ALERT Geomaterials
The alliance of Laboratories in Europe for Education, Research and Technology

University of Strathclyde
Department of Civil and Environmental Engineering

Universitat Politècnica de Catalunya - BarcelonaTech
Department of Geotechnical Engineering & Geosciences
International Centre for Numerical Methods in Engineering

TERRE
Training Engineers and Researchers to Rethink geotechnical Engineering for a low carbon future

12th ALERT Olek Zienkiewicz School 2021
Looking into the rhizosphere: the interface between plant science and soil mechanics

13 & 20 April 2021

18-20 May 2021

Online platform
(TBC)

Organised by

The Alliance of Laboratories in Europe for Education, Research and Technology (ALERT Geomaterials)

University of Strathclyde (Department of Civil and Environmental Engineering)

Universitat Politècnica de Catalunya (Department of Geotechnical Engineering & Geosciences) & CIMNE (Geomechanics Group)

TERRE Network

Coordinated by

Alessandro Tarantino (University of Strathclyde)

Enrique Romero (Universitat Politècnica de Catalunya / CIMNE)

RATIONALE

Man-made earth structures such as flood embankments, railway and roadway embankments, dams, cut slopes, are very often covered by vegetation. The same applies to natural ground forming slopes, supporting above-ground structures, and generating thrust against retaining structures.

Vegetation affects significantly the hydro-mechanical response of the ground. Plant roots act as a natural anchor system similar to geotextiles and nails, plants affect the process of atmosphere-driven water uptake via transpiration, and plants modify the soil microstructure via bio-chemical processes that affect the hydraulic response of the ground in the rooting zone (rhizosphere). Geotechnical engineers are therefore faced with the challenge of understanding plant behaviour and its hydro-mechanical interaction with the soil to design their geotechnical structures.

At the same time, plant scientists recognise more and more the importance of mechanics and hydraulics of (unsaturated) soils to understand and model plant root growth (e.g. soil mechanical resistance to root penetration) and plant adaptation mechanisms to environmental stresses (e.g. water content redistribution within the soil). Plant scientists are therefore faced with the challenge of understanding unsaturated soil behaviour and its hydro-mechanical interaction with the plant to identify conditions favourable to shoot development and therefore, crop yields in agriculture.

This Olek Zienkiewicz School is aimed at stimulating synergies between these two disciplines, soil mechanics and plant science. It is mainly designed for researchers having a soil mechanics background. Its main goal is to introduce the fundamentals of plant morphology, anatomy and physiology and the different hydraulic, hydrological, and mechanical interactions of plants with the ground. It is also aimed at demonstrating the role of continuum and discrete soil mechanics in understanding and modelling plant behaviour with a focus on real applications involving ground-vegetation interactions.

However, the course is also open to researchers having plant science background and a short pre-course will be offered to introduce the fundamentals of soil mechanics and hydraulics and enable plant science researchers to attend fruitfully the course.

ORGANISATION OF THE COURSE

The course will be held online on 18-20 May 2021. It is organised in five sessions

- Root-soil mechanical interactions
- Hydrological soil-plant interactions
- Effect of rhizosphere on soil hydraulic properties
- Short research presentations
- Case studies: mock-up tests, artificial slopes, and natural slopes

The course will be preceded by preparatory lectures organised in four sessions over two days

- Session: Mechanics and hydraulics of saturated soils
  Target audience: researchers and practitioners with non-civil engineering background
- Session: Mechanics and hydraulics of unsaturated soils
  Target audience: researchers and practitioners with no-unsaturated soil background
- Session: Plant physiology
  Target audience: researchers and practitioners with non-plant science background
- Session: Plant hydraulics
  Target audience: researchers and practitioners with non-plant science background

LECTURERS

PRE-COURSE
Maria Marin, University of Aberdeen, Scotland, UK
David Boldrin, University of Dundee, Scotland, UK
Alexia Stokes, INRAE – UMR AMAP, Montpellier, France
Mohsen Zarebanadkouki, University of Bayreuth, Germany
Scott McAdam, Purdue University, USA
Sylvain Delzon, INRAE - University of Bordeaux, UMR BIOGECO, Bordeaux, France
Bruna Lopes, University of Strathclyde, Glasgow, Scotland, UK
Alessandro Tarantino, University of Strathclyde, Glasgow, Scotland, UK

COURSE

18 May 2021
Evelyne Kolb, Sorbonne Université, France
Jean-Yves Delenne, French National Institute for Agriculture, Food, and Environment (INRAE), France
Jonathan Knappett, University of Dundee, Scotland, UK
Gerrit Meijer, University of Bath, UK
Barbara Switala, Institute of Hydro-Engineering, Polish Academy of Sciences, Gdańsk, Poland

19 May 2021
Thierry Fourcaud, CIRAD - UMR AMAP, France
A. Glyn Bengough, University of Dundee, Scotland, UK
Andrea Carminati, ETH Zürich, Switzerland
Louise Egerton-Warburton, Chicago Botanic Garden, USA
Anthony Leung, Hong Kong University of Science and Technology, Hong Kong, China
Katerina Tsiampousi, Imperial College London, UK

20 May 2021
Tiina Roose, University of Southampton, UK
Enrique Romero, Universitat Politècnica de Catalunya / CIMNE, Spain
Luca Pagano, Università di Napoli Federico II, Italy
Joel Smethurst, University of Southampton, UK
Dominika Krzeminska, NIBIO Norwegian Institute of Bioeconomy Research, Norway
Alessandro Fraccica, CIMNE / Universitat Politècnica de Catalunya, Spain
Marianna Pirone & Gianfranco Urciuoli, Università di Napoli Federico II, Italy
Federica Cotecchia & Vito Tagarelli, Politecnico di Bari, Italy
Slobodan B. Mickovski & Alejandro Gonzalez-Ollauri, Glasgow Caledonian University, Scotland, UK
Alessandro Tarantino, University of Strathclyde, Scotland, UK

SHORT RESEARCH PRESENTATION
20 May 2021
Floriana Anselmucci, Université Grenoble Alpes, France
Alessandro Fraccica, CIMNE, Spain
Ana Sofia Dias, Durham University, UK
Roberta Dainese, University of Strathclyde, Scotland, UK
Vittoria Capobianco, NGI Norwegian Geotechnical Institute, Norway

COURSE PLATFOM & REGISTRATION

The course will be offered through the Flexible Learning platform of the University of Strathclyde (https://flexible.strath.ac.uk/). A unique web link (**TBC**) will allow registration to the course and access the course. Lectures will be offered live through the Zoom platform. Material and recorded lectures will remain available for one month after the end of the course.

The course is free of charge for participants affiliated to institutions member of ALERT Geomaterials (http://alertgeomaterials.eu/alert-geomaterials/members/). If you wish to attend the course, please send an email to alessandro.tarantino@strath.ac.uk and bruna.lopes@strath.ac.uk with subject '**OZC 2021 – Registration ALERT Participant'**.

If you are not affiliated to an institution member of ALERT Geomaterials, the fee is £100 and can be paid at

TBC

This will give you access to the material and lectures (both live and recorded).

PRE-COURSE

Please note that times are displayed in Central European Time (CET)

PLANT PHYSIOLOGY & HYDRAULICS   ***13 April 2021***

Session: Plant physiology *Target audience: researchers and practitioners with non-plant science background*	
09:00 – 10:00	**How plants function and grow - a brief introduction to what you need to know as an engineer** *Maria Marin, University of Aberdeen, Scotland, UK*
10:00 – 11:00	**Understanding plant ecology, and why biodiversity is important for soils and bioengineering** *David Boldrin, University of Dundee, Scotland, UK*
11:00 – 11:30	**Break**
11:30 – 12:30	**The why and how of tree biomechanics - or what makes trees fall over?** *Alexia Stokes, INRAE – UMR AMAP, Montpellier, France*

12:30 – 13:30	**Lunch**

Session: Plant hydraulics *Target audience: researchers and practitioners with non-plant science background*	
13:30 – 14:30	**Quantification of root water uptake and hydraulic conductivities from root to the cellular scale** *Mohsen Zarebanadkouki, University of Bayreuth, Germany*
14:30– 15:30	**How stomata respond to water: metabolism vs biophysics** *Scott McAdam, Purdue University, USA*
15:30 – 16:00	**Break**
16:00 – 17:00	**The ascent of sap and xylem vessel (dis)content: 4 centuries of debate** *Sylvain Delzon, INRAE - University of Bordeaux, UMR BIOGECO, Bordeaux, France*

MECHANICS AND HYDRAULICS OF SATURATED & UNSATURATED SOILS   ***20 April 2021***

Session: Mechanics and hydraulics of saturated soils *Target audience: researchers and practitioners with non-civil engineering background*	
09:00 – 10:00	**Water flow in rigid and deformable saturated soils** *Bruna Lopes, University of Strathclyde, Glasgow, Scotland, UK*
10:00 – 11:00	**Compressibility and shear strength of saturated soils** *Alessandro Tarantino, University of Strathclyde, Glasgow, Scotland, UK*
11:00 – 11:30	**Break**
11:30 – 12:30	**Stability analysis of infinite slope** *Bruna Lopes, University of Strathclyde, Glasgow, Scotland, UK*

12:30 – 13:30	**Lunch**

Session: Mechanics and hydraulics of unsaturated soils *Target audience: researchers and practitioners with no-unsaturated soil background*	
13:30 – 14:30	**Water retention behaviour of unsaturated soils** *Alessandro Tarantino, University of Strathclyde, Glasgow, Scotland, UK*
14:30– 15:30	**Hydraulic conductivity and water flow in unsaturated soils #** *Bruna Lopes, University of Strathclyde, Glasgow, Scotland, UK*
15:30 – 16:00	**Break**
16:00 – 17:00	**Compressibility and shear strength of unsaturated soils** *Alessandro Tarantino, University of Strathclyde, Glasgow, Scotland, UK*

12TH ALERT OLEK ZIENKIEWICZ SCHOOL 2021

Looking into the rhizosphere: the interface between plant science and soil mechanics

PROGRAMME

Please note that times are displayed in Central European Time (CET)

DAY 1 –18 May 2021	
09:30 – 10:00	**Welcome address** *Alessandro Tarantino, Alert School Coordinator (University of Strathclyde, Glasgow, Scotland)* *Enrique Romero, Alert School Coordinator (Universitat Politècnica de Catalunya / CIMNE, Spain)* *Frédéric Collin, Director ALERT Geomaterials (Université de Liège, Belgium)*
ROOT-SOIL MECHANICAL INTERACTIONS	
10:00 – 11:00	**Physical modelling of root-soil interactions** *Evelyne Kolb, Sorbonne Université, France*
11:00 – 12:00	**Root growth and force chains in granular soil** *Jean-Yves Delenne, French National Institute for Agriculture, Food, and Environment (INRAE), France*
12:00 – 13:00	**Lunch**
13:00 – 14:00	**From root-soil interactions to stability assessment of vegetated slopes** *Jonathan Knappett, University of Dundee, Scotland, UK*
14:00 – 15:00	**No strain, no gain: serviceability aspects of mechanical root-reinforcement** *Gerrit Meijer, University of Bath, UK*
15:00 – 15:30	**Break**
15:30 – 16:30	**Implementation of models for root-reinforced soils into finite element codes** *Barbara Switala, Institute of Hydro-Engineering, Polish Academy of Sciences, Gdańsk, Poland*

DAY 2 - 19 May 2021

HYDROLOGICAL SOIL-PLANT INTERACTIONS	
09:00 – 10:00	**Modelling growth and development of plant root systems** *Thierry Fourcaud, CIRAD - UMR AMAP, France*
10:00 – 11:00	**Rhizosphere biophysics and its control on soil hydrology** *Glyn A. Bengough, University of Dundee, Scotland, UK*
11:00 – 11:30	**Break**
11:30 – 12:30	**Role of mucilage in shaping rhizosphere hydraulic properties and regulating root water uptake** *Andrea Carminati, ETH Zürich, Switzerland*
12:30 – 13:30	**Role of root hairs in regulating root water uptake** *Andrea Carminati, ETH Zürich, Switzerland*

13:30 – 14:30	**Lunch**

14:30 – 15:30	**Role of arbuscular mycorrhizas and ectomycorrhizas in regulating root water uptake** *Louise Egerton-Warburton, Chicago Botanic Garden, USA*
15:30 – 16:30	**Hydrological reinforcement to soil: insights from plant-water relation** *Anthony Leung, Hong Kong University of Science and Technology, Hong Kong, China*
16:30 – 17:00	**Break**
17:00 – 18:00	**Numerical modelling of vegetation-mediated ground atmosphere interaction** *Katerina Tsiampousi, Imperial College London, UK*

DAY 3 - 20 May 2021

SHORT RESEARCH PRESENTATIONS	
9:00 – 10:30	**Sand deformation around growing maize roots: an investigation with x-ray tomography** *Floriana Anselmucci, Université Grenoble Alpes, France* **Tensile strength of a vegetated and partially saturated soil** *Alessandro Fraccica, CIMNE / Universitat Politècnica de Catalunya, Spain* **The water retention properties of root-permeated pyroclastic soil** *Ana Sofia Dias, Durham University, UK* **High-Capacity Tensiometer: measuring xylem water pressure to investigate soil-plant hydraulics** *Roberta Dainese, University of Strathclyde, Scotland, UK* **The influence of long-root grass on hydro-mechanical behaviour of volcanic soils: an experimental study at lab scale** *Vittoria Capobianco, NGI Norwegian Geotechnical Institute, Norway*
10:30 – 11:00	**Break**
EFFECT OF RHIZOSPHERE ON SOIL HYDRAULIC PROPERTIES	
11:00 – 12:00	**Hydraulic behaviour of compacted vegetated soils** *Enrique Romero, Universitat Politècnica de Catalunya / CIMNE, Spain*
12:00 – 13:00	**Multiscale Image Based Modelling of the Rhizosphere** *Tiina Roose, University of Southampton, UK*
13:00 – 13:50	**Lunch**
CASE STUDIES: MOCK-UP TESTS AND ARTIFICIAL SLOPES	
13:50 – 14:10	**The effects of bare and vegetated conditions on the hydrological response of a silty volcanic layer tested by a lysimeter** *Luca Pagano, Università di Napoli Federico II, Italy*
14.10 – 14:30	**Seasonal variations in soil water content and pore water pressure in a vegetated clay highway cut slope** *Joel Smethurst, University of Southampton, UK*
CASE STUDIES: NATURAL SLOPES	
14:30 – 14:50	**Effect of riparian vegetation on stream bank stability** *Dominika Krzeminska, NIBIO Norwegian Institute of Bioeconomy Research, Norway*
15.10 – 15:30	**Fallow and vegetated slopes under heavy rainfalls in Costa Rica** *Enrique Romero & Alessandro Fraccica, Universitat Politècnica de Catalunya / CIMNE, Spain*
15:30 – 15:50	**Effects of vegetation on hydro-mechanical behaviour of unsaturated pyroclastic slopes: two case studies in Campania (Southern Italy)** *Marianna Pirone & Gianfranco Urciuoli, Università di Napoli Federico II, Italy*
15:50 – 16:10	**Break**
16:10 – 16:30	**Effects of different crop types on the state of soils at depth and their impact on the stability of slopes: the real scale model set up at Pisciolo** *Federica Cotecchia & Vito Tagarelli, Politecnico di Bari, Italy*
16:30 – 16:50	**Hydrological effect of vegetation against rainfall-induced landslides: case study of Catterline Bay** *Alejandro Gonzalez-Ollauri & Slobodan B. Mickovski, Glasgow Caledonian University, Scotland, UK*
16:50 – 17:10	**A case study on the hydraulic control of the rhizosphere on rainfall-induced shallow landslides** *Alessandro Tarantino, University of Strathclyde, Scotland, UK*
17:10 – 17:30	**Closure** *Alessandro Tarantino, Alert School Coordinator (University of Strathclyde, Glasgow, Scotland)* *Enrique Romero, Alert School Coordinator (Universitat Politècnica de Catalunya / CIMNE, Spain)* *Cino Viggiani, President ALERT Geomaterials (Université Grenoble Alpes, Laboratoire 3SR, France)*


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