Aalto-yliopisto

"BLOCK SHEAR"

- Interaction Behaviour of Backfill Interfaces -

BOA Seminar 2014

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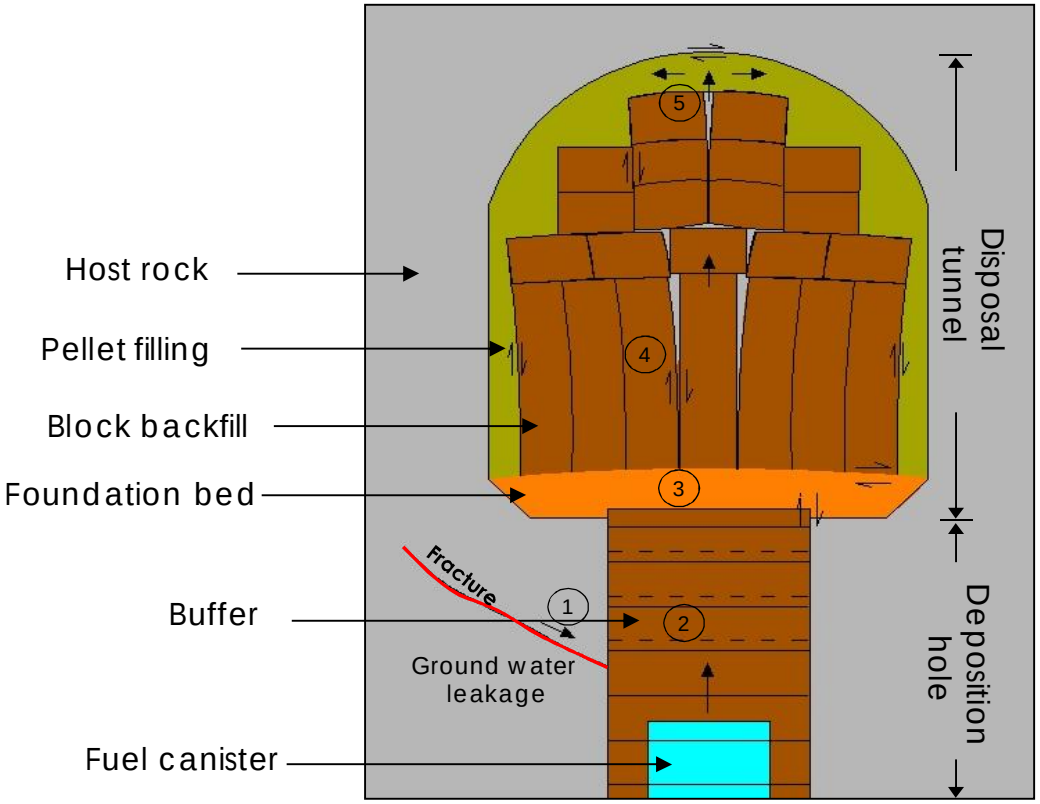
Objectives

Interface shear resistance of backfill materials under

- Natural conditions
- Varying temperature conditions
- Varying groundwater salinity conditions
- Varying water content (saturation)conditions

Backfill Interface Shear and Buffer Density



(1) GW leakage through fractures
(2) swelling & subsequent upheaval of buffer
(3) upheaval of the foundation bed
(4) shearing between blocks
(5) shearing between blocks & pellet filling

BUFFER DENSITY CRITERIA

- Saturated buffer density 1950 – 2050 kg/m^3

- Lower-bound > Corrosion protection
- Upper-bound > Protect the host-rock from cracking

- Backfill interface shear is crucial in controlling the buffer density during early stages of saturation (i.e. when the backfill is dry)

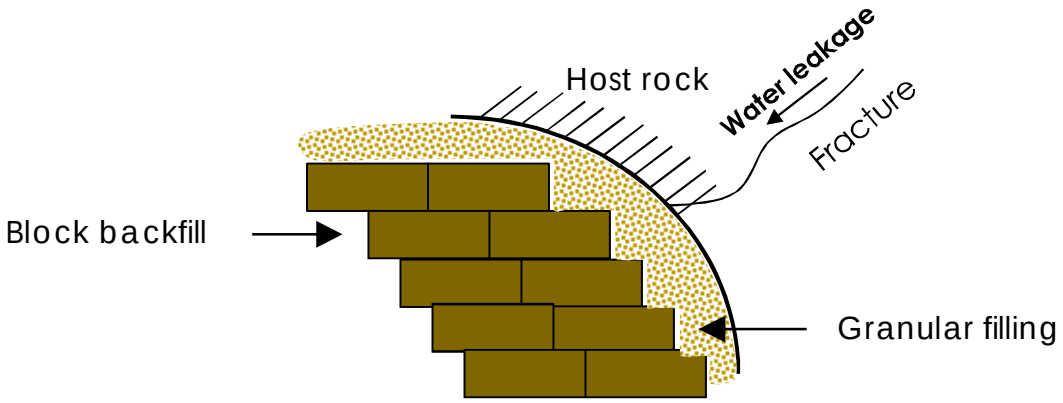
- Backfill interfaces need adequate shear resistance to control the swelling of buffer

Factors Affecting Interface Shear

- Temperature
- Groundwater salinity
- Water content (Saturation)

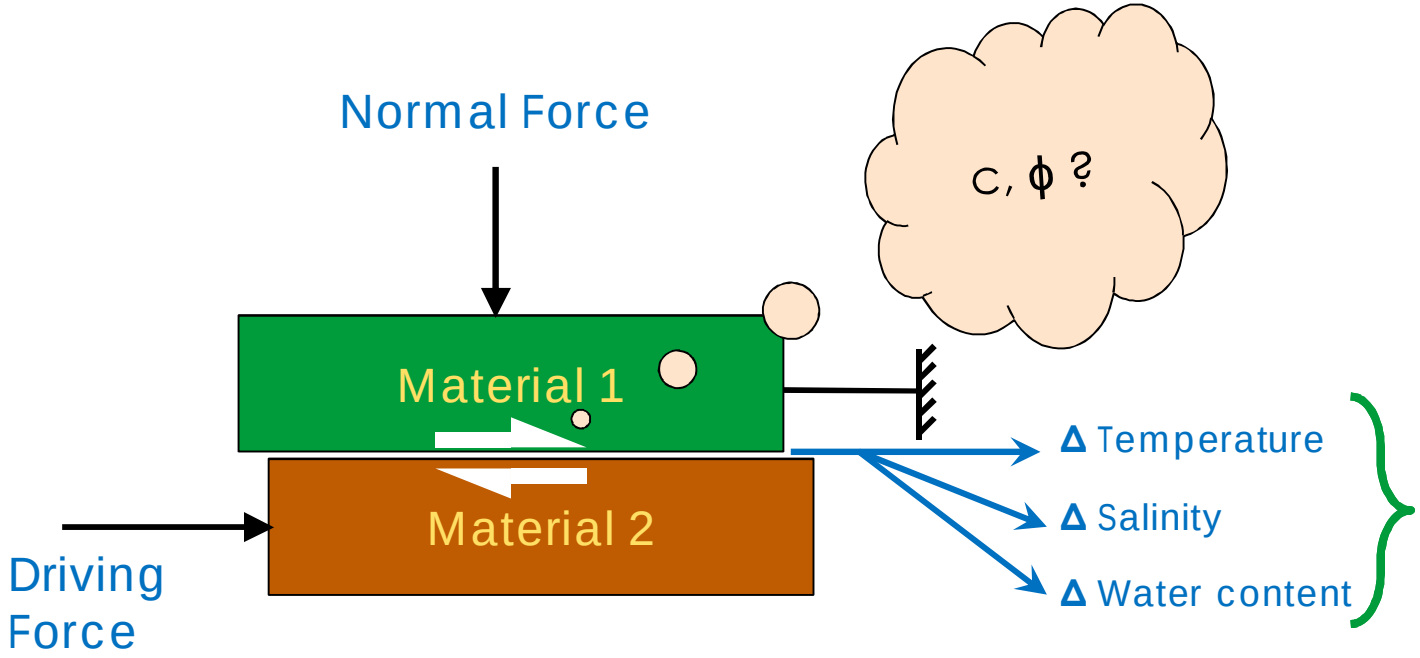
Case 1: Block backfill (DRY) - Granular filling (WET)

Case 2: Block backfill (WET) - Granular filling (WET)



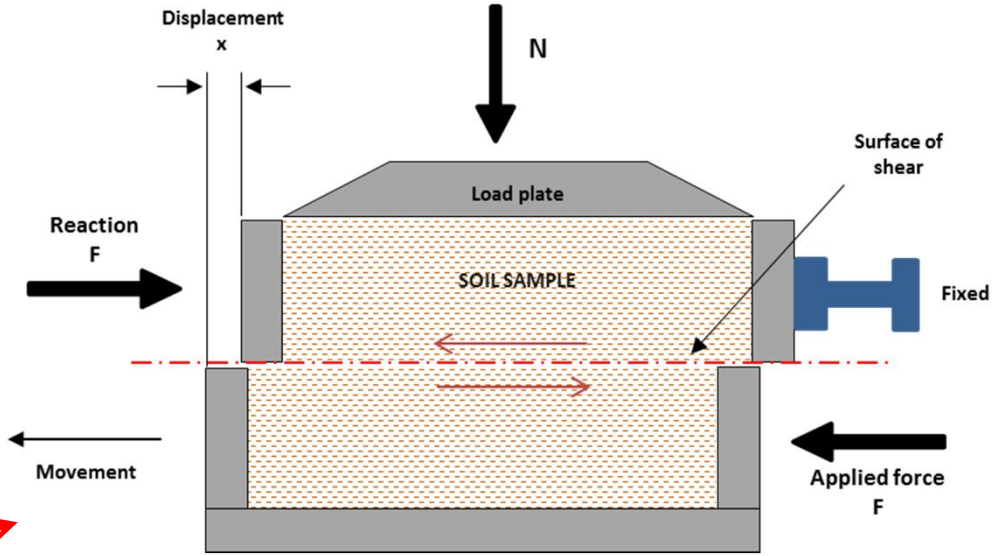
How do we study/test?

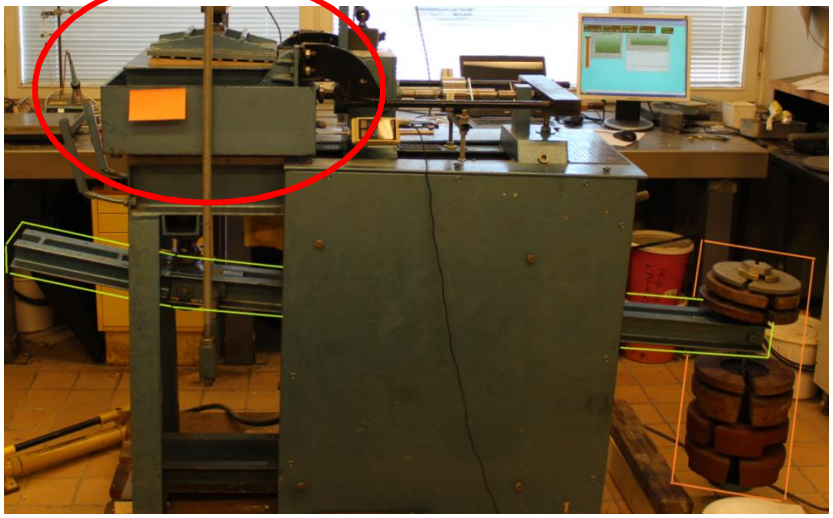
Interface Shear resistance – Cohesion (c), Friction angle (ϕ)



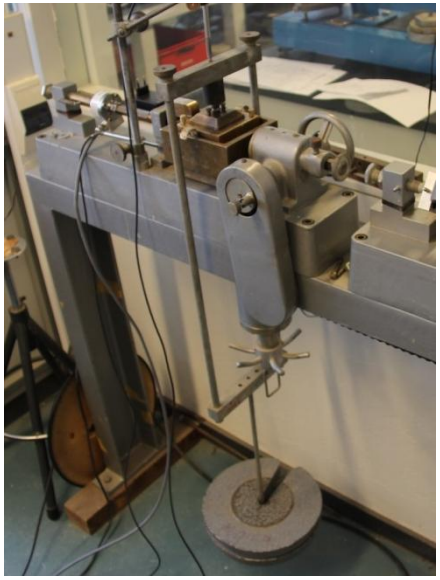
Testing Programme

a. Testing Apparatus





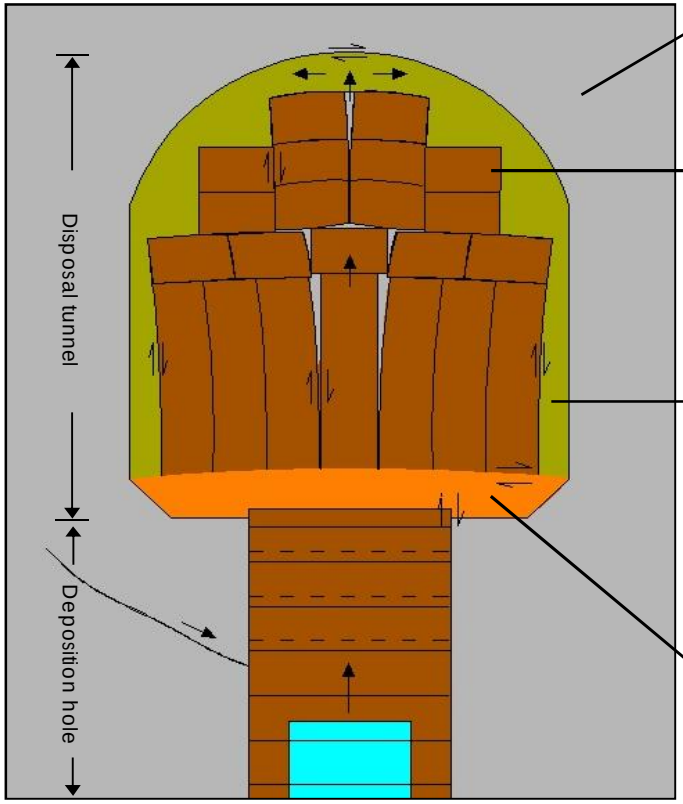
Large shear box (300 mm x 300 mm)



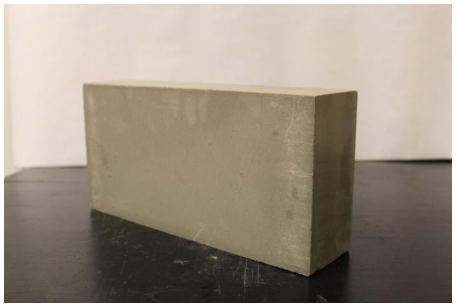
Small shear box (60 mm x 60 mm)

b. Materials Tested

2012/2013

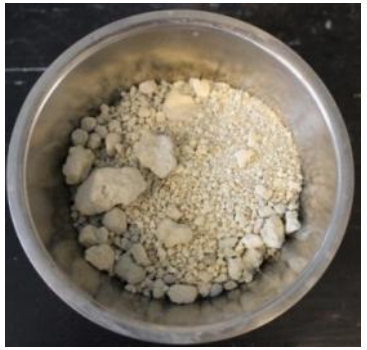


Granite Stone (GS)



Friedland Clay Blocks (FCB)

Pellets (QSEP)



Granulated Bentonite (GB)

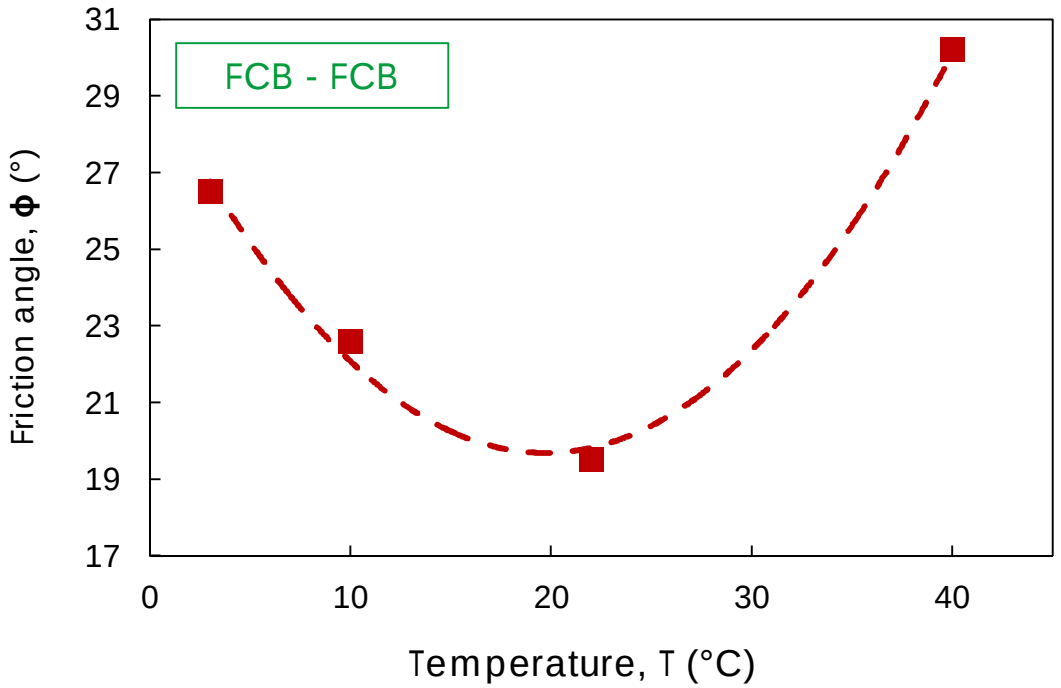
AC 200

Crushed Rock

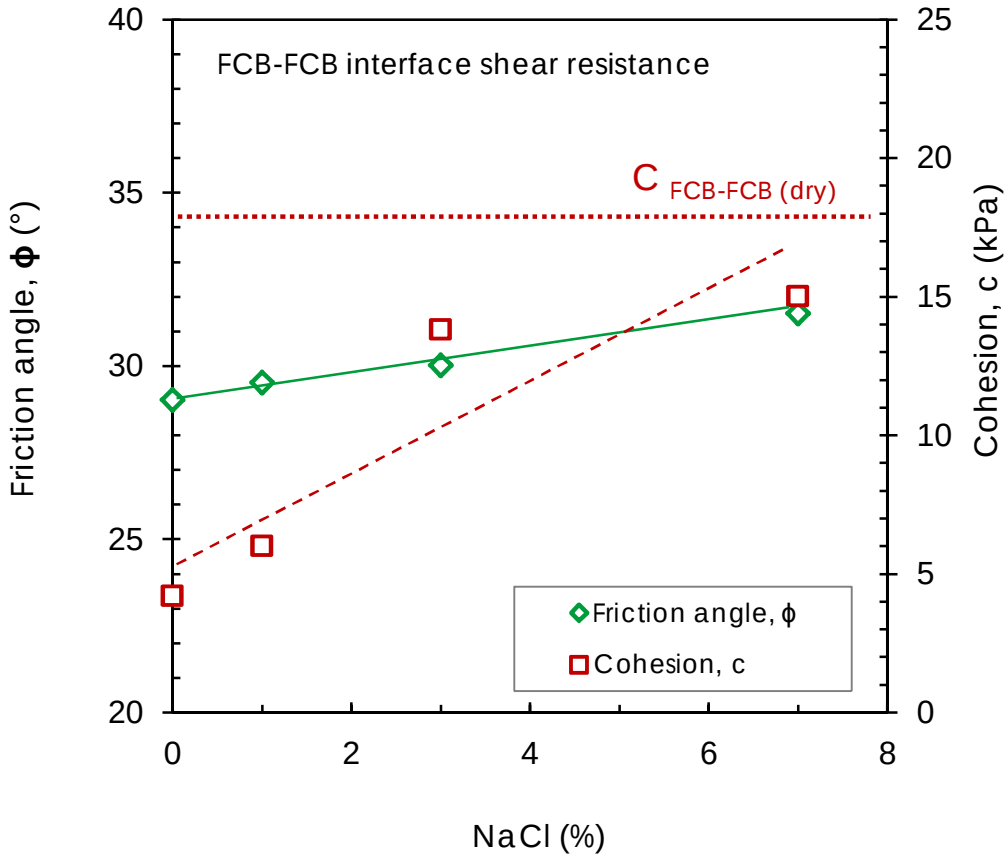
1:1 Mixture

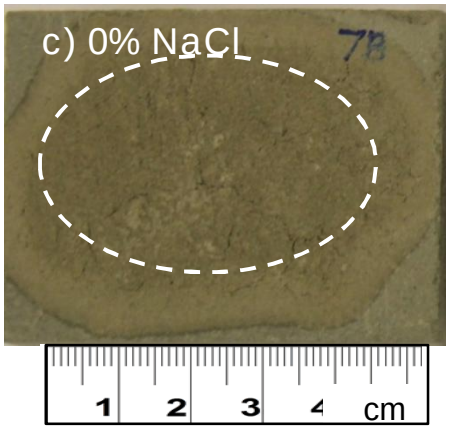
Summary of Results – 2013 / 2014

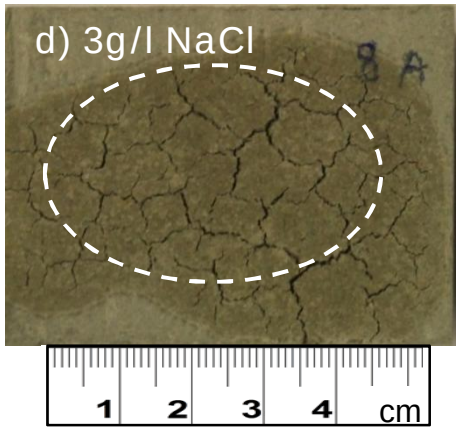
a. Temperature

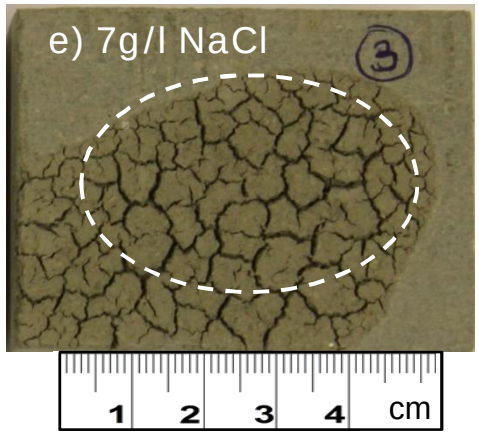


b. Salinity


FCB-FCB interface shear resistance
C FCB-FCB (dry)
Friction angle, ϕ (°)
Cohesion, c (kPa)
NaCl (%)
Friction angle, ϕ
Cohesion, c
40
35
30
25
20
25
20
15
10
5
0
0
2
4
6
8

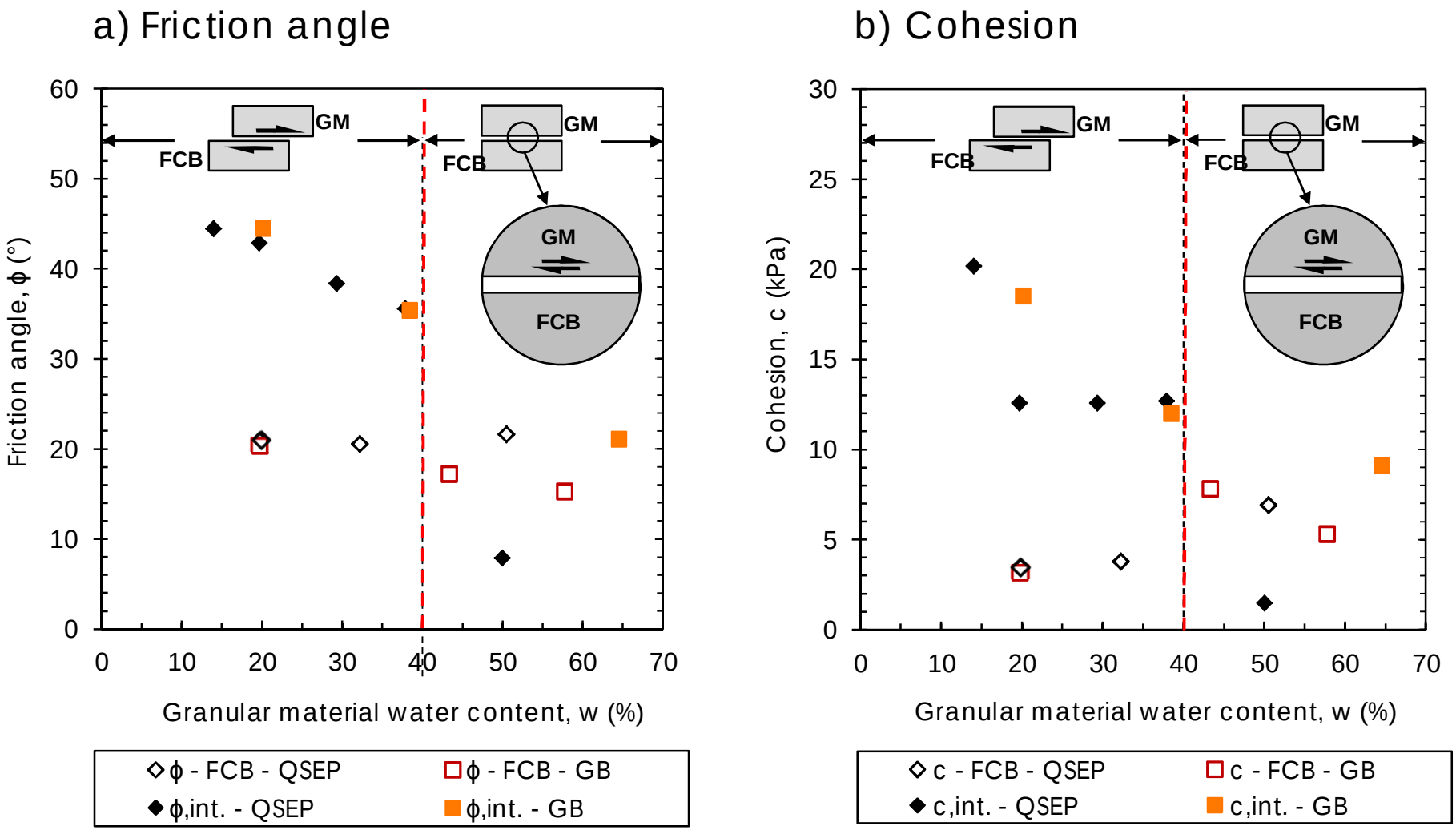

c) 0% NaCl
1 2 3 4 cm


d) 3g/l NaCl
1 2 3 4 cm


e) 7g/l NaCl
1 2 3 4 cm

c. Water content

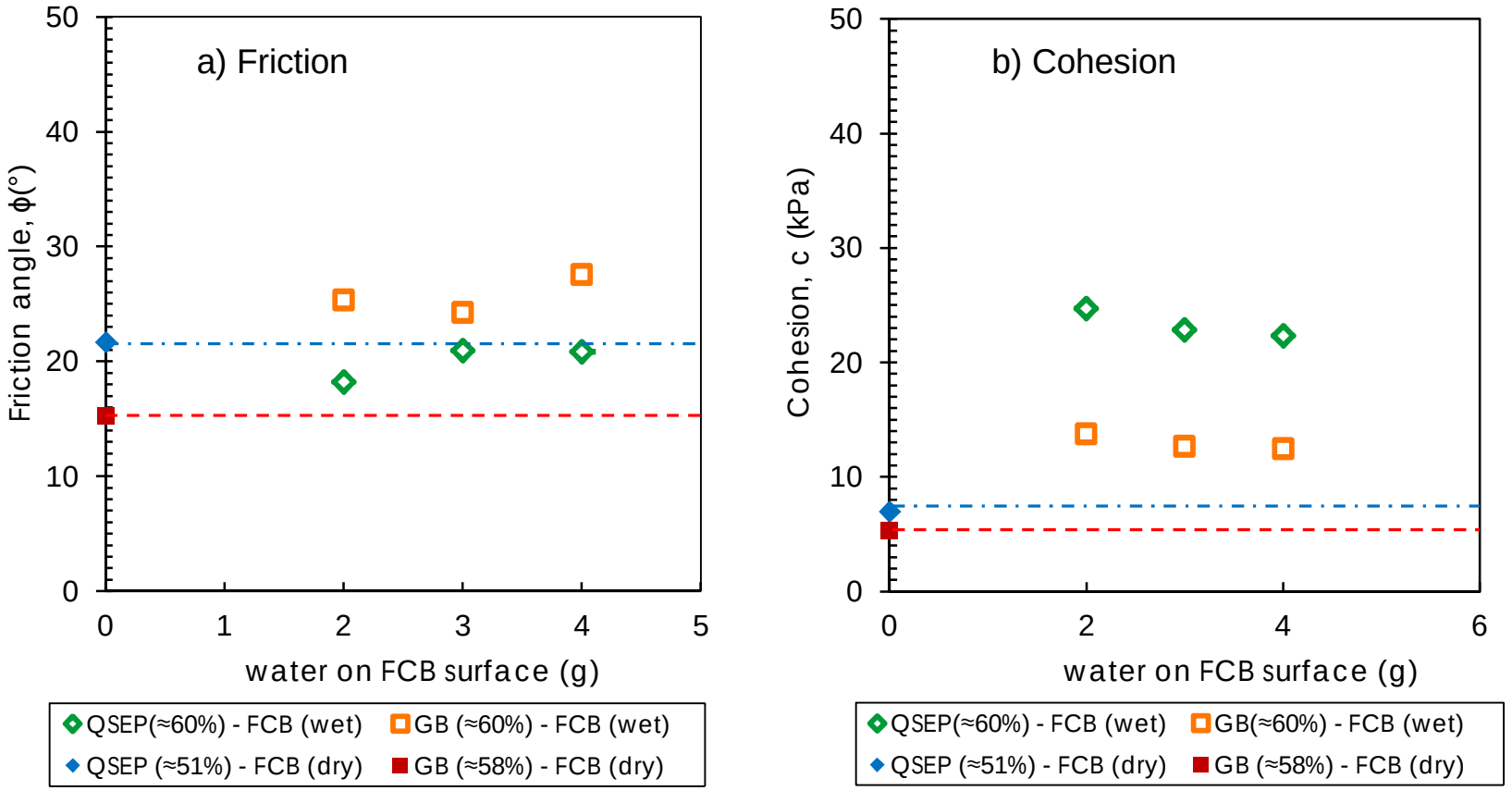
Case 1: Block backfill (DRY) - Granular filling (WET)



Notations: ϕ-friction angle; c-cohesion; int. – internal; FCB- Friedland clay block; GM- Granular materials (i.e., QSEP, GB); QSEP – Pellets , and GB – Granules of Bentonite.

c. Water content

Case 2: Block backfill (WET) - Granular filling (WET)



Notations: ϕ-friction angle; c-cohesion; int. – internal; min. – minimum; QSEP – Pellets and, GB – Granules of Bentonite

Publications

- Journal Articles

[1] Sinnathamby, G., Korkiala-Tanttu, L. & Gallardo, J. (2014). Interface shear behaviour of tunnel backfill materials in a deep-rock nuclear waste repository in Finland. *Journal of Soils and Foundations* (DOI: 10.1016/j.sandf.2014.06.027)

[2] Sinnathamby, G., Korkiala-Tanttu, L. & Salvador, L.T. (2013). Shear resistance of various tunnel backfill interfaces of Finnish KBS-3V type nuclear waste repository under varying repository conditions. (Under Revision: *Applied Clay Science*)

- Master Theses

[3] Gallardo, J. (2012). Shear resistance of backfill components' interfaces in nuclear waste deposition tunnels. *Master's Thesis.* Aalto University, School of Engineering, Department of Civil and Environmental Engineering.

[4] Salvador, L.T. (2013). Shear resistance of the interfaces of backfill components in nuclear waste deposition tunnels affected by changes in temperature, water content and salinity. *Master's Thesis,* Aalto University, School of Engineering, Department of Civil and Environmental Engineering.

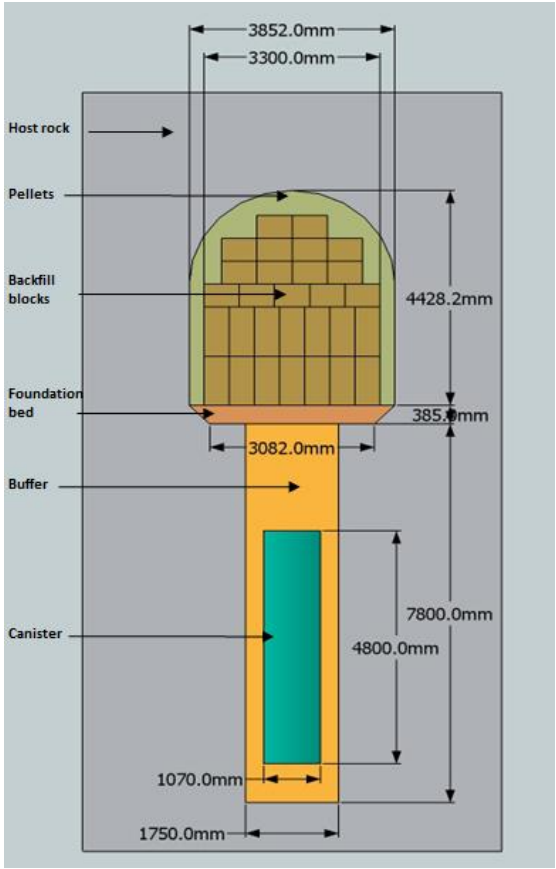
Future Research

Frost heave and swelling testing in the frost cell with re-compacted backfill and buffer materials under:

- Normal water

- Water with different salt content

Thank You!


3852.0mm
3300.0mm
Host rock
Pellets
Backfill blocks
4428.2mm
Foundation bed
385.8mm
3082.0mm
Buffer
7800.0mm
Canister
4800.0mm
1070.0mm
1750.0mm