INTRODUCTION TO ‘MUSE’

Mechanics of Unsaturated Soils for Engineering

Research Training Network funded by the European Commission

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SUMMARY

◊ EU POLICY IN R&D

◊ INTRODUCTION TO 'MUSE'

◊ RESEARCH & TRAINING PROGRAMME
EU POLICY IN R&D

Political Initiatives

- **Lisbon Mandate**: by 2010, making Europe the most dynamic and competitive knowledge-based economy in the world

- **Barcelona Mandate**: by 2010, devote 3% of GDP to research

- **Establishment of an internal market for science and technology (European Research Area)** aiming to overcome fragmentation of Europe efforts in research through promotion of co-operation at different levels, co-ordinating national and European policies, networking teams and increasing mobility of individuals and ideas.
“The development of an European area for the coherent and co-ordinated pursuit of research activities and policies, in which researchers and knowledge move freely, will encourage the expression of European excellence by making it possible to establish a ‘critical mass’ of potential excellence, by networking capacities present in different Member States, by attracting to Europe the best researchers from the rest of the world, in the same way that American campuses are currently attracting researchers.”

Philippe Busquin
Ex European Commissioner for Research & Development
EU POLICY IN R&D

Issues of Concern

- Urgent need to increase the number of well qualified researchers in Europe

- Obstacles to researchers’ mobility (geographically, between sectors)

- The diminishing interest of young people for scientific studies and lack of recognition of research as a profession

- Persistent under-representation of women
EU POLICY IN R&D

EU Strategy

- Financial support for training, transfer of knowledge and trans-national mobility of researchers

- Improvement of information and practical assistance to mobile researchers (Pan-European Researcher’s Mobility Portal and ERA-MORE: the European Network of Mobility Centres)

- Improvement of the legislative, regulatory and administrative environment

- Social visibility of researchers
EU POLICY IN R&D

Research Framework Programme

- The FP is the EU’s main instrument for research funding in Europe.
- The FP is proposed by the European Commission and adopted by Council and the European Parliament following a co-decision procedure.
- FPs cover a period of five years with the last year of one FP and the first year of the following FP overlapping.
- For current FP 6 projects must be transnational. Activities at national level cannot be funded under FP6.
## EU POLICY IN R&D

### 6th Framework Programme

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EU POLICY IN R&D
Research Training Networks

**Aim:** Trans-national network of host institutions with common research project providing training and transfer of knowledge mainly through research. Project duration of 4 years

**Recruited Fellows:** Early stage researchers (less than 4 years experience) and experienced researchers (between 4 and 10 years experience). Duration of fellowships from 3 months to 3 years

**Research hosts:** Teams from at least 3 Member or Associated EU States.

**Funding of recruited fellows:** costs include mainly living and mobility allowances paid through either a fixed-stipend or employment contract

**Funding of research hosts:** costs include researcher networking, general organisation of the project, audit, management costs and overheads
INTRODUCTION TO ‘MUSE’

Research Teams

Research Hosts:
- University of Durham, UK (Coordinator)
- Università di Trento, Italy
- Ecole Nationale des Ponts et Chaussées, France
- Universitat Politècnica de Catalunya, Spain
- University of Glasgow, UK
- Università di Napoli Federico II, Italy

Industrial associated partners:
- Geomod, Switzerland
- Geotechnical Observations, UK
- Terrasol, France
- Provincia di Bolzano, Italy
- Wykeham Farrance International, UK

Overall budget ≈ 1.25 million €
RESEARCH & TRAINING PROGRAMME

Scientific Objectives

- database of experimental results;
- development and validation of improved constitutive models;
- development and validation of improved numerical modelling for analysing coupled hydro-mechanical boundary;
- application of the constitutive and numerical modelling capabilities to a range of practical problems;

“benchmarking” of laboratory testing techniques, constitutive models and finite element codes.
RESEARCH & TRAINING PROGRAMME

Project Tasks

Task A: Laboratory Testing
Task leader: Dr Alessandro Tarantino, UNITN

Task B: Constitutive Modelling
Task leader: Prof Simon Wheeler, GU

Task C: Numerical Modelling
Task leader: Dr Jean Vaunat, UPC

Task D: Applications
Task leader: Dr Berhouz Gatmiri, ENPC

A1: Circulation of existing test data
A2: Controlled-suction testing
- reconstituted non-expansive clay
- compacted non-expansive clay
- compacted highly expansive clay
- natural clay
- compacted granular soil
- artificial cemented soil
- natural cemented soil
- pyroclastic soil
A3: Benchmarking methods of suction control
A4: Testing to investigate the role of degree of saturation
A5: Resonant column testing and bender element testing
A6: Non-isothermal testing
A7: Improved methods of suction measurement

B1: Interpretation with existing constitutive models
B2: Development of constitutive models corresponding to unsaturated materials and determination of the degree of saturation
B3: Implementation of plastic constitutive models
B4: Development of models incorporating the role of degree of saturation
B5: Incorporation of plastic anisotropy
B6: Models for cyclic and dynamic loading
B7: Models incorporating thermal and/or chemical effects
B8: Benchmarking of parameter determination procedures
B9: Benchmarking of constitutive models

C1: Formulating improved algorithms and numerical techniques
C2: Implementation in F.E. codes and development of a new F.E. code
C3: Implementation of new constitutive models in F.E. codes
C4: Further development of F.E. codes with thermo-chemical capabilities
C5: Benchmarking of F.E. codes
C6: Benchmarking of constitutive models at the level of boundary value problems

D1: Slope instabilities and flowslides
D2: Containment of nuclear waste
D3: Embankments and earth dams
D4: Pollutant migration, performance of landfill liners and covers
D5: Seismic analysis of dams and response to ground vibrations
D6: Benchmarking of numerical modelling of case histories
D7: Propose improvements to existing design methods
D8: Numerical modelling of in-situ tests
D9: Development or validation of new equipment and procedures for in-situ monitoring
D10: Dissemination of results
RESEARCH & TRAINING PROGRAMME

Training

Training of a new generation of researchers in the area of unsaturated soil mechanics by:

- Their involvement in the MUSE research project including the relevant management aspects
- Offer of teaching modules in the area of unsaturated soil mechanics available at member institutions
- Visits to associated industrial partners
- Participation to international conferences and scientific meetings
RESEARCH & TRAINING PROGRAMME

Networking

- Organization of annual network meetings of 1 week duration held at different universities in rotation. Each meeting will be divided in:
  - a workshop focused on presentations from junior researchers about the MUSE research programme
  - a school where speakers from industry and academia will give lectures around a specific geotechnical theme. The school will also include lectures for training on complementary skills. **Next MUSE school to be held during week starting 15 May 2006 at ENPC in Paris will be open to researchers from outside the network**
  - a “hands-on” training session providing practical training in a particular area of expertise of the university holding the meeting
Benchmarking of laboratory techniques (subtask A3)

- Comparison of different techniques for suction control/measurement used for the definition of the water retention curve (in terms of gravimetric water content and volumetric water content) of the same soil.

- Must ensure that 'identical' specimens are tested by all partners, i.e. soil type and sample preparation must be the same for all partners.

- Specimens will be normally consolidated from slurry under one-dimensional conditions to a given vertical stress (drying WRC).

- In order to compare experimental techniques, the specimens must such that the water retention curve:
  - Has an air-entry suction not exceeding 100-200 kPa
  - Has a slope beyond the air-entry suction not too steep
  - Develops over a large range of suction so that the same samples can be used for matric suction and total suction.
RESEARCH & TRAINING PROGRAMME

Benchmarking of laboratory techniques (subtask A3)

MIXTURE A
70% sand - 10% kaolin - 20% bentonite
(two data point so far, in progress)

MIXTURE B
80% sand - 10% kaolin - 10% bentonite
(in progress)

?
Water retention curve in the low range (0-1000 kPa) will be determined by using the following techniques:

- **Axis translation technique** (suction controlled/water content measured)
- **Tensiometer** (suction measured/water content controlled)
- **Osmotic technique** (suction controlled/water content measured)
- **Filter paper technique** (suction measured/water content controlled)

Water retention curve in the high range (> 1000 kPa) will be determined by using the following techniques:

- **Filter paper technique** (suction measured/water content controlled)
- **Transistor psychrometer** (suction measured/water content controlled)
- **Vapour technique** (suction controlled/water content measured)

At least two institutions will be using the same technique to determine the WRC to cross-check the experimental data.
Benchmarking of constitutive models (subtask B8)

Subtask B8 involves benchmarking of parameter determination procedures for the Barcelona Basic constitutive Model (BBM)

Each partner is provided with the same set of experimental data from controlled-suction laboratory tests (i.e. M. Barrera PhD thesis at UPC)

Each partner uses these experimental data to determine values of the parameters within BBM

Each partner submit their choice of BBM parameters to the task leader, who uses these different parameter sets to produce different sets of simulations for a range of different stress paths including paths different from those followed in the experimental tests

The objective is to investigate whether different parameter determination procedures arrive to same parameter values from the same experimental data
Subtask B9 involves benchmarking of the performance of different constitutive models by performing blind predictions of laboratory test results.

- Each partner is provided with the same set of experimental data from controlled-suction laboratory tests (i.e. M. Barrera PhD thesis at UPC).

- Each partner employs a different constitutive model, which is calibrated by using the given experimental data.

- Each partner produces a class A prediction of further tests on the same soil corresponding to stress paths different to those used for calibration.

- Each partner submits their class A predictions to the task leader, who presents the comparison between all predictions and the experimental data.

The objective is to investigate the strengths, weaknesses and limitations of various constitutive models for unsaturated soil.
RESEARCH & TRAINING PROGRAMME

Publication of vacancies

Network website:
http://muse.dur.ac.uk/

Marie Curie Search Tool:
http://mc-opportunities.cordis.lu/home_vac.cfm

Mailing lists:
Unsaturated-soil / Engineering-geotech
http://www.jiscmail.ac.uk/

Pan-European Researcher’s Mobility Portal:
http://europa.eu.int/eracareers/index_en.cfm

National mailing lists:
http://www.jobs.ac.uk/
Contact and further informations

Network website:
http://muse.dur.ac.uk

Network Coordinator:
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Email: domenico.gallipoli@durham.ac.uk
THANK YOU FOR YOUR ATTENTION
INTRODUCTION TO ‘MUSE’

Università di Napoli Federico II, Naples, Italy (UNINA)

Host academic staff:
- Prof Claudio Mancuso (Leading Senior Scientist, Scientist in Charge)
- Prof Filippo Vinale
- Dr Luca Pagano
- Dr Filippo Santucci de Magistris
- Dr Anna d’ Onofrio

Recruited Fellows:
- Mr Juan Carlos Rojas Vidovic (from Bolivia)
  (further recruitment is planned)
INTRODUCTION TO ‘MUSE’

Università di Trento, Trento, Italy (UNITN)

Host academic staff:
- Prof Luigi Mongiovì (Leading Senior Scientist)
- Dr Alessandro Tarantino (Network Secretary, Scientist in Charge)
- Dr Lucia Simeoni
- Dr Giovanni Bosco

Recruited Fellows:
- Dr Christian Hoffmann (from Spain)
INTRODUCTION TO ‘MUSE’

Universitat Politècnica de Catalunya, Barcelona, Spain (UPC)

Host academic staff:
- Prof Antonio Gens (Leading Senior Scientist)
- Prof Eduardo Alonso (Leading Senior Scientist)
- Dr Jean Vaunat (Scientist in Charge)
- Dr Enrique Romero
- Prof Sebastián Olivella
- Prof Antonio Lloret
- Prof Alberto Ledesma

Recruited Fellows:
- Mr Benoit Garitte (from Belgium)
  (further recruitment is planned)
INTRODUCTION TO ‘MUSE’

Ecole Nationale des Ponts et Chaussées, Paris, France (ENPC)

Host academic staff:
- Prof Pierre Delage (Senior Leading Scientist)
- Dr Yu-Jun Cui (Senior Leading Scientist)
- Dr Vincenzo De Gennaro (Scientist in Charge)
- Dr Berhouz Gatmiri
- Dr Jean Michel Pereira

Recruited Fellows:
- Dr Juan Jorge Muñoz (from Spain)
  (further recruitment is planned)
INTRODUCTION TO ‘MUSE’

University of Glasgow, Glasgow, UK (GU)

Host academic staff:
- Prof Simon Wheeler (Senior Leading Scientist, Scientist in Charge)
- Dr Minna Karstunen (invited from Strathclyde University)

Recruited Fellows:
- Mr A. Raveendiraraj (from Sri Lanka)
  (further recruitment is planned)
INTRODUCTION TO ‘MUSE’

University of Durham, Durham, UK (DU)

Host academic staff:
- Dr David Toll (Research Supervisor, Senior Leading Scientist)
- Dr Domenico Gallipoli (Network Coordinator, Scientist in Charge)
- Dr Charles Augarde (Training Supervisor)

Recruited Fellows:
- Mr Wojciech Solowski (from Poland)
  (further recruitment is planned)