

# Phase<sup>2</sup> 7.0

Excavation & Support Design Software

**rocs**science software tools for rock and soil

*Phase<sup>2</sup> 7.0 is an extremely versatile 2D elasto-plastic finite element stress analysis program for designing underground or surface excavations and their support systems. Phase<sup>2</sup> 7.0 can be used for rock or soil applications and includes finite element slope stability and groundwater seepage analysis.*

## Modeling

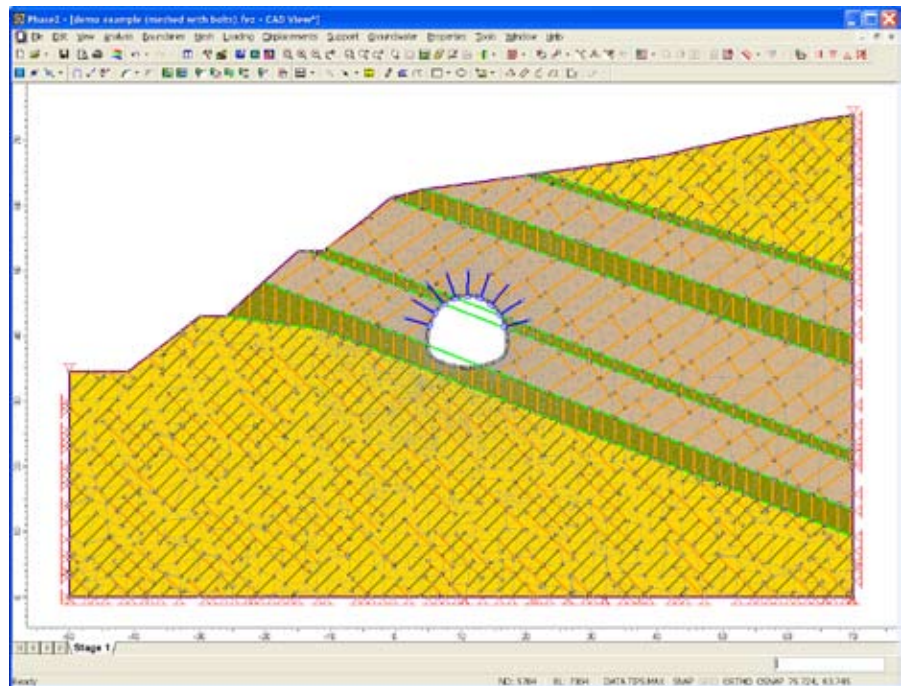
Phase<sup>2</sup> 7.0 provides material models for rock and soil including Mohr-Coulomb, Generalized Hoek-Brown and Cam-Clay. Complex multi-stage excavations can be easily created and edited using state-of-the-art CAD tools. Groundwater pore pressure can be determined using steady state finite element seepage analysis – flows, pressures and gradients are calculated based on user defined hydraulic boundary conditions.

## Support Design

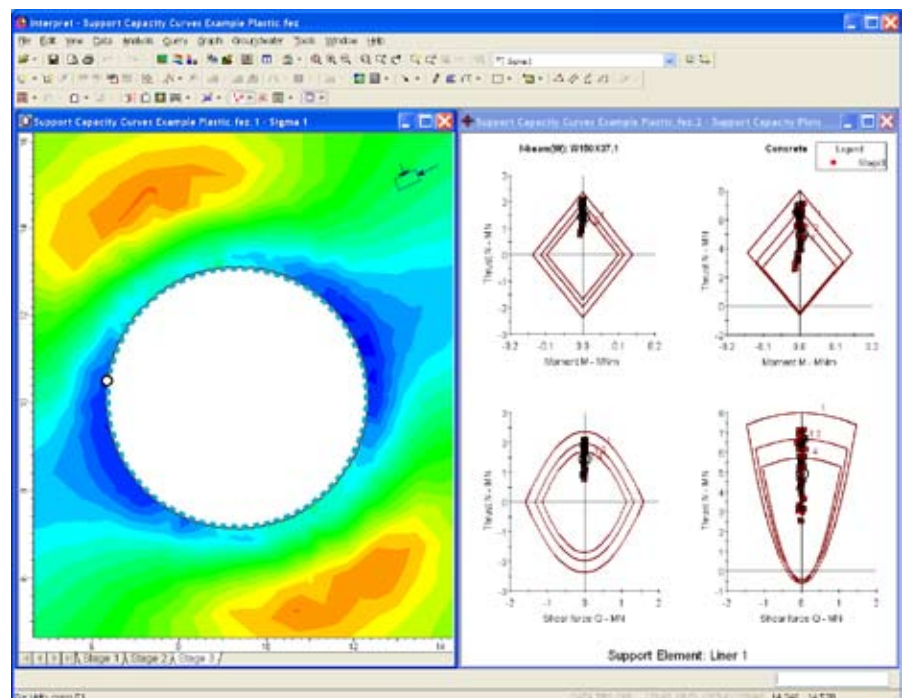
Phase<sup>2</sup> 7.0 offers a wide range of support modeling options. Bolt types include end anchored, fully bonded, cable bolts, split sets and grouted tiebacks. Liner elements can be applied in the modeling of shotcrete, concrete, steel set systems, retaining walls, piles, multi-layer composite liners, geotextiles and more. New liner design tools include support capacity plots which allow you to determine the safety factor of reinforced liners.

## FE Slope Stability

One of the major features of Phase<sup>2</sup> is finite element slope stability analysis using the shear strength reduction method. This option is fully automated and can be used with either Mohr-Coulomb or Hoek-Brown strength parameters. The analysis parameters can be customized if required. Slope models can be imported from Slide and computed in Phase<sup>2</sup> allowing easy comparison of limit equilibrium and finite element results.



*Tunnel supported by rock bolts, excavated below slope. Network of bedding and cross-joints automatically created with the joint network option.*



Support capacity plots for reinforced liner around circular tunnel. Envelopes represent thrust-moment and thrust-shear capacity for different values of safety factor.

### Modeling

- interactive geometry entry
- boundaries – external, material, excavation, stage, joint, piezo, structural interface
- grid/vertex/object snapping
- sequential staging of excavation and support (up to 300 stages)
- plane strain or axisymmetric analysis
- one-click material assignment
- import/export in DXF format
- unlimited undo/redo
- right-click editing shortcuts

### Elements & Meshing

- triangular or quadrilateral finite elements
- 3 or 6-noded triangles
- 4 or 8-noded quadrilaterals
- one-click mesh generation
- graded, uniform or radial meshing
- mapped meshing
- custom meshing
- check/define mesh quality
- easily apply boundary conditions
- infinite elements

### Materials

- elastic or non-linear
- strength criteria – Mohr-Coulomb, Generalized Hoek-Brown, Cam-Clay, Modified Cam-Clay, Drucker-Prager
- staged material properties
- datum dependent properties
- isotropic, transversely isotropic, orthotropic elastic models
- import from RocLab/RocData

### Groundwater

- finite element seepage analysis (saturated/unsaturated, steady-state flow)
- staged groundwater
- define discharge sections
- include pore pressure for effective stress analysis
- piezometric lines

- pore pressure grids (total head, pressure head, pore pressure)

### Support

- staged support installation
- bolt types – end anchored, fully bonded, cable bolts, Swellex, split-set, tiebacks
- define bolt patterns
- liner types – beam, reinforced concrete, geotextile, cable truss
- composite liners
- reinforcement database
- Timoshenko or Bernoulli beam models
- staged liner properties
- elastic or non-linear
- peak/residual strength
- interactive support capacity plots (thrust/moment, thrust/shear) for reinforced concrete liners

### Far-field Stress

- constant stress field
- gravity stress field
- multiple stress fields (customize per material)
- load split at any stage, load split per material

### Loads

- constant or linear distributed loads
- concentrated load
- seismic load
- ponded water load
- staged loading
- springs

### Joints

- elastic or non-linear
- Mohr-Coulomb, Barton-Bandis or Hyperbolic slip criterion
- natural or artificial joints
- pressurized joints
- staged joint properties
- statistical modeling of joint networks

### Finite Element Slope Stability

- automated FE slope stability using shear strength reduction method
- import/export *Slide* models

### Data Interpretation

- view stress, displacement, strength factor contours
- effective stress, pore pressure contours
- contour user-defined data
- stress/failure trajectories, deformation vectors
- display deformations to user-defined scale
- query and graph material, support, joint data
- export to Excel
- show values directly on model
- highlight yielded material, support, joint elements
- add iso-contours
- data tips for any object
- ubiquitous joints
- annotation and dimensioning tool kit
- save display options, drawings, annotations
- export image/movie files

### Price & Licensing

*Phase<sup>2</sup>* 7.0 is sold as a single license, which is purchased outright, for \$3495 US (\$4195 CDN).

Network licenses are also available; they are sold as a yearly subscription, with price based on the number of concurrent users. Please contact [software@rocscience.com](mailto:software@rocscience.com) for more information.

[www.rocscience.com](http://www.rocscience.com)