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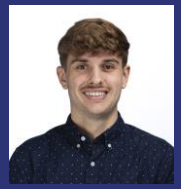

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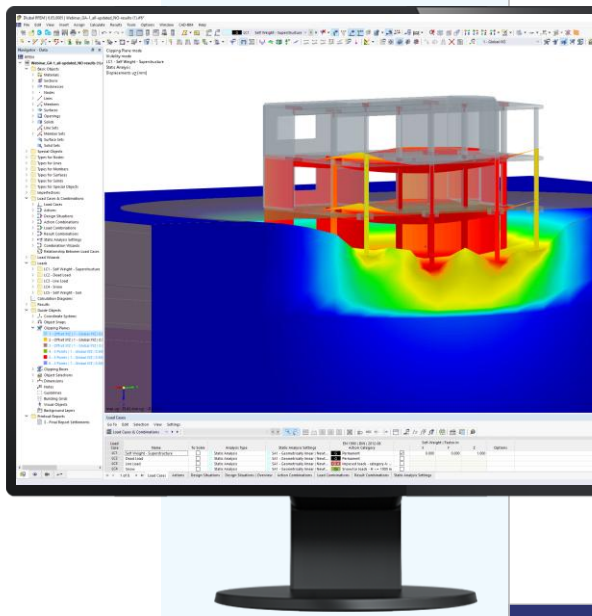
Moderator

Senior Support Engineer

Webinar

Geotechnical Soil-Structure Interaction in RFEM 6



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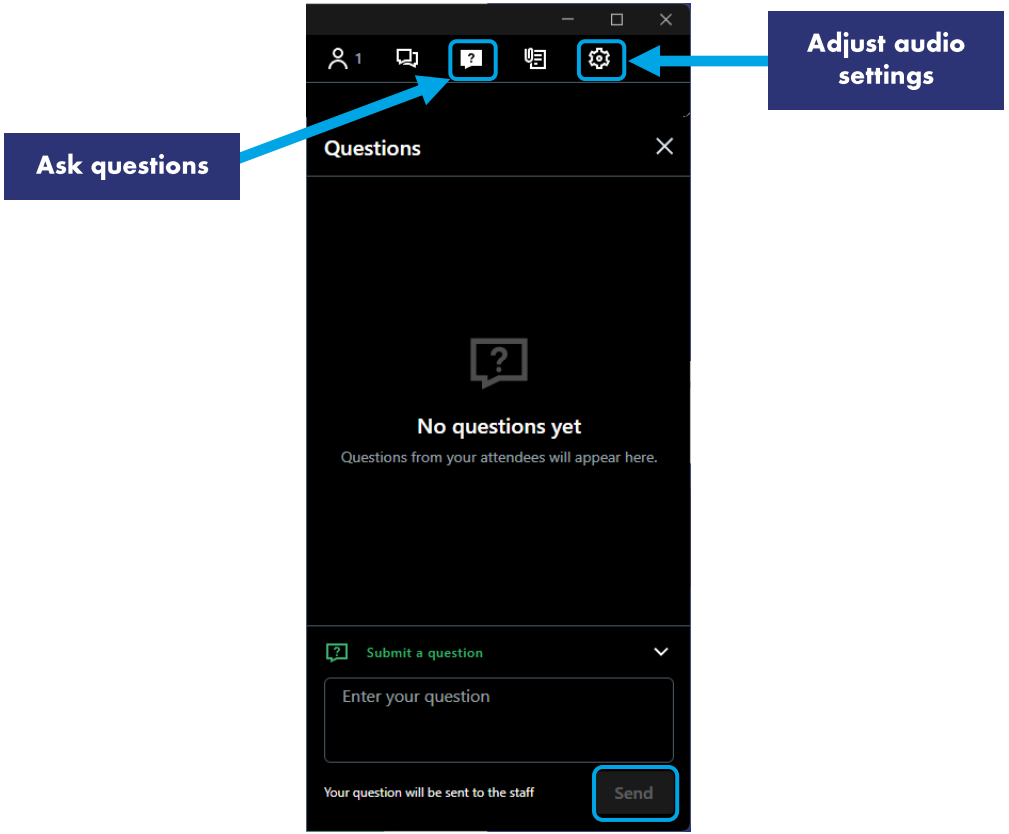
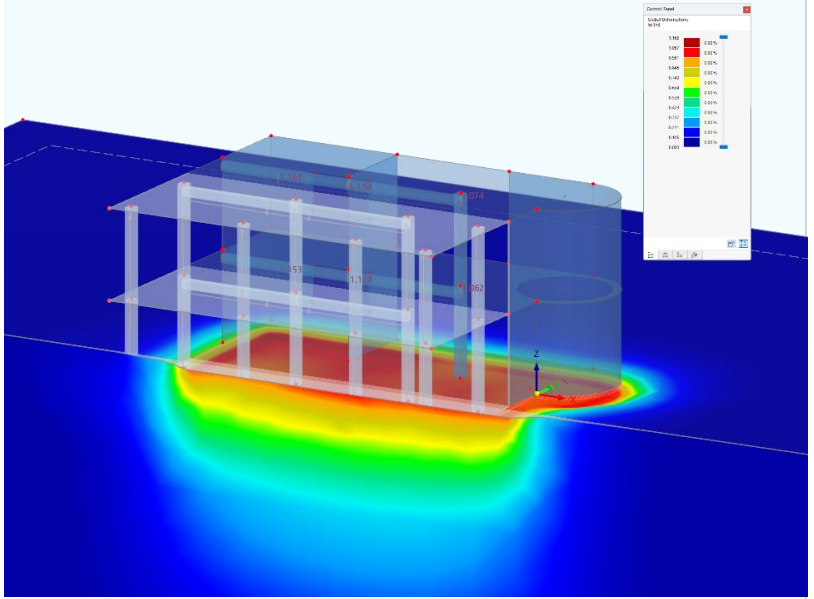


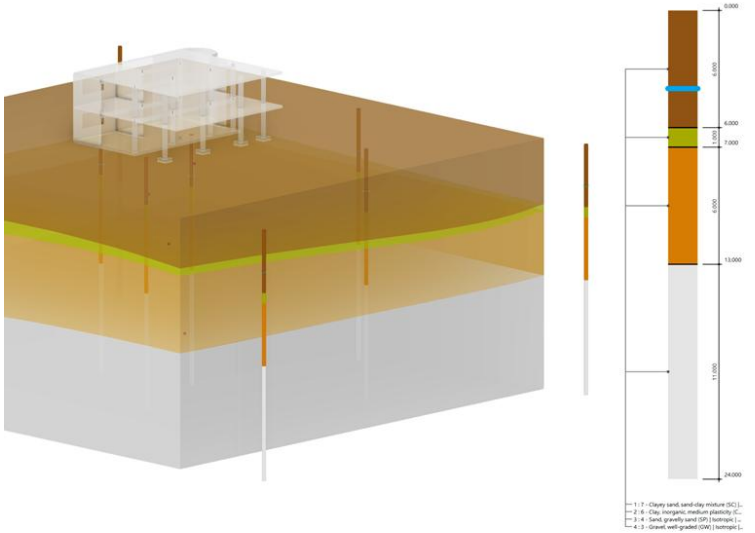
Content



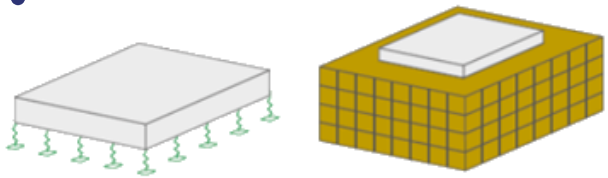
Webinar

Geotechnical Analysis Add-on Overview

- Realistically analyze soil-structure interaction
- Direct input of soil boring logs to generate 3D soil solid
- Consideration of groundwater level
- Nonlinear soil material models available
- Integration with the structure for full soil-structure interaction
- Determine settlement, soil stresses, etc.

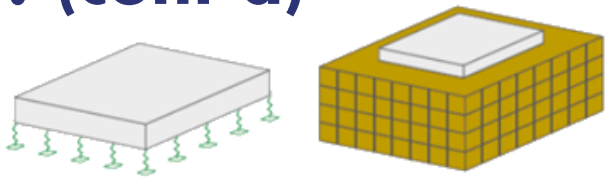


Why Geotechnical Analysis add-on?



- Realistic Soil-Structure Interaction
  - Captures load distribution, lateral pressures, and shear interaction in all directions – beyond just vertical support
- Nonlinear & Layered Soil Behavior
  - Account for stress-dependent stiffness, plastic deformation, and layered soil profiles for accuracy
- Accurate Settlement & Deformation Predictions
  - Captures differential settlement, lateral spreading, and localized failure more effectively

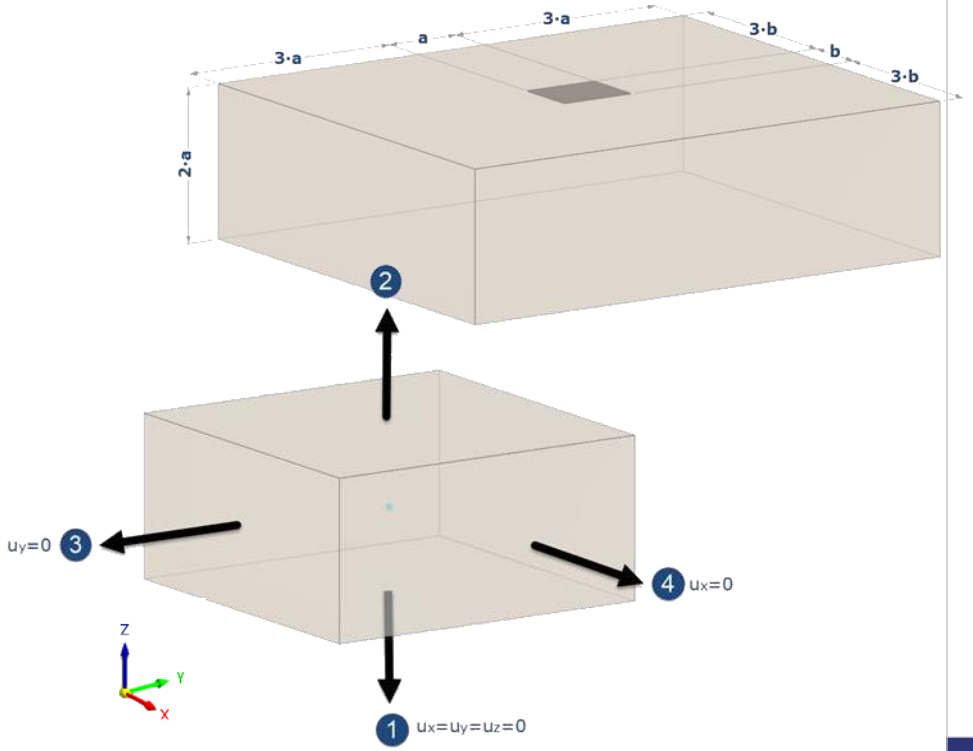
Why Geotechnical Analysis add-on? (cont'd)



- Advanced Soil Material Models
  - Supports Modified Mohr-Coulomb, Modified Hardening Soil, Hoek-Brown, and Nonlinear Elastic models
- Coupled Soil-Structure Analysis
  - Analyzes foundation and soil behavior together, accounting for realistic load redistribution
- Better for Complex Geotechnical Scenarios
  - Ideal for deep foundations, excavations, and variable soil conditions where surface springs fall short

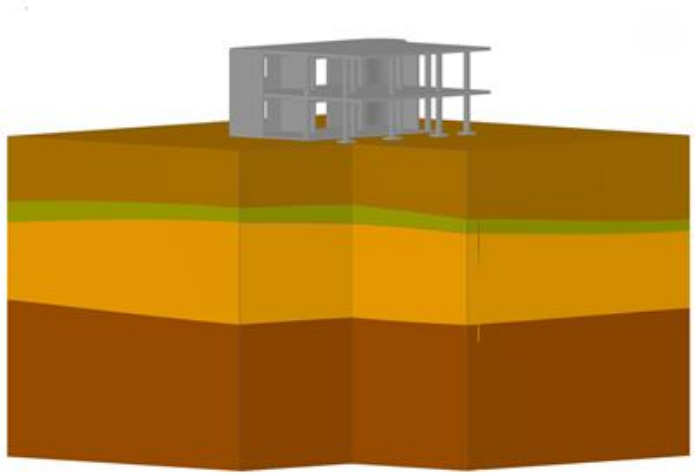
Geotechnical Analysis Modeling Tips

- Soil solid dimensions are adequately defined when compared to the structure dimensions
- Edge distance result study should be carried out (i.e., <10% change in stress at boundary surface)
- Ensure proper soil layer definitions (i.e., soil stiffness increases with depth)
- Default boundary conditions defined but editable



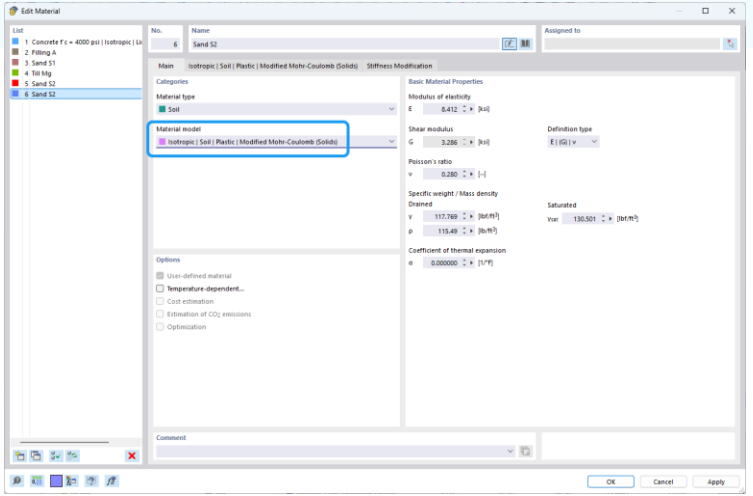
Nonlinear Solid Soil Material Models

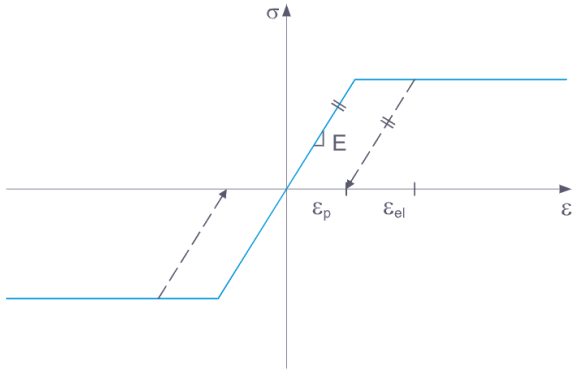
- Soil is a highly nonlinear three-part system including soil particles, water, and air
- Utilize special material models that mathematically represent soil behavior
- Currently, four material models available in RFEM:
  - Modified Mohr-Coulomb
  - Nonlinear Elastic
  - Modified Hardening Soil
  - Hoek-Brown



Modified Mohr-Coulomb

- Combines linear-elastic and ideal plastic behavior
- Reversible linear elastic behavior within a stress limit zone
- When stress reaches yield point, irreversible plastic behavior begins acc. to Mohr-Coulomb rule
- Material fails when shear stress exceed material's shear resistance
- Actual soil behavior approximation with few material property definitions

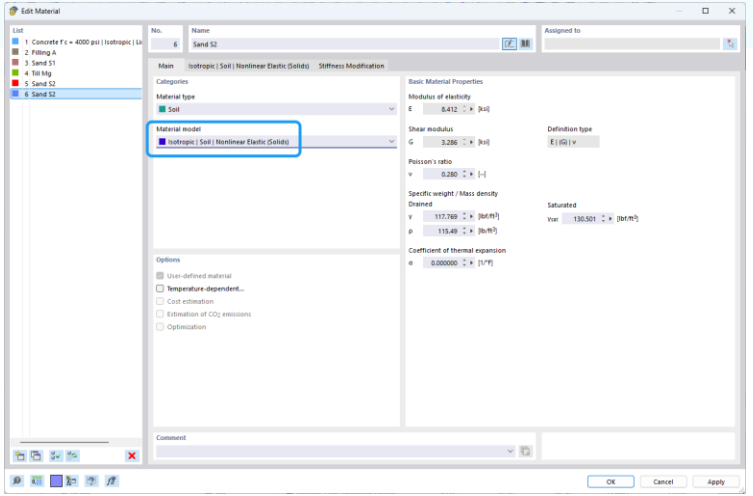


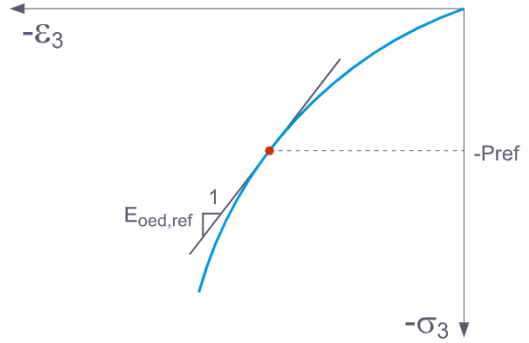


Linear-Elastic Ideal-Plastic Stress-Strain Relationship

Nonlinear Elastic

- Hyperbolic, nonlinear elastic behavior
- Nonlinear stress-strain curve w/ no plastic deformation (reversible deformations)
- Stress dependent stiffness (higher stress → high stiffness)
- Stiffness is load-path dependent w/ unloading/reloading stiffness higher than initial loading
- Does not simulate plasticity or material failure
- Soil behavior under vertical loading and minimal horizontal displacement

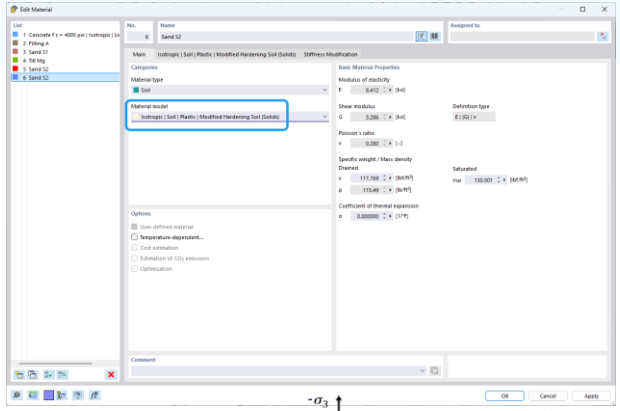


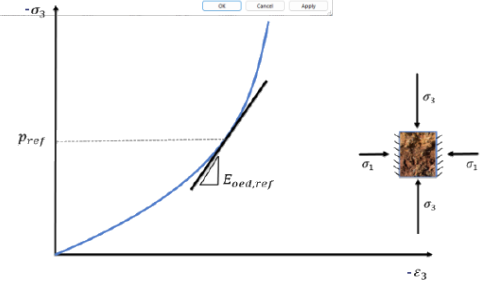


Nonlinear Elastic Stress-Strain Relationship

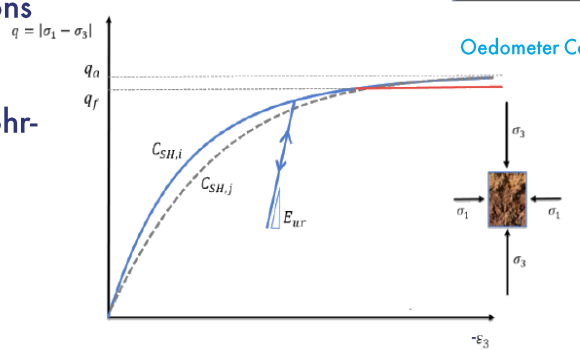
Modified Hardening Soil

- Advanced elasto-plastic soil model for nonlinear soil behavior
- Elastic behavior soil stiffness varies w/ stress level for oedometer and triaxial stress-strain responses
- When stress reaches yield point, elasto-plastic with double hardening behavior begins
- Stress-dependent stiffness w/ increased stiffness with higher stresses (deeper soil levels resist deformations better)
- More realistic predictions compared to simpler Mohr-Coulomb model
- Ideal for soft and over-consolidated soils





Oedometer Conditions - Stress-Strain Relationship

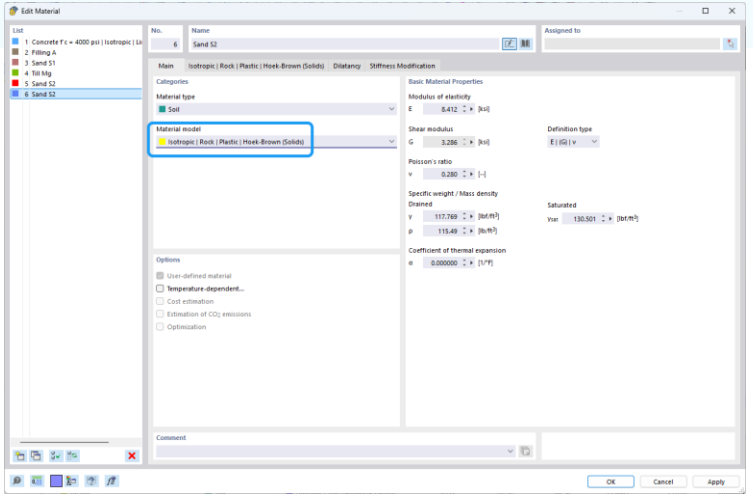


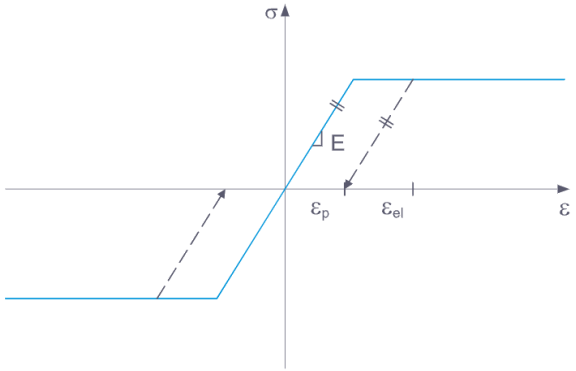
Triaxial Conditions - Stress-Strain Relationship

Webinar

Hoek-Brown

- Combines linear-elastic and ideal plastic behavior specific to rock masses
- Reversible linear elastic behavior within a stress limit zone
- When stress reaches yield point, irreversible plastic behavior begins acc. to Hoek-Brown rule
- Relates max and min principal stresses capturing nonlinear behavior of rock
- Ideal for modeling jointed rock masses where strength decreases due to fractures

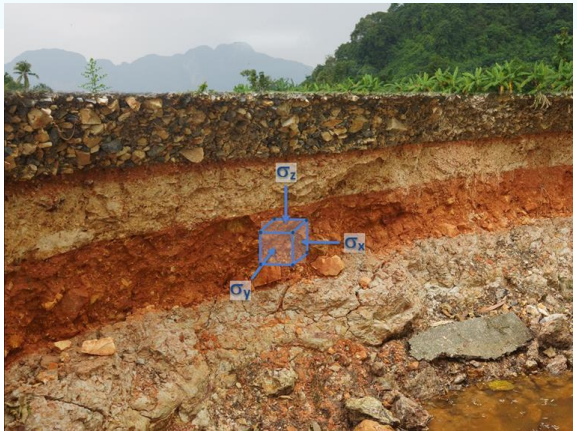


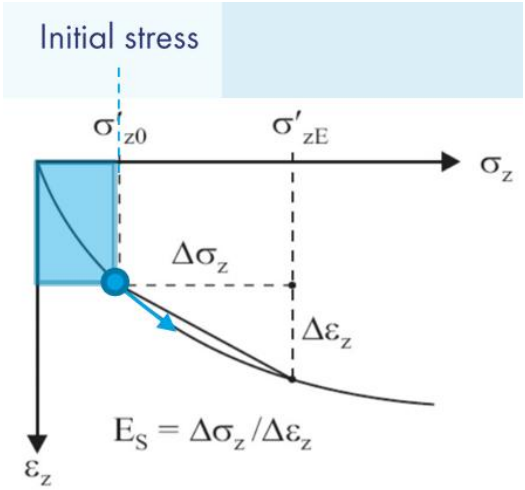


Linear-Elastic Ideal-Plastic Stress-Strain Relationship

Initial State Considerations

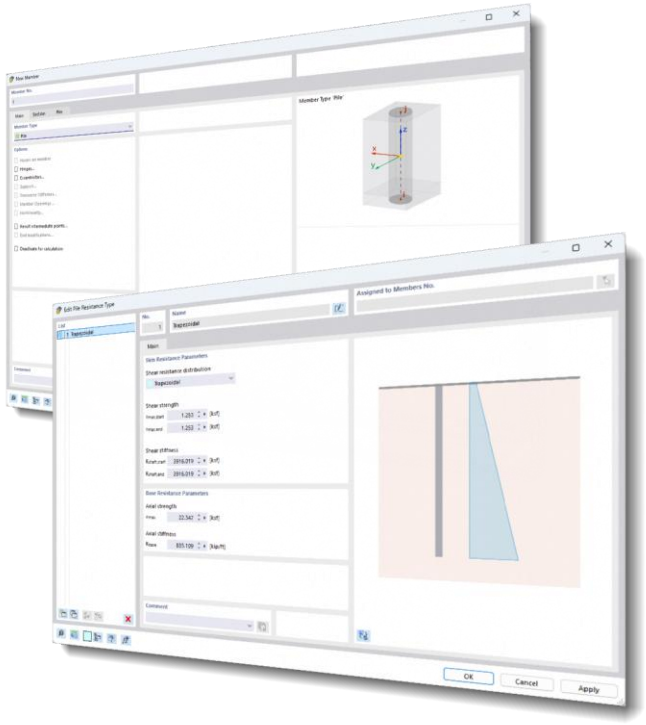
- Consider the soil self-weight before construction begins
- Calculate soil self-weight analysis in the initial load case
- The starting point will reflect the soil's initial stress state and stiffness
- Focus on deformation resulting from new loading, rather than the initial deformation
- Enable LC "Equilibrium for Undeformed Structure"





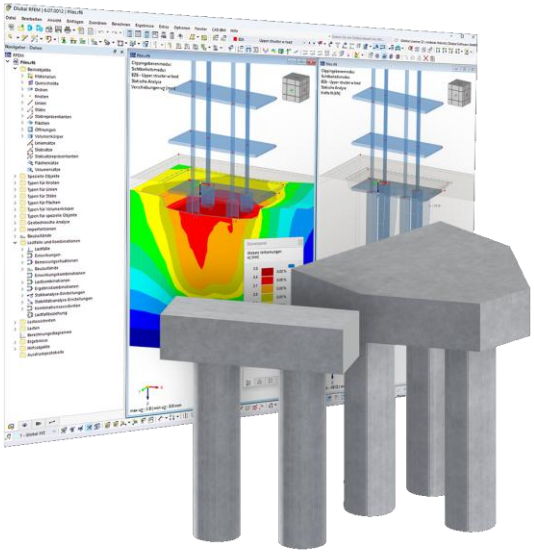
Pile Design Requirements

- **New Member Type:** "Pile"
- **Required Add-On:** Construction Stages Analysis (CSA) for calculation
- **Nonlinear Material Model:** Select either "Modified Mohr-Coulomb" or "Modified Hardening Soil"
- **Pile Integration:** Pile member line is integrated into solid independently (solid is the primary component, pile is secondary)
- **FE Mesh Length for Soil Solids:** Approximate to pile diameter
- **Pile Result Element Length:** Corresponds to the size of the 3D soil element (Mesh Settings – Number of divisions for special members)



Geotechnical Analysis add-on Future Developments

- Additional soil material models
  - Cam Clay Model – Used to represent clay soils including soil behavior under different loading conditions
  - Jointed Rock Model – Used to represent rock materials with jointed or fractured characteristics
- 2D| Constrained Modulus Method
  - Surface support conditions (elastic spring coefficients) determined from soil properties
  - Calculated according to a non-linear iterative method
  - Simplified method compared to 3D soil solid



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