Suomen Akatemia

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Soft seabed: the challenge for offshore infrastructure in Finland

Wojciech Sołowski, Aalto University

11.12.2024

Geomeasure

Wojciech Sołowski & Joonas Virtasalo

- Survey Finnish coastal areas
  - Remote sensing
  - Free-fall marine cone penetrometer tests
  - Core samples
- Laboratory testing of the core samples
  - Mechanical properties
  - Behaviour under cyclic loading
- Numerical replication of the free-fall penetrometer tests, new correlations between the tests and sample properties
- Connecting infrastructure and risks

More: solowski.info/geomeasure

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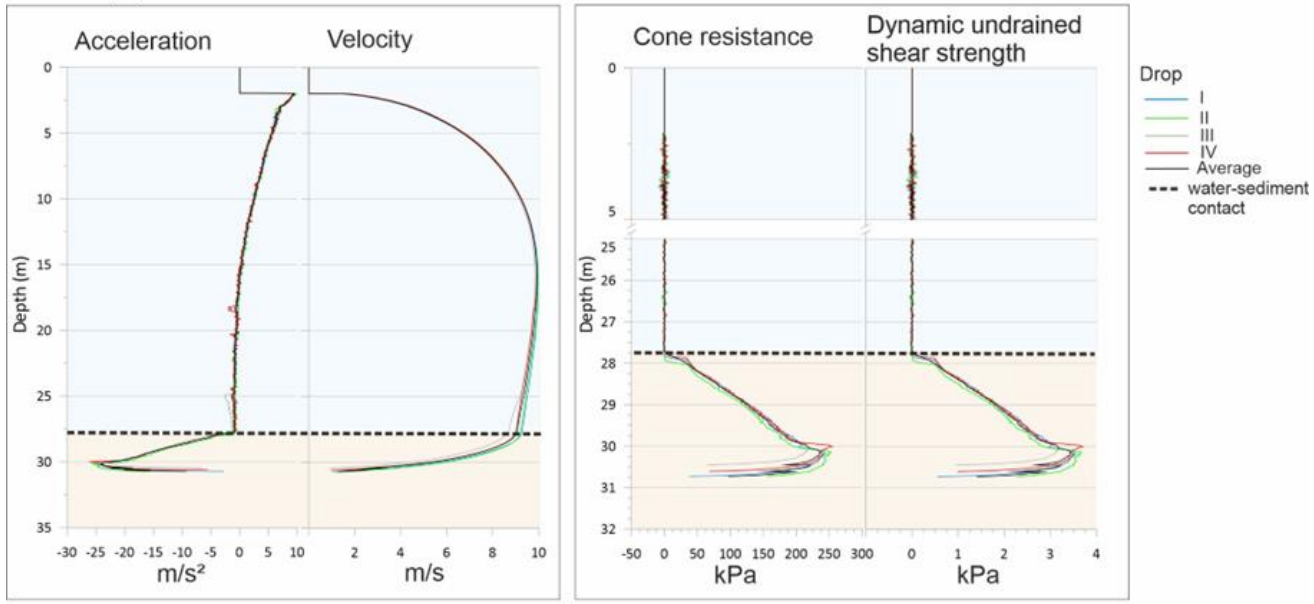
Free Fall Cone Penetration Test results example

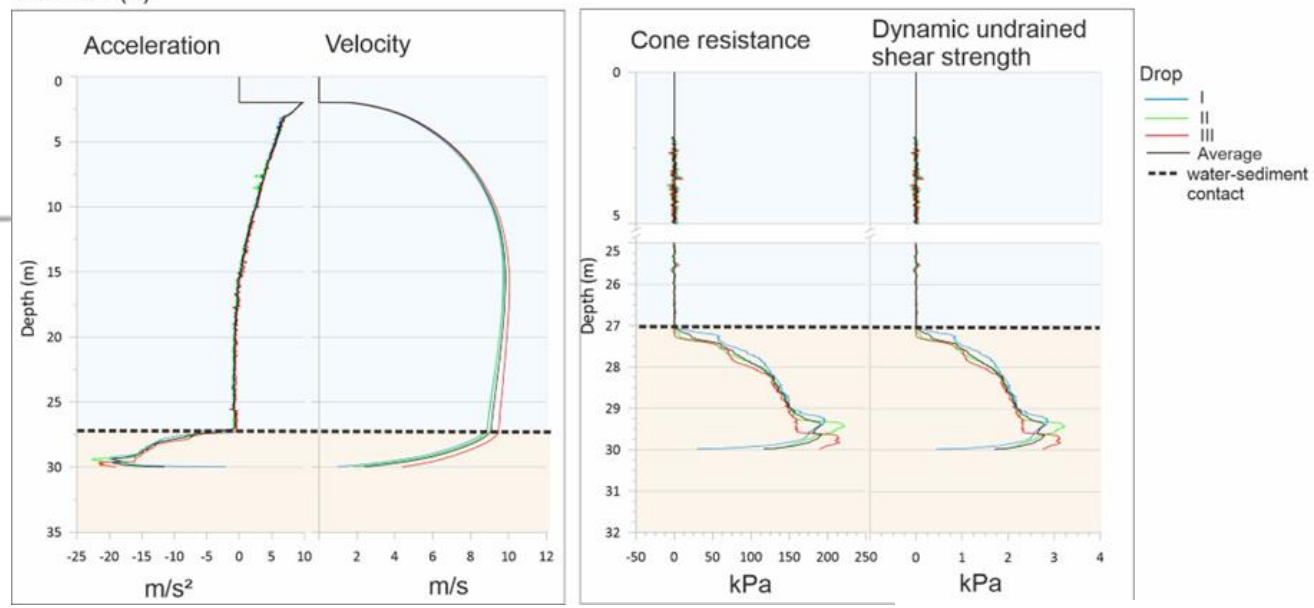
- 3-4 drops at one site
  - Quick measurement
- Characteristic unit properties
- Ground-truthing of seismic profile interpretations

dotOcean Graviprobe 2.0

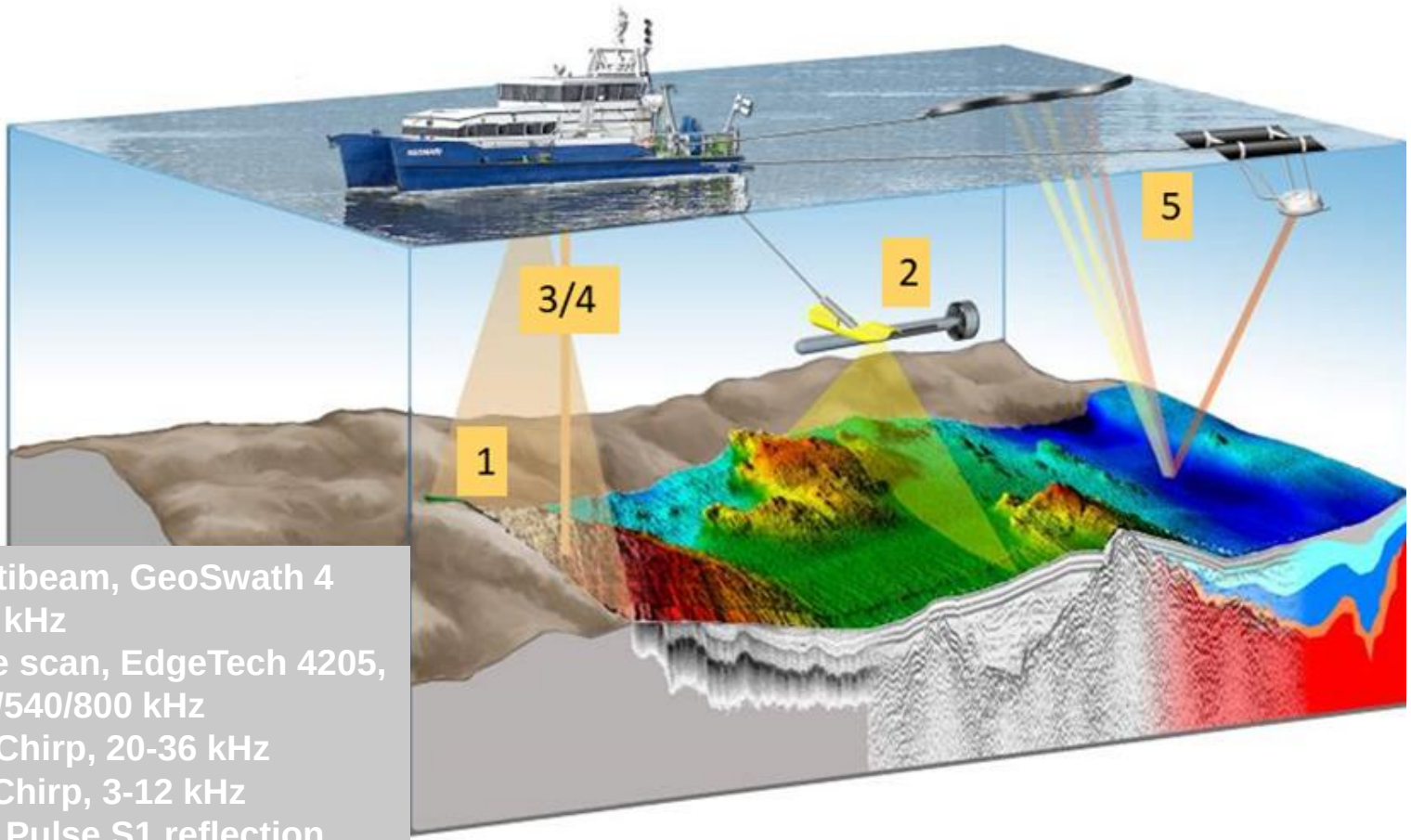
MGKU 1(2)



MGKU 3(4)



Offshore site investigations on board R/V Geomari



Research vessel Geomari, GTK

1. Multibeam, GeoSwath 4 125 kHz
2. Side scan, EdgeTech 4205, 230/540/800 kHz
3. HF-Chirp, 20-36 kHz
4. LF-Chirp, 3-12 kHz
5. SIG Pulse S1 reflection seismic system, 0.2-2.0 kHz

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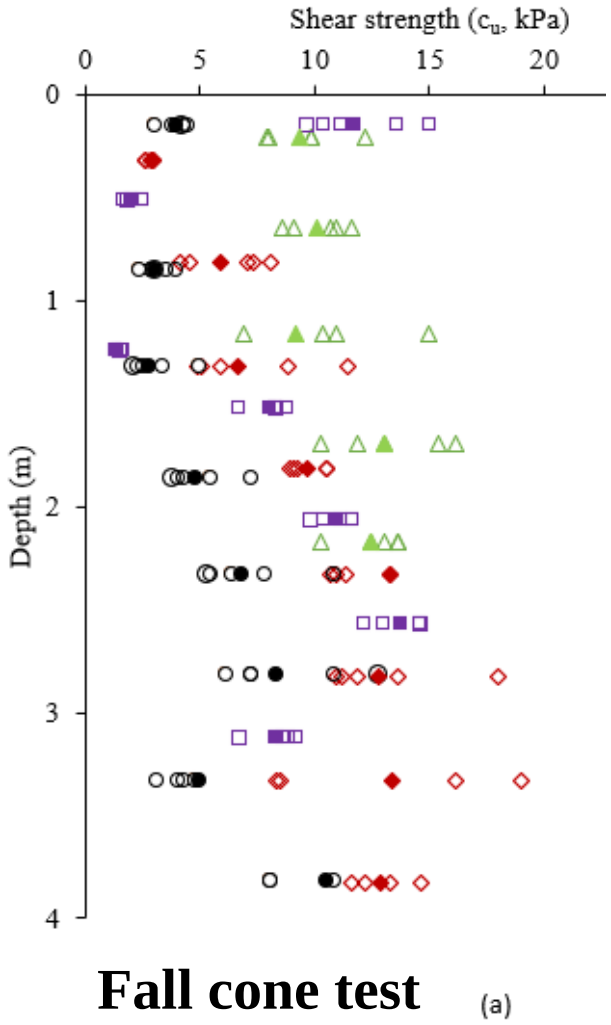
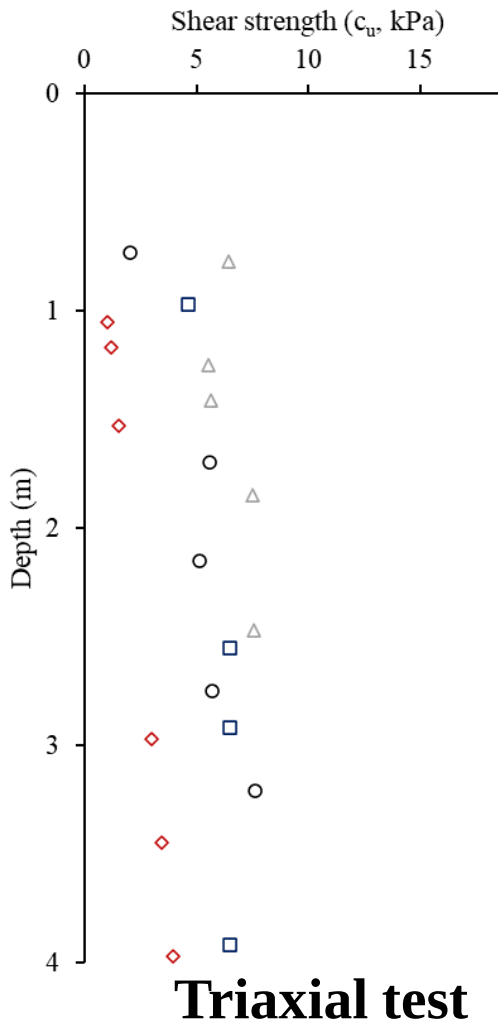
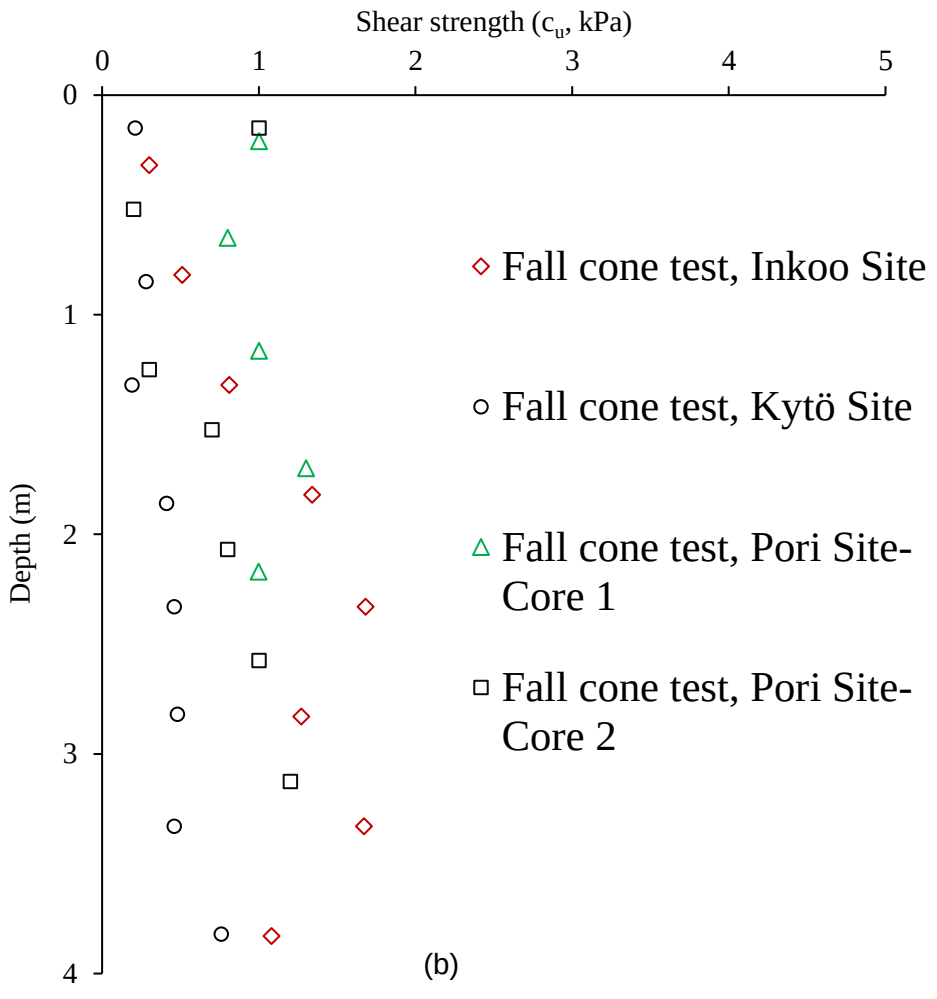
Undrained shear strength tests performed on marine clay at the Inkoo, Kytö, and Pori sites



Fall cone test



Triaxial test



Fall cone test remoulded

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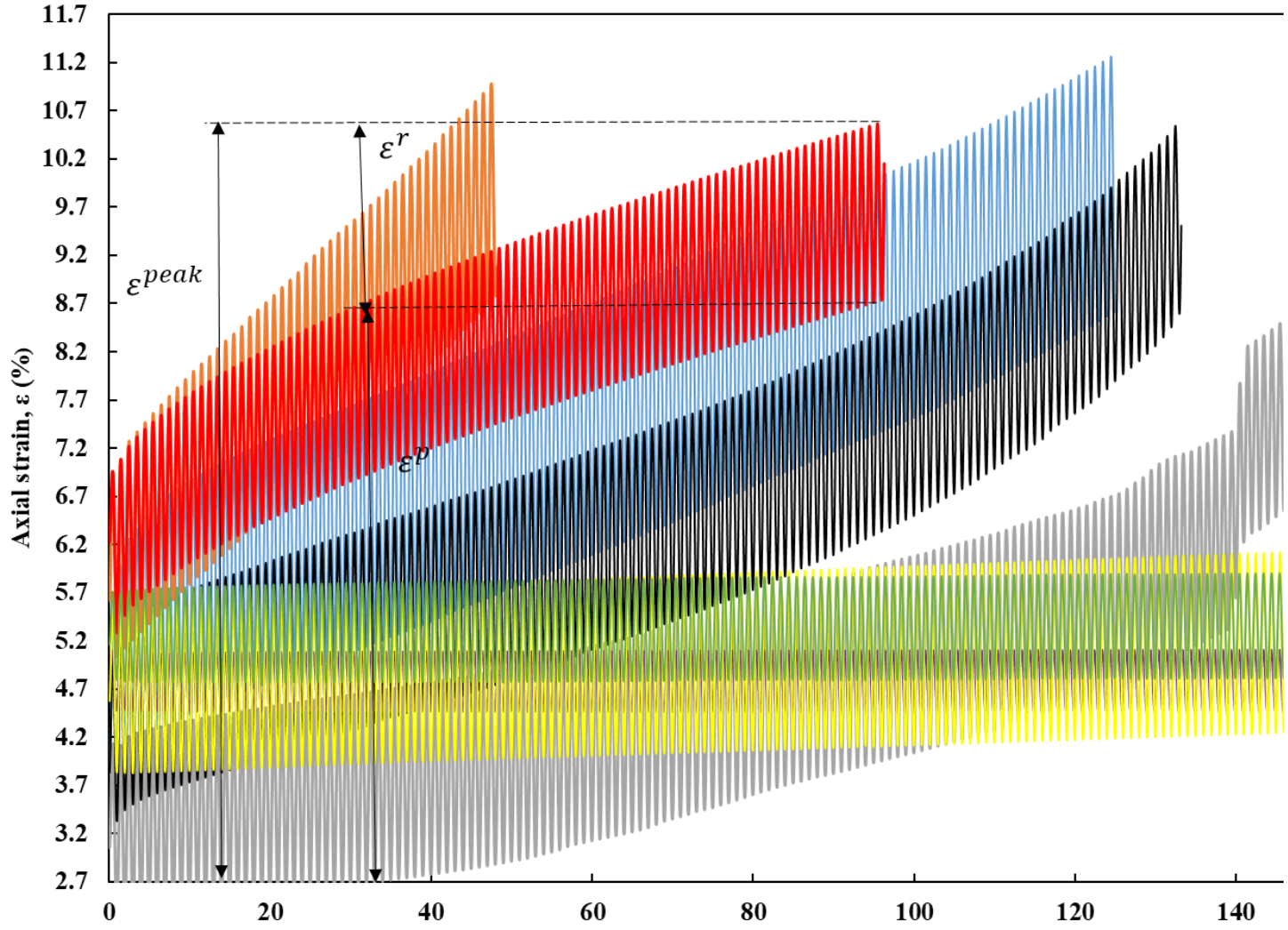
Cyclic tests

- Still ongoing
- Differences between cyclic triaxial and simple shear
  - different stress state in the sample: simple shear reduces the horizontal stress alongside the vertical state, while triaxial test keep cell pressure constant



ε^{p} =The permanent axial strain
ε^{r} =The resilient axial strain
ε^{peak} =The peak axial strain

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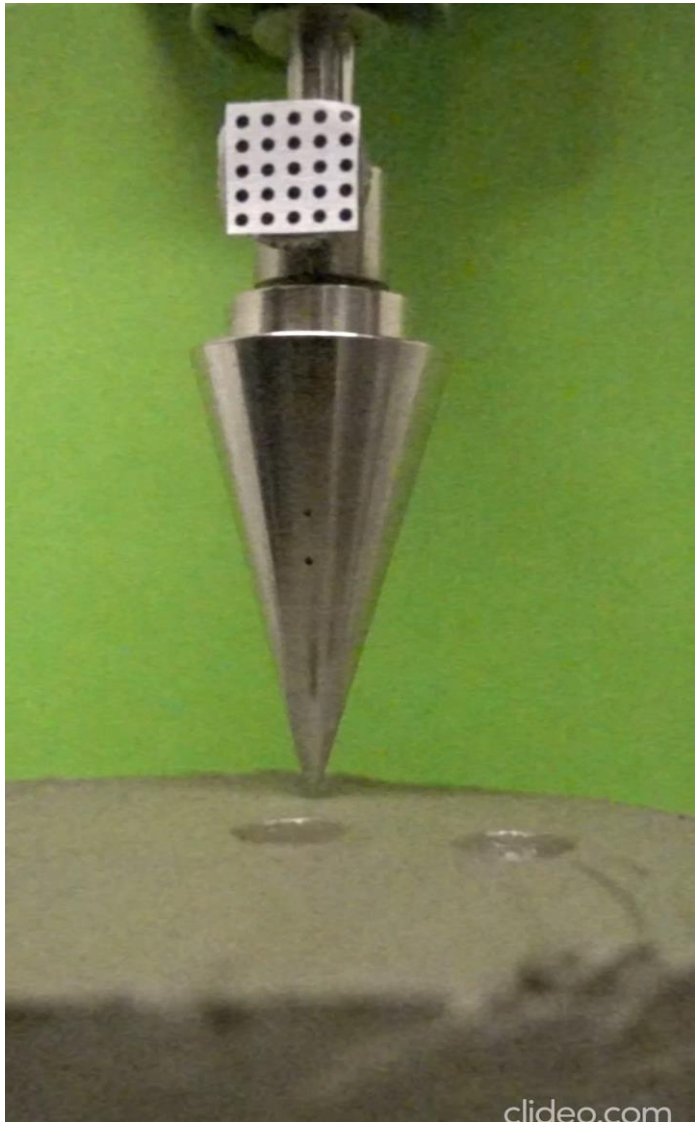
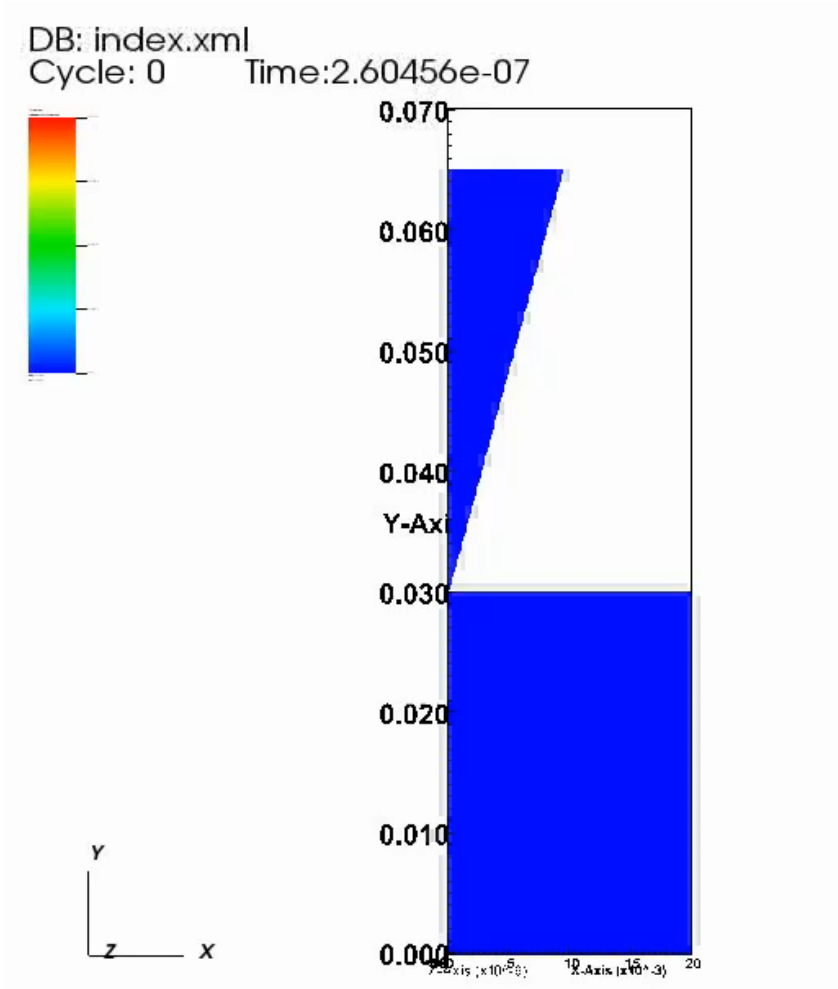
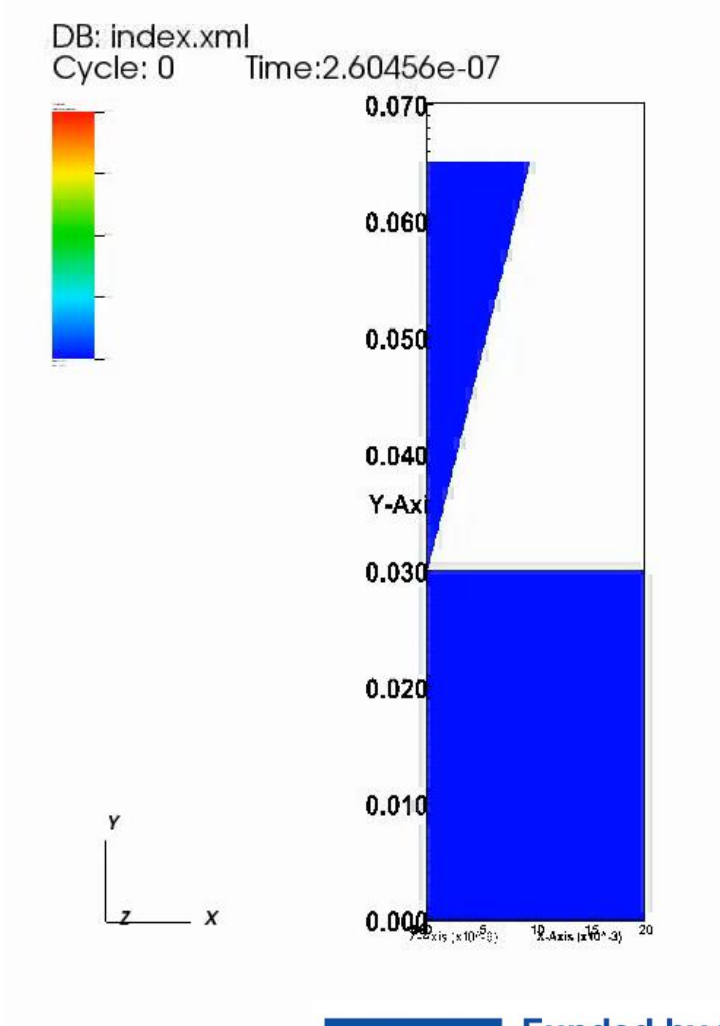
Fall cone test simulation using GIMP



Displacement



Velocity



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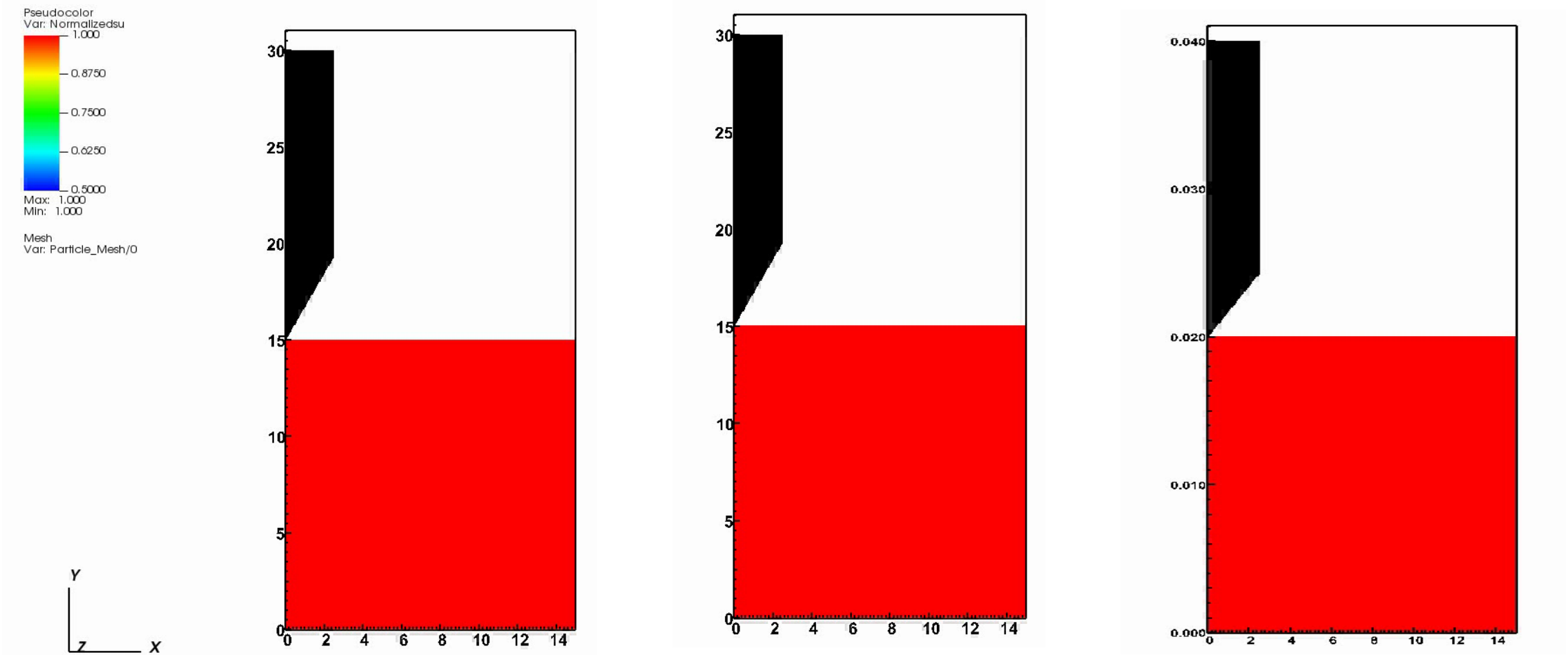
Laboratory FFCPT simulation using GIMP



Drop height 0 | Drop height 10 mm | Drop height 20 mm

Colours show degradation of undrained shear strength s_u

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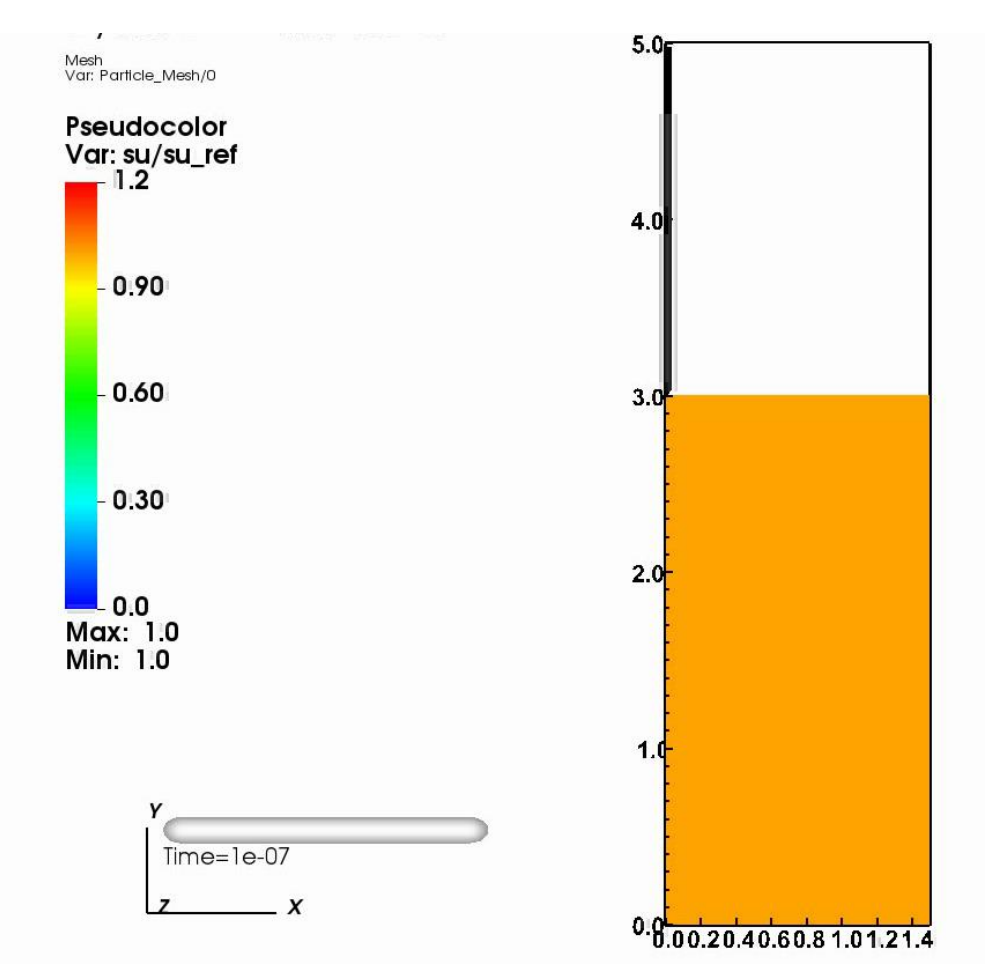
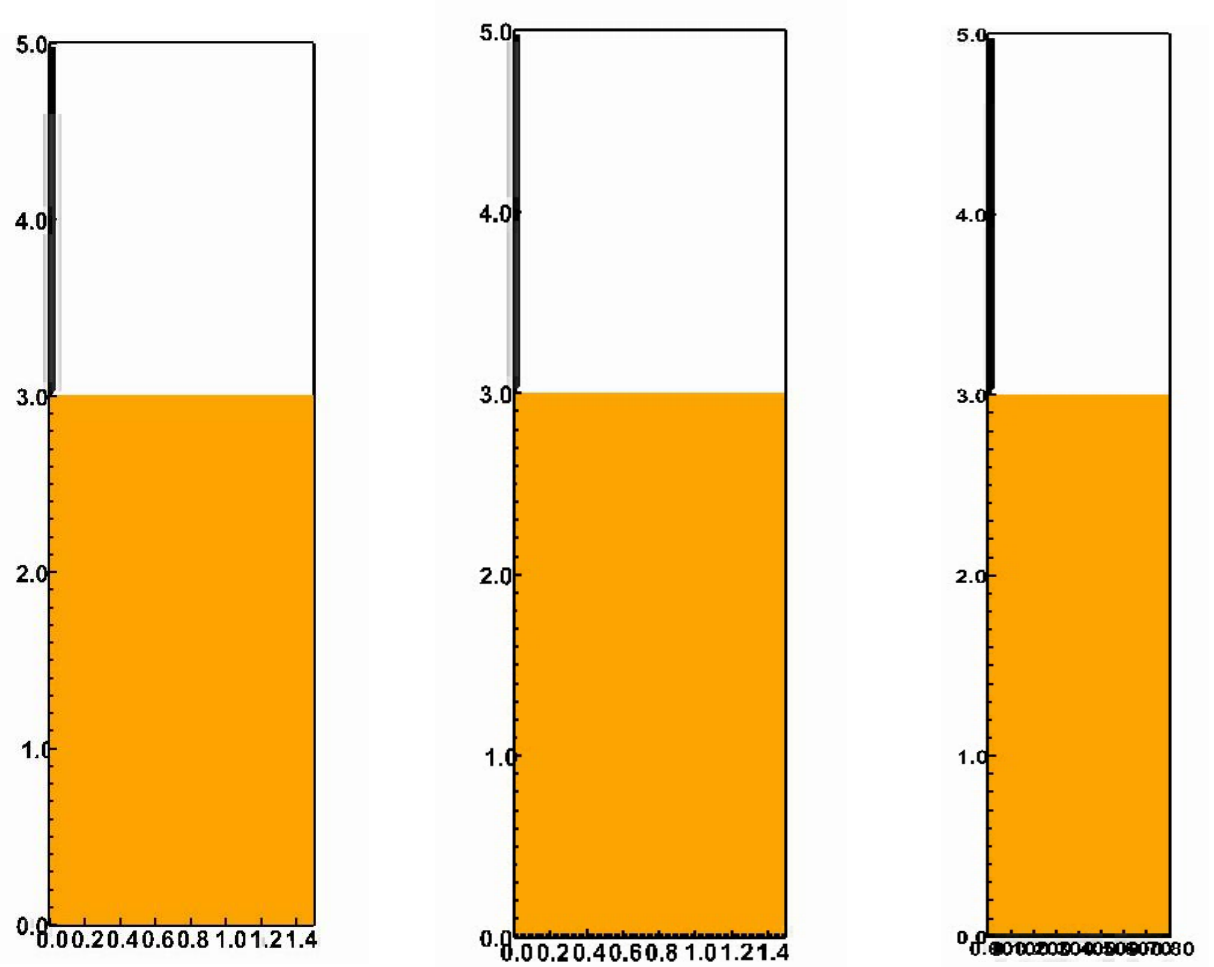
In-situ FFCPT simulation using GIMP





Inkoo

Kytö

Pori

Colours show degradation of undrained shear strength s_u

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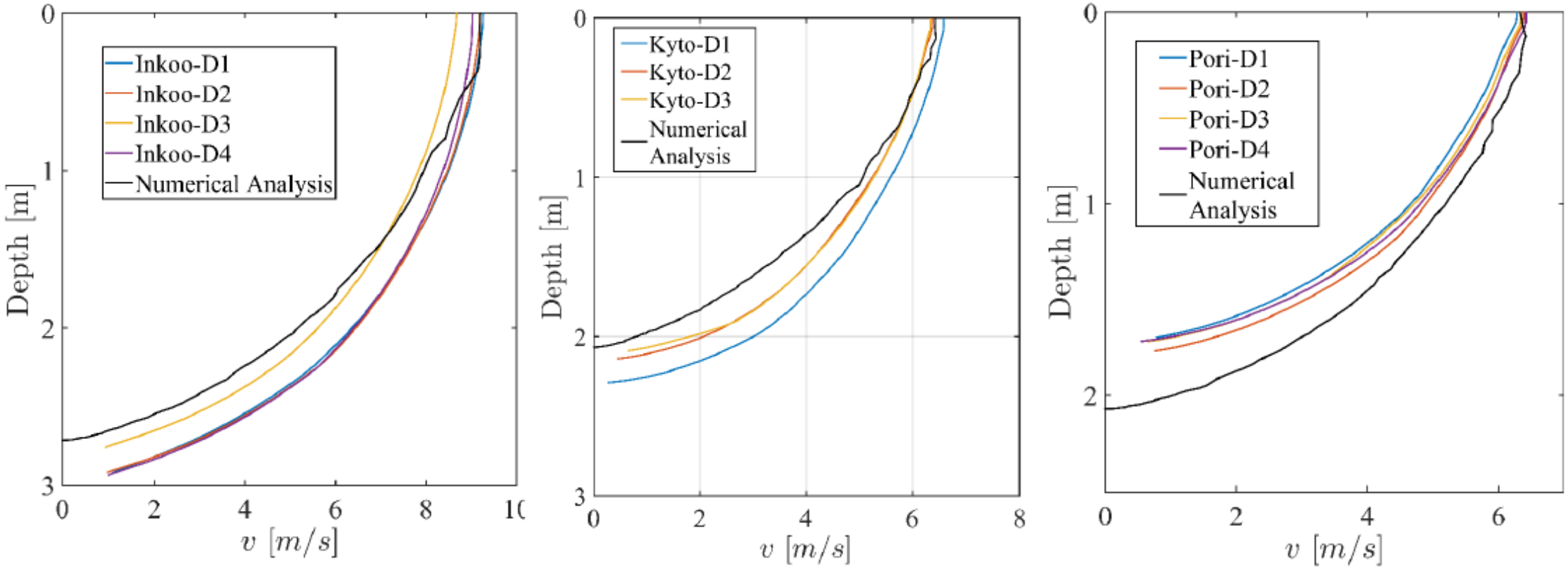
Comparison between GIMP simulation based on triaxial data and experiment



(a) Inkoo site (b) Kyto site (c) Pori site

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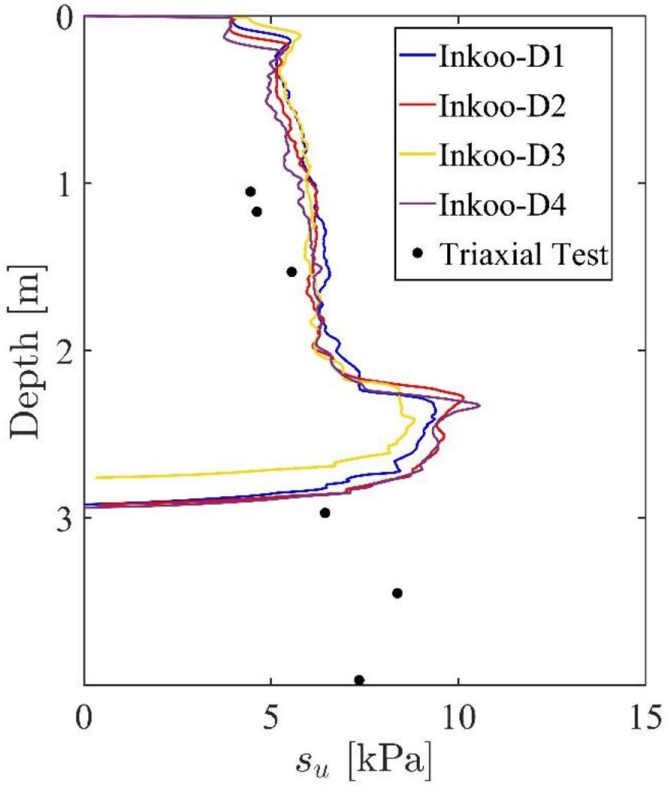
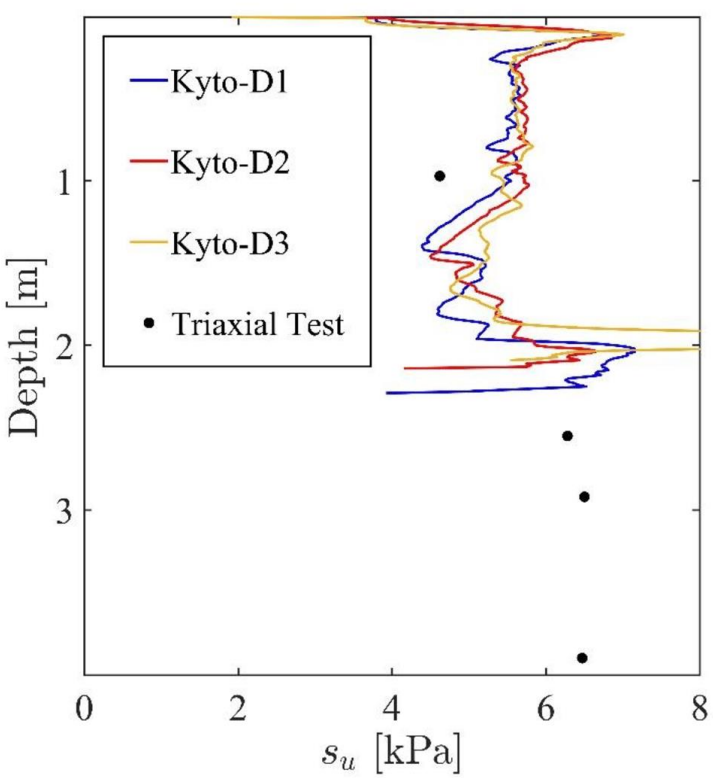
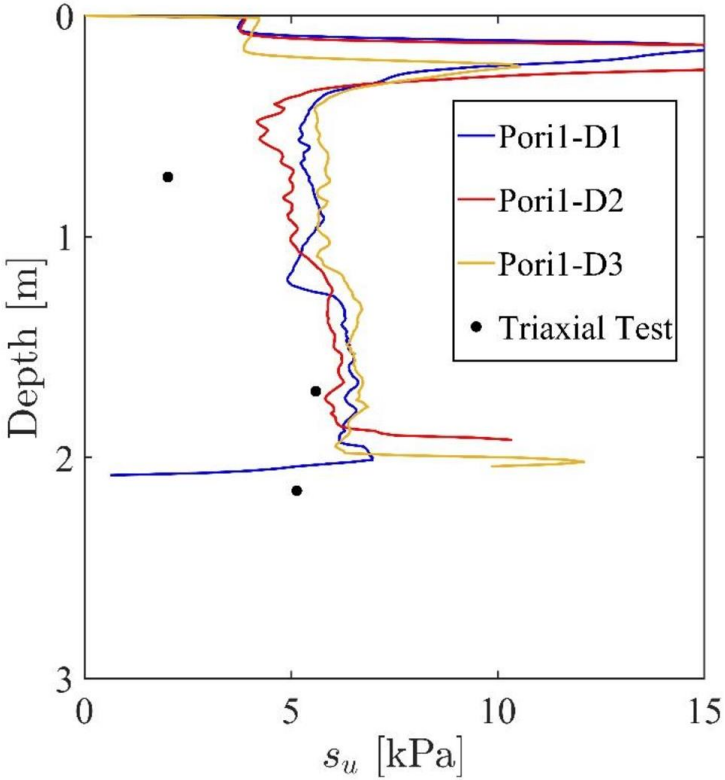
Comparison between values obtained with the improved analytical method of analysing FFCPT and triaxial test



(a) Inkoo site



(b) Kyto site



(c) Pori site

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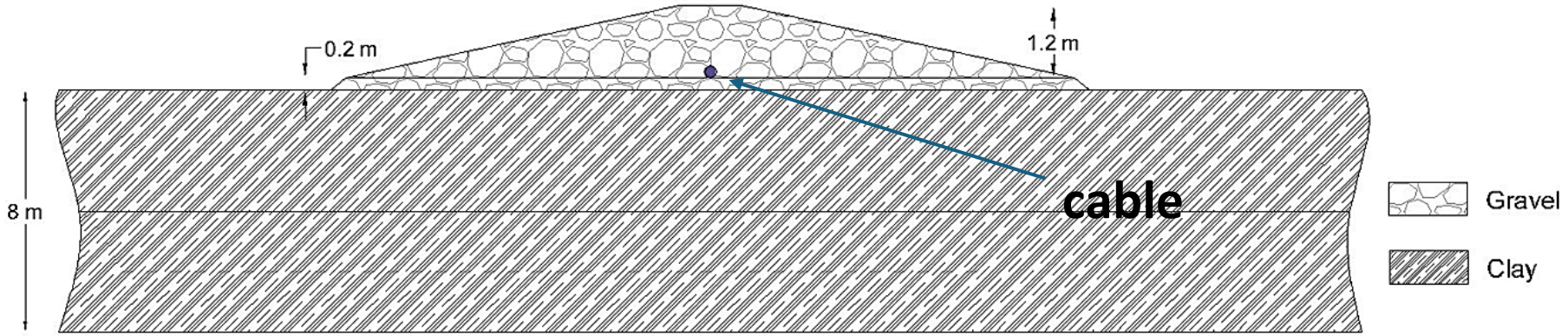
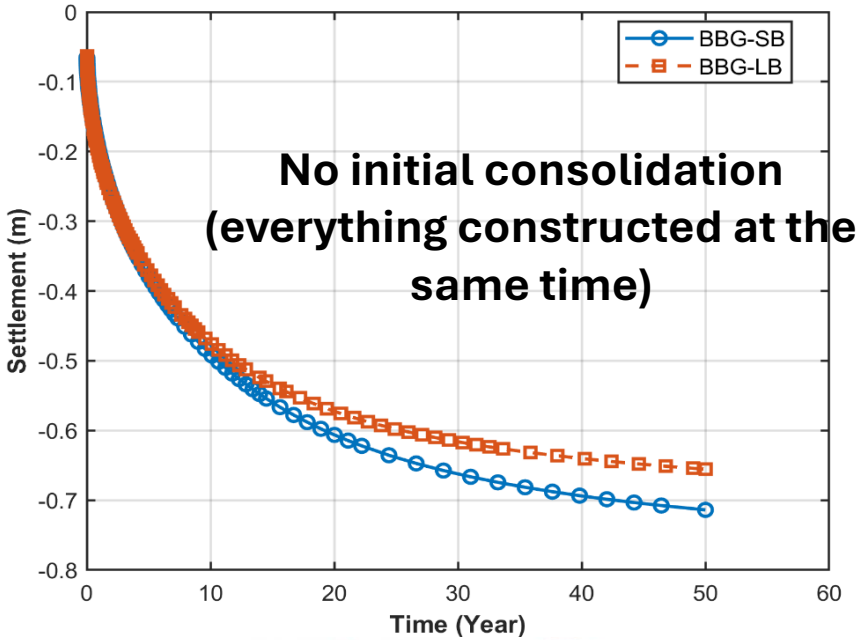
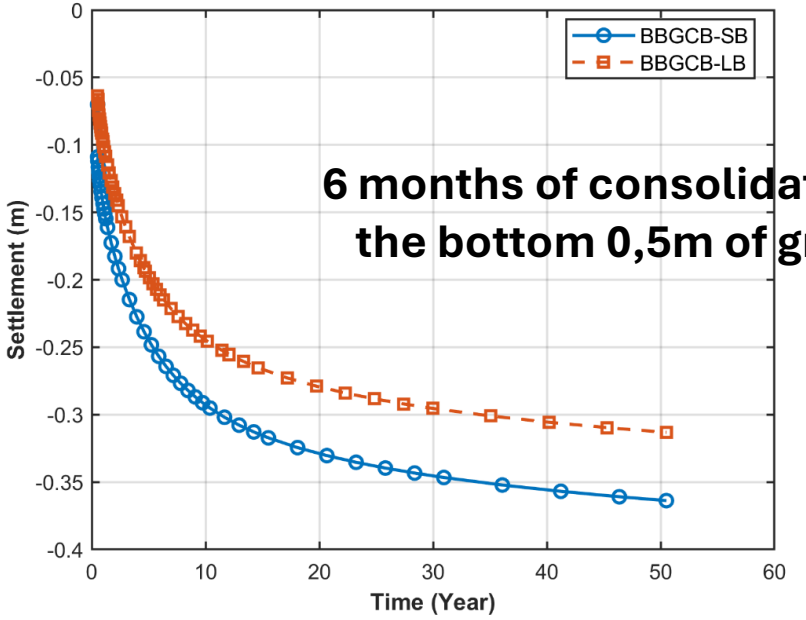
Cables on seabed





No initial consolidation (everything constructed at the same time)



6 months of consolidation of the bottom 0,5m of gravel

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