42.2226 g		2.2183	**2.1235**
		2.2170	**2.1222**
		2.2196	**2.1247**
		2.2177	**2.1229**
		2.2196	**2.1247**
		2.2170	**2.1222**
		2.2183	**2.1235**
		2.2189	**2.1240**
		2.2177	**2.1229**
		2.2196	**2.1247**
average		**2.18**	**2.086**
median			2.0941
Stddev			0.0531
min			2.0070
max			2.1471

Sieve curves

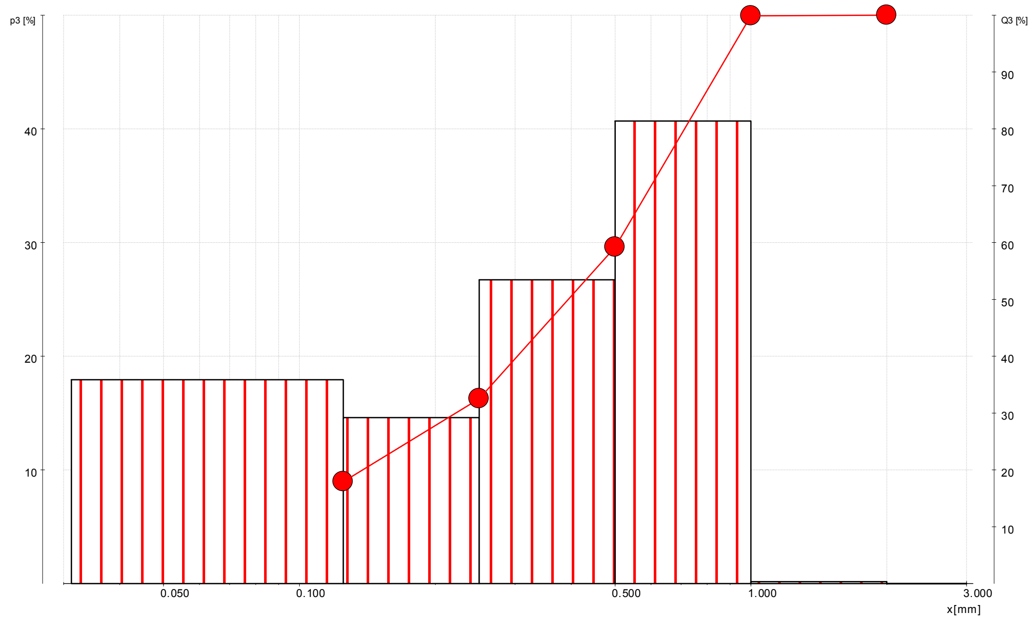
ID2: dried raw material, sample amount 255 g

Parameter		Parameter	
>2 mm	0%	d10	0.186 mm
1.0 - 2.0 mm	49.4%	d30	0.637 mm
0.5 - 1.0 mm	28.1%	d50	0.992 mm
0.25 – 0.5 mm	8.9%	d60	1.193 mm
<0.25 mm	13.5%	d90	1.801 mm
		C_U	6.41
		C_C	1.83



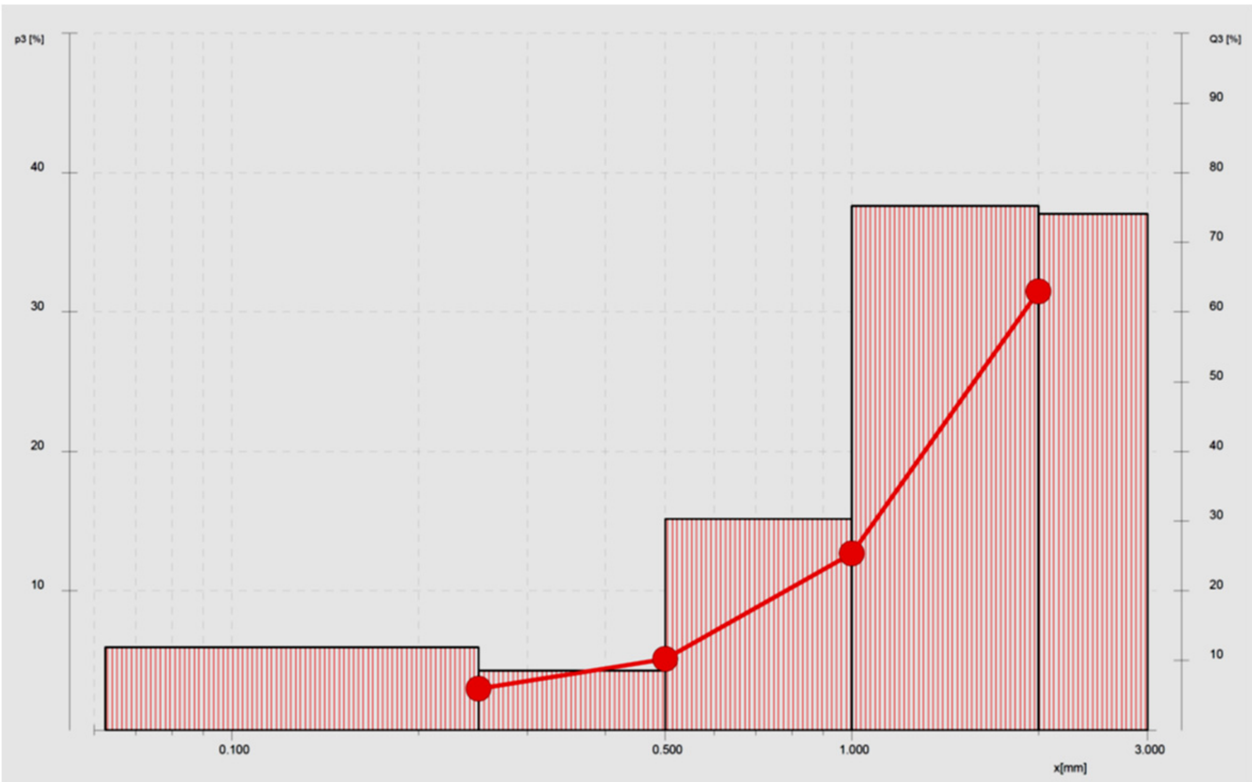
ID3: Dried raw material, sample amount 2 x 242 g

Parameter		Parameter	
>2 mm	0%	d10	0.070 mm
1.0 - 2.0 mm	0.1%	d30	0.228 mm
0.5 - 1.0 mm	40.6%	d50	0.414 mm
0.25 – 0.5 mm	26.8%	d60	0.509 mm
0.125 - 0.25 mm	14.6%	d90	0.878 mm
<0.125 mm	17.9%		
		C_U	7.27
		C_C	1.47



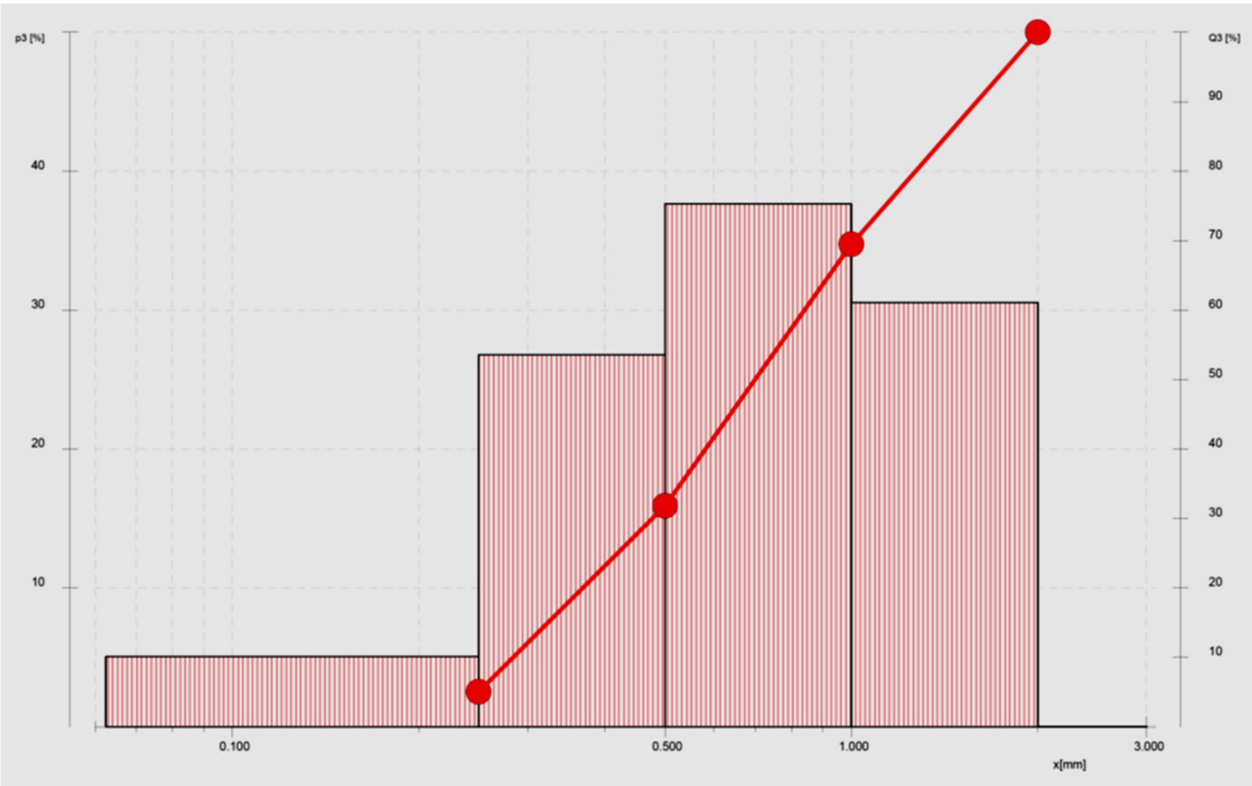
ID6: Raw material, sample amount 348 g

Parameter		Parameter	
>2 mm	37.0%	d10	0.488 mm
1.0 - 2.0 mm	37.6%	d30	1.124 mm
0.5 - 1.0 mm	15.2%	d50	1.655 mm
0.25 – 0.5 mm	4.3%	d60	1.921 mm
<0.25 mm	5.9%	d90	2.730 mm
		C_U	3.94
		C_C	1.35



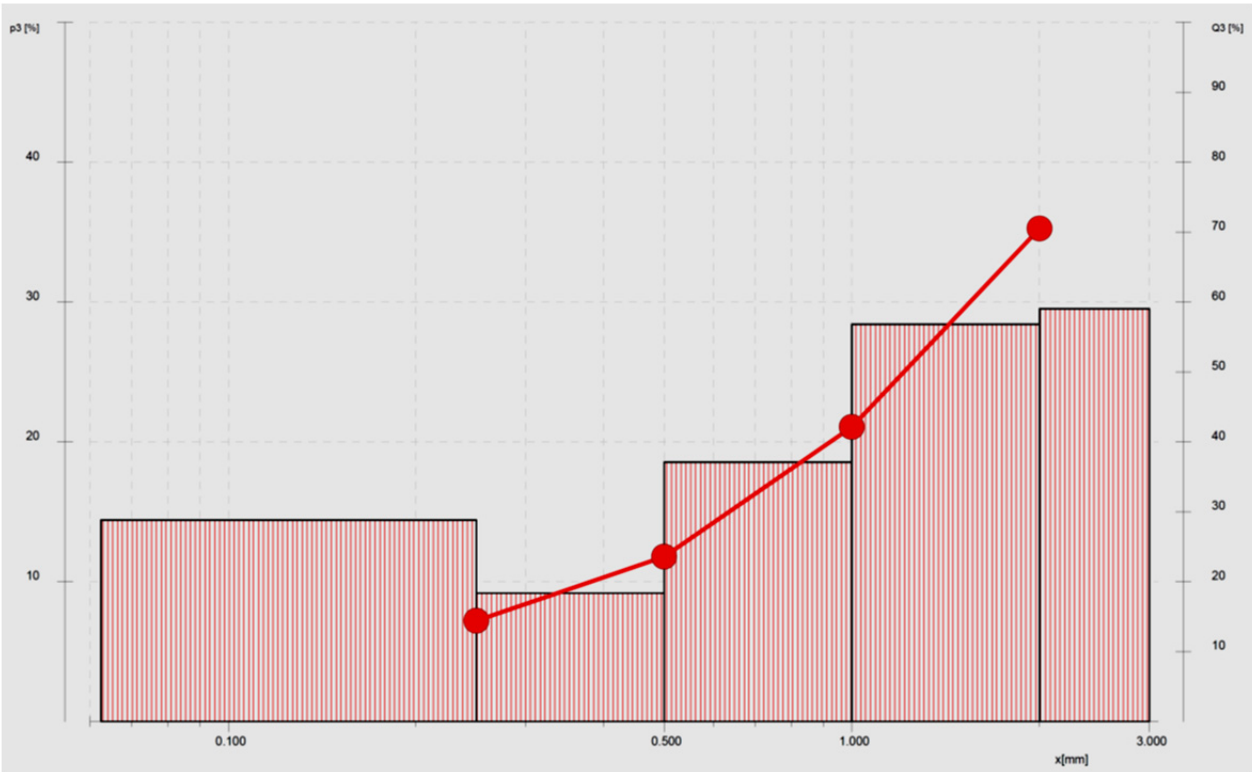
ID7: dried, crushed and sieved material, sample amount 203 g

Parameter		Parameter	
>2 mm	0%	d10	0.296 mm
1.0 - 2.0 mm	30.5%	d30	0.483 mm
0.5 - 1.0 mm	37.6%	d50	0.741 mm
0.25 – 0.5 mm	26.8%	d60	0.874 mm
<0.25 mm	5.1%	d90	1.673 mm
		C_U	2.95
		C_C	0.90



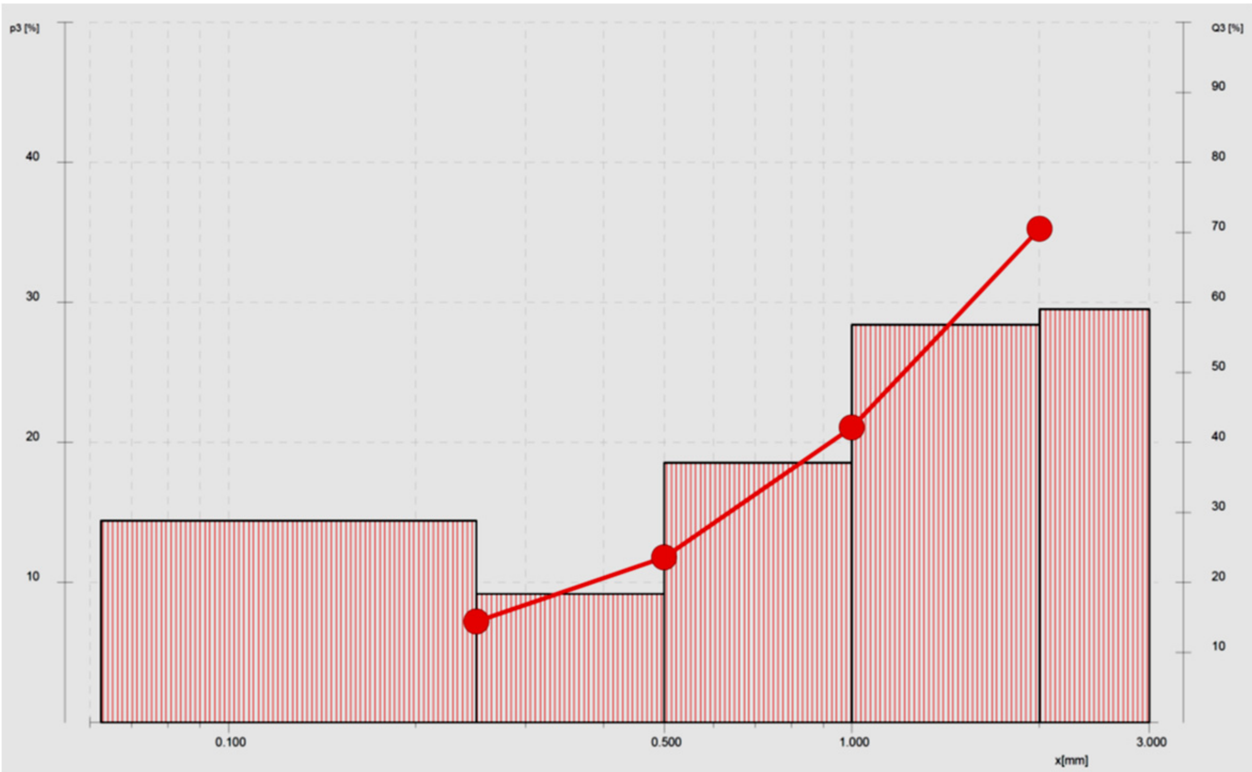
ID9: raw material, sample amount 1455 g

Parameter		Parameter	
>2 mm	29.5%	d10	0.174 mm
1.0 - 2.0 mm	28.4%	d30	0.673 mm
0.5 - 1.0 mm	18.5%	d50	1.278 mm
0.25 – 0.5 mm	9.2%	d60	1.630 mm
<0.25 mm	14.4%	d90	2.661 mm
		C_U	9.37
		C_C	1.60



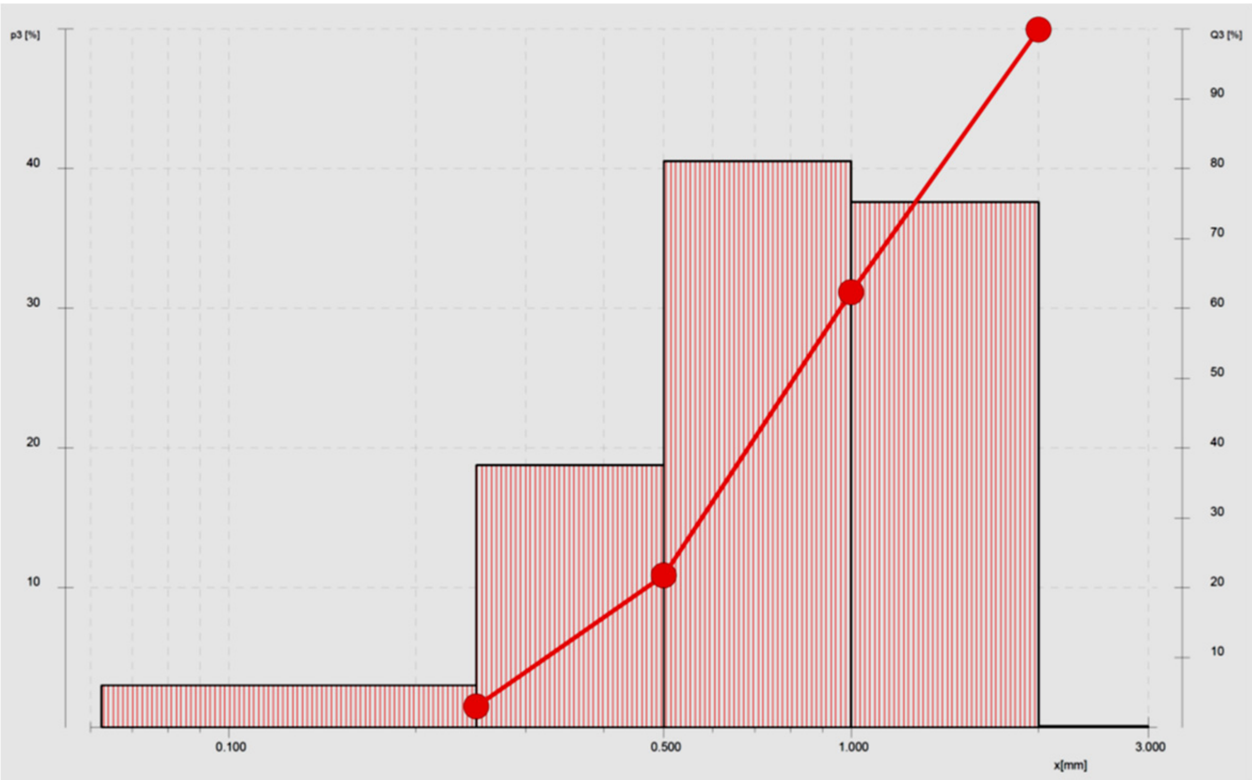
ID12: raw material, sample amount 123 g

Parameter		Parameter	
>2 mm	0%	d10	0.095 mm
1.0 - 2.0 mm	0.8%	d30	0.266 mm
0.5 - 1.0 mm	15.8%	d50	0.354 mm
0.25 – 0.5 mm	57.1%	d60	0.397 mm
<0.25 mm	26.3%	d90	0.709 mm
		C_U	4.18
		C_C	1.88



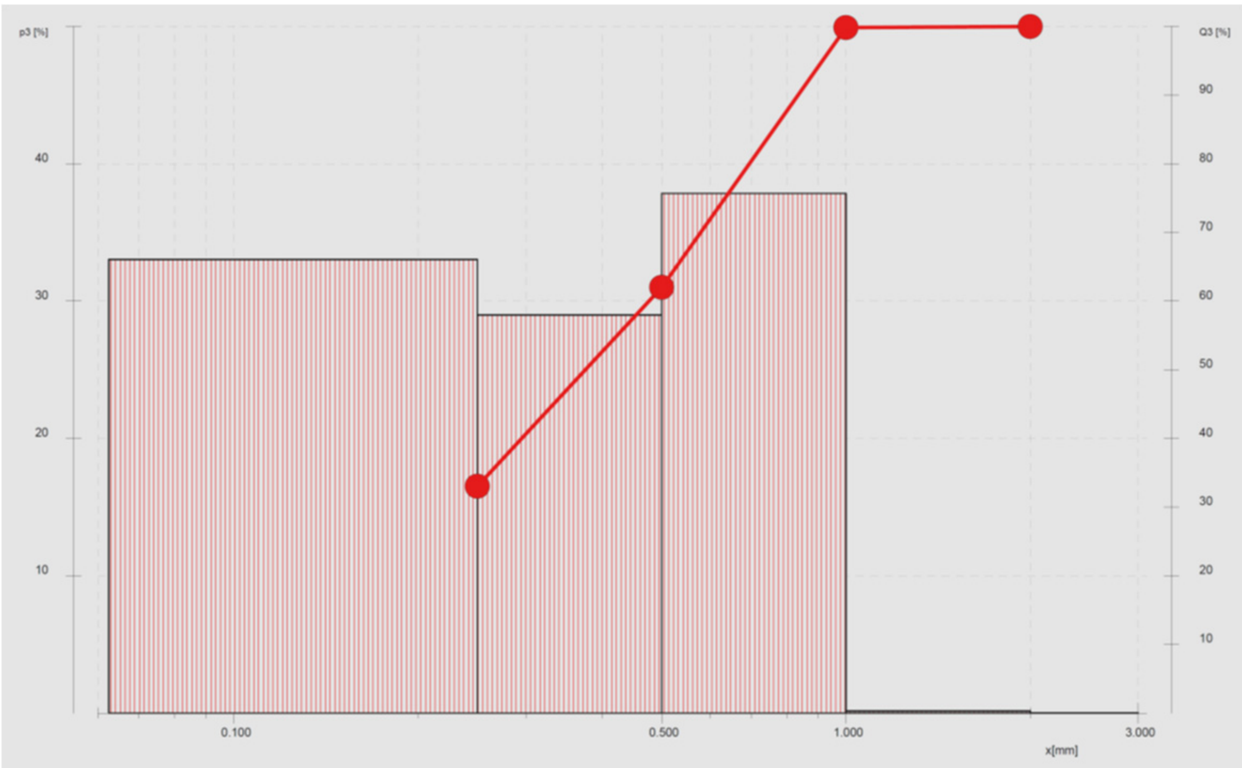
ID13: raw material, sample amount 202 g

Parameter		Parameter	
>2 mm	0.1%	d10	0.343 mm
1.0 - 2.0 mm	37.6%	d30	0.602 mm
0.5 - 1.0 mm	40.5%	d50	0.848 mm
0.25 – 0.5 mm	18.8%	d60	0.972 mm
<0.25 mm	3.0%	d90	1.736 mm
		C_U	2.83
		C_C	1.09



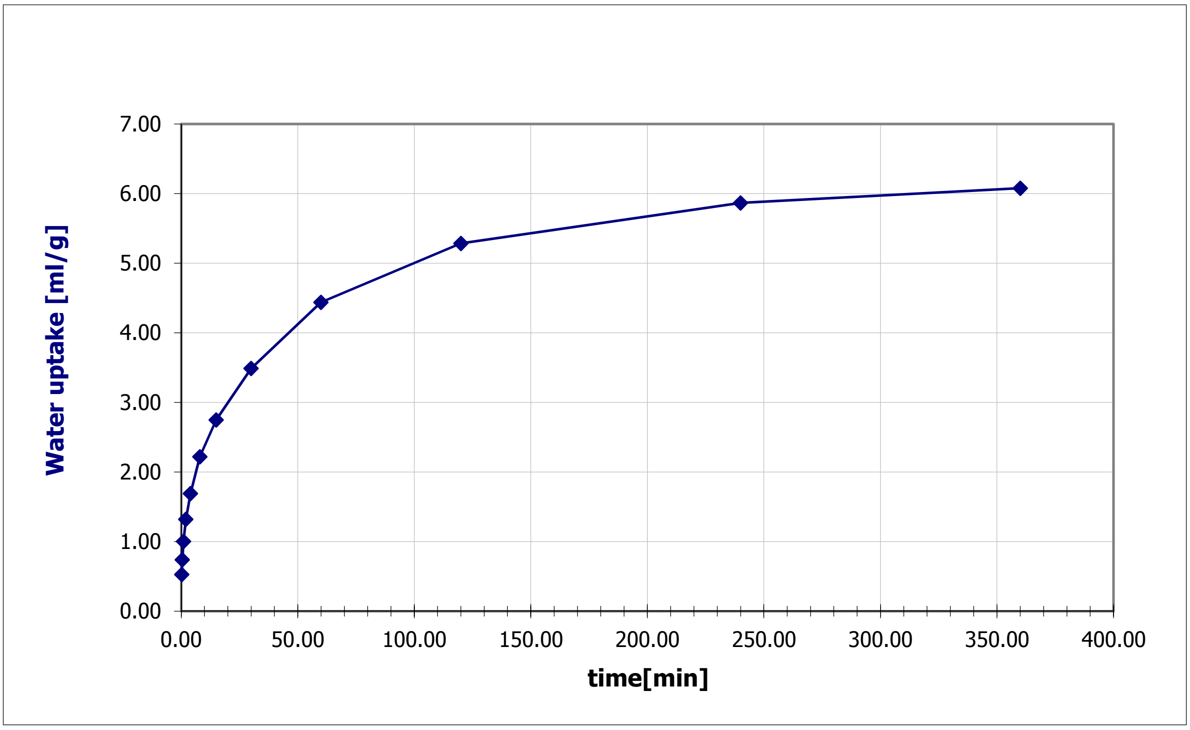
MX-80, raw material, sample amount 344 g

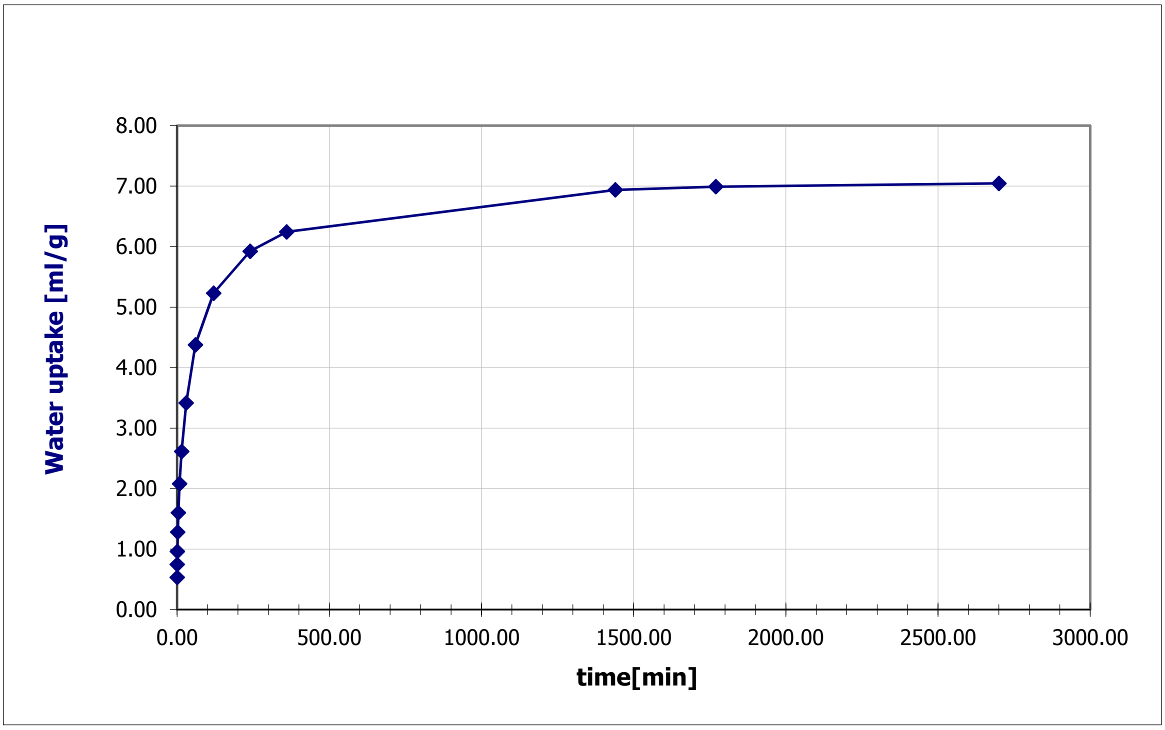
Parameter		Parameter	
>2 mm	0%	d10	0.076 mm
1.0 - 2.0 mm	0.1%	d30	0.227 mm
0.5 - 1.0 mm	37.8%	d50	0.396 mm
0.25 – 0.5 mm	29.0%	d60	0.483 mm
<0.25 mm	33.0%	d90	0.870 mm
		C_U	2.13
		C_C	1.40



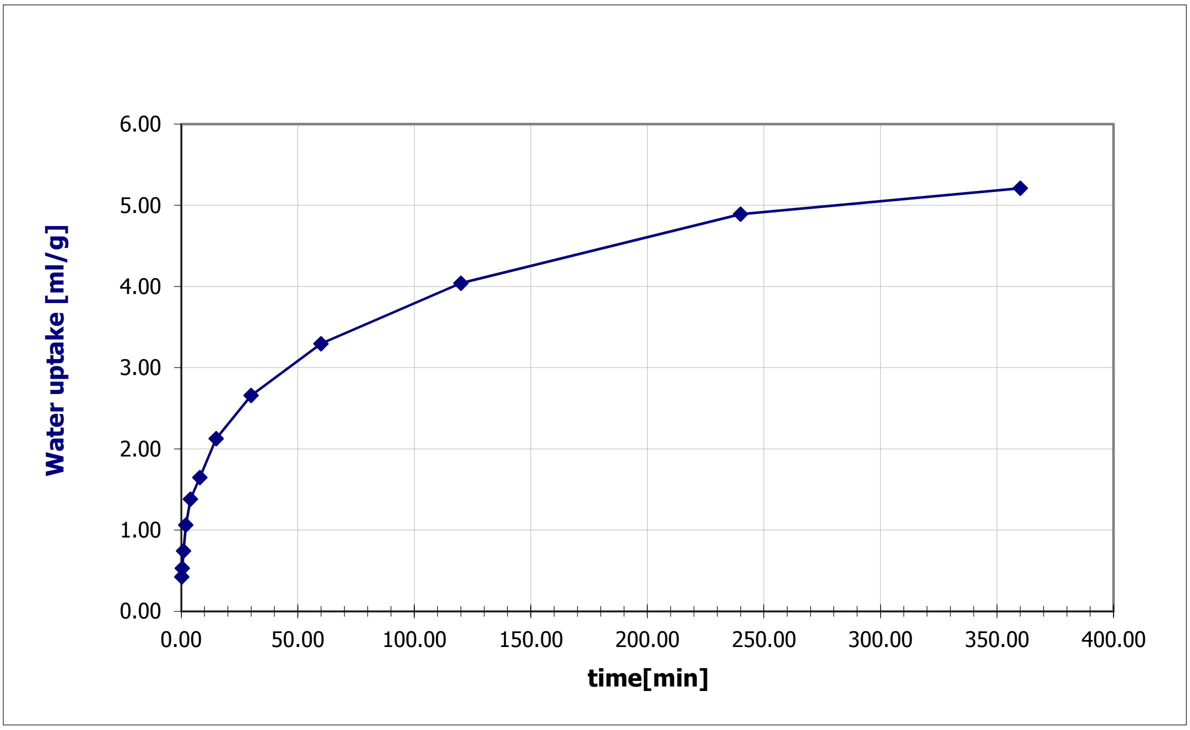
Water uptake curves (Enslin-Neff)

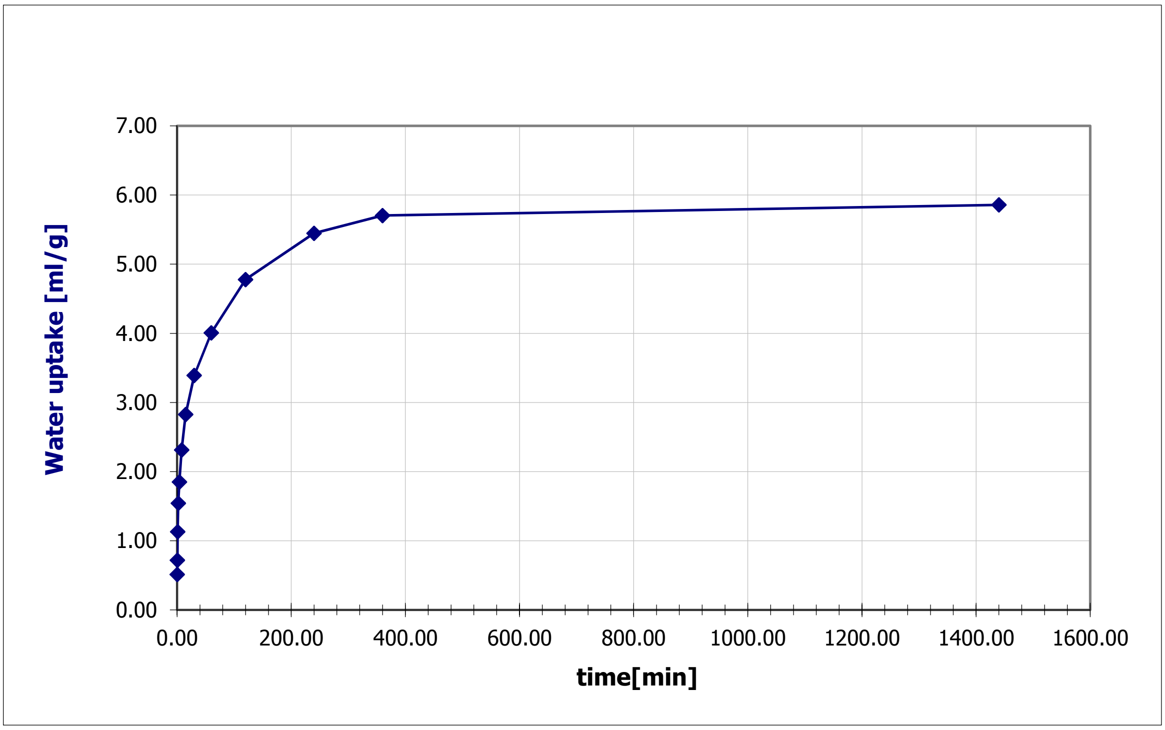
ID2: dried raw material



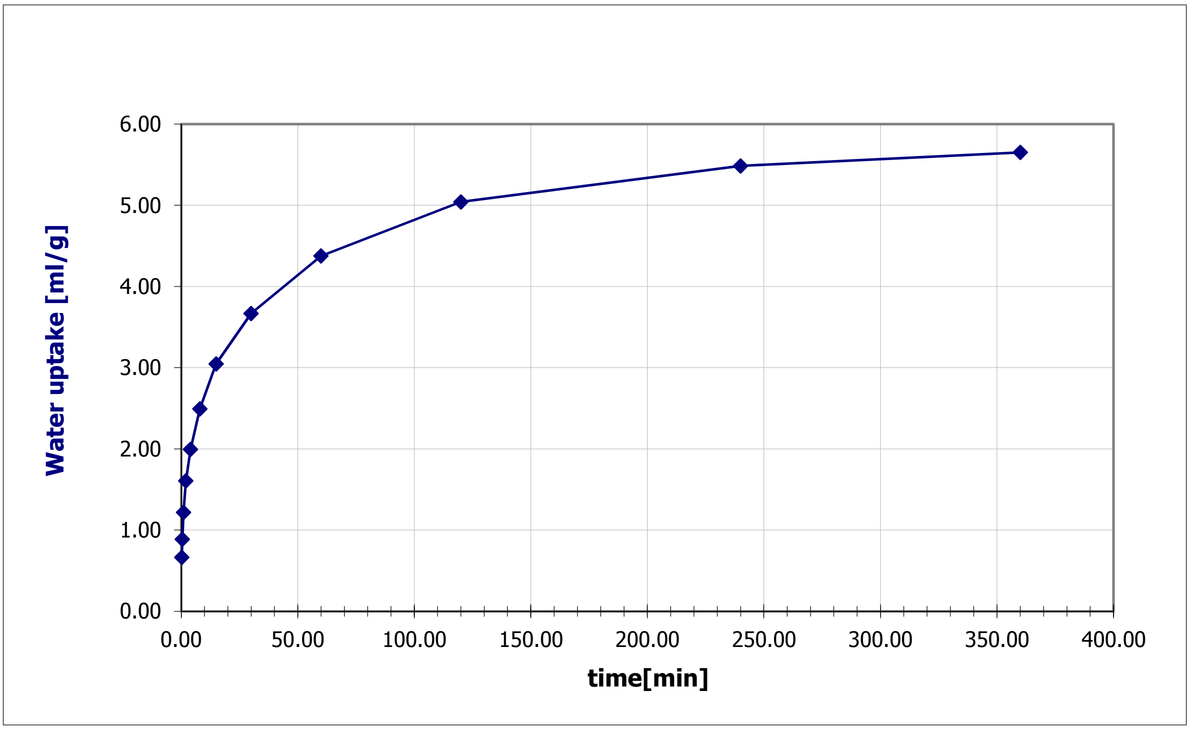


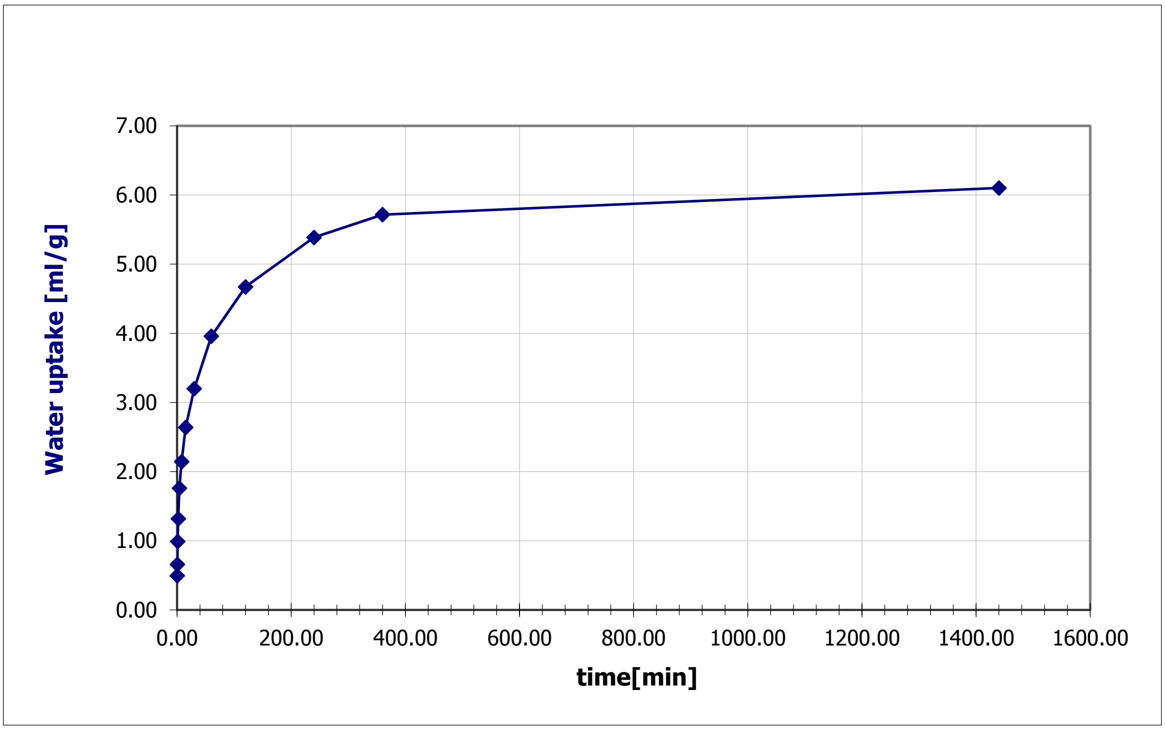
ID7: dried crushed and sieved raw material



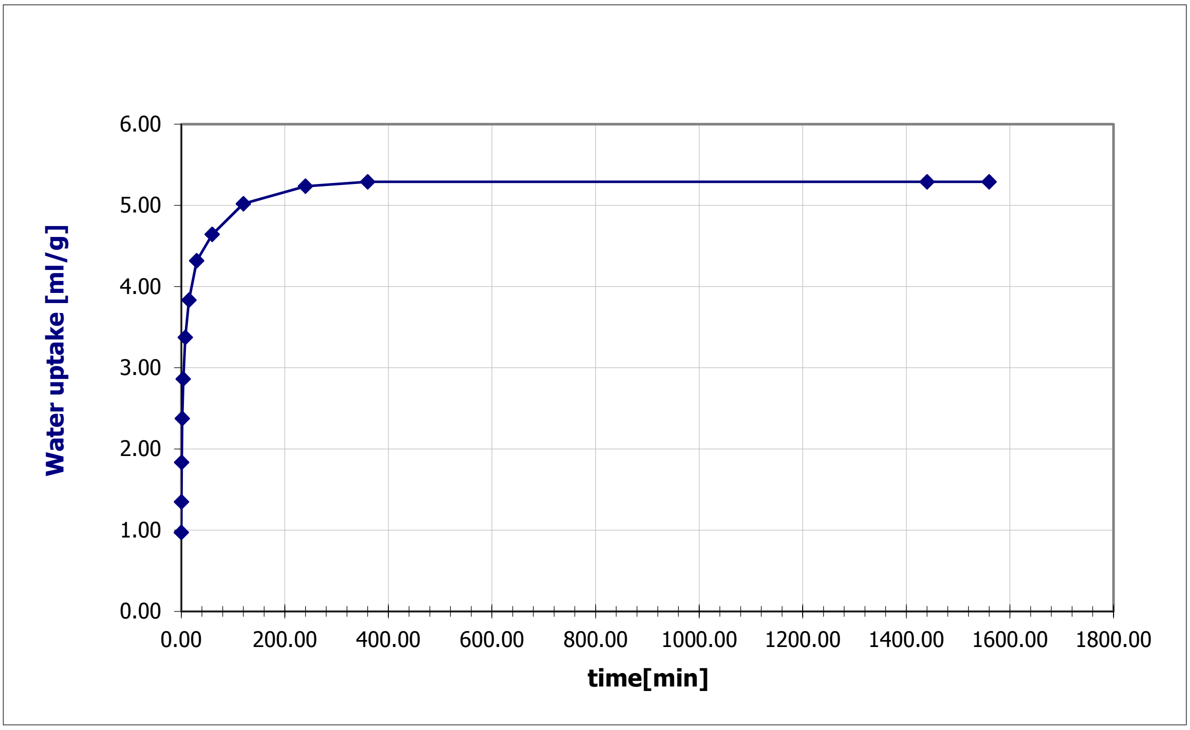


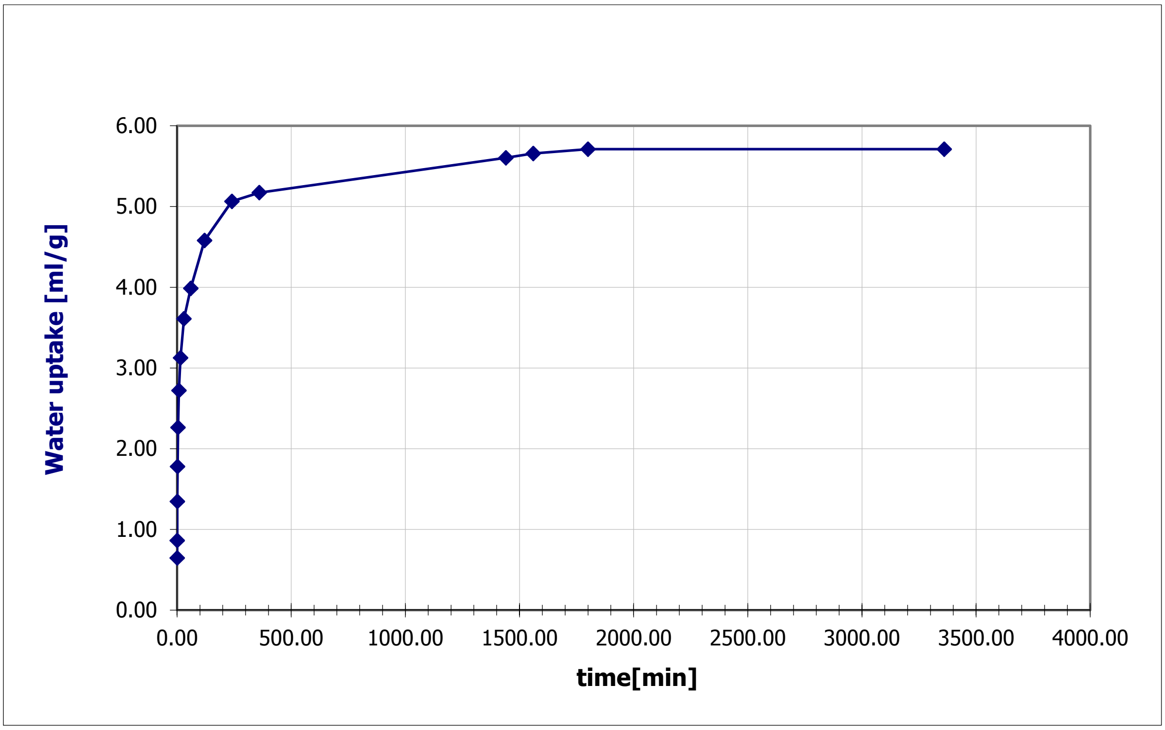
ID9: raw material



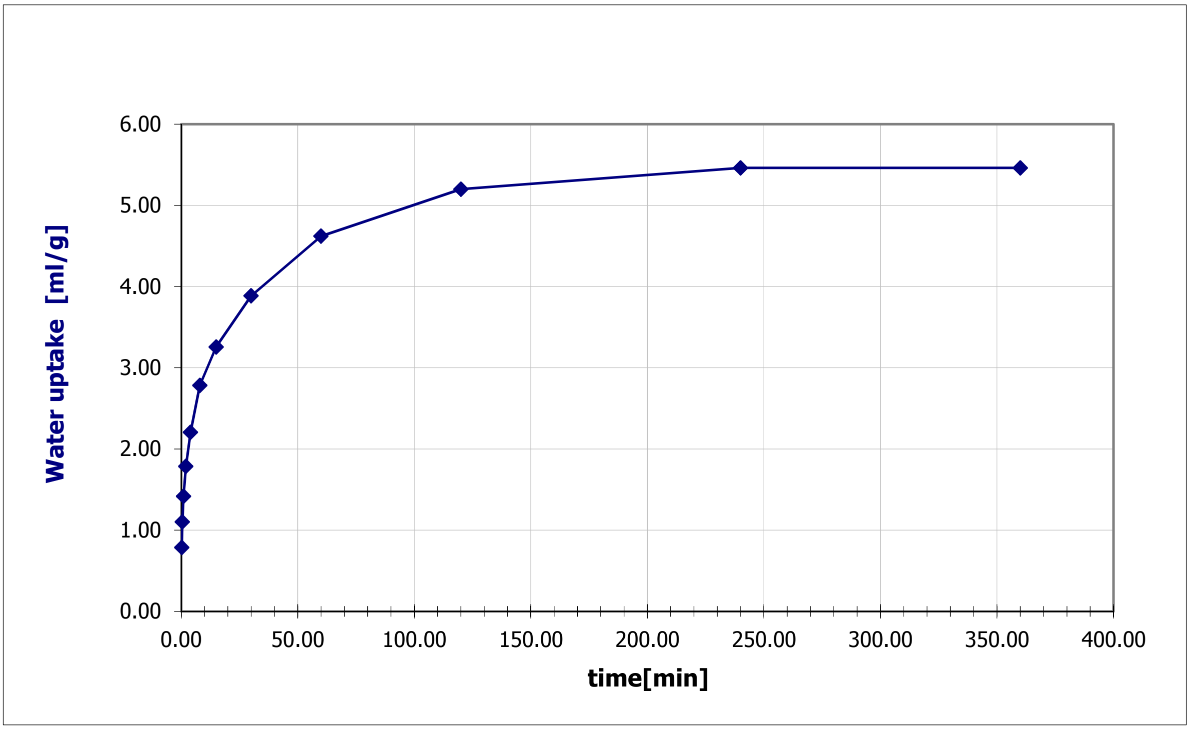


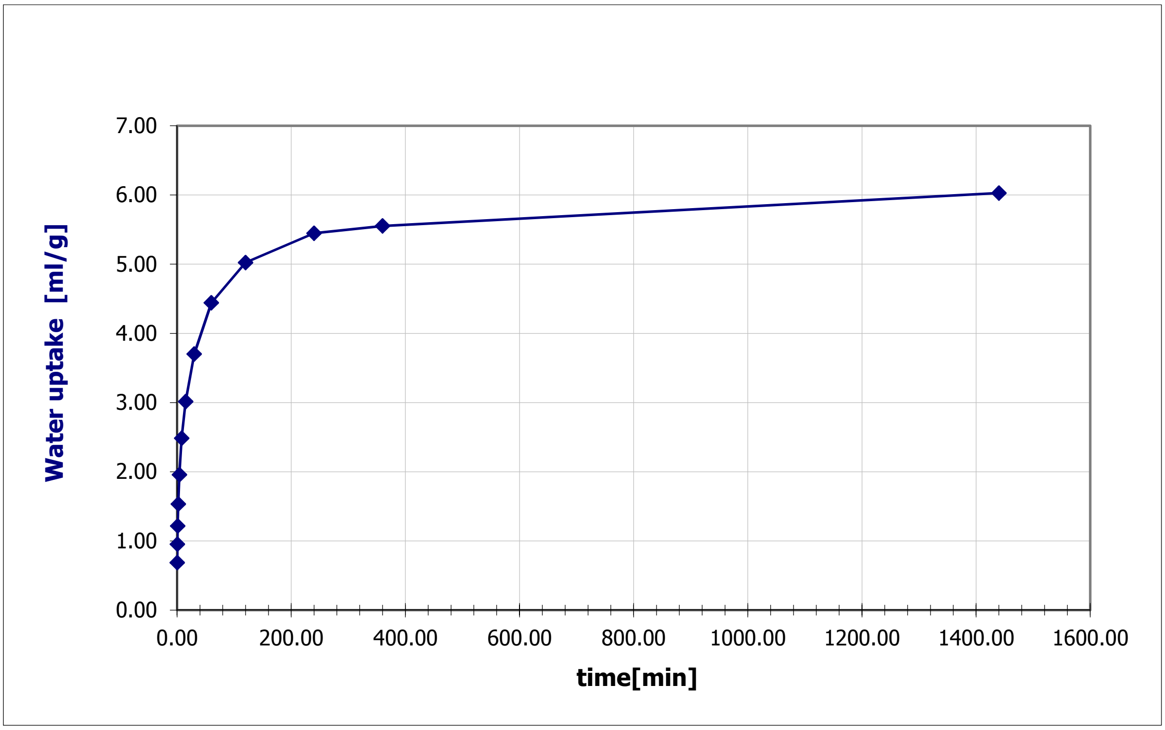
ID12: raw material





ID13: raw material





Appendix F: Chemical homogeneity of the raw material for blocks and GBM on a statistical basis by BGR

Quality control of FE-bentonites used in the Mont Terri Project

Section:	**B2.1/ L3.8**
Authors:	**S. Kaufhold** **R. Dohrmann** **s.kaufhold@bgr.de**
Date:	**26 Feb. 2015**
Auftrag-No.	**49931,2 and 50004**
LIMS-No.	**1414759-802;** **1414811-860** **1420531-546**
R-No.	

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Landesamt für Bergbau, Energie und Geologie (LBEG), Stilleweg 2, D-30655 Hannover

Motivation

NAGRA asked BGR to take care about the analysis of several samples of the installed FE project (Mont Terri Project). The bentonite used is from Wyoming, USA. Wyoming bentonites can contain smectite, quartz, feldspar, cristobalite, calcite, muscovite, heulandite, and S-phases (gypsum and/or pyrite). Mineralogical analysis were not performed because highly accurate analyses are preferable for quality control.
Particular focus was on quality control for future benchmark tests. Samples were taken both from production of blocks and from the installed blocks before the experiment started.
More information about this 1:1 test (real scale test) can be found here:
https://www.youtube.com/watch?v=5R6kk_jMFnM
https://www.youtube.com/watch?v=wm6gLH4SjMs

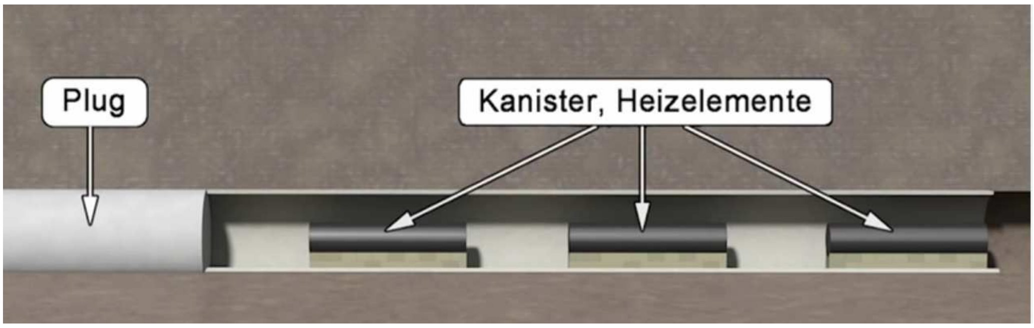


Fig. 1: Principle of the FE-experiment.

Sample base

Dr. Benoit Garitte provided 20 samples from the blocks and 20 from the pellet mixture. The aim was to compare the samples and assess the homogeneity of the entire experiment before the heating phase. The differences between the samples were expected to be small. Therefore, only quantitative methods with high accuracy as CEC (including exchange cations) and XRF analysis were carried out.

GBM-samples were from the production of granulates (pellets). The precursor material was the „National Standard WP2 Cebo, Netherlands“. The precursor material for block production (for the BB-samples) was “Bentosund A100“ (Gelclay WH2) provided by Laviosa-MPC, France.

The sample list is given in Tab. 1.

Tab. 1: sample base.

pellet mixture		
Bezeichnung alt		Bezeichnung neu BGR
Charge	Mischung Nr.	
unbeschr. 1	-	GBM 1 A
unbeschr. 2	-	GBM 2 A
140618	1	GBM 3 A
140618	3	GBM 4 A
140522	6	GBM 5 A
140522	7	GBM 6 A
140522	2	GBM 7 A
140522	3	GBM 8 A
140522	9	GBM 9 A
140522	11	GBM 10 A
140522	12	GBM 11 A
140522	8	GBM 12 A
140522	4	GBM 13 A
140522	5	GBM 14 A
140614	4	GBM 15 A
140618	2	GBM 16 A
140614	1	GBM 17 A
140614	3	GBM 18 A
140614	2	GBM 19 A

Blocks
Bezeichnung neu BGR
BBO 1 A
BBO 2 A
BBO 3 A
BBO 4 A
BBO 5 A
BBO 6 A
BB 1 A
BB 2 A
BB 3 A
BB 4 A
BB 5 A
BB 6 A
BB 7 A
BB 8 A
BB 9 A
BB 10 A
BB 11 A
BB 12 A
BB 13 A
BB 14 A
BB 15 A
Bbent A

Methods

The samples were received as powder, hence no further treatments were necessary.

Cation exchange capacity and exchangeable cations

The CEC was measured based on the Cu-Triethylenetetramine method (Meier & Kahr, 1999[1]). The “3xcalcite-method” was used described in detail by Dohrmann & Kaufhold (2009[2]). The accuracy is discussed by Dohrmann et al. (2013[3]).

Chemical composition

To be able to compare the chemical compositions the water content reflected by the LOI (loss on ignition) was not considered – results were recalculated to LOI = 0.
For XRF analysis of powdered samples, a PANalytical Axios spectrometer was used (ALMELO, The Netherlands). Samples were prepared by mixing with a flux material (lithium metaborate Spectroflux, Flux No. 100A, Alfa Aesar) and melting into glass beads. The beads were analyzed by wavelength-dispersive XRF. To determine loss on ignition (LOI), 1000 mg of sample material were heated to 1030ºC for 10 min.

Results

Cation exchange capacity and exchangeable cations

The Na^{+}-content of the GBM-series is slightly lower (about 3 meq/100g). This difference corresponds to about 0.1 mass% Na_2O which is reflected by the XRF data. Also a systematic difference of exchangeable Mg^{2+} was detected in the GBM and the BB samples (about 2 meq/100g more Mg^{2+} in the BB samples). This difference, however, is not reflected by the XRF data.
Even more remarkable is the marked difference of the exchangeable Ca^{2+} values of samples BBO1A-BBO4A (about 13 meq/100g) which is also not reflected by the XRF data (Table 2). This could possibly be explained by different amounts of gypsum, however this has to be confirmed by mineral analysis and sulfur analysis. Sample #32 (BB7A) showed the largest Mg^{2+} value and was also recognized by XRF-Surprisingly, the MgO-content of sample #32 was not striking in contrast to the Al-, Si-, Fe-, and Ca-content.

The data is summarized in Tab. 2.

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[1] Meier, L.P., Kahr, G., 1999. Determination of the cation exchange capacity (CEC) of clay minerals using the complexes of Copper (II) ion with Triethylenetetramine and Tretraethylenepentamine. Clays and Clay Minerals, 47, p. 386 – 388

[2] Dohrmann, R., Kaufhold, S. 2009. Three new, quick CEC methods for determinining the amounts of exchangeable calcium cations in calcareous clays. Clays and Clay Minerals, 57(3), 338–352

[3] Dohrmann, R., Genske, D., Karnland, O., Kaufhold, S., Kiviranta, L., Olsson, S., Plötze, M., Sandén, T., Sellin, P., Svensson, D., Valter, M. 2012. Interlaboratory CEC and Exchangeable Cation Study of Bentonite Buffer Materials: I. Cu(II)-Triethylentetramine Method. Clays and Clay Minerals, 60, 162–175

Table 2: CEC data of all samples. S-value=sum of exchangeable cations.

sample	No.	Na+	K+	Mg2+	Ca2+	S-value	CEC	sum-CEC
					meq/100 g			
GBM 1 A	1	54	1.4	3.3	25	84	80	4
GBM 2 A	2	55	1.5	3.3	25	85	80	4
GBM 3 A	3	55	1.3	3.4	26	85	82	4
GBM 4 A	4	56	1.4	3.5	26	86	82	4
GBM 5 A	5	54	1.4	3.4	25	84	80	5
GBM 6 A	6	54	1.3	3.3	25	84	80	4
GBM 7 A	7	54	1.4	3.1	25	83	79	4
GBM 8 A	8	54	1.4	3.2	25	84	80	4
GBM 9 A	9	57	1.7	3.3	26	88	82	6
GBM 10 A	10	55	1.6	3.2	25	85	79	6
GBM 11 A	11	55	1.7	3.3	25	84	80	5
GBM 12 A	12	55	1.6	3.2	25	84	79	5
GBM 13 A	13	54	1.6	3.4	25	84	79	6
GBM 14 A	14	55	1.7	3.3	25	85	79	6
GBM 15 A	15	56	1.5	3.4	26	87	81	6
GBM 16 A	16	56	1.5	3.5	26	87	82	5
GBM 17 A	17	57	1.9	3.6	26	89	81	7
GBM 18 A	18	57	1.7	3.7	26	89	81	7
GBM 19 A	19	57	1.7	3.7	26	88	81	7

Sample	No.	Na+	K+	Mg2+	Ca2+	S-value	CEC	sum-CEC
					meq/100 g			
BBO 1 A	20	59	1.8	5.6	**39**	105	87	18
BBO 2 A	21	58	1.8	5.2	**38**	103	86	17
BBO 3 A	22	58	1.6	5.5	**39**	104	88	17
BBO 4 A	23	57	1.9	5.2	**38**	102	86	16
BBO 5 A	24	57	1.4	5.5	24	88	86	2
BBO 6 A	25	61	1.8	5.8	26	94	87	8
BB 1 A	26	61	1.8	5.5	26	95	87	8
BB 2 A	27	62	1.9	5.8	26	95	88	7
BB 3 A	28	61	1.8	5.8	26	95	87	8
BB 4 A	29	61	1.8	5.8	25	94	87	7
BB 5 A	30	61	1.8	5.5	26	94	87	8
BB 6 A	31	60	1.6	5.2	26	93	84	9
BB 7 A	32	60	1.6	**6.3**	26	94	84	10
BB 8 A	33	59	1.6	5.4	26	92	84	9
BB 9 A	34	59	1.6	5.6	26	92	83	9
BB 10 A	35	58	1.7	5.3	25	89	83	7
BB 11 A	36	60	1.7	5.4	27	93	84	10
BB 12 A	37	60	1.7	5.6	26	93	84	9
BB 13 A	38	61	1.8	5.4	27	95	86	9
BB 14 A	39	61	1.8	5.2	27	95	85	10
BB 15 A	40	61	1.6	5.2	26	94	86	9
BBentA	41	73	2.2	7.6	31	114	103	11

Chemical composition

The sum of main elements ranged from 99.7 and 99.8 % and reflects both the analytical accuracy as well as missing trace elements. Data is given in Tab. 1.

The main oxides of Si, Al, Fe, and Ca were plotted to image the variability (Fig. 1). The CaO-content of samples #4 and #32 indicates a somewhat larger carbonate content which translates into lower Si-contents. Interestingly, sample #32 also has a larger Fe-content (along with sample #26, Fig. 2). The differences, however, are small. As an example, the SiO_2-content translates into a difference of the quartz content of 0.5 %. Such small differences should only be taken for granted if the independent ICP-analysis of other laboratories such as actlabs confirmed these findings.

Conclusions

The variability of the chemical composition was determined based on a statistically significant sample base. The differences were small (mostly << 0.5 %) and hence may represent the analytical accuracy rather than material heterogeneities. Actual material heterogeneities would be confirmed if results of ICP measurements (actlabs results) corresponded to the small XRF-differences. This has to be finally assessed by NAGRA when comparing both sets of chemical analysis.

Materials from the GBM and BB-series differed with respect to the amount of exchangeable Na^+ which was measured both by CEC and XRF-measurements.

Also the content of exchangeable Mg^{2+} was found to differ between the two series which, however, is not reflected by XRF. Therefore, it is not yet clear if either the Mg^{2+}-differences are too small to be detected by XRF (2 meq/100 g Mg^{2+} correspond to about 0.04 % MgO) or if they can be explained by systematic analytical errors. The accuracy of the method, however, was assessed by Dohrmann et al. (2012) and found to be better than the 2 meq/100g Mg^{2+}.

Four of the six BBO-samples showed much larger Ca^{2+} values but no higher CaO-contents. The difference of about 20 meq/100g (corresponding to about 0.5 % CaO) had to be reflected by XRF. The difference, therefore, can be explained either by different solubility of the gypsum/carbonates (as if acid was added or as if different crystallinity was present) or by analytical errors. The CEC-analysis, however, was performed with double specimen and deviations were in the expected range (about 1 meq/100g) and hence do not indicate technical problems.

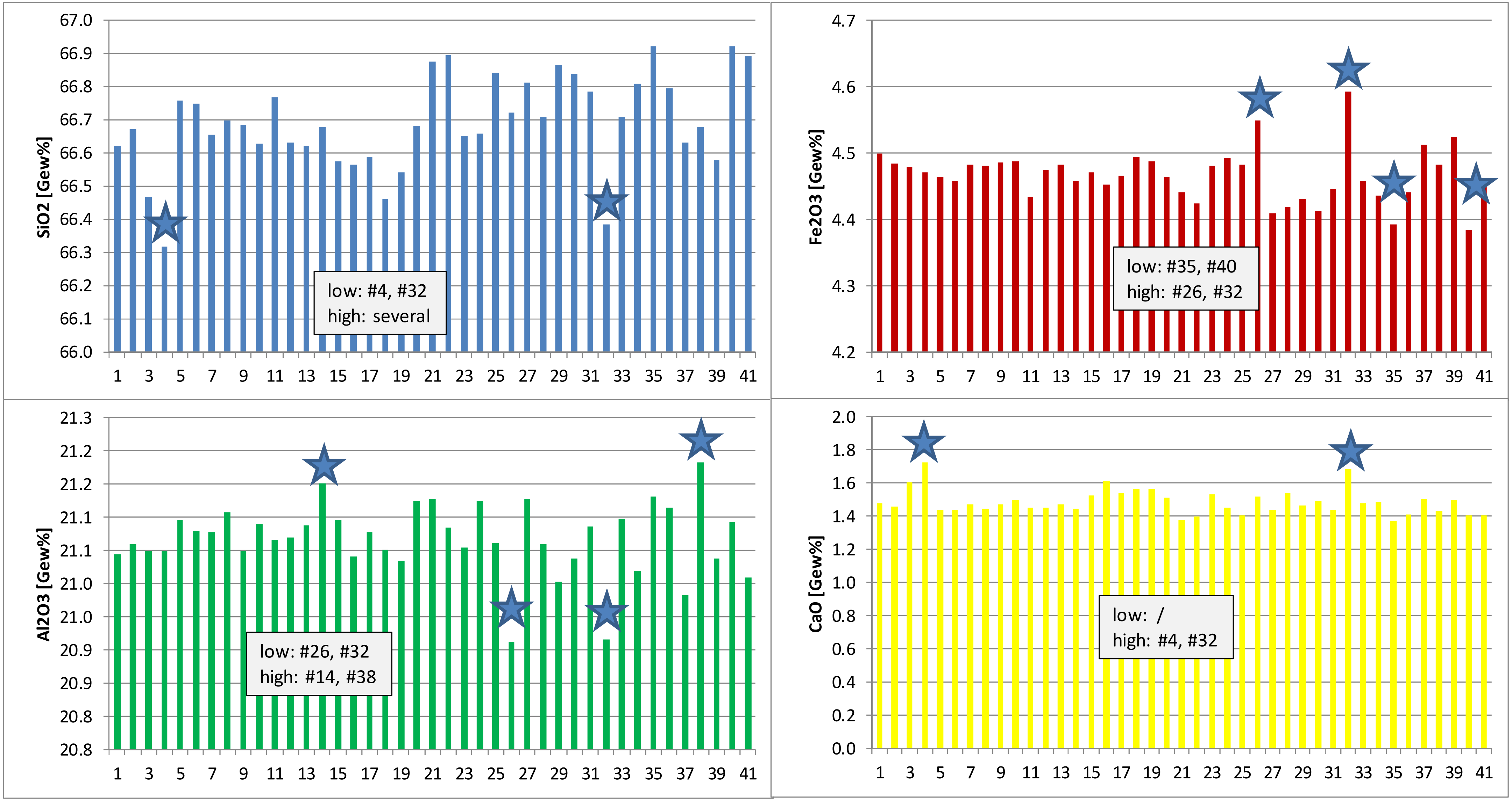

Fig. 2: XRF data of selected elements.

Tab. 3: XRF data of all samples.

	No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	(SO_3)	sum
		mass%											
GBM 1 A	1	66.6	0.2	21.0	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.7
GBM 2 A	2	66.7	0.2	21.1	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.7
GBM 3 A	3	66.5	0.2	21.0	4.5	0.0	2.6	1.6	2.2	0.6	0.1	0.5	99.7
GBM 4 A	4	66.3	0.2	21.1	4.5	0.0	2.6	1.7	2.2	0.6	0.1	0.5	99.7
GBM 5 A	5	66.8	0.2	21.1	4.5	0.0	2.6	1.4	2.2	0.6	0.1	0.4	99.8
GBM 6 A	6	66.7	0.2	21.1	4.5	0.0	2.6	1.4	2.2	0.6	0.1	0.4	99.8
GBM 7 A	7	66.7	0.2	21.1	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.8
GBM 8 A	8	66.7	0.2	21.1	4.5	0.0	2.6	1.4	2.2	0.6	0.1	0.4	99.8
GBM 9 A	9	66.7	0.2	21.0	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.7
GBM 10 A	10	66.6	0.2	21.1	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.8
GBM 11 A	11	66.8	0.2	21.1	4.4	0.0	2.6	1.4	2.2	0.6	0.1	0.4	99.8
GBM 12 A	12	66.6	0.2	21.1	4.5	0.0	2.6	1.4	2.2	0.6	0.1	0.4	99.8
GBM 13 A	13	66.6	0.2	21.1	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.8
GBM 14 A	14	66.7	0.2	21.2	4.5	0.0	2.6	1.4	2.2	0.6	0.1	0.4	99.8
GBM 15 A	15	66.6	0.2	21.1	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.8
GBM 16 A	16	66.6	0.2	21.0	4.5	0.0	2.6	1.6	2.2	0.6	0.1	0.5	99.7
GBM 17 A	17	66.6	0.2	21.1	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.5	99.7
GBM 18 A	18	66.5	0.2	21.1	4.5	0.0	2.6	1.6	2.2	0.6	0.1	0.5	99.7
GBM 19 A	19	66.5	0.2	21.0	4.5	0.0	2.6	1.6	2.2	0.6	0.1	0.5	99.7
BBO 1 A	20	66.7	0.2	21.1	4.5	0.0	2.6	1.5	2.1	0.6	0.1	0.5	99.8
BBO 2 A	21	66.9	0.2	21.1	4.4	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BBO 3 A	22	66.9	0.2	21.1	4.4	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BBO 4 A	23	66.7	0.2	21.1	4.5	0.0	2.6	1.5	2.1	0.6	0.1	0.5	99.7
BBO 5 A	24	66.7	0.2	21.1	4.5	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BBO 6 A	25	66.8	0.2	21.1	4.5	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BB 1 A	26	66.7	0.2	20.9	4.5	0.0	2.6	1.5	2.1	0.6	0.1	0.5	99.7
BB 2 A	27	66.8	0.2	21.1	4.4	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BB 3 A	28	66.7	0.2	21.1	4.4	0.0	2.6	1.5	2.1	0.6	0.1	0.5	99.7
BB 4 A	29	66.9	0.2	21.0	4.4	0.0	2.6	1.5	2.1	0.6	0.1	0.4	99.7
BB 5 A	30	66.8	0.2	21.0	4.4	0.0	2.6	1.5	2.1	0.6	0.1	0.4	99.7
BB 6 A	31	66.8	0.2	21.1	4.4	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BB 7 A	32	66.4	0.2	20.9	4.6	0.0	2.6	1.7	2.1	0.6	0.1	0.5	99.7
BB 8 A	33	66.7	0.2	21.1	4.5	0.0	2.6	1.5	2.1	0.6	0.1	0.4	99.7
BB 9 A	34	66.8	0.2	21.0	4.4	0.0	2.6	1.5	2.1	0.6	0.1	0.4	99.7
BB 10 A	35	66.9	0.2	21.1	4.4	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BB 11 A	36	66.8	0.2	21.1	4.4	0.0	2.6	1.4	2.2	0.6	0.1	0.4	99.7
BB 12 A	37	66.6	0.2	21.0	4.5	0.0	2.6	1.5	2.1	0.6	0.1	0.5	99.7
BB 13 A	38	66.7	0.2	21.2	4.5	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
BB 14 A	39	66.6	0.2	21.0	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.5	99.7
BB 15 A	40	66.9	0.2	21.1	4.4	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
Bbent A	41	66.9	0.2	21.0	4.5	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7
average		66.7	0.2	21.1	4.5	0.0	2.6	1.5	2.2	0.6	0.1	0.4	99.7
st.dev.		0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
max		66.9	0.2	21.2	4.6	0.0	2.6	1.7	2.2	0.6	0.1	0.5	99.8
min		66.3	0.2	20.9	4.4	0.0	2.6	1.4	2.1	0.6	0.1	0.4	99.7

	As	*Ba*	*Bi*	*Ce*	*Co*	*Cr*	*Cs*	*Cu*	*Ga*	*Hf*	*La*	*Mo*	*Nb*	*Nd*	*Ni*	*Pb*	*Rb*	*Sb*	*Sc*	*Sm*	*Sn*	*Sr*	*Ta*	*Th*	*U*	*V*	*W*	*Y*	*Zn*	*Zr*
														ppm																
GBM 1 A	11	569	<5	90	<7	25	<65	9	28	<16	46	<6	28	44	11	46	18	<87	<23	<40	<35	222	<11	40	11	<15	<10	42	102	179
GBM 2 A	11	601	<5	118	<7	23	<65	12	28	<16	66	7	29	43	13	50	19	<88	<24	<40	<35	215	<11	40	15	<15	<10	42	101	182
GBM 3 A	11	618	<5	95	<7	21	<65	11	29	<16	49	<6	27	36	12	47	17	<86	<23	<40	<35	235	<11	40	15	<15	<10	42	108	181
GBM 4 A	11	580	<5	108	<7	18	<65	14	28	<16	53	7	29	48	12	47	17	<87	<23	<40	<35	228	<11	39	15	<15	<10	42	104	178
GBM 5 A	10	302	<5	95	<7	21	<65	7	29	<16	51	<6	28	51	10	47	17	<88	<23	<40	<35	212	<11	37	14	<15	<10	42	95	187
GBM 6 A	10	347	<5	94	<7	22	<65	8	28	<16	64	<6	27	40	9	46	16	<87	<23	<40	<35	219	<11	37	13	<15	<10	43	95	186
GBM 7 A	11	333	<5	89	<7	19	<65	12	29	<16	41	8	29	41	12	45	18	<87	<23	<40	<34	214	<11	40	14	<15	<10	42	123	183
GBM 8 A	11	284	<5	94	<7	18	<65	10	28	<16	62	<6	28	37	11	45	19	<88	<24	<40	<34	211	<11	39	15	<15	<10	43	125	181
GBM 9 A	11	572	<5	110	<7	16	<65	11	28	<16	<40	<6	29	55	9	47	21	<88	<24	<40	<35	222	<11	38	13	<15	<10	41	93	178
GBM 10 A	11	570	<5	85	<7	25	<66	7	28	<16	42	8	29	48	13	47	16	<87	<24	<40	<35	222	<11	39	12	<16	<10	41	104	181
GBM 11 A	11	367	<5	90	<7	19	<65	9	28	<16	54	<6	27	50	9	48	17	<87	<24	<40	<35	210	<11	37	14	<15	<10	44	97	179
GBM 12 A	11	415	<5	99	<7	18	<65	12	29	<16	61	8	29	<36	11	46	17	<88	<23	<40	<35	216	<11	39	14	<15	<10	44	107	181
GBM 13 A	10	318	<5	116	<7	17	<66	10	28	<16	56	7	29	54	9	48	18	<88	<24	<40	<35	218	<11	40	14	<15	<10	43	93	183
GBM 14 A	11	303	<5	92	<7	19	<65	10	29	<16	56	<6	27	53	12	47	21	<87	<23	<40	<35	215	<11	39	16	<15	<10	42	100	184
GBM 15 A	11	613	<5	85	<7	19	<65	7	28	<16	54	<6	28	41	9	48	19	<87	<23	<40	<35	234	<11	34	14	<15	<10	41	91	181
GBM 16 A	11	581	<5	108	<7	21	<65	10	28	<16	54	7	27	45	11	46	18	<88	<23	<40	<35	227	<11	37	14	<15	<10	41	90	176
GBM 17 A	9	633	<5	96	<7	21	<66	12	28	<16	<40	7	27	41	12	50	16	<87	<23	<40	<35	232	<11	38	13	<15	<10	41	89	181
GBM 18 A	11	724	<5	99	<7	21	<66	9	28	<16	61	<6	28	51	10	47	18	<87	<23	<40	<35	235	<11	39	14	<15	<10	44	97	185
GBM 19 A	11	770	<5	107	<7	18	<66	9	28	<16	59	<6	27	44	13	46	17	<88	<24	<40	<35	236	<11	38	15	<16	<10	43	96	184
BBO 1 A	10	233	<5	99	<7	14	<65	7	27	<16	51	7	27	47	8	49	17	<87	<23	<40	<35	203	<11	38	14	<15	<10	43	77	172
BBO 2 A	10	226	<5	105	<7	14	<64	10	27	<16	49	<6	28	45	9	45	16	<86	<23	<39	<35	216	<11	39	14	<15	<10	40	84	175
BBO 3 A	10	222	<5	94	<7	13	<65	10	30	<16	49	<6	29	42	7	49	16	<86	<23	<39	<34	201	<11	39	14	<15	<10	42	76	173
BBO 4 A	8	193	<5	89	<7	<11	<64	10	28	<16	47	7	28	47	8	48	18	<87	<23	<39	<34	202	<11	36	14	16	<10	39	81	173
BBO 5 A	9	212	<5	104	<7	<11	<65	10	28	<16	48	<6	27	38	9	48	18	<87	<23	<40	<35	197	<11	38	12	<15	<10	40	141	170
BBO 6 A	11	182	<5	109	<7	15	<64	8	28	<16	53	<6	27	49	9	47	17	<86	<23	<39	<34	200	<11	36	14	<15	<10	40	84	173
BB 1 A	9	346	<5	86	<7	14	<65	11	28	<16	54	<6	27	48	9	46	18	<86	<23	<40	<35	203	<11	37	13	16	<10	42	87	171
BB 2 A	9	210	<5	89	<7	14	<65	14	28	<16	52	<6	29	42	12	47	18	<86	<24	<39	<34	197	<11	40	13	<15	<10	39	79	173
BB 3 A	9	196	<5	103	<7	15	<64	11	29	<16	56	7	27	45	9	48	18	<86	<23	<39	<35	197	<11	37	14	<15	<10	41	72	173
BB 4 A	8	306	<5	115	<7	12	<65	10	28	<16	55	<6	29	50	8	47	20	<87	<23	<40	<35	205	<11	37	14	<15	<10	41	78	173
BB 5 A	10	175	<5	91	<7	11	<64	10	29	<16	44	<6	28	51	7	46	16	<87	<23	<40	<34	199	<11	38	15	<15	<10	39	73	174
BB 6 A	11	201	<5	107	<7	13	<65	9	28	<16	47	<6	27	51	8	47	17	<87	<23	<40	<34	204	<11	39	14	<15	<10	39	77	172
BB 7 A	9	296	<5	77	<7	18	<64	11	28	<16	50	<6	27	47	9	47	19	<86	<23	<39	<35	205	<11	38	11	16	<10	38	87	172
BB 8 A	10	201	<5	98	<7	13	<65	10	29	<16	54	<6	28	44	7	46	18	<87	<23	<40	<34	202	<11	39	14	<15	<10	41	76	178
BB 9 A	8	196	<5	93	<7	12	<65	10	28	<16	58	7	27	60	9	49	20	<87	<23	<40	<35	204	<11	39	15	<15	<10	40	92	170
BB 10 A	9	217	<5	98	<7	12	<65	7	28	<16	57	7	27	45	9	47	19	<86	<23	<40	<34	197	<11	37	14	<15	<10	39	82	175
BB 11 A	10	260	<5	99	<7	15	<65	10	28	<16	67	<6	29	51	9	48	19	<87	<23	<40	<34	200	<11	38	15	<15	<10	41	75	176
BB 12 A	11	272	<5	96	<7	16	<65	11	28	<16	55	9	28	45	9	48	20	<87	<23	<40	<35	210	<11	38	14	<15	<10	39	78	171
BB 13 A	11	201	<5	81	<7	24	<64	7	30	<16	48	8	29	55	15	46	18	<86	<23	<40	<35	205	<11	38	12	<15	<10	42	88	175
BB 14 A	11	208	<5	94	<7	13	<65	11	28	<16	63	<6	26	<36	9	47	17	<86	<23	<40	<35	201	<11	36	14	<15	<10	41	79	173
BB 15 A	8	222	<5	90	<7	12	<65	9	28	<16	49	<6	25	42	8	48	19	<86	<23	<40	<35	200	<11	40	14	<15	<10	41	72	172
Bbent A	9	193	<5	114	<7	22	<64	11	28	<16	57	<6	27	57	12	49	17	<86	<23	<39	<34	192	<11	36	15	<15	<10	41	84	177
average	10	353		98		17		10	28		54	7	28	47	10	47	18					211		38	14	16		41	91	177
st.dev.	1	174		10		4		2	1		6	1	1	6	2	1	1					12		1	1	0		1	15	5
max	11	770		118		25		14	30		67	9	29	60	15	50	21					236		40	16	16		44	141	187
min	8	175		77		11		7	27		41	7	25	36	7	45	16					192		34	11	16		38	72	170

Appendix G: Independent QC of mineralogy by ETH

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Project FE/LUCOEX, Filling stage

Analysis of bentonite materials

IGT Report IGT-CL1051, Nagra 13’309
15th April 2015

Content:

1 Introduction

NAGRA assigned the Institute of Geotechnical Engineering of the ETH Zurich (IGT) with the analysis of bentonite (blocks and granular material) from the "Full-Scale Emplacement Experiment" within the framework of the "Large Underground Concept Experiments".

For the granular material (CEBO National Standard WP2) the water content, the density of the pellets as well as the pouring density, the grain size distribution, the cation exchange capacity (CEC), the mineralogical composition and the water uptake under free swelling conditions were to examine. The blocks (curved and cubic from Laviosa-MPC Bentosund 100 former Gelclay WH2) were to examine in terms of homogeneity of the water content, the density and porosity. Additionally the mineralogical composition, the CEC and the thermal conductivity were to determine.

2 Samples

The samples were delivered in sealed plastic bags by Nagra between Oct 2014 and Mar 2015. The list of the samples together with the analyses carried out is given in table 1.

Tab. 1: Samples FE.

Delivery Date	Samples	Analyses
28.10.2014	BB7 23.09.2014 16:00 BB19 24.09.2014 10:00 BB48 24.09.14 17:25 BB101 25.09.2014 9:30	Water content Pellet density, Sieve analysis, Cation exchange capacity
31.10.2014	BB89 23.10.2014 16:27 BB210 23.10.2014 18:01 BB313 23.10.2014 20:16 BB245 24.10.2014 10:13 BB195 27.10.2014 8:17 BB219 27.10.2014 10:26 BB225 27.10.2014 14:40	Water content, Pellet density, Sieve analysis, Cation exchange capacity
5.12.2014	BB254 20.11.2014 15:52 BB231 20.11.2014 17:38 BB262 21.11.2014 9:52 BB228 21.11.204 12:07 BB279 24.11.2014 9:44	Water content, Pellet density, Sieve analysis, Cation exchange capacity
	drum of granular material CEBO Standard (MX-80)	Water content, Pellet density, Sieve analysis, Cation exchange capacity, Mineralogy, Water uptake, Pouring Density
	Block Bentosund100 cubic A1569 Block Bentosund100 curved	Water content, Bulk density,

		Cation exchange capacity, Mineralogy, Pore size distribution, Heat conductivity
9.2.2015	BB307 21.01.2015 09:32 BB295 21.01.2015 11:16 BB302 22.01.2015 10:16 BB GR2-30 22.01.20125 13:30 BB GR2-18 22.01.2015 16:44 BB GR2-X2 23.01.2015 09:35 BB P-31 12.02.2015 8:55	Water content Pellet density, Sieve analysis, Cation exchange capacity
25.3.2015	55 Screw conveyor samples Slope 1 - 11	Sieve analysis

The sealed blocks were delivered on 5th December 2014. To investigate the homogeneity in compaction and mineralogy samples were taken from different localities of the blocks (Figs. 1 and 2). Appendix 1 shows the photo documentation of the sampling.

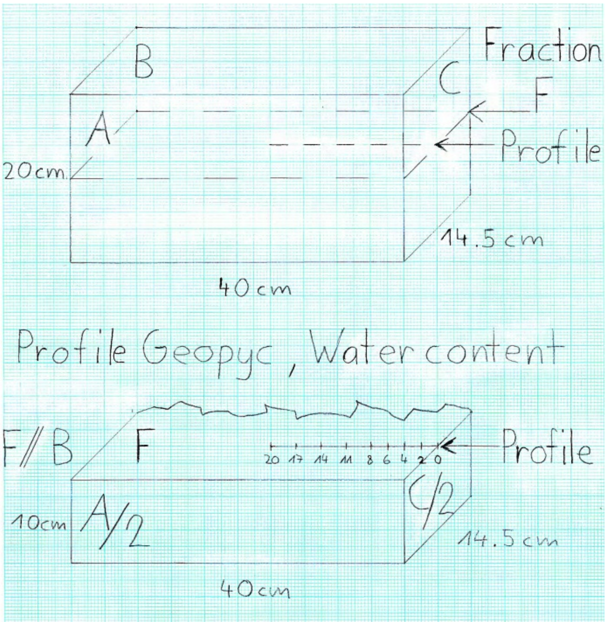


Fig. 1: Sampling scheme, cubic block A1569.

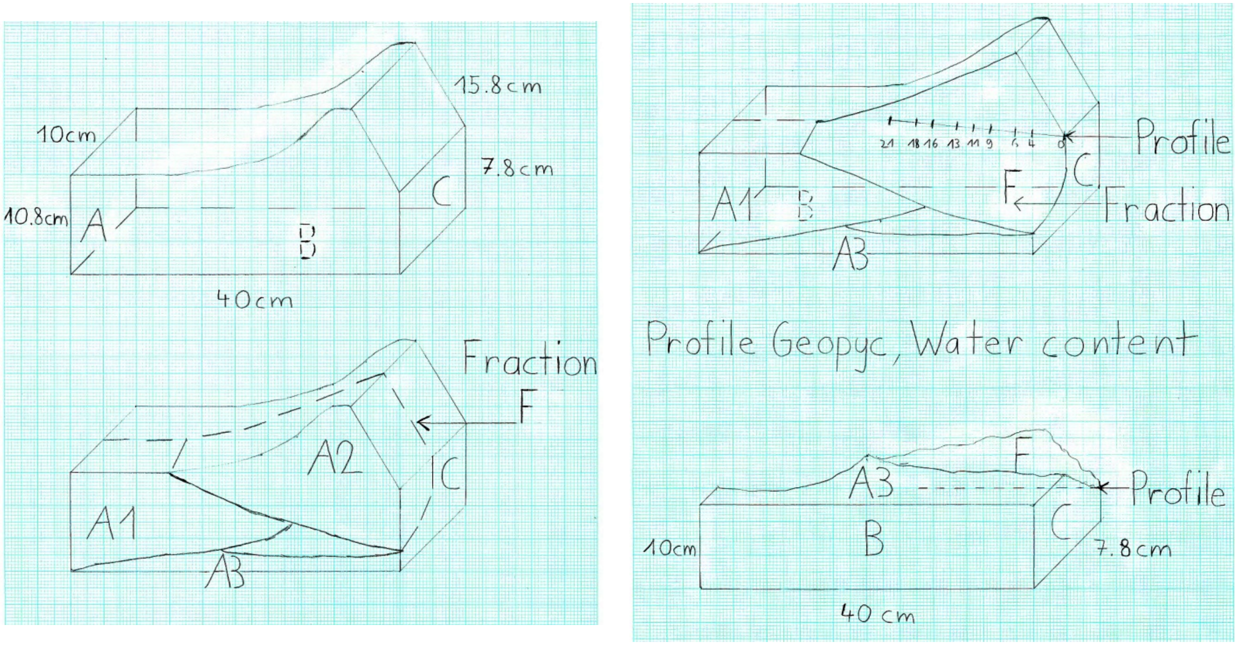


Fig. 2: Sampling scheme, curved block HPW52.

3 Methods

3.1. Water content

The gravimetric water content (w) is defined as the ratio between the weight of water and the weight of dry solid expressed as a percentage. The water content was determined in accordance with SN 670 3406. Approx. 2 g material (moist) were weighed out immediately after sampling and dried at 105 ± 3 °C for 72 h (until constant weight).

$$w = \frac{M - M_d}{M_d} \cdot 100$$

w = water content in per cent, M = sample mass in moist state and M_d = sample mass after drying.

From the gravimetric water content, the volumetric can be calculated as follows:

$$w_v = w \cdot (\rho_d / \rho_w)$$

w = gravimetric water content in per cent, w_v = volumetric water content in per cent, ρ_d = dry bulk density of the material in g/cm^3 and ρ_w = density of water = 1 g/cm^3)

3.2 Bulk density

Density is the mass of an object divided by its volume. Bulk density is the mass of an object divided by its volume where the volume includes that of its pores and small cavities. The volume determination can be achieved by simple measuring of the sample dimensions (DIN 18125/1) or in the case of irregularly formed samples with a pycnometer by displacement of a medium (e.g.

water). However in this case all pores have to be closed before e.g. with wax (DIN 30911) or there is a medium to be used which not intrudes into the sample pores under normal pressure conditions, e.g. mercury (ASTM Standard Test Method C493-93).

The bulk (moist) density ρ of the bentonite granules was determined with the Micromeritics GeoPyc 1360 (Fig. 3). The GeoPyc 1360 is an instrument that determines the volume and density of a solid object by displacement of a solid medium (so called DryFlow, a silica nano powder). The medium is a narrow distribution of small, rigid spheres that have a high degree of flowability and achieve close packing around the object without invading pore space. The method is applicable for irregular formed bodies and granular material with a size of in minimum 2 mm diameter.

Fig. 3: GeoPyc 1360 (Micromeritics) for measurement of bulk density. The sample is in the small cell (arrow).

The measurements were carried out 10 times at least on two samples (appr. 6 g) in the original delivery state from pellets larger 2 mm and from different position in the blocks.

The measured bulk density is the moist density. Based on the determined water content w the moist bulk density can be recalculated into dry density ρ_d.

$$\rho_d = \frac{\rho}{1 + \frac{w}{100}}$$

ρ_d = dry density in g/cm^3 (or kg/l), ρ = moist density in g/cm^3 and w = water content in per cent.

3.3. Porosity and pore size distribution (Mercury intrusion porosimetry)

The porosity n includes all pores (open and closed). The porosity determined with MIP only determines the percentage of open pores that are Hg-accessible. MIP was carried out with a combined instrument (Pascal 140 + 440, POROTEC) for measuring macro- and mesopores in the range 58000 - 1.8 nm.

Fig. 4: Porotec Pascal 140 + 440 for pore radius measurements in the range 1.8 nm – 58 µm (ISO 15901/1).

From selected spots (surface C and centre of the blocks) approx. 1 g sample material was weighed with a precision of ±1 mg in the dilatometer. Measurements were carried out at least in replicates. First, the air-dry specimens were evacuated to about 0.01 bar for two hours to dry. Then the measurements were conducted by incrementing the pressure up to 400 MPa on a sample immersed in the non-wetting mercury. Hereby, the rate of pressure increase was automatically adjusted in an advanced procedure with lower rates at lower pressure levels and during measured intrusion processes. With increasing pressure, mercury intrudes into progressively smaller voids. The pore volume can be derived from the quantity of intruded mercury. The pore size distribution can be determined according to the Washburn equation, which gives a relationship between the pressure *p* and pore size *r* (Washburn 1921).

$$r = - \frac{2\, \gamma \cos \Theta}{p}$$

r = pore radius, *p* = pressure, γ = surface tension of mercury = 0.48 N/m, Θ = wetting angle of mercury (139°)

3.4 Minimal and maximal pouring density

The emplacement densities of the granular bentonite material were determined adapted to different procedures (SN 670 335a, DIN 18126, and ASTM D 4253-93).

Density is the mass of an object divided by its volume. Bulk density is the mass of an object divided by its volume where the volume includes that of its pores and small cavities. The volume determination can be achieved by simple measuring of the sample dimensions. The measurement principle is based on filling a graded cylinder. A cylinder with a diameter of 10 cm and a volume of 2000 cm^3 with a 50 ml scale was used. About 2500 g material was filled through a funnel (height 1 cm) to exact 2000 mL and weighed. The filling was carried out in two different ways: a) carefully, loosely without falling height (minimum emplacement density ρ_{min}) and b) with a falling height of 80 cm (Fig. 5).

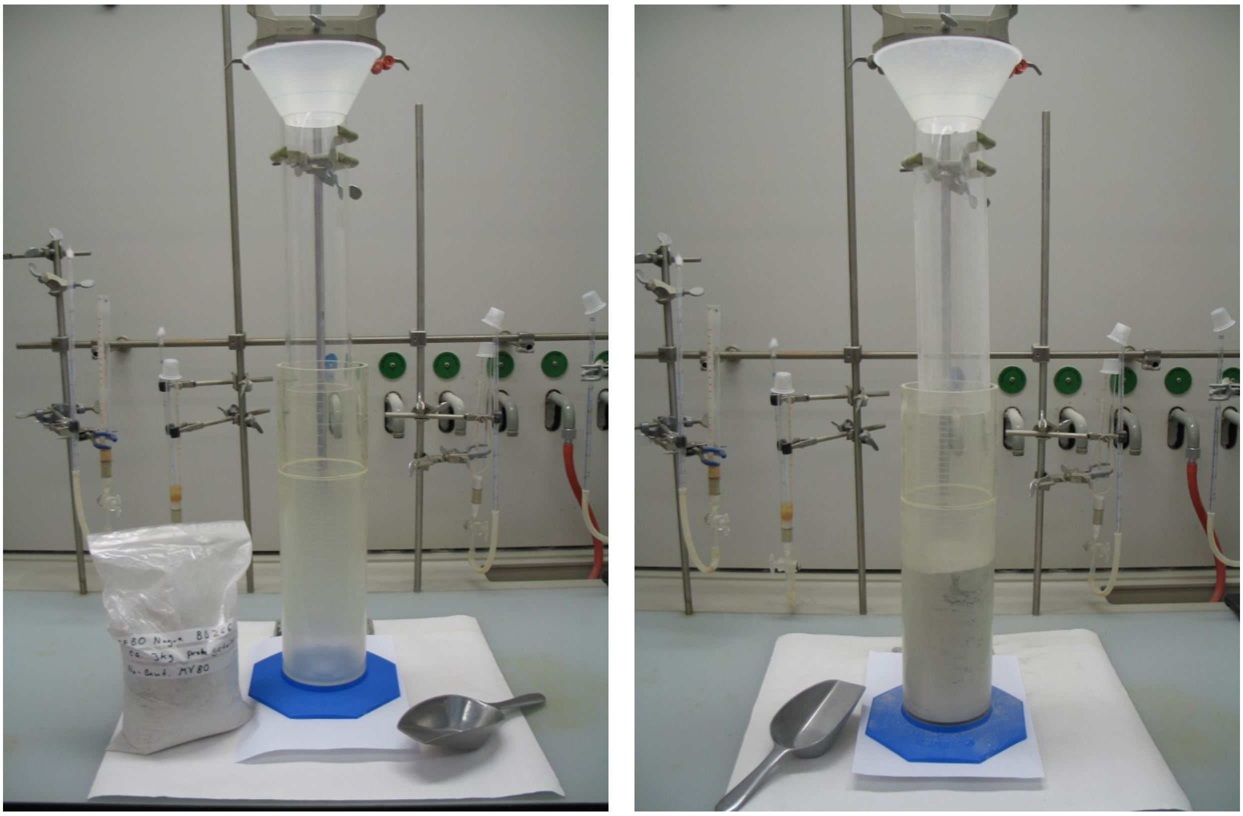


Fig. 5: Filling the graded cylinder for determination of the pouring density. Falling height 80 cm, Volume 2000 mL

Afterwards, to determine the maximum emplacement density ρ_{max}, the filled cylinder was vibrated on a RETSCH AS200 sieve shaker table (amplitude 60, time 2 min) until volume constancy and the volume was determined (Fig. 6).

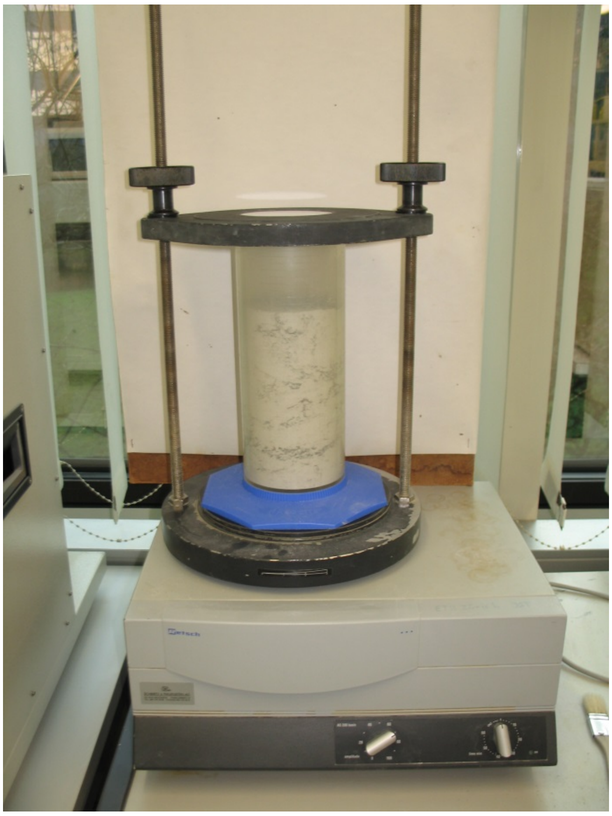


Fig. 6: Compaction by vibration until height constancy.

The measurements were carried out in duplicates and averaged. The density variation is ±0.015 g/mL. The so determined filling density is the moist density. The values were recalculated as given in 3.2 with the water content from 3.1 into the dry density (ρ_d).

3.5 Grain size distribution (sieve analysis)

The grain size distribution was determined by dry sieving (Fig. 8) of the approx.. 500 g sample material. Sieving was executed according to SN 670 004-2b-NA (EN ISO 14688-2) with a 3D sieve shaker AS200 (amplitude 1 mm, time 3 min) (RETSCH) and sieves of 6.3 mm, 2 mm, 0.63 mm, 0.2 mm, and 0.063 mm opening (Fig. 7). The fractions below 0.2 mm were sieved separately for 10 min each.

Fig. 7: Sieving with RETSCH AS200, the small fractions for 10 min additionally (right).

The screw conveyor samples were sieved according to SN 670 810 C with a 3D sieve shaker AS450 (amplitude 1 mm, time 3 min) (RETSCH). Approx. 1500 g were analysed which were beforehand representatively split (Fig. 8). Sieves of 8 mm, 5 mm, 2 mm, 1.4 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm, and 0.063 mm opening (high-grade steel of mesh sieves acc. DIN 4188 or DIN ISO 3310/1) were used (Fig. 9). The fractions below 0.2 mm were sieved separately for 10 min each. The value Q3 gives the amount passing (mesh minus) and the value p3 the residual amount (mesh plus).

Fig. 8: Sample splitter.

Fig. 9: Sieving with RETSCH AS450.

The evaluation of particle size distribution permits various conclusions on the compaction behaviour. Thus, the distortion number of C_U and the curvature number of C_C from the particle size distribution are computed. The distortion number of C_U represents thereby the relationship of the values for to the grain diameters at 10% and 60% sieve passage.

$$C_U = d_{60}/d_{10}$$

Values below five show the predomination of a certain grain size (poorly graded), whereas values above are typical for well-graded materials. Since with the computation by C_U a large grain range is not considered, one computes the curvature number C_C.

$$C_C = (d_{30})^2 / (d_{60} \cdot d_{10})$$

Well-graded material shows good compaction behaviour. The parameters for the ideal, so-called Fuller curve are $C_U = 36$ and $C_C = 2.25$.

3.6 Mineralogical Composition

Mineralogy of the sample was determined on randomly oriented powder specimens with X-ray diffraction analysis. The samples were air dried crushed in a Retsch-jaw breaker <0.4 mm and split representatively. An aliquot of about 2 g was then milled in ethanol to a grain size below 20 µm with a McCrone micronizing mill (Fig. 10a). For frontloading preparation, about 1.5 g of the powdered dry material was gentle pressed in a sample holder for packing, sample-height adjustment and forming a flat surface. Preferred orientation is to be avoided by using a blade for surface preparation. The second sample preparation for clayey materials produces oriented specimens (Fig. 10b). This smearing technique enhances the basal reflections from clay minerals thereby facilitating their identification by typical the shift of basal peak position after different treatments. The specimens were measured air dry, after intercalation of ethylene glycol (smectite shift from 14 to 17 Å, illite no change) and after 2 h heating (disappearing kaolinite, basal spacing of smectite shifts to 9.6 Å).

X-ray measurements are made using a Bragg-Brentano diffractometer (Bruker AXS D8 Advance, CoKα with automatic theta compensating divergence and antiscattering slit and SolX solid state detector) in the range of 2 to 80°2Θ with a step width of 0.02°2Θ and a counting time of 4 s per step (Fig. 9b).

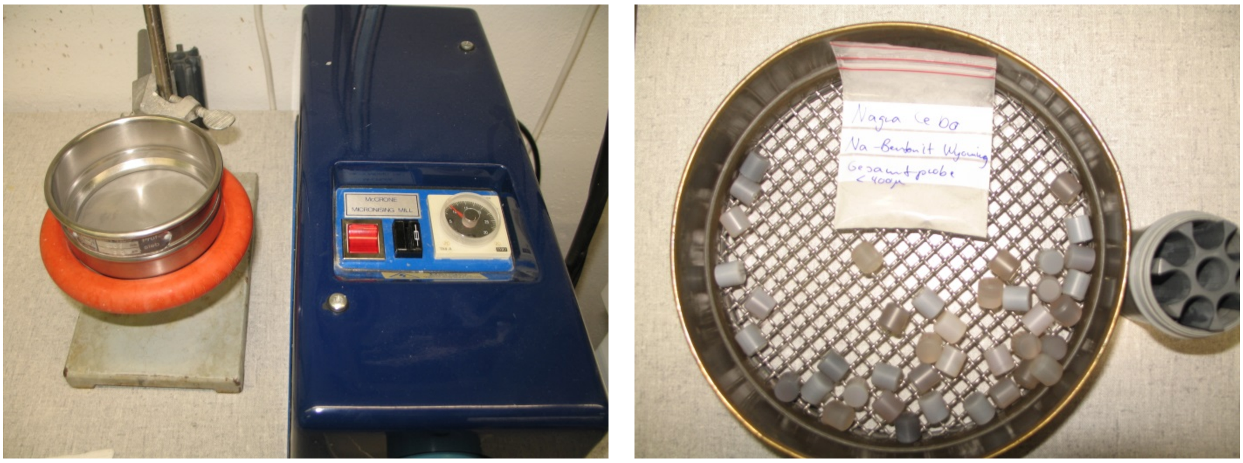


Fig. 10a: McCrone mill (left) and the agate milling bodies (right).

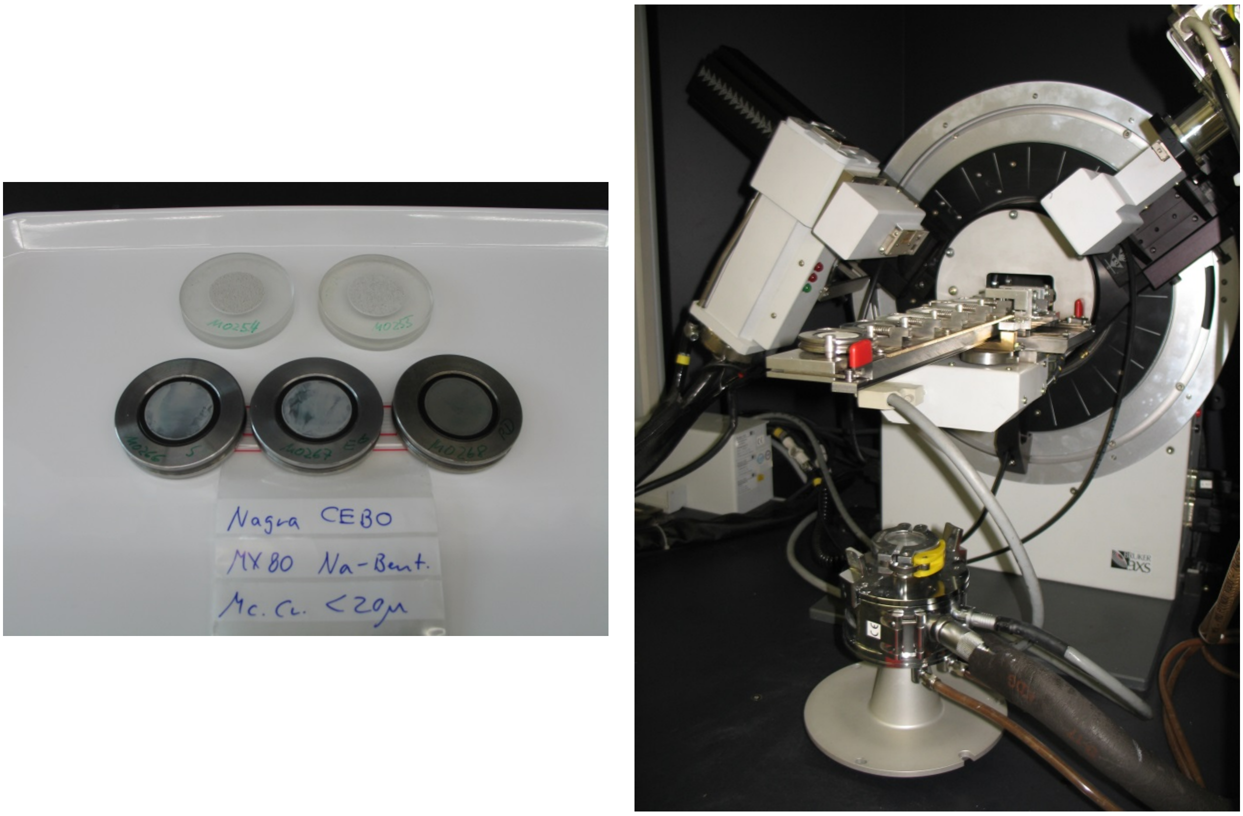


Fig. 10b: XRD-specimens (left) and XRD device Bruker AXS D8 (right).

The qualitative phase analysis was carried out with the software package DIFFRACplus (Bruker AXS). The phases were identified according to the position and relative intensity of the peaks in comparison to the ICDD database. The amount of the mineral phases was calculated by Rietveld-analysis of the measured patterns based on the results of the qualitative phase analysis. This full pattern-fitting method consists in the calculation of the X-ray diffraction pattern and its iterative adjustment to the measured diffractogram. In the refinements, the phase specific parameters and the phase content were adapted to minimize the difference between the calculated and the measured X-ray diffractogram. The latter forms the basis for the standardless quantitative analysis. The quantitative phase analysis of the sample was carried out with the Rietveld program AutoQuan (GE SEIFERT).

3.7 Cation exchange capacity (CEC)

The cation-exchange capacity (CEC) was determined using complexes of copper (II) ion with triethylenetetramine (Meier & Kahr 1999). The copper complex has a high affinity for clay minerals. 200 mg of clay sample are added to 35 ml of ultrapure water and dispersed by ultrasonic treatment (Fig. 11a). The suspension is transferred into the flask with 5 ml of the Cu-trien complex solution then diluted to 50 ml with ultrapure water and overhead shaken (Fig. 11b). After 3 min reaction time, the suspension is centrifuged for 30 min. The supernatant solution is carefully removed and the photometric extinction is measured at 572 nm against a blank. The CEC is then calculated with reference to the dry clay weight using the water content determined with thermal analysis. The variation in the measured value of a standard is ±2 meq/100 g.

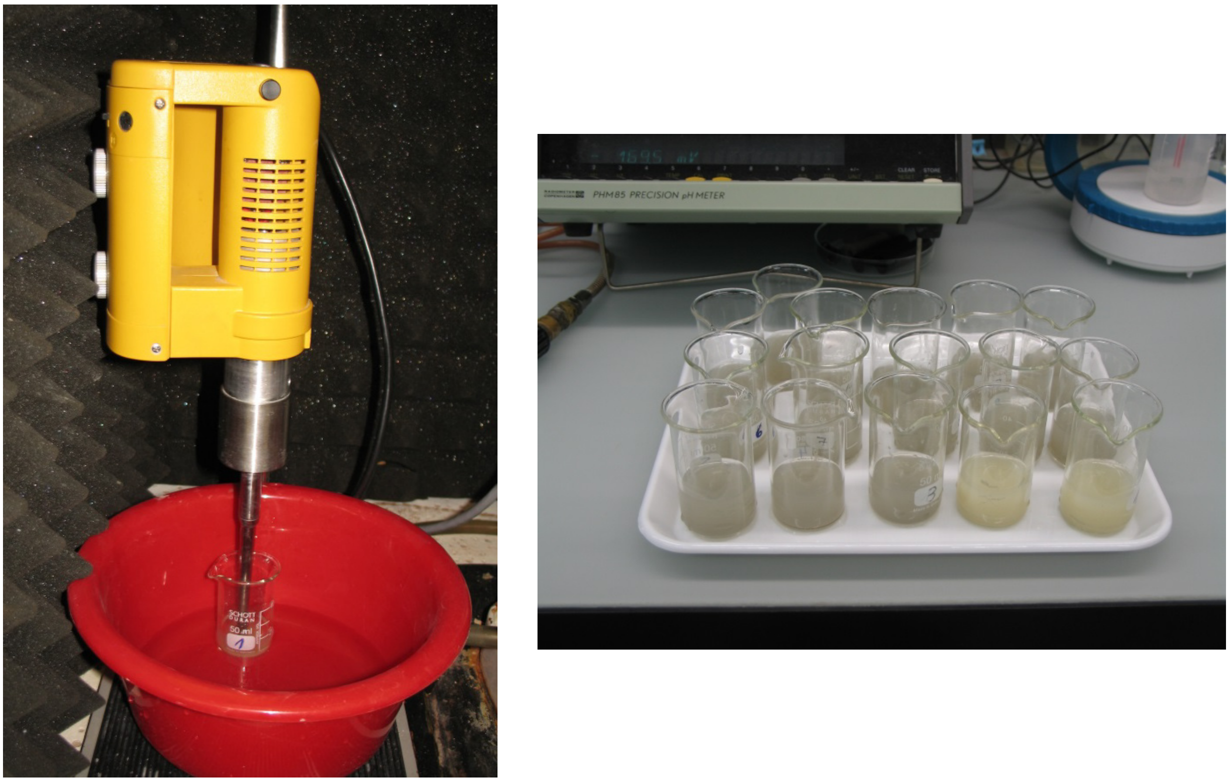


Fig. 11a: Dispersion of the clay sample by ultrasonic treatment for CEC measurement.

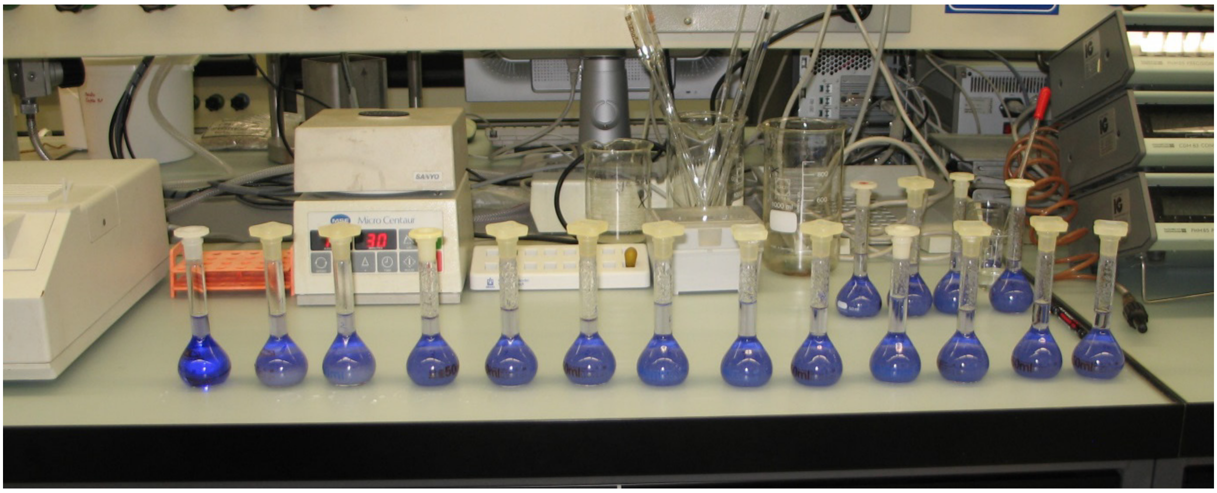


Fig. 11b: Clay suspensions after cation exchange reaction. The flask on the left is the Cu-trien solution without clay.

Fig. 11c: Centrifuging the suspension and photometric measurement of the clear supernatant.

3.8 Water uptake

The water uptake under free swelling conditions was determined using the Enslin-Neff technique (DIN 18132) on approx. 0.1 g bentonite (Fig. 12).

The amount of water and suction time depends from material (grain size for the capillary uptake and content of swellable clay minerals and the ionic form particularly the content of Na for interlayer uptake). The amount and speed of up-taken water under the suction conditions are normally measured up to 24 h. In case of bentonite, the time can be more than 24 h until maximal uptake. The measurements were terminated after three constant data of water uptake. The measurements were carried out in duplicate using desalted and degassed water. The water uptake ability W_b (in % or mg/g) can be calculated as follows:

$$W_b = \frac{W_{\max}}{M_d} \cdot 100$$

where W_{max} = amount of uptaken water and M_d = dry weight of the sample.

Fig. 12a: Enslin-Neff buerettes prepared for the measurements..

Fig. 12b: Left: Sample after 30 min (the top part is still dry) and right after 24 h. The sample is wet and would start to flow by vibration.

3.9 Thermal conductivity

The thermal conductivity of the bentonite blocks was analysed on the three sites using the fast thermal conductivity meter ISOMET2114 (Applied Precision) (Fig. 13) at room temperature. Measurement is based on analysis of the temperature response of the analysed material to heat flow impulses. Heat flow is excited by electrical heating of resistor heater inserted into the probe which is in direct heat contact with the tested specimen. For the measurements, a surface probe a so-called half-space probe (HLQ) with the line heat source at the boundary of two half-spaces (bentonite and probe) in the transient method was used. The heat source located at the bottom of a cylinder (Fig. 13) which is pressed with 5 kg on as flat as possible surface of the bentonite block in different directions to investigate a possible anisotropy related to the direction of the block compaction. The heat produced during the measurement is delivered to the bentonite material. The heat penetrates several millimetres into the sample material. Evaluation of thermal conductivity and volume heat capacity is based on periodically (100x) sampled temperature records as function of time, provided that heat propagation occurs in unlimited medium. The device was calibrated by measurements of a reference material (Fig.13). The tolerance value for the accuracy is ±3%.

Fig. 13a: Calibration of the HLQ probe for the measurement of thermal conductivity.

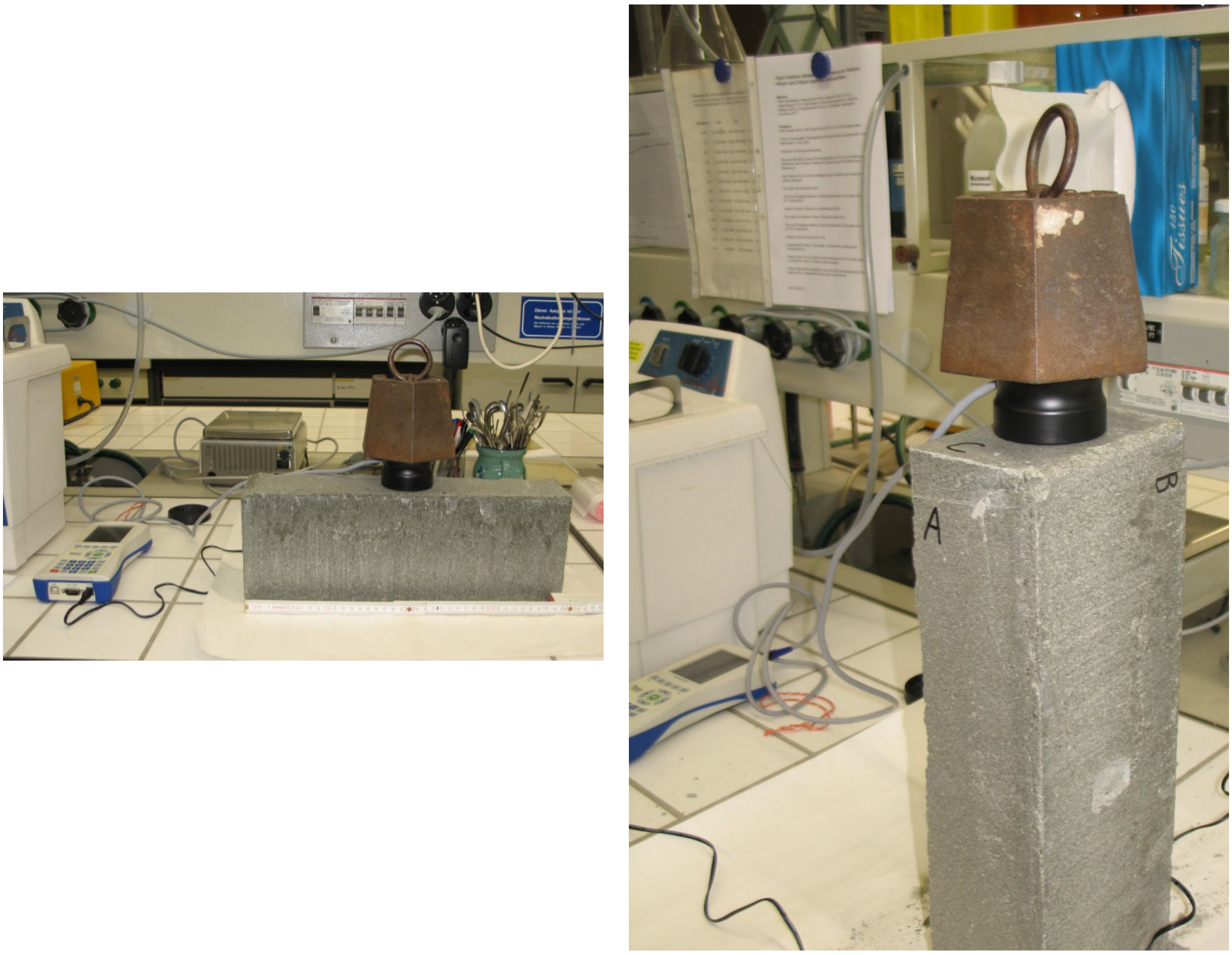


Fig. 13b: Examples for the measurement of thermal conductivity. Cubic block plane A (left) and plane C (right).

4 Results

4.1 BigBag samples, Granular material CEBO standard WP2

4.1.1 Water content

Tab 2: Water content of the granular bentonite samples.

Date of Delivery	Samples	Gravimetric water content related to the dry weight in wt.%				
		Whole sample	Fraction >6.3 mm	Fraction 6.3-2 mm	Fraction >2 mm	Fraction 2-0.63 mm
28.10.2014	BB7 23.09.2014 16:00	5.93	5.33	5.73		
	BB19 24.09.2014 10:00	5.91	5.03	5.59		
	BB48 24.09.14 17:25	6.17	5.81	6.09		
	BB101 25.09.2014 9:30	5.89	5.10	5.66		
31.10.2014	BB89 23.10.2014 16:27	5.52	5.14	5.26		
	BB210 23.10.2014 18:01	5.42			5.48	
	BB313 23.10.2014 20:16	6.57			6.51	
	BB245 24.10.2014 10:13	6.63			6.98	
	BB195 27.10.2014 8:17	5.35			5.48	
	BB219 27.10.2014 10:26	5.43			5.43	
	BB225 27.10.2014 14:40	5.82			5.65	
5.12.2014	BB254 20.11.2014 15:52	5.67			5.58	5.98
	BB231 20.11.2014 17:38	5.48			5.31	5.72
	BB262 21.11.2014 9:52	5.75			5.66	6.11
	BB228 21.11.204 12:07	5.59			5.59	5.87
	BB279 24.11.2014 9:44	5.62			5.44	5.99
9.2.2015	BB307 21.01.2015 09:32	5.52			5.60	5.89
	BB295 21.01.2015 11:16	5.36			5.27	5.62
	BB302 22.01.2015 10:16	5.81			5.85	6.24
	BB GR2-30 22.01.20125 13:30	5.99			5.99	6.14
	BB GR2-18 22.01.2015 16:44	6.02			5.96	6.14
	BB GR2-X2 23.01.2015 09:35	5.80			5.74	5.96
	BB P-31 12.02.2015 8:55	5.68			5.38	5.54
	average	**5.75**	**5.61**			**5.88**

The water content of the granular bentonite in the BigBags for filling is on average 5.75 wt.% (st.dev. 0.36). The coarser fraction >2 mm shows a slightly lower average water content of 5.61 wt.% (st.dev. 0.44) whereas the fraction <2 mm a slightly higher with 5.88 wt.% (st.dev. 0.31). The highest overall water content was 6.98 wt.% and the lowest 5.03 wt.%. The water content shows no increase with time from Sep 2014 until Feb 2015 (Fig. 14).

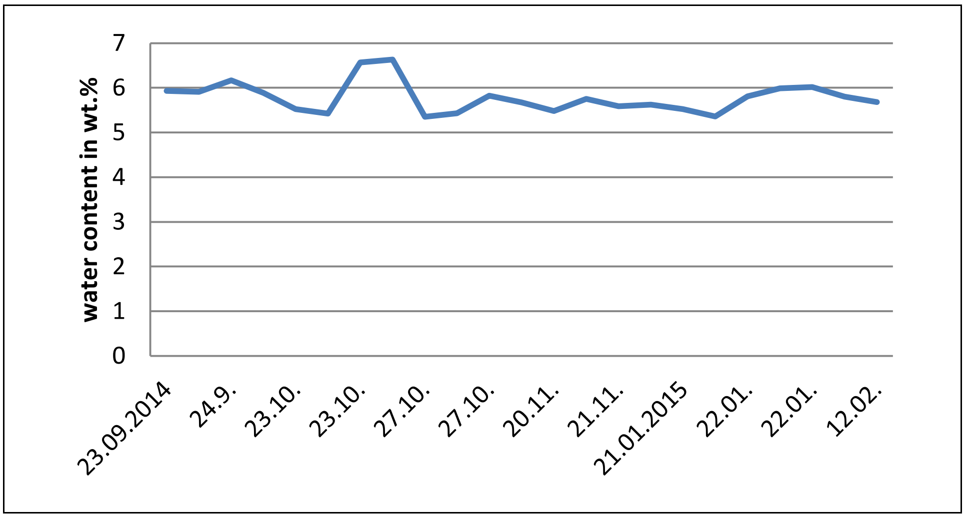


Fig. 14: Development of the water content of the granular bentonite with time.

4.1.2 Bulk density of pellets

Tab 3: Bulk density of pellets from granular bentonite (average of two replicates).

Date of Delivery	Samples	Bulk density in g/cm^3			
		Pellets >6.3 mm		Pellets >2 mm	
		moist	dry ρ_d	moist	dry ρ_d
28.10.2014	BB7 23.09.2014 16:00	2.2436	2.1300		
	BB19 24.09.2014 10:00	2.3088	2.1981		
	BB48 24.09.14 17:25	2.2913	2.1654		
	BB101 25.09.2014 9:30	2.2975	2.1861		
31.10.2014	BB89 23.10.2014 16:27	2.2874	2.1756		
	BB210 23.10.2014 18:01			2.3149	2.1946
	BB313 23.10.2014 20:16			2.2136	2.0782
	BB245 24.10.2014 10:13			2.2529	2.1058
	BB195 27.10.2014 8:17			2.2981	2.1787
	BB219 27.10.2014 10:26			2.2910	2.1729
	BB225 27.10.2014 14:40			2.2684	2.1471
5.12.2014	BB254 20.11.2014 15:52			2.2766	2.1562
	BB231 20.11.2014 17:38			2.2757	2.1609
	BB262 21.11.2014 9:52			2.2785	2.1563
	BB228 21.11.204 12:07			2.2728	2.1524
	BB279 24.11.2014 9:44			2.2602	2.1435
9.2.2015	BB307 21.01.2015 09:32			2.2648	2.1446
	BB295 21.01.2015 11:16			2.2688	2.1552
	BB302 22.01.2015 10:16			2.2764	2.1506
	BB GR2-30 22.01.20125 13:30			2.2533	2.1258
	BB GR2-18 22.01.2015 16:44			2.2424	2.1162
	BB GR2-X2 23.01.2015 09:35			2.2468	2.1248
	BB P-31 12.02.2015 8:55			2.3007	2.1833

The average dry density of the bentonite pellets with size >2 mm is 2.154 g/cm^3 (st.dev.0.028).

An attempt to measure the density of grains with smaller size failed because of methodological limits. A powder of material with this small size contains pores in the size range of pores within bigger grains. During the measurement, these pores were accounted as pores within the solid material that leads to an underestimation of the determined bulk density.

4.1.3 Cation exchange capacity (CEC)

Tab 4: Cation exchange capacity of the granular bentonite (average of two replicates).

Date of Delivery	Samples	CEC in meq/100 g (resp. = cmole(+)/kg)
28.10.2014	BB7 23.09.2014 16:00 BB19 24.09.2014 10:00 BB48 24.09.14 17:25 BB101 25.09.2014 9:30	84 86 86 86
31.10.2014	BB89 23.10.2014 16:27 BB210 23.10.2014 18:01 BB313 23.10.2014 20:16 BB245 24.10.2014 10:13 BB195 27.10.2014 8:17 BB219 27.10.2014 10:26 B225 27.10.2014 14:40	86 89 87 89 88 89 93
5.12.2014	BB254 20.11.2014 15:52 BB231 20.11.2014 17:38 BB262 21.11.2014 9:52 BB228 21.11.204 12:07 BB279 24.11.2014 9:44	87 89 89 87 88
9.2.2015	BB307 21.01.2015 09:32 BB295 21.01.2015 11:16 BB302 22.01.2015 10:16 BB GR2-30 22.01.20125 13:30 BB GR2-18 22.01.2015 16:44 BB GR2-X2 23.01.2015 09:35 BB P-31 12.02.2015 8:55	88 88 88 87 86 87 84

The average cation exchange capacity of the whole granular bentonite is 87 meq/100 g ± 2 meq/100 g. The extreme values of 84 and 93 meq/100 g are probably caused by material inhomogeneities.

4.1.4 Grain size distribution

In Tab. 5 parameters of the grain size distribution and the calculated values of C_U and C_C of the granular bentonite are shown. Fig. 15 illustrates the variations in the grain size distribution curves. The curves and detailed data are given in appendix 2. Sample BB GR2-30 shows the finest grain size distribution and BB210 and 313 the coarsest. BB7, BB GR2-18 and BB P-31 are closest to the Fuller curve in the grains size distribution.

Tab 5: Calculated parameters from grain size distribution of the granular bentonite.

Date of Delivery	Samples	d_{50} in mm	distortion number C_U	curvature number C_C
28.10.2014	BB7 23.09.2014 16:00 BB19 24.09.2014 10:00 BB48 24.09.14 17:25 BB101 25.09.2014 9:30	1.58 1.38 1.86 1.57	37.47 49.18 37.90 31.56	3.13 2.88 3.63 5.34
31.10.2014	BB89 23.10.2014 16:27 BB210 23.10.2014 18:01 BB313 23.10.2014 20:16 BB245 24.10.2014 10:13 BB195 27.10.2014 8:17 BB219 27.10.2014 10:26 B225 27.10.2014 14:40	1.87 2.28 2.28 1.82 2.04 1.63 1.75	47.96 55.12 60.51 54.69 52.62 61.40 52.69	5.36 3.48 2.84 2.00 3.15 1.80 2.21
5.12.2014	BB254 20.11.2014 15:52 BB231 20.11.2014 17:38 BB262 21.11.2014 9:52 BB228 21.11.204 12:07 BB279 24.11.2014 9:44	1.83 1.98 2.23 2.16 1.80	67.10 52.61 54.30 52.49 48.70	2.34 2.80 3.38 3.31 2.36
9.2.2015	BB307 21.01.2015 09:32 BB295 21.01.2015 11:16 BB302 22.01.2015 10:16 BB GR2-30 22.01.20125 13:30 BB GR2-18 22.01.2015 16:44 BB GR2-X2 23.01.2015 09:35 BB P-31 12.02.2015 8:55	1.79 2.24 1.53 1.22 1.35 1.32 1.58	57.24 62.29 45.90 43.39 38.86 42.11 36.04	2.22 3.13 1.53 1.61 1.72 1.76 4.69

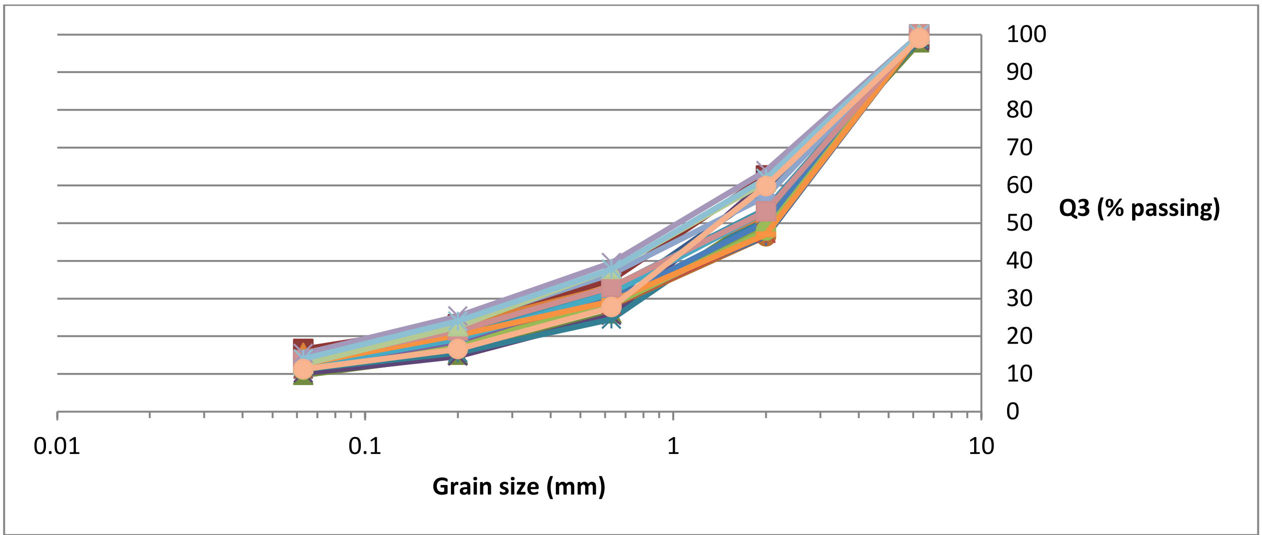


Fig. 15: Grain size distribution curves all samples of the granular bentonite.

4.2 Granular material CEBO standard WP2 BB266

The material from the BB266 was investigated more in detail and therefore listed here separately.

4.2.1 Water content

Tab 6: Water content of the granular bentonite CEBO standard.

Date of Delivery	Sample	Gravimetric water content related to the dry weight in wt.%		
		Whole sample	Fraction >2 mm	Fraction 2-0.63 mm
5.12.2014	CEBO standard WP2 BB266 #1 CEBO standard WP2 BB266 #2	5.18 5.18	4.93 4.97	5.29 5.28
	average	**5.18**	**4.95**	**5.29**

4.2.2 Bulk density of pellets

Tab 7: Bulk density of pellets of the granular bentonite CEBO standard (average of two replicates).

Date of Delivery	Samples	Bulk density in g/cm^3	
		Pellets >2 mm	
		moist	dry ρ_d
5.12.2014	CEBO standard WP2 BB266 #1 CEBO standard WP2 BB266 #2	2.269 2.283	2.162 2.175
	average	2.276	**2.168**

4.2.3 Cation exchange capacity (CEC)

Tab 8: Cation exchange capacity of the granular bentonite CEBO standard WP2 (average of two replicates).

Date of Delivery	Samples	CEC in meq/100 g (resp. = cmole(+)/kg)
5.12.2014	CEBO standard BB266 #1 CEBO standard BB266 #2	87 88
	average	**87.5**

4.2.4 Grain size distribution

Tab. 9: Grain size distribution of granular bentonite CEBO standard WP2 BB266, pooled #1 - #4.

Parameter	p3	Parameter	
>6.3 mm	0%		
2-6.3 mm	46.9%	d_{10}	0.053 mm
0.63-2 mm	21.7%	d_{30}	0.579 mm
0.2-0.63 mm	12.2%	d_{50}	1.804 mm
0.063-0.2 mm	7.4%	d_{60}	2.632 mm
<0.063 mm	11.8%	d_{90}	5.383 mm
		d_{100}	6.3 mm
		C_U	49.66
		C_C	2.40

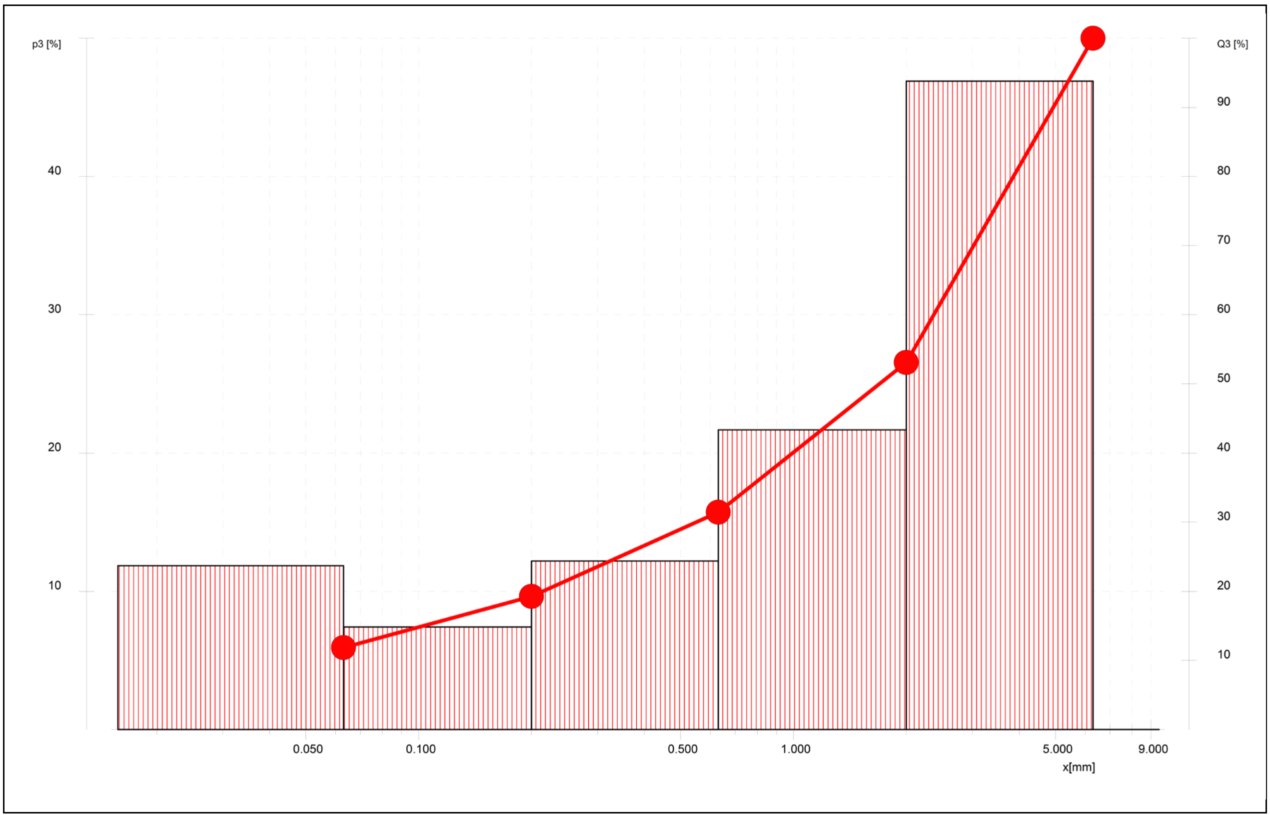


Fig 16: Sieve curve granular bentonite CEBO standard WP2, pooled #1 - #4.

4.2.5 Pouring density

The maximum dry emplacement density of the granular bentonite CEBO standard reaches after vibration on average 1.65 g/cm^3 independently from the initial filling procedure (Tab. 10).

Tab. 10: Emplacement densities of the granular bentonite CEBO standard WP2 BB266.

Sample	Min. emplacement/filling densities ρ_{min} in g/cm^3		Max. emplacement/filling densities ρ_{max} in g/cm^3	
	moist	dry	moist	dry
#1 No filling height	1.59		1.71	
#2 No filling height	1.57		1.75	
average	1.58	**1.50**	1.73	**1.65**
#1 80 cm filling height	1.56		1.71	
#2 80 cm filling height	1.49		1.75	
average	1.52	**1.45**	1.73	**1.65**
Overall average		**1.48**		**1.65**

4.2.6 Water uptake (Enslin-Neff)

The water uptake under free swelling conditions within 24 h was 665 ± 10% (average of two measurements). The maximum water uptake was reached already after 6 h. Fig. 17 illustrates the water uptake curves.

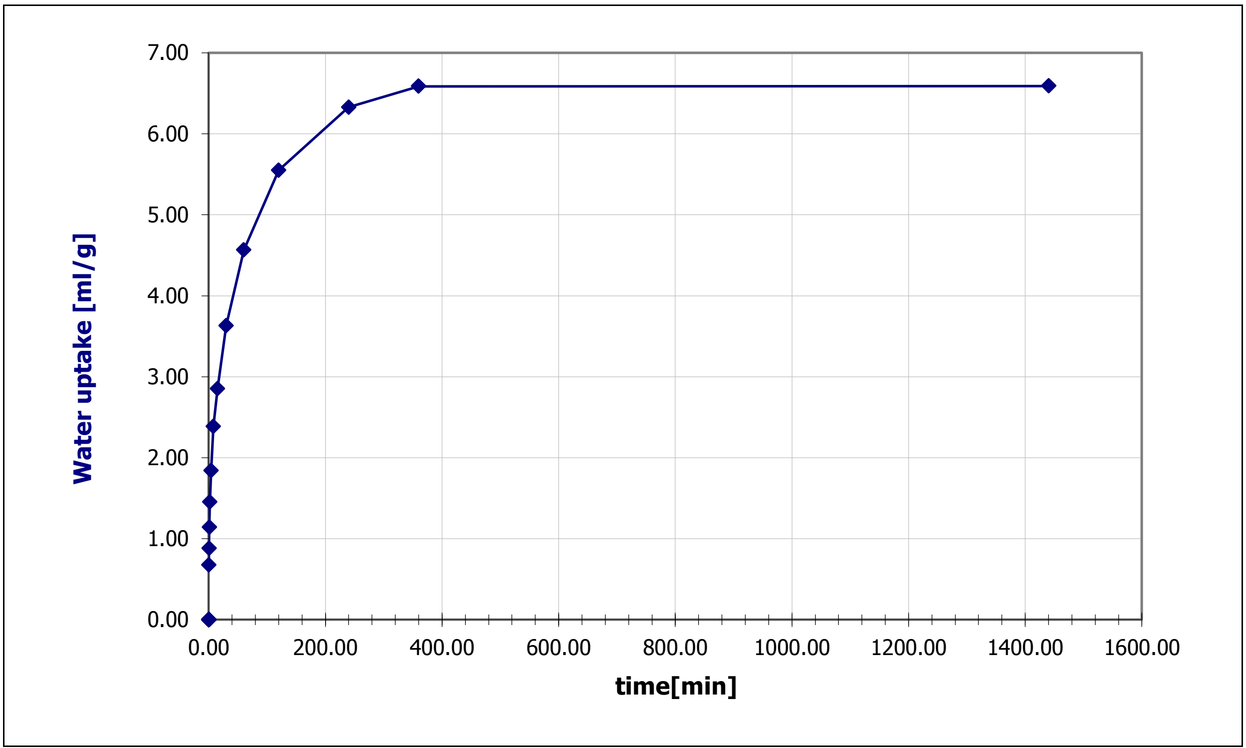


Fig. 17a: Water uptake under free swelling of the granular bentonite CEBO standard WP2 BB266 (meas. 1).

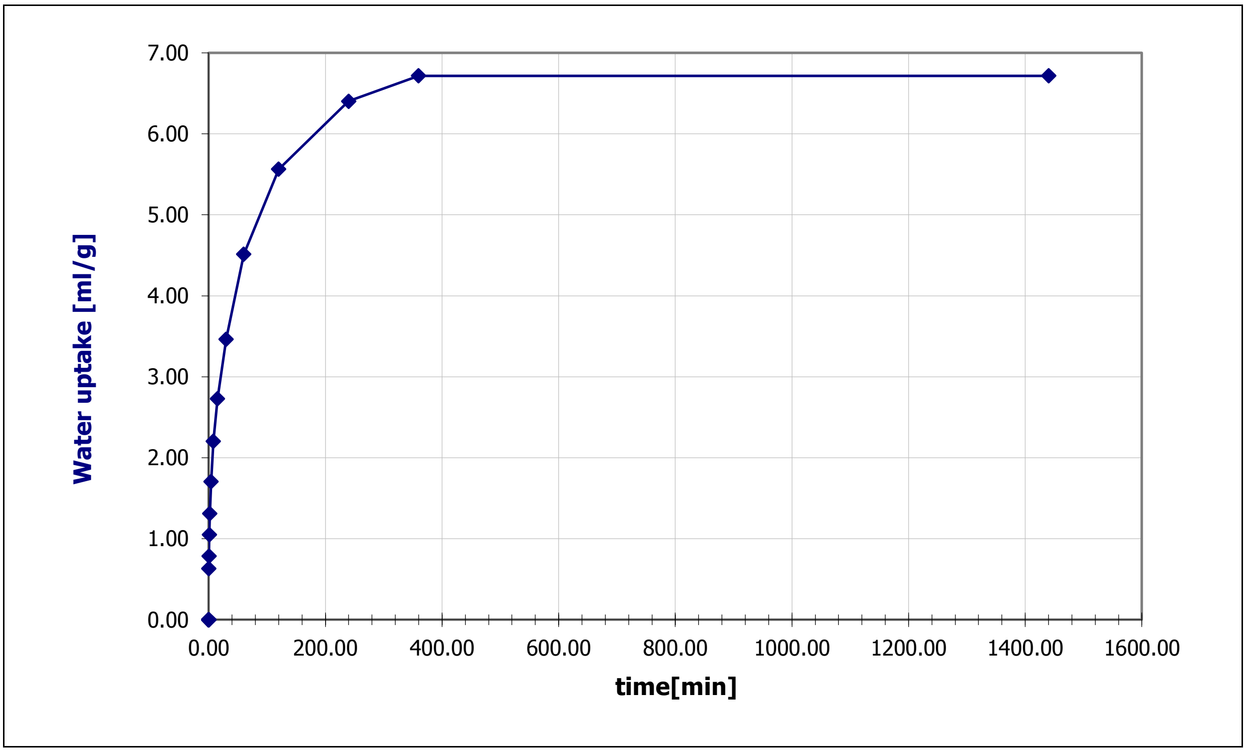


Fig. 17b: Water uptake under free swelling of the granular bentonite CEBO standard WP2 BB266 (meas. 2).

4.2.7 Mineralogical composition

The material is a Na-bentonite (as expected for MX-80). The composition is close to the values of ID7 IGT report CL1044 (Dec. 2013).

Tab. 11: Mineralogical composition of the granular bentonite CEBO standard WP2 (data in wt% with 3σ absolute error).

Mineral	granular bentonite CEBO standard WP2 BB266
Calcite	1.2 (0.2)
Illite	3.2 (0.6)
K-Feldspar	4.0 (0.4)
Na-plagioclase	3.0 (0.5)
Pyrite	0.3 (0.1)
Quartz	7.0 (0.3)
Cristobalite	1.1 (0.6)
Siderite	0.3 (0.2)
Gypsum	nn
Na-Smectite	79.8 (3.0)

4.3 Blocks BentosundA100

4.3.1 Water content

Tab 12: Water content of the Bentonite Blocks Bentosund A100 Laviosa MPC.

Date of Delivery	Sample	Gravimetric water content related to the dry weight in wt.%
5.12.2014	Block cubic 0-2 cm	16.99
	Block cubic 2-4 cm	16.72
	Block cubic 4-6 cm	17.09
	Block cubic 6-8 cm	17.12
	Block cubic 8-11 cm	17.61
	Block cubic 11-14 cm	17.79
	Block cubic 14-17 cm	17.98
	Block cubic 17-20 cm	17.44
	Block cubic surface A	17.52
	Block cubic surface B	17.13
	Block cubic surface C	16.79
	average	**17.29**
	Block curved 0-4 cm	16.91
	Block curved 4-6 cm	17.77
	Block curved 6-9 cm	18.42
	Block curved 9-11 cm	18.42
	Block curved 11-13 cm	18.33
	Block curved 13-16 cm	18.44
	Block curved 16-18 cm	18.43
	Block curved 18-21 cm	17.85
	Block curved surface A	18.39
	Block curved surface B	17.04
	Block curved surface C	16.05
	average	**17.82**

The water content of the blocks is on average 17.6 wt.% (st.dev. 0.69). A clear tendency of decreasing water content by appr. 1 wt.% towards the outer part is obvious. This could be explained by drying even when the blocks were sealed. Especially the surface C, which is the narrow side of the block has in both cases the lowest water content. Interestingly, the sample from most inner part of the blocks shows again a slightly lower water content.

4.3.2 Bulk density

Tab 13: Bulk density distribution within the Bentonite Blocks Bentosund A100 Laviosa MPC (average of two replicates).

Date of Delivery	Sample	Bulk density in g/cm^3	
		moist	dry ρ_d
5.12.2014	Block cubic 0-2 cm	2.0647	1.7649
	Block cubic 2-4 cm	2.0299	1.7391
	Block cubic 4-6 cm	2.0547	1.7547
	Block cubic 6-8 cm	2.0409	1.7425
	Block cubic 8-11 cm	2.0725	1.7622
	Block cubic 11-14 cm	2.0240	1.7183
	Block cubic 14-17 cm	2.0103	1.7040
	Block cubic 17-20 cm	2.0573	1.7517
	average		**1.7422**
	Block curved 0-4 cm	2.0108	1.7200
	Block curved 4-6 cm	2.0026	1.7004
	Block curved 6-9 cm	2.0199	1.7057
	Block curved 9-11 cm	2.0027	1.6912
	Block curved 11-13 cm	1.9799	1.6732
	Block curved 13-16 cm	2.0068	1.6943
	Block curved 16-18 cm	2.0230	1.7081
	Block curved 18-21 cm	2.0133	1.7083
	average		**1.7002**

The dry bulk density of the blocks is on average 1.721 g/cm^3 (st.dev. 0.034). There is no gradient within the block however a clear difference between the cubic and the curved block. The latter one shows a lower dry density.

4.3.3 Porosity

The porosity of the compressed blocks shows low variations with on average 26.8% (Tab. 14).. The cubic block has slightly lower porosity compared to the curved block, mainly because of a lower amount of pores in the range >2 µm (14% compared to 19%). Furthermore, it is visible that the centre is slightly less compacted as the surface, especially for the cubic block with a difference of up to 3% porosity. The porosity is mainly caused by mesopores below 100 nm diameter (main pore diameter 16.6 – 19.7 nm) and by interaggregate pores >6 µm (Fig. 18). The samples with the lowest porosity (cubic block surface) show the smaller diameter of these interaggregate pores (appr. 7 µm vs. 15 µm) (Fig. 18).

Tab 14: Pore size distribution of the bentonite blocks Bentosund A100 Laviosa MPC (MIP measurements in replicates).

sample	Total porosity	Pore size distribution (diameter)		
	accessible at 400 MPa	58 – 2 µm	2 µm – 100 nm	100 – 1.8 nm
	%	%	%	%
Block cubic				
Surface #1	24.3	15.07	7.31	77.62
Surface #2	26.0	13.95	6.16	79.89
Centre #1	27.0	19.65	7.78	72.57
Centre #2	27.6	18.68	7.43	73.89
Block curved				
Surface C #1	26.4	18.15	6.16	75.69
Surface C #2	27.3	20.69	5.86	73.45
Centre #1	28.2	19.64	7.24	73.12
Centre #2	27.8	20.54	6.22	73.25

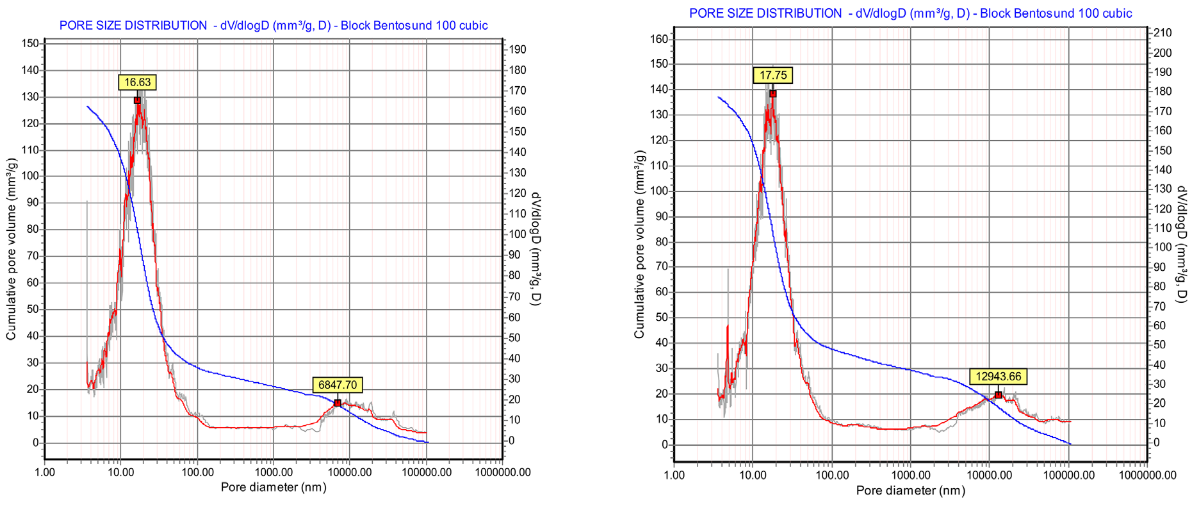


Fig. 18a: Pore size distribution curve of the cubic block Bentosund A100 Laviosa MPC (left surface, right centre).

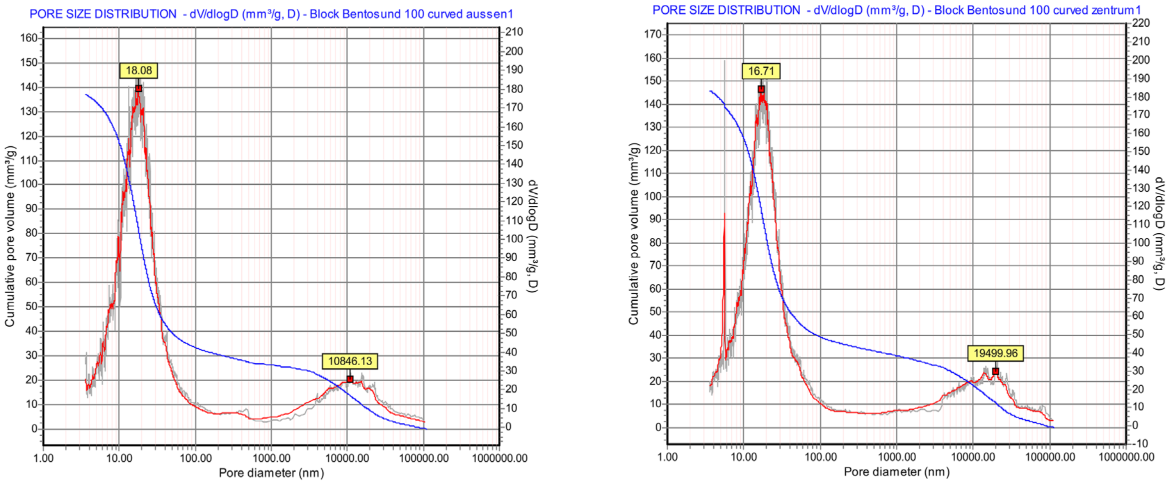


Fig. 18b: Pore size distribution curve of the curved block Bentosund A100 Laviosa MPC (left surface, right centre).

4.3.4 Cation exchange capacity (CEC)

Tab 15: CEC of the bentonite from Blocks Bentosund A100 Laviosa MPC (average of two replicates).

Date of Delivery	Samples	CEC in meq/100 g (resp. = cmole(+)/kg)
5.12.2014	Block cubic Block curved	90 90
	average	**90**

The CEC of the bentonite Bentosund A100 from the blocks is on average 90 meq/100 g and slightly higher as from the granular material CEO standard WP2.

4.3.5 Mineralogical composition

Tab. 16: Mineralogical composition of selected bentonite materials (data in wt% with 3σ absolute error).

Mineral	Block cubic	Block curved
Calcite	0.9 (0.2)	0.9 (0.2)
Illite	1.3 (0.5)	1.4 (0.5)
K-Feldspar	3.9 (0.3)	3.7 (0.4)
Na-plagioclase	4.1 (0.5)	4.4 (0.5)
Pyrite	0.4 (0.1)	0.4 (0.1)
Quartz	7.2 (0.3)	6.7 (0.3)
Cristobalite	1.3 (0.3)	1.5 (0.5)
Siderite	0.5 (0.1)	0.5 (0.2)
Gypsum	<0.1	<0.1
Na-Smectite	80.3 (3.3)	80.3 (3.3)

4.3.6 Heat conductivity

Tab 17: Heat conductivity of the bentonite blocks Bentosund A100 Laviosa MPC.

Date of Delivery	Samples	Heat conductivity in W/m·K
5.12.2014	Block cubic Surface A Surface B Surface C	 0.9405 1.1061 1.1486
	average	1.065
	Block curved Surface A Surface B Surface C	 1.1520 1.1326 1.1401
	average	1.142

The thermal conductivity of the bentonite blocks is on average 1.103 W/m·K (st.dev. 0.081), which is slightly lower as measured for MX-80 blocks within the project ABM (1.19 W/m·K) but clearly higher as for granular materials with 0.3-0.8 W/m·K (Plötze, M. & Valter, M. (2011): Bentonite as barrier material – Thermal conductivity of compacted bentonite. NAB 11-16). The measurements of thermal conductivity λ showed slightly higher values for the curved bentonite block. This could be explained by its slightly higher water content, which is one of the most important factors influencing the thermal conductivity of bentonite. However, the differences in the water content of the different surface do not correlate with the thermal conductivity. There are additional factors like the roughness (and therefore the contact of the probe to the surface) which additionally influence the measured result.

4.4 Screw Conveyor samples

4.1.4 Grain size distribution

The parameters and the curves of the grain size distribution of the granular bentonite from screw conveyor samples are given in appendix 3.

5 Concluding remarks

The investigations were carried out taking into account the current scientific and technical knowledge carefully to the best of our knowledge and belief. We are always looking for ways to provide the best analysis results. The test results refer exclusively to the aforementioned samples. We disclaim any responsibility to be held liable for damages that may arise using the analysis results.

Report Nr. IGT-CL1051/MP

Zurich, 15th April 2015

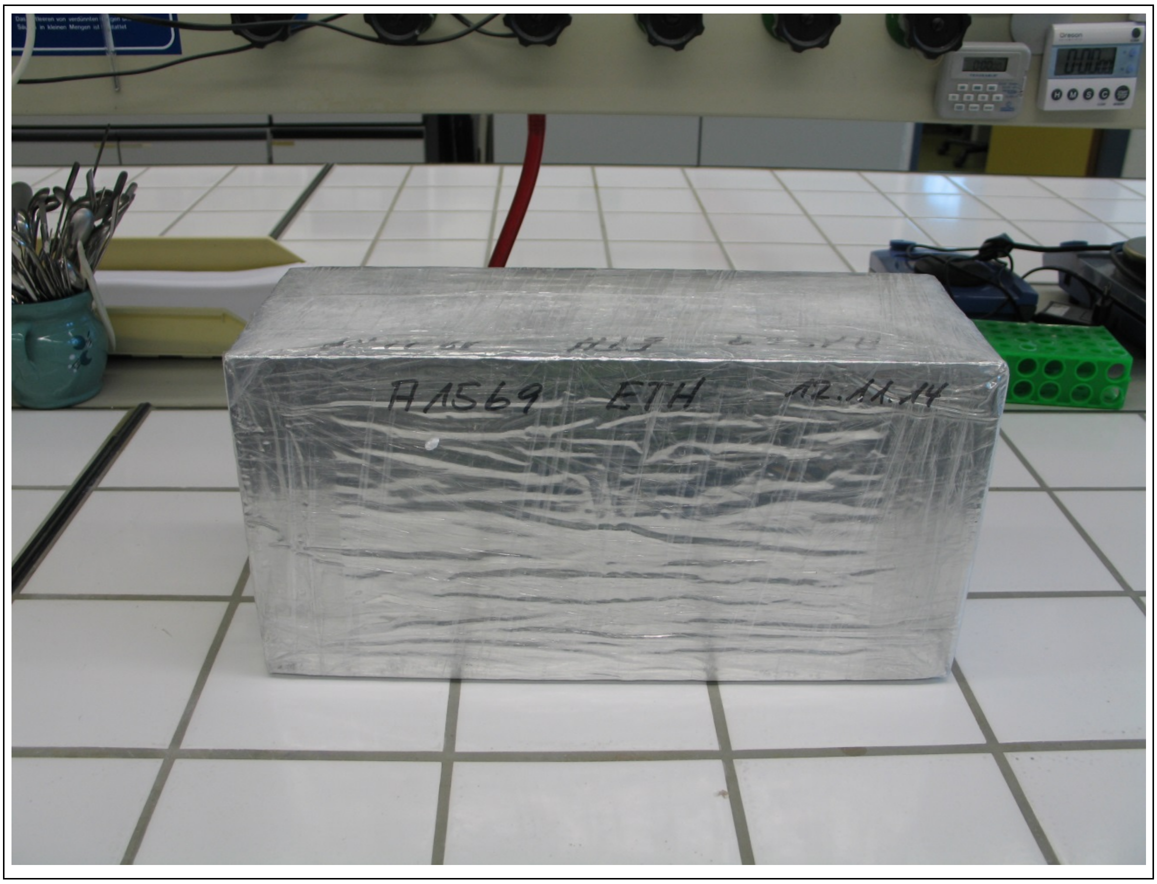
ETH Zurich

Institute for Geotechnical Engineering (IGT)

Dr. M. Plötze

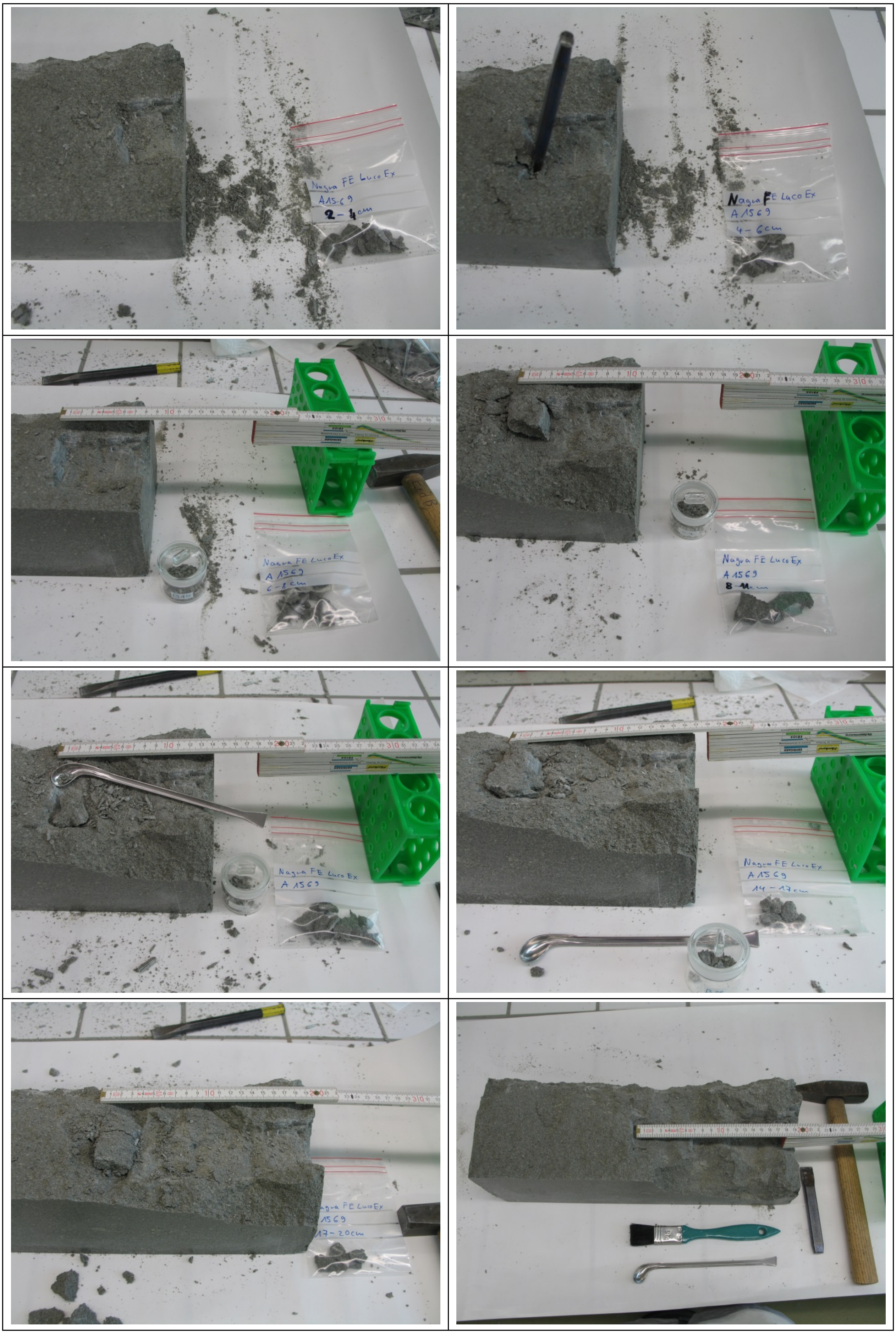
Appendix

Appendix 1: Block sampling

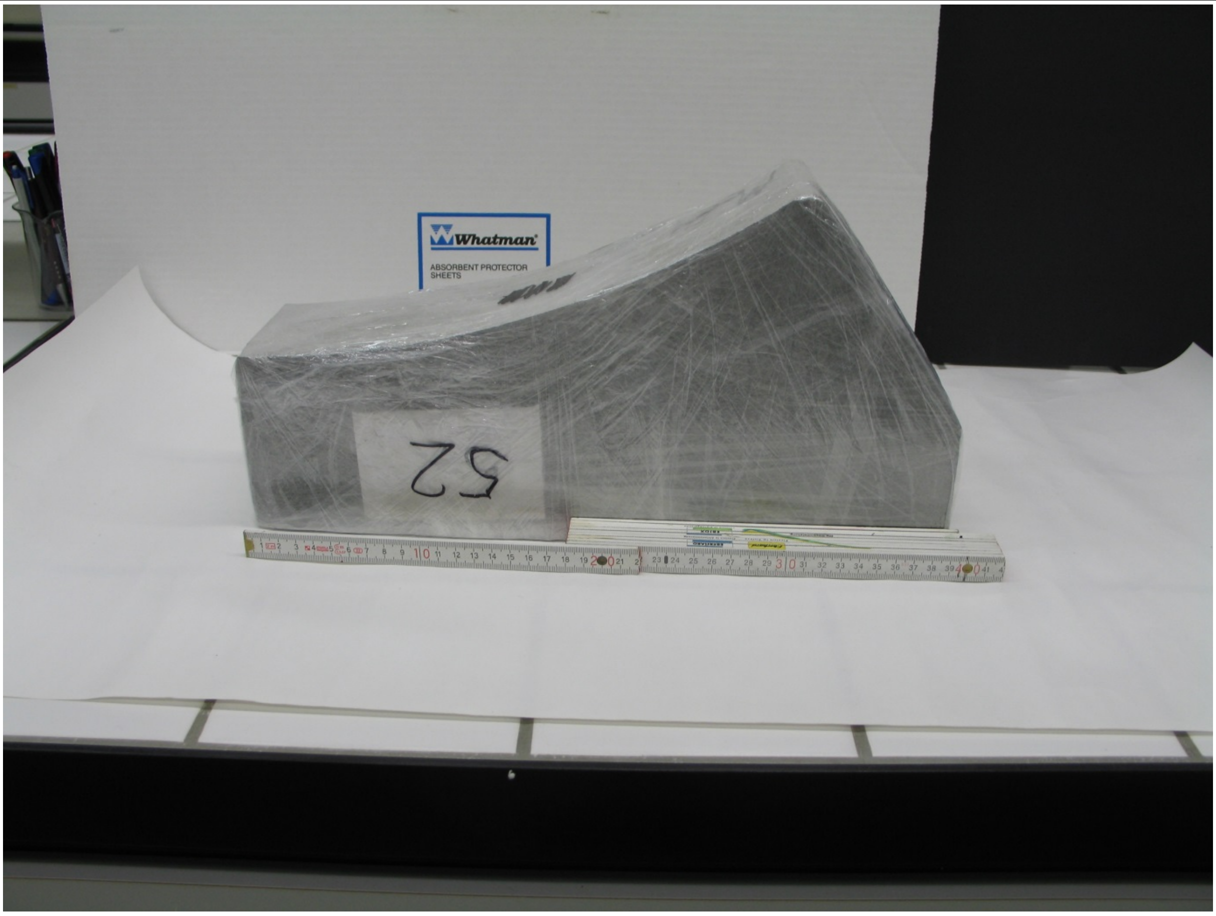


Block cubic, delivery state

Block cubic, cleaving

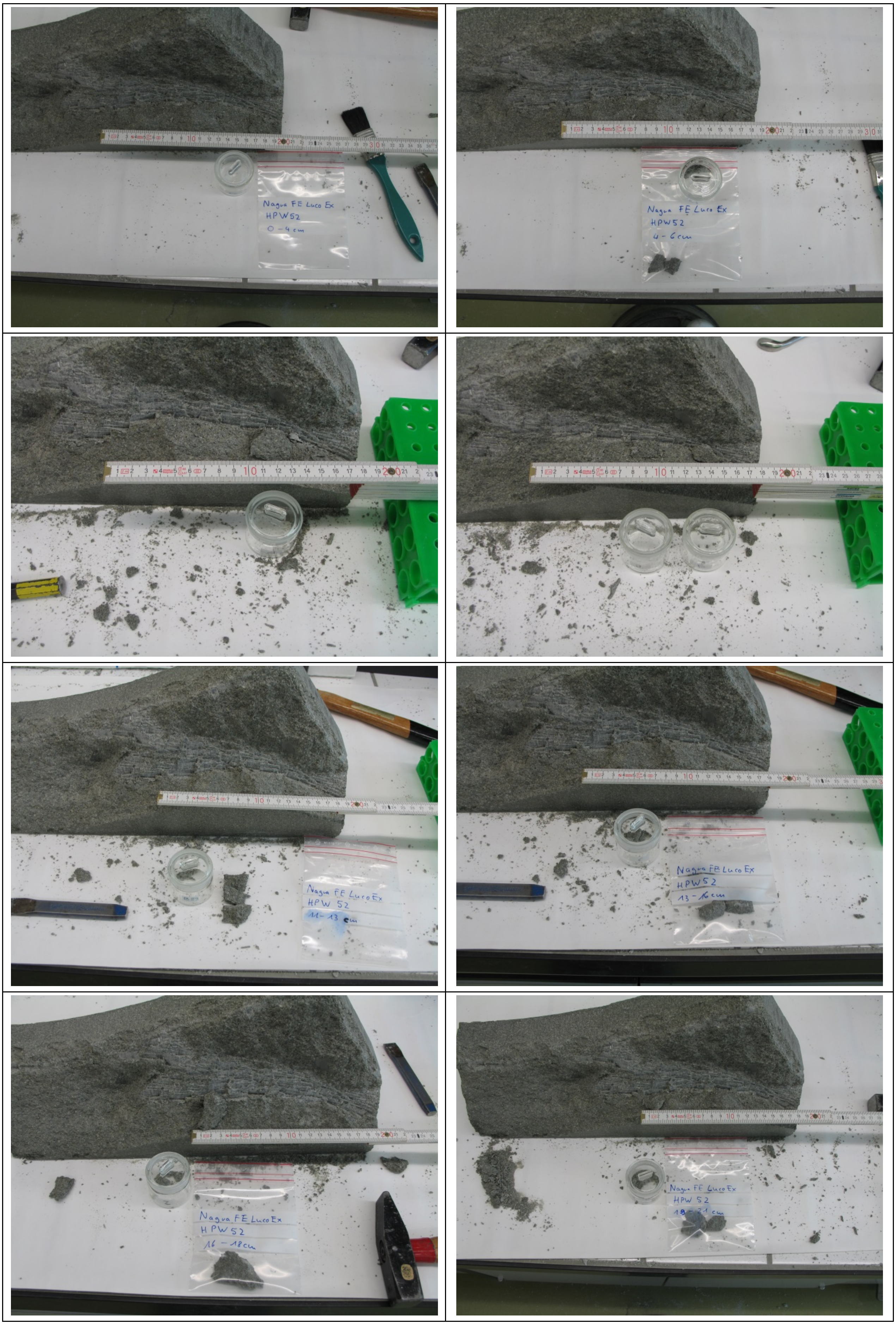


Block cubic, profile sampling



Block curved, delivery state

Block curved, cleaving



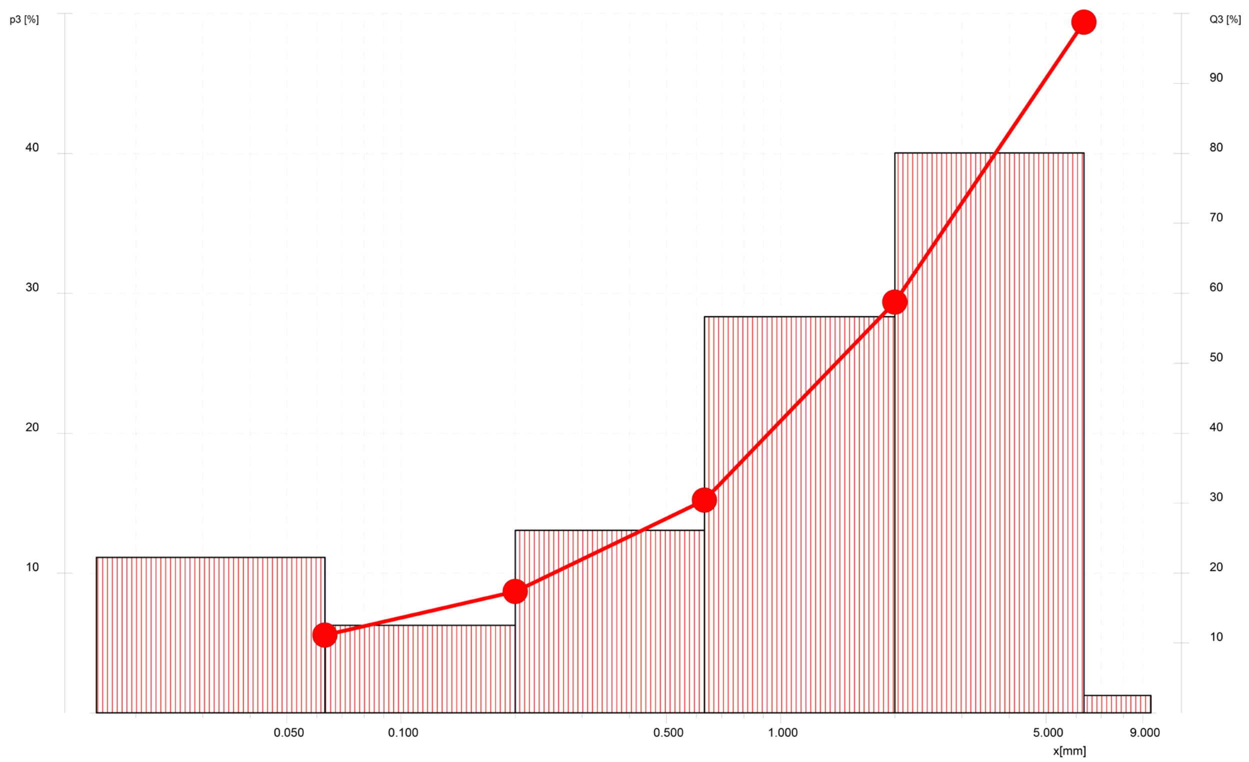
Block curved, profile sampling

Appendix 2: Sieve curves and parameter of BigBag samples

Granular Bentonite CEBO Standard WP2

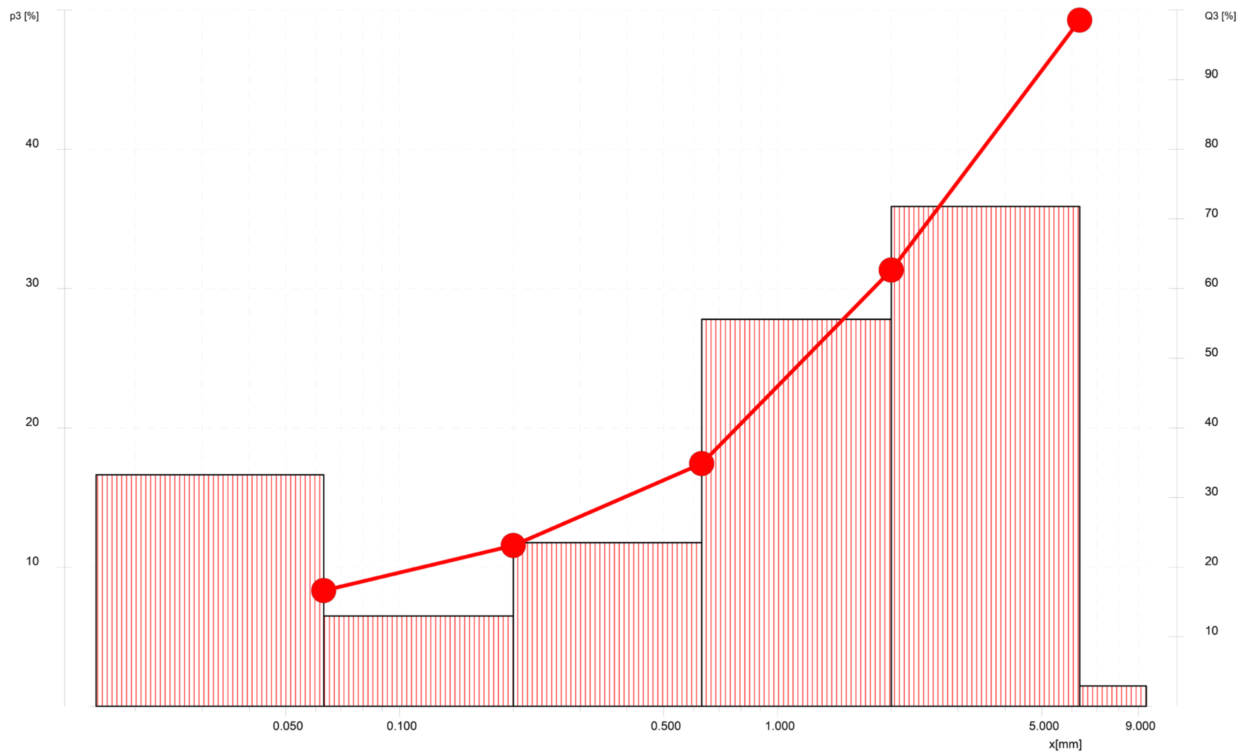
Grain size distribution of granular bentonite BB7 23.09.2014 16:00.

Parameter		Parameter	
>6.3 mm	1.2%		
2-6.3 mm	40.0%	d_{10}	0.057 mm
0.63-2 mm	28.3%	d_{30}	0.617 mm
0.2-0.63 mm	13.1%	d_{50}	1.578 mm
0.063-0.2 mm	6.3%	d_{60}	2.136 mm
<0.063 mm	11.1%	d_{90}	5.359 mm
amount	462 g	C_U	37.47
		C_C	3.13



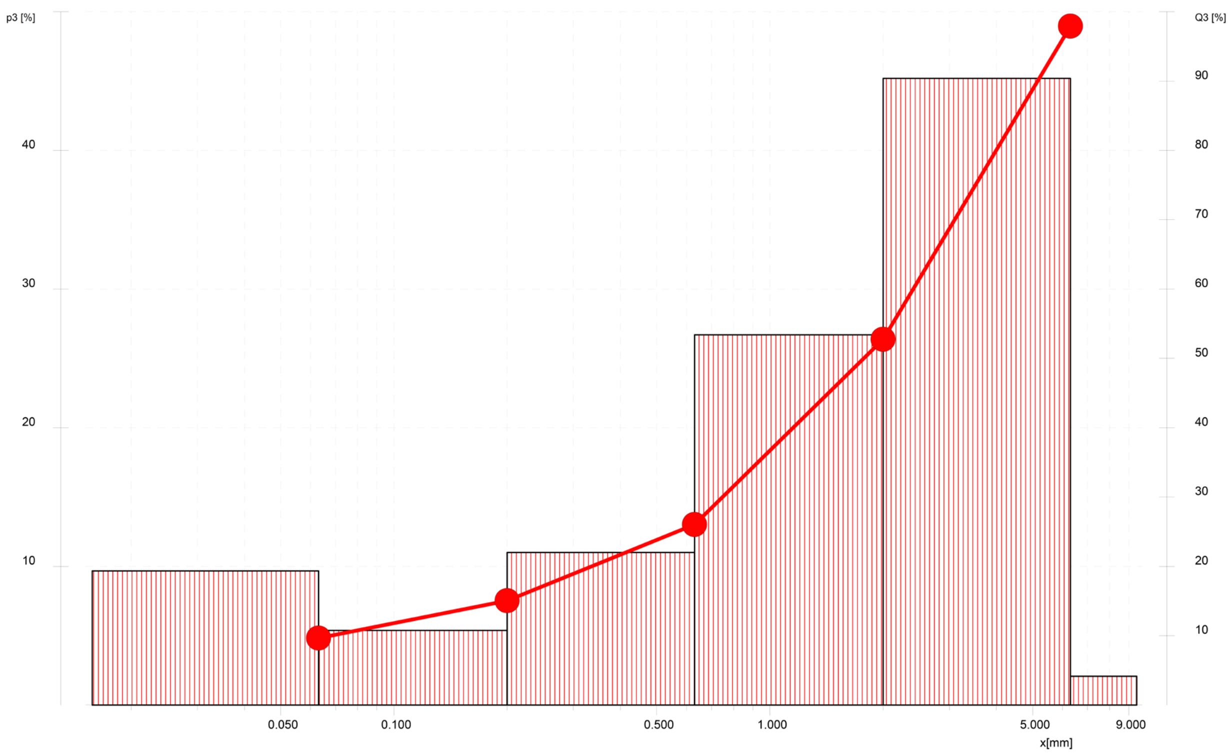
Grain size distribution of granular bentonite BB19 24.09.2014 10:00.

Parameter		Parameter	
>6.3 mm	1.5%		
2-6.3 mm	35.9%	d_{10}	0.038 mm
0.63-2 mm	27.8%	d_{30}	0.452 mm
0.2-0.63 mm	11.8%	d_{50}	1.377 mm
0.063-0.2 mm	6.5%	d_{60}	1.869 mm
<0.063 mm	16.6%	d_{90}	5.276 mm
amount	470 g	C_U	49.18
		C_C	2.88



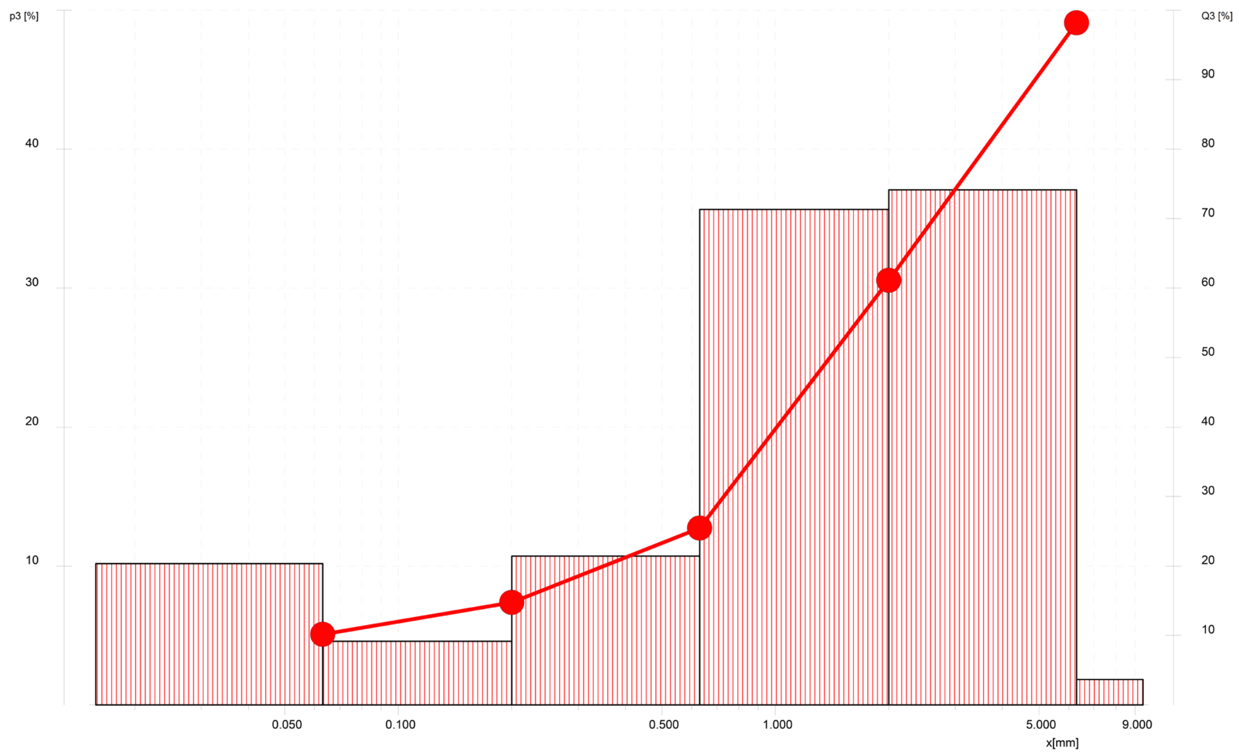
Grain size distribution of granular bentonite BB48 24.09.14 17:25.

Parameter		Parameter	
>6.3 mm	2.1%		
2-6.3 mm	45.2%	d_{10}	0.071 mm
0.63-2 mm	26.7%	d_{30}	0.833 mm
0.2-0.63 mm	11.0%	d_{50}	1.859 mm
0.063-0.2 mm	5.4%	d_{60}	2.691 mm
<0.063 mm	9.7%	d_{90}	5.545 mm
amount	494 g	C_U	37.90
		C_C	3.63



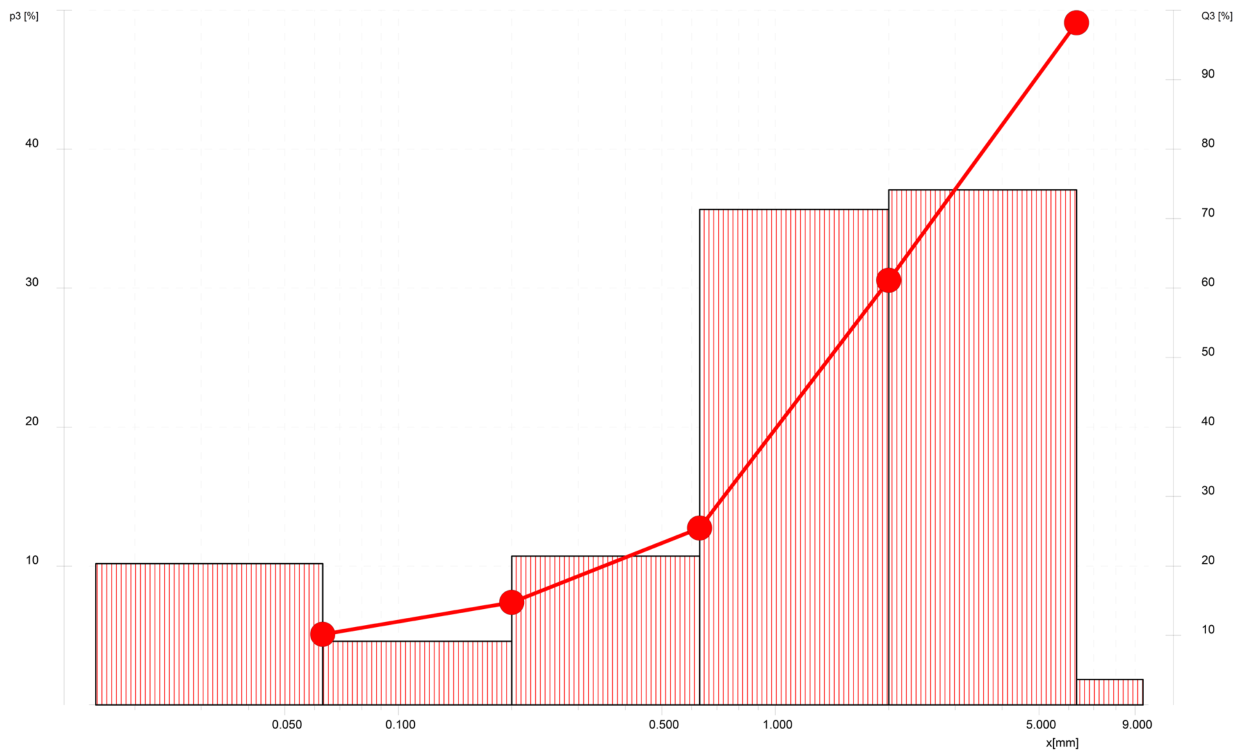
Grain size distribution of granular bentonite BB101 25.09.2014 9:30.

Parameter		Parameter	
>6.3 mm	1.8%		
2-6.3 mm	37.1%	d_{10}	0.062 mm
0.63-2 mm	35.7%	d_{30}	0.805 mm
0.2-0.63 mm	10.7%	d_{50}	1.573 mm
0.063-0.2 mm	4.6%	d_{60}	1.957 mm
<0.063 mm	10.2%	d_{90}	5.352 mm
amount	468 g	C_U	31.56
		C_C	5.34



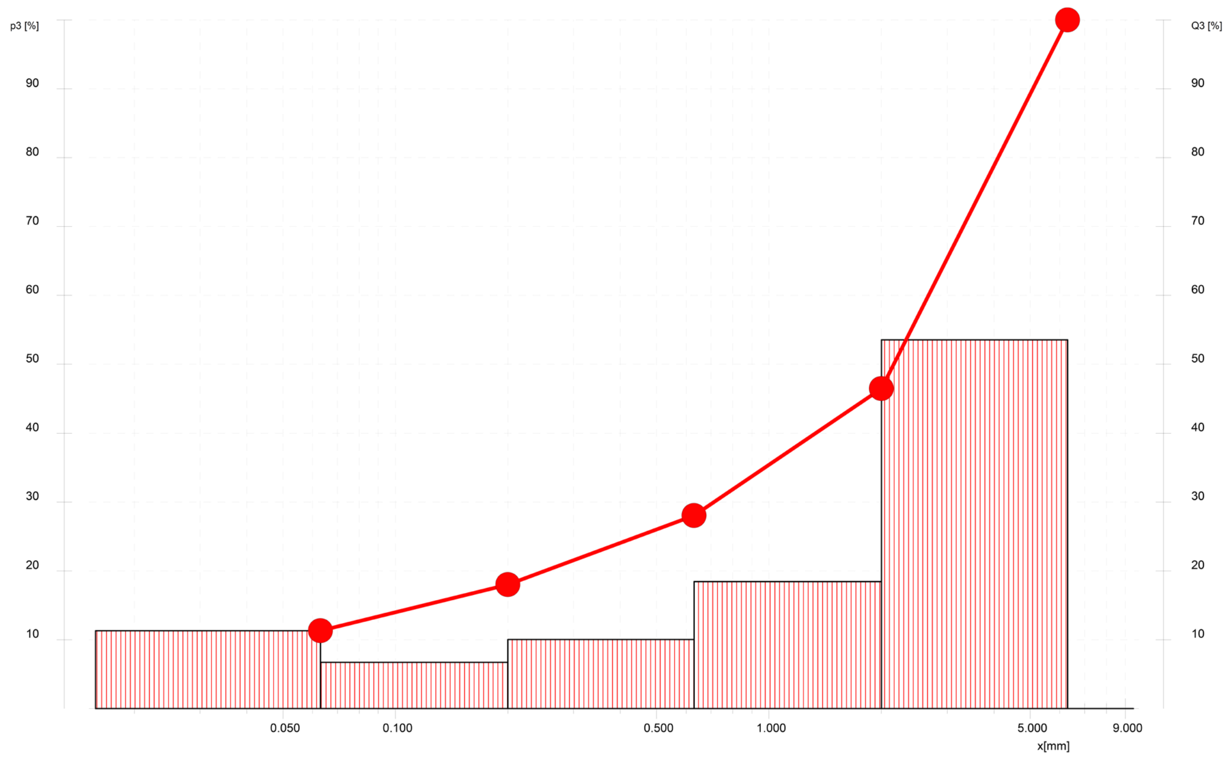
Grain size distribution of granular bentonite BB89 23.10.2014 16:27.

Parameter		Parameter	
>6.3 mm	1.2%		
2-6.3 mm	46.2%	d_{10}	0.056 mm
0.63-2 mm	28.1%	d_{30}	0.898 mm
0.2-0.63 mm	8.9%	d_{50}	1.872 mm
0.063-0.2 mm	4.3%	d_{60}	2.686 mm
<0.063 mm	11.2%	d_{90}	5.481 mm
amount	414 g	C_U	47.96
		C_C	5.36



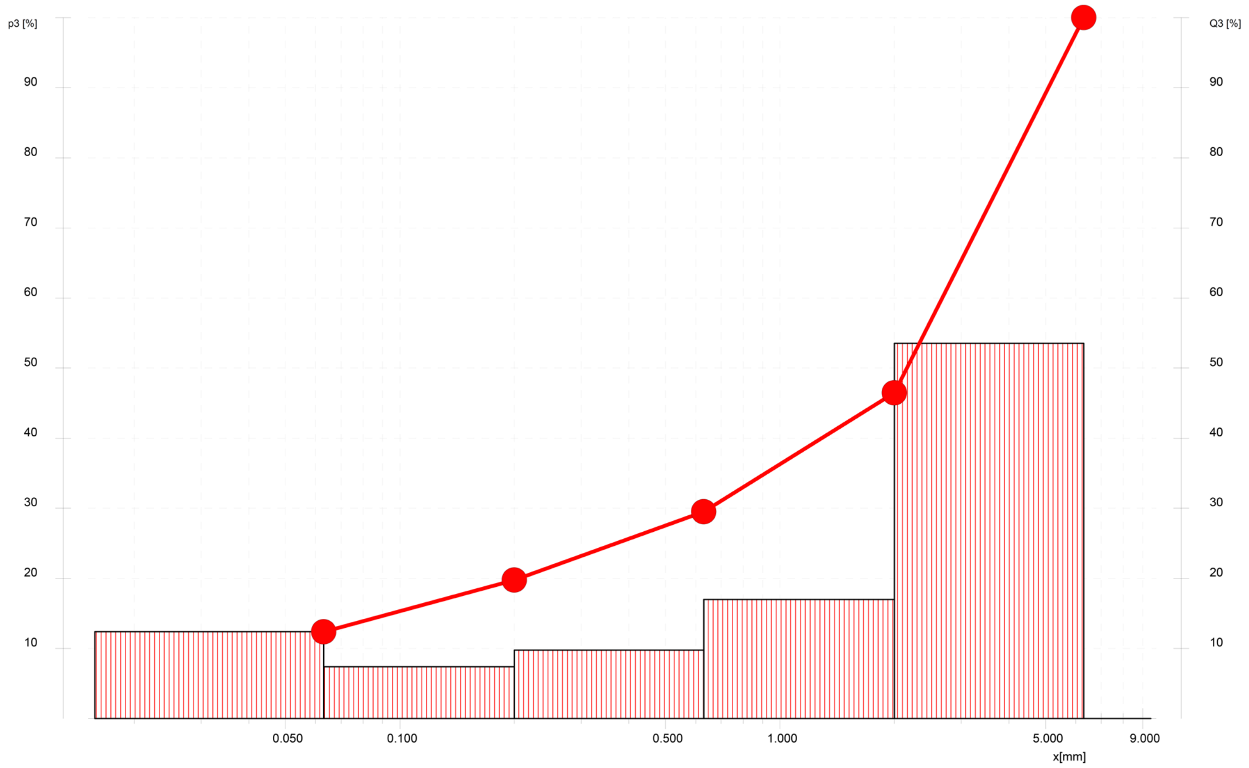
Grain size distribution of granular bentonite BB210 23.10.2014 18:01.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	53.5%	d_{10}	0.056 mm
0.63-2 mm	18.4%	d_{30}	0.776 mm
0.2-0.63 mm	10%	d_{50}	2.284 mm
0.063-0.2 mm	6.7%	d_{60}	3.087 mm
<0.063 mm	11.3%	d_{90}	5.497 mm
amount	508 g	C_U	55.12
		C_C	3.48



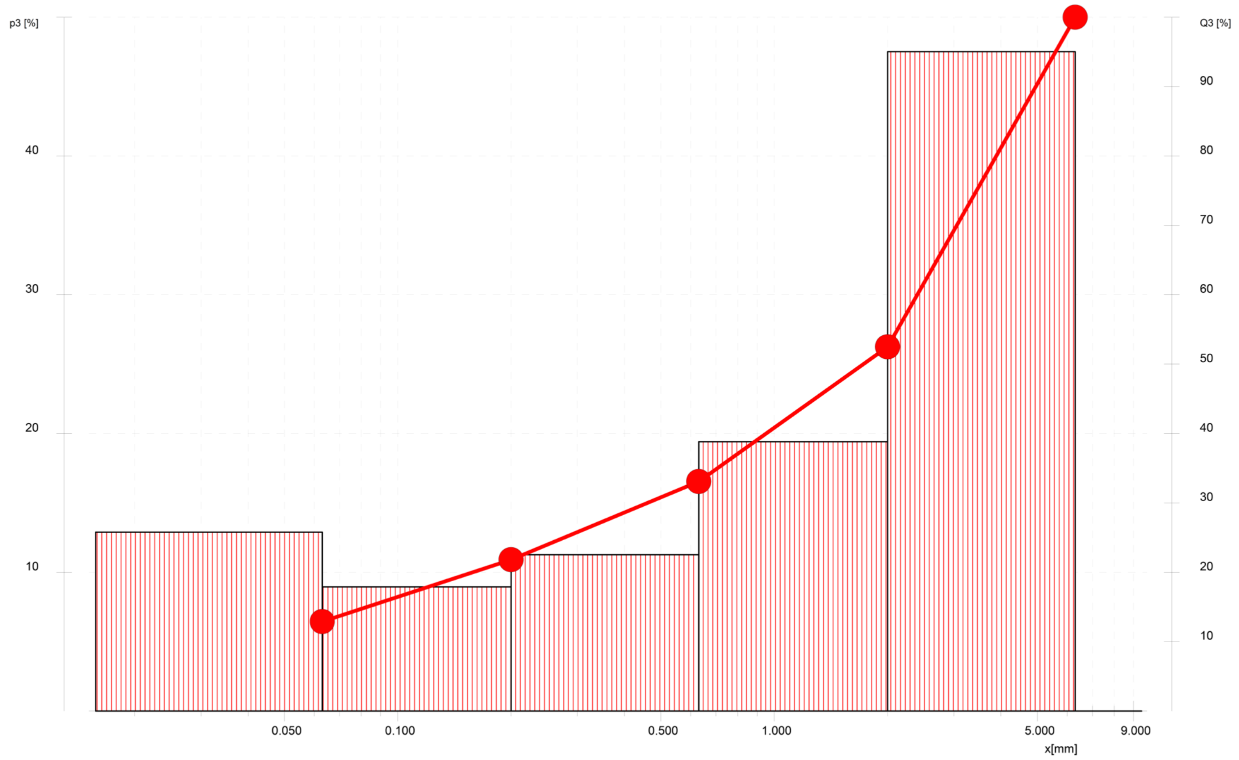
Grain size distribution of granular bentonite BB313 23.10.2014 20:16.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	53.5%	d_{10}	0.051 mm
0.63-2 mm	17.0%	d_{30}	0.669 mm
0.2-0.63 mm	9.8%	d_{50}	2.283 mm
0.063-0.2 mm	7.4%	d_{60}	3.086 mm
<0.063 mm	12.4%	d_{90}	5.497 mm
amount	524 g	C_U	2.84
		C_C	3.48



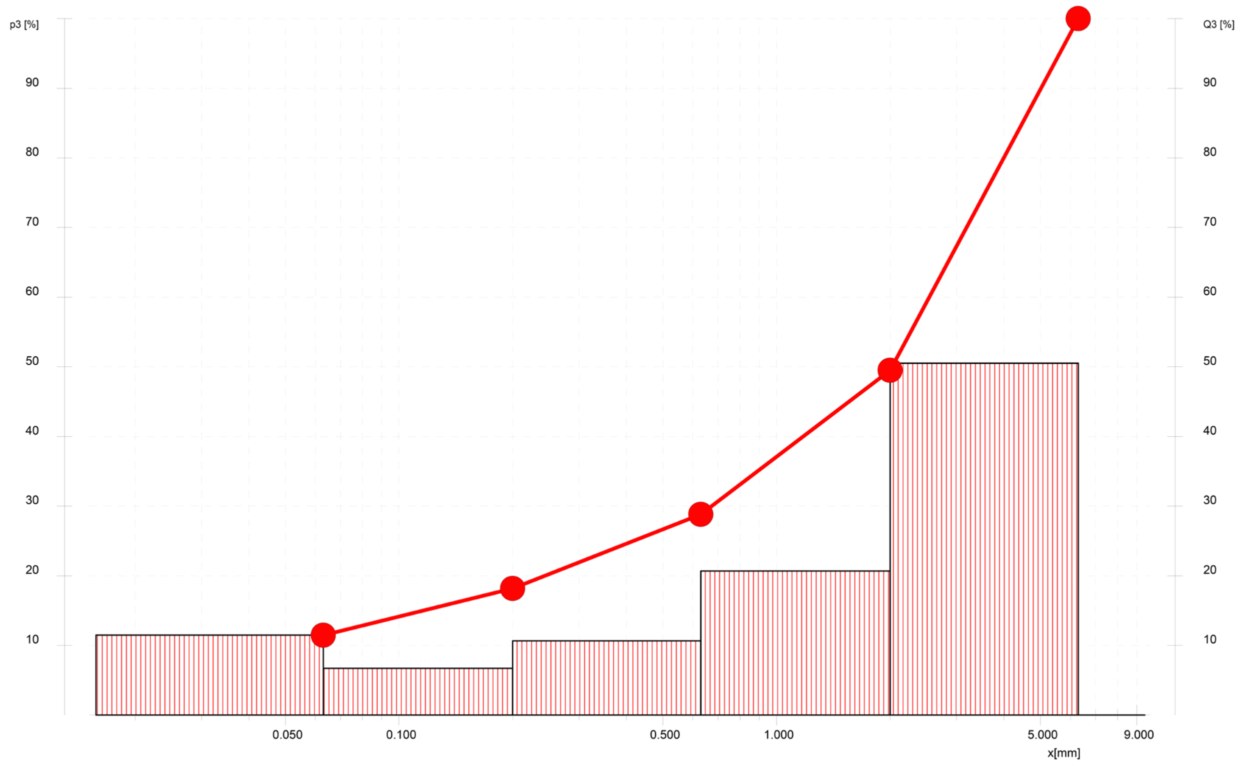
Grain size distribution of granular bentonite BB245 24.10.2014 10:13.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	47.5%	d_{10}	0.049 mm
0.63-2 mm	19.4%	d_{30}	0.512 mm
0.2-0.63 mm	11.3%	d_{50}	1.824 mm
0.063-0.2 mm	8.9%	d_{60}	2.680 mm
<0.063 mm	12.9%	d_{90}	5.395 mm
amount	490 g	C_U	54.69
		C_C	2.00



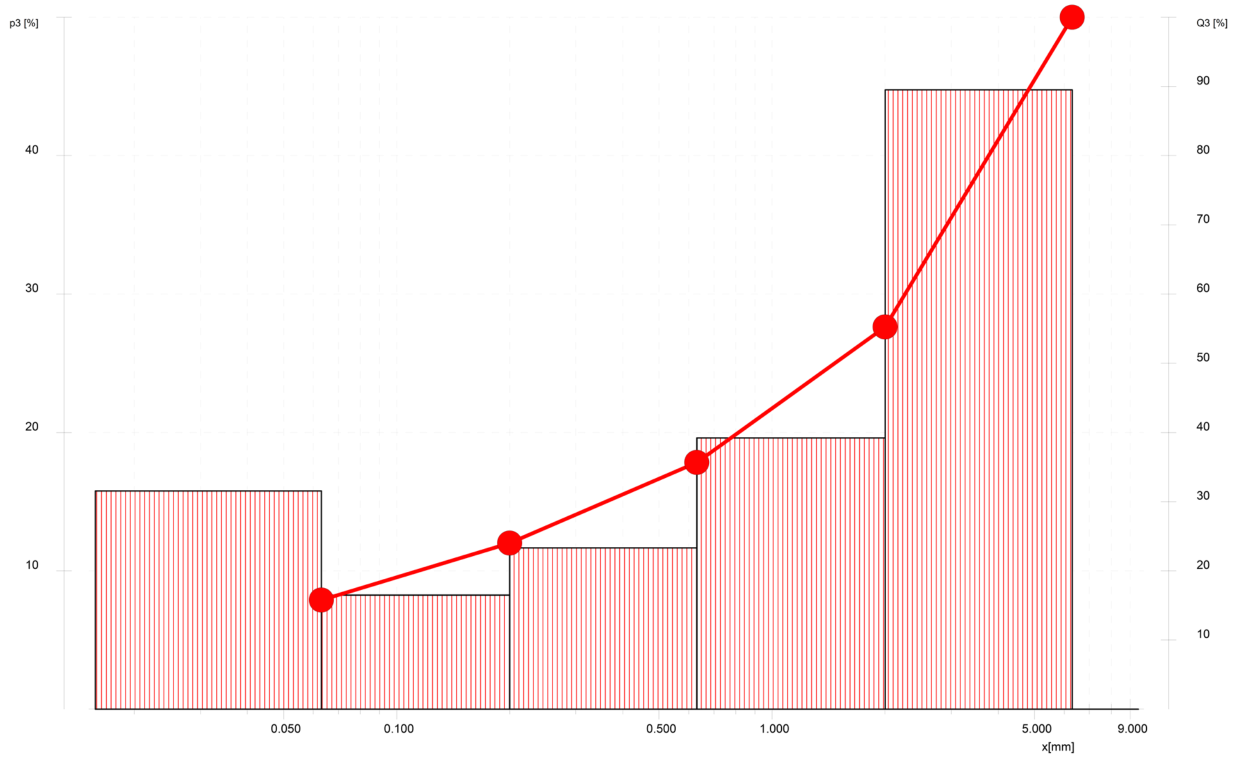
Grain size distribution of granular bentonite BB195 27.10.2014 8:17.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	50.5%	d_{10}	0.055 mm
0.63-2 mm	20.7%	d_{30}	0.708 mm
0.2-0.63 mm	10.6%	d_{50}	2.043 mm
0.063-0.2 mm	6.7%	d_{60}	2.894 mm
<0.063 mm	11.5%	d_{90}	5.449 mm
amount	381 g	C_U	52.62
		C_C	3.15



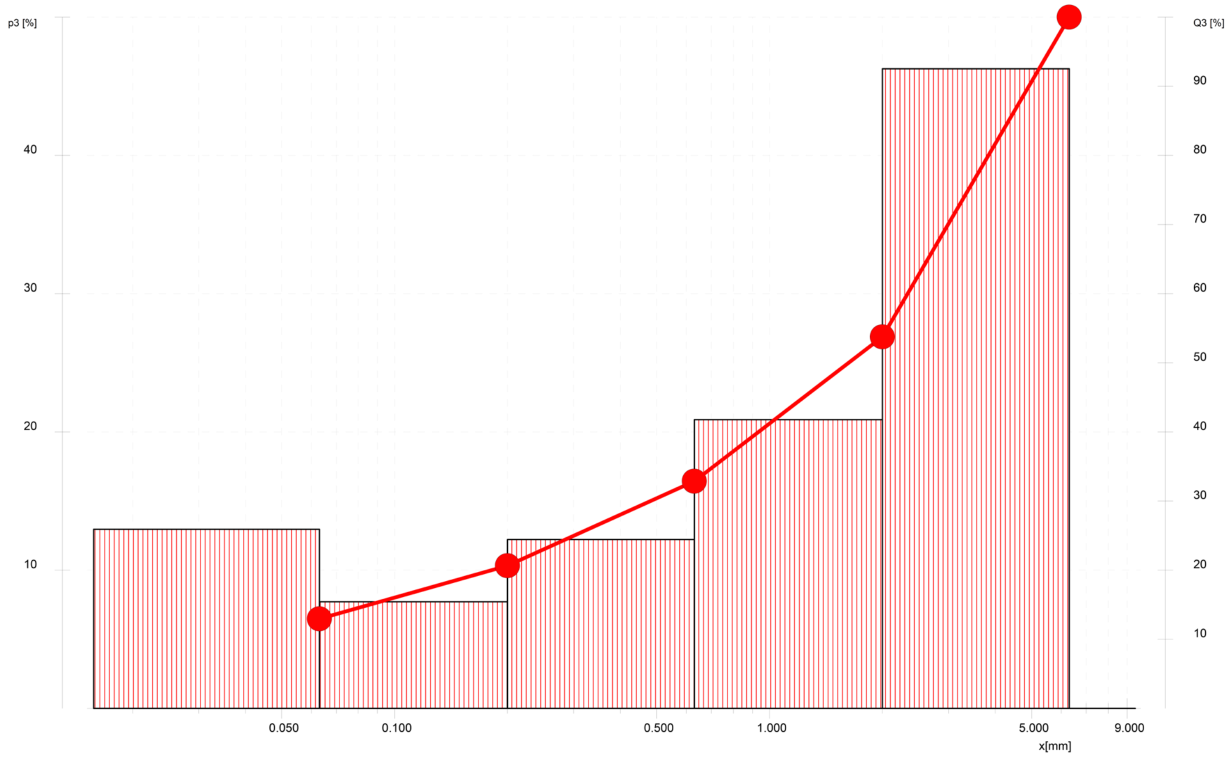
Grain size distribution of granular bentonite BB219 27.10.2014 10:26.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	46.3%	d_{10}	0.040 mm
0.63-2 mm	20.9%	d_{30}	0.421 mm
0.2-0.63 mm	12.2%	d_{50}	1.633 mm
0.063-0.2 mm	7.7%	d_{60}	2.456 mm
<0.063 mm	12.9%	d_{90}	5.339 mm
amount	408 g	C_U	61.40
		C_C	1.80



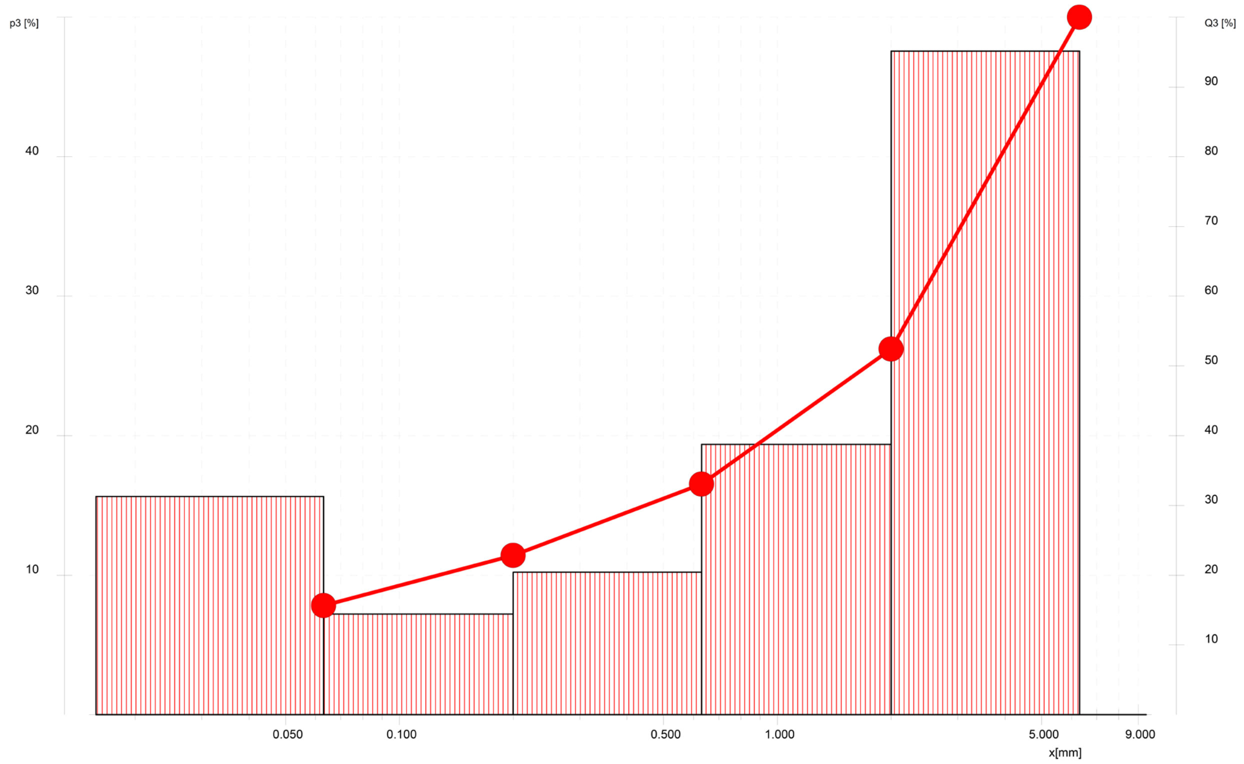
Grain size distribution of granular bentonite BB225 27.10.2014 14:40.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	46.3%	d_{10}	0.049 mm
0.63-2 mm	20.9%	d_{30}	0.529 mm
0.2-0.63 mm	12.2%	d_{50}	1.754 mm
0.063-0.2 mm	7.7%	d_{60}	2.582 mm
<0.063 mm	12.9%	d_{90}	5.370 mm
amount	421 g	C_U	52.69
		C_C	2.12



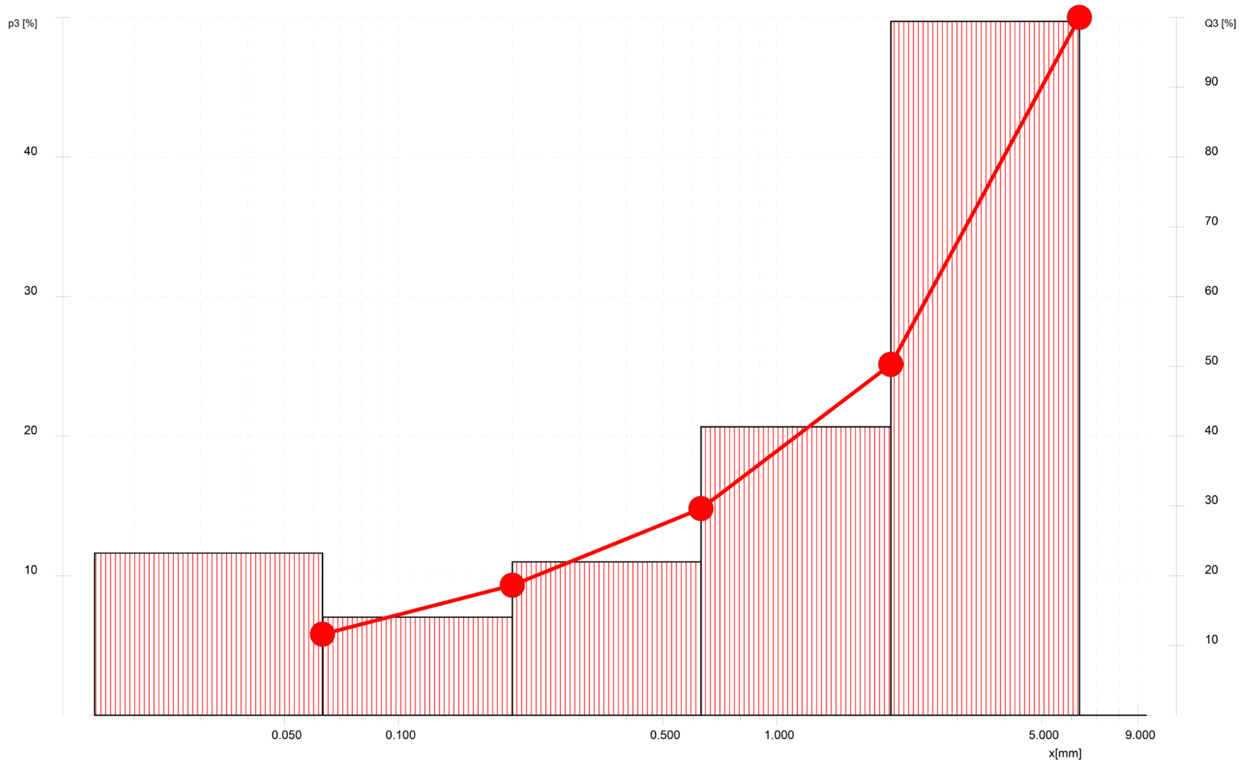
Grain size distribution of granular bentonite BB254 20.11.2014 15:52.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	47.6%	d_{10}	0.040 mm
0.63-2 mm	19.4%	d_{30}	0.501 mm
0.2-0.63 mm	10.2%	d_{50}	1.828 mm
0.063-0.2 mm	7.2%	d_{60}	2.684 mm
<0.063 mm	15.6%	d_{90}	5.396 mm
amount	392 g	C_U	67.10
		C_C	2.34



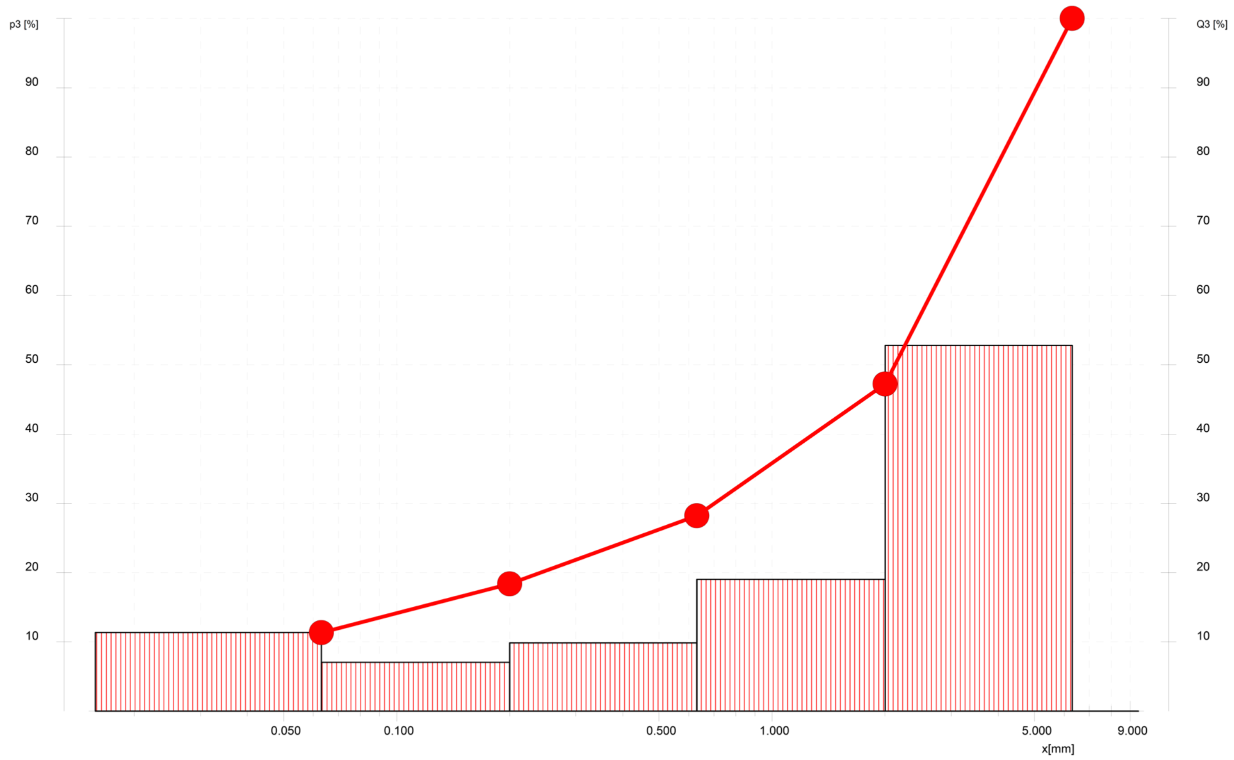
Grain size distribution of granular bentonite BB231 20.11.2014 17:38.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	49.7%	d_{10}	0.054 mm
0.63-2 mm	20.7%	d_{30}	0.655 mm
0.2-0.63 mm	11.0%	d_{50}	1.981 mm
0.063-0.2 mm	7.0%	d_{60}	2.841 mm
<0.063 mm	11.6%	d_{90}	5.435 mm
amount	532 g	C_U	52.61
		C_C	2.80



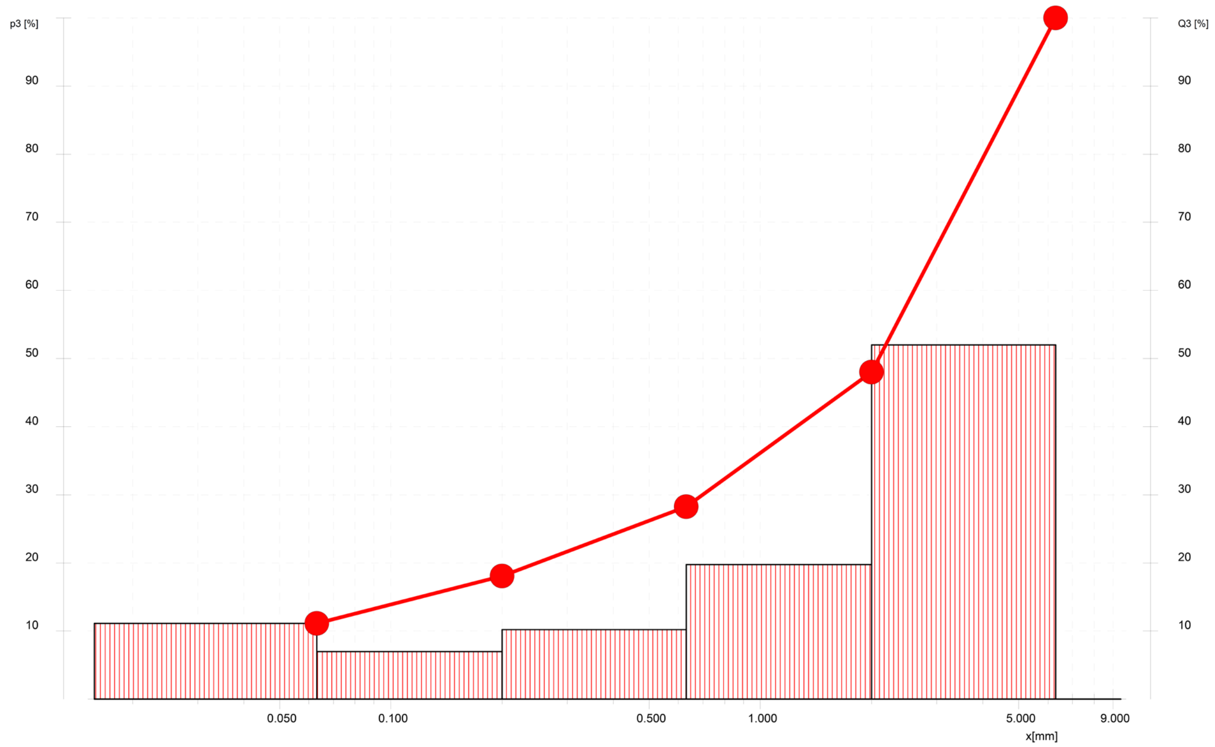
Grain size distribution of granular bentonite BB262 21.11.2014 9:52.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	52.8%	d_{10}	0.056 mm
0.63-2 mm	19.0%	d_{30}	0.759 mm
0.2-0.63 mm	9.8%	d_{50}	2.226 mm
0.063-0.2 mm	7.0%	d_{60}	3.041 mm
<0.063 mm	11.3%	d_{90}	5.485 mm
amount	514 g	C_U	54.30
		C_C	3.38



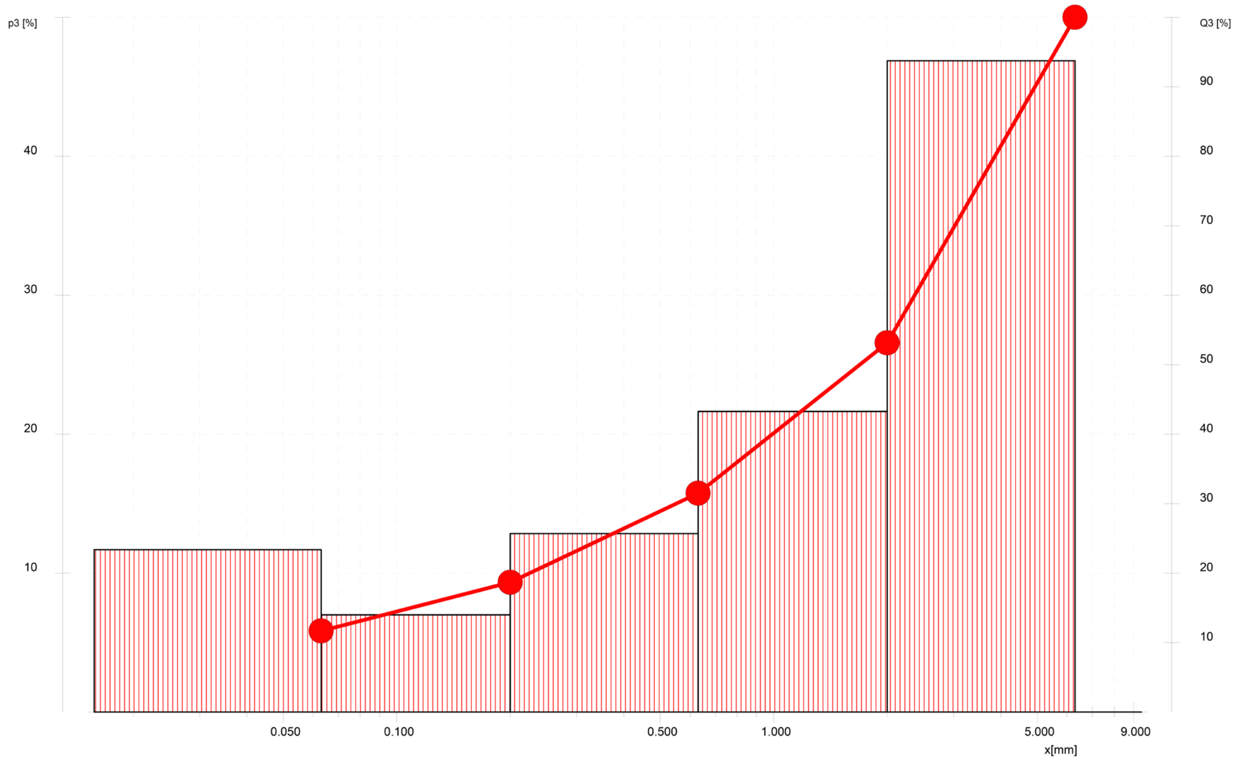
Grain size distribution of granular bentonite BB228 21.11.204 12:07.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	52.0%	d_{10}	0.057 mm
0.63-2 mm	19.8%	d_{30}	0.751 mm
0.2-0.63 mm	10.2%	d_{50}	2.165 mm
0.063-0.2 mm	7.0%	d_{60}	2.992 mm
<0.063 mm	11.1%	d_{90}	5.473 mm
amount	512 g	C_U	52.49
		C_C	3.31



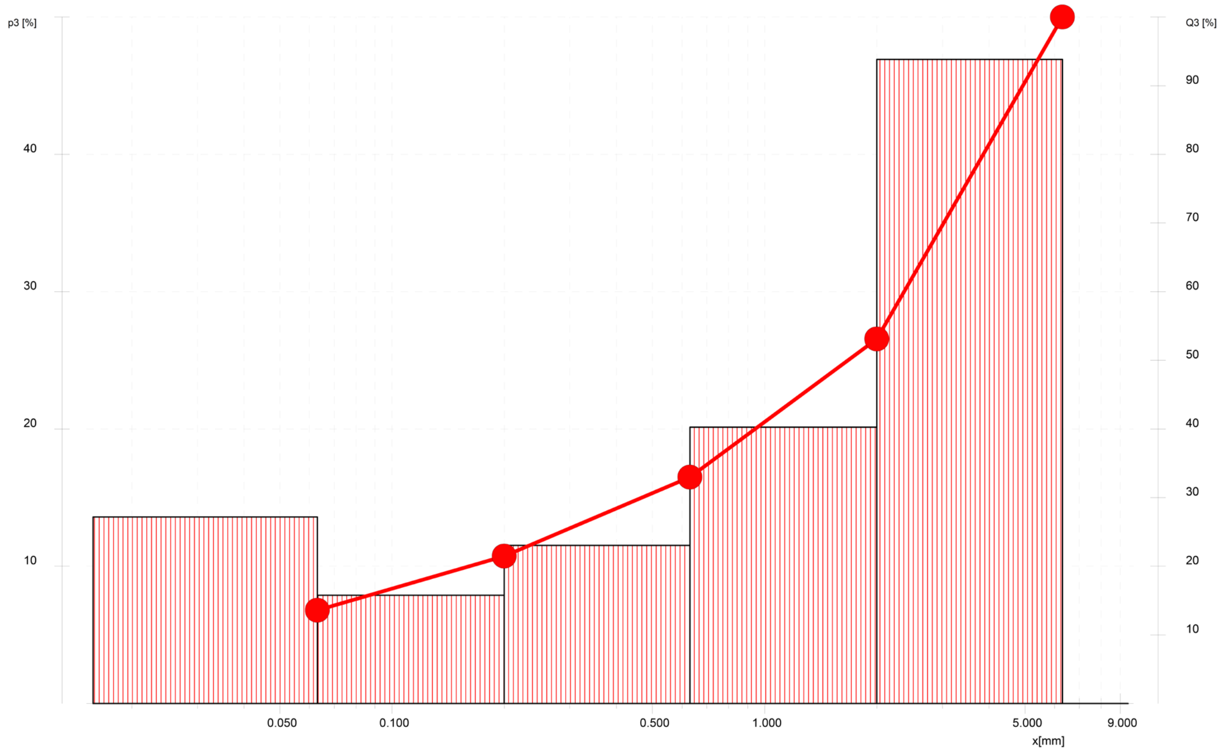
Grain size distribution of granular bentonite BB279 24.11.2014 9:44.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	46.9%	d_{10}	0.054 mm
0.63-2 mm	21.6%	d_{30}	0.579 mm
0.2-0.63 mm	12.8%	d_{50}	1.802 mm
0.063-0.2 mm	7.0%	d_{60}	2.630 mm
<0.063 mm	11.7%	d_{90}	5.383 mm
amount	535 g	C_U	48.70
		C_C	2.36



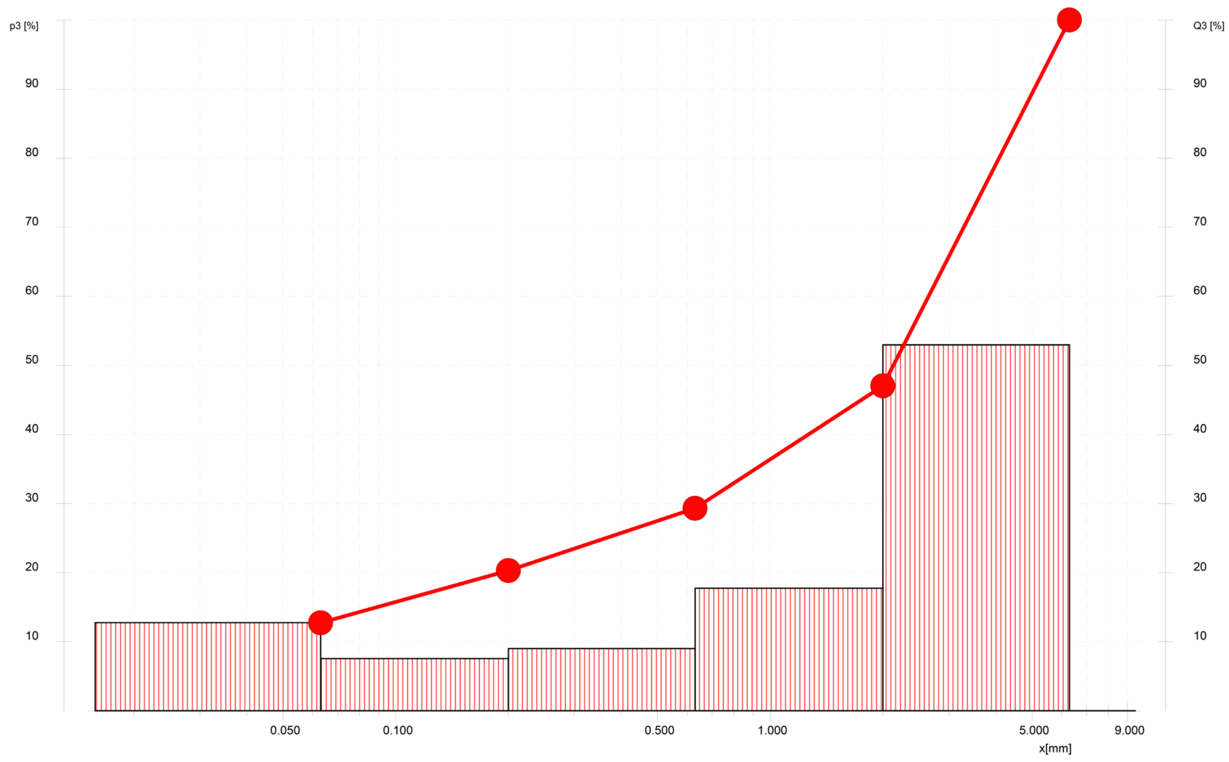
Grain size distribution of granular bentonite BB307 21.01.2015 09:32.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	46.9%	d_{10}	0.046 mm
0.63-2 mm	20.1%	d_{30}	0.519 mm
0.2-0.63 mm	11.5%	d_{50}	1.789 mm
0.063-0.2 mm	7.9%	d_{60}	2.633 mm
<0.063 mm	13.6%	d_{90}	5.383 mm
amount	420 g	C_U	57.24
		C_C	2.22



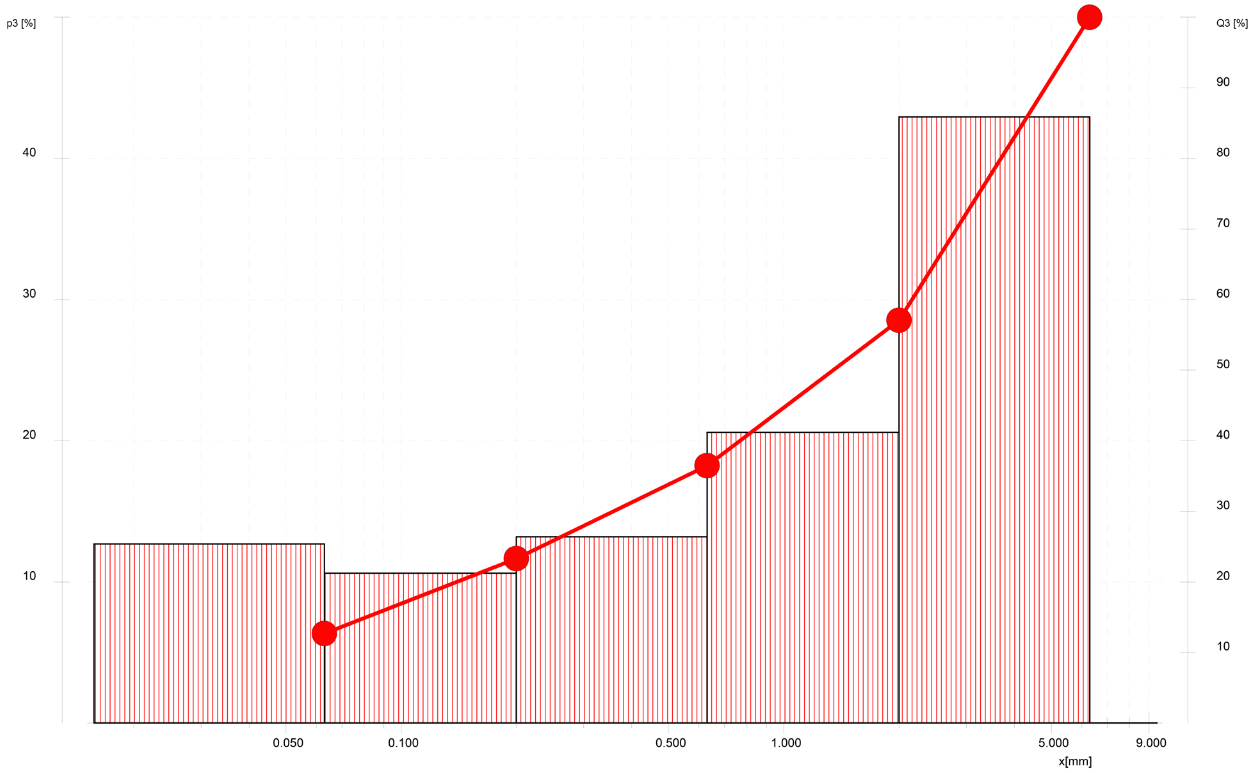
Grain size distribution of granular bentonite BB295 21.01.2015 11:16.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	53.0%	d_{10}	0.049 mm
0.63-2 mm	17.7%	d_{30}	0.684 mm
0.2-0.63 mm	9.0%	d_{50}	2.240 mm
0.063-0.2 mm	7.6%	d_{60}	3.052 mm
<0.063 mm	12.7%	d_{90}	5.488 mm
amount	459 g	C_U	62.29
		C_C	3.13



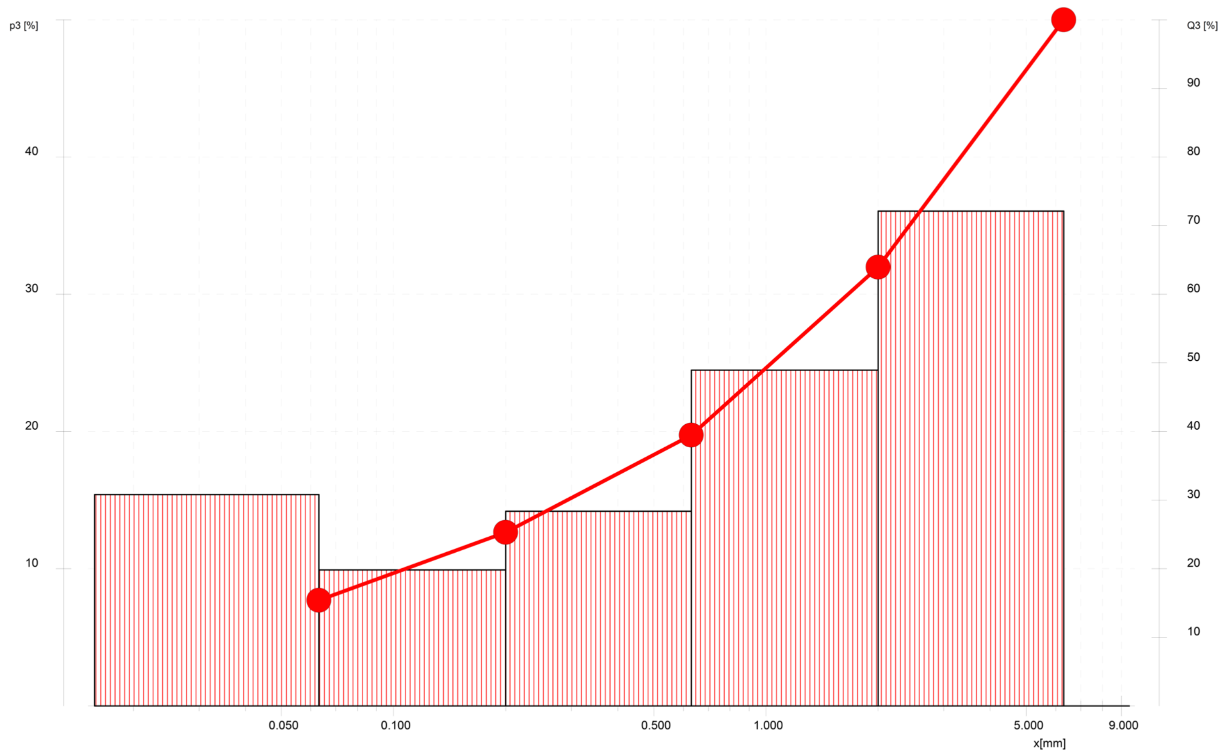
Grain size distribution of granular bentonite BB302 22.01.2015 10:16.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	42.9%	d_{10}	0.050 mm
0.63-2 mm	20.6%	d_{30}	0.419 mm
0.2-0.63 mm	13.2%	d_{50}	1.531 mm
0.063-0.2 mm	10.6%	d_{60}	2.295 mm
<0.063 mm	12.7%	d_{90}	5.299 mm
amount	558 g	C_U	45.90
		C_C	1.53



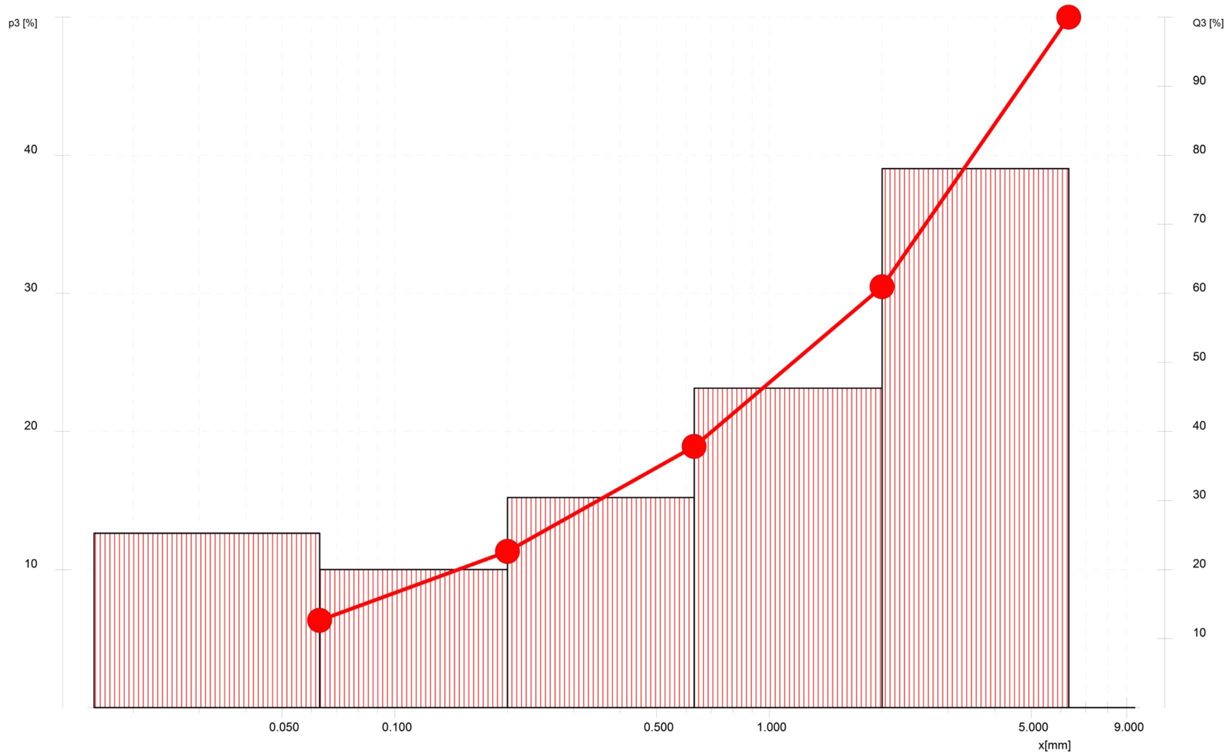
Grain size distribution of granular bentonite BB GR2-30 22.01.20125 13:30.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	36.1%	d_{10}	0.041 mm
0.63-2 mm	24.5%	d_{30}	0.343 mm
0.2-0.63 mm	14.2%	d_{50}	1.219 mm
0.063-0.2 mm	9.9%	d_{60}	1.779 mm
<0.063 mm	15.4%	d_{90}	5.107 mm
amount	393 g	C_U	43.39
		C_C	1.61



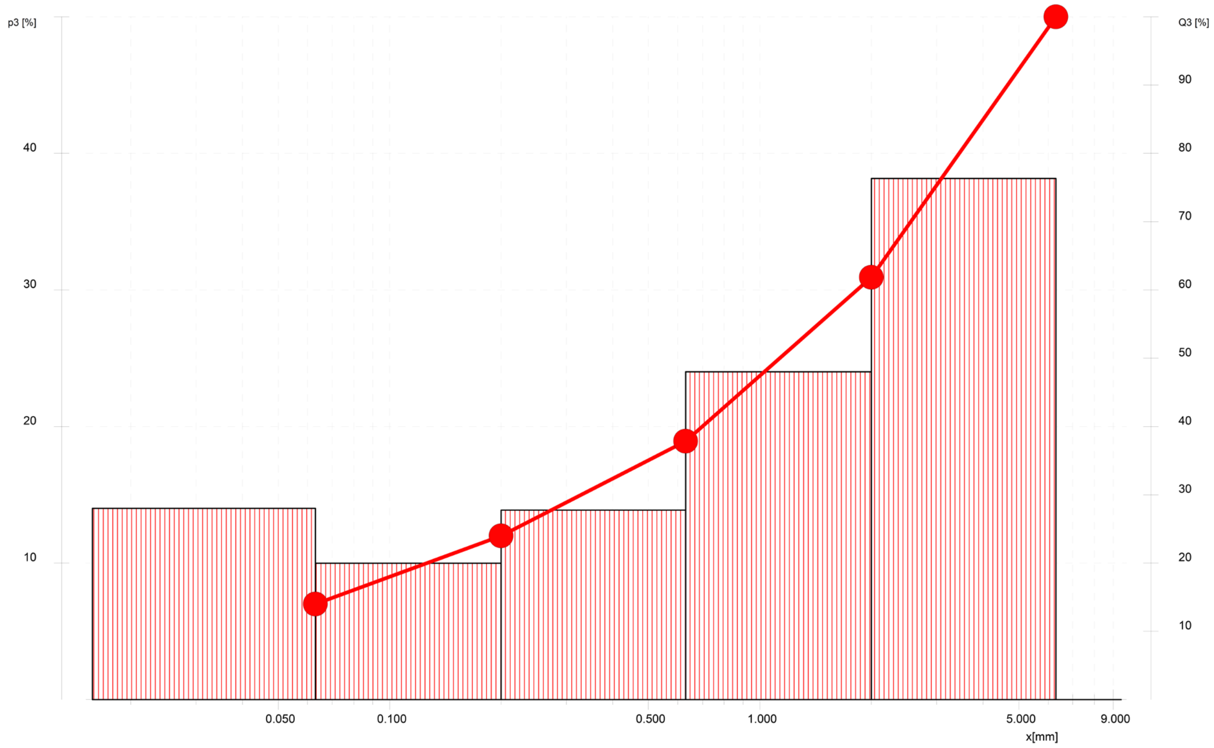
Grain size distribution of granular bentonite BB GR2-18 22.01.2015 16:44.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	39.0%	d_{10}	0.050 mm
0.63-2 mm	23.1%	d_{30}	0.409 mm
0.2-0.63 mm	15.2%	d_{50}	1.350 mm
0.063-0.2 mm	10.0%	d_{60}	1.943 mm
<0.063 mm	12.6%	d_{90}	5.198 mm
amount	420 g	C_U	38.86
		C_C	1.72



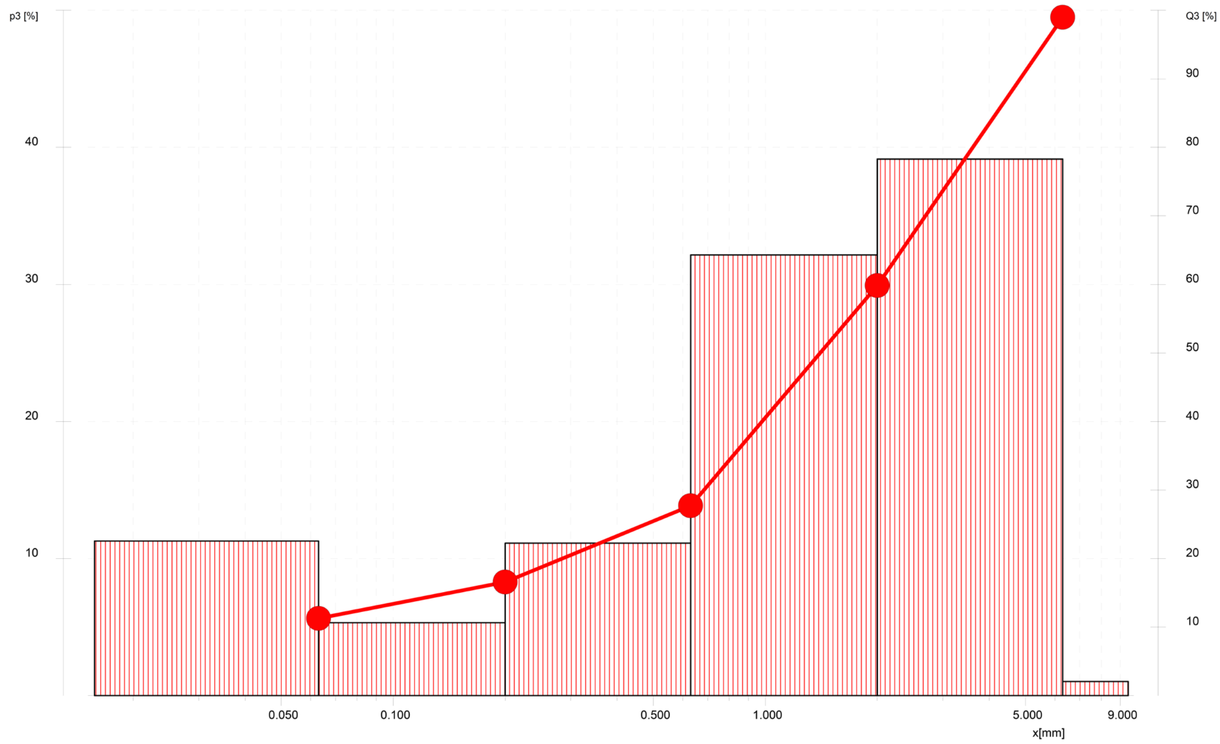
Grain size distribution of granular bentonite BB GR2-X2 23.01.2015 09:35.

Parameter		Parameter	
>6.3 mm	0%		
2-6.3 mm	38.2%	d_{10}	0.045 mm
0.63-2 mm	24.0%	d_{30}	0.387 mm
0.2-0.63 mm	13.9%	d_{50}	1.324 mm
0.063-0.2 mm	10.0%	d_{60}	1.895 mm
<0.063 mm	14.0%	d_{90}	5.173 mm
amount	504 g	C_U	42.11
		C_C	1.76



Grain size distribution of granular bentonite BB P-31 12.02.2015 8:55.

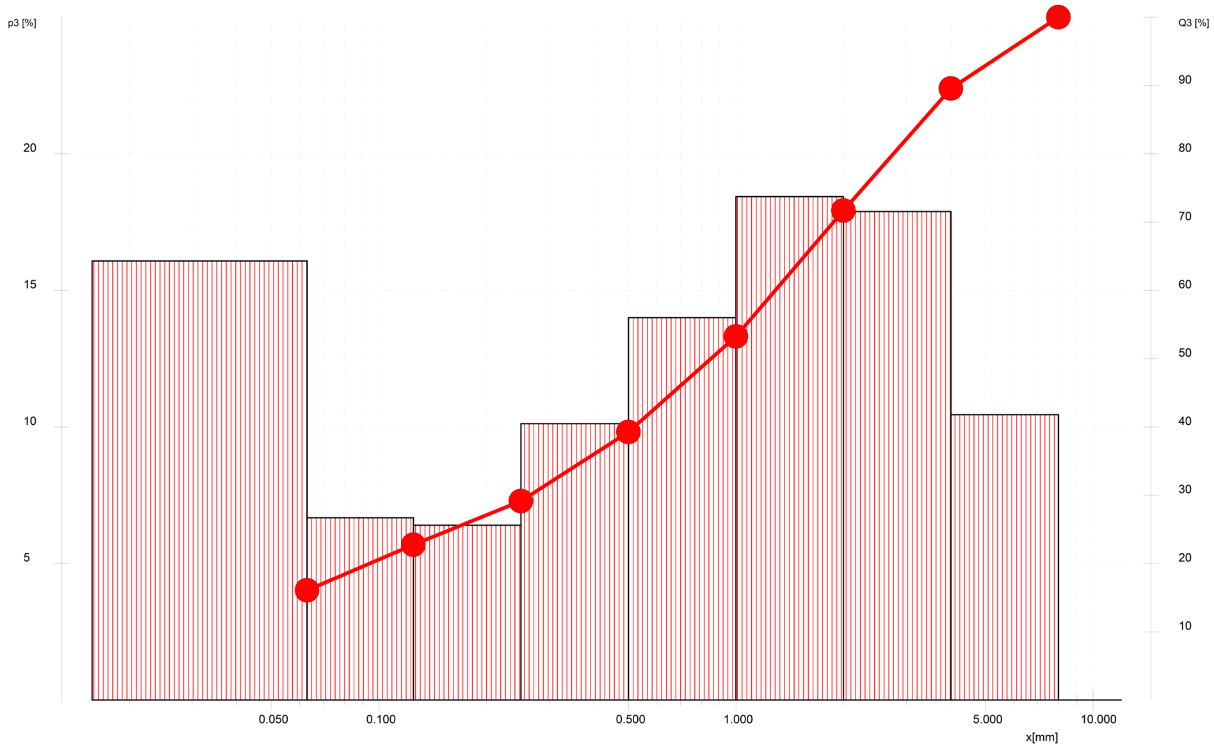
Parameter		Parameter	
>6.3 mm	1.0%		
2-6.3 mm	39.1%	d_{10}	0.056 mm
0.63-2 mm	32.1%	d_{30}	0.728 mm
0.2-0.63 mm	11.1%	d_{50}	1.581 mm
0.063-0.2 mm	5.3%	d_{60}	2.018 mm
<0.063 mm	11.3%	d_{90}	5.313 mm
amount	742 g	C_U	36.04
		C_C	4.69



Appendix 3: Sieve curves and parameter of screw conveyor samples

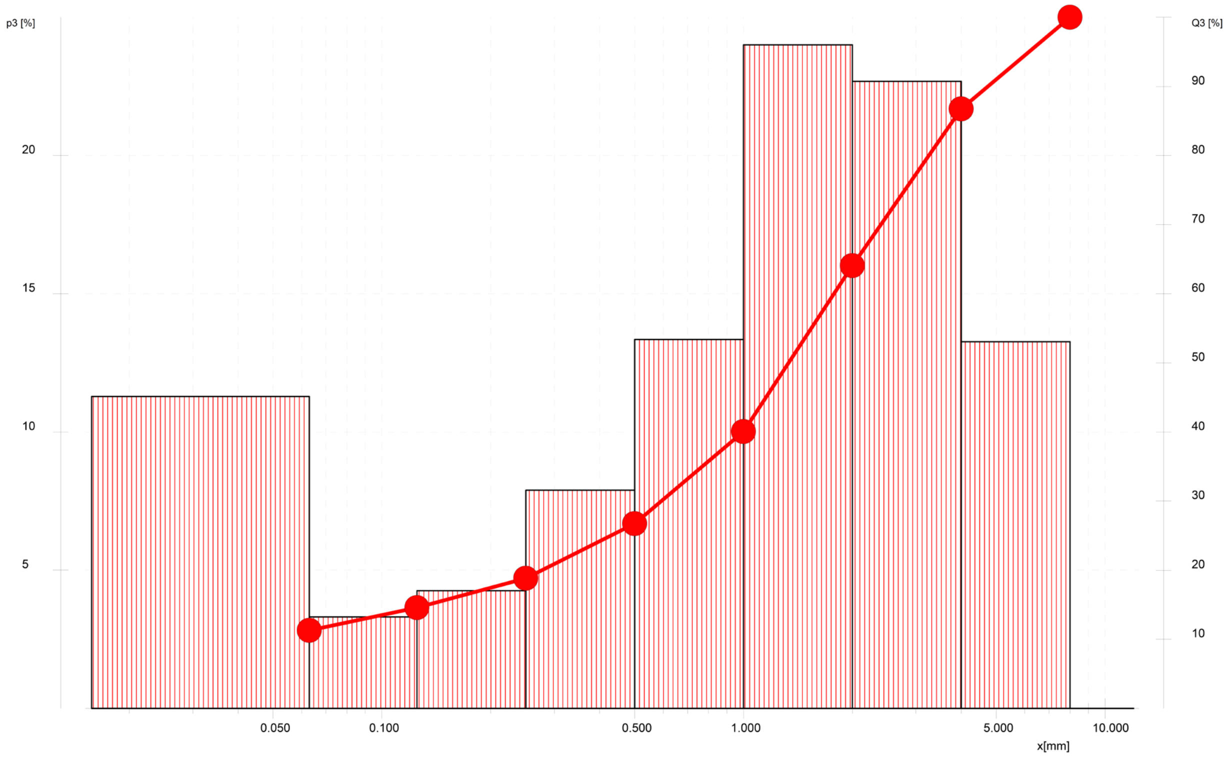
Grain size distribution of granular bentonite Conveyor Screw S1 24.09.2014.

Parameter		Parameter	
>8 mm	1.0%		
4-8 mm	10.4%	d_{10}	0.039 mm
2-4 mm	17.9%	d_{30}	0.271 mm
1-2 mm	18.4%	d_{50}	0.884 mm
0.5-1 mm	14.0%	d_{60}	1.366 mm
0.25-0.5 mm	10.1%	d_{90}	4.170 mm
0.125-0.25 mm	6.4%		
0.063-0.125 mm	6.7%		
<0.063 mm	16.1%		
		C_U	35.03
amount	1847 g	C_C	1.38



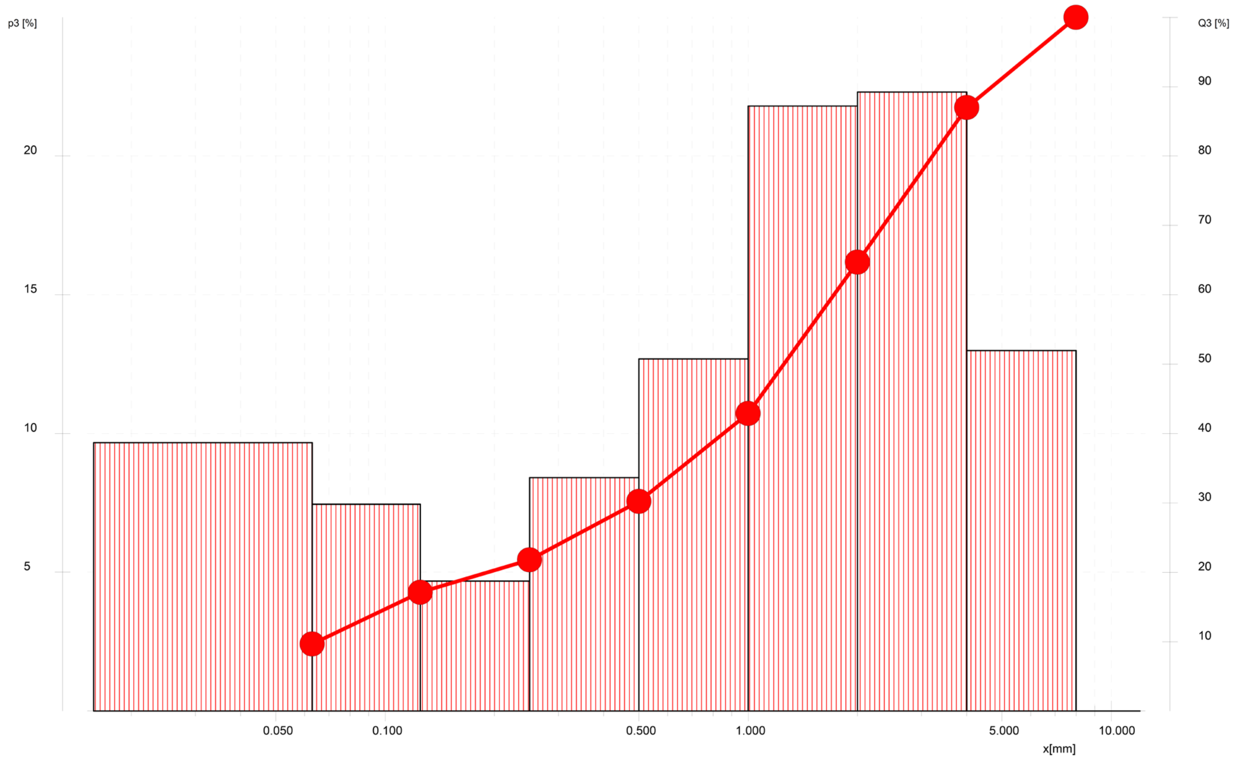
Grain size distribution of granular bentonite Conveyor Screw S2 24.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	13.3%	d_{10}	0.056 mm
2-4 mm	22.7%	d_{30}	0.623 mm
1-2 mm	24.0%	d_{50}	1.414 mm
0.5-1 mm	13.3%	d_{60}	1.831 mm
0.25-0.5 mm	7.9%	d_{90}	4.983 mm
0.125-0.25 mm	4.3%		
0.063-0.125 mm	3.3%		
<0.063 mm	11.3%		
		C_U	32.70
amount	2465 g	C_C	3.78



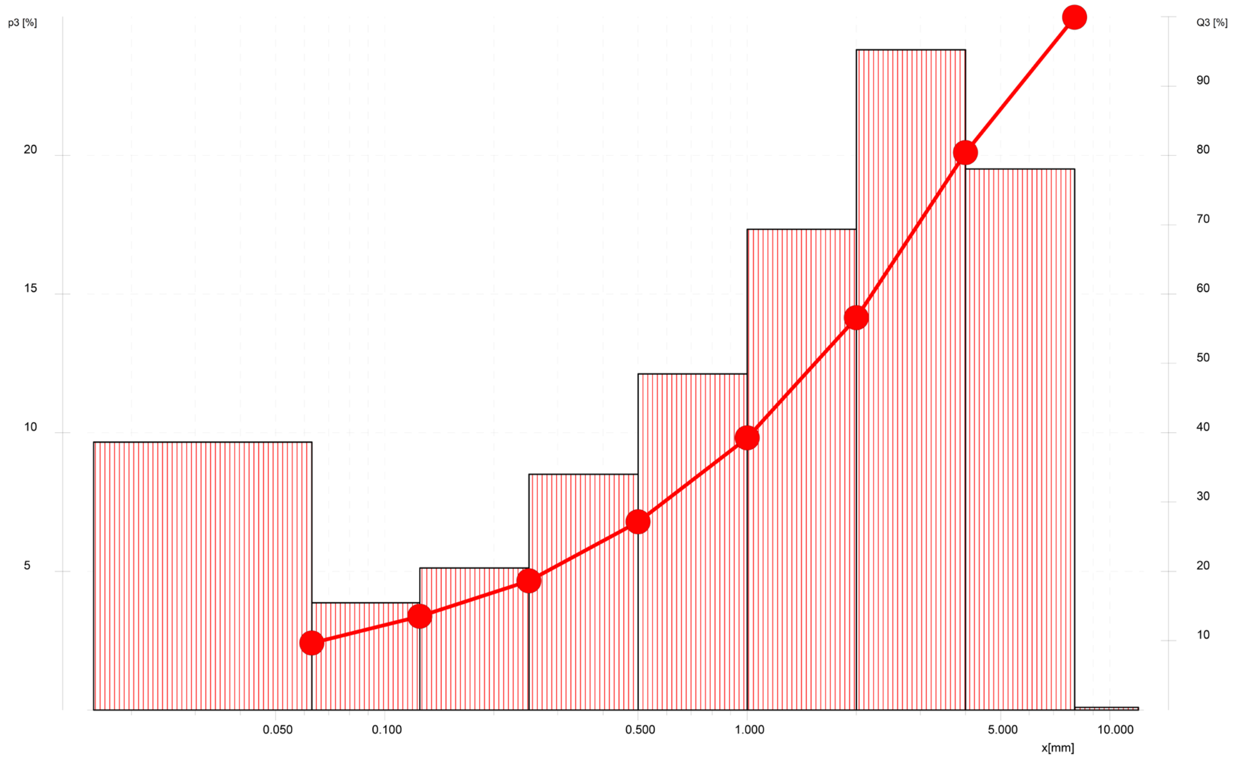
Grain size distribution of granular bentonite Conveyor Screw S3 24.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	13.0%	d_{10}	0.066 mm
2-4 mm	22.3%	d_{30}	0.494 mm
1-2 mm	21.8%	d_{50}	1.326 mm
0.5-1 mm	12.7%	d_{60}	1.784 mm
0.25-0.5 mm	8.4%	d_{90}	4.921 mm
0.125-0.25 mm	4.7%		
0.063-0.125 mm	7.5%		
<0.063 mm	9.7%		
		C_U	27.03
amount	1998 g	C_C	2.07



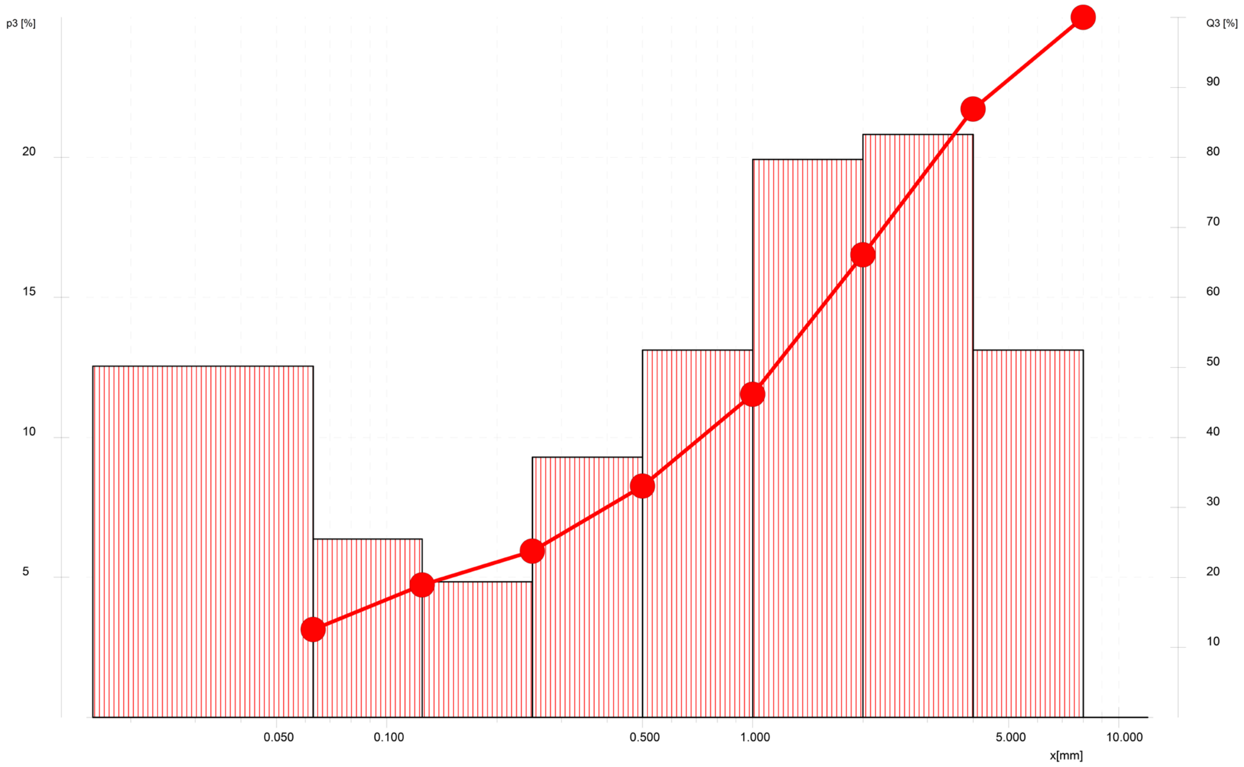
Grain size distribution of granular bentonite Conveyor Screw S4 24.09.2014.

Parameter		Parameter	
>8 mm	0.1%		
4-8 mm	19.5%	d_{10}	0.069 mm
2-4 mm	23.8%	d_{30}	0.618 mm
1-2 mm	17.3%	d_{50}	1.62 mm
0.5-1 mm	12.1%	d_{60}	2.286 mm
0.25-0.5 mm	8.5%	d_{90}	5.969 mm
0.125-0.25 mm	5.1%		
0.063-0.125 mm	3.9%		
<0.063 mm	9.7%		
		C_U	33.13
amount	2090 g	C_C	2.42



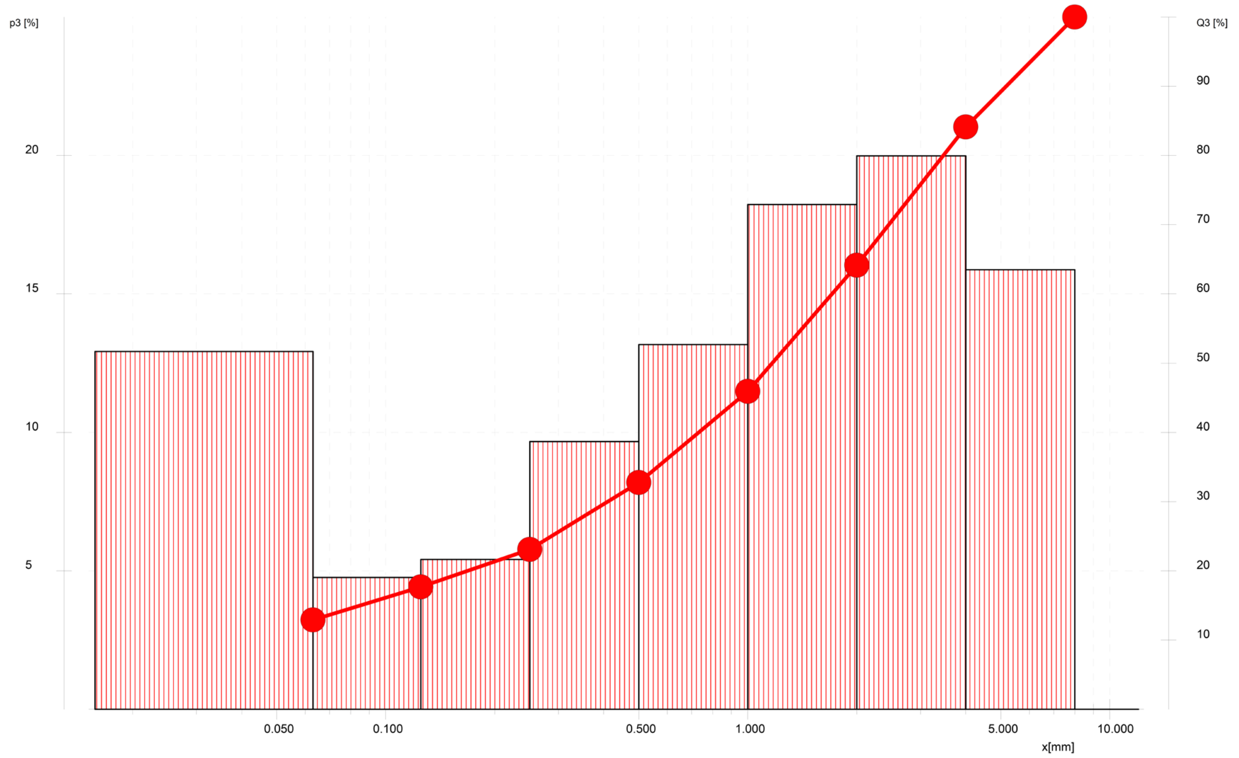
Grain size distribution of granular bentonite Conveyor Screw S5 24.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	13.1%	d_{10}	0.050 mm
2-4 mm	20.8%	d_{30}	0.418 mm
1-2 mm	19.9%	d_{50}	1.193 mm
0.5-1 mm	13.1%	d_{60}	1.695 mm
0.25-0.5 mm	9.3%	d_{90}	4.950 mm
0.125-0.25 mm	4.8%		
0.063-0.125 mm	6.4%		
<0.063 mm	12.5%		
		C_U	33.90
amount	1571 g	C_C	2.06



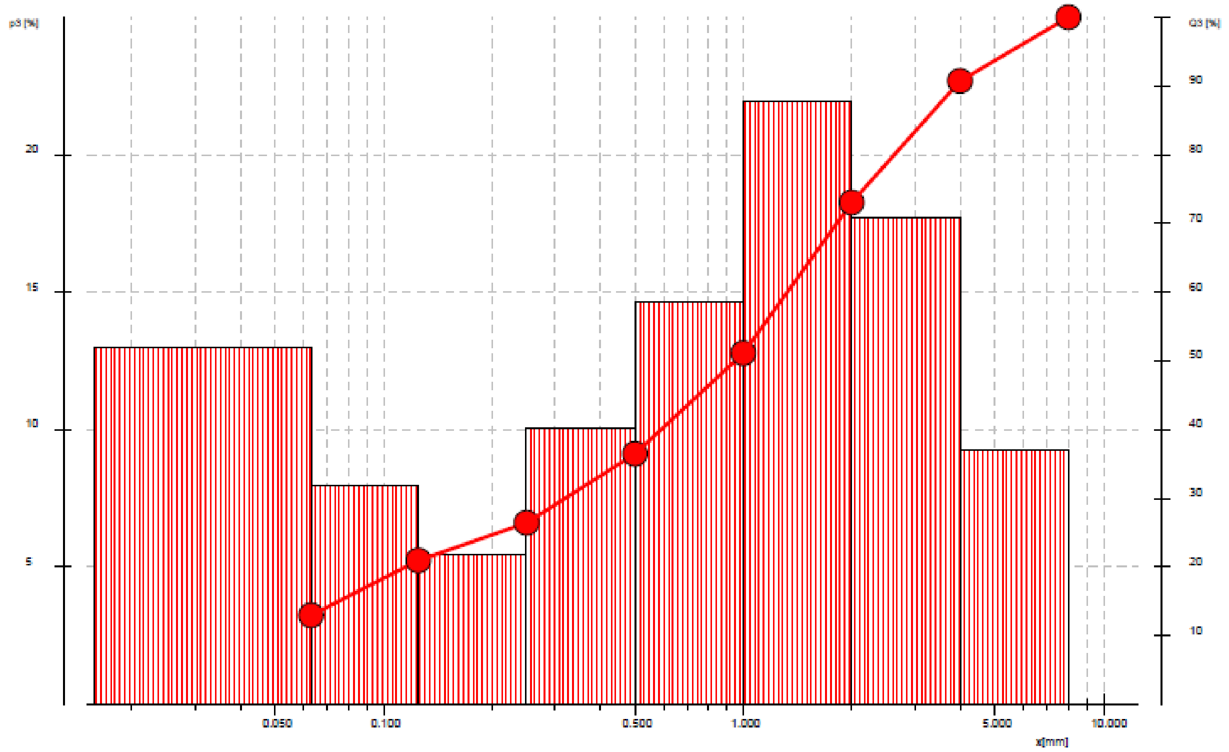
Grain size distribution of granular bentonite Conveyor Screw SCH1 25.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	15.9%	d_{10}	0.049 mm
2-4 mm	20.0%	d_{30}	0.429 mm
1-2 mm	18.2%	d_{50}	1.224 mm
0.5-1 mm	13.2%	d_{60}	1.773 mm
0.25-0.5 mm	9.7%	d_{90}	5.480 mm
0.125-0.25 mm	5.4%		
0.063-0.125 mm	4.8%		
<0.063 mm	12.9%		
		C_U	36.18
amount	2020 g	C_C	2.12



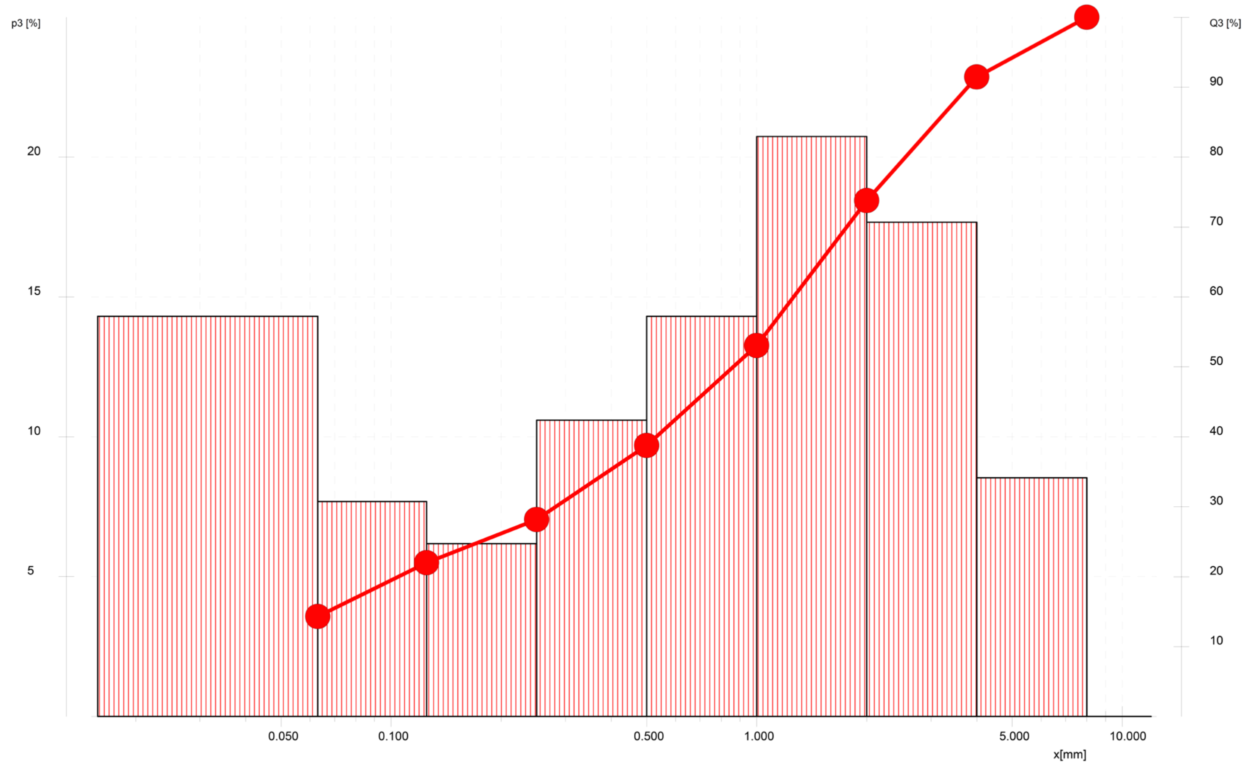
Grain size distribution of granular bentonite Conveyor Screw SCH2 25.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.3%	d_{10}	0.048 mm
2-4 mm	17.7%	d_{30}	0.338 mm
1-2 mm	21.9%	d_{50}	0.961 mm
0.5-1 mm	14.7%	d_{60}	1.404 mm
0.25-0.5 mm	10.0%	d_{90}	3.917 mm
0.125-0.25 mm	5.5%		
0.063-0.125 mm	8.0%		
<0.063 mm	13.0%		
		C_U	29.25
amount	2268 g	C_C	1.70



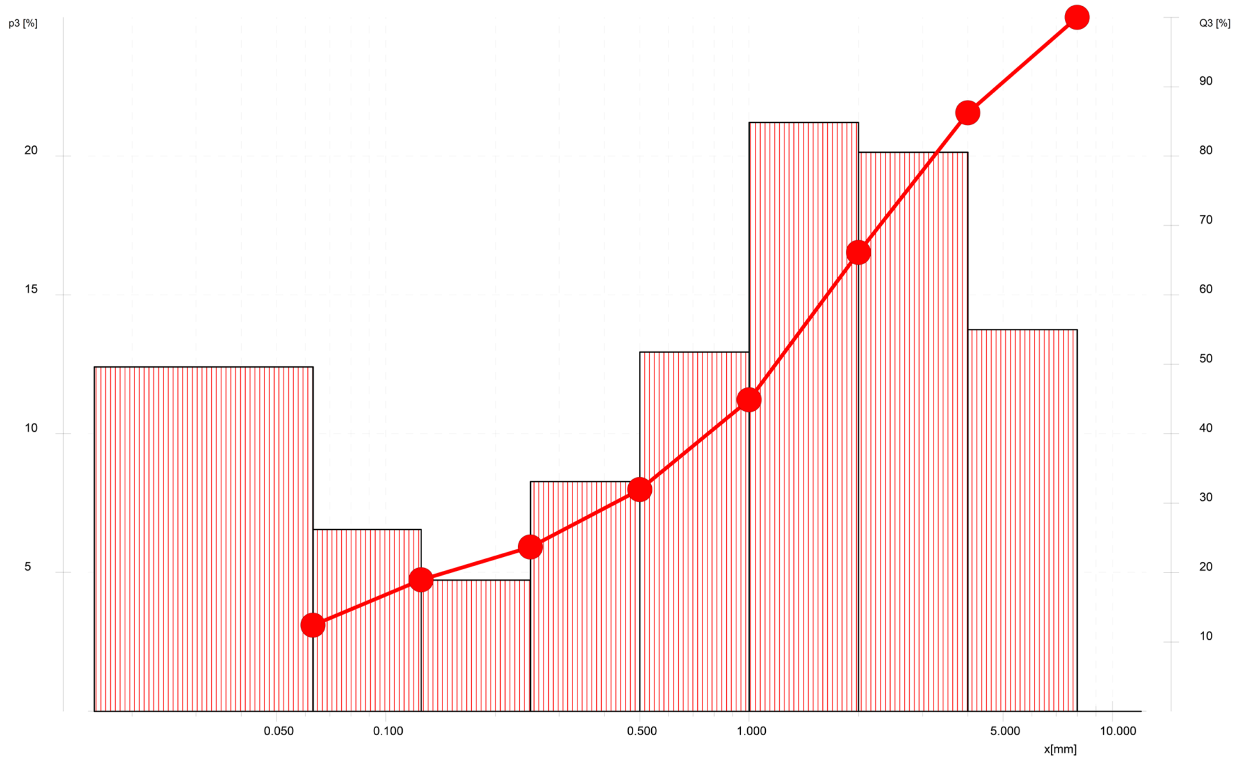
Grain size distribution of granular bentonite Conveyor Screw SCH3 25.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.5%	d_{10}	0.044 mm
2-4 mm	17.7%	d_{30}	0.293 mm
1-2 mm	20.7%	d_{50}	0.893 mm
0.5-1 mm	14.3%	d_{60}	1.335 mm
0.25-0.5 mm	10.6%	d_{90}	3.834 mm
0.125-0.25 mm	6.2%		
0.063-0.125 mm	7.7%		
<0.063 mm	14.3%		
		C_U	30.34
amount	2009 g	C_C	1.46



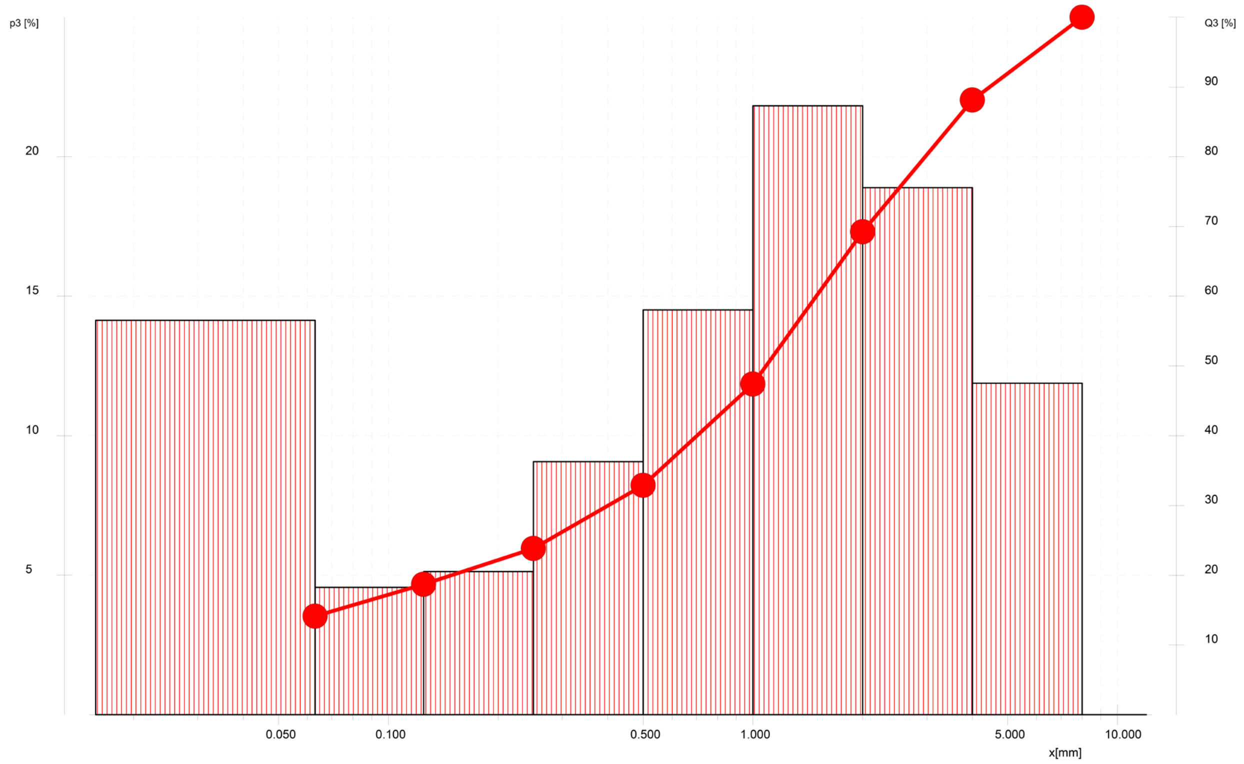
Grain size distribution of granular bentonite Conveyor Screw SCH4 25.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	13.7%	d_{10}	0.051 mm
2-4 mm	20.1%	d_{30}	0.441 mm
1-2 mm	21.2%	d_{50}	1.241 mm
0.5-1 mm	12.9%	d_{60}	1.712 mm
0.25-0.5 mm	8.3%	d_{90}	5.091 mm
0.125-0.25 mm	4.7%		
0.063-0.125 mm	6.6%		
<0.063 mm	12.4%		
		C_U	33.57
amount	1871 g	C_C	2.23



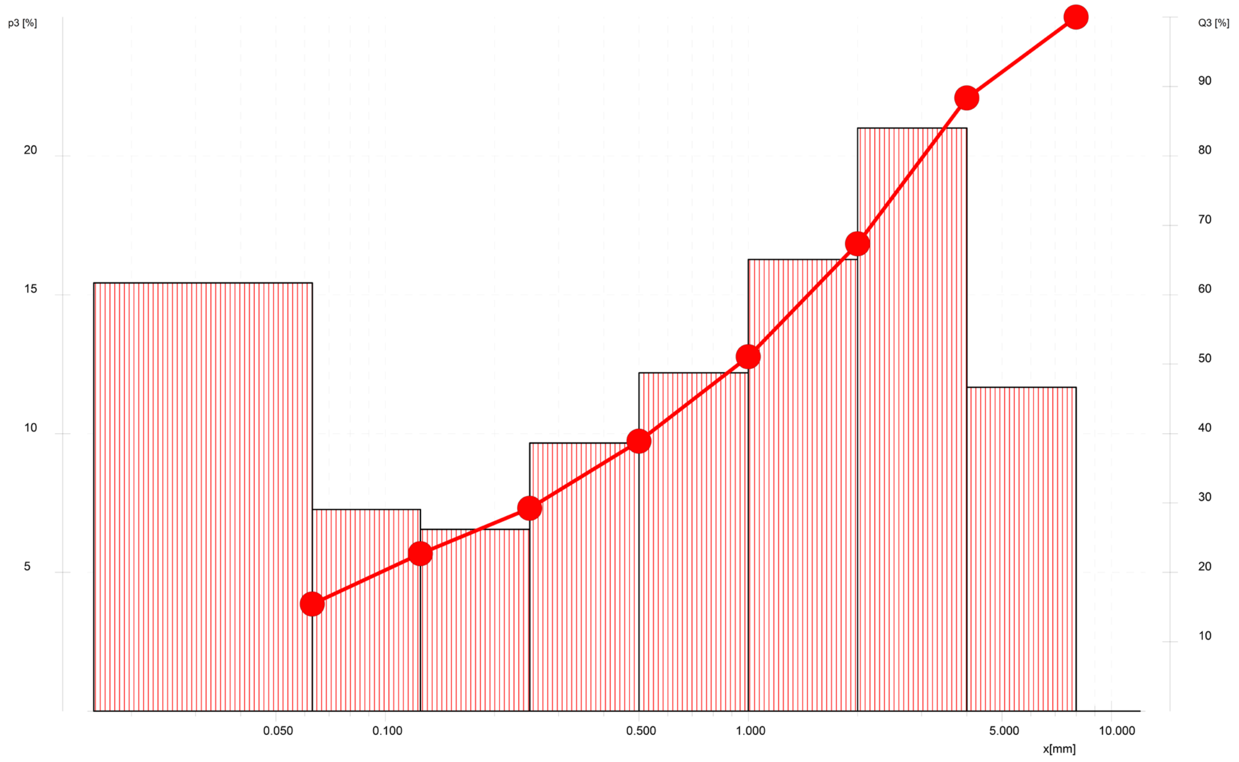
Grain size distribution of granular bentonite Conveyor Screw SCH5 25.09.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	11.9%	d_{10}	0.045 mm
2-4 mm	18.9%	d_{30}	0.420 mm
1-2 mm	21.8%	d_{50}	1.119 mm
0.5-1 mm	14.5%	d_{60}	1.577 mm
0.25-0.5 mm	9.1%	d_{90}	4.634 mm
0.125-0.25 mm	5.1%		
0.063-0.125 mm	4.6%		
<0.063 mm	14.1%		
		C_U	35.04
amount	1625 g	C_C	2.49



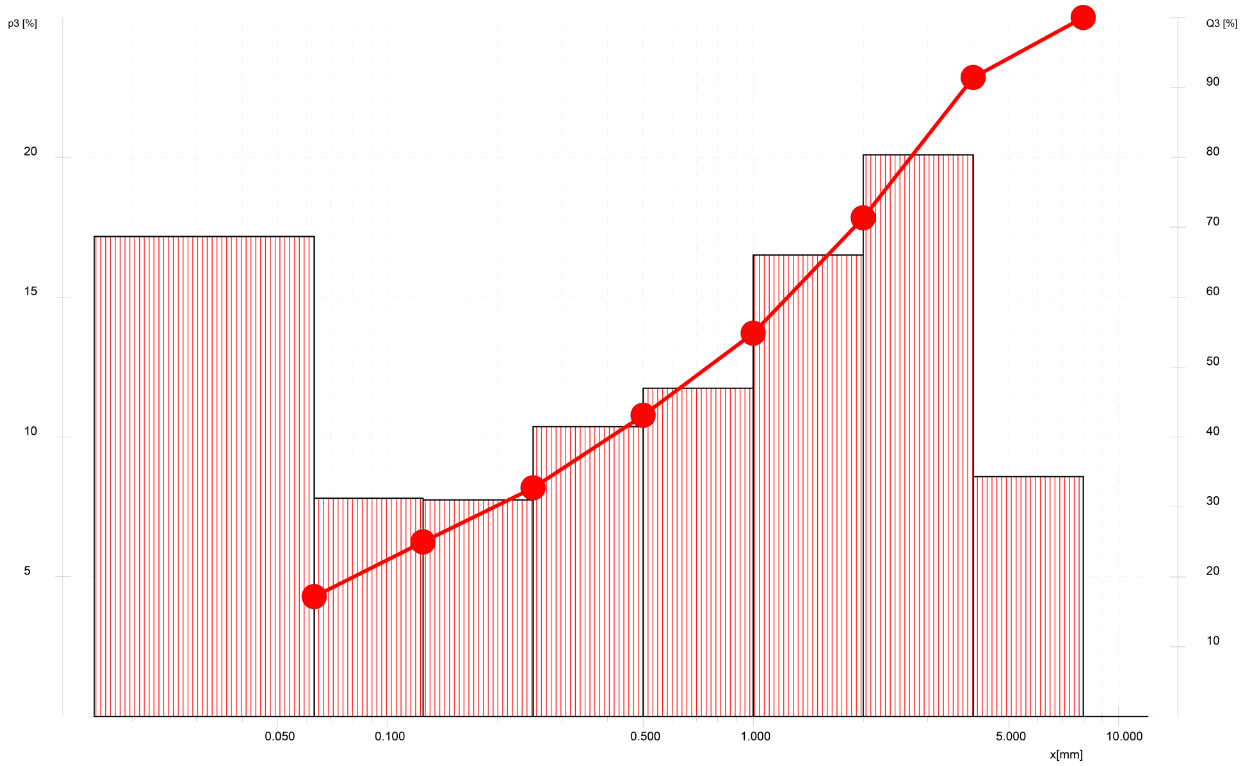
Grain size distribution of granular bentonite Conveyor Screw SCH1 23.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	11.7%	d_{10}	0.041 mm
2-4 mm	21.0%	d_{30}	0.270 mm
1-2 mm	16.3%	d_{50}	0.956 mm
0.5-1 mm	12.2%	d_{60}	1.549 mm
0.25-0.5 mm	9.7%	d_{90}	4.571 mm
0.125-0.25 mm	6.5%		
0.063-0.125 mm	7.3%		
<0.063 mm	15.4%		
		C_U	37.78
amount	1565 g	C_C	1.15



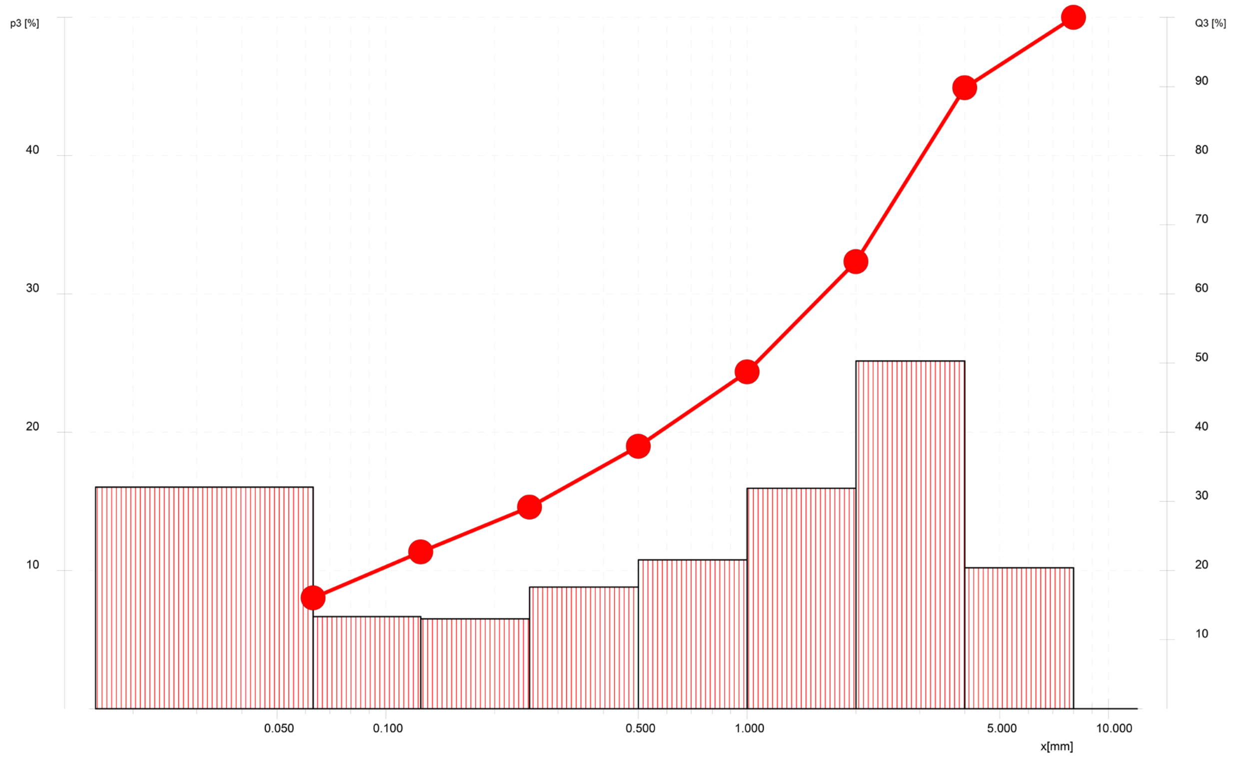
Grain size distribution of granular bentonite Conveyor Screw SCH2 23.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.6%	d_{10}	0.037 mm
2-4 mm	20.1%	d_{30}	0.206 mm
1-2 mm	16.5%	d_{50}	0.794 mm
0.5-1 mm	11.7%	d_{60}	1.313 mm
0.25-0.5 mm	10.4%	d_{90}	3.859 mm
0.125-0.25 mm	7.7%		
0.063-0.125 mm	7.8%		
<0.063 mm	17.2%		
		C_U	35.49
amount	1712 g	C_C	0.87



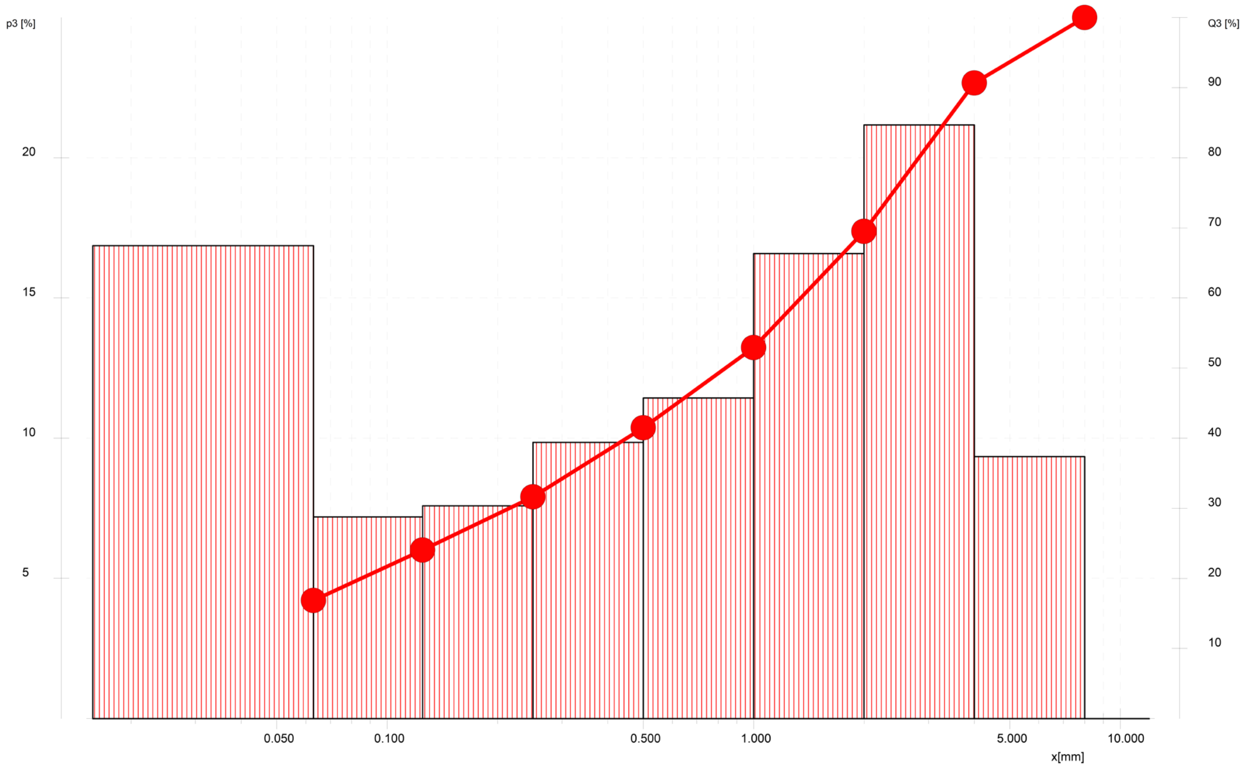
Grain size distribution of granular bentonite Conveyor Screw SCH3 23.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	10.2%	d_{10}	0.039 mm
2-4 mm	25.1%	d_{30}	0.274 mm
1-2 mm	15.9%	d_{50}	1.080 mm
0.5-1 mm	10.8%	d_{60}	1.707 mm
0.25-0.5 mm	8.8%	d_{90}	4.074 mm
0.125-0.25 mm	6.5%		
0.063-0.125 mm	6.7%		
<0.063 mm	16.0%		
		C_U	43.77
amount	1233 g	C_C	1.13



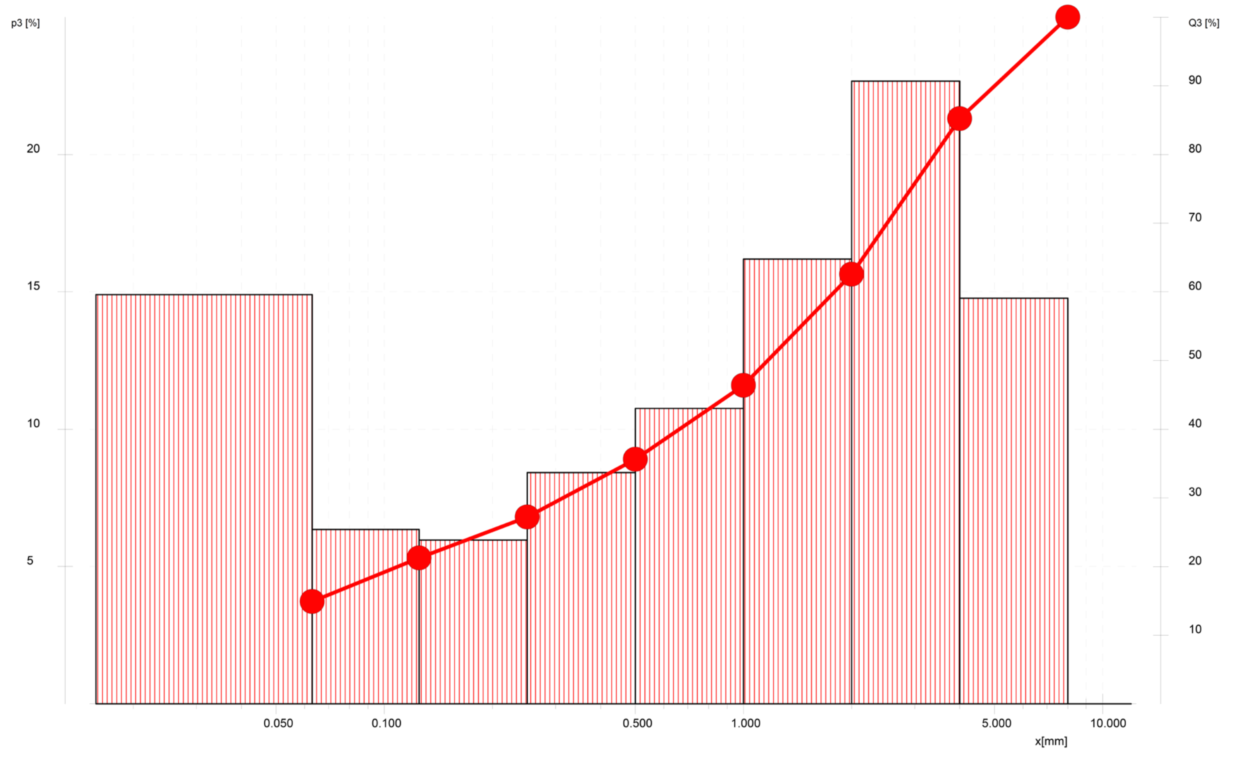
Grain size distribution of granular bentonite Conveyor Screw SCH4 23.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.3%	d_{10}	0.037 mm
2-4 mm	21.2%	d_{30}	0.223 mm
1-2 mm	16.6%	d_{50}	0.873 mm
0.5-1 mm	11.4%	d_{60}	1.427 mm
0.25-0.5 mm	9.8%	d_{90}	3.937 mm
0.125-0.25 mm	7.6%		
0.063-0.125 mm	7.2%		
<0.063 mm	16.9%		
		C_U	38.57
amount	1807 g	C_C	0.94



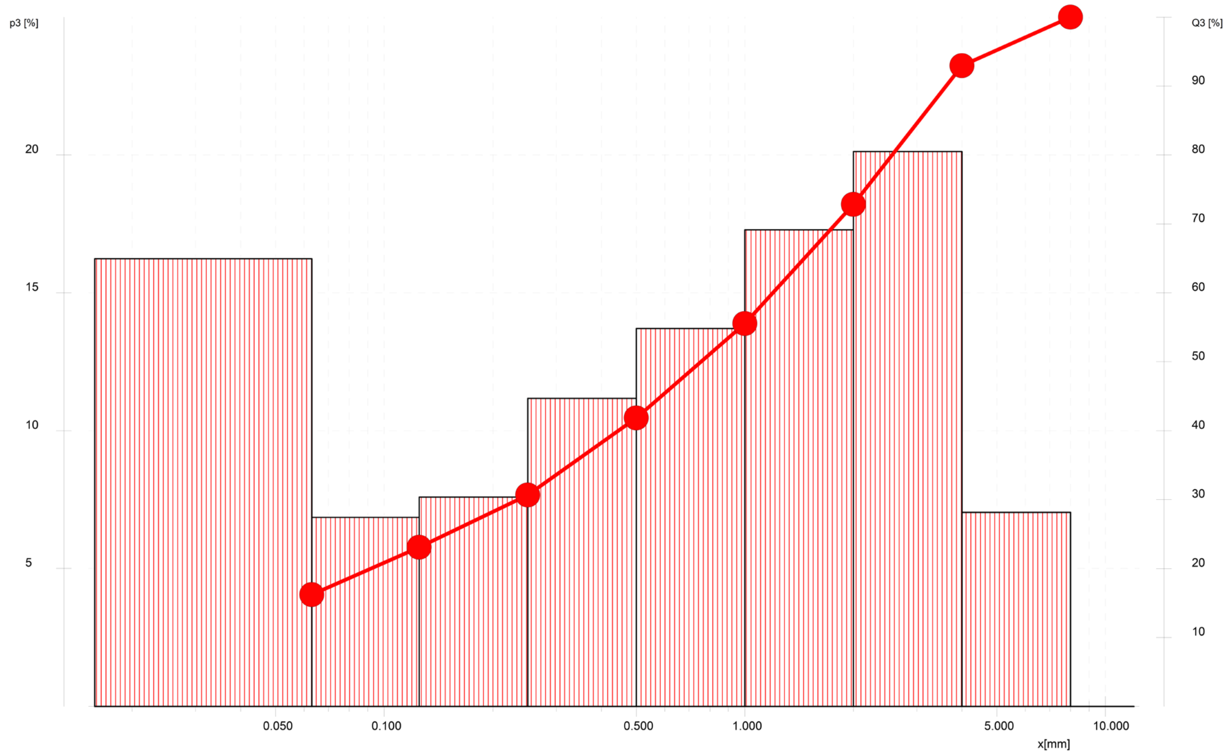
Grain size distribution of granular bentonite Conveyor Screw SCH5 23.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	14.8%	d_{10}	0.042 mm
2-4 mm	22.7%	d_{30}	0.333 mm
1-2 mm	16.2%	d_{50}	1.224 mm
0.5-1 mm	10.8%	d_{60}	1.842 mm
0.25-0.5 mm	8.4%	d_{90}	5.291 mm
0.125-0.25 mm	6.0%		
0.063-0.125 mm	6.3%		
<0.063 mm	14.9%		
		C_U	43.86
amount	1565 g	C_C	1.43



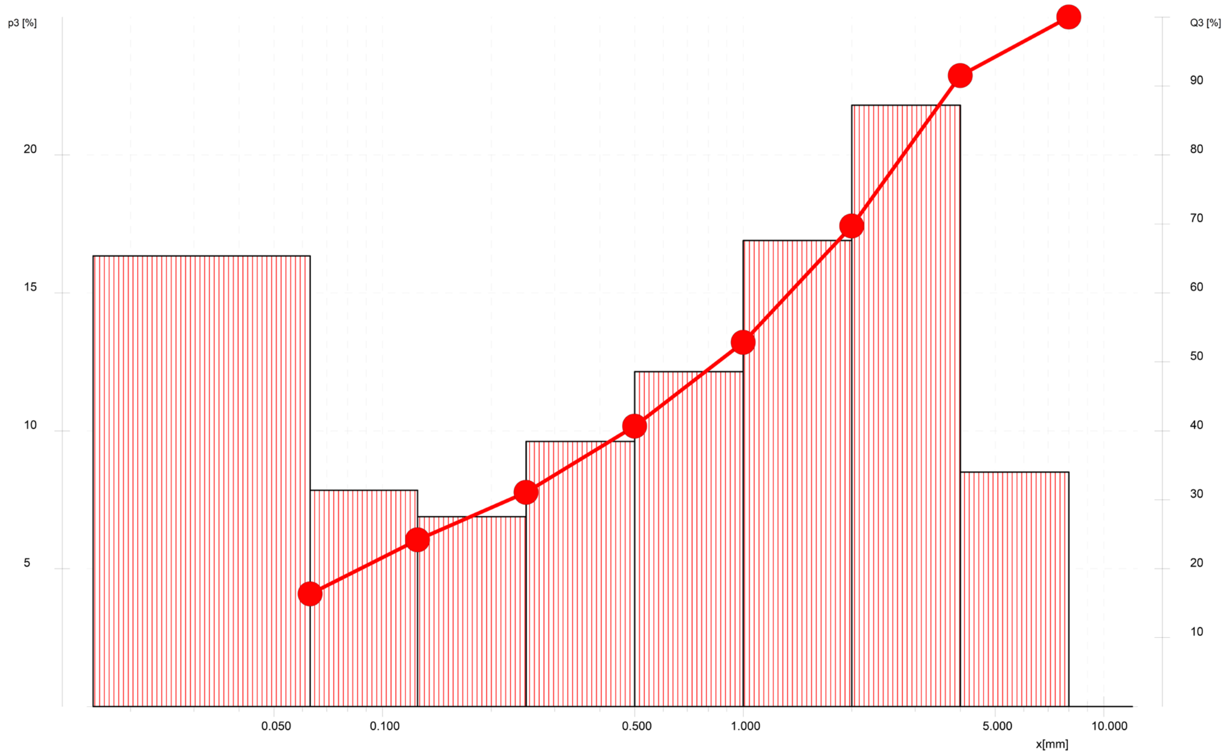
Grain size distribution of granular bentonite Conveyor Screw SCH1 24.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	7.0%	d_{10}	0.039 mm
2-4 mm	20.1%	d_{30}	0.239 mm
1-2 mm	17.3%	d_{50}	0.797 mm
0.5-1 mm	13.7%	d_{60}	1.257 mm
0.25-0.5 mm	11.2%	d_{90}	3.706 mm
0.125-0.25 mm	7.6%		
0.063-0.125 mm	6.9%		
<0.063 mm	16.2%		
		C_U	32.23
amount	1660 g	C_C	1.16



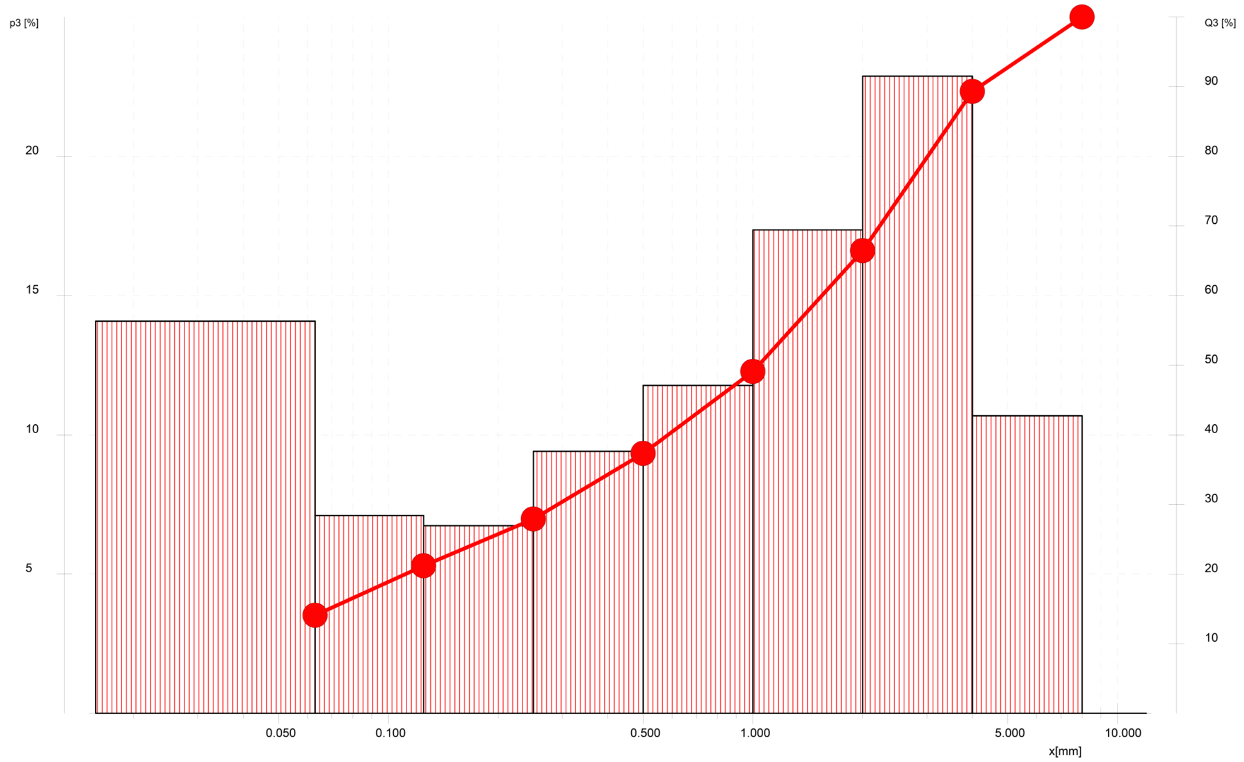
Grain size distribution of granular bentonite Conveyor Screw SCH2 24.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.5%	d_{10}	0.039 mm
2-4 mm	21.8%	d_{30}	0.231 mm
1-2 mm	16.9%	d_{50}	0.884 mm
0.5-1 mm	12.1%	d_{60}	1.426 mm
0.25-0.5 mm	9.6%	d_{90}	3.862 mm
0.125-0.25 mm	6.9%		
0.063-0.125 mm	7.8%		
<0.063 mm	16.3%		
		C_U	36.56
amount	1986 g	C_C	0.96



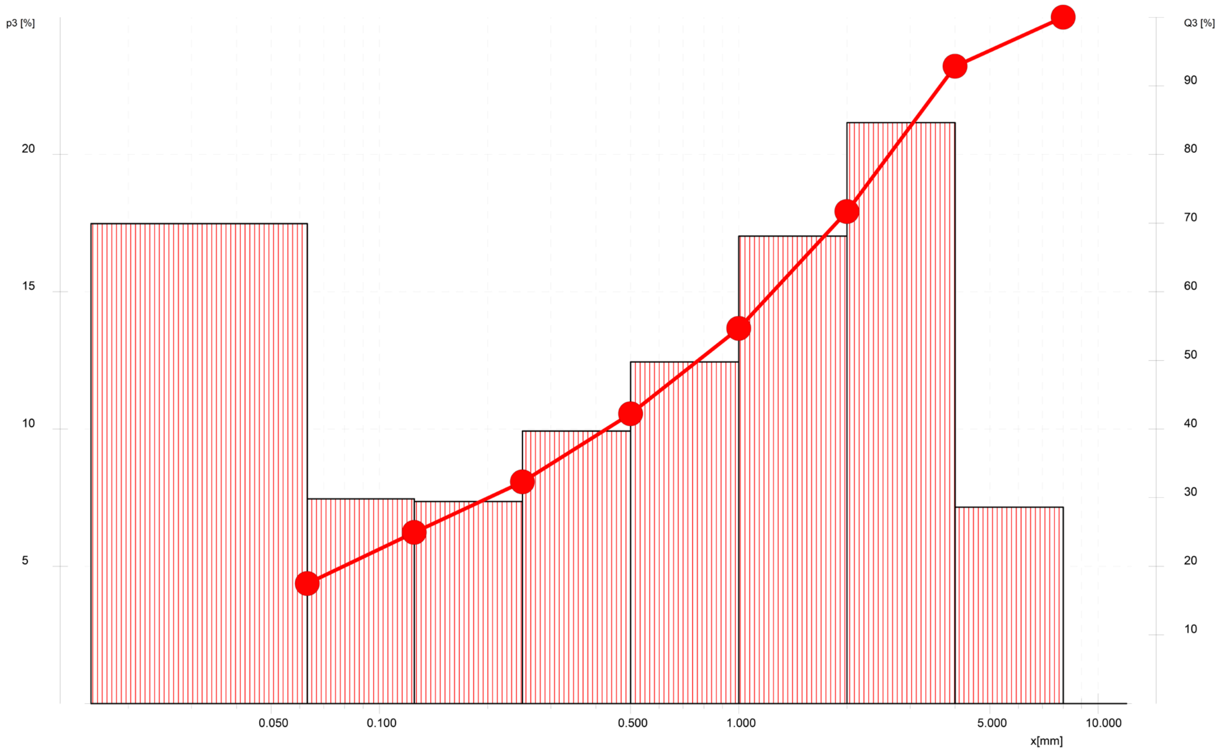
Grain size distribution of granular bentonite Conveyor Screw SCH3 24.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	10.7%	d_{10}	0.045 mm
2-4 mm	22.9%	d_{30}	0.305 mm
1-2 mm	17.4%	d_{50}	1.052 mm
0.5-1 mm	11.8%	d_{60}	1.629 mm
0.25-0.5 mm	9.4%	d_{90}	4.255 mm
0.125-0.25 mm	6.7%		
0.063-0.125 mm	7.1%		
<0.063 mm	14.1%		
		C_U	36.20
amount	1638 g	C_C	1.27



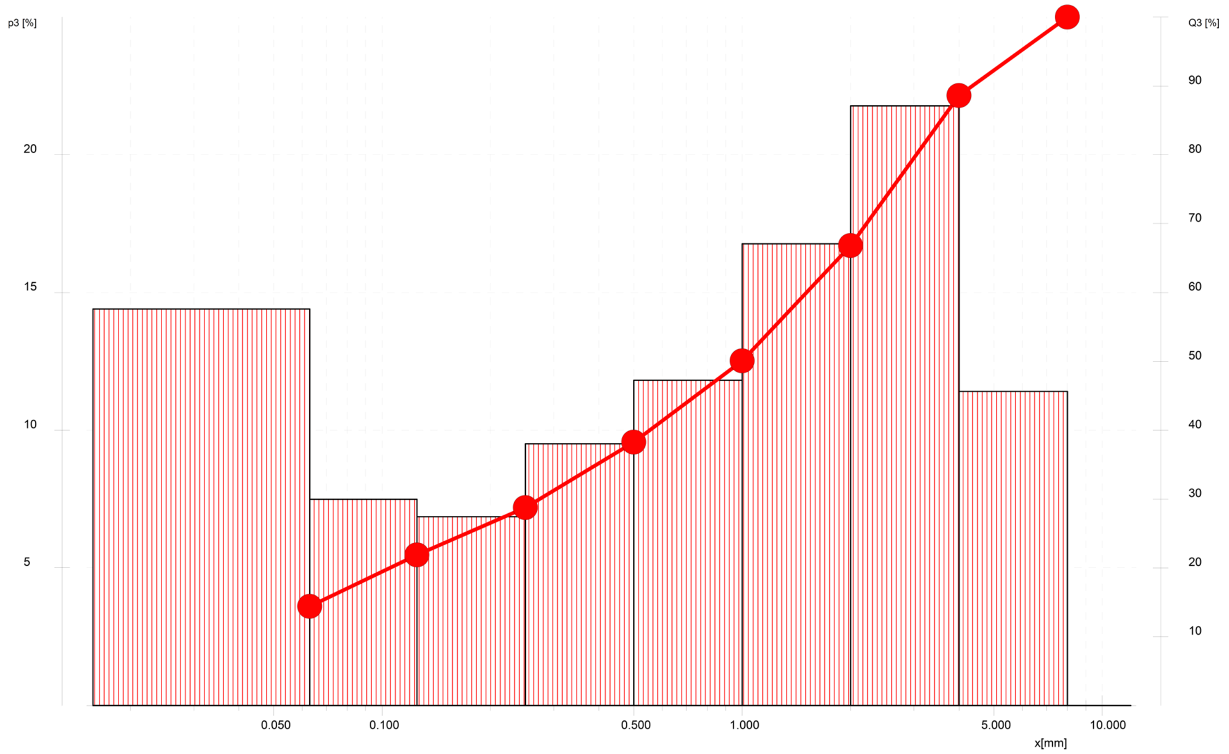
Grain size distribution of granular bentonite Conveyor Screw SCH4 24.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	7.2%	d_{10}	0.036 mm
21.2	22.9%	d_{30}	0.211 mm
1-2 mm	17.0%	d_{50}	0.813 mm
0.5-1 mm	12.4%	d_{60}	1.314 mm
0.25-0.5 mm	9.9%	d_{90}	3.731 mm
0.125-0.25 mm	7.4%		
0.063-0.125 mm	7.5%		
<0.063 mm	17.5%		
		C_U	36.50
amount	1993 g	C_C	0.94



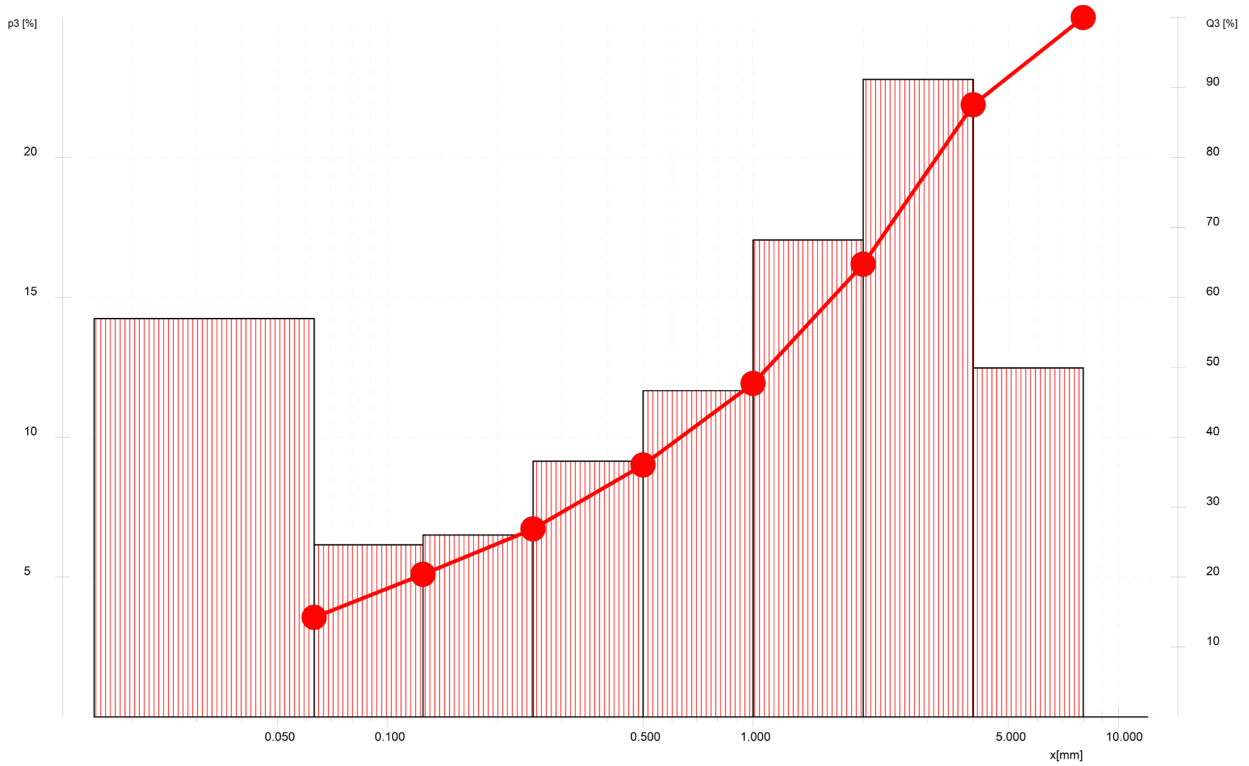
Grain size distribution of granular bentonite Conveyor Screw SCH5 24.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	11.4%	d_{10}	0.044 mm
21.2	21.8%	d_{30}	0.283 mm
1-2 mm	16.8%	d_{50}	0.998 mm
0.5-1 mm	11.8%	d_{60}	1.593 mm
0.25-0.5 mm	9.5%	d_{90}	4.493 mm
0.125-0.25 mm	6.9%		
0.063-0.125 mm	7.5%		
<0.063 mm	14.4%		
		C_U	36.20
amount	1749 g	C_C	1.14



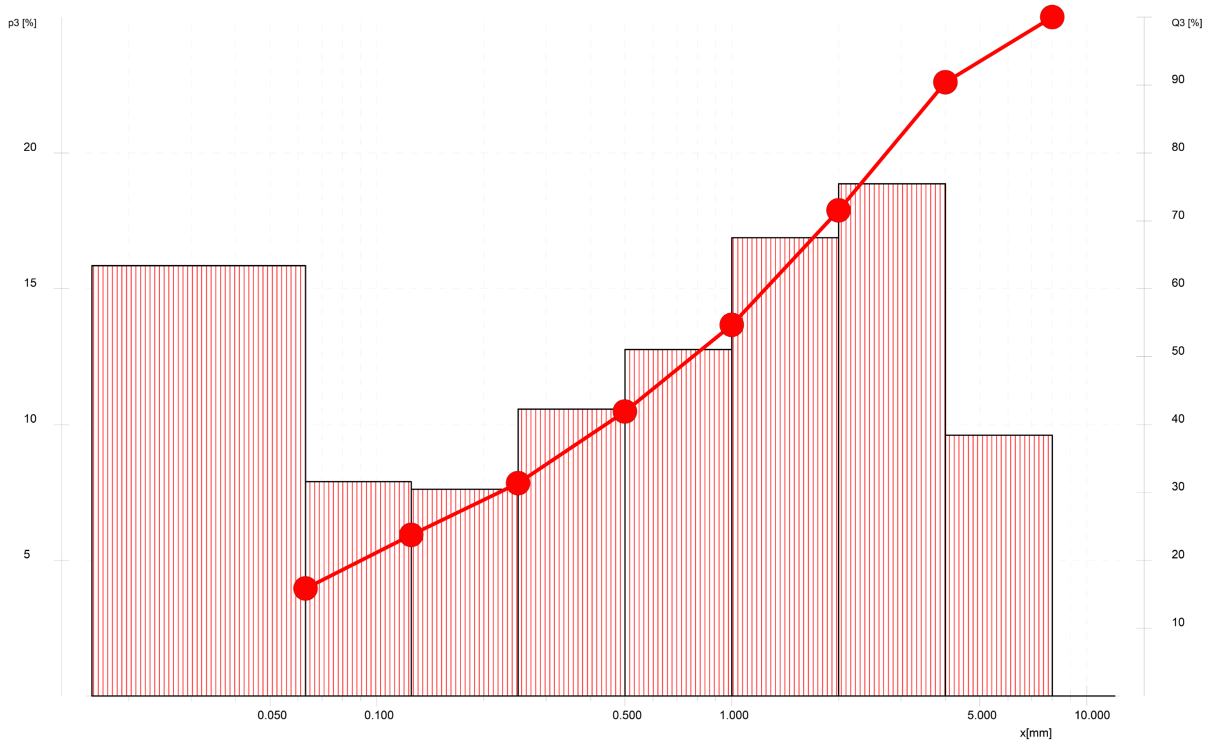
Grain size distribution of granular bentonite Conveyor Screw SCH1 27.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	12.5%	d_{10}	0.044 mm
21.2	22.8%	d_{30}	0.335 mm
1-2 mm	17.0%	d_{50}	1.136 mm
0.5-1 mm	11.7%	d_{60}	1.722 mm
0.25-0.5 mm	9.1%	d_{90}	4.794 mm
0.125-0.25 mm	6.5%		
0.063-0.125 mm	6.2%		
<0.063 mm	14.2%		
		C_U	39.14
amount	1725 g	C_C	1.48



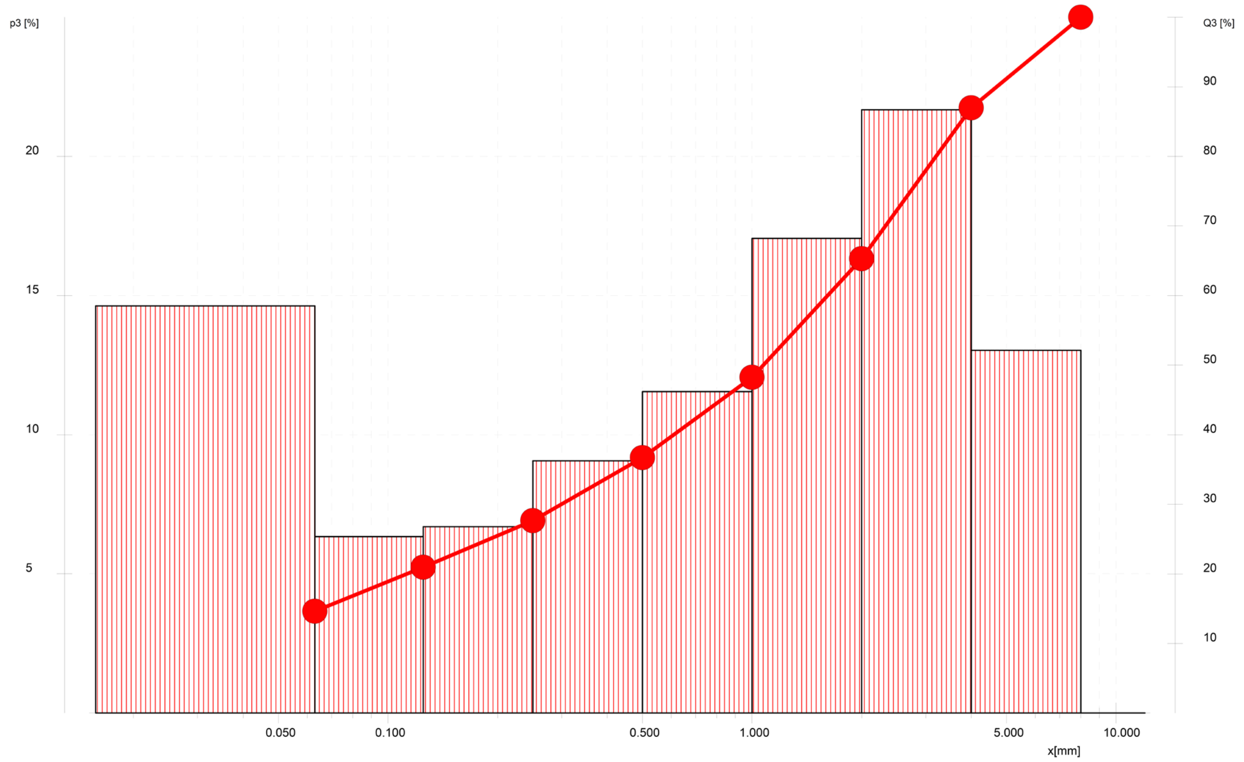
Grain size distribution of granular bentonite Conveyor Screw SCH2 27.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.6%	d_{10}	0.040 mm
21.2	18.9%	d_{30}	0.228 mm
1-2 mm	16.9%	d_{50}	0.817 mm
0.5-1 mm	12.8%	d_{60}	1.316 mm
0.25-0.5 mm	10.6%	d_{90}	3.958 mm
0.125-0.25 mm	7.6%		
0.063-0.125 mm	7.9%		
<0.063 mm	15.8%		
		C_U	32.90
amount	1473 g	C_C	0.99



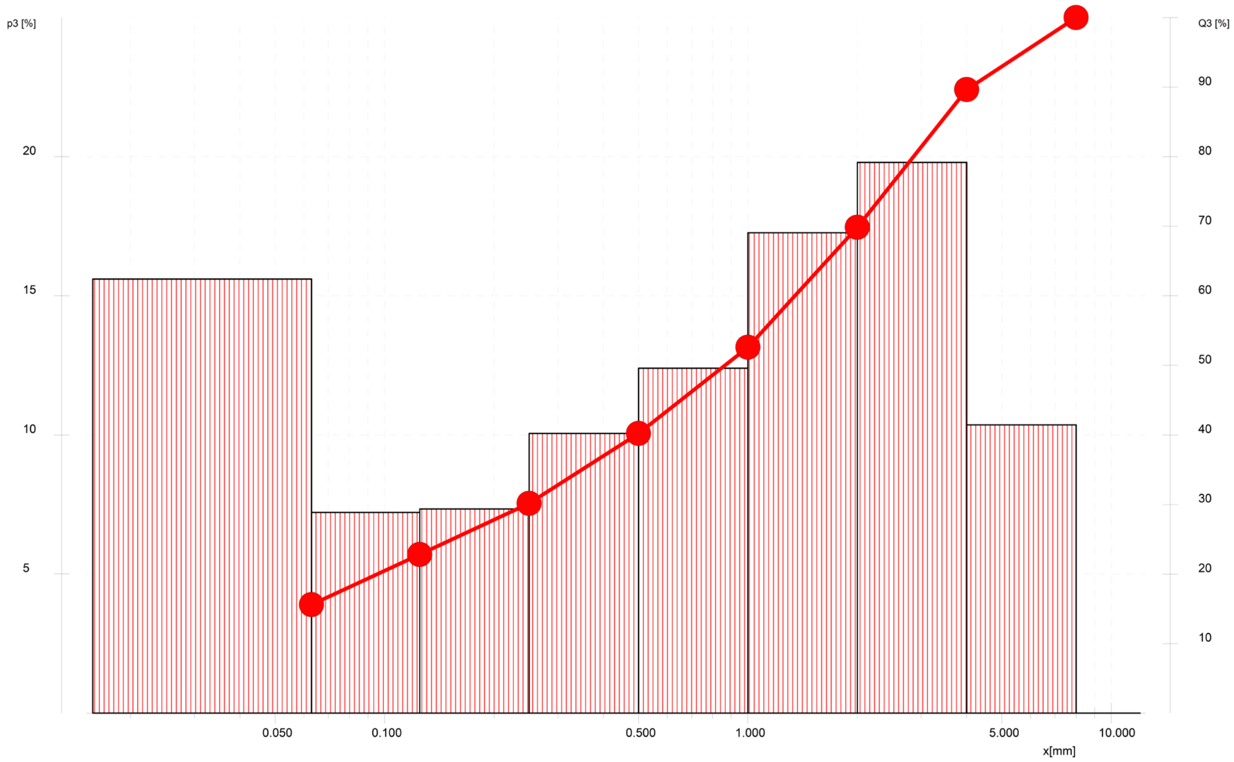
Grain size distribution of granular bentonite Conveyor Screw SCH3 27.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	13.0%	d_{10}	0.043 mm
21.2	21.7%	d_{30}	0.315 mm
1-2 mm	17.1%	d_{50}	1.102 mm
0.5-1 mm	11.5%	d_{60}	1.689 mm
0.25-0.5 mm	9.1%	d_{90}	4.929 mm
0.125-0.25 mm	6.7%		
0.063-0.125 mm	6.3%		
<0.063 mm	14.6%		
		C_U	39.28
amount	1705 g	C_C	1.37



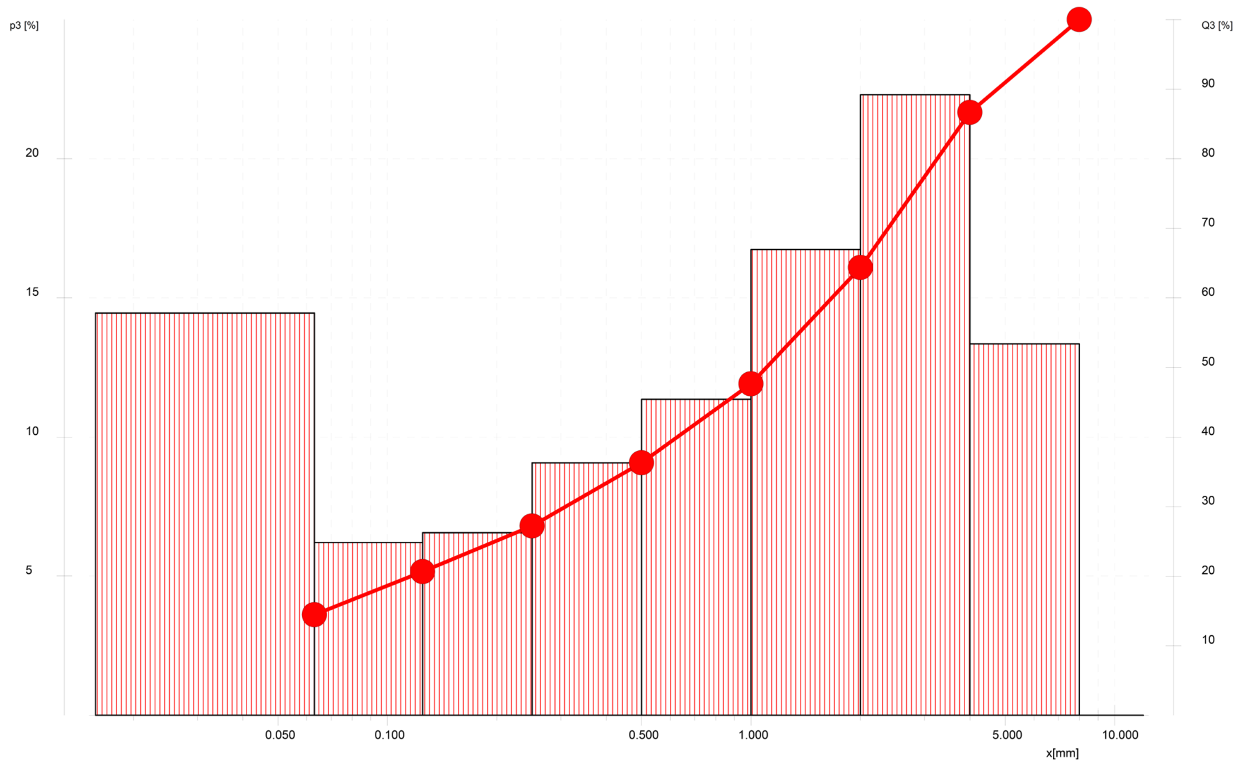
Grain size distribution of granular bentonite Conveyor Screw SCH4 27.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	10.4%	d_{10}	0.040 mm
21.2	19.8%	d_{30}	0.247 mm
1-2 mm	17.3%	d_{50}	0.896 mm
0.5-1 mm	12.4%	d_{60}	1.429 mm
0.25-0.5 mm	10.0%	d_{90}	4.138 mm
0.125-0.25 mm	7.3%		
0.063-0.125 mm	7.2%		
<0.063 mm	15.6%		
		C_U	35.72
amount	1633 g	C_C	1.07



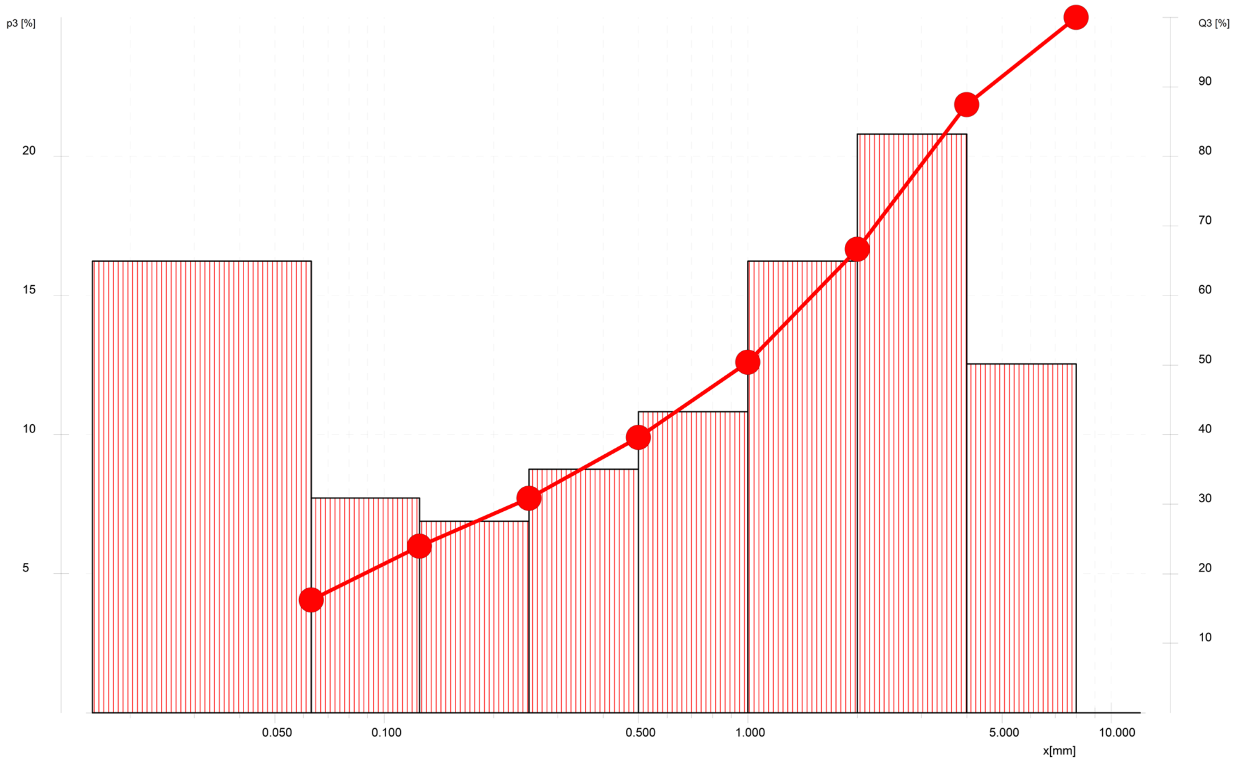
Grain size distribution of granular bentonite Conveyor Screw SCH5 27.10.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	13.3%	d_{10}	0.044 mm
21.2	22.3%	d_{30}	0.327 mm
1-2 mm	16.7%	d_{50}	1.142 mm
0.5-1 mm	11.4%	d_{60}	1.739 mm
0.25-0.5 mm	9.1%	d_{90}	5.002 mm
0.125-0.25 mm	6.6%		
0.063-0.125 mm	6.2%		
<0.063 mm	14.5%		
		C_U	39.52
amount	1712 g	C_C	1.40



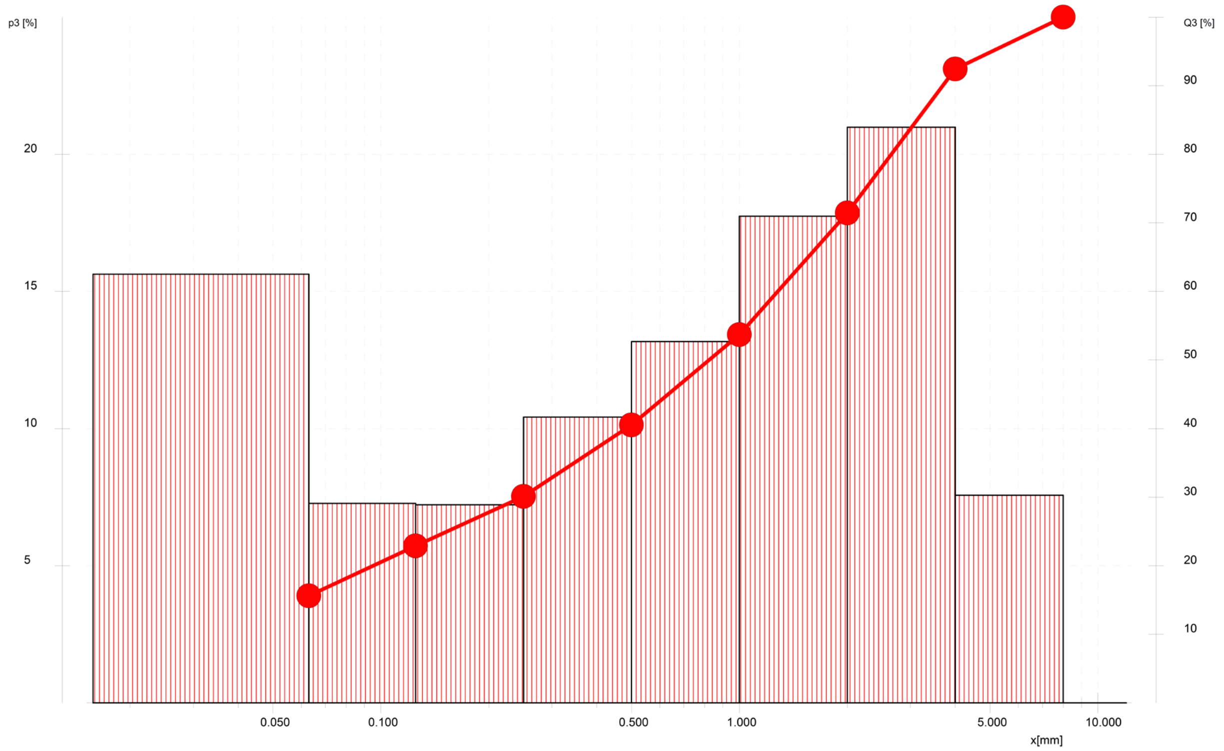
Grain size distribution of granular bentonite Conveyor Screw SCH1 20.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	12.5%	d_{10}	0.039 mm
21.2	20.8%	d_{30}	0.235 mm
1-2 mm	16.2%	d_{50}	0.981 mm
0.5-1 mm	10.8%	d_{60}	1.590 mm
0.25-0.5 mm	8.8%	d_{90}	4.811 mm
0.125-0.25 mm	6.9%		
0.063-0.125 mm	7.7%		
<0.063 mm	16.2%		
		C_U	40.77
amount	2032 g	C_C	0.89



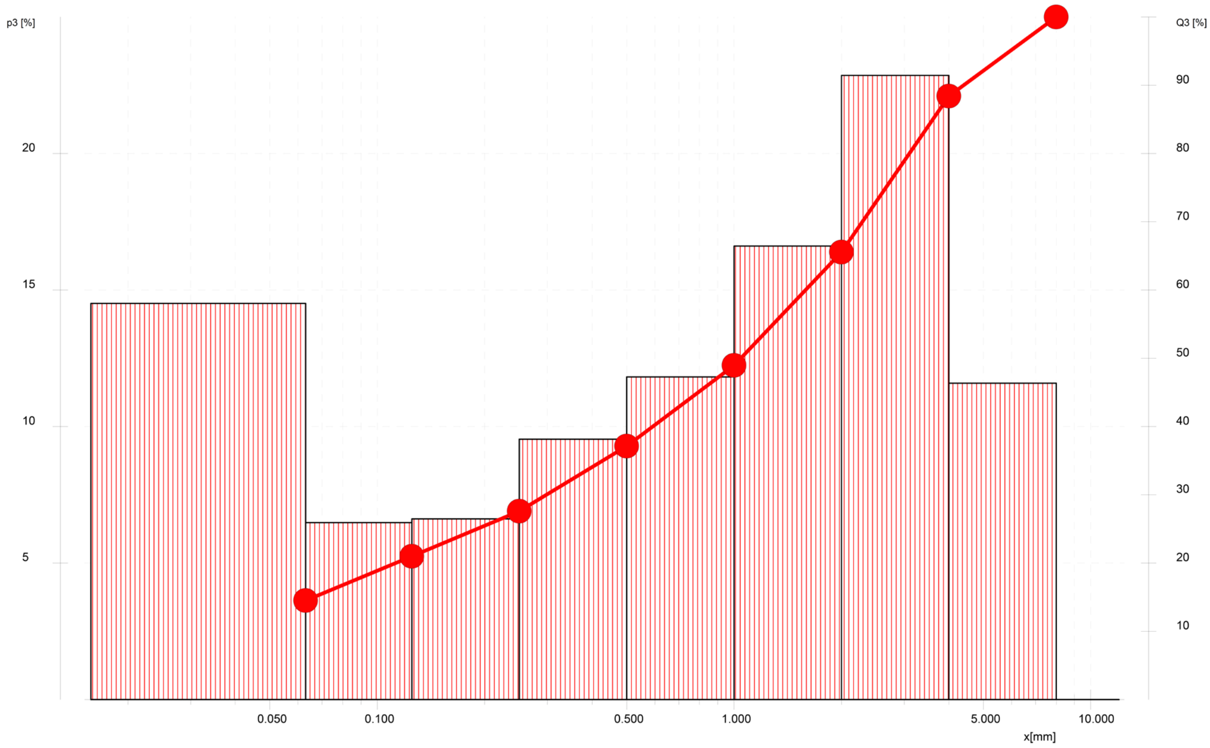
Grain size distribution of granular bentonite Conveyor Screw SCH2 20.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	7.6%	d_{10}	0.040 mm
21.2	21.0%	d_{30}	0.248 mm
1-2 mm	17.7%	d_{50}	0.859 mm
0.5-1 mm	13.2%	d_{60}	1.355 mm
0.25-0.5 mm	10.4%	d_{90}	3.768 mm
0.125-0.25 mm	7.2%		
0.063-0.125 mm	7.3%		
<0.063 mm	15.6%		
		C_U	33.88
amount	2028 g	C_C	1.14



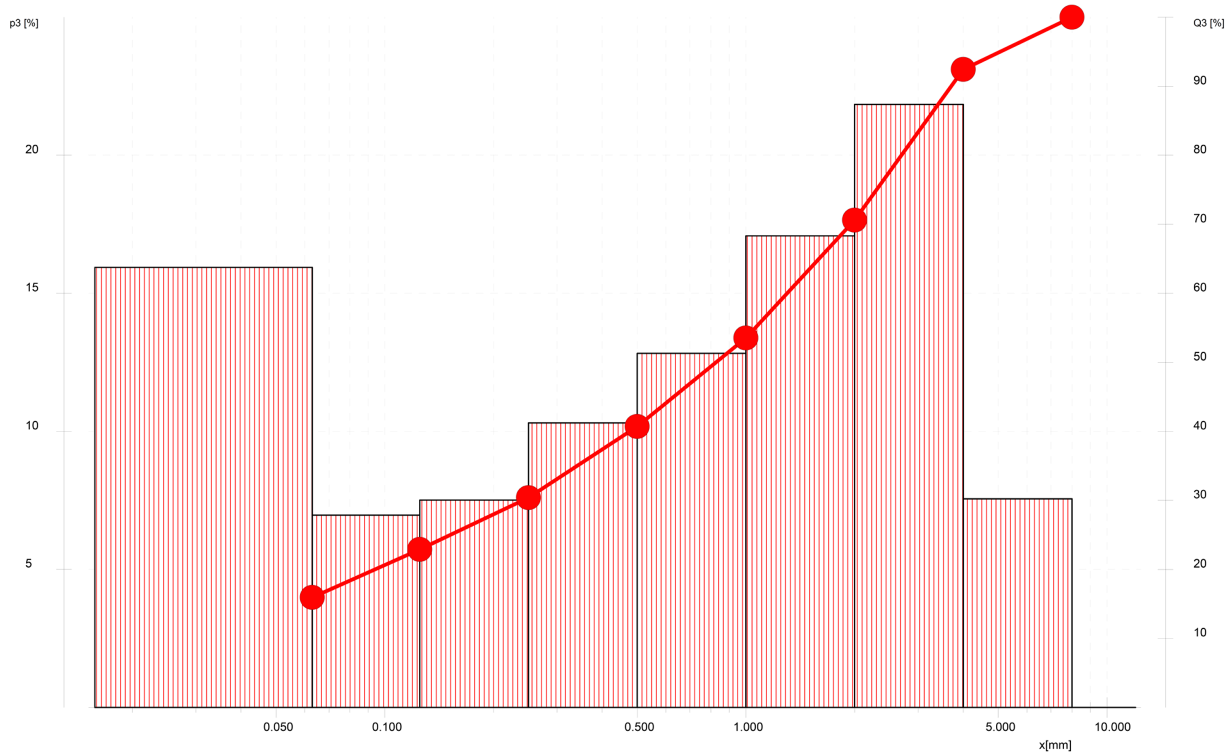
Grain size distribution of granular bentonite Conveyor Screw SCH3 20.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	11.6%	d_{10}	0.043 mm
21.2	22.9%	d_{30}	0.313 mm
1-2 mm	16.6%	d_{50}	1.063 mm
0.5-1 mm	11.8%	d_{60}	1.665 mm
0.25-0.5 mm	9.5%	d_{90}	4.548 mm
0.125-0.25 mm	6.6%		
0.063-0.125 mm	6.5%		
<0.063 mm	14.5%		
		C_U	38.72
amount	2201 g	C_C	1.37



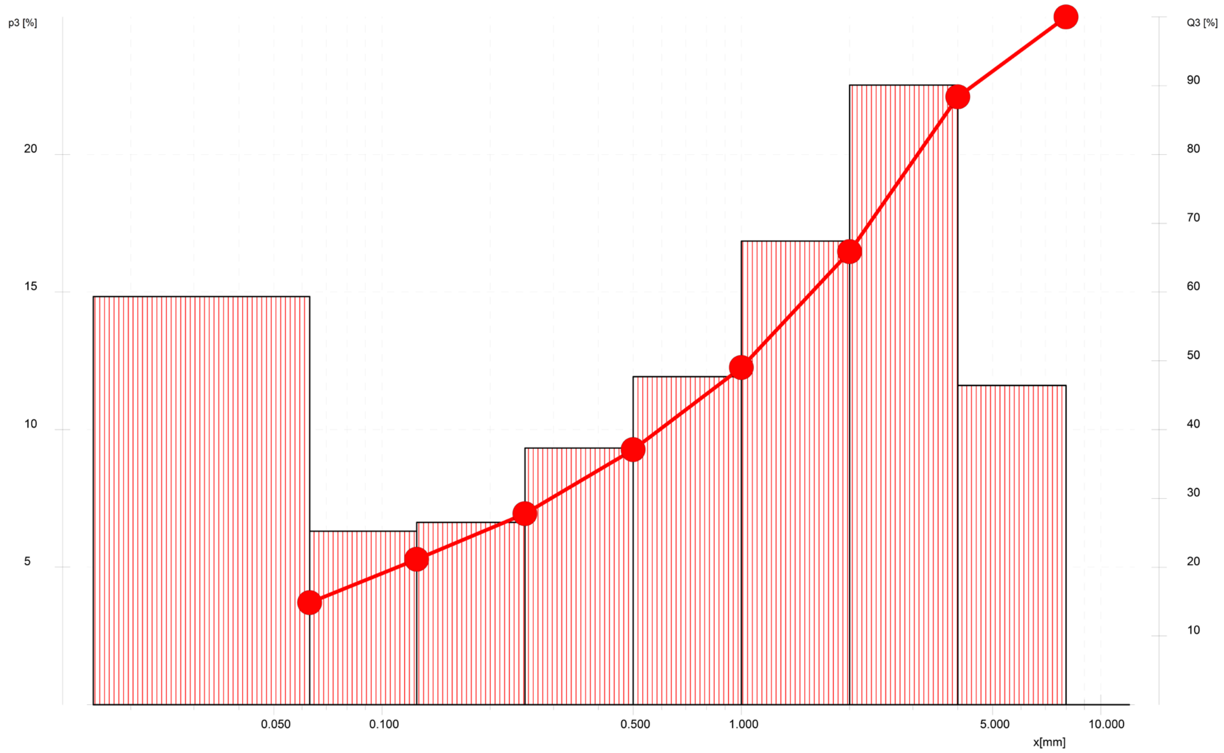
Grain size distribution of granular bentonite Conveyor Screw SCH4 20.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	7.6%	d_{10}	0.040 mm
21.2	21.8%	d_{30}	0.243 mm
1-2 mm	17.1%	d_{50}	0.863 mm
0.5-1 mm	12.8%	d_{60}	1.379 mm
0.25-0.5 mm	10.3%	d_{90}	3.776 mm
0.125-0.25 mm	7.5%		
0.063-0.125 mm	7.0%		
<0.063 mm	15.9%		
		C_U	34.48
amount	2193 g	C_C	1.07



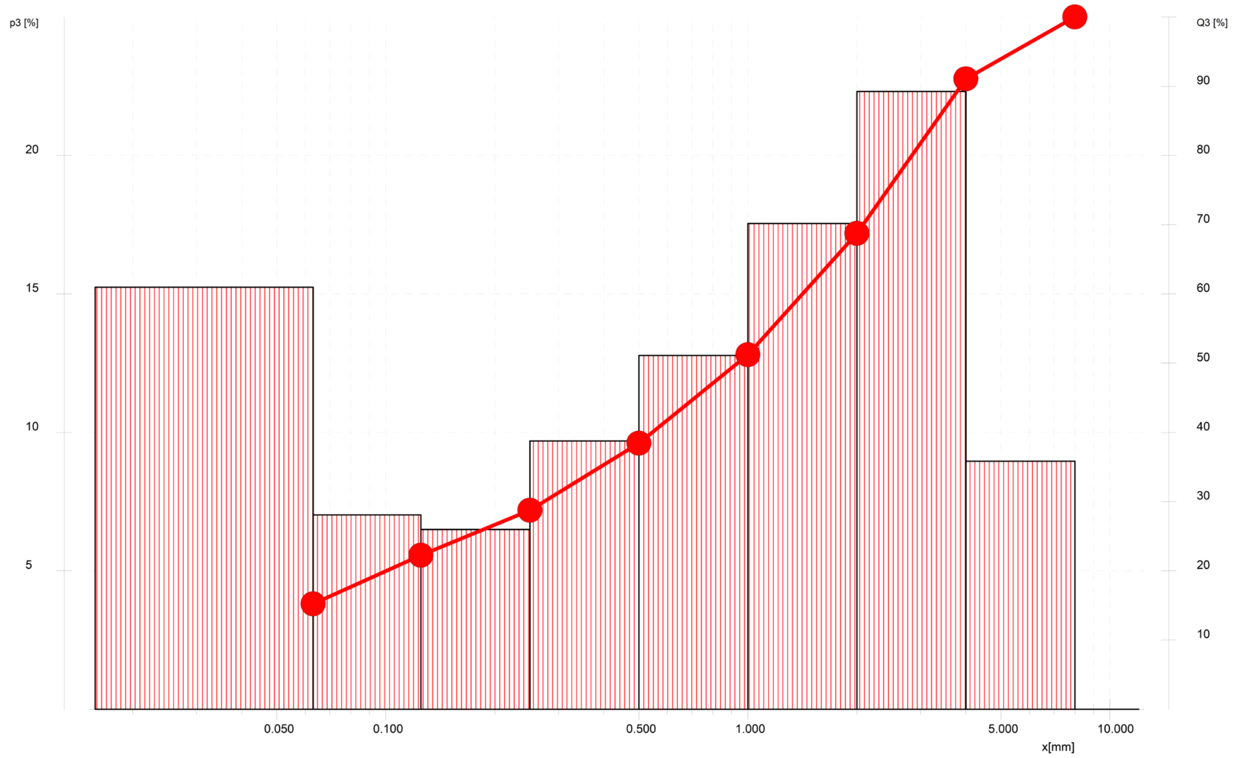
Grain size distribution of granular bentonite Conveyor Screw SCH5 20.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	11.6%	d_{10}	0.042 mm
21.2	22.5%	d_{30}	0.310 mm
1-2 mm	16.9%	d_{50}	1.058 mm
0.5-1 mm	11.9%	d_{60}	1.652 mm
0.25-0.5 mm	9.3%	d_{90}	4.553 mm
0.125-0.25 mm	6.6%		
0.063-0.125 mm	6.3%		
<0.063 mm	14.8%		
		C_U	39.33
amount	1893 g	C_C	1.38



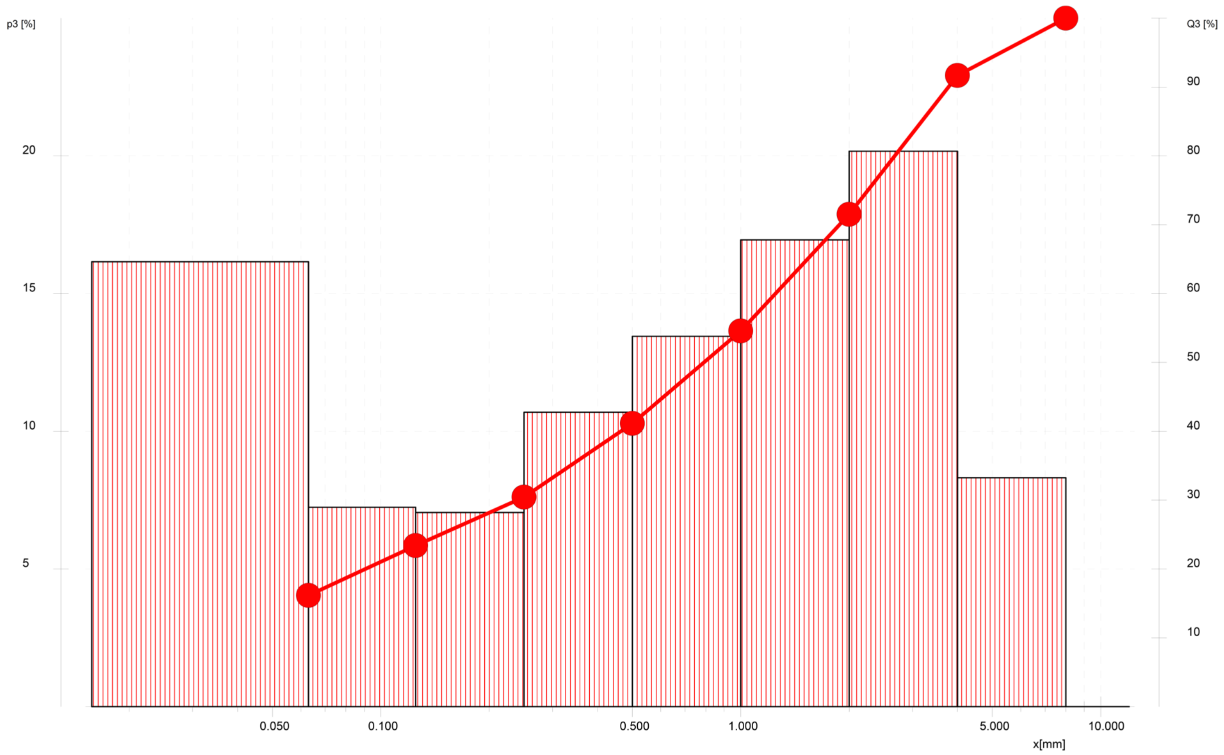
Grain size distribution of granular bentonite Conveyor Screw SCH1 21.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.0%	d_{10}	0.041 mm
21.2	22.3%	d_{30}	0.282 mm
1-2 mm	17.5%	d_{50}	0.953 mm
0.5-1 mm	12.8%	d_{60}	1.501 mm
0.25-0.5 mm	9.7%	d_{90}	3.906 mm
0.125-0.25 mm	6.5%		
0.063-0.125 mm	7.0%		
<0.063 mm	15.2%		
		C_U	36.61
amount	1913 g	C_C	1.29



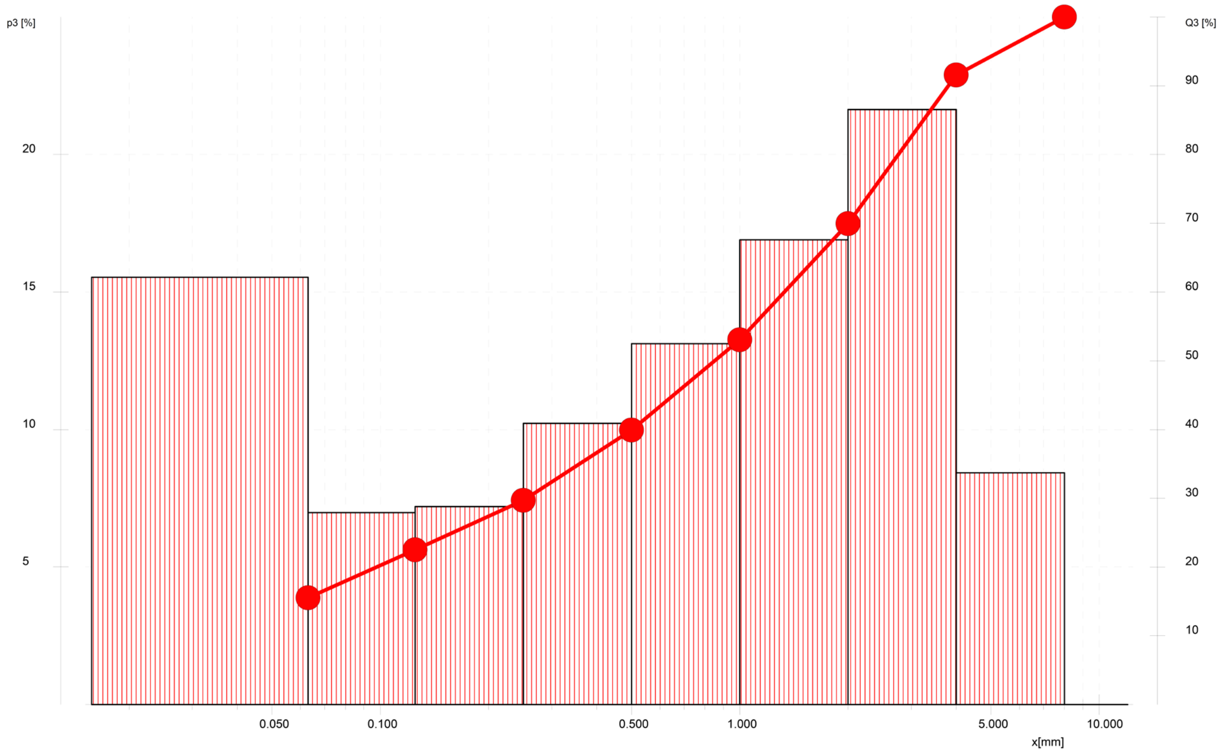
Grain size distribution of granular bentonite Conveyor Screw SCH2 21.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.3%	d_{10}	0.039 mm
21.2	20.2%	d_{30}	0.242 mm
1-2 mm	16.9%	d_{50}	0.830 mm
0.5-1 mm	13.4%	d_{60}	1.320 mm
0.25-0.5 mm	10.7%	d_{90}	3.832 mm
0.125-0.25 mm	7.0%		
0.063-0.125 mm	7.2%		
<0.063 mm	16.2%		
		C_U	33.85
amount	2141 g	C_C	1.14



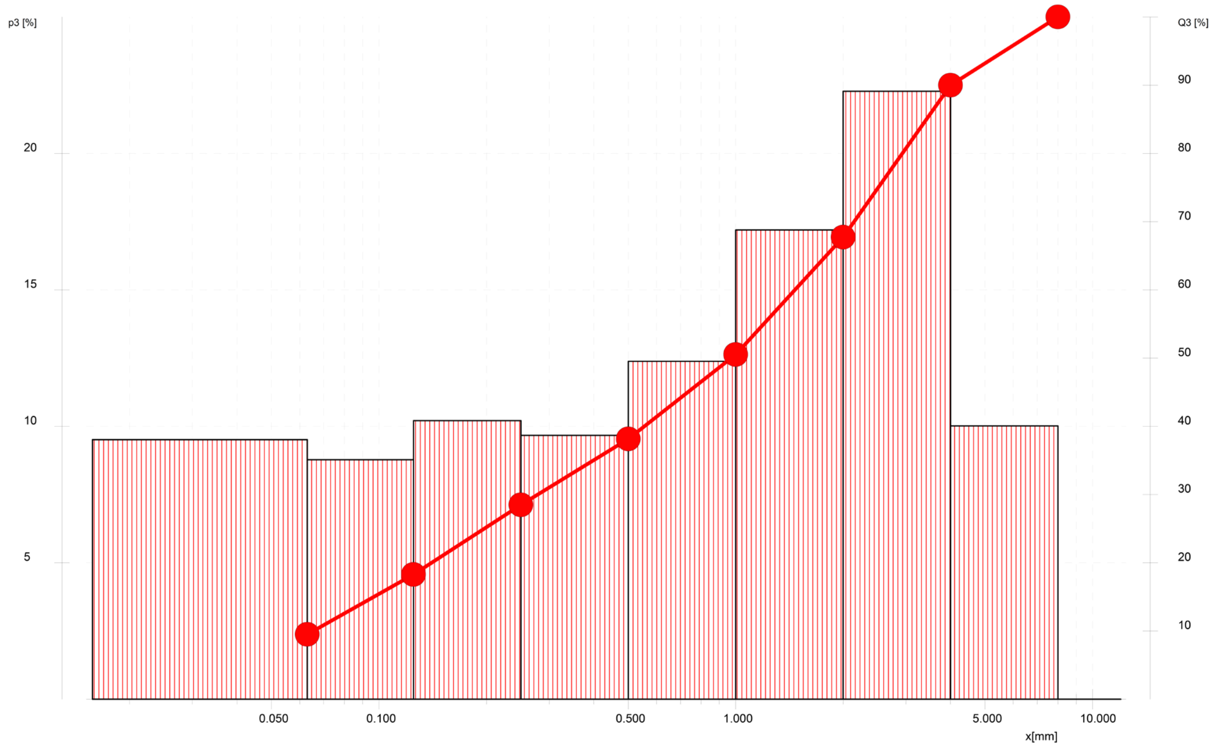
Grain size distribution of granular bentonite Conveyor Screw SCH3 21.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.4%	d_{10}	0.041 mm
21.2	21.6%	d_{30}	0.257 mm
1-2 mm	16.9%	d_{50}	0.884 mm
0.5-1 mm	13.1%	d_{60}	1.411 mm
0.25-0.5 mm	10.2%	d_{90}	3.854 mm
0.125-0.25 mm	7.2%		
0.063-0.125 mm	7.0%		
<0.063 mm	15.5%		
		C_U	34.42
amount	2295 g	C_C	1.14



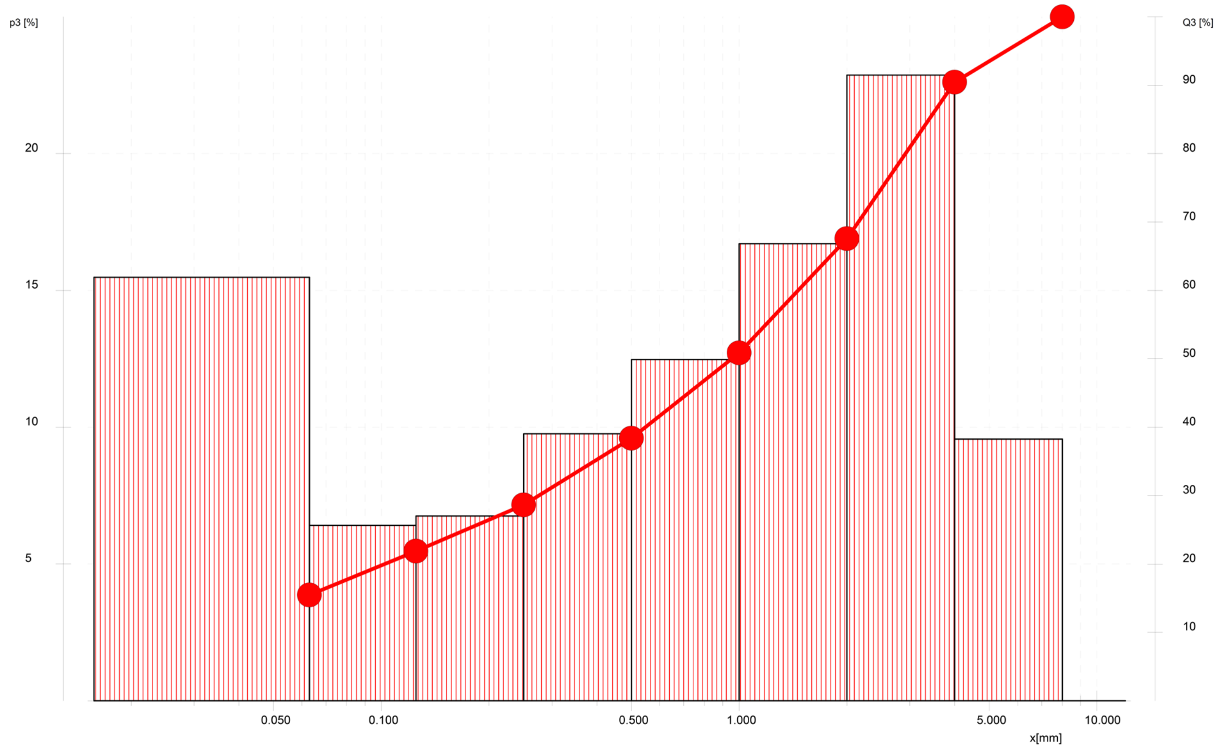
Grain size distribution of granular bentonite Conveyor Screw SCH4 21.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	10.0%	d_{10}	0.066 mm
21.2	22.3%	d_{30}	0.289 mm
1-2 mm	17.2%	d_{50}	0.979 mm
0.5-1 mm	12.4%	d_{60}	1.551 mm
0.25-0.5 mm	9.7%	d_{90}	4.005 mm
0.125-0.25 mm	10.2%		
0.063-0.125 mm	8.8%		
<0.063 mm	9.5%		
		C_U	23.50
amount	2592 g	C_C	0.82



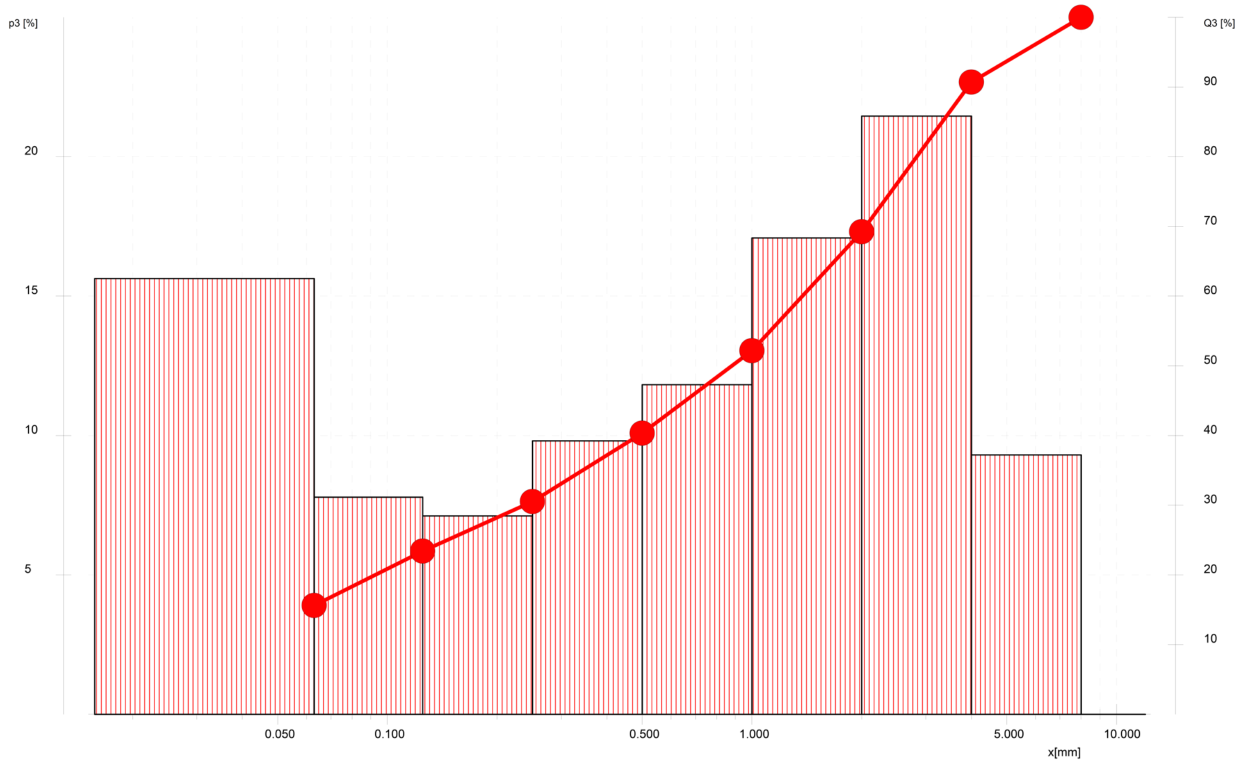
Grain size distribution of granular bentonite Conveyor Screw SCH5 21.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.6%	d_{10}	0.041 mm
21.2	22.9%	d_{30}	0.285 mm
1-2 mm	16.7%	d_{50}	0.965 mm
0.5-1 mm	12.5%	d_{60}	1.547 mm
0.25-0.5 mm	9.8%	d_{90}	3.962 mm
0.125-0.25 mm	6.8%		
0.063-0.125 mm	6.4%		
<0.063 mm	15.5%		
		C_U	37.73
amount	2037 g	C_C	1.28



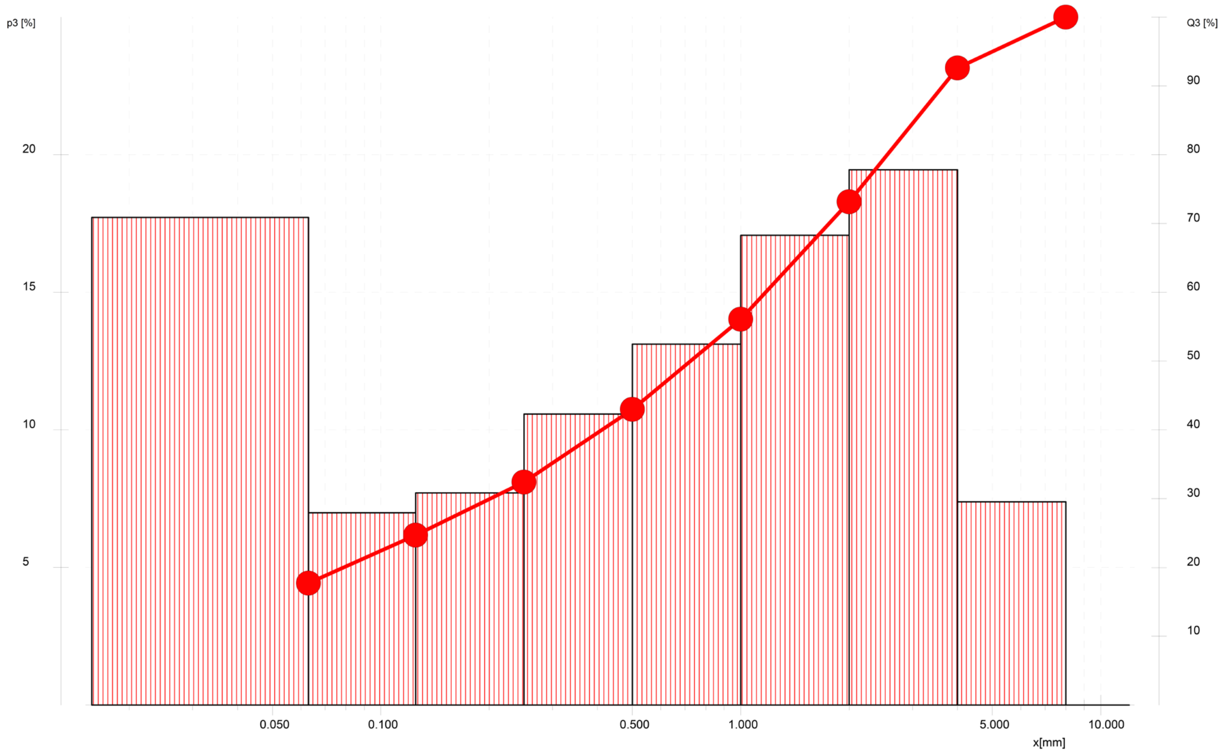
Grain size distribution of granular bentonite Conveyor Screw SCH1 24.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.3%	d_{10}	0.040 mm
21.2	21.5%	d_{30}	0.241 mm
1-2 mm	17.1%	d_{50}	0.909 mm
0.5-1 mm	11.8%	d_{60}	1.459 mm
0.25-0.5 mm	9.8%	d_{90}	3.935 mm
0.125-0.25 mm	7.1%		
0.063-0.125 mm	7.8%		
<0.063 mm	15.6%		
		C_U	36.48
amount	1785 g	C_C	1.00



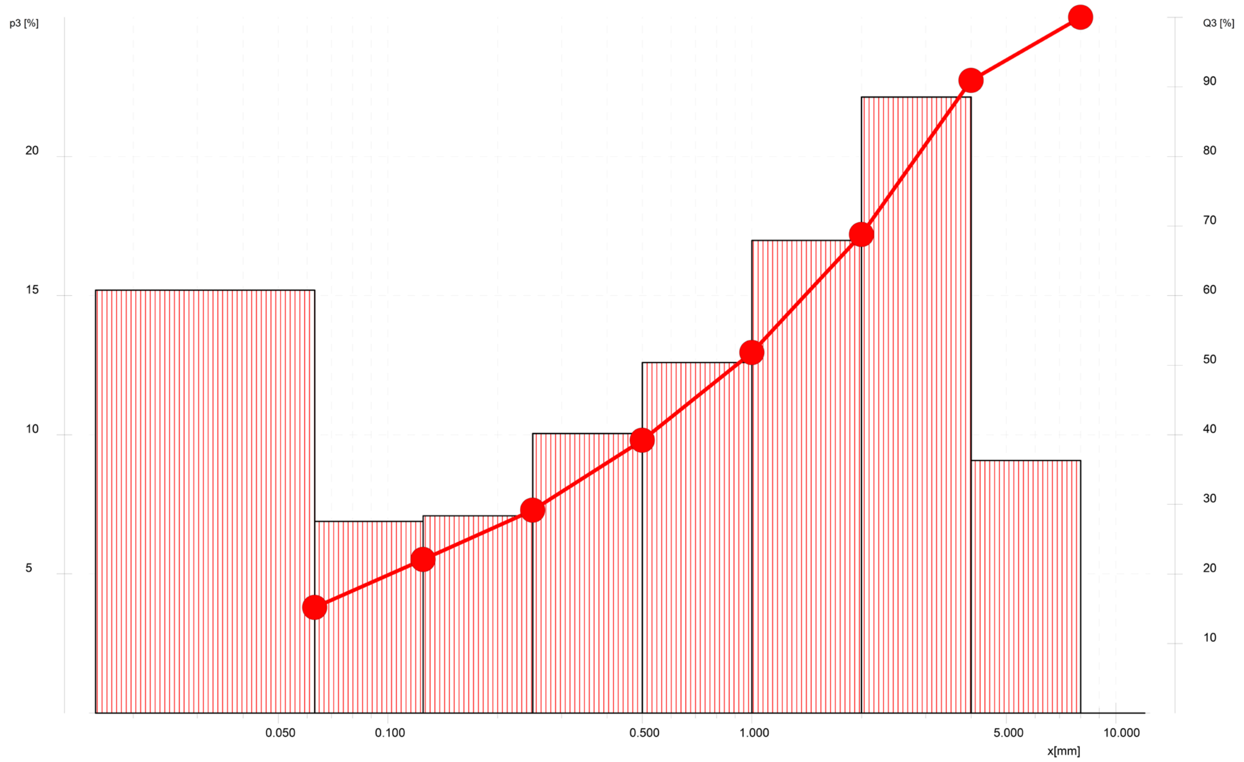
Grain size distribution of granular bentonite Conveyor Screw SCH2 24.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	7.4%	d_{10}	0.036 mm
21.2	19.5%	d_{30}	0.211 mm
1-2 mm	17.1%	d_{50}	0.768 mm
0.5-1 mm	13.1%	d_{60}	1.229 mm
0.25-0.5 mm	10.6%	d_{90}	3.731 mm
0.125-0.25 mm	7.7%		
0.063-0.125 mm	7.0%		
<0.063 mm	17.7%		
		C_U	34.14
amount	2483 g	C_C	1.01



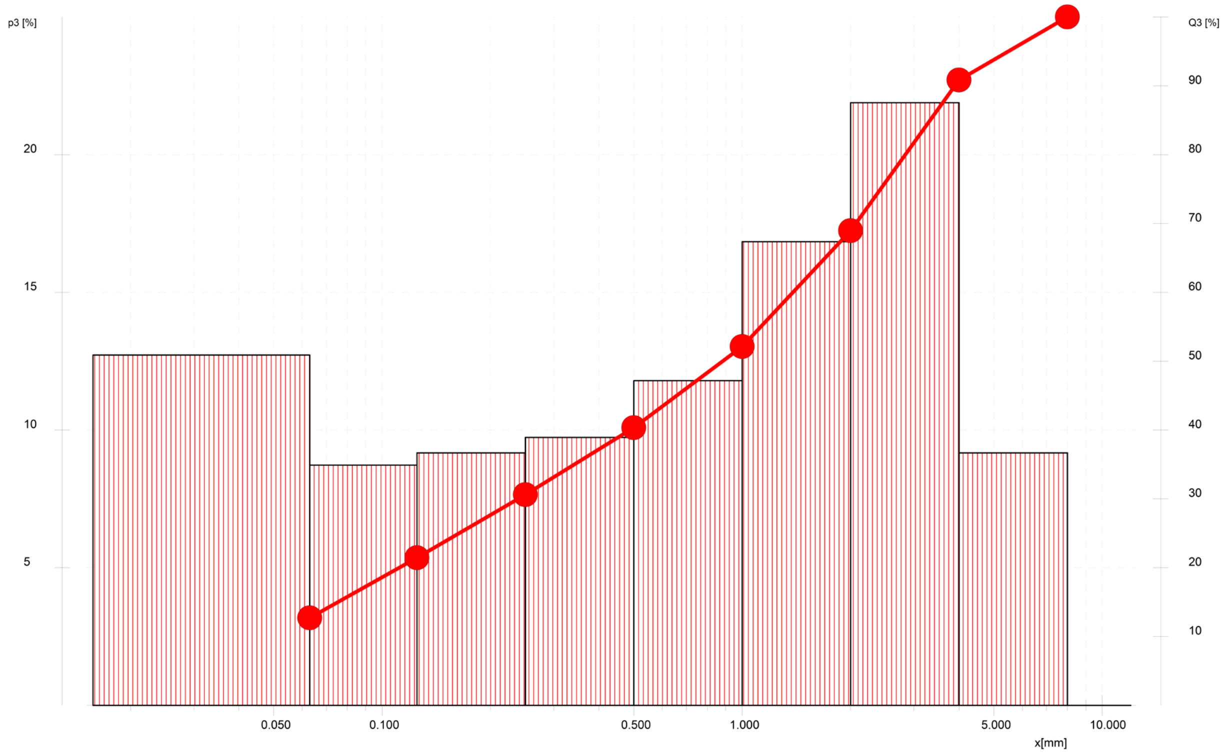
Grain size distribution of granular bentonite Conveyor Screw SCH3 24.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.1%	d_{10}	0.041 mm
21.2	22.1%	d_{30}	0.271 mm
1-2 mm	17.0%	d_{50}	0.928 mm
0.5-1 mm	12.6%	d_{60}	1.482 mm
0.25-0.5 mm	10.0%	d_{90}	3.917 mm
0.125-0.25 mm	7.1%		
0.063-0.125 mm	6.9%		
<0.063 mm	15.2%		
		C_U	36.15
amount	1979 g	C_C	1.21



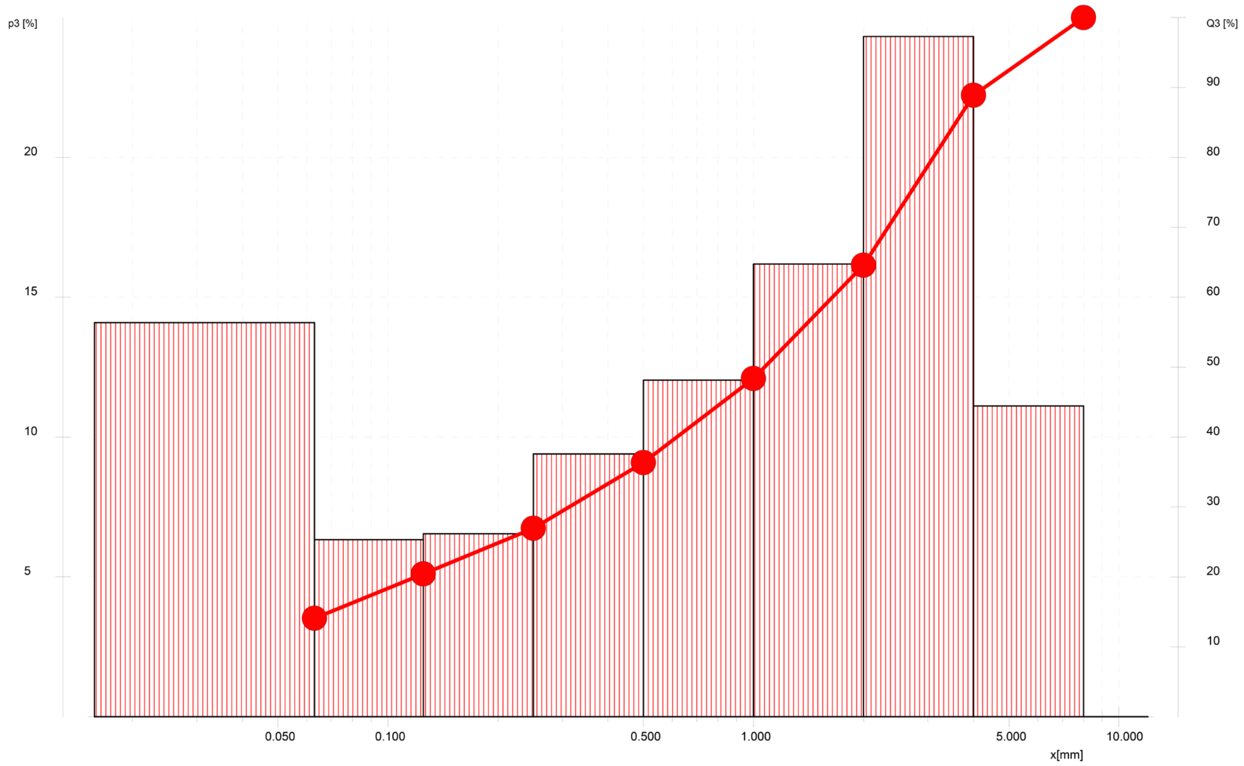
Grain size distribution of granular bentonite Conveyor Screw SCH4 24.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.2%	d_{10}	0.050 mm
21.2	21.9%	d_{30}	0.242 mm
1-2 mm	16.8%	d_{50}	0.910 mm
0.5-1 mm	11.8%	d_{60}	1.468 mm
0.25-0.5 mm	9.7%	d_{90}	3.924 mm
0.125-0.25 mm	9.2%		
0.063-0.125 mm	8.7%		
<0.063 mm	12.7%		
		C_U	29.36
amount	2502 g	C_C	0.80



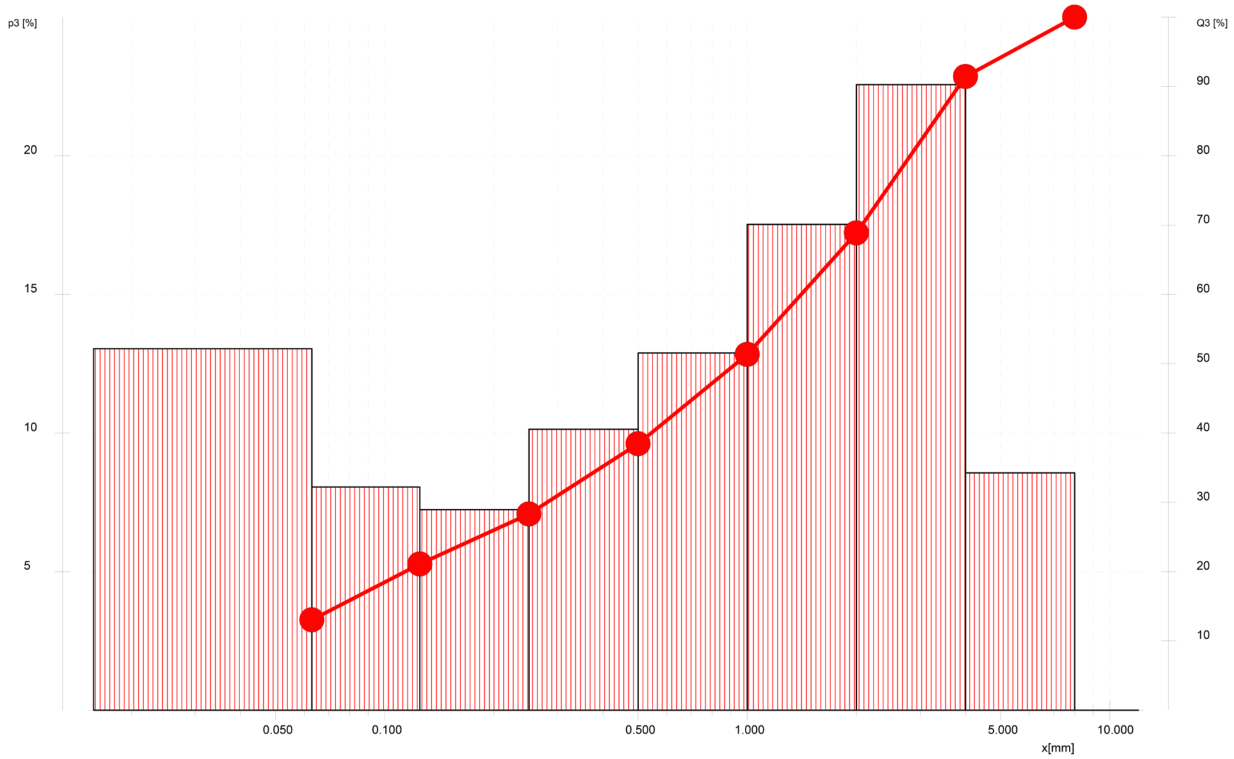
Grain size distribution of granular bentonite Conveyor Screw SCH5 24.11.2014.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	11.1%	d_{10}	0.045 mm
21.2	24.3%	d_{30}	0.331 mm
1-2 mm	16.2%	d_{50}	1.100 mm
0.5-1 mm	12.0%	d_{60}	1.718 mm
0.25-0.5 mm	9.4%	d_{90}	4.400 mm
0.125-0.25 mm	6.5%		
0.063-0.125 mm	6.3%		
<0.063 mm	14.1%		
		C_U	38.18
amount	2398 g	C_C	1.42



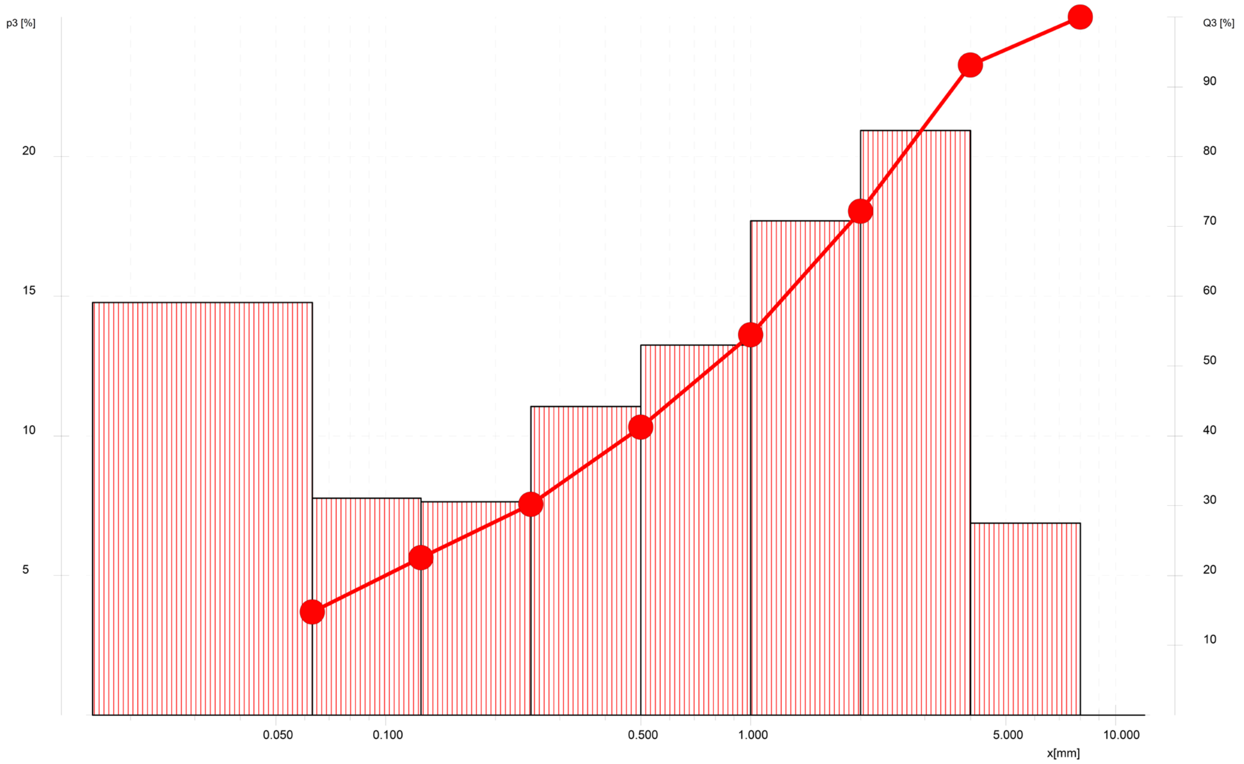
Grain size distribution of granular bentonite Conveyor Screw SCH1 21.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.6%	d_{10}	0.048 mm
21.2	22.6%	d_{30}	0.291 mm
1-2 mm	17.5%	d_{50}	0.948 mm
0.5-1 mm	12.9%	d_{60}	1.442 mm
0.25-0.5 mm	10.1%	d_{90}	3.911 mm
0.125-0.25 mm	7.2%		
0.063-0.125 mm	8.0%		
<0.063 mm	13.0%		
		C_U	30.04
amount	1973 g	C_C	1.22



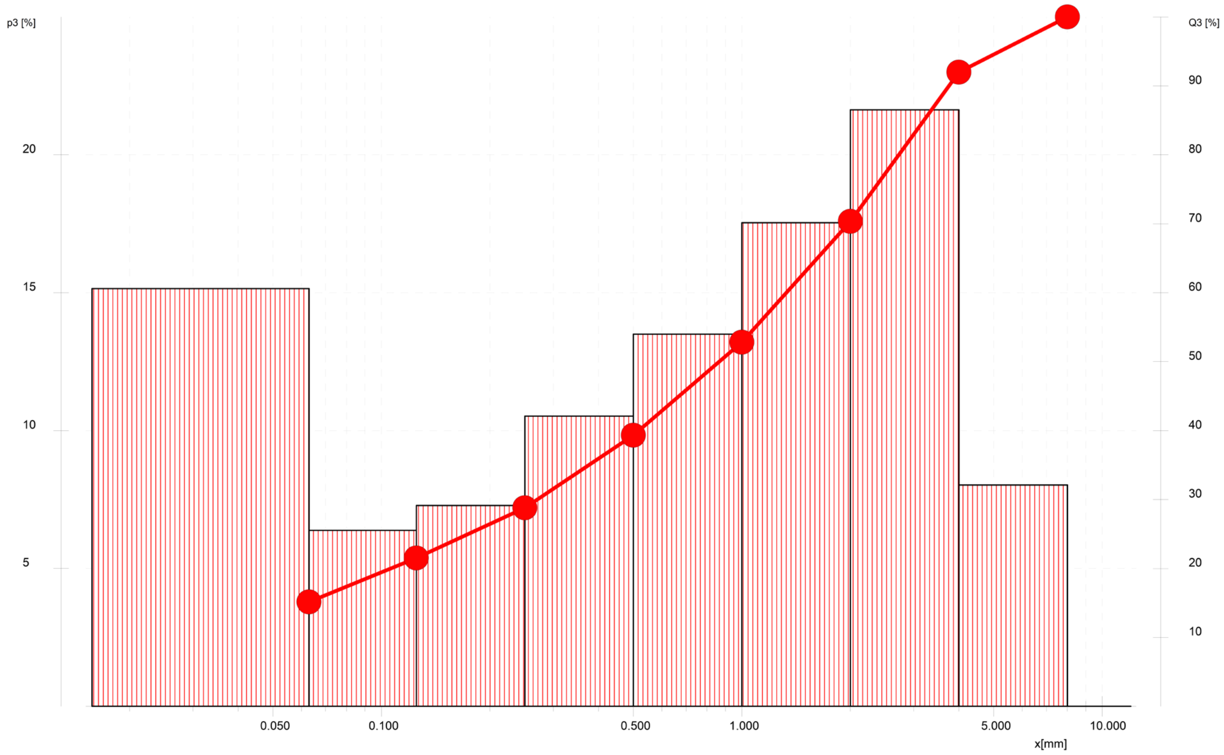
Grain size distribution of granular bentonite Conveyor Screw SCH2 21.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	6.9%	d_{10}	0.043 mm
21.2	20.9%	d_{30}	0.247 mm
1-2 mm	17.7%	d_{50}	0.831 mm
0.5-1 mm	13.3%	d_{60}	1.311 mm
0.25-0.5 mm	11.1%	d_{90}	3.701 mm
0.125-0.25 mm	7.6%		
0.063-0.125 mm	7.8%		
<0.063 mm	14.8%		
		C_U	30.49
amount	2242 g	C_C	1.08



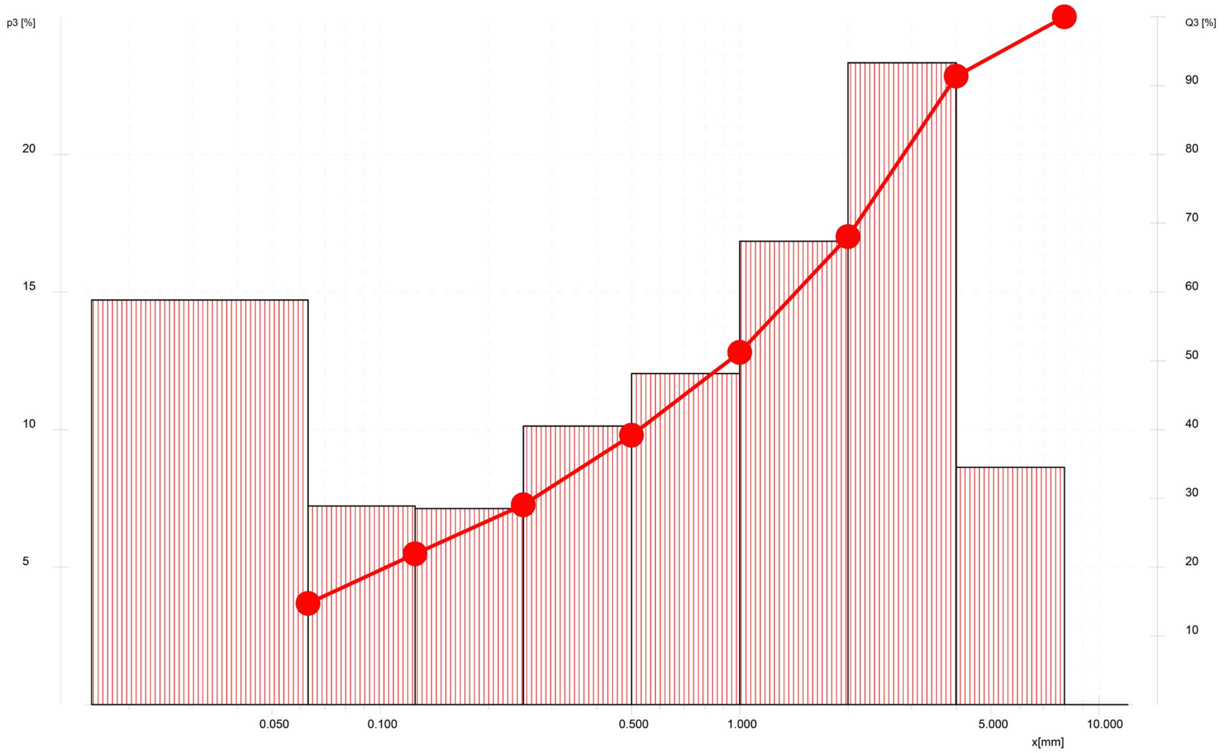
Grain size distribution of granular bentonite Conveyor Screw SCH3 21.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.0%	d_{10}	0.042 mm
21.2	21.6%	d_{30}	0.279 mm
1-2 mm	17.5%	d_{50}	0.896 mm
0.5-1 mm	13.5%	d_{60}	1.410 mm
0.25-0.5 mm	10.5%	d_{90}	3.817 mm
0.125-0.25 mm	7.3%		
0.063-0.125 mm	6.4%		
<0.063 mm	15.1%		
		C_U	33.57
amount	1892 g	C_C	1.31



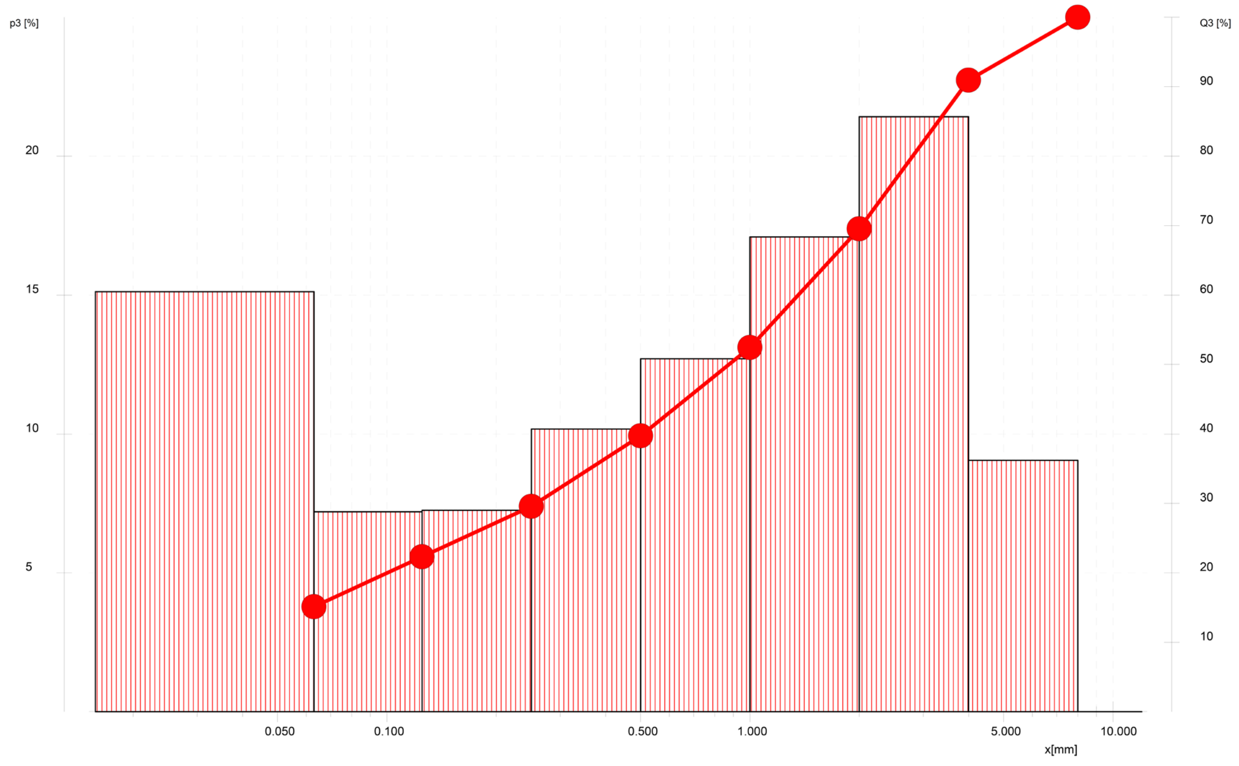
Grain size distribution of granular bentonite Conveyor Screw SCH4 21.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.6%	d_{10}	0.043 mm
21.2	23.3%	d_{30}	0.273 mm
1-2 mm	16.8%	d_{50}	0.950 mm
0.5-1 mm	12.0%	d_{60}	1.522 mm
0.25-0.5 mm	10.1%	d_{90}	3.882 mm
0.125-0.25 mm	7.1%		
0.063-0.125 mm	7.2%		
<0.063 mm	14.7%		
		C_U	35.40
amount	2212 g	C_C	1.14



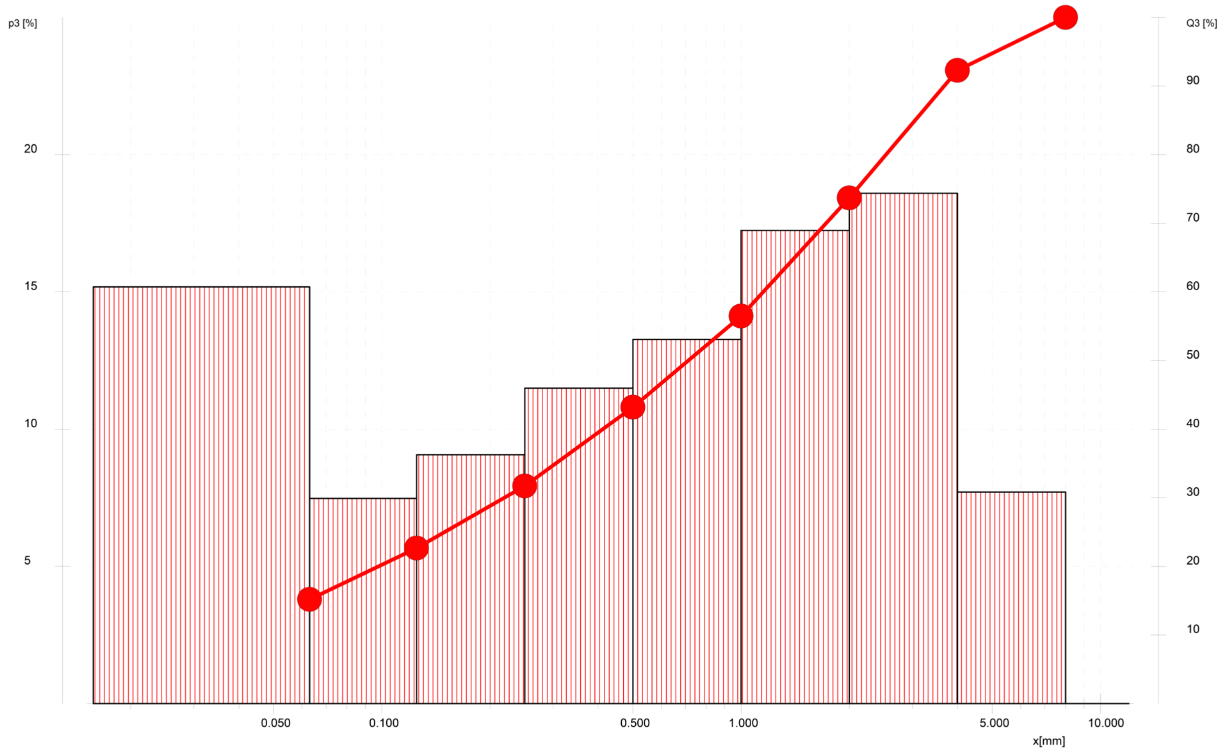
Grain size distribution of granular bentonite Conveyor Screw SCH5 21.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.1%	d_{10}	0.042 mm
21.2	21.4%	d_{30}	0.261 mm
1-2 mm	17.1%	d_{50}	0.904 mm
0.5-1 mm	12.7%	d_{60}	1.442 mm
0.25-0.5 mm	10.2%	d_{90}	3.911 mm
0.125-0.25 mm	7.3%		
0.063-0.125 mm	7.2%		
<0.063 mm	15.1%		
		C_U	34.33
amount	1785 g	C_C	1.12



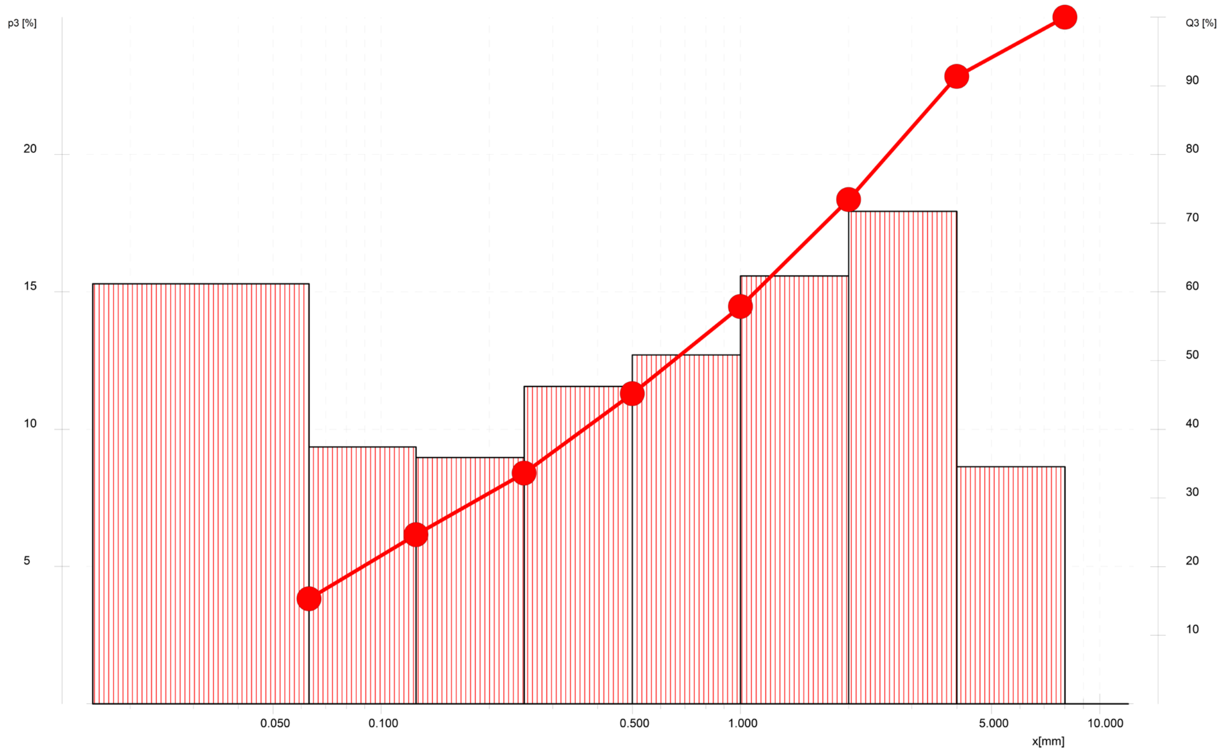
Grain size distribution of granular bentonite Conveyor Screw SCH1 22.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	7.7%	d_{10}	0.042 mm
21.2	18.6%	d_{30}	0.226 mm
1-2 mm	17.2%	d_{50}	0.756 mm
0.5-1 mm	13.3%	d_{60}	1.205 mm
0.25-0.5 mm	11.5%	d_{90}	3.753 mm
0.125-0.25 mm	9.1%		
0.063-0.125 mm	7.5%		
<0.063 mm	15.2%		
		C_U	28.69
amount	2142 g	C_C	1.01



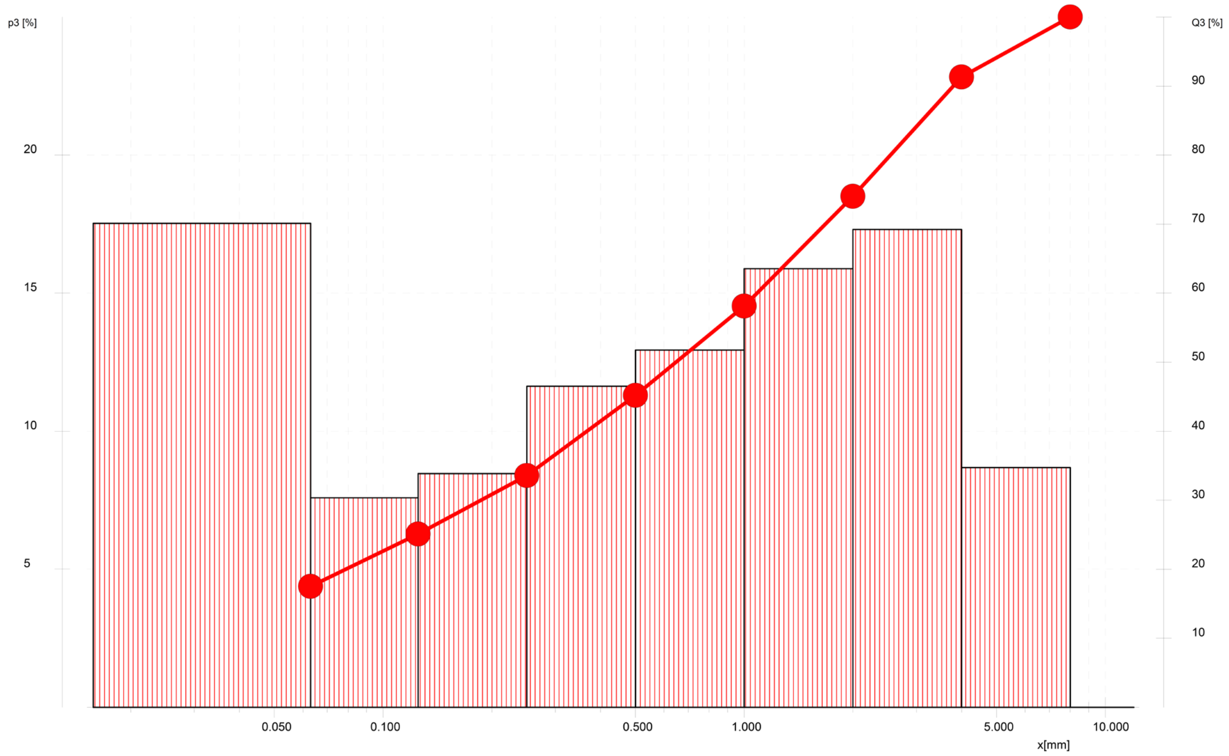
Grain size distribution of granular bentonite Conveyor Screw SCH2 22.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.6%	d_{10}	0.041 mm
21.2	17.9%	d_{30}	0.200 mm
1-2 mm	15.6%	d_{50}	0.691 mm
0.5-1 mm	12.7%	d_{60}	1.137 mm
0.25-0.5 mm	11.6%	d_{90}	3.847 mm
0.125-0.25 mm	9.0%		
0.063-0.125 mm	9.3%		
<0.063 mm	15.3%		
		C_U	27.73
amount	2094 g	C_C	0.86



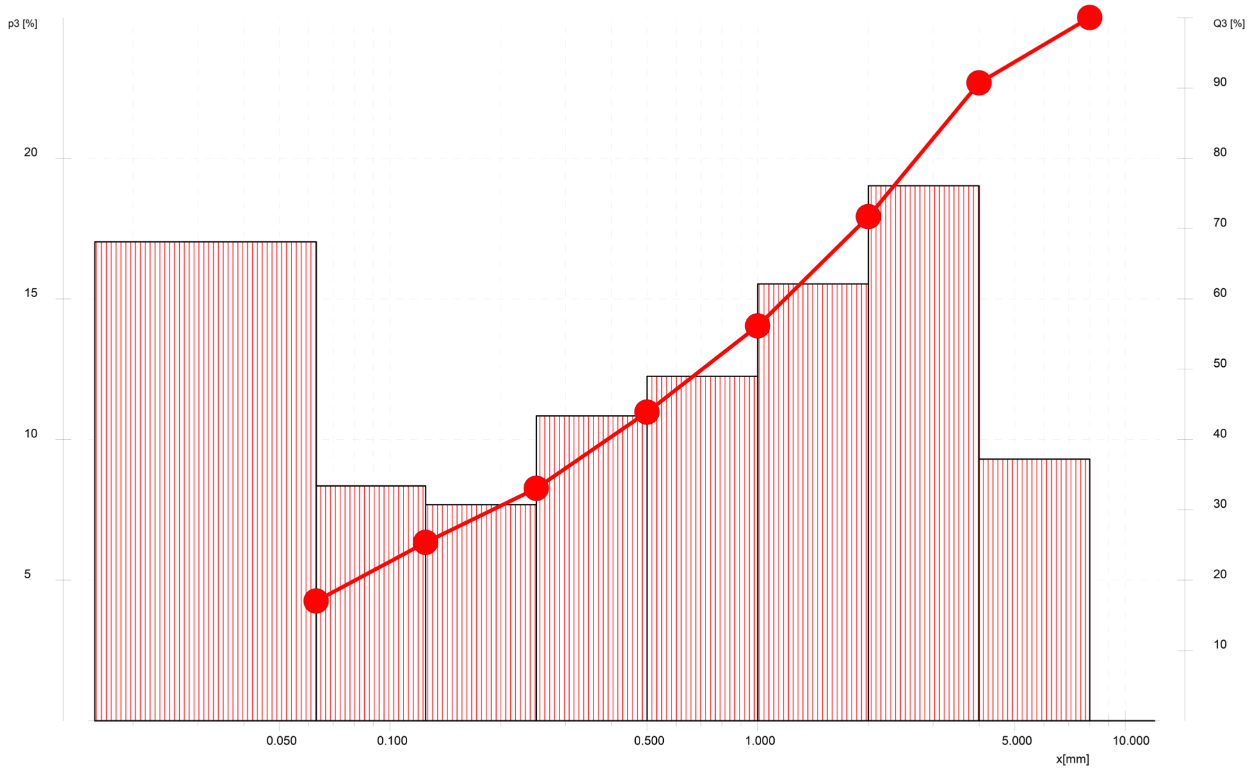
Grain size distribution of granular bentonite Conveyor Screw SCH3 22.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.7%	d_{10}	0.036 mm
21.2	17.3%	d_{30}	0.197 mm
1-2 mm	15.9%	d_{50}	0.686 mm
0.5-1 mm	12.9%	d_{60}	1.118 mm
0.25-0.5 mm	11.6%	d_{90}	3.847 mm
0.125-0.25 mm	8.5%		
0.063-0.125 mm	7.6%		
<0.063 mm	17.5%		
		C_U	31.06
amount	1842 g	C_C	0.96



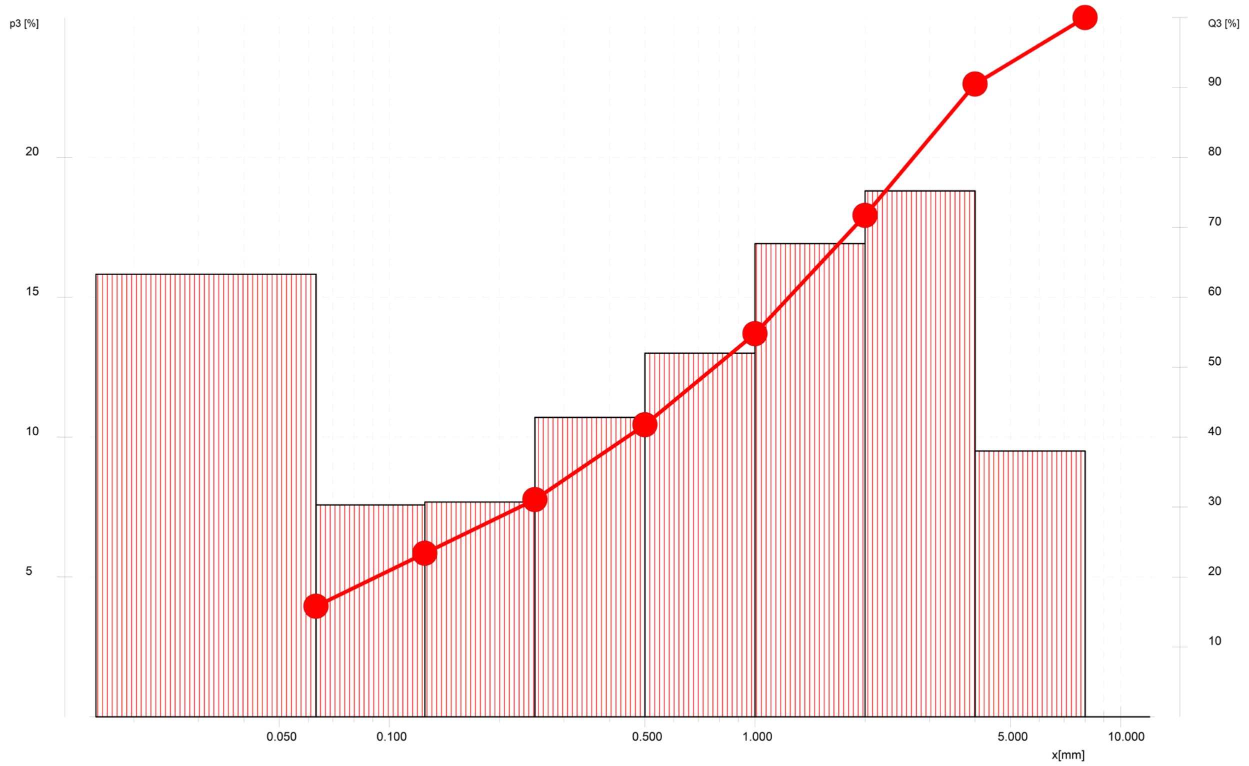
Grain size distribution of granular bentonite Conveyor Screw SCH4 22.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.3%	d_{10}	0.037 mm
21.2	19.0%	d_{30}	0.200 mm
1-2 mm	15.5%	d_{50}	0.749 mm
0.5-1 mm	12.3%	d_{60}	1.248 mm
0.25-0.5 mm	10.8%	d_{90}	3.927 mm
0.125-0.25 mm	7.7%		
0.063-0.125 mm	8.3%		
<0.063 mm	17.0%		
		C_U	33.73
amount	2399 g	C_C	0.87



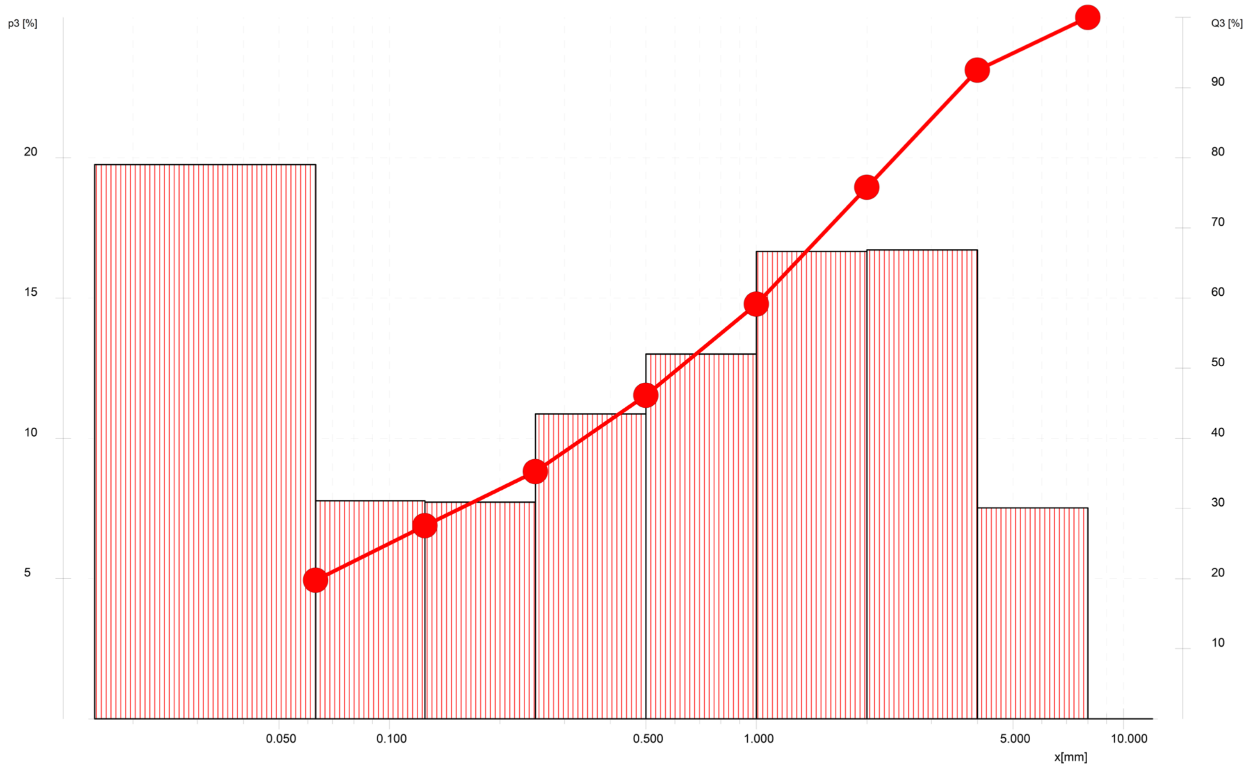
Grain size distribution of granular bentonite Conveyor Screw SCH5 22.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.5%	d_{10}	0.040 mm
21.2	18.8%	d_{30}	0.233 mm
1-2 mm	16.9%	d_{50}	0.816 mm
0.5-1 mm	13.0%	d_{60}	1.309 mm
0.25-0.5 mm	10.7%	d_{90}	3.947 mm
0.125-0.25 mm	7.7%		
0.063-0.125 mm	7.6%		
<0.063 mm	15.8%		
		C_U	32.72
amount	1922 g	C_C	1.04



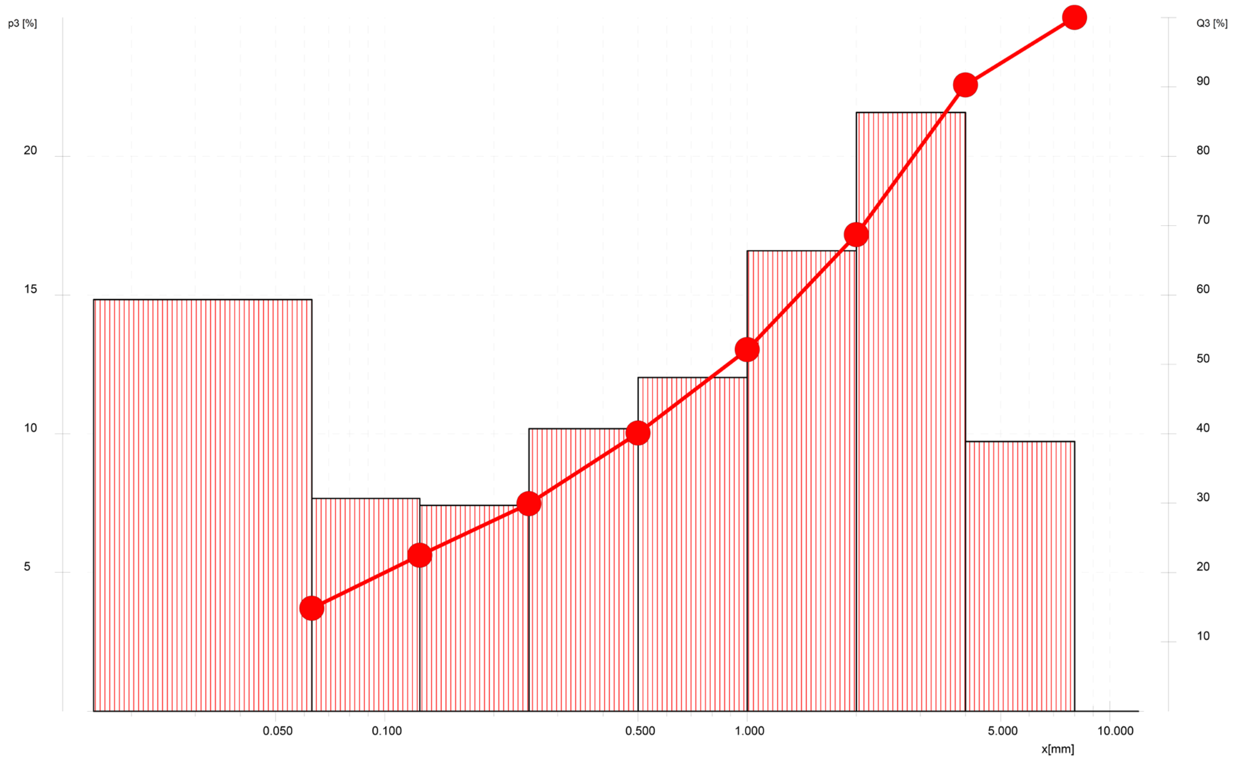
Grain size distribution of granular bentonite Conveyor Screw SCH1 23.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	7.5%	d_{10}	0.032 mm
21.2	16.7%	d_{30}	0.165 mm
1-2 mm	16.7%	d_{50}	0.649 mm
0.5-1 mm	13.0%	d_{60}	1.053 mm
0.25-0.5 mm	10.9%	d_{90}	3.703 mm
0.125-0.25 mm	7.7%		
0.063-0.125 mm	7.8%		
<0.063 mm	19.8%		
		C_U	32.91
amount	1969 g	C_C	0.81



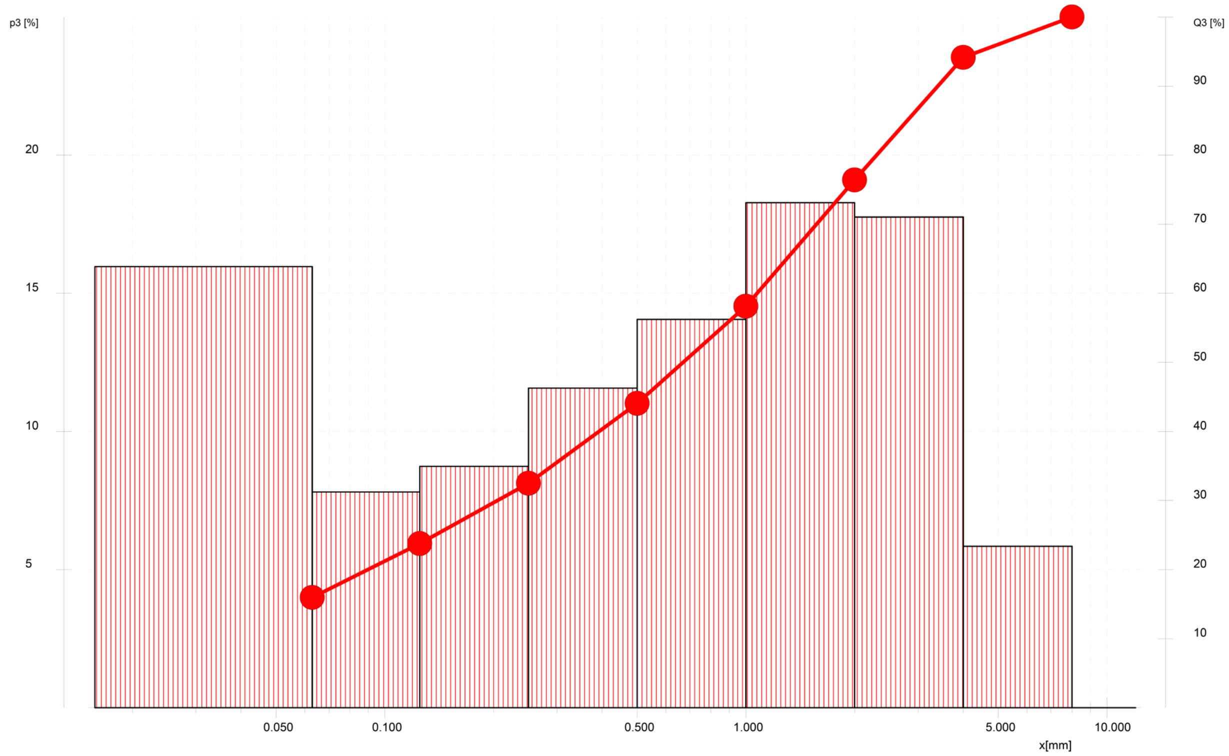
Grain size distribution of granular bentonite Conveyor Screw SCH2 23.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.7%	d_{10}	0.042 mm
21.2	21.6%	d_{30}	0.252 mm
1-2 mm	16.6%	d_{50}	0.912 mm
0.5-1 mm	12.0%	d_{60}	1.475 mm
0.25-0.5 mm	10.2%	d_{90}	3.974 mm
0.125-0.25 mm	7.4%		
0.063-0.125 mm	7.7%		
<0.063 mm	14.8%		
		C_U	35.12
amount	2387 g	C_C	1.02



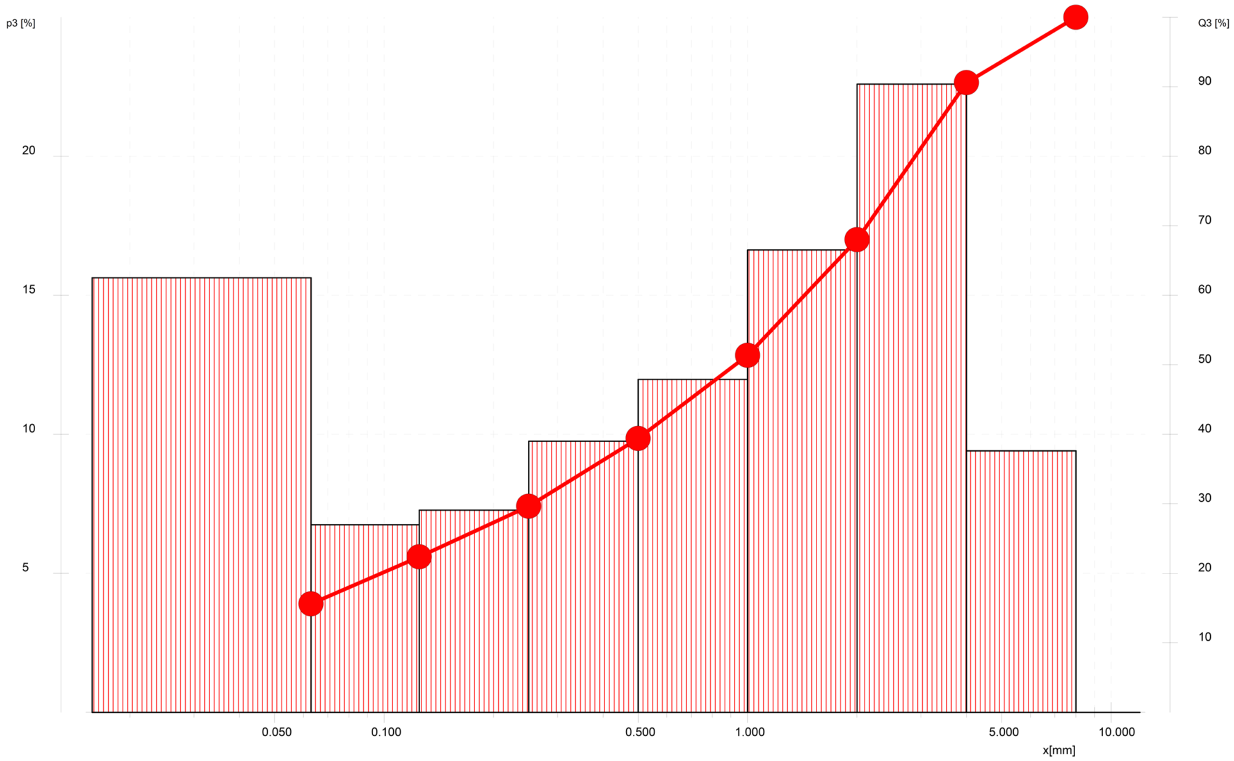
Grain size distribution of granular bentonite Conveyor Screw SCH3 23.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	5.8%	d_{10}	0.039 mm
21.2	17.8%	d_{30}	0.214 mm
1-2 mm	18.3%	d_{50}	0.711 mm
0.5-1 mm	14.1%	d_{60}	1.103 mm
0.25-0.5 mm	11.6%	d_{90}	3.532 mm
0.125-0.25 mm	8.7%		
0.063-0.125 mm	7.8%		
<0.063 mm	16.0%		
		C_U	28.28
amount	1735 g	C_C	1.06



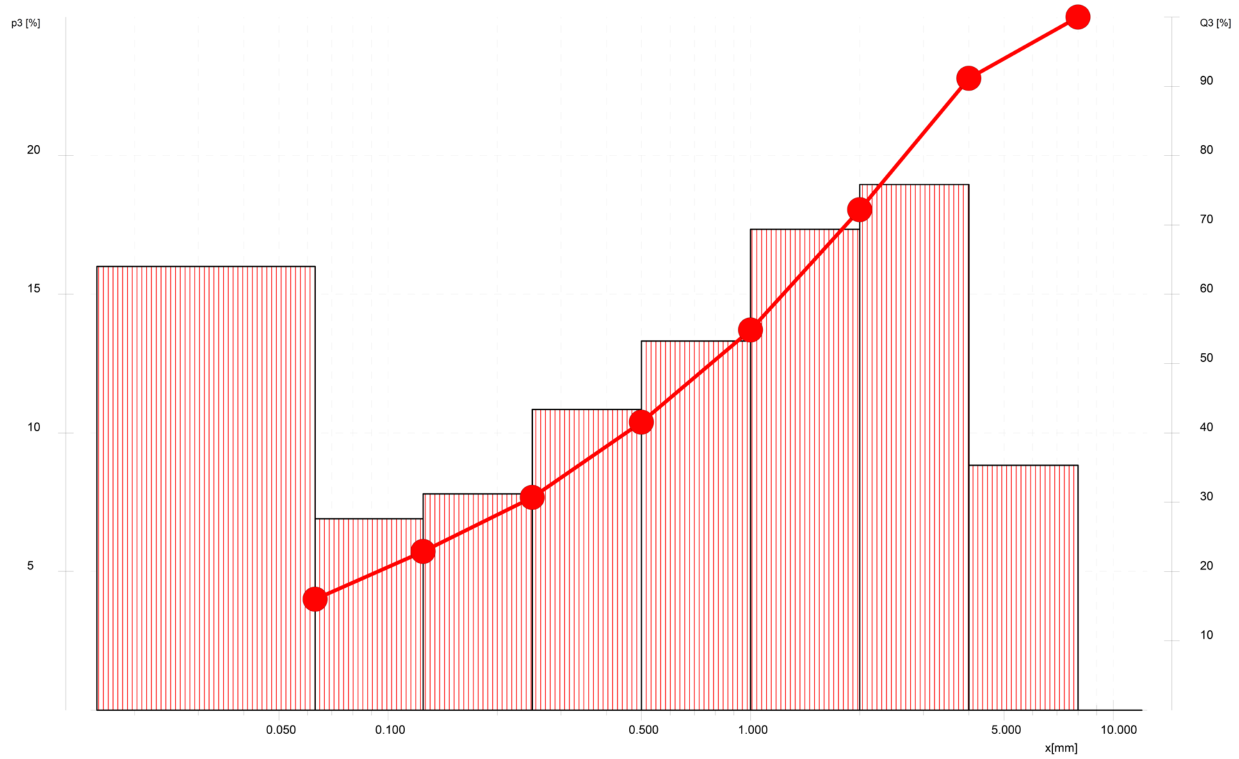
Grain size distribution of granular bentonite Conveyor Screw SCH4 23.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	9.4%	d_{10}	0.040 mm
21.2	22.6%	d_{30}	0.259 mm
1-2 mm	16.6%	d_{50}	0.943 mm
0.5-1 mm	12.0%	d_{60}	1.519 mm
0.25-0.5 mm	9.8%	d_{90}	3.947 mm
0.125-0.25 mm	7.3%		
0.063-0.125 mm	6.7%		
<0.063 mm	15.6%		
		C_U	37.98
amount	2309 g	C_C	1.10



Grain size distribution of granular bentonite Conveyor Screw SCH5 23.01.2015.

Parameter		Parameter	
>8 mm	0%		
4-8 mm	8.8%	d_{10}	0.039 mm
21.2	19.0%	d_{30}	0.239 mm
1-2 mm	17.3%	d_{50}	0.817 mm
0.5-1 mm	13.3%	d_{60}	1.296 mm
0.25-0.5 mm	10.8%	d_{90}	3.877 mm
0.125-0.25 mm	7.8%		
0.063-0.125 mm	6.9%		
<0.063 mm	16.0%		
		C_U	33.23
amount	2242 g	C_C	1.13



Appendix H: Quality certificates for the raw material offered by CEBO

Note: The raw material proposed by CEBO is a natural sodium bentonite, mined by Bentonite Performance Minerals (BPM) in Wyoming. The commercial name of this bentonite is National ® Standard. The commercial name of the bentonite produced by CEBO as end product of WP 2 is National ® Standard WP2. Bentonite Performance Minerals (BPM) is a mining company owned by Halliburton since 2003. Since 2006, Halliburton also owns 50 % of CEBO (the other 50 % of CEBO are owned by S&B) and since January 2013 CEBO is the official reseller of bentonite for BPM in Europe. The crude material arrives in shipments of 20'000 tons in Amsterdam's harbour and is then distributed by CEBO.

National Standard WP2

Product Data Sheet

Application
Sealing

Description
The basis for **National Standard WP2** is a natural sodium bentonite from Wyoming (U.S.A.), which has been specially selected for environmental use such as soil sealing. A feature of **National Standard WP2** is its considerable water absorption capacity, as a result of swelling up considerably when in contact with water.

Properties
National Standard WP2 has the following properties;

High swelling capacity
The large water absorption capacity makes a very high-quality bentonite seal possible.

National Standard WP2 has the following typical values;

Typical values National Standard WP2		
Parameter	**Test method**	**Typical value**
Montmorillonite content	XRD	**89 – 90%**
Moisture content	DIN 18121-1	**4,5 – 6,5%**
Water absorption capacity after 24 hours	DIN 18132	**850%**
Specific density	-	**2300 kg / m^3 +/- 10%**
Bulk density	-	**1100 kg / m^3 +/- 10%**

National Standard WP2 has the following chemical and physical properties;

Chemical and physical properties National Standard WP2	
Composition	**High quality natural sodium bentonite**
Colour	**Light gray**
Grain size	**0,5% > 1,0 mm** **3% < 0,074 mm**

Packaging
National Standard WP2 is available in the following packaging;
- 1000 kg big bag

Revision date : 22.11.2013
Document number : 101001GB

Cebo Holland

Industrial Minerals, Powerful Logistics

Cebo Holland BV, Westerduinweg 1, 1976 BV IJmuiden, The Netherlands
Tel. +31(0)255-546262, Fax +31-(0)255-546202, info@cebo.com, www.cebo.com

Safety data sheet

according to 1907/2006/EC, Article 31

Printing date 03.12.2013 Version number 3 Revision: 05.06.2013

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SECTION 1: Identification of the substance/mixture and of the company/undertaking

· ***1.1 Product identifier***

· ***Trade name:*** National standard WP2

· ***CAS Number:***
1302-78-9

· ***EC number:***
215-108-5

· ***Registration number***
This product is exempt from REACH registration according to EC Regulation 1907/2006 Article 2 § 7 b and Annex V, point 7.

· ***1.2 Relevant identified uses of the substance or mixture and uses advised against*** -

· ***Application of the substance / the preparation*** Used in various industrial applications.

· ***1.3 Details of the supplier of the safety data sheet***

· ***Manufacturer/Supplier:***
CEBO Holland B.V.
Westerduinweg 4
NL-1970 AB IJmuiden
The Netherlands
tel: +31(0)255-546262
fax: +31(0)255-546202
www.cebo.com

· ***Further information obtainable from:*** Product safety department: msds@cebo.com

· ***1.4 Emergency telephone number:***
National Poisons Information Service (NPIS): 0870 600 6266 (UK only).
Cebo Holland +31(0)255-546245 (only during local working hours)

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SECTION 2: Hazards identification

· ***2.1 Classification of the substance or mixture***

· ***Classification according to Regulation (EC) No 1272/2008*** The substance is not classified according to the CLP regulation.

· ***Classification according to Directive 67/548/EEC or Directive 1999/45/EC*** Not applicable.

· ***Information concerning particular hazards for human and environment:***
This product may contains a certain amount of crystalline silica. However the grain size distribution of the product means that it is not classified as hazardous.
Any respirable crystalline dust generated by processing and handling of the product may cause health effects (see chapter 11).

· ***2.2 Label elements***

· ***Labelling according to Regulation (EC) No 1272/2008*** Not applicable

· ***Hazard pictograms*** Not applicable

· ***Signal word*** Not applicable

· ***Hazard statements*** Not applicable

· ***2.3 Other hazards***
Depending on the type of handling and use (e.g. grinding, drying), airborne respirable crystalline silica may be generated. Prolonged and/or massive inhalation of respirable crystalline silica dust may cause lung fibrosis, commonly referred to as silicosis. Principal symptoms of silicosis are cough and breathlessness.
Occupational exposure to respirable crystalline.

· ***Results of PBT and vPvB assessment***

· ***PBT:*** Does not meet the criteria for classification as PBT.

· ***vPvB:*** Does not meet the criteria for classification as vPvB.

SECTION 3: Composition/information on ingredients

· ***3.1 Substances***

· ***CAS No. Description***
1302-78-9 Bentoniet

(Contd. on page 2)

Safety data sheet
according to 1907/2006/EC, Article 31

Printing date 03.12.2013 Version number 3 Revision: 05.06.2013

Trade name: **National standard WP2**

(Contd. of page 1)

· ***Identification number(s)***
· ***EC number:*** 215-108-5

* SECTION 4: First aid measures

· ***4.1 Description of first aid measures***
· ***General information:*** No known delayed effects. Consult a physician for all exposures except for minor instances.
· ***After inhalation:***
Supply fresh air; consult doctor in case of complaints.
In case of unconsciousness place patient stably in side position for transportation.
· ***After skin contact:***
Immediately wash with water and soap and rinse thoroughly.
If skin irritation continues, consult a doctor.
· ***After eye contact:***
Flush with plenty of water, also under the eyelids, for at least 15 minutes. If possible, use handwarm water. Consult a physician. Do not rub eyes, mechanical irritation.
· ***After swallowing:***
Rinse out mouth and then drink plenty of water.
If symptoms persist consult doctor.
· ***4.2 Most important symptoms and effects, both acute and delayed***
The acute symptoms would cause pain in the eyes because of dust. No delayed effects are anticipated if first aid treatment is applied effectively.
· ***4.3 Indication of any immediate medical attention and special treatment needed***
No need for immediate medical attention; follow the advises given in section 4.1

* SECTION 5: Firefighting measures

· ***5.1 Extinguishing media***
· ***Suitable extinguishing agents:***
The product is not combustible. Use a dry water, powder, foam or CO2 fire extinguisher to extinguish the surrounding fire.
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
· ***5.2 Special hazards arising from the substance or mixture*** No hazardous thermal decomposition products.
· ***5.3 Advice for firefighters***
· ***Protective equipment:***
Breathing apparatus is adviced.
Standard equipment for firefighters.
Product on floor when wetted will become slippery and may present a hazard; wear anti-slip boots.

* SECTION 6: Accidental release measures

· ***6.1 Personal precautions, protective equipment and emergency procedures***
Wear protective equipment. Keep unprotected persons away.
Ensure adequate ventilation
Remove persons from danger area.
Product forms slippery surface when combined with water.
Avoid formation of dust.
· ***6.2 Environmental precautions:***
If product is released from trucks in roads, place signposts to divert traffic and remove the spill using vacuum cleaning systems.
· ***6.3 Methods and material for containment and cleaning up:***
Moisten spilled material with water before cleanup.
Pick up mechanically.
· ***6.4 Reference to other sections***
No dangerous substances are released.
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.

(Contd. on page 3)

Safety data sheet
according to 1907/2006/EC, Article 31

(Contd. of page 2)

See Section 13 for disposal information.

* SECTION 7: Handling and storage

· ***7.1 Precautions for safe handling***
Prevent formation of dust.
Ensure good ventilation/exhaustion at the workplace.
More information about handling can be found via de link in Chapter 16.
· ***Information about fire - and explosion protection:*** The product is not flammable.

· ***7.2 Conditions for safe storage, including any incompatibilities***
· ***Storage:***
· ***Requirements to be met by storerooms and receptacles:*** Store in a dry place.
· ***Information about storage in one common storage facility:***
Minimise airborne dust generation and prevent wind dispersal during loading and unloading. Keep containers closed and store packaged products so as to prevent accidental bursting.
· ***Further information about storage conditions:*** None.
· ***7.3 Specific end use(s)*** No further relevant information available.

* SECTION 8: Exposure controls/personal protection

· ***Additional information about design of technical facilities:*** No further data; see item 7.

· ***8.1 Control parameters***
· ***Ingredients with limit values that require monitoring at the workplace:***
The OEL (Occupational Exposure Limit) for respirable crystalline silica dust is 4 mg/m³ in Great Brittain, measured as an 8 hour TWA (Time Weighted Average). For the equivalent limits in other countries, please consult a competent occupational hygienist or the local regulatory authority.
Maintain personal exposure below occupational exposure limit for inhalable and respirable dust as dictated in the national legislation.
· ***Additional information:*** The lists valid during the making were used as basis.

· ***8.2 Exposure controls***
· ***Personal protective equipment:***
· ***General protective and hygienic measures:***
The usual precautionary measures are to be adhered to when handling chemicals.
Keep away from foodstuffs, beverages and feed.
Wash hands before breaks and at the end of work.
Do not eat, drink, smoke or sniff while working.
· ***Respiratory protection:***
Short term filter device:
Local ventilation to keep levels below established threshold values is recommended. In case of prolonged exposure to airborne dust concentrations, a suitable particle filter mask that complies with the requirements of national legislation is recommended, depending on the expected exposure levels.
Thermal hazard.
· ***Protection of hands:***
Protective gloves and protective skin cream
The glove material has to be impermeable and resistant to the product/ the substance/ the preparation.
The use of protective gloves must comply with the specifiacties of EC directive 89/686/EEC and the resultant standard EN374.
· ***Material of gloves***
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer. As the product is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.
· ***Penetration time of glove material***
The determined penetration times according to EN 374 part III are not performed under practical conditions. Therefore a maximum wearing time, which corresponds to 50% of the penetration time, is recommended.

(Contd. on page 4)

(Contd. of page 3)

· ***Eye protection:***

Tightly sealed goggles

Do not wear contact lenses.
For powders, tight fitting goggles with side shields, or wide vison full goggles.
It is also advisable to have individual pocket eyewash.

· ***Limitation and supervision of exposure into the environment***
Emissions from ventilation or work process equipment should be checked to ensure that it meets the requirements of environmental legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment to reduce emissions to acceptable levels.

* SECTION 9: Physical and chemical properties

· ***9.1 Information on basic physical and chemical properties***	
· ***General Information***	
· ***Appearance:***	
Form:	Solid in various forms
Colour:	According to product specification
· ***Odour:***	Odourless
· ***Odour threshold:***	Not determined.
· ***pH-value:***	9.0 - 10.5 (5% solids in water suspension)
· ***Change in condition***	
Melting point/Melting range:	>450 °C (EU A.1)
Boiling point/Boiling range:	Not applicable.
· ***Flash point:***	Not applicable.
· ***Flammability (solid, gaseous):***	Product is not flammable.
· ***Ignition temperature:***	
Decomposition temperature:	Not applicable.
· ***Self-igniting:***	Not applicable
· ***Danger of explosion:***	Product does not present an explosion hazard.
· ***Explosion limits:***	
Lower:	Not applicable.
Upper:	Not applicable.
· ***Dust explosion:***	
Vapour pressure:	Not applicable.
· ***Density at 20 °C:***	2.6 g/cm³
· ***Bulk density at 20 °C:***	1 - 1.4 kg/m³
· ***Vapour density***	Not applicable.
· ***Evaporation rate***	Not applicable.
· ***Solubility in / Miscibility with water at 20 °C:***	<0.0009 g/l (EU A.6)
· ***Partition coefficient (n-octanol/water):***	Not determined.
· ***Viscosity:***	
Dynamic:	Not applicable.
Kinematic:	Not applicable.

(Contd. on page 5)

(Contd. of page 4)

· ***Solvent content:***	
Organic solvents:	0.0 %
VOC (EC)	0.00 %
Solids content:	100.0 %
· ***9.2 Other information***	No further relevant information available.

*
SECTION 10: Stability and reactivity

· ***10.1 Reactivity*** Inert, non reactive.
· ***10.2 Chemical stability*** Stable
· ***Thermal decomposition / conditions to be avoided:*** No decomposition if used according to specifications.
· ***10.3 Possibility of hazardous reactions*** No dangerous reactions known.
· ***10.4 Conditions to avoid*** No further relevant information available.
· ***10.5 Incompatible materials:*** Do not store together with materials that may be affected by dust.
· ***10.6 Hazardous decomposition products:*** No dangerous decomposition products known.

*
SECTION 11: Toxicological information

· ***11.1 Information on toxicological effects***
· ***Acute toxicity:***

· ***LD/LC50 values relevant for classification:***		
1302-78-9 Bentoniet		
Oral	LD50	> 2000 mg/kg (rat) (OECD 420)
Inhalative	LC50/4 h	> 5.27 mg/l (rat) (OECD 436)

· ***Primary irritant effect:***

· ***on the skin:***		
1302-78-9 Bentoniet		
Irritation of skin	In vivo	negative (rabbit)

· ***on the eye:***		
1302-78-9 Bentoniet		
Irritation of eyes	In vivo	negative (rabbit) Kay & Calandra: mild irritant to eyes.

· ***Sensitization:***		
1302-78-9 Bentoniet		
Sensitisation	Local lymph node assay	negative (-)

· ***Additional toxicological information:***
When used and handled according to specifications, the product does not have any harmful effects to our experience and the information provided to us.
The substance is not subject to classification according to the latest version of the EU lists.
· ***Repeated dose toxicity***
STOT Oral:
Short-term repeated dose toxicity study (28 days) and sub-chronic toxicity study (90 day) on mices have been conducted with bentonite.
Bentonite fed to mice at 10%, 25%, or 50% for 61 days. Hepatoma was seen in mice receiving a diet of 50% bentonite. This was due to bentonite being a base-exchange silicate and thus removing choline from the content of the intestine > 200 day feeding study of 50% bentonite. Hepatomas developed in 11 of 12 mice. The livers of mice on 50/50 bentonite-basal diet were severely damaged.
The liver damage noted in the group ingesting bentonite is consistent with that expected during prolonged choline deficiency, a base-exchange silicate, is advanced as a partial explanation for the development of the hepatomas in the mice in these experiments
Effect seen on livers. However study were conducted in mice at very high concentration and effects seen are considered secondary due to disrupture of digestion.

(Contd. on page 6)

(Contd. of page 5)

Therefore, classification of bentonite for toxicity upon prolonged exposure by oral route is not warranted.

STOT Inhalation:
Animal and in vitro data indicate a difference between crystalline quartz and the quartz-content of bentonite. A quantitative assessment based on the animal data is not possible as no relevant repeated-dose inhalation study is available.
Human data is restricted to case reports that suggest a relationship between high bentonite exposure (exposures in the early 20th century without state-of-the-art protective measures and maximum dust exposure limits). The link between bentonite exposure and silicosis is not considered to be demonstrated sufficiently.
With regards to classification and labelling of bentonite, the evidence is not considered adequate to come to a conclusion on specific classification of bentonite with specific target organ toxicity upon repeated exposure (STOT-RE). The lung can be affected at repeated high-dose exposure which has been suggested by case reports in humans. Whether this effect occurs only at concentrations overloading the lung’s clearance capacity and is not relevant to humans since establishment of general dust exposure limits.
Therefore, classification of bentonite for toxicity upon prolonged exposure by inhalation is not warranted.
Prolonged and/or massive exposure to respirable crystalline silica-containing dust may cause silicosis, a nodular pulmonary fibrosis caused by deposition in the lungs of fine respirable particles of crystalline silica.

· ***CMR effects (carcinogenity, mutagenicity and toxicity for reproduction)***
Carcinogenicity:
No data available.
Sepiolite was evaluated by IARC as class 3 ("Cannot be classified as to carcinogenicity to humans"). Based on read-across with sepiolite, entonite
was assessed as non-carcinogenic.
Classification for carcinogenicity is not warranted.Toxicity for reproduction:

Reproduction Toxicity:
Two developmental studies are available:
* Abdel-Wahhab et al (1999): Bentonite had no effect on maternal and fetal parameters at a dietary level of 0.5% w/w (equivalent to 250 mg/kg bw).
* Wiles et al (2004): 2% calcium montmorillonite or sodium montmorillonite in the diet had no effect on maternal weight or maternal organ weights, litter weight, embryonic implantations, or resorptions.
In both animal studies no effects on maternal/foetal parameters were detected.
Classification for reproductive toxicity according to regulation (EC) 1272/2008 is not warranted.
In 1997, IARC (the International Agency for Research on Cancer) concluded that crystalline silica inhaled from occupational sources can cause lung cancer in humans. However it pointed out that not all industrial circumstances, nor all crystalline silica types, were to be incriminated. (IARC Monographs on the evaluation of the carcinogenic risks of chemicals to humans, Silica, silicates dust and organic fibres, 1997, Vol. 68, IARC, Lyon, France.)
In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. “There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore preventing the onset of silicosis will also reduce the cancer risk…“ (SCOEL SUM Doc 94-final, June 2003).
So there is a body of evidence supporting the fact that increased cancer risk would be limited to people already suffering from silicosis. Worker protection against silicosis should be assured by respecting the existing regulatory occupational exposure limits and implementing additional risk management measures where required (see section 16 below).

· ***Test Results:***	
1302-78-9 Bentoniet	
In vitro	negative (-) (OECD 471, 473, 476.)

*
SECTION 12: Ecological information

· ***12.1 Toxicity***

· ***Aquatic toxicity:***	
1302-78-9 Bentoniet	
EC50 (48h)	> 100 mg/l (Daphnia Magna)

(Contd. on page 7)

(Contd. of page 6)

EC50 (72h)	> 100 mg/l (Freshwater Algae)
EC50 (96h)	81.6 mg/l (Dungeness Crab)
	24.8 mg/l (Dock Shrimp)
LC50 (24h)	2800-3200 mg/l (Black Bass)
	2800-3200 mg/l (Blue Gill)
	> 500 mg/l (C. Dubia)
	> 500 mg/l (H. Limbata)
	2800-3200 mg/l (Sun Fish)
	2800-3200 mg/l (Warmouth Bass)
LC50 (96h)	16000 mg/l (Rainbow Trout)

· ***12.2 Persistence and degradability*** Not relevant for inorganic substances.
· ***12.3 Bioaccumulative potential*** Not relevant for inorganic substances
· ***12.4 Mobility in soil*** Bentonite is almost insoluble and thus presents a low mobility in most soils.
· ***Other information:***
No effect was observed on the growth of beans (Phaseolus vulgaris) or corn (Zea mays) when bentonite was added at a concentration of 135 g/1.6 kg soil.
· ***Additional ecological information:***
· ***General notes:***
This material is on the PLONOR safe list for OSPAR.
Generally not hazardous for water
· ***12.5 Results of PBT and vPvB assessment***
· ***PBT:*** Does not meet the criteria for classification as PBT.
· ***vPvB:*** Does not meet the criteria for classification as vPvB.
· ***12.6 Other adverse effects*** No further relevant information available.

* SECTION 13: Disposal considerations

· ***13.1 Waste treatment methods***
· ***Recommendation***
The residues/unused product can be disposed in landfills following national and local regulations.
Dispose in such a way to avoid dust generation. Where possible, recycling should be preferred to disposal.

· ***Uncleaned packaging:***
· ***Recommendation:*** Empty contaminated packagings thoroughly. They may be recycled after thorough and proper cleaning.

SECTION 14: Transport information

· ***14.1 UN-Number*** · ***ADR, ADN, IMDG, IATA***	Not applicable
· ***14.2 UN proper shipping name*** · ***ADR, ADN, IMDG, IATA***	Not applicable
· ***14.3 Transport hazard class(es)*** · ***ADR, ADN, IMDG, IATA*** · ***Class***	Not applicable
· ***14.4 Packing group*** · ***ADR, IMDG, IATA***	Not applicable
· ***14.5 Environmental hazards:*** · ***Marine pollutant:***	No

(Contd. on page 8)

· ***14.6 Special precautions for user***	Not applicable.
· ***14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code***	Not applicable.
· ***UN "Model Regulation":***	-

*
SECTION 15: Regulatory information

· ***15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture***

· ***National regulations:***

· ***Other regulations, limitations and prohibitive regulations*** This material is on the PLONOR safe list for OSPAR.

· ***15.2 Chemical safety assessment:***
Bentonite is exempted from REACH registration in accordance with Annex V.7. A hazard assessment has been conducted under the umbrella of the European Bentonite Association (EUBA) and the outcome was that bentonite is not a hazardous substances.
A Chemical Safety Assessment has not been carried out.

*
SECTION 16: Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· ***Training hints***
A multi-sectoral social dialogue agreement on Workers Health Protection through the Good Handling and Use of Crystalline Silica and Products Containing it was signed on 25 April 2006. This autonomous agreement, which receives the European Commission's financial support, is based on a Good Practices Guide. The requirements of the Agreement came into force on 25 October 2006. The Agreement was published in the Official Journal of the European Union (2006/C 279/02). The text of the Agreement and its annexes, including the Good Practices Guide, are available from http://www.nepsi.eu and provide useful information and guidance for the handling of products containing respirable crystalline silica. Literature references are available on request from EUROSIL, the European Association of Industrial Silica Producers,

· ***Department issuing MSDS:*** Product safety department

· ***Abbreviations and acronyms:***
RID: Règlement international concernant le transport des marchandises dangereuses par chemin de fer (Regulations Concerning the International Transport of Dangerous Goods by Rail)
ICAO: International Civil Aviation Organization
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
EINECS: European Inventory of Existing Commercial Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
VOC: Volatile Organic Compounds (USA, EU)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent

· **** Data compared to the previous version altered.***

Appendix I: Independent QC by BGR of the bentonite provided by CEBO

Random samples taken during the GBM production process were tested by BGR. The results were satisfactory.

		Nagra 1	**Nagra 2**	**Nagra 3**	**Nagra 4**	**B20**	**B33**
XRD (IR) *DTA*		Crude national standard	Pellet fraction A	Pellet fraction C	Ground and sieved, national std WP2	MX80 BGR Project	MX80 BGR Project
smectite		89.0	88.9	88.5	88.3	85.7	89.3
muscovite		0.4	0.4	0.4	0.4	1.7	
quartz		4.0	4.2	4.1	4.1	4.4	3.5
feldspar		3.7	3.1	3.4	3.6	5.3	7.0
gypsum	DTA+LECO	0.8	0.8	0.8	0.8	0.6	0.2
pyrite	DTA+LECO	0.3	0.3	0.3	0.3		
calcite	DTA+LECO	0.1	0.5	0.5	0.5	0.5	0.5
siderite	DTA+LECO	1.3	1.3	1.3	1.3		
cristobalite		0.3	0.4	0.6	0.6	2.0	
summe		100	100	100	100	100	100
BET							
	[m2/g]	36	28	33	22	22	16
pH							
	[pH]	n.d.	n.d.	n.d.	n.d.	9.5	9.4
LECO							
C_{total}	[wt.%]	0.32	0.48	0.45	0.38	0.33	0.11
C_{org}	[wt.%]	0.17	0.28	0.28	0.20	0.13	0.05
C_{inorg}	[wt.%]	0.15	0.20	0.18	0.18	0.20	0.06
S_{total}	[wt.%]	0.33	0.35	0.32	0.30	0.25	0.00
CEC		*Cu_{trien} 5x*				*Cu_{trien} normal*	
Na	[meq/100g]	56	53	53	55	58	57
K	[meq/100g]	2	2	1	1	2	2
Mg	[meq/100g]	7	4	4	5	8	5
Ca	[meq/100g]	28	24	25	25	35	33
sum cations	[meq/100g]	4	2	2	3	20	15
CEC	[meq/100g]	87	78	80	82	82	82
XRF							
SiO_2	[wt.%]	**56.8**	59.7	59.3	59.6	60.8	58.6
TiO_2	[wt.%]	0.1	0.1	0.1	0.1	0.1	0.1
Al_2O_3	[wt.%]	18.1	18.7	18.7	18.8	19.0	19.5
Fe_2O_3	[wt.%]	3.8	4.0	3.9	4.0	3.6	3.6
MnO	[wt.%]	0.0	0.0	0.0	0.0	0.0	0.0
MgO	[wt.%]	2.2	2.3	2.3	2.3	2.3	2.4
CaO	[wt.%]	1.2	1.4	1.3	1.4	1.2	1.2
Na_2O	[wt.%]	1.9	1.9	1.9	2.0	2.0	2.1

		Nagra 1	Nagra 2	Nagra 3	Nagra 4	B20	B33
XRD (IR) **DTA**		Crude national standard	Pellet fraction A	Pellet fraction C	Ground and sieved, national std WP2	MX80 BGR Project	MX80 BGR Project
XRF							
K_2O	[wt.%]	0.5	0.6	0.5	0.6	0.5	0.5
P_2O_5	[wt.%]	0.0	0.1	0.0	0.1	0.1	0.0
(SO3)	[wt.%]	0.4	0.5	0.5	0.6	0.3	0.2
(Cl)	[wt.%]	0.0	<0.002	<0.002	0.0	<0.002	0.0
(F)	[wt.%]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
LOI	[wt.%]	**14.8**	10.5	11.1	10.5	9.9	11.4
Sum	[wt.%]	99.8	99.8	99.8	99.8	99.7	99.7
As	[ppm]	11	11	8	9	10	9
Ba	[ppm]	187	264	219	300	262	248
Bi	[ppm]	<5	<6	<6	<6	<3	<3
Ce	[ppm]	106	93	95	90	115	98
Co	[ppm]	<7	<7	<7	<7	6	<3
Cr	[ppm]	<10	<11	<11	<11	8	10
Cs	[ppm]	<64	<65	<64	<64	<5	<5
Cu	[ppm]	11	9	10	8	<10	<10
Ga	[ppm]	27	28	28	30	30	29
Hf	[ppm]	<16	<16	<16	<16	6	<5
La	[ppm]	67	46	52	50	53	68
Mo	[ppm]	<6	<6	<6	<6	4	4
Nb	[ppm]	27	28	29	29	27	27
Nd	[ppm]	48	53	51	47	<50	56
Ni	[ppm]	8	<5	6	<5	<3	<3
Pb	[ppm]	42	44	45	47	41	40
Rb	[ppm]	16	15	14	16	18	18
Sb	[ppm]	<86	<87	<86	<87	<5	19
Sc	[ppm]	<23	<23	<23	<23	7	5
Sm	[ppm]	<39	<40	<40	<40	<50	<50
Sn	[ppm]	<34	<35	<35	<35	13	9
Sr	[ppm]	237	217	210	221	250	227
Ta	[ppm]	<10	<11	<11	<11	<5	<5
Th	[ppm]	43	45	46	45	51	38
U	[ppm]	15	12	15	14	15	13
V	[ppm]	<15	<15	<15	<15	7	<5
W	[ppm]	<10	<10	<10	<10	6	<5
Y	[ppm]	41	41	43	45	35	31
Zn	[ppm]	87	100	96	92	90	84
Zr	[ppm]	168	178	176	177	185	191

Conclusions

- The chemical composition proved that all samples are rather similar in composition.
- Sample 1 contains a little more water which results in a lower content of all element oxides.
- The larger water content is also reflected by both DTA and XRD.
- DTA showed a more pronounced dehydration peak and more water desorption in the TG mode.
- XRD showed a larger d-spacing and more intensity of the d001 reflection.
- The hydration state of the other samples is similar.
- The larger water content can be partly explained by larger CEC (about 10 meq/100 g more than the others).
- XRD Rietveld could not resolve this difference which either indicates a larger LCD of NAGRA1 or can be explained by the analytical error.
- With XRD no gypsum and only 0.1 % pyrite were found. The S-content, however, is larger and DTA-MS proved the presence of almost equal amounts of SO_2 from the pyrite and the gypsum range.
- Considering the S-contents of the pure phases results in 0.8 mass% gypsum and 0.3 mass% pyrite (in conclusion: both exist and both are well below 1 mass%).
- Only the XRD trace of #1 shows the gypsum peak and the feldspar peaks of #4 a larger compared to the others.
- Both XRD differences probably result from single crystal reflexes rather than real differences (because they don't reflect in the XRF data).
- BET values range from 22 – 36 m^2/g and prove that sample pre-treatment does affect certain properties of the clays – the four bentonites are not equal but similar.
- DTA-MS and LECO proved the presence of some organics. A peak at 550 °C may belong to a special carbonate (siderite).
- A peak at 680 °C indicates the presence of a second carbonate. This one, however, is absent in sample1.
  - in the %-range XRD is much less accurate than above. To obtain some reasonable figures DTA-MS and LECO data was used.
  - the muscovite content is supposed to be a little larger. The smectites were fitted after Cutrien-saturation with a special Cutrien-Rietveld-model, which could have "taken" some muscovite intensity.
  - the samples are almost identical – sample 1 has a somewhat large water content (in the interlayer) because of larger CEC.

Appendix J: Protocol to measure pellet dry density at JRS

During production of the pellets, the **dry density of the particles** has to be measured on a regular basis.

Sampling rate is once every 3 tons during normal production. Sampling rate for material dried at Schüle is once every ton. The sampling rate amounts to 70 samples and thus 70 measurements in total.

The dry density of a pellet is the mass of solid in a particle divided by its volume. It can also be expressed as the density of a particle and its water content:

$$\boldsymbol{\rho_{dry} = \frac{m_s}{V_t} = \frac{\rho_{geometrical\ one\ particle}}{1 + w_c}}$$

Two measurements have thus to be performed: 1) measurement of the water content of the pellets and 2) measurement of the geometrical density of 1 particle.

1. <u>Measurement of the water content</u>

The water content is measured with a thermogravimetric moisture analyzer (OHAUS MB 35). 1 to 3 g of fine milled pellets have to be introduced for each sample and resides in the drying chamber of the analyzer at a temperature of 105°, untill a constant mass is reached.

2. <u>Measurement of the geometrical density of 1 particle</u>

The geometrical density of 1 particle is measured by immersion of 40 g (± 5 g) of pellets in olive oil in a 50 ml burette (with 0.5ml graduation).

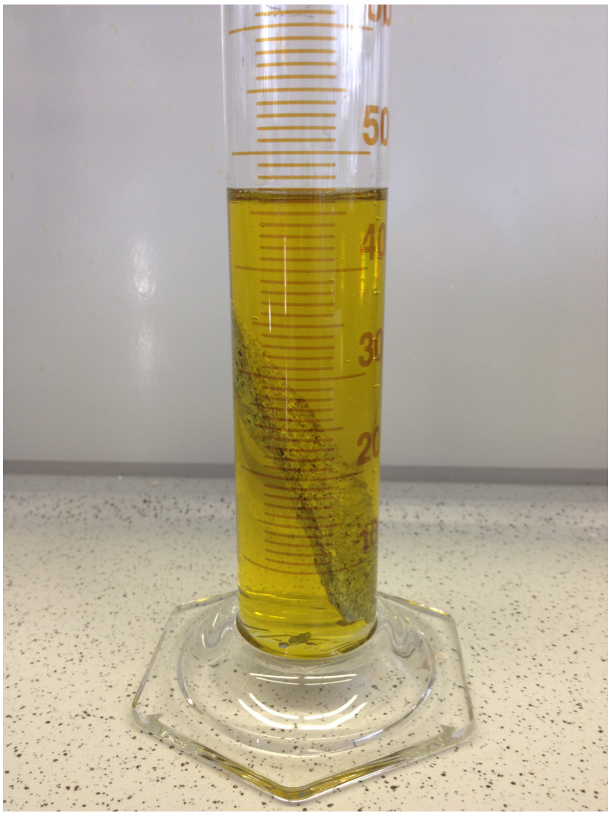
3. <u>Working steps</u>

An xls file has been prepared to report the procedure. The measurement steps for each sample are the following:

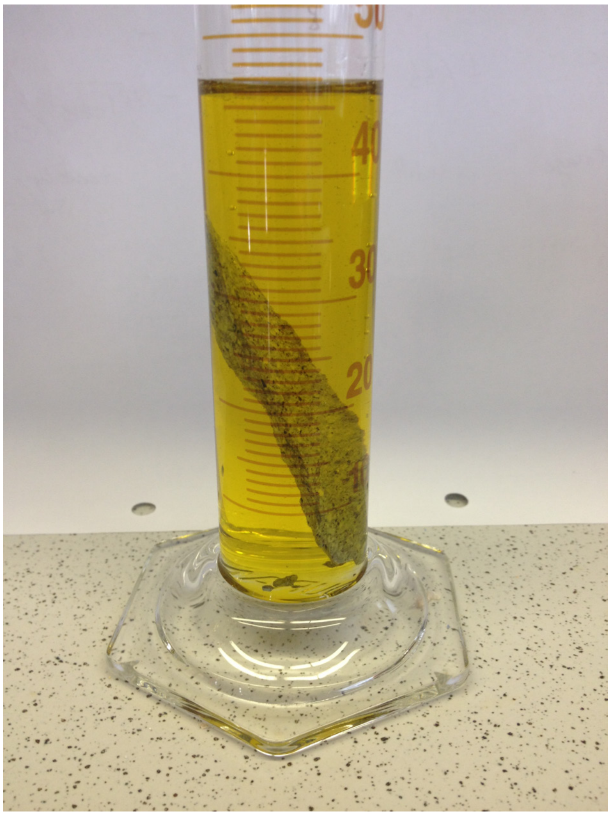
1. Report production date, measurement date, operator and sample provenance (bigbag number) in columns A, B, C, D
2. Take 3 g of pellets, mill them finely and measure water content → report w_c in xls file (column P)
3. Fill burette with olive oil to approximately 25 ml → report V1 in xls file (column H)
4. Weight 40 g ± 5 g → report M in xls file (column E)
5. Fill material from step 3 slowly into burette (making sure all pellets sink into olive oil: no pellets sticking to wall and olive oil around all pellets, without air bubles) → report V2 in xls file (column I)
6. The pellet dry density appears in column N and is graphed in BB_dd automatically

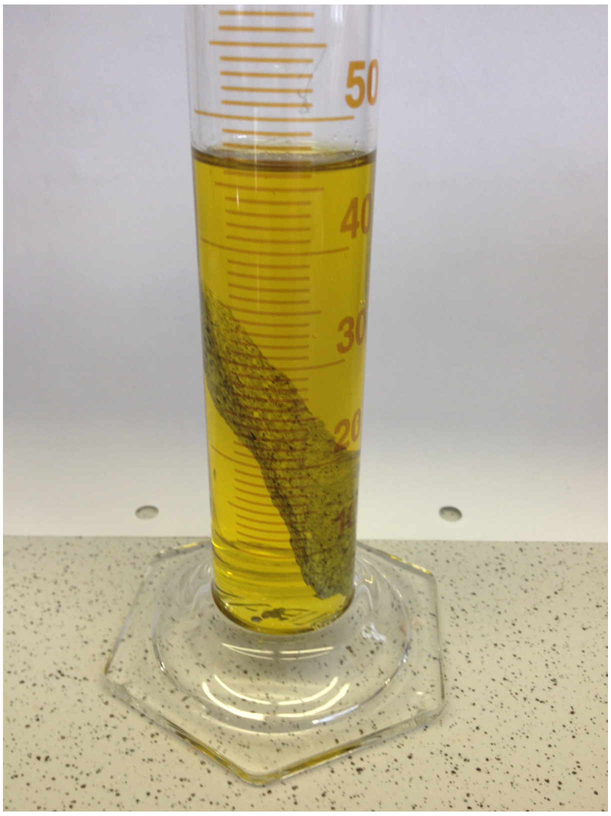
<u>Remarks</u>

It was verified that bentonite pellets do not absorb olive oil. Reason here for is the low water content of olive oil (ranging between 0.1 % and 0.2 %, Ragni et al. 2012).

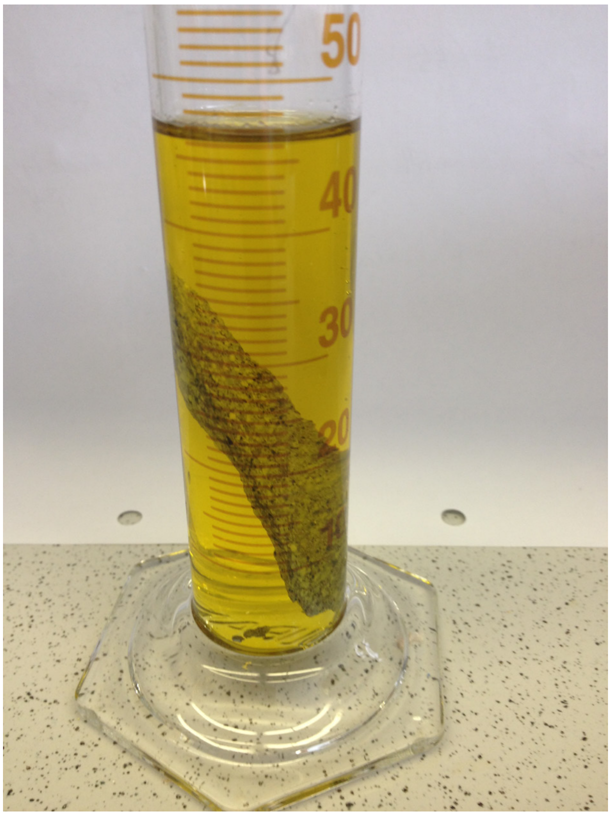


After 1 min

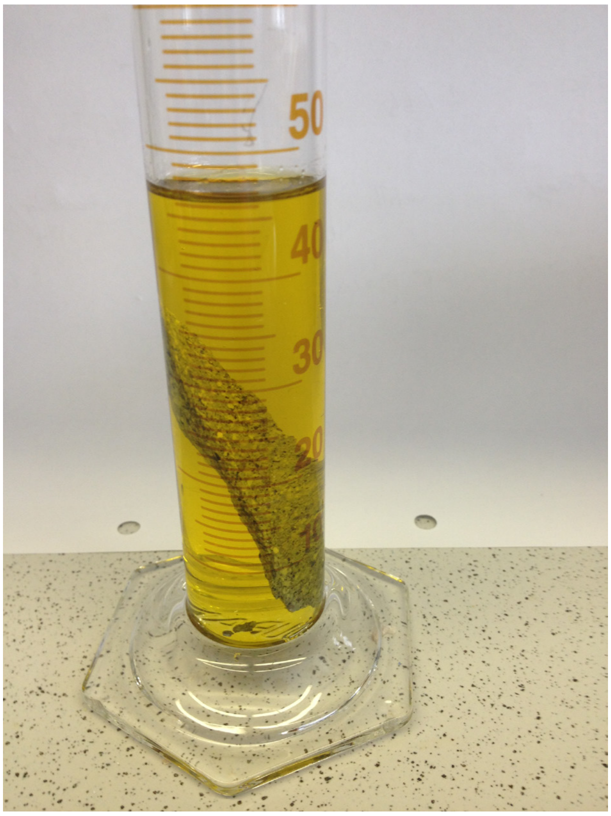

After 5 mins



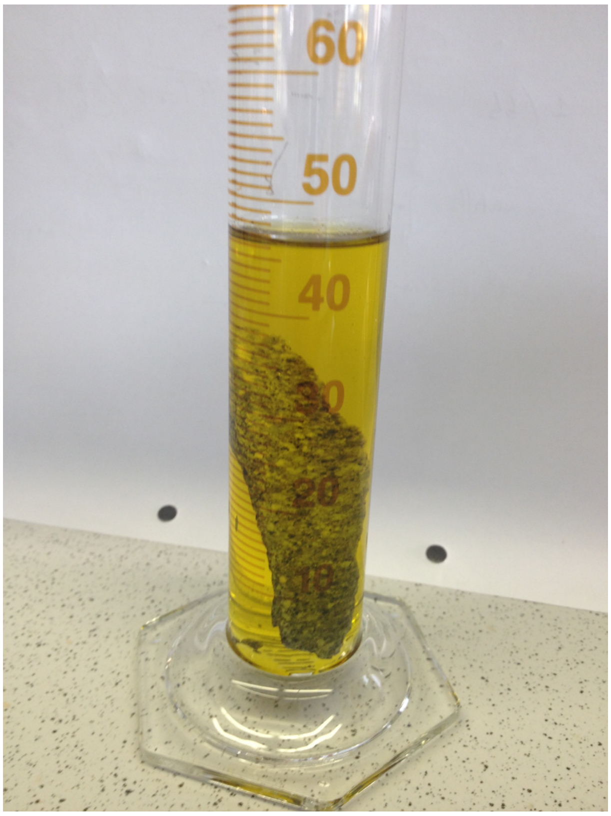
After 10 mins



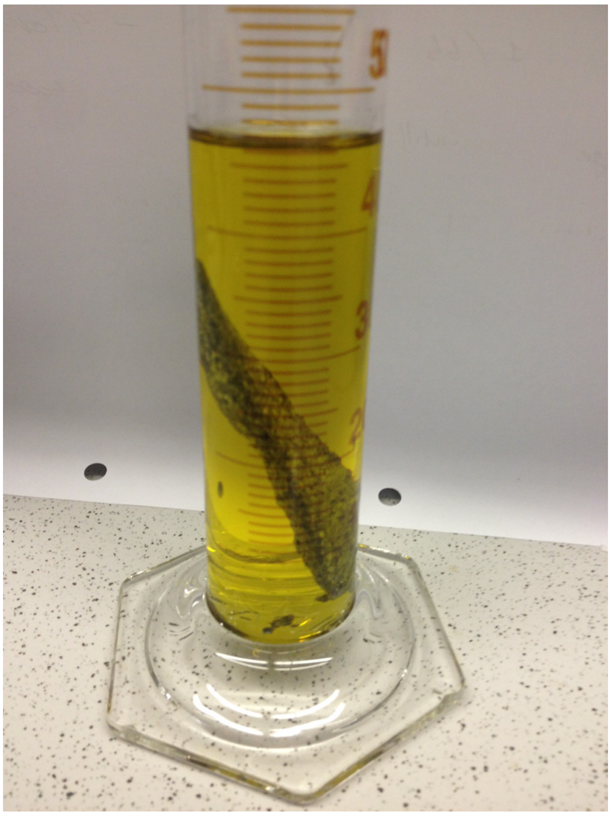
After 20 mins



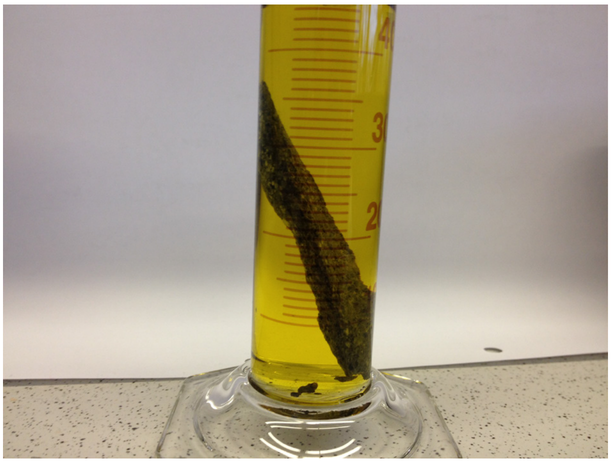
After 45 mins



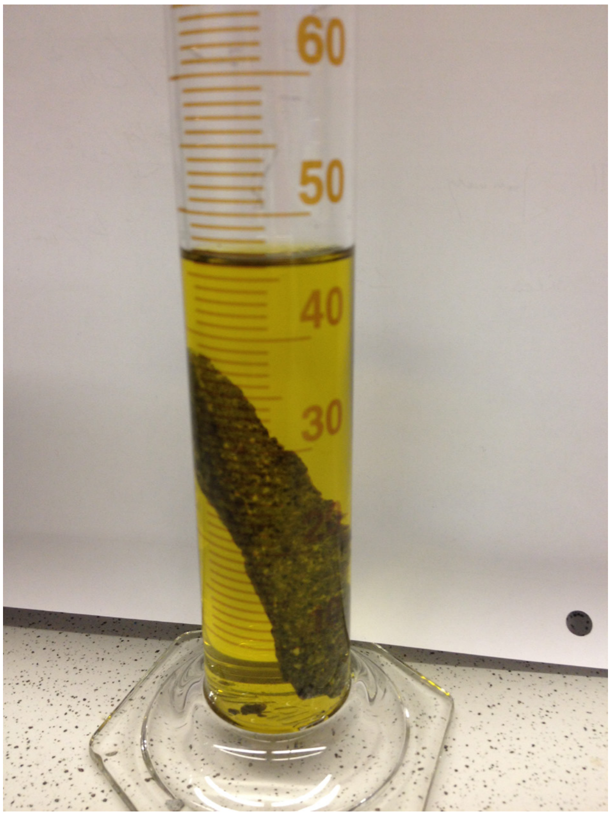
After 2.5 hours



After 18 hours



After 48 hours



After 72 hours

Fig. J-1: Bentonite pellet left in olive oil for three days and photographed at several times to check no oil intruded the pellet.

The oil level remained constant (46 mL) and the pellet did not seem to absorb oil and or to disintegrate.

The measurement error of the pellet dry density is dependent on the quantity of pellets used in each measurement. Around 40 g of pellets result in measurement error lower than 0.04 g/cm^3 (see Fig. J-2).

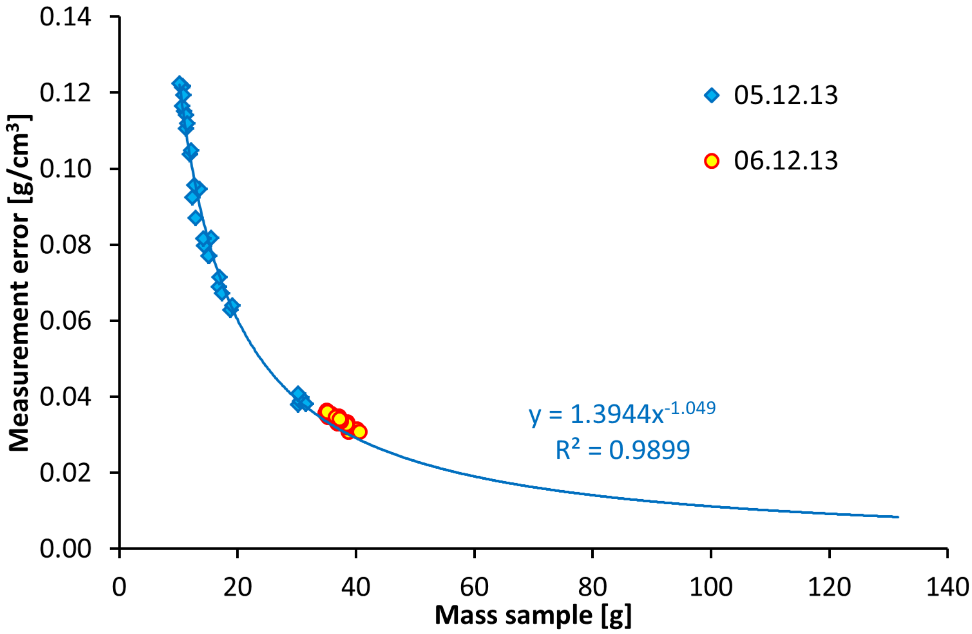


Fig. 138: Measurement error of the pellet dry density as a function of the mass used in different measurements.

For the volume measurements (V1 and V2) a precision of half the graduation (0.25 ml) can be taken. For the volume lecture, always consider the same reference (which can vary from operator to operator), e.g. bottom of black line in Fig. J-4a.

Putting the pellets in the burette must be done slowly to allow the oil to surround each pellet and to make sure no air bubbles are present between the pellets (Fig. J-4b).

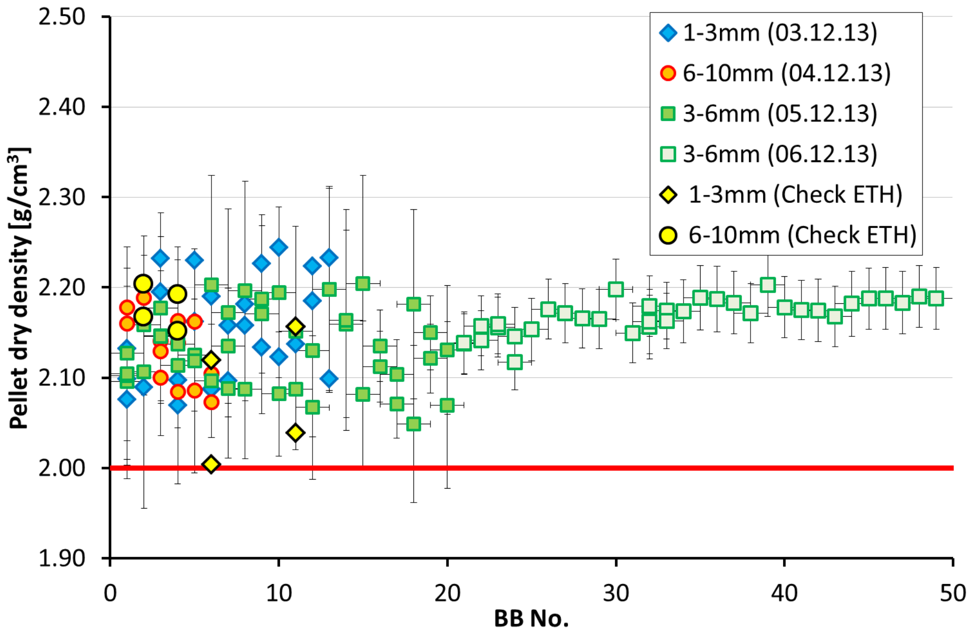
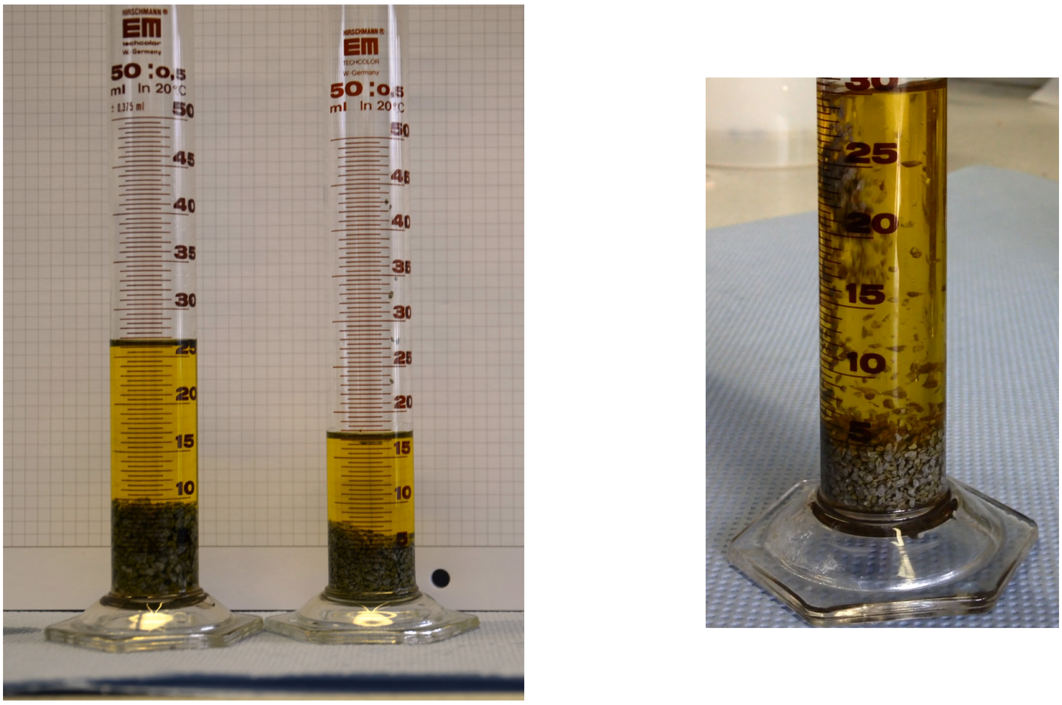


Fig. J-3: Measured pellet dry density in the first three test batches (03.12.13, 04.12.13 and 05.12.13) when only 10 to 20 g of pellets were used in each measurement and measurements on 06.12.13 with increased amount of test material.

The vertical bars represent the measurement error of each measurement.



(a) (b)

Fig. J-4: Measurement of the volume of bentonite pellets: (a) final volume (with pellets and oil) and (b) slow pouring of the pellets in order to have oil around each pellet.

Fig. J-5: Bentonite samples of 700 kg bigbag 5, fraction 1 – 3 mm, at the beginning of the filling (Anfang), when half filled (Mitte) and at the end of the filling (Ende).

Pellet dry density obtained during cleaning operations with National ® Standard WP2β: 2 and 2.09.

Appendix K: Measurement protocol of the mixture pouring dry density

The measurement of the pouring density of a mixture depends on:

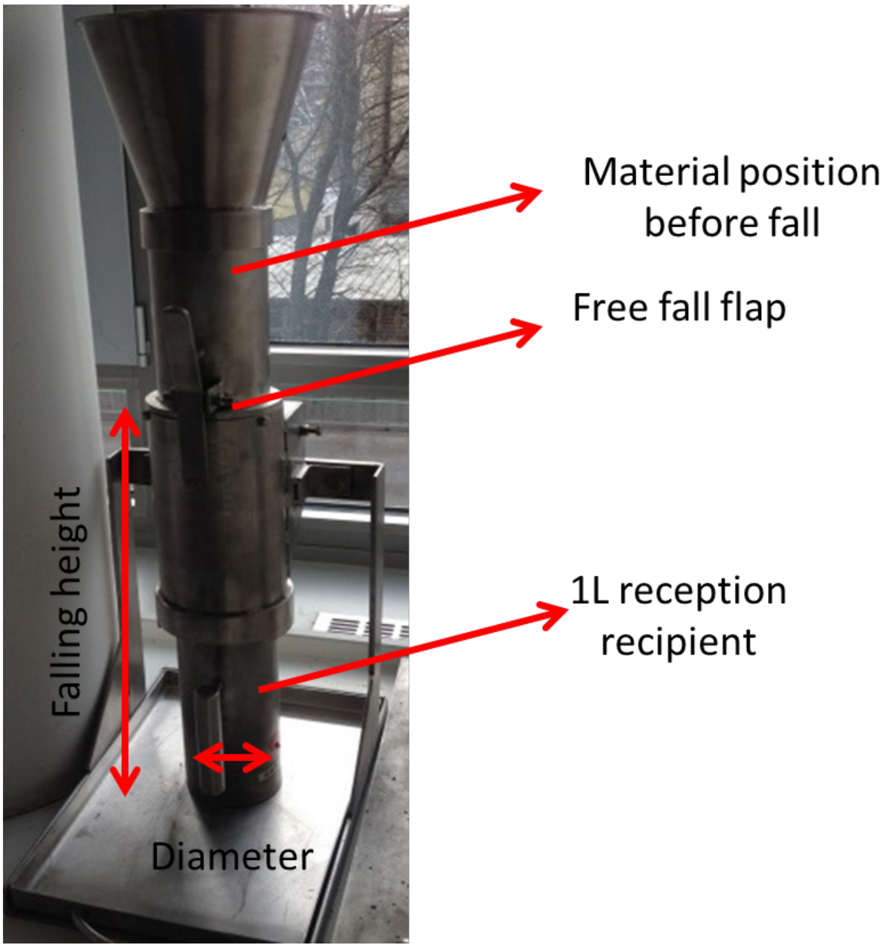
- The manner in which the mixture is poured
- The measurement volume

Here for a protocol was set up to measure the mixture pouring dry density in a reproducible way at JRS. As a matter of facts, this aims at comparing the mixture pouring dry density measurements presented in this report between them, but also makes it difficult to compare the pouring densities presented herein with other values presented elsewhere.

Measurement of water content

The water content is measured with a thermogravimetric moisture analyzer (OHAUS MB 35). 1 to 3 g of fine milled pellets mixture have to be introduced for each sample and resides in the drying chamber of the analyzer at a temperature of 105°, until a constant mass is reached.

Measurement of the bulk density is performed by pouring approx. 2 L of mixture in the device presented hereunder. The mixture is stopped at the level of the free fall flap. Then the free fall flap is opened by unlocking (the device is such that unlocking always happens in the same way) and the mixture falls into a 1L recipient located at the bottom of the device. The falling height is 380 mm and the inner diameter of the recipient is 80 mm. The recipient is than removed and the weight of 1 L of material gives the bulk density.



Appendix L: Optimum grading of bentonite pellets

U 143203 Optimum grading of bentonite pellets

Literature review and laboratory tests

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Wildegg, 18th of March, 2014

L.1 Assignment

TFB was assigned by Nagra to carry out a literature study about the effect of grains size distribution on the packing density of dry bentonite materials. This literature study functioned as a basis for a series of laboratory experiments that were carried out by TFB as well. The literature review and laboratory experiments are given in this report.

All the work was carried out as described in TFB quotation 72964/2014 (dated 11.02.2014) and the assignment confirmation letter from Nagra, Order No. 12.436 (dated 25.02.2014).

L.2 Literature review

L.2.1 Introduction

Bentonite is often proposed as an effective sealant in radioactive waste repositories. The performance of Bentonite as a sealant depends largely on how densely it can be emplaced around the waste containers. Raw bentonite as a commercial product, such as MX-80 Amcol, is a relatively coarse grained powder consisting of agglomerated clay particles. The bulk 'pouring' density of the dried, raw bentonite powder depends on water content and ranges from 1000 to 1110 kg/m^3 for MX-80 Amcol (De Bock et al. 2009). The clay minerals in bentonite have a much higher average density of 2674 kg/m^3 (De Bock et al. 2009), which means that the bulk density of bentonite powder is limited by its intergranular porosity. Since compaction of bentonite powder on-site is practically not possible, the dry (uncompacted/poured) bulk density of granular bentonite materials should be increased as much as possible before emplacement. A common approach to do this is to industrially compact the raw bentonite powder into low porosity pellets and to build up dense graded granular material out of these pellets.

Packing density of granular materials (powders) is a topic in many fields of science, since it is of high importance for food and pharmaceutical industries and for the manufacturing of engineering materials such as concrete and ceramics. The most important parameters that affect particle packing is the grain size distribution and particle shape, and the vibration energy brought into a system to organize the particles in a gravity field. When powders are forced to compact under applied load, other factors start to play a role, such as internal deformability of the grains and friction between particles. A review of the science behind particle packing is beyond the scope of this assignment and therefore we restrict ourselves to the literature on Bentonite powders in the following.

L.2.2 Particle packing of bentonite powders

A number of research studies on granular bentonite studies have been carried in the last 10 years, and in some Nagra was involved. All these studies worked with pelleted Bentonite as the starting materials, prepared from commercially available raw Bentonite such as MX-80 Amcol or others. These pelleted bentonite systems have a number of special characteristic that makes it hard to predict what theoretically the best packing geometry would be: (i) The pellets have a non-spherical shape; (ii) pellets are produced in a limited number of size fractions (usually one or two). (iii) Pellets may be milled and rounded before use. This broadens the particle size distributions of the initial pelleted product. (iv) The density of milled pellets may decrease with grain size, especially for the finest fractions. One would expect that the finest fractions approach the density of the raw starting material.

For pelleted bentonite systems with irregular shaped grains, a change in the grain size distribution can have positive and negative effects on packing density. A continuous grading of grains from larger to smaller fractions, generally provides the best packing density for spherical grains. However, for irregular shaped (e.g., flaky-like) bentonite this may not necessarily be the case. An increase of maximum pelleted grain size and amount of the coarsest fraction is expected to beneficial, because this means that a higher portion of space is filled with high density material. However, a too large amount of coarse material may lead to a discontinuous grading and the requirement of the addition of a disproportional high amount of fines. Increased amounts of fines (< 125 μm) may be efficient in reducing interpellet pore space. If the density of fines is significantly lower than the one of coarser fractions, then increasing amounts of fines may start to have a negative effect on bulk density from a certain dosage onwards. For these reasons it is hard to predict what theoretically the best grading would be.

A computer modelling study carried out by Nagra showed that the bentonite material should have a Fuller-grading in the range of 0-10 mm with a Bi-modal distribution to achieve optimum packing (De Bock et al. 2009). Details of these simulations are described in Nagra Working Report NAB 06-02 (Te Kamp & Konietzky 2006). On basis of these simulations, 8 different pelleted bentonite gradings were experimentally tested within the ESDRED-project (Te Kamp & Konietzky 2006). All were composed of pellets with two distinct size fractions (coarse average = 3.2 mm; fines = 0.5 – 1.5 mm) and having pellet densities of around 2.0 kg/m^3. The pellets were rounded before use to improve the flowability and produce a better-graded grain size distribution. The results showed that the obtained pour dry density of the granular system increased from 1.38 to 1.48 kg/m^3 with the addition of fine pellets from 0 to 10%. However, further increasing the amount of fine pellets to 30% did not clearly change the packing density. The highest measured dry mix density of these 8 experiments was 1.51 kg/m^3.

The importance of fines in pelleted bentonite mixtures to fill up intergranular pore space was also shown in a study conducted in Canada (Marjavaara et al. 2013). Mixtures consisting of coarse pellets with different sizes, shapes and densities only achieved a maximum dry pour density of 1075 kg/m^3. The presence of fines is generally beneficial for packing density, but they may also cause segregation of the mixture during its emplacement. This, in turn, may lower the powder density again. Hoffmann et al. (2007) reported that a minimum grain size of 0.4 mm was needed in order to avoid segregation during sample preparation (Hoffmann et al. 2007). Dixon et al. (2011) also report segregation of bentonite mixtures during transport and generation of excessive dust during emplacement of mixtures with fines. Moreover, they mention that systems with more fines may be more prone to wetting in moist environment (before emplacement) because of their higher internal specific surface (Dixon et al. 2011).

Dixon et al. (2011) reported the results of two projects in which bentonite pellets/powder mixtures had been used. In the Bacchus-2 project, so-called Boom clay pellets (with a density of 2100 kg/m^3) were mixed with Boom clay powder in the range of 0 – 2 mm. An in-situ dry density of about 1700 kg/m^3 was achieved for bentonite. In the Reseal project, so-called FoCa clay was used in the powder/pellet mixture compaction trials. It was found that a ratio of 65 % pellets and 35 % powder gave the best dry density, but this ratio tended to segregate during handling. A 50/50 mixture was less prone to pellet-powder segregation and was therefore chosen for field installation. A dry density between 1400 and 1600 kg/m^3 was achieved in the compaction trials and after emplacement a compacted dry density of 1550 kg/m^3 was measured.

In the abovementioned studies mainly bi-modal mixtures were used, with narrower or broader size distributions depending on whether the pellets were rounded and milled during mixing. Theoretically, continuous gradings provide a better packing for spherical particles with a size-independent density. The Fuller grading is a widely used grading in civil engineering to create concretes with a high density. Grading of the coarse and sand aggregates is important, but also grading of the cement binder is important when high or ultra high-strengths concretes are to be obtained (Bleeck 2011). The general formula for a continuous grading obtained by a grain sieving process is:

$$P(D) = \frac{D^q - D_{\min}^q}{D_{\max}^q - D_{\min}^q}$$

With *P(D)* being the fraction of grains passing a sieve with opening *D*; D_{max}, D_{min} are the maximum and minimum grain size of granular material, respectively (D_{min} is mostly taken as 0); and q is the grading exponent. When $q = 0.5$ the well-known Fuller curve is obtained. Bleeck (2011) mentions that studies have shown that the optimal packing occurs when $q = 0.37$ for high-strength concretes.

Nagra recently carried out a series of experiments on pelleted bentonite systems to test the effect of grading exponent on dry pour packing density. They found that mixtures with q = 0.4 produced a similar density as those with q = 0.5, and the best fit through all data points seems to suggest that the optimum may be around 0.45 (Fig. L-1). Moreover, these experiments showed that more fines (< 1 mm) generally produced higher packing density up to some maximum amount of around 6%. Furthermore, they showed that in their laboratory tests a dry bulk density of around 1450 kg/m^3 was the maximum achievable for the range of mixtures that were studied.

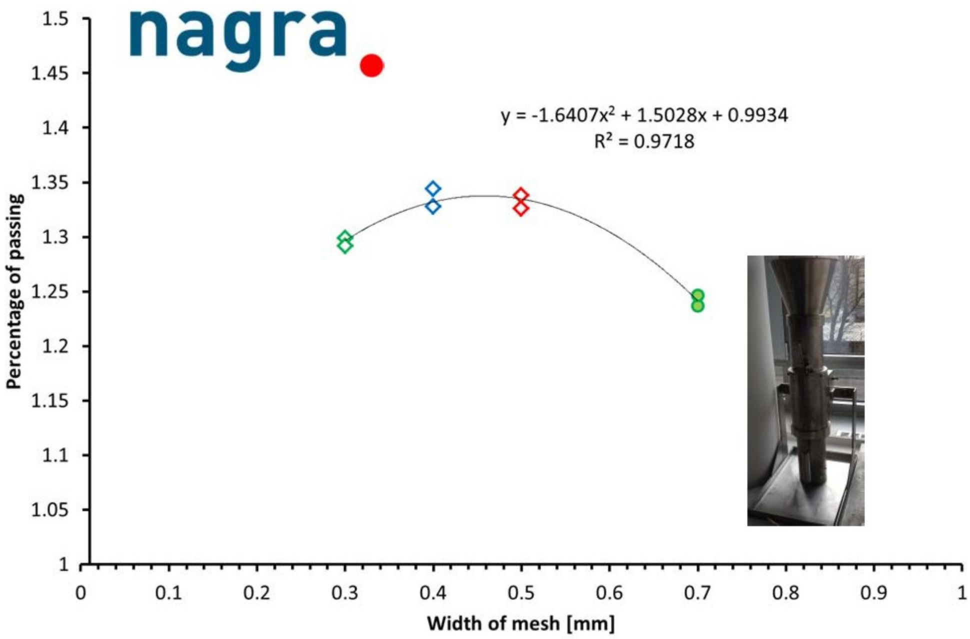


Fig. L-1: Effect of grading exponent q on dry packing density.

L.3 Experimental strategy

Based on the results of previous bentonite studies (see Section 2.2) we have selected 6 gradings to be tested in the TFB laboratory (see Fig. ; Tab.). The aim of testing these mixtures was to show: (i) the effect of more or less fines on packing density; (ii) the effect of the source and grading of fines; (iii) the effect of grading exponent; and (iv) the effect of having a discontinuous versus a continuous grading.

- **Grading 1** is a continuous grading with the ‘optimum’ grading exponent of 0.45. This mixture functions as a reference, and a similar mixture was tested before by Nagra. The fines (< 63 µm) were replaced by the fines of the raw powder for practical reasons. Production of fines by milling of coarse pellets is a time-consuming process. If fines from raw produce a good result, it may practically be possible to obtain enough fines for large body emplacements.
- **Grading 2** is a continuous grading with a grading exponent of 0.4. This mixture should show the effect of increased amount of fines in the system while maintaining a continuous grading. Compared to grading 1, this mixture should reveal if increased amounts of fines (and decreased amount of coarse fraction) has a beneficial or negative effect on packing density.
- **Grading 3** is a continuous grading with an 'optimum' grading exponent of 0.45 similar to grading 1 but with reduced and non-Fuller graded fines (< 125 µm). This mixture will also show the importance of the amount and grading of fines on packing density.

- **Grading 4** is a continuous grading with a grading exponent of 0.6 to test how decreased amounts of fine in the system affect packing density while maintaining a continuous grading. The higher the grading exponent, the coarse the mixture, and the more easy/economical the production of the bentonite material is expected to be. This is because the production of fines from coarse pellets costs time and energy.
- **Grading 5** is a continuous grading with an 'optimum' grading exponent of 0.45 and maximum pellet size of 4 mm, instead of 8 mm. If larger pellet size has a positive effect on packing density, then it may be worth looking into methods of creating larger pellets (e.g., 20 – 30 mm).
- **Grading 6** is a discontinuous (gap) grading that is tested to see if continuous gradings are really needed to achieve the required packing density when enough fines are available to fill interpellet pore space. Discontinuous mixture may be easier to produce because they do not require milling of pellets, if pellets of two size fractions are prepared.

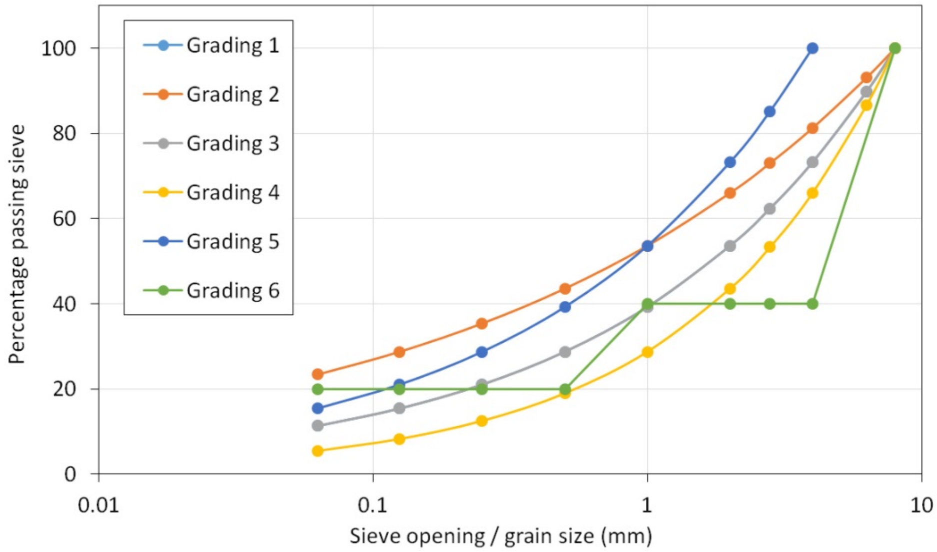


Fig. L-2: Tested bentonite gradings.

Grading number refers to gradings given in Table L1. Note that gradings 1 and 3 overlap, and only differ in the way the fines are composed (see Table L1).

Tab. L-1: Tested bentonite gradings.

For the coarsest fractions (1 – 8 mm) the original unmilled pellets were used. For the middle fractions (0.125 – 1 mm) we used the milled/rounded pellets. The source material for the finest fraction (< 0.063 µm) was the raw bentonite powder (MX-80).

Fractions:	**1** n = 0.45	**2** n = 0.3	**3** n = 0.45	**4** n = 0.6	**5** n = 0.45	**6**
> 6.3 mm	61.15	41.50	61.15	80.12	-	360.00
4 – 6.3 mm	99.62	71.15	99.62	124.03	-	-
2.8 – 4 mm	65.13	49.45	65.13	76.26	88.97	-
2 – 2.8 mm	52.56	42.04	52.56	58.42	71.80	-
1 – 2 mm	86.16	74.32	86.16	88.86	117.69	-
0.5 -1 mm	63.07	60.37	63.07	58.63	86.16	108.00
0.25 – 0.5 mm	46.17	49.03	46.17	38.68	63.07	-
0.125 – 0.25 mm	33.80	39.83	33.80	25.52	46.17	-
0.063 – 0.125 mm	24.50	32.01	92.34 (from pellets)	16.68	33.47	-
0 – 0.063 mm	67.84	140.29		32.80	92.67	132.00
Total	600	600	600	600	600	600

L.4 Experimental Method

A simple method was used to determine the bulk ('pouring') density of the bentonite mixtures: The mixtures in Table 1 were prepared in plastic jars and manually rotated to homogenize the mixtures. Then, these mixtures were slowly poured from a constant height, bit by bit, in glass beakers such as shown in Fig. 3. During pouring the beaker was rotated in order to fill it homogenously. The volume markers on the beakers are only approximate markers and needed to be calibrated. This was done before by filling them with water on a balance assuming a water density of 1.0 g/cm^3.

After pouring, the top surface of the mixtures were softly flattened using a spoon and were then covered with concrete cylinder slice to obtain a surface marker. The concrete slice did not result in a compaction of the bentonite. All mixtures were photographed and the height (= volume) of the bentonite surface was precisely measured using image analysis. Dry bulk density was obtained by dividing the specimen volume by its weight.

Subsequently the mixtures were compacted by drumming a small rubber hammer on all sides of the beaker, without the concrete slice on the top. This was continued for a few minutes until no further compaction was observed. Again the surface was flattened and covered with the concrete slice in order to determine the bentonite volume precisely. The test procedure was carried out twice for all 6 test mixtures to check reproducibility. At all stages in the experiment exposure of the mixtures to atmosphere was limited as much as possible (to avoid moisture uptake).

L.5 Results and conclusions

Most mixtures remained uniformly mixed after pouring and compaction as far as this could be observed from the outer surfaces of the mixtures. Only mixture 4 seemed to be rather unstable, and segregated in the two test runs (Fig. a). There was a notable wall-effect in all experiments that created an enhanced local porosity (Fig. b, c). This porosity usually disappeared after compaction.

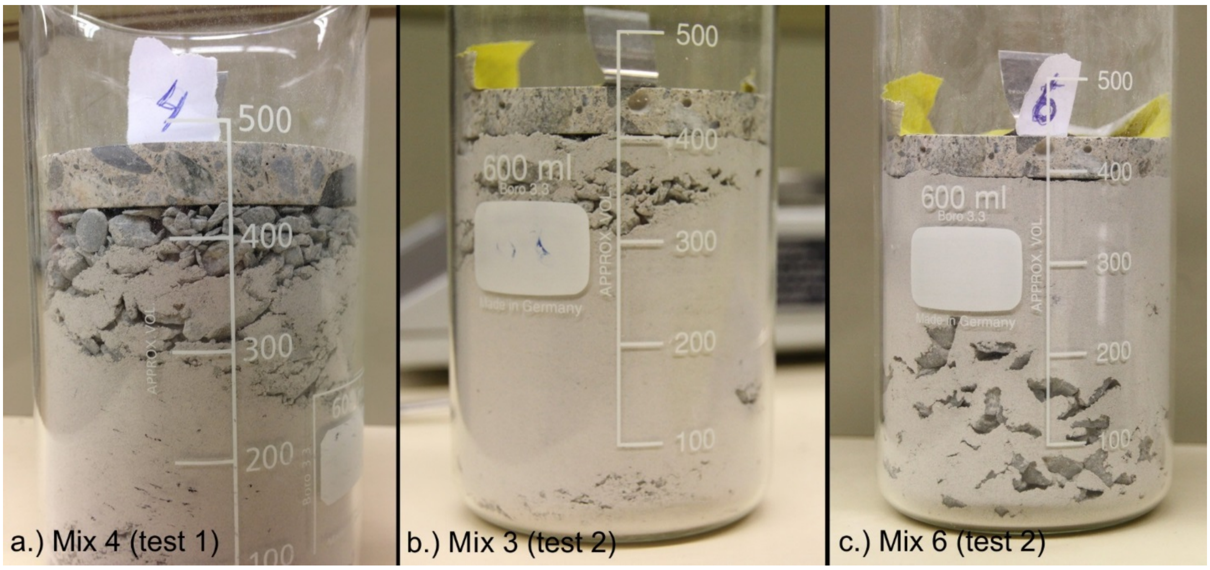


Fig. L-3: Bulk volume of the three test mixtures 3, 4 and 6 showing varying degrees of segregation and wall-effects.

The reproducibility of the applied method was tested on the same sample and is reasonable (see Fig.). The two test series (that were carried out on different days) did not overlap, but they did follow the same trends quite precisely. The reason for the systematic offset between both experimental runs is not clear. It may be related to minor moisture uptake by the bentonite that led to decreased density of the material and/or a change in the bentonite mixture due to the first compaction process.

Mixtures 3 and 6 had the highest bulk density in the two runs, mixture 2 the lowest (Fig.). The manual 'drumming compaction' led to an increase of 10 – 13 % in pour density (Fig.). Generally, the compacted densities of the mixtures are more similar than their bulk densities. An exception to this trend is mixture 4 which segregated during pouring. This segregation had a relatively small effect on the bulk density, but it did affect the compaction potential as expected as the data seem to indicate (see Fig.).

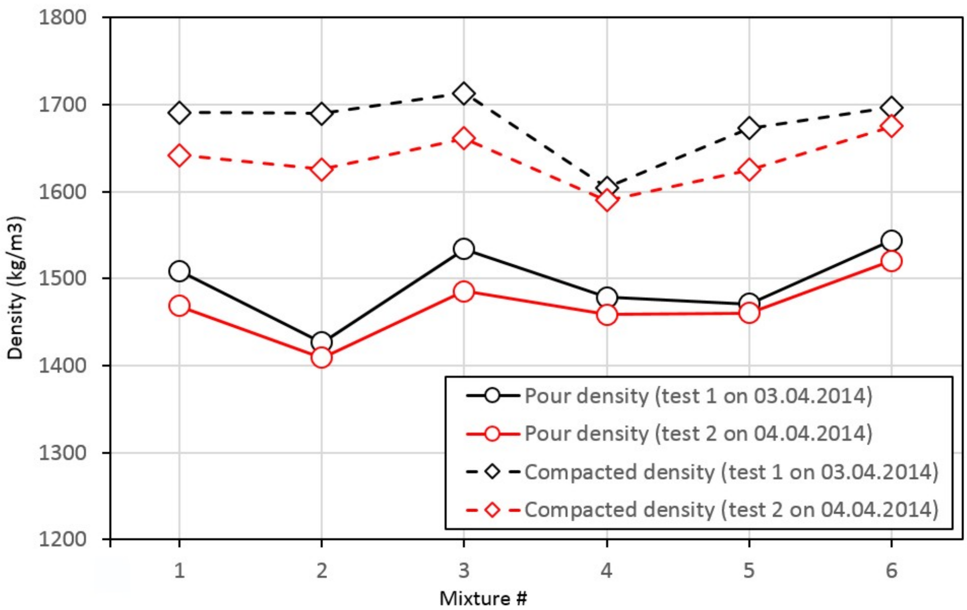


Fig. L-4: Pour and compacted densities of tested bentonite gradings.
Mixture numbers refer to the gradings given in Tab. L-1.

<u>From these experiments it can be concluded that:</u>

- A continuous grading with grading exponent q = 0.45 produced higher bulk densities than gradings with q = 0.3 or 0.6. The bulk density of mixture 4 (q = 0.6) may still be acceptable, but the relatively low amount of fines in this mixture may lead to segregation problems (i.e., high porosity zones).
- Mixture 6 with a gap grading produced higher bulk densities than all other tested mixtures with a continuous grading. This result seems to indicate that having a high content of the coarsest fraction, in conjunction with sufficient fines to fill up intergranular porosity, is the deciding factor for achieving high density.
- Mixture 2 and 5 also showed that the lower proportion of coarse grains in these mixtures reduced their bulk density compared to the other mixtures.

- Mixture 3 with fines (< 0.125 mm) from milled pellets produced a higher bulk density compared to the same mixture with fines (< 0.063 mm) of the raw bentonite powder (MX-80). This indicates that the use of denser fines may be beneficial. Moreover, it seems that the better graded fines in mixture 1 did not compensate for the loss of density by using the raw bentonite powder (MX-80). Nevertheless, the difference between mixture 1 and 3 is small, and production costs may therefore become a decisive factor for either choosing mixture 1 or 3.

L.6 Recommendation

The results presented in Fig. were obtained using relative small specimens with possibly a relatively large wall-effect. In order to test if these specimens are representative for large body bentonite emplacements, it is recommended to repeat selected tests on a much larger scale (e.g. > 10 L). Larger graded bentonite volumes, especially those based on a gap grading, may be more prone to segregation, during transport or during pouring due to the development of avalanches.

Appendix M: Independent measurement of the pouring dry density

Envoi :

Le 12/09/2014 Nagra a envoyé environ 50 kg de hcGBM produite en Juin 2014 chez JRS à MPC-Laviosa. MPC a réalisé les essais décrit dans ce rapport afin de comparer le matériau du FE à celui de l'expérience FSS d'ANDRA. Le rapporteur est Sébastien Paysan.

Réception :

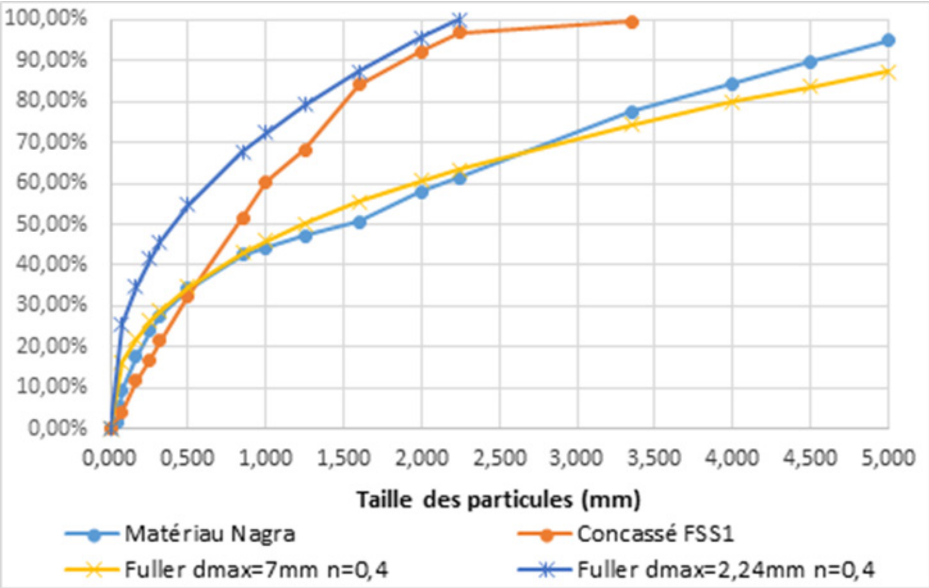
Date	17/09/2014
Conditionnement	3 seaux scellés avec du scotch
Quantités	11,20 kg + 16,65 kg + 24,20 kg = 52,05 kg
Visuel	

Aspect visuel :

Granulométrie :

Matériau	Concassé FSS1	Nagra
Couleur courbe	Rouge	Bleue
Coupure haute (mm)	2,5 mm	7 à 8 mm *

* Le plus gros tamis disponible au laboratoire a une ouverture de 5 mm.
7 à 8 mm est donc une estimation visuelle.



Teneur en eau :

Matériau	Teneur en eau (%)
Nagra – Seau n°1	5,72
Nagra – Seau n°2	5,78
Nagra – Seau n°3	5,70
Concassé FSS1 *	4,15

* Moyenne des contrôles des 330 lots de 1,1T livrés à St. Dizier

Densité de foisonnement sur éprouvette 1L :

Procédure : L'éprouvette graduée est remplie manuellement en limitant les chocs pour ne pas tasser le matériau. L'éprouvette graduée est remplie en matériau jusqu'au trait de jauge d'un litre, la surface arasée, puis le tout est pesé. Pour limiter les erreurs et donner un résultat fiable, chaque mesure est faite 3 fois ; le résultat final est toujours la moyenne de 3 mesures identiques répétées. Les résultats obtenus sur le concassé FSS1 est aussi donné pour comparaison.

Matériau	Densité de foisonnement (Mg/m^3)	Densité sèche de foisonnement (Mg/m^3)
Nagra - Seau n°1	1,508	1,426
Nagra - Seau n°2	1,496	1,415
Nagra - Seau n°3	1,500	1,419
Concassé FSS1 *	1,297	1,246

* Moyenne des contrôles des 330 lots de 1,1 T livrés à St Dizier

Visuel :

Remarque :

- Des zones mal remplies sont visibles (zones plus sombres).
- Etant donné la taille des plus grosses particules du matériau Nagra par rapport au diamètre de l'éprouvette, un essai de densité de foisonnement sur une maquette Øint 240 mm h 400 mm a été fait.

<u>Densité de foisonnement sur maquette 20 L :</u>

Procédure : La cellule est remplie manuellement en limitant les chocs pour ne pas tasser le matériau. La cellule est remplie en matériau, la surface arasée, je mesure la hauteur moyenne avec 4 à points et je pèse le tout. Pour limiter les erreurs et donner un résultat fiable, chaque mesure est faite 3 fois ; le résultat final est toujours la moyenne de 3 mesures identiques répétées.

2 essais de remplissage de la maquette 20 L ont été faits, chacun en 2 fois : une mesure à 10 kg remplis, puis une finale après 20 kg remplis.

N° essai	Masse (kg)	Densité de foisonnement (Mg/m^3)	w (%)	Densité sèche de foisonnement (Mg/m^3)
1	10,75	1,533	5,73	1,450
	23,10	1,556	5,73	1,472
2	10,35	1,553	5,73	1,469
	22,80	1,548	5,73	1,464

Les densités sèches de foisonnement mesurées sont un peu plus élevées sur la maquette 20 L que sur l'éprouvette 1 L mais reste dans le même ordre de grandeur.

Visuel :

Afin de comparer un peu mieux, j'ai essayé de tamiser votre matériau à 2,24 mm pour le comparer avec la densité de foisonnement du concassé FSS1, à coupure haute équivalente.

Visuel :

Plus bas les résultats de densité de foisonnement sur éprouvette 1L :

Matériau	Densité de foisonnement (Mg/m^3)	Densité sèche de foisonnement (Mg/m^3)
Nagra - Seau n°3 tamisé à 2,24mm	1,325	1,253

Visuel :

Remarque :

- Il n’y a pas de zone mal remplie.