50 years of University of Split

# INTERNATIONAL SPLIT SUMMER SCHOOL 2026

## COURSE: Numerical Modeling and Field Validation in Geotechnics

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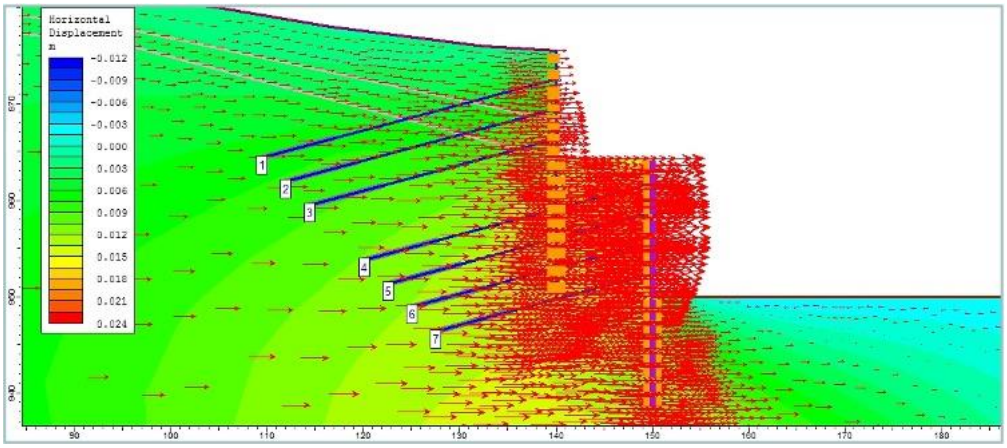

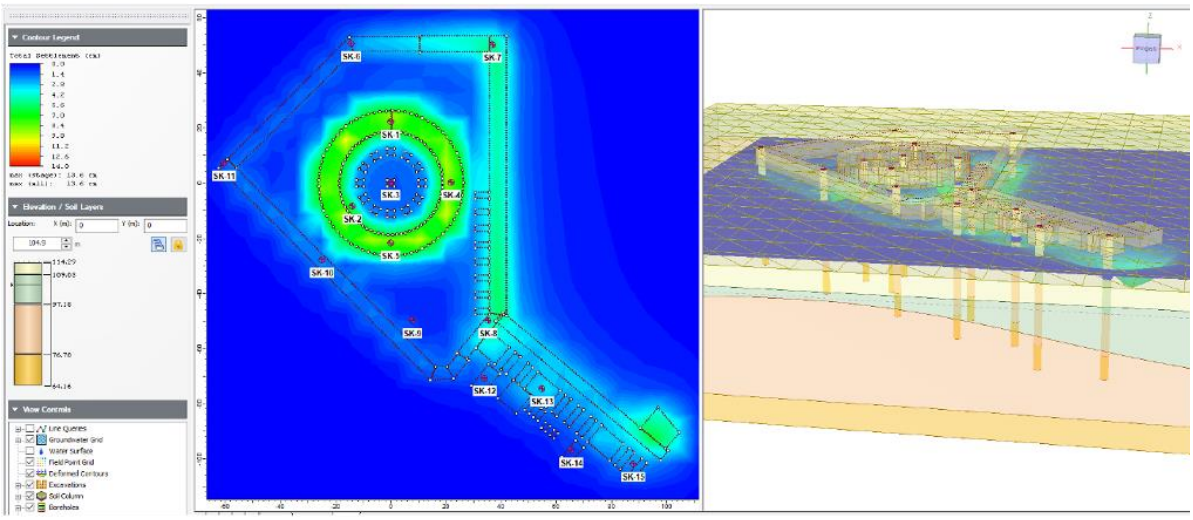

**Main Topics**

- Deep Excavation Support System Design Using Finite Elements, Monitoring of Deep Excavations
- Characterization and Stability Analysis of Slopes and Engineered Fills Under Various Loading Conditions, Field Performance Assessment of Fill Sites
- Analysis of Settlement Under Foundations, Ground Improvement, Axial Static Load Testing of Instrumented Piles, Area Loading of Improved Ground Sites Under Design Loads
- Geomechanical Behaviour of Tunnels, Finite Element Analysis of Tunnels, Tunnel Monitoring
- Slope Stability Assessment in Rock Masses, Modeling Anisotropy in Rock Masses, Limit Equilibrium and Finite Element Based Slope Stability Evaluation

**Programme Structure**

- **5-day Course**
- Review of Practical Aspects of Geotechnical Modeling with Emphasis on a Diverse Range of Applications and Case Studies
- Hands-on Numerical Modeling Experience
- Deeper Understanding of Soil/Rock Characterization, Modeling and Field Performance Validation Process
- Learn the Fundamentals of Developing a Geotechnical Monitoring Programme

The structure of the course is designed to address participants with diverse technical backgrounds and will cover brief overview of the theoretical aspects of various topics in geotechnical practice. Hands-on applications using numerical modelling software will be provided. This framework will be supplemented with analysis of data from real case studies, address common tips and pitfalls. A brief discussion on case specific project management skills will also be delivered. Each day will include opportunities for the participants to get directly involved in the cases analysed. Participation with a laptop computer is essential. Temporary licenses of the software and digital versions of the course notes will be provided in advance.

The course aims to develop a wider understanding of selected geotechnical problems in practice, using a well-crafted balance between theory, application and project management. The content will discuss various aspects of approaching to the problem, starting with site characterization to geotechnical modelling and extending to field performance monitoring, and will help the participants step towards closing the loop of management of geo-risks, design optimization and sustainable methods of managing the project lifecycle.

**Important dates**

Course dates: 31 August – 4 September, 2026.
Deadline for application: 6 July, 2026
Payment due by: 19 August, 2026
Confirmation of the course: 13 July, 2026
**Price of the course:** 300 Euros

## Program Plan

**Day 1: 2D Finite Element Modeling of Deep Excavations in Urban Environments**

The topic will evolve around discussing the basic principles of temporary deep excavation – support systems, choosing a proper conceptual support pattern and a global stability check using limit equilibrium methods. Starting from discussions on site characterization stage and selection of geomechanical parameters, the modelling phase will commence with defining the model geometry of the deep excavation system, diving into details of defining liners and support elements with particular emphasis to real life analogies in practice. Discussions on sources of uncertainty in input parameters and their impact on the overall response and structural performance will be brought into consideration. Different approaches in modelling groundwater effects will be introduced, with in-depth discussions on common errors encountered in design practice and how to avoid them. The worked example will utilize a 2D finite element software

package with hands-on modelling opportunity during class, supported with instant feedback and review of design code requirements.

Second part of the day will be reserved for introducing the basics of geotechnical and structural monitoring planning at a deep excavation site, introducing the basic concepts of monitoring design; including the selection of parameters to monitor, required hardware, installation basics, commissioning, taking and recording measurements and harmonizing all field evidence to assess the performance of the built structure and adjacent properties. In particular, the content includes brief introduction to principles of taking deformation measurements around a deep excavation support system pit, addressing all critical aspects of planning, implementation and data interpretation stages.

**Day 2: Engineering Characterization, 2D and 3D Analysis of Waste Dump Slopes**

Day 2 will start with emphasizing the importance of engineering characterization of rock waste dumps, heap leaches and engineered / unengineered fills in general. An overview of in-situ and laboratory testing methods will be presented. The flow includes presentation of a real case utilizing a combination of in-situ and advanced laboratory testing efforts to develop the yield criteria and constitutive model for the fill material. Second phase of the course will be devoted to constructing a 3D geometry model for a waste dump facility, including property definitions of fill material and underlying rock mass. Stability checks using various critical surface search algorithms will be made to assess the potentially unstable stable zones under different loading conditions using 3D limit equilibrium analysis tools. Attention will be given to selecting design basis magnitudes for seismic loading and options for ground water modelling. Analysis results will be blended with selected 2D limit equilibrium analysis and 2D shear strength reduction analysis using finite elements.

Second part of the course will be reserved for introducing approaches and technologies used for monitoring the performance of similar slopes. The participants will interactively design a monitoring plan, set out the principles of condition assessment using singular sensors, sensor arrays or remote sensing tools. Bill of quantities for the monitoring program, a draft technical specification and draft budget preparation exercise will be conducted.

**Day 3: Ground Improvement for Foundation Design of Settlement Sensitive Structures and Field Performance Verification Through Instrumentation & Monitoring**

Day 3 will highlight the theoretical basics of soil characterization and settlement analysis under foundation loads and present a case study incorporating a real-world application. The scope includes utilization of a software package to predict the elastic and consolidation settlement of non-horizontal saturated soil layers under designated non- uniform structural loads. The second part will discuss the innovative ground improvement technique applied to mitigate settlement related consequences as well as remediation of seismic soil liquefaction related risks. The numerical tools used to represent this case such as 2D and 3D finite element-based software will be introduced with real data.

Summary on field performance verification of the applied ground improvement method is also presented. Load – settlement and mobilized strength behaviour of deep foundation members via instrumented static axial test loading is thoroughly discussed, starting from instrumentation

planning phase to hardware configuration, installation, testing and result interpretation. The discussion is complemented with design and implementation of a full- scale zone loading performed at project site. The setup details include settlement plates, piezometers, rod extensometers and total earth pressure cells; and the discussion involves monitoring planning, execution, commissioning, principles of real time monitoring as well as interpretation of results.

**Day 4: Numerical Analysis of Underground Openings: Basic Principles and Beyond**

This module covers the principles of explaining elasto-plastic geomechanical behaviour of tunnel openings using concepts of simplified yield criteria and stress and deformation relations. Fundamental concepts such relaxation with respect to in-situ stresses, convergence confinement, excavation sequencing, longitudinal displacement profiles and effect of round lengths on support system – tunnel interaction are explained using examples and finite element-based modelling tools. Strength and deformation mobilization mechanisms of different types of tunnel lining and support elements are introduced with analogies to real cases. Finite element meshing, boundary condition setup, ground water modelling, effect of joints around tunnel openings are brought into discussion with hand on modelling experience.

Final part of the module is reserved for planning and execution of monitoring and instrumentation around tunnel openings with particular emphasis on tunnel – tunnel interaction and tunnel – structure interaction for excavations performed at shallow depths. Two case studies highlighting the critical aspects of monitoring of tunnels serving the transportation infrastructure will be shared.

**Day 5: Numerical Modeling of Rock Slopes Controlled by Discontinuities**

The closing day of the course will be devoted to characterization and slope stability analysis of rock slopes with particular emphasis on limit equilibrium and finite element- based analysis methods and tools. The session begins with a simple example deliberately underestimating the presence of discontinuities in the rock mass and presents its impact on obtained safety factors using a limit equilibrium-based stability assessment. Concepts such as mechanical anisotropy is gradually introduced, and effect of scale is thoroughly stressed to help conceptualize how anisotropy can be incorporated into numerical models, by preserving the engineering perspective. Several exercises are introduced incorporating 2D and 3D limit equilibrium models. Similar cases are then revisited using the 2D and 3D finite elements, in which individual joints, implicitly expressed using anisotropic strength material models, or explicitly modelled using scaled joint network sets are demonstrated. Last, the participants will see how 3D fracture networks are utilized in finite elements to assess the stability of slopes.

**Lecturers**

A. Anıl Yunatcı, Ph.D
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Managing Director, Geodestek Ltd. Sti.

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