



Imperial College  
London



TC29

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AFTERNOON SEMINAR

at

ROOM 201, DEPARTMENT OF CIVIL ENGINEERING, IMPERIAL COLLEGE,  
SKEMPTON BUILDING, LONDON, SW7

on

Wednesday 17 March 2010 at 1.30m

## **UNDERSTANDING THE MEASUREMENT OF SOIL DYNAMIC PROPERTIES**

*Speakers:*

**Prof Mathew Coop and Dr Giovanni Alvarado – Imperial College**  
**Dr Rune Dyvik – Norwegian Geotechnical Institute**  
**Prof Herve Di Benedetto - ENTPE, France**  
**Geoff Ricketts – Soil Mechanics Ltd**  
**Prof Sebastino Foti – Politecnico di Torino, Italy**  
**Prof Richard Jardine – Imperial College**

*Chair:*

**Dr Stavroula Kontoe – Imperial College**  
**Andrew Coatsworth – Nuclear Installations Inspectorate**

Non-members of the Society are welcome to attend.

This is a joint seminar of SECED with Imperial College, the British Geotechnical Association and TC29 of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)

Please note that there is no charge to attend.  
Seats are allocated on a first come, first served basis.  
Tea and coffee will be served from 2.45pm – 3.15pm.

For further information please contact James Mitchell, Associated Societies Executive, at the ICE  
on Tel: +44 (0) 20 7665 2229020 7665 2238, or Fax +44 (0) 20 7799 1325 or Email:

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# Overview and Programme of the Seminar

Dynamic soil properties are of intrinsic interest in many engineering applications ranging from foundations for vibrating machinery to earthquake engineering. Dynamic soil properties are also of extrinsic interest as a surrogate measure of static soil properties, especially at small strains. The two sessions of the seminar discuss various laboratory and field methods of measuring dynamic soil properties, giving particular emphasis to data interpretation.

## Session 1: Laboratory measurements 1:30-2:45pm

### ***The Use and Interpretation of Bender Elements***

Prof Mathew Coop and Dr Giovanni Alvarado, Imperial College

Bender elements have gained increasing popularity as a cheap and non-destructive means of making measurements of elastic shear stiffness in soils and weak rocks. Combined with accurate measurement of strains during triaxial probing tests, bender elements now allow the complete set of elastic parameters to be determined for a cross-anisotropic soil. However, in recent years, difficulties with interpretation of the signals from the elements have called into question the accuracy of the technique. Methods of interpretation will be outlined that now allow good consistency to be achieved.

### ***Resonant column tests***

Dr Rune Dyvik, NGI

Geotechnical laboratory resonant column tests are used to determine the small strain modulus and damping characteristics of soil specimens. Different aspects of this type of testing will be presented, including some description of the equipment used, such as types of devices and principles of operation, as well as how such tests are performed and the types of results that can be obtained.

### ***Anisotropic characterization using triaxial test with cyclic and dynamic measurements***

Prof Herve Di Benedetto, University of Lyon, ENTPE, DGCB

A new prototype of triaxial device is presented. It allows characterisation of the globally anisotropic unbound granular materials by combining “small” quasi-static axial loading cycles and waves propagating in different directions. Evolution of the 5 anisotropic parameters during triaxial compression and extension loading are presented. Anisotropic modelling using hypoelastic models (DBGS and DBGSP) is introduced.

**Break 2:45 -3:15pm**

**Session 2: Field measurements and closing remarks 3:15-4:30pm**

***Borehole Seismic Methods of Obtaining Soil Dynamic Properties***

Geoff Ricketts – Soil Mechanics Ltd

The methodology of each of these intrusive methods will be described and their advantages and disadvantages discussed. Emphasis will be given to the confidence that may be placed in the results of the various methods and also to consideration of what is actually being measured. Field examples comparing crosshole with downhole and P-S suspension logging will be presented and a brief appraisal made of experience in deriving damping ratio from crosshole seismograms

***Surface wave methods***

Prof Sebastino Foti – Politecnico di Torino

Non-invasive seismic tests based on surface waves are gaining popularity because they are cost and time effective options for site characterization in seismic projects. Different options for collecting and analysing experimental data will be presented, highlighting advantages and pitfalls. The implications of solution non-uniqueness on inversions strategies will be discussed, with reference to some case histories.

***Attempting to synthesise lab and field measurements***

Prof Richard Jardine – Imperial College

Laboratory and field measurements are reported from research sites including a Holocene dense sand sequence, and for the London Tertiary mudrocks encountered beneath a nuclear power station and a new airport Terminal. It is shown that anisotropy must be considered if different measurements are to be reconciled, and that some divergence may remain, between static and dynamic, and laboratory and field tests due to the effects of frequency and in-situ macro-fabric.

Following the seminar, BGA will host the annual Rankine Lecture. This lecture, which also takes place at Imperial College, is on a theme closely related to this seminar:

***Stiffness at Small Strain – Research and Practice***

**Professor Chris Clayton - University of Southampton**

## About the speakers

**Matthew Coop** has around 25 years experience in the testing of soils and weak rocks, currently as Professor of Experimental Soil Mechanics at Imperial College London and formerly at City University. Following experience in geotechnical design in Columbia, Giovanni Alvarado completed his PhD at Imperial College in 2007. After two years in the Geotechnical Consulting Group he moved to Edafos in Athens where he is now a senior engineer.

**Rune Dyvik** has worked at the Norwegian Geotechnical Institute (NGI) since 1982, after receiving his PhD from RPI in Troy, New York. He has primarily worked with developing, performing and evaluating different types of geotechnical laboratory tests, as well as laboratory and field model tests. His very first project at NGI was to assemble, calibrate, use and evaluate NGI's resonant column devices. This work (including the related bender element technique) has continued to the present.

**Professor Hervé Di Benedetto** teaches in the fields of soil mechanics, road structure behaviour and rheology of geomaterials. His research focuses on the study of mechanical, thermo-mechanical and structural behaviour of geomaterials, including experimental and modelling aspects. He has been the supervisor of a large volume of research works. He is Editor-in-Chief of the International Journal "*Road Materials and Pavement Design*" (SCI publication).

**Geoff Ricketts** is Technical Manager of SM Pelorus, the geophysical specialist unit within Soil Mechanics. He has over 20 years experience in crosshole, downhole, seismic cone and suspension logging techniques to obtain seismic velocity profiles for determining soil dynamic properties. He has been involved in equipment and software development and is joint author of a paper dealing with confidence in ground characterisation by seismic velocity measurement.

**Sebastiano Foti** (PhD) is Assistant Professor of Geotechnical Engineering at Politecnico di Torino (Italy), and was formerly Research Associate at UWA in Perth. His research is mainly related to geophysical methods of geotechnical characterisation, focusing on surface wave testing, seismic waves in porous media and geophysical techniques in the lab. He has been awarded the Geotechnical Research Medal (Bishop Medal) 2003 by ICE.

**Professor Richard Jardine** has conducted research and teaching for 30 years at Imperial College, London where he is currently Head of Geotechnics. He has published extensively. His work on small strain stiffness, which started in 1981, has been applied widely in practice. He Chairs the International group (TC-29, ISSMGE) that oversees advanced laboratory testing and has consulted on many projects as an Associate of GCG, London.