The Impact of the used Sampling Method on the Results of Laboratory testing on Peat

Research carried out under supervion of the CUR-committee
"Quality of Soil Investigations"

by H.C. (Henk) van de Graaf,
Lankelma Geotechniek Zuid / VOTB (Dutch Drillers Association)

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Why this research programme ?

- Initiated by VOTB (Dutch Drillers Association).
- Contacts in Europeen Standardisation Comitte feel that the common practice of soil sampling in the Netherlands is very cheap, but "quick and dirty".
- Common practice is mostly (95%) shell and auger drilling and soil sampling with thin-walled sampling tube, hammered down the hole (so called Ackermann sampling).
- Calculation methods and laboratory testing in the Netherlands have strongly been improved over the latest 20 years, however this samplings technique has not been changed since 1936 (excepted more powerful machines, resulting in higher production rate).
- The purpose of the research is to find out how good or bad this common practice is.

CUR COMMITTEE "Quality of Soil Investigations"

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Robert Schippers	Mos Grondmechania
Adriaan van Seters	Fugro GeoServices B.V.
Rob van der Sman	Royal Haskoning DHV
Cor Zwanenburg	Deltares

Partners that have carried out the research programme

In-situ testing, drilling and sampling, VOTB members

- Fugro GeoServices
- Gemeente Rotterdam
- Inpijn-Blokpoel
- Mos Grondmechanica
- Lankelma Geotechniek Zuid
- De Ruiter Boringen en Bemalingen
- Wiertsema & Partners

Laboratory testing and data analyses

- Deltares

PHASE 1 OF RESEARCH PROGRAMME

Focussed on peat, because:

- interest of most of the potential sponsors (dikes on peat)
- Worldwide not much comparative studies have been done on peat

Disadvantage:

The differences in quality between the drilling- and sampling techniques will probable be less clear than in for instance (sensitive) clay.

Soil Conditions Test Site Location

From Ground Level: 4 to 5 m of very soft peat with very low effective stress, overlaying soft organic clay.

Parameters of the peat:

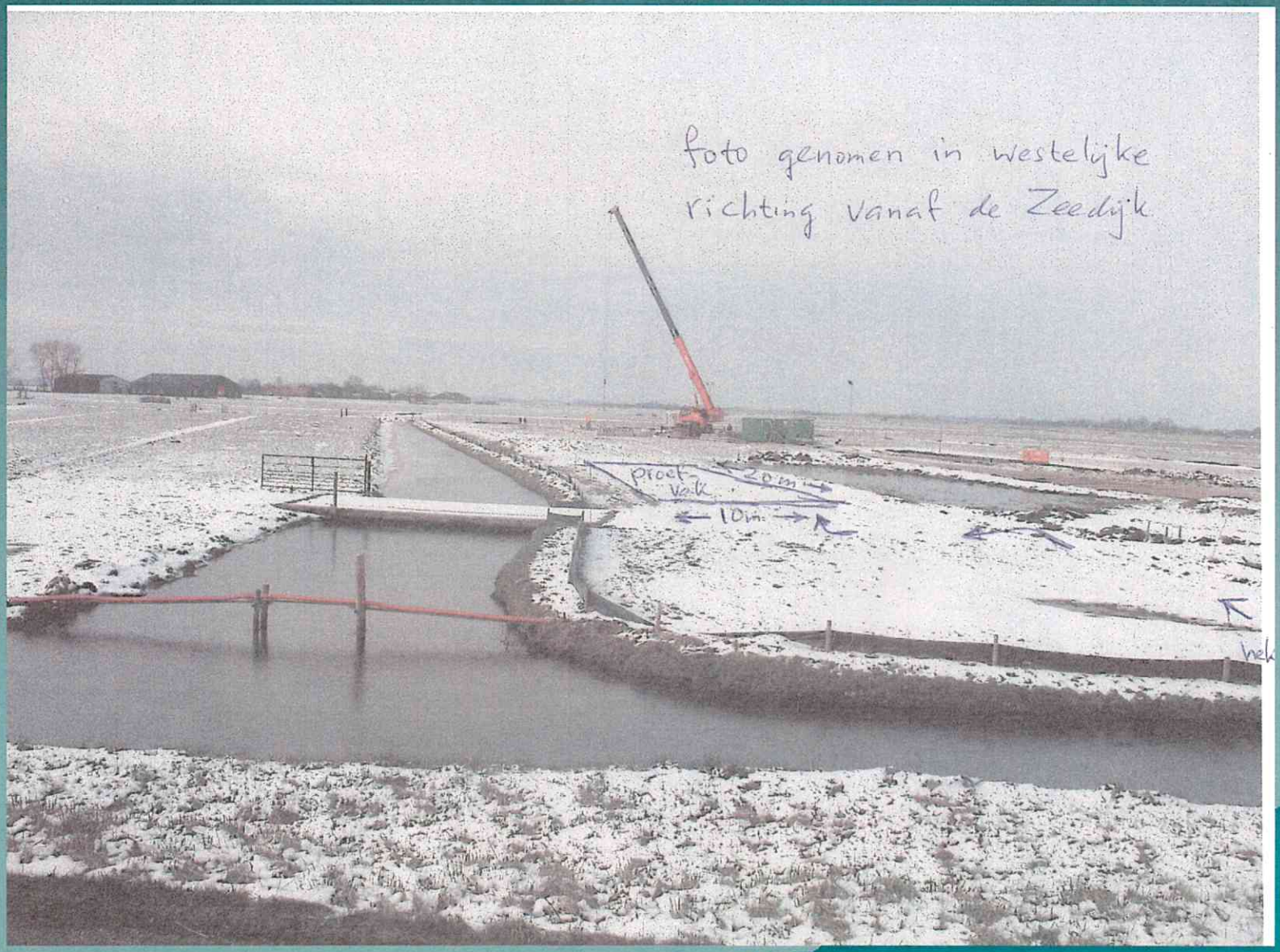
- Cone resistance q_c = 0.1 MPa
- Friction ratio = 8%
- Pore pressure index B_q = 0.3
- Undrained shear peak strength from vane test = 20 kPa
- Water content 800 – 1200 %
- Organic content 90%

Test site location at Uitdam, situated at the land side of the IJsselmeer dike Hoorn - Amsterdam

- Many soil data available, as in 2011 large scale failure tests on embankments have been carried out.

- Large interest of the owner of this dike, as it does not meet existing rules and therefore should be enlarged, cost € 300 million. Many experts have doubts about the need.

Test site Uitdam



Site characterization

- Piezocone with dissipation tests, 10 cm^2 cone
- Ball cone CPTs, ball 100 cm^2
- In-situ vane tests

Ball cone

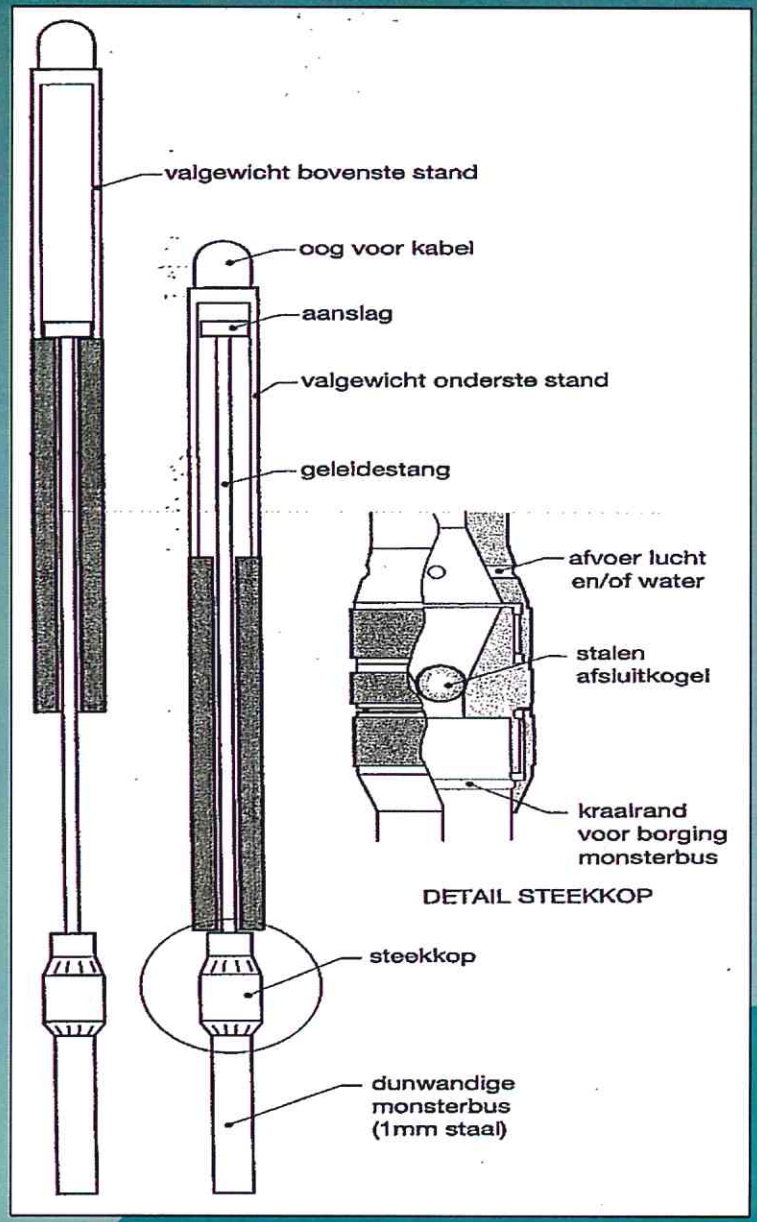
CPTs

Ball cone

TESTED DRILLING AND SAMPLING METHODS

- Socalled shell and auger drilling, combined with hammered thin walled sampler (puls-Ackermann boring)
- Same, but sampler is pushed-in
- Begemann sampler
- Stationary piston sampler
- Hollow stem auger with triple tube core barrel
- Sonic drilling

Shell and auger drilling with hammered thin walled (Ackermann) sampler

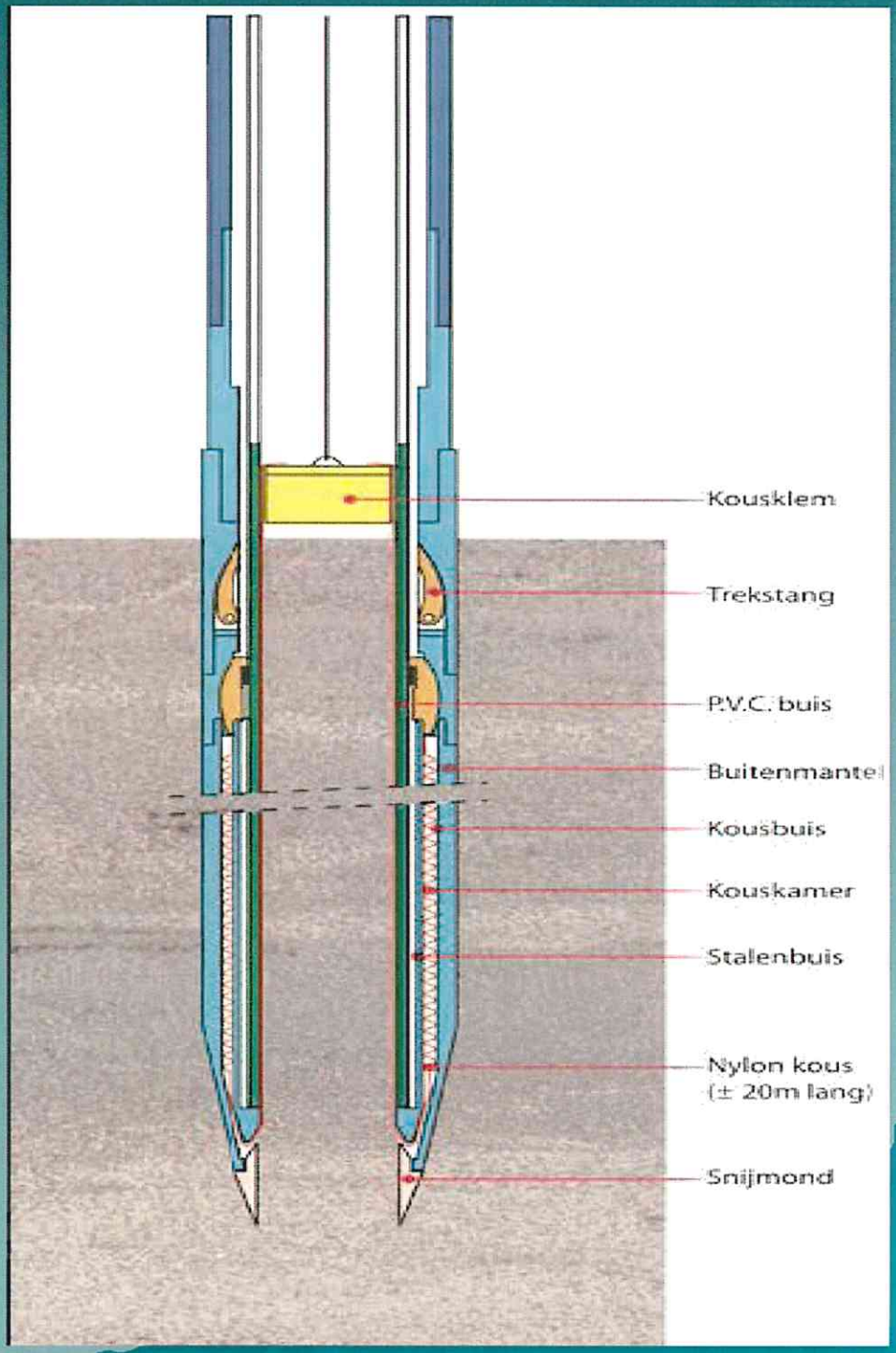


Shell and auger drilling with hammered thin walled (Ackermann) sampler

In the Netherlands 95% of all undisturbed samples are taken with this sampler, developped before World War 2

Pushed thin-walled Ackermann sampler

Begemann sampler



Begemann sampler

Stationary piston sampler

Stationary piston sampler

Sonic Drill

Principle

- The sampling tube penetrates into the ground under extremely high-frequency, socalled sonic, vibrations (max. 150 Hz), amplitude 3 mm. The frequency is adjustable for obtaining soil resonancy.
- During penetration the open end of the sampling tube is "closed" by water under high pressure (water valve), without any water flow.
- Once the sampling tube has reached the depth where the sample will be taken, the water pressure is stopped. A sample is taken by further "sonic" penetration over 1 meter.
- The sampling tube is retrieved and the sample is pushed out
- The whole cycle is repeated for a next sample

Sonic Drill

Usual procedure: single sampling tube, pushed out in the field (not used at the test site).

Sonic Drill

Sonic Drill

On the test site a double tube sampler has been used.
The sample remains in the transparant sampling liner for transport to the laboratory

Hollow stem auger with core barrel, equiped with liner

Hollow stem auger with core barrel, equiped with liner

SAMPLING PROGRAMME

- 3 borings, 5 to 6 m deep for each tested drilling and sampling technique
- 72 oedometer tests, 7 stages, from which 1 unloading stage
- 72 analyses of organic content
- 72 x bulk density and water content
- Photographs and soil classification
- 24 (DSS-tests) (Direct Simple Shear)

Drilling and Sampling Activities

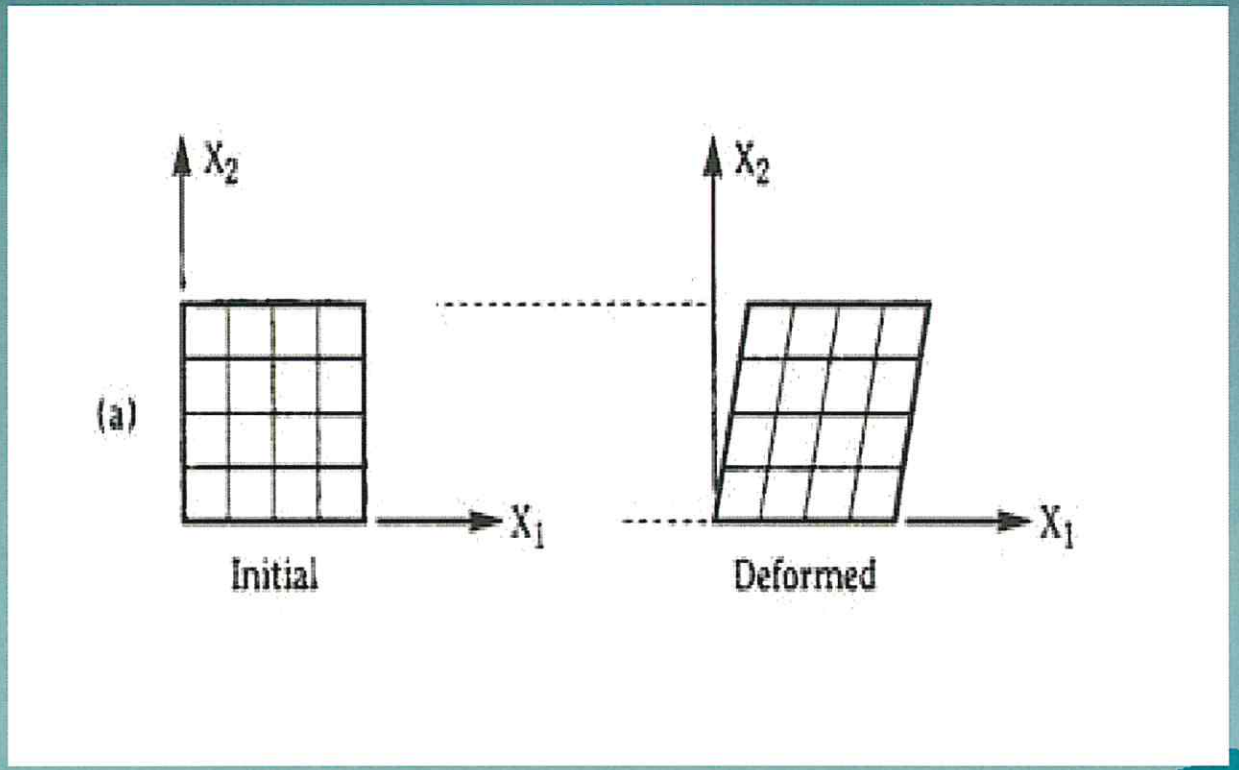
SAMPLE DISTURBANCE DETERMINED FROM OEDOMETER TESTS

The sample disturbance has been assessed from the oedometer tests, according to the Sample Distubance Index (SDI)-Method (Lunne, 1997).

SDI is defined by the decrease of the void ratio (%) before reaching the in-situ stress

The higher the SDI-value (in Dutch MVI, from Monster Verstorings Index), the more disturbance during sampling (or handling of the sample) has occured.

PRINCIPLE OF THE DIRECT SIMPLE SHEAR TEST



Direct Simple shear test

DSS Equipment, especially designed for low consolidation stress

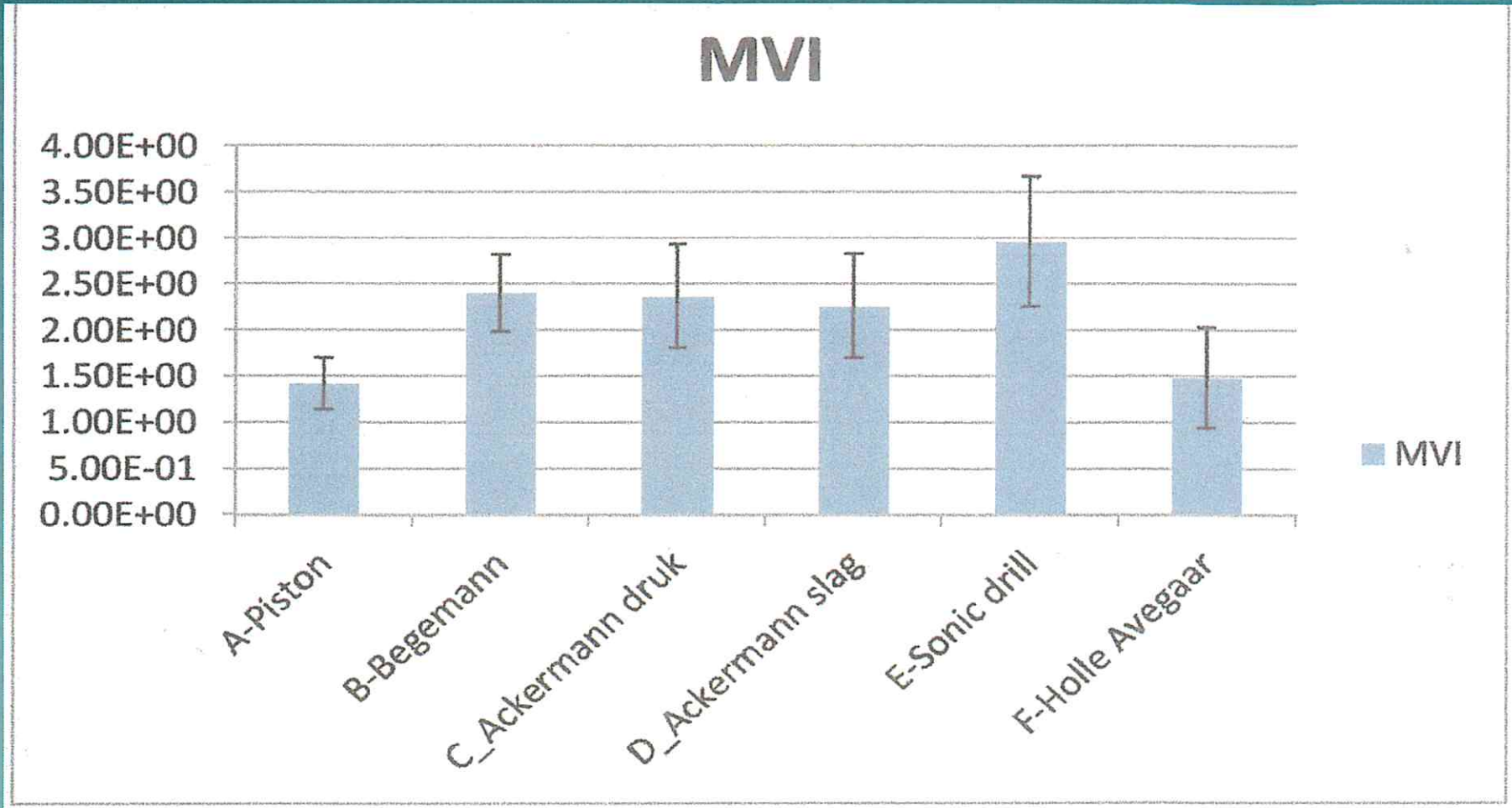
Peat sample

Trimming to obtain a test specimen from the sample

Trimming to obtain a test specimen from the sample

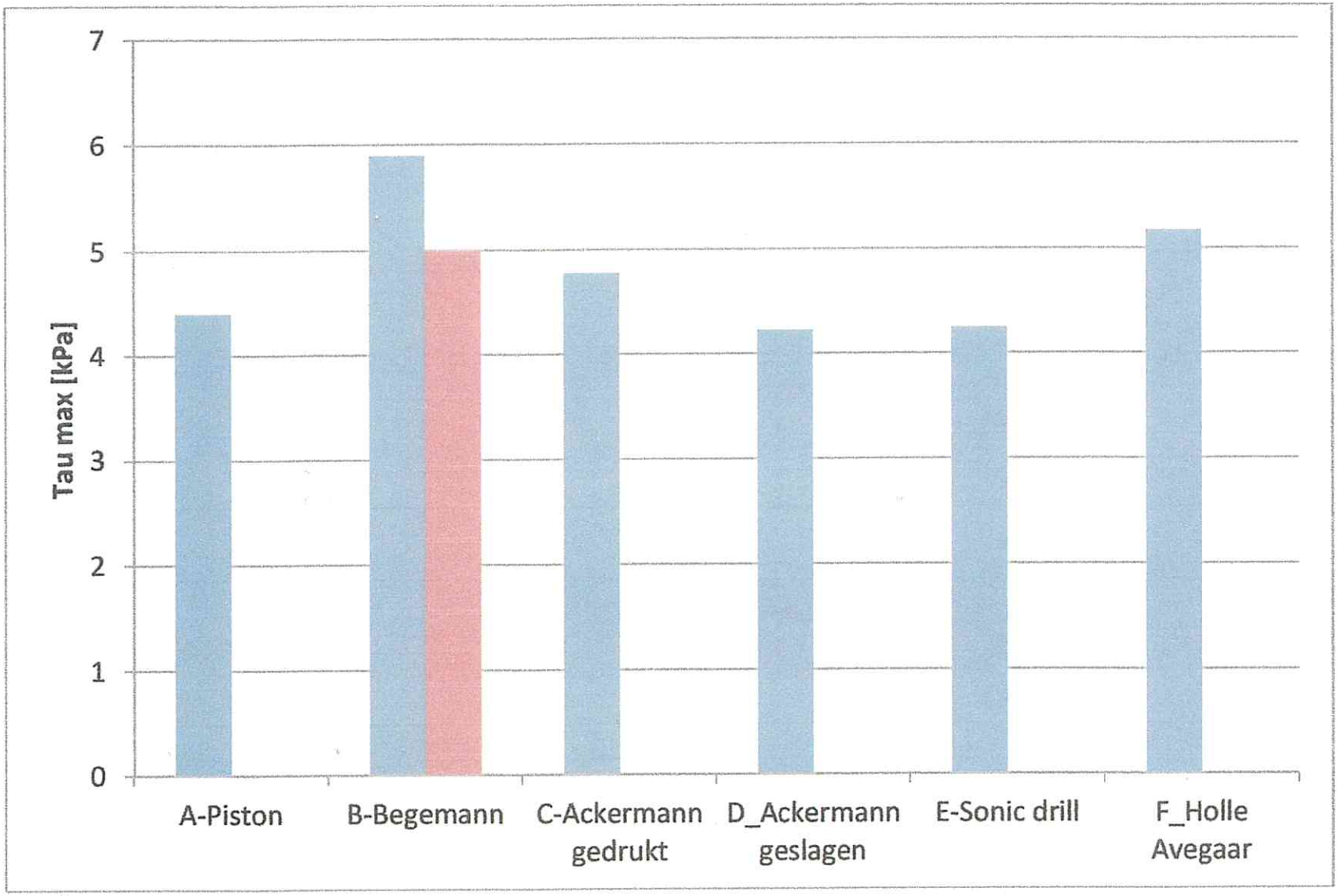
Specimen entering the oedometer ring

Sample disturbance index results



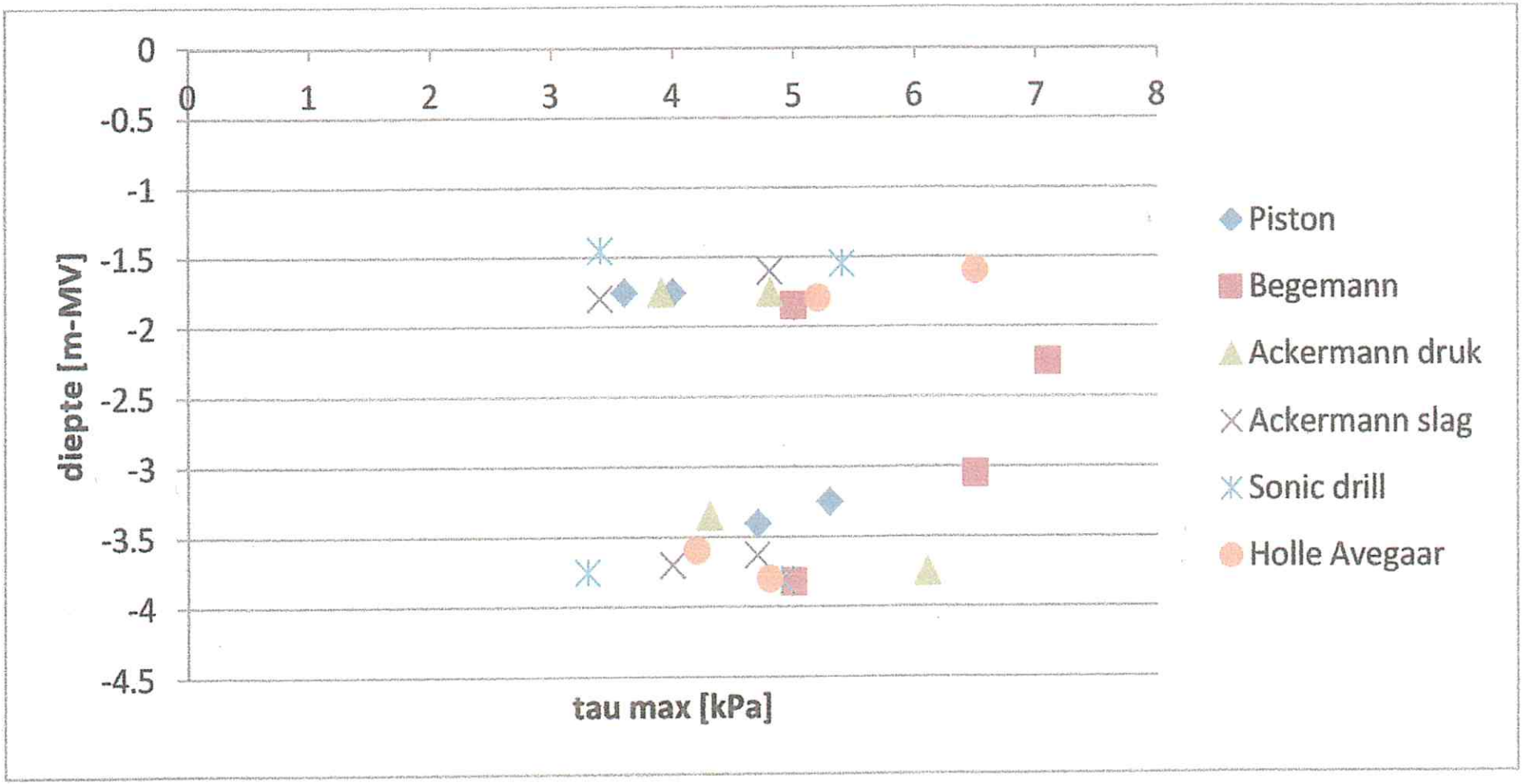
Figuur 3.7 Gemiddelde monsterverstoringsindex per boorsystem

DSS-results



Figuur 3.13 Maximale schuifsterktes per boorsysteem

Shear strength results versus sample depth



Figuur 3.15 Maximale schuifsterkte vs. monsterdiepte

CONCLUSIONS

The drilling and sampling technique has an impact on strength and stiffness parameters of peat, determined in the laboratory:

- No clear impact on the determination of the bulk density, the water content and organic content.
- Comparing DSS test results of only 4 test per sampling methode, there is some impact on the shear strength at failure and on the strength mobilized at a certain shear strain.
- Large impact on the compressibility at stress levels before reaching the in-situ

CONCLUSIONS

Shear strength peak value of samples from hollow stem auger and Begemann sampler give slightly (in absolute value) higher values than samples taken by the other methods.

CONCLUSIONS

Larger diameter samples, trimmed in the laboratory to fit in the testing equipment give better quality test specimens than samples having the same diameter as the testing equipment.

CONCLUSIONS

- Considering the Sample Disturbance Index, the Stationary Piston Sampler and the Hollow Stem Auger with core barrel perform the best.

- For a final appreciation of the systems also other criteria will be taken into account, such as:
  - Comparison of RR_0 / RR_1 (stiffness below in situ stress / stiffness during reload stage)
  - Comparison of variaton coefficients of different parameters
  - Sample recovery (sample length / length of sampling run)

STATUS OF THE PROJECT

- SBR-CURnet Committee is now preparing a guideline for undisturbed sampling methods of peat (when shall be used which method). As soon as mature this draft will be circulated to interested parties.

- The Committee is working on a proposal for phase 2 of the project, which is a simular testing programme in another soil type, probably organic clay.

- The Committee seeks potential sponsors.