



# Session Report 1: CPT Equipment & Procedures

CPT10 – 10th May 2010

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# CPT Equipment & Procedures

- There are only 17 papers allocated to this session!
- Maybe this is an indication of the maturity of the development in, and the use of, CPT and its associated add-on modules.
- Is it?

# Papers - Grouping

- **EXISTING CPT/CPTU EQUIPMENT REVISITED**

- NEW SITUATIONS 6
- NATIONAL PRACTICE 1

- **NEW EQUIPMENT/PROCEDURES**

- NEW EQUIPMENT 3
- NEW PROCEDURES 1

- **ADD-ON DEVICES**

- OLD FAVOURITES 3
- NEW ADDITIONS 3

## Existing CPT/CPTU equipment revisited

Yoon et al - The field application of a continuous intrusion miniature CPT system in south Korea

- 2 cm<sup>2</sup> calibrated against existing 10 cm<sup>2</sup> in Korean soils, good agreement!  $q_c$  or  $q_t$ ?

Anilionis - In situ geotechnical testing using lightweight machine & electric CPT

- Lightweight mobile equipment use in Lithuania. Equipment achieving Application Class 1!!

Garcia & Devincenzi - A combined up-hole drilling/CPT equipment for near-shore site investigation

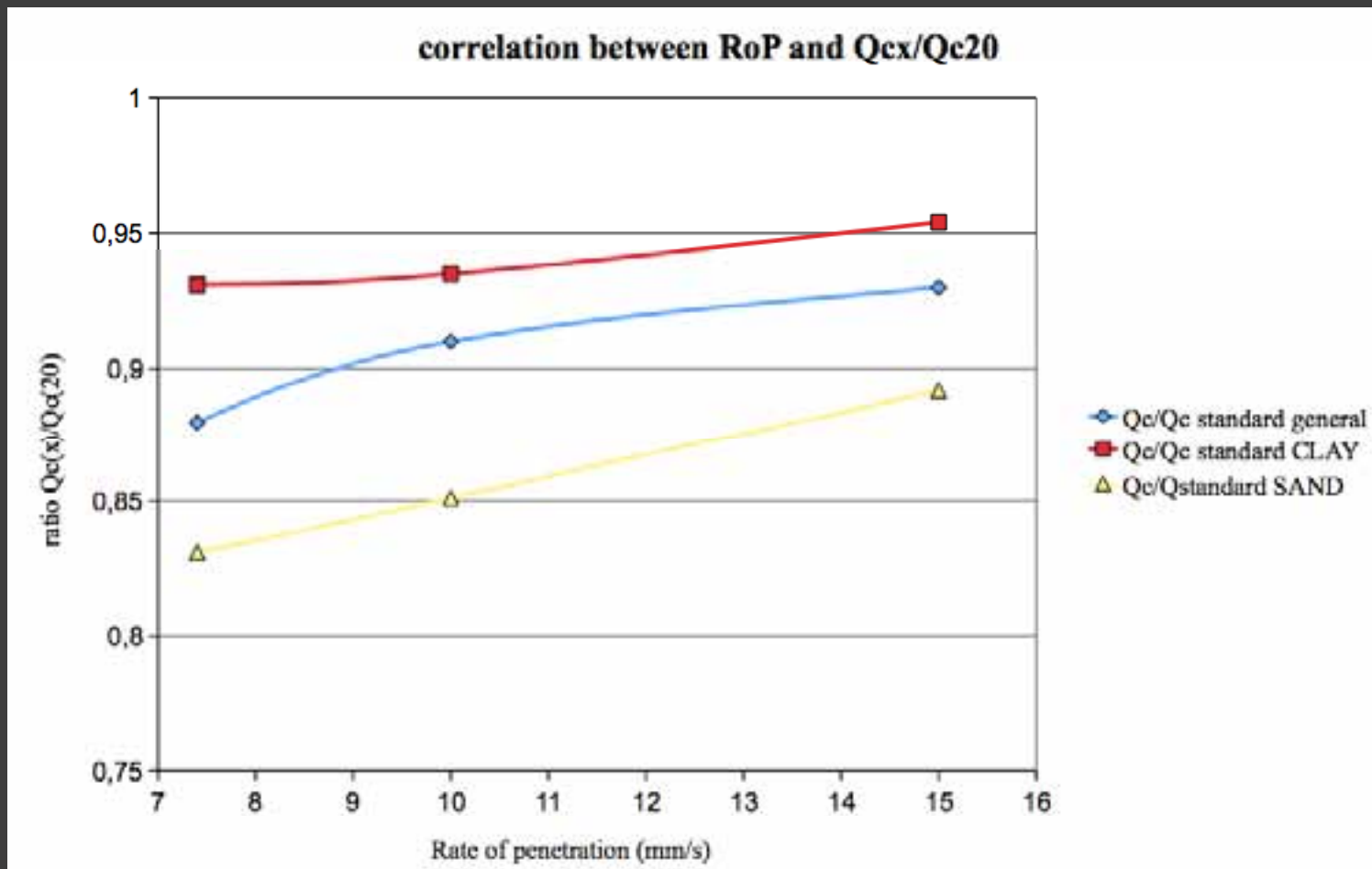
- Use of essentially land based equipment for shallow water applications, reduced costs and faster operation

# Existing CPT/CPTU equipment revisited

Sacchetto & Trevisan - Non-standard CPT in deep tests & extremely stiff soils

- Trying to correct for effects of varying Rate of testing on test results, however effects are counter-intuitive

# Sacchetto & Trevisan – rate (other influences?)



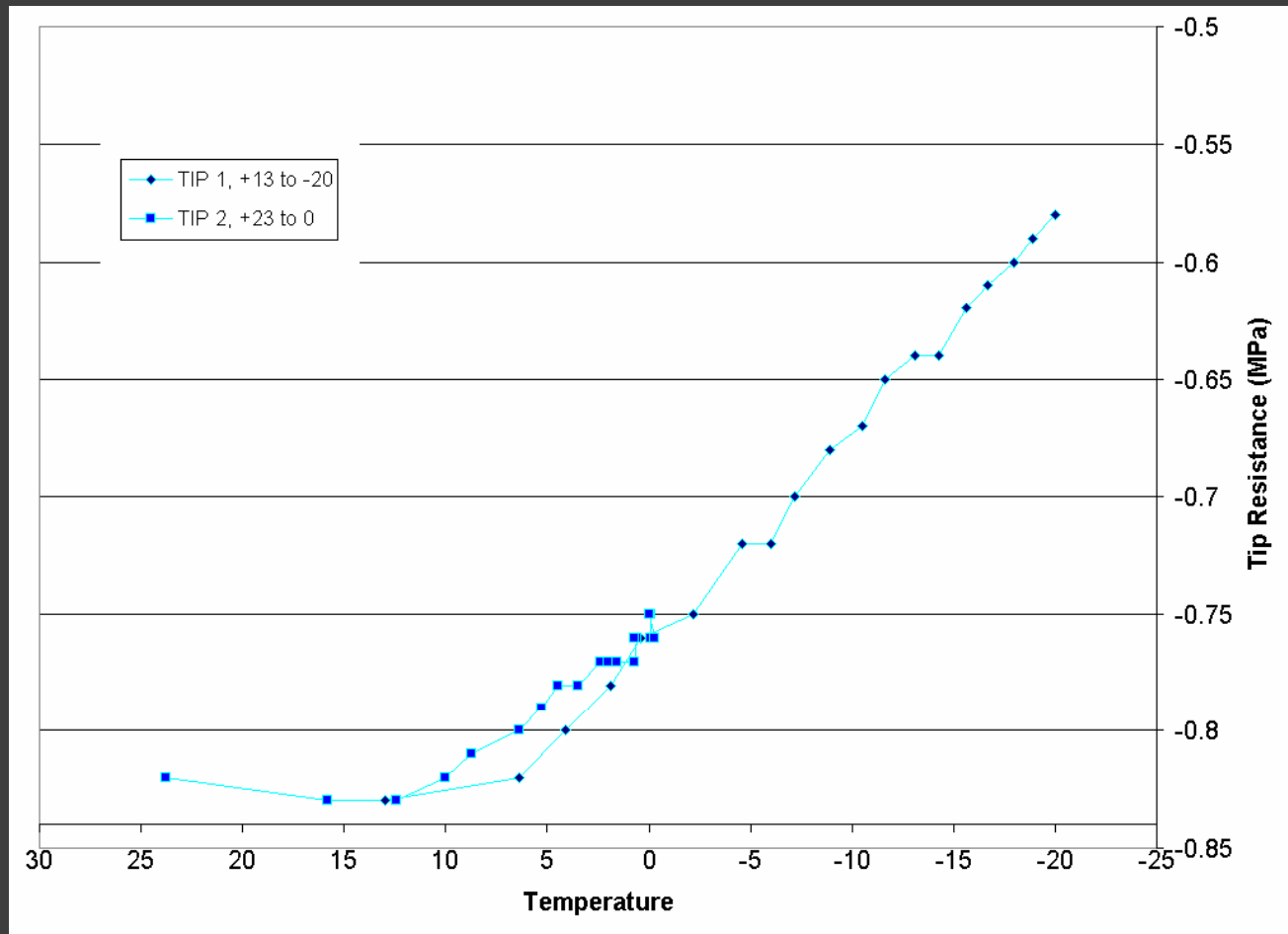
# Existing CPT/CPTU equipment revisited

These could all be said to be adapting existing equipment to new situations

McCallum et al - Cone penetration testing in polar snow - equipment and procedures

- Interesting problem of trying to undertake CPT testing in snow. Zero shifts due to temperature particularly below 8°C and even then you need to allow for equalization. Field testing yet to be undertaken.

# Zero shifts - McCallum et al



A challenge!

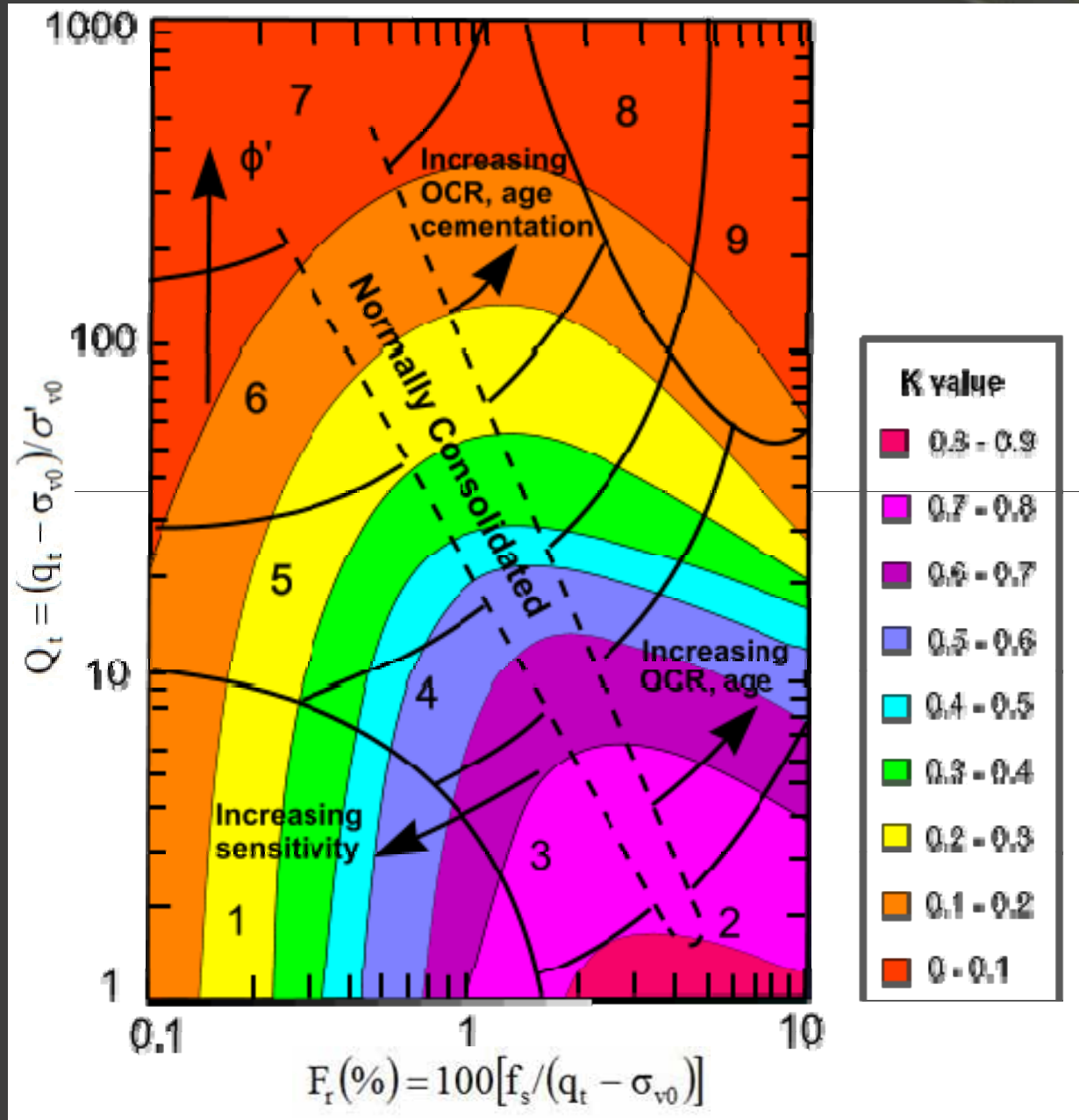
# Existing CPT/CPTU equipment revisited

Peuchen et al - Estimation of  $u_1/u_2$  conversions factor for piezocone

- Benefits of using  $u_1$  filters, but then develops new correction procedure to assess  $u_2$  from  $u_1$  for use in deriving  $q_t$ .
- Linking this with superposition on Robertson soil Identification chart
- More validation?

# Peuchen et al

$$k = u_2 / u_1$$



# Existing CPT/CPTU equipment revisited

Liu et al - A comparative study of International piezocone and China  
Double bridge CPT test

- Trying to link results from National cones to those now in use Internationally.
- Problems in that all previous work was based on  $q_c$  and combined  $q_c$  plus  $f_s$
- There are significant differences of +/- 50%. So how to proceed.

# New Equipment/procedures

Kim et al - Real-Time Temperature Compensation Technique on the CPT using FBG Sensor

- Interesting paper looking at temperature effects on measured results during pushing at the model scale, using Fibre Bragg gratings.
- In the sands used, then correction was needed for the strain gauge load cells and this is shown to be temperature related as the cone heats up.

Kim et al



Field applications?

# New Equipment/procedures

Colreavy et al - Field experience of the piezoball in soft clay

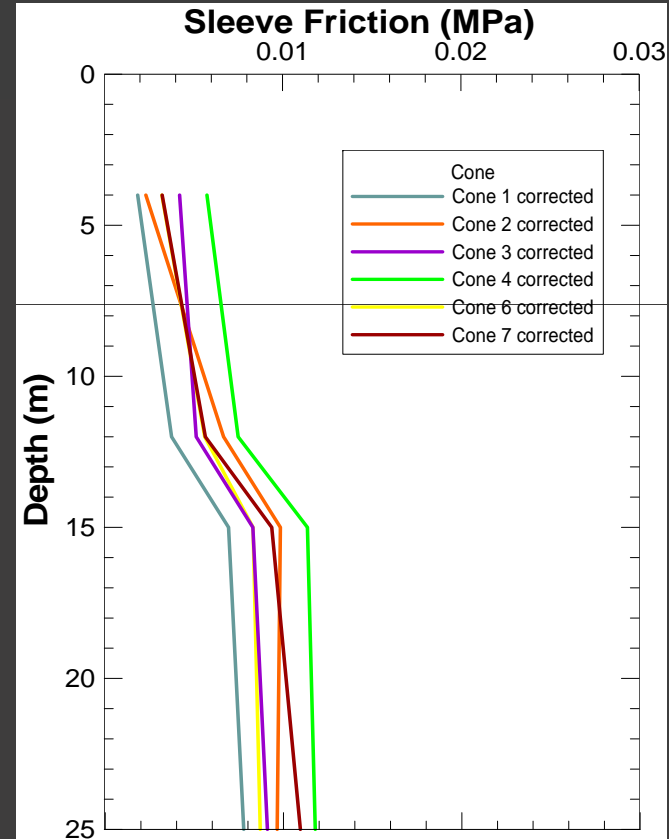
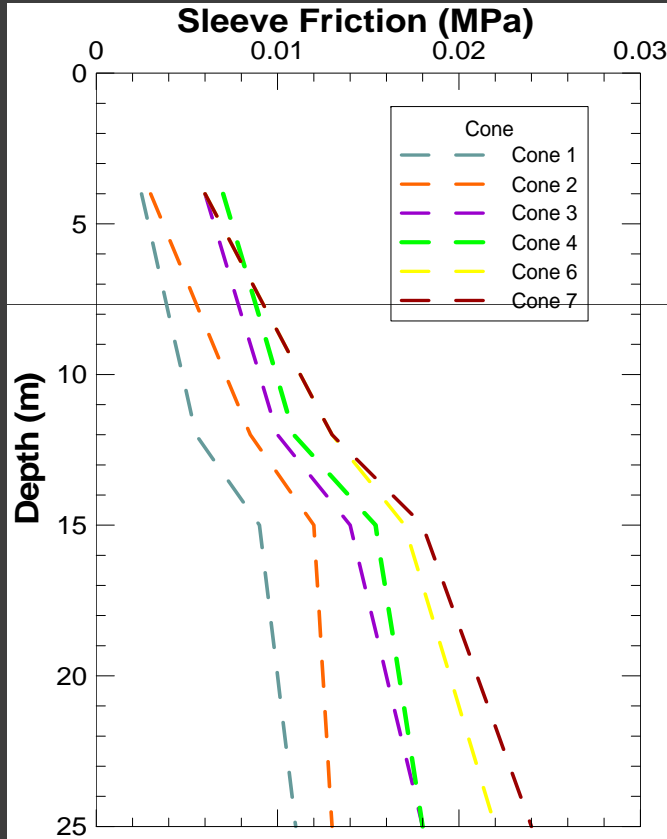
- Comparisons between their new piezoball and standard CPTU testing. Interesting comparisons with the piezoball coming out on top?
- (But even the piezoball can be a problem if operated without care? Same site different results!)
- They show the beginnings of an interesting study on dissipation testing with the ball and compared to CPTU but size etc

# New Equipment/procedures

Boggess & Robertson - CPT in soft soils and deepwater

- Looking at problems and possible sources of inaccuracies in sleeve friction measurements,  $f_s$ , due to geometries, unequal end areas and differences between  $u_2$  and  $u_3$ .
- How reliable are our friction sleeve results in softer deposits? Errors of between 7 and 74% for a soft clay example. But it is not just that!

# $f_s$ correction



Not just pore water pressure then?

# New Equipment/procedures

## Boggess & Robertson - CPT in soft soils and deepwater

- Looking at problems and possible sources of inaccuracies in sleeve friction measurements due to geometries, unequal end areas and differences between  $u_2$  and  $u_3$ .
- How reliable are our friction sleeve results in softer deposits? Errors of between 7 and 74% for a soft clay example. But it is not just that!
- They also look at the problems of load cell capacities and offsets when working in deep water.
- A new load cell design has been developed that enables zero load to be recorded when a cone is lowered into very deep water. Field trials awaited.

## New Equipment/procedures

Ali et al - Study of Influence factor of Cone Loading test in Centrifuge

- A new stage to CPT testing, a load displacement test (incremental maintained load test) after a dissipation test and including unload/reload tests. Results are repeatable and compare well with plate load test but need to be factored.
- Sand and model scale. To be extended

## ADD-on devices - OLD Favourites

Dijkstra & Broere - The applicability of soil density measurements using a soil penetrating probe

- Resistivity sensor. Penetration densifies the soil and affects the measurements made.
- Qualitative not quantitative

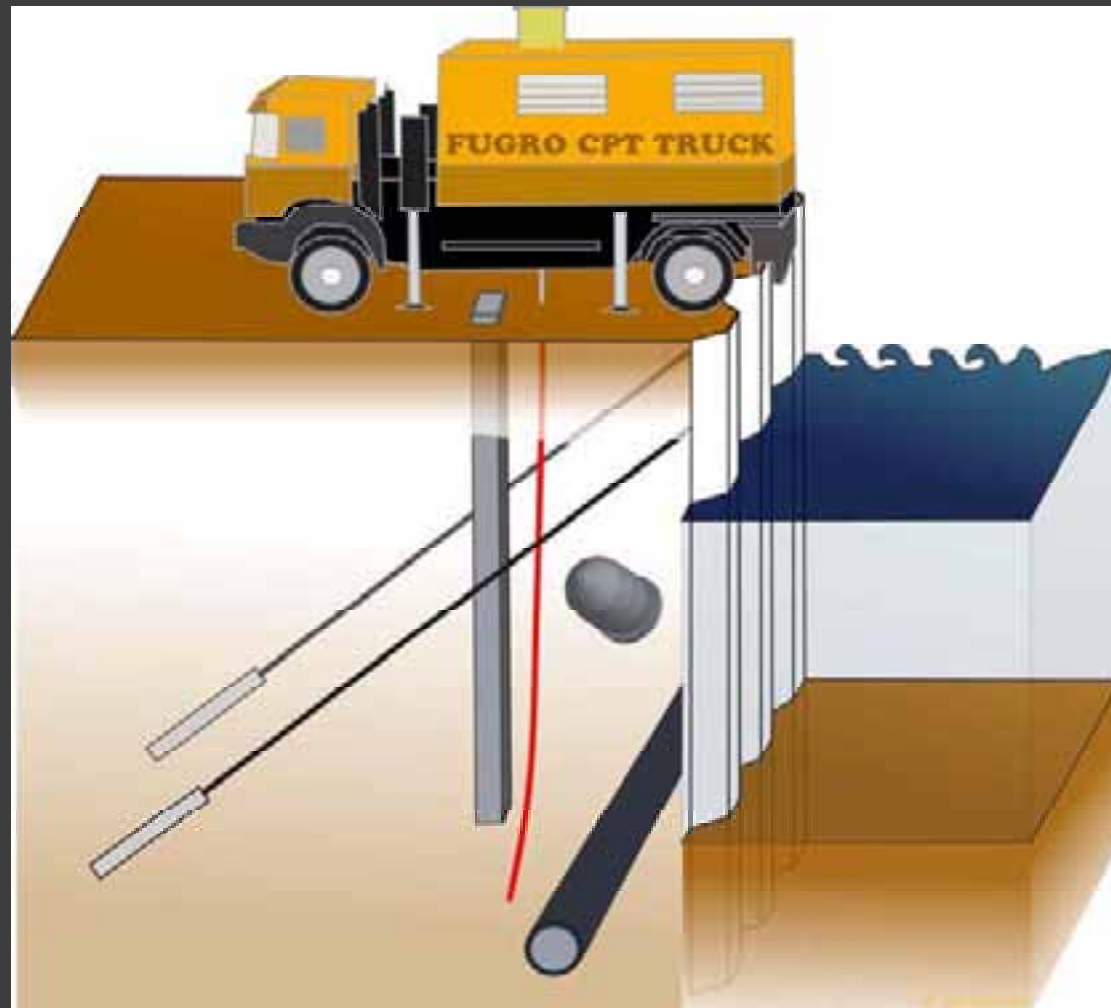
Peixoto et al - Electrical Resistivity Developing to Geotechnical and Geo-environmental Characterization

- Detection of pollution plumes, laboratory based, tropical soils
- Key factors are effect of moisture content and frequency
- This will be extended to field work.

## ADD-on devices - OLD Favourites

Elgun et al - Safely uncovering deep foundations and services with magnetometer cone

- They show the wide range of applications for the magnetometer cone in determining location, size and depth of buried object containing steel.



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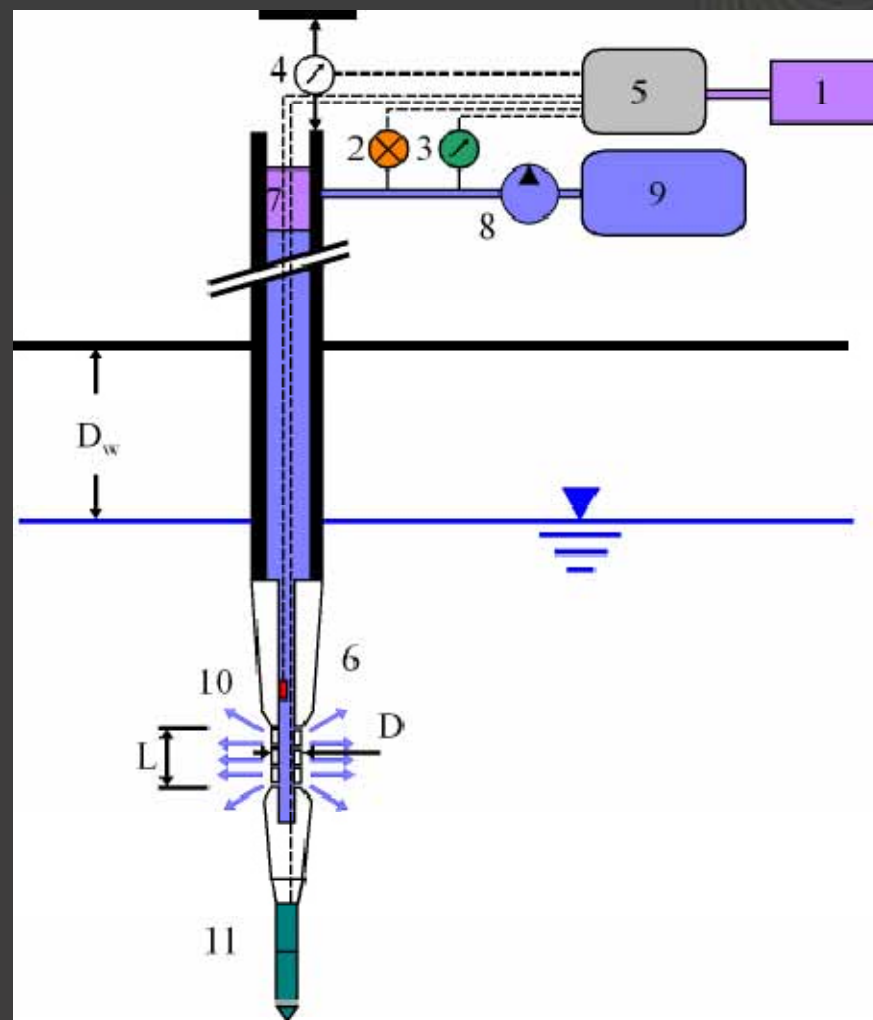
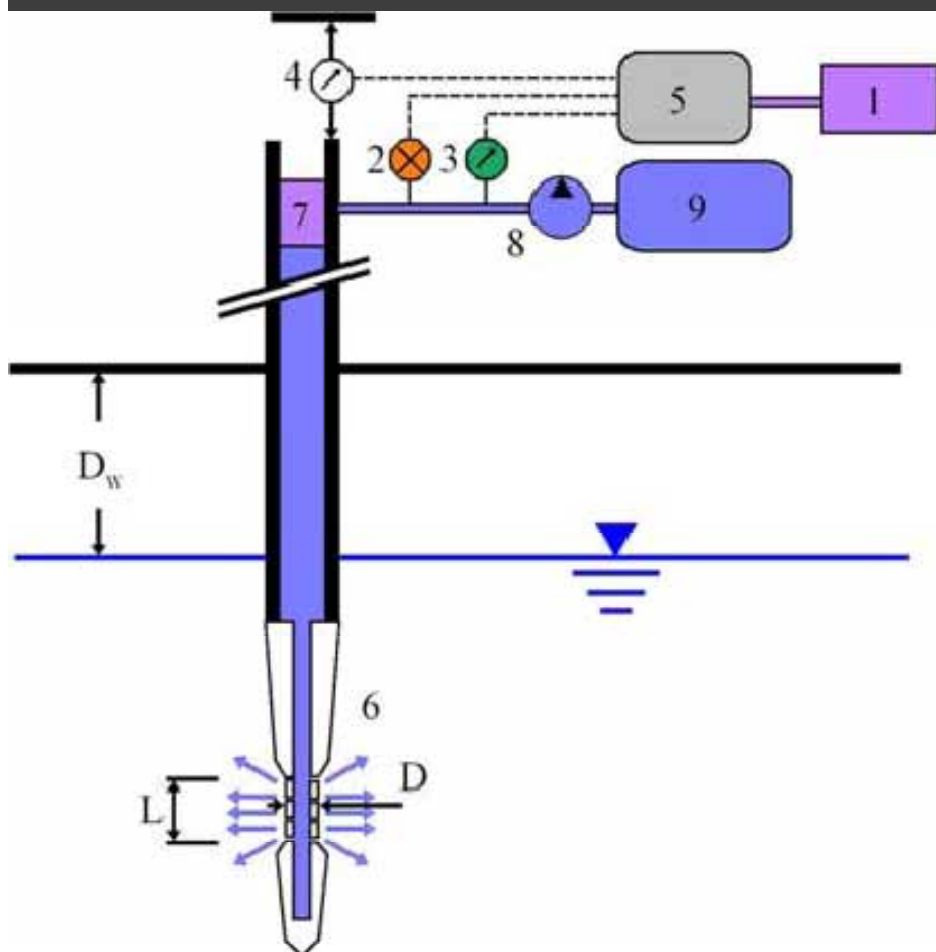
- They show the wide range of applications for the magnetometer cone in determining location, size and depth of buried object containing steel.
- Predictive modelling is often required and it would be good to know when level of accuracy they can achieve in depth determination etc.

## ADD-on devices – NEW additions

Reiffsteck et al - Presentation of a new Hydraulic profiling tool including CPT measurements

- Existing equipment with CPTU added so better soil identification
- 10 sec duration and every 20cm if required – permeable soils but good when mapping dykes etc

# ADD-on devices – NEW additions



## ADD-on devices – NEW additions

Homma et al - A cone permeameter for determining hydraulic conductivity in unsaturated soils

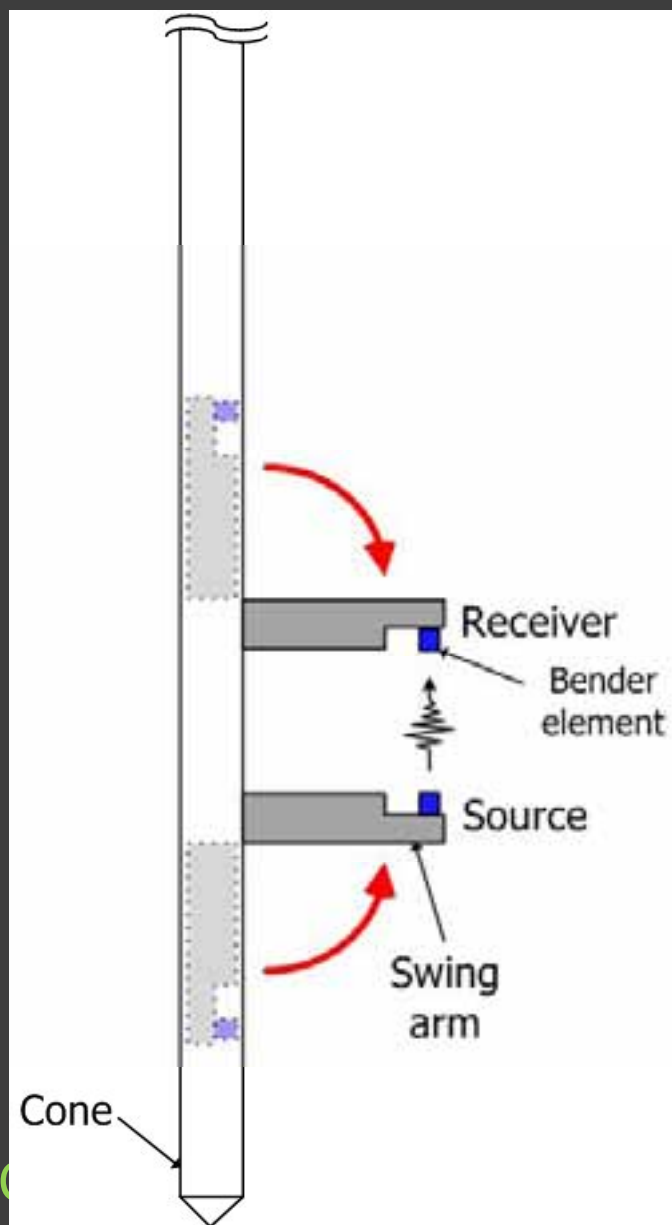
- Water is introduced into the ground through a small filter and measurements made on two tension rings above the filter
- No CPT linkage as yet. Promising in sands but problems elsewhere. Under development!

## ADD-on devices – NEW additions

Jang et al - A pilot study of in-hole type CPTu using piezoelectric bender elements

- Interesting study to see if piezobenders could be incorporated into the CPTU and be used to determine small strain stiffness .

# Jang et al



## ADD-on devices – NEW additions

Jang et al - A pilot study of in-hole type CPTu using piezoelectric bender elements

- Interesting study to see if piezobenders could be incorporated into the CPTU and be used to determine small strain stiffness .
- Disturbance is found to a significant factor, it will be interesting to see how this is taken forward

## Conclusions/thoughts - general

The papers (or lack of) to this session could lead us to conclude:

- The CPT/CPTU is a relatively mature testing technique with little more needed relating to cones and associated equipment.
- We have all we need for the basic test, is that correct?
- Techniques now moving between countries and cross correlation to other national practices. (But what does this mean for local correlations etc;  $q_c$  or  $q_t$  )

## Conclusions/thoughts - general

With the adoption of the new International standards there should be greater flexibility in exchanging experiences around the world but care will still be needed to ensure quality and the effects of differing soil types.

While strict adherence to these standards should allow greater confidence in the results obtained, we will first have to prove that the equipment available is capable of achieving the accuracies required of the various Application classes – why not more papers on this?

## Conclusions/thoughts - general

Existing equipment is often good but sometimes poorly operated or maintained.

What of the  $f_s$  problem in soft soils?

Understanding the inconsistencies in sleeve friction measurements results is one of the challenges for the future; it is a topic that would usefully receive more attention and would give valuable pay back. (Lunne 2010)

What it will mean to our databases if we start to convert to  $f_t$ .?

## Conclusions/thoughts - ADD-on devices

- How often are the various ADD-ONS used in the field?
- Do we believe the results?
- How likely are these LAB/Model prototypes to see full scale field trials?
- Why are some of the add-on devices not seeing much use, were they oversold?

## Conclusions/thoughts

- The challenge is still there to get reliable data that can be trusted, is repeatable and accurate, especially in soft soils.
- How do we ensure adherence to standards and quality of maintenance and operation?
- We need to also maximise the amount and value of data gathered by add-on devices.

# Conclusions/thoughts

Thank you and over to Joek