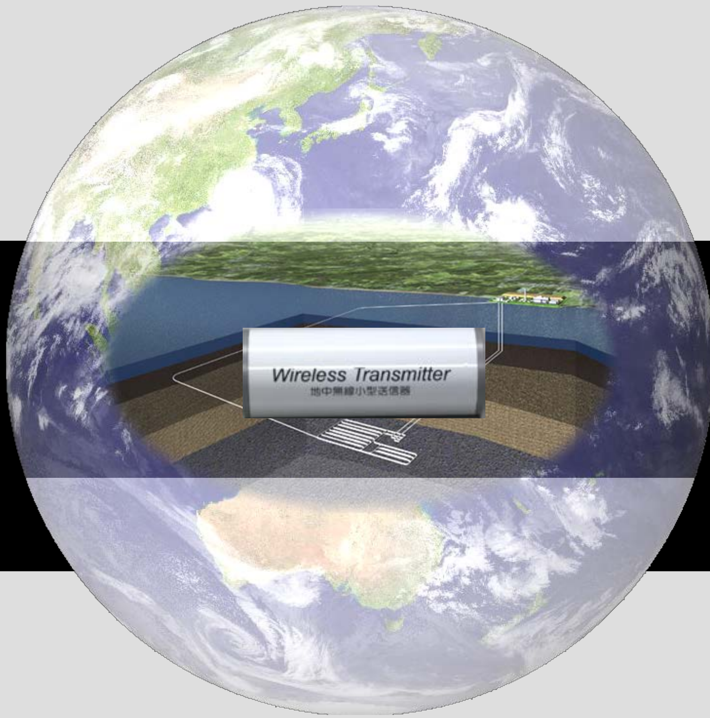


State of art and typology for the wireless transmission system in real use. The estimation and judgment for the triggered value in EBS against the reference design value

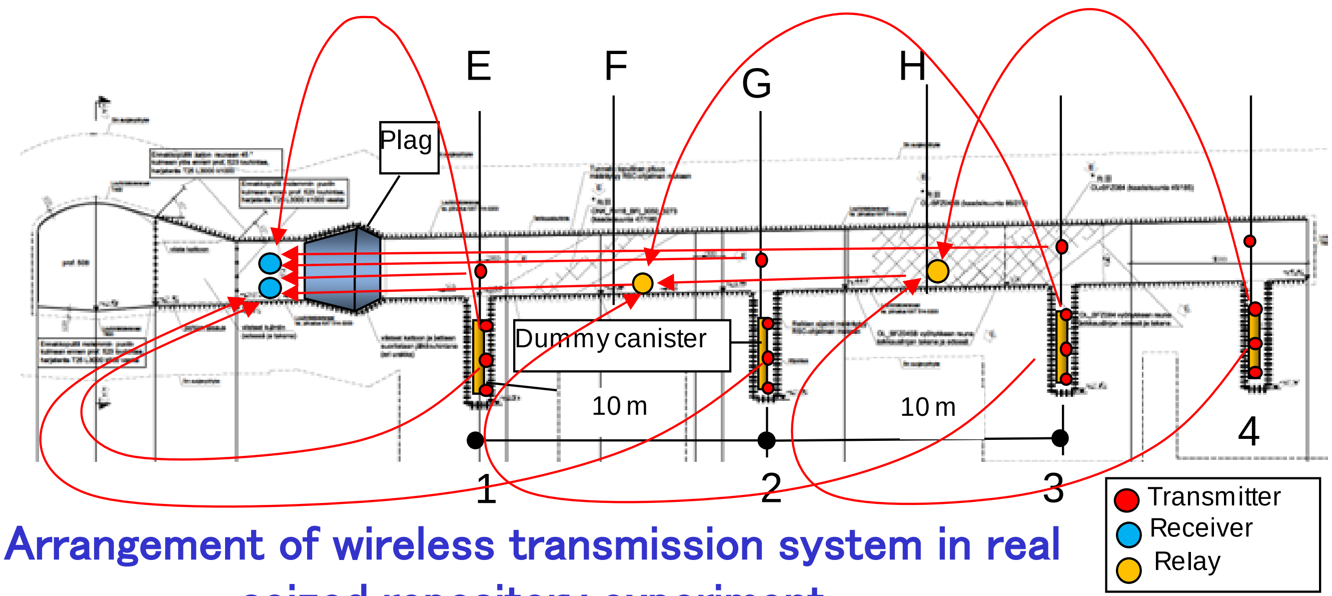
Kei SUZUKI, RWMC

Presentation

1. What we learned from MoDeRn project
2. Typology of Transmitters
3. Sampling time and battery life
4. Make sensors more small
5. **Estimation and judgment for the triggered value in EBS reference design**
6. **Conclusion**

1. What we learned from MoDeRn Project

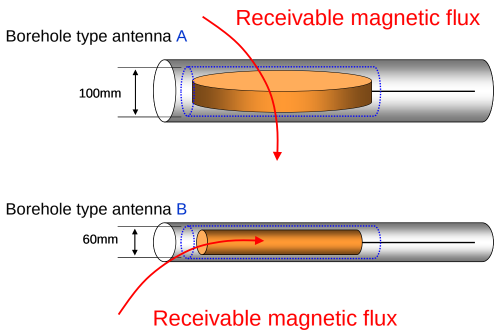
➢From MoDeRn Case study in WP4, the idealistic arrangement of wireless transmission systems are proposed. This make us possible to consider the typology of wireless transmission system, and make us to develop new system.



Arrangement of wireless transmission system in real seized repository experiment

Type	Short-range	Mid-range 1
Size	Φ : 50mm L :130mm	Φ :216mm L :310mm
Transmi. Test through rock in URL	L=25m Callovo-Oxfordian layer Noise:10mV	L=40m
Transmi. Test on the gorund	L=38m Noise:2.0mV	L=100m Noise:1.5mV

Type of transmitter

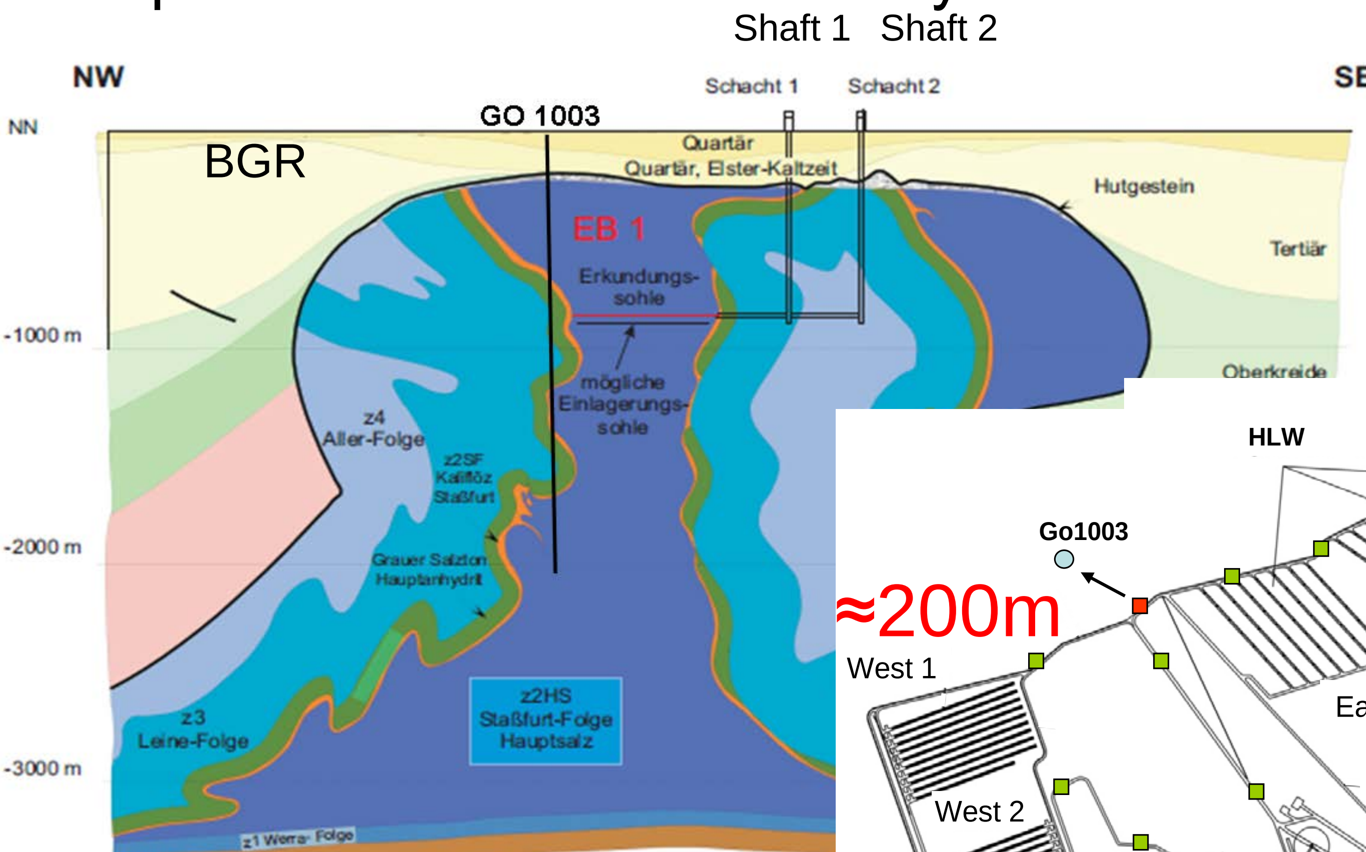


Type of receiver

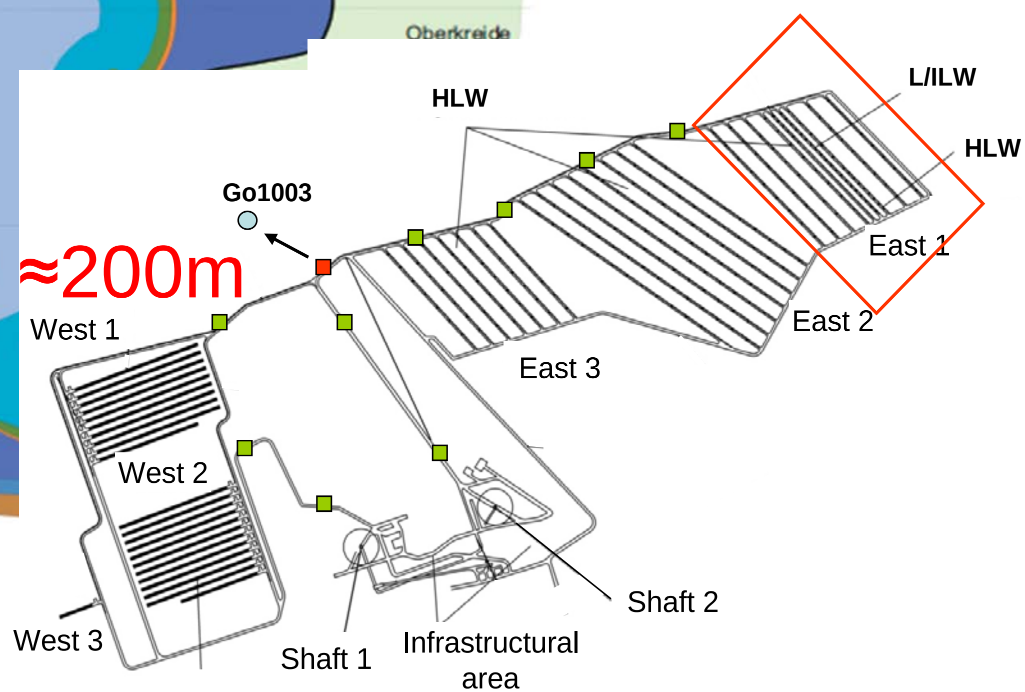
1. Small size, or the same size as an canister
2. Any direction, 3. Relay system

Wireless monitoring (case 1)

- Required distance are shown by the members



Source: *Köhte et al., 2007*



Ref: M. Jobmann, DB-TEC

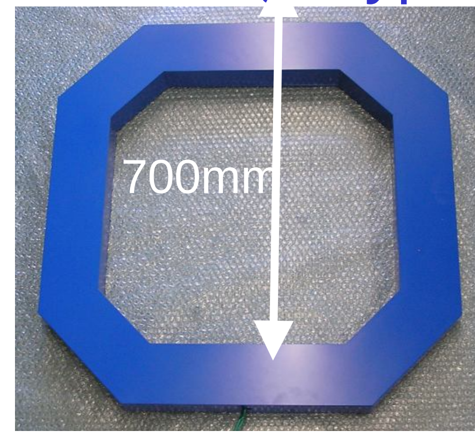
4. Relay system for transmitting 200m from URL to surface

2. Typology of the transmitter

Short-range type

Middle-range type 1

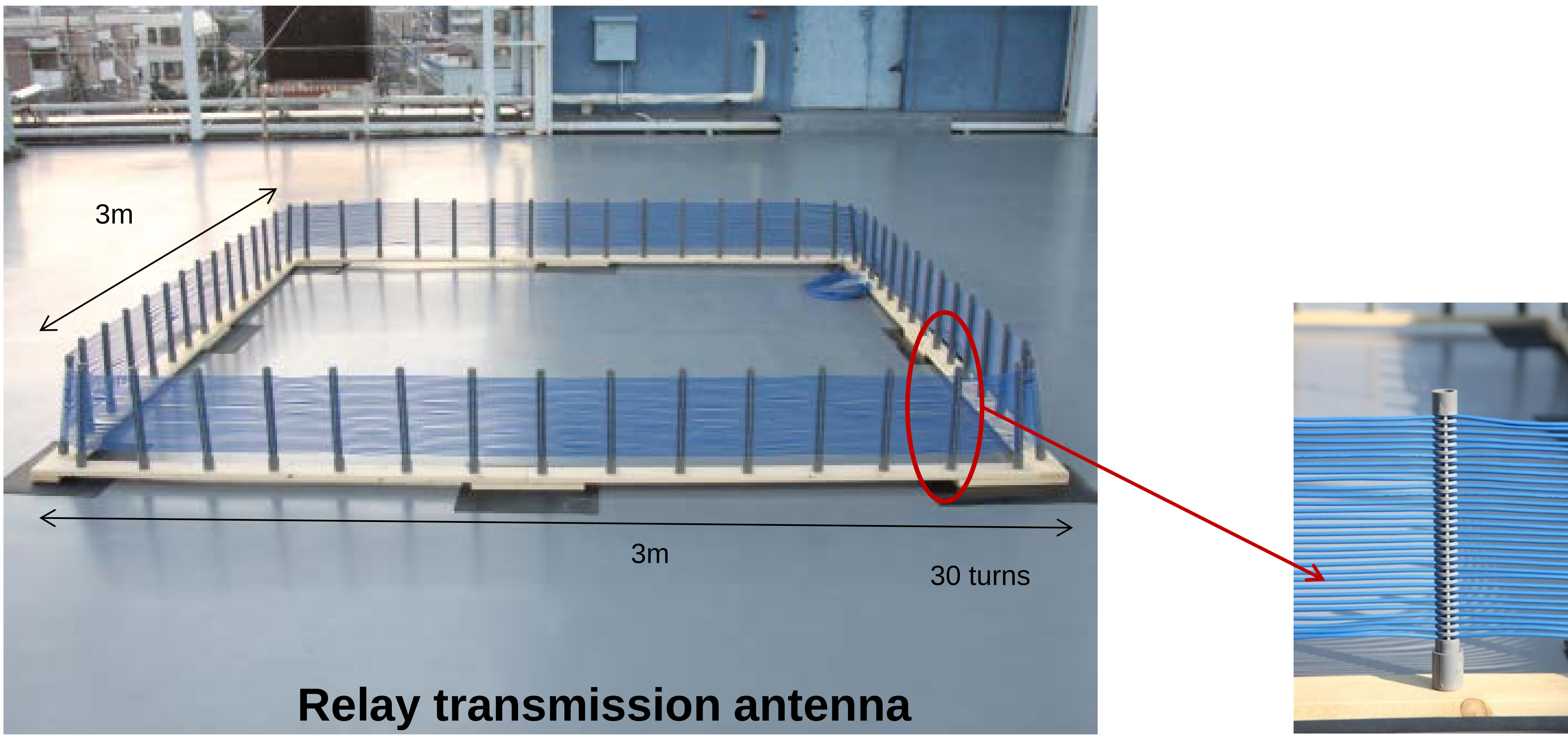
Middle-range type 2



Type	Short-range	Mid-range 1	Mid-range 2
Size	Φ : 50mm L :130mm	Φ :216mm L :310mm	Φ :700mm L : 70mm
Transmi.Test in CMHM URL	L=25m Callovo-Oxfordian layer Noise:10mV	L=40m	L=50m Callovo-Oxfordian layer Noise:2.0mV
Transmi. Test on the surface	L=38m Noise:2.0mV	L=100m Noise:1.5mV	L=240m Noise:1.5mV

Long-range

- The long range antenna was developed in 2012, it will be tested over 110m in Horonobe URL in 2013. The result will be shown in WS of monitoring in Paris, May 2014



Relay transmission antenna

3. Sampling time and battery life

Operation period (Battery life time)			Short	Middle
Type of transmitter				
Transmission distance			Maximum 25m in rock Note 1: Transmission distance depends on the noise level where the receiver is placed	Maximum 40m in rock
Available channel			Thermometer and one channel (1 sensor)	4 channel s(4sensor)
Transmission period (under the condition that the temperature is around 20-30℃)	Case1	Measurement 24 times/day Transnmission1 time/day	1sensor: 3-4years	1sensor: 6years 4sensors: 3years
	Case2	Measurement 4times/day Transnmission1time/week	1sensor: 7years	1sensor: 10years 4sensors: 8years
	Case3	Measurement 1time /day Transnmission1time/week	1sensor: 10years	1sensor: 10years 4sensors: 8years
	Case4	Measurement 1time /week Transnmission1time/month	1sensor: 10years	1sensor: 10years 4sensors: 8years

Note 2: Transmission periods (battery's durability) depend on the frequency and transmission.
Note 3: Transmission periods becomes shorter, if the te

➢ We need more longer battery life.

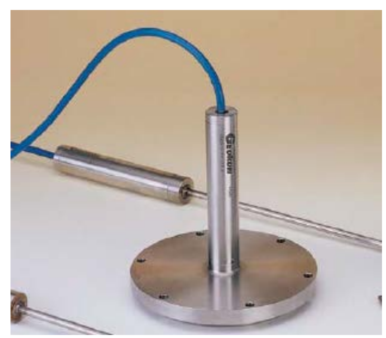
4. Make sensors more small

Sensor Type	Manufacturer	Material	Pressure	temperature	Sensor Cable
Total pressure	Geokon 4800	SS316	20MPa	50℃	PVC
Pore pressure	Geokon4500HT	SS316	10MPa	50℃	PVC
RH humidity	Aitemin	Stainless steel	5MPa	50℃	Twisted shielded, Teflon jacketed

- For RH humidity with10MPa sensor is able to offer.

Pore pressure 4500HT
Cell 133mmX19.1mm

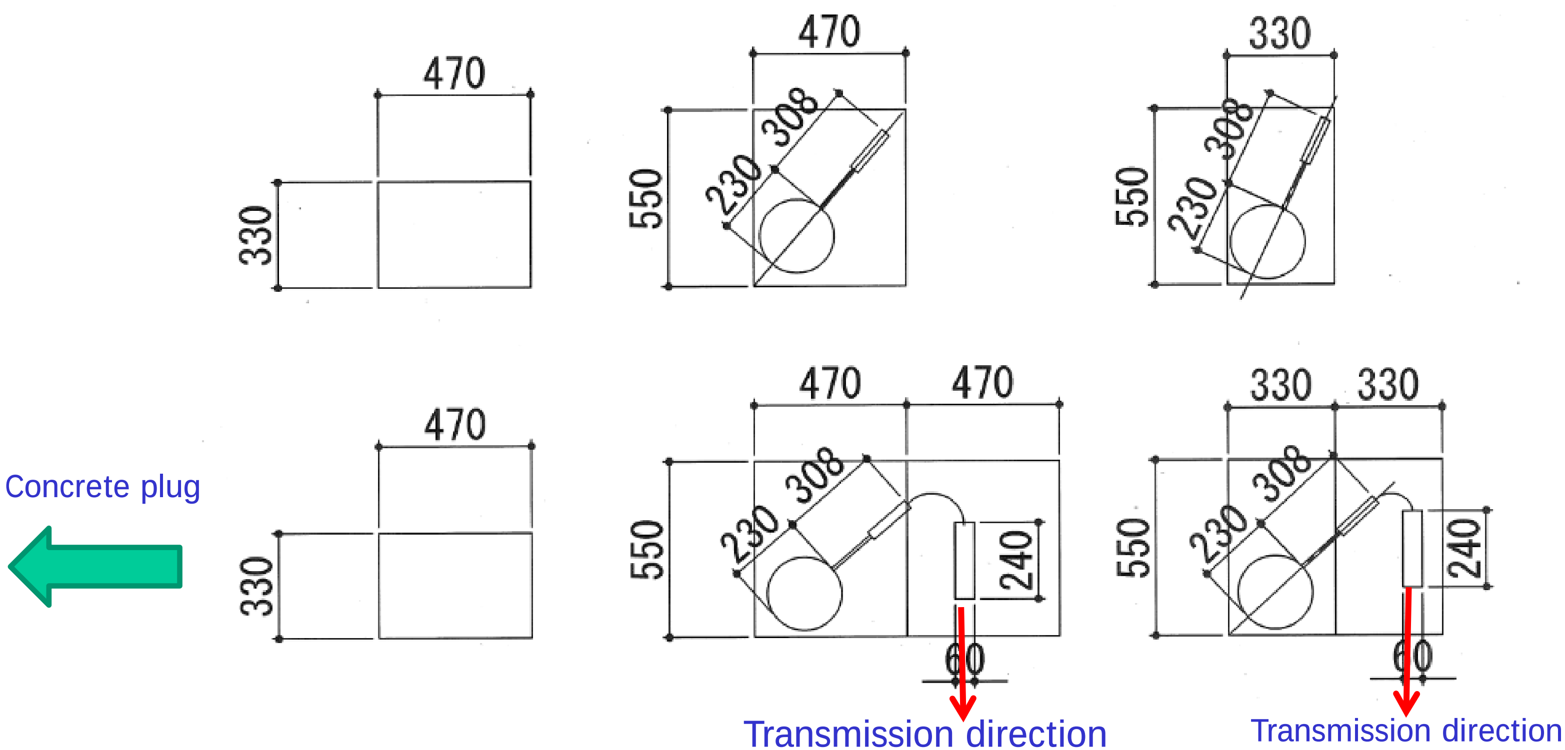
Total pressure 4800
Cell 230mmX6mm



Total pressure 4820
150mmX12mm

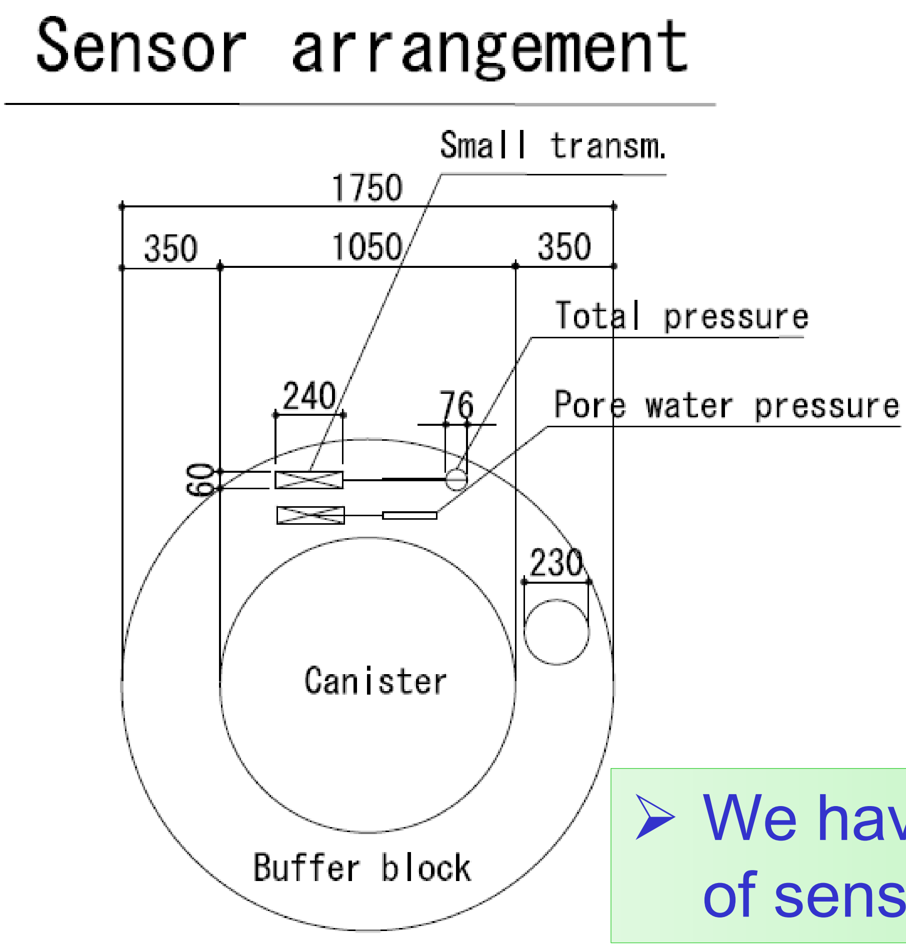
Relative humidity SHT75-V3

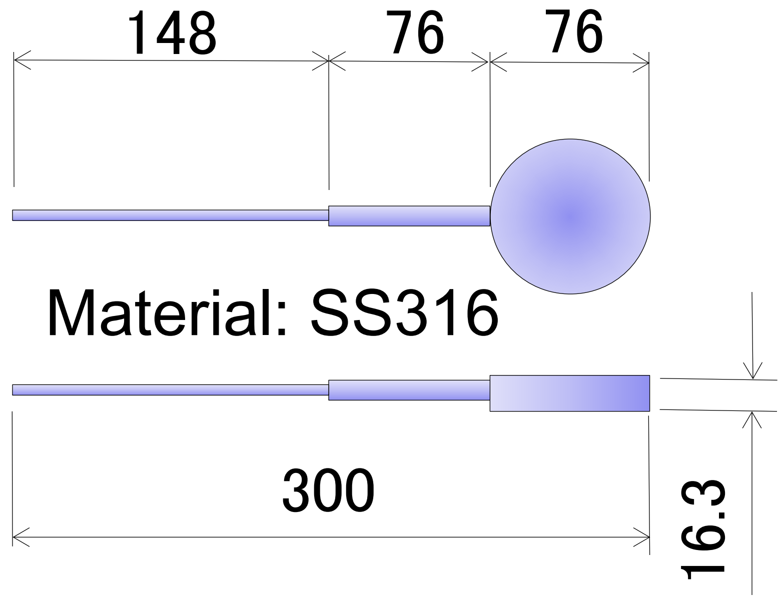
➢RWMC examined the total pressure sensor of Geokon 4800 in a bentonite block of 470X550X330 for backfill, we need more smaller sensor.



Arrangement of sensor in a backfill block

- New types of small sensors are developed day after day, Try to use them without restriction which requires more than 5 years of real usage.





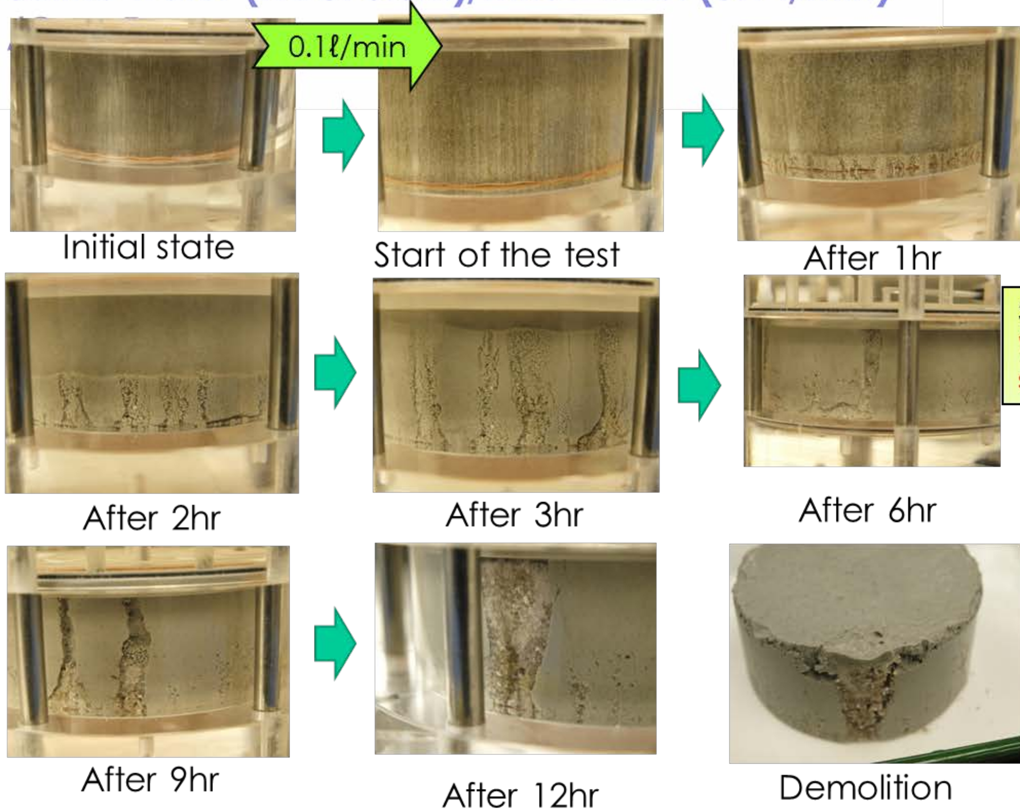
New type of Geokon 4800,
Total pressure
(not Hydraulic type)

- We have to collaborate with specialist of sensors, if problems would occur.

5. Estimation and judgment for the triggered value in EBS reference design

- There are some parameters which could not be detected by the sensors during re-saturation, such as inflow rate, piping and erosion phenomena.

Bentonite block(Dry density:1.6Mg/m³)
Saline water (NaCl 0.5M)/Inflow rate: (0.1 l/min)



Piping procedure

1hr: More sedimentation is observed.

P_w=60kPa : constant

3hr:Gap is filled by sedimentation
Water channels emerge in the sedimentation.

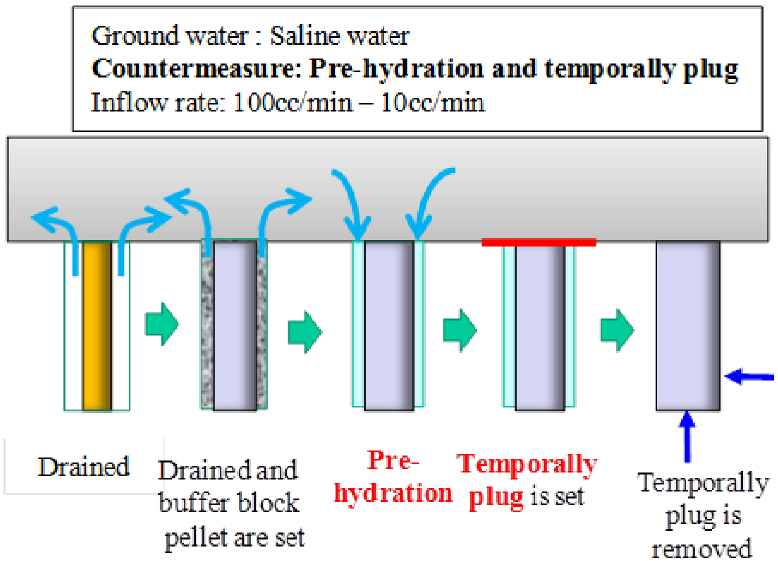
6hr: Erosion goes on.
No sealing can be seen.
Accumulation of Sand.

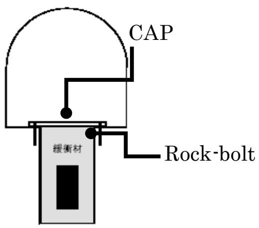
P_w=60kPa : constant
V_{erosin}=0.39%/hr

- In case of saline water, accumulation of sand occurs.
- Incase of 0.1 l/min, no sealing occurs.

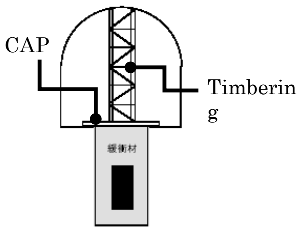
- The **behavior of buffer during re-saturation stage should be carefully estimated**, because it has strong relationship between water management and geo-hydrological condition, and also to the long term safety of EBS.

Countermeasure against piping and erosion





Rock-bolt method



Direct supporting on the seal

- If the hydro-geological condition is not good (hy < $1.0X10^{-6}$ m/s), we have to consider the site measurement of inflow rate, result of laboratory test and the result of water management, such as Post- and Pre- grouting.

6. Conclusion

- MoDeRn project made us opportunity to consider the typology of wireless transmission system.
- The future work is revealed, such as to postpone the battery life and distance, to study influence of temperature and radiation to wireless system.
- The sensors are developed day by day, we have to welcome this technical development and to collaborate with specialist of sensors.
- The behavior of buffer during re-saturation stage should be carefully estimated considering the result of laboratory test , site-measurement and water management, and geo-hydrological condition of rock.
- I hope to collaborate with members of IGD-TP as MoDeRn project did.

Than you very much !