Applied Numerical Modeling in Geotechnical Engineering Course

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Amman (Jordan)



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Introduction:

The Applied Numerical Modeling in Geotechnical Engineering Training Course provides engineers with practical computational methods to simulate soil-structure interaction, groundwater seepage, and earth-retaining systems. This one-week course prepares foundation and geostructural engineering specialists to formulate constitutive soil parameters and assemble a complete Geotechnical Finite Element Analysis and Foundation Verification Dossier. Delivered at practitioner depth through a hands-on modelling build practical mode, delegates calibrate numerical meshes against ASTM International field test procedures and International Building Code Chapter 18 criteria. Geotechnical practitioners master computational simulation by attending the Applied Numerical Modeling in Geotechnical Engineering Training Course with Blackbird Training Centre.

Course Objectives:

- Select appropriate constitutive soil models by evaluating soil behaviour under linear elastic, Mohr-Coulomb, and advanced hardening formulations.
- Distinguish between limit-equilibrium method factors of safety and finite element shear strength reduction strength factors in slope stability evaluations.
- Compare drained vs undrained shear conditions during transient construction staging to evaluate pore water pressure dissipation in cohesive soils.
- Apply ASTM D1586 Standard Penetration Test and ASTM D5778 cone penetration data to derive stiffness and strength parameters for numerical meshes.
- Interpret coupled groundwater flow and deformation outputs to predict settlement, basal heave, and structural wall deflections under deep excavations.
- Justify foundation support selections under International Building Code Chapter 18 and ACI 318 requirements for shallow raft versus piled raft configurations.

Target Audience:

- Geotechnical analysis teams responsible for site characterisation who must decide between linear elastic-plastic and hardening soil constitutive models for ground deformation simulations.
- Foundation design practitioners responsible for substructure calculations who must choose between shallow spread footings and piled raft systems based on numerical settlement predictions.
- Excavation and shoring specialists responsible for earth-retaining systems who must select between anchored diaphragm walls and braced sheet pile support configurations during dewatering.
- Ground engineering consultants responsible for forensic slope assessments who must judge whether limit-equilibrium slicing or finite element strength reduction provides adequate safety margins.



Course Outline:

Day 1: Numerical Principles and Geotechnical Site Characterisation

- Finite Element Formulation: Discretising Soil Continua Into Nodes and Elements for Stress Analysis
- Continuum vs Discontinuum Modelling: Selecting Appropriate Numerical Approaches for Intact Soil and Jointed Rock
- ASTM D1586 Standard Penetration Testing: Deriving Elastic Modulus and Bearing Resistance for Computational Meshes
- ASTM D5778 Piezocone Penetration Profiling: Interpreting In-Situ Stratigraphy and Piezometric Profiles for Numerical Geometry
- Initial Stress State Generation: Applying Jacky K0 Procedures to Establish Geostatic Stresses

Day 2: Constitutive Soil Models and Regulatory Design Standards

- Linear Elastic vs Mohr-Coulomb Models: Evaluating Failure Criteria and Plastic Deformations Under Monotonic Loading
- Hardening Soil Constitutive Model: Simulating Stress-Dependent Soil Stiffness and Yield Surfaces in Numerical Analyses
- International Building Code Chapter 18: Structuring Foundation Verification Criteria for Substructure Numerical Analysis
- ACI 318 Structural Concrete Code: Checking Structural Plate and Beam Action Within Continuum Soil Meshes
- Drained vs Undrained Behaviour: Setting Pore Water Pressure Formulations Across Cohesive Ground Strata

Day 3: Deep Excavations and Groundwater Seepage Simulation

- Staged Excavation Numerical Sequences: Activating Structural Retaining Walls and Deactivating Soil Clusters Systematically
- Diaphragm Walls vs Contiguous Bored Piles: Comparing Lateral Retaining Wall Deflections in Multi-Propped Excavations
- Steady-State vs Transient Groundwater Seepage: Calculating Hydraulic Gradients and Steady Flow Meshes in GeoStudio
- Dewatering Pore Pressure Drawdown: Modelling Effective Stress Increases and Ground Surface Subsidence Trajectories
- Soil-Structure Interface Elements: Specifying Friction Reduction Factors to Capture Relative Soil-Wall Slip



Day 4: Foundation Systems and Slope Stability Mechanics

- Limit-Equilibrium vs Finite Element Strength Reduction: Evaluating Slope Factor of Safety in Heterogeneous Ground
- Spread Footings vs Piled Raft Systems: Predicting Differential Settlement and Axial Pile Load Sharing Configurations
- PLAXIS Finite Element Settlement Analysis: Calculating Complex Ground-Structure Consolidation and Primary Settlement Trajectories
- Collapsible and Expansive Soil Simulation: Incorporating Suction Matric Potentials and Volume Change Volumetric Boundaries
- Dynamic Vibratory Load Verification: Assessing Machine Foundation Resonance and Soil Damping Using Numerical Meshes

Day 5: Modelling Build Practical Mode and Deliverable Compilation

- Geometry Construction and Mesh Generation: Refining Finite Element Discretisation Across Critical Foundation Boundaries
- Constitutive Parameter Calibration: Applying Site Investigation Laboratory Data to Finalise Hardening Soil Properties
- Excavation Sequence vs Foundation Loading Build: Running Coupled Deformation Stages and Convergence Verification Runs
- Model Sensitivity and Error Diagnostics: Auditing Boundary Fixities and Element Aspect Ratios for Stability
- Final Deliverable Formulation: Validating the Geotechnical Finite Element Analysis and Foundation Verification Dossier

Skills You Will Gain:

- Finite Element Mesh Generation
- Constitutive Model Calibration
- Pore Pressure Seepage Modelling
- Strength Reduction Factor Analysis
- Deep Excavation Wall Sizing
- Piled Raft Settlement Prediction
- Geostatic Stress Initialisation
- Numerical Convergence Diagnostics



Why Attend This Course:

- From relying solely on empirical footing equations to simulating complex soil-structure interaction using calibrated finite element models.
- From simplistic limit-equilibrium slope assumptions to executing strength reduction analyses that capture realistic progressive failure mechanisms.
- From uncoupled seepage estimates to predicting construction dewatering impacts, pore water pressure dissipation, and ground settlement simultaneously.
- From unverified simulation outputs to producing a validated Geotechnical Finite Element Analysis and Foundation Verification Dossier for structural design compliance.

Conclusion:

Numerical geotechnical modelling enables engineers to predict ground deformation, seepage dynamics, and soil-structure interaction with computational accuracy. This course clarifies essential distinctions between limit-equilibrium safety factors and finite element strength reduction methods, as well as basic Mohr-Coulomb approximations and advanced hardening constitutive models. Geotechnical engineers and foundation designers operating at practitioner depth will find this course well suited to their professional requirements, equipping them to build stable numerical simulations and verify compliance under international civil engineering codes.

Frequently Asked Questions FAQ:

What is applied numerical modeling in geotechnical engineering?

Applied numerical modeling in geotechnical engineering is the computational simulation of soil and rock behaviour under structural loading, excavation, and fluid flow. It uses mathematical frameworks such as the finite element method to evaluate stress distribution, pore water pressure changes, and boundary deformations in complex ground conditions.

What is the difference between limit-equilibrium methods and finite element strength reduction in geotechnical modeling?

Limit-equilibrium methods assume pre-defined failure surfaces to compute a single factor of safety based on static equilibrium, whereas finite element strength reduction iteratively reduces soil shear parameters until numerical non-convergence occurs, identifying critical failure mechanisms automatically without assuming a failure geometry.

Which standards govern applied numerical modeling in geotechnical engineering?

Applied numerical modeling aligns with ASTM International testing protocols including ASTM D1586 and ASTM D5778 for soil property characterisation, alongside the structural and foundation verification requirements established in International Building Code Chapter 18 and American Concrete Institute standard ACI 318.



Is the applied numerical modeling in geotechnical engineering course suitable for foundation design practitioners?

Yes, this course is designed specifically for foundation design practitioners and geotechnical engineers operating at practitioner depth. It provides direct methods for calibrating constitutive soil parameters, constructing numerical meshes, and validating excavation and foundation models against structural engineering standards.

