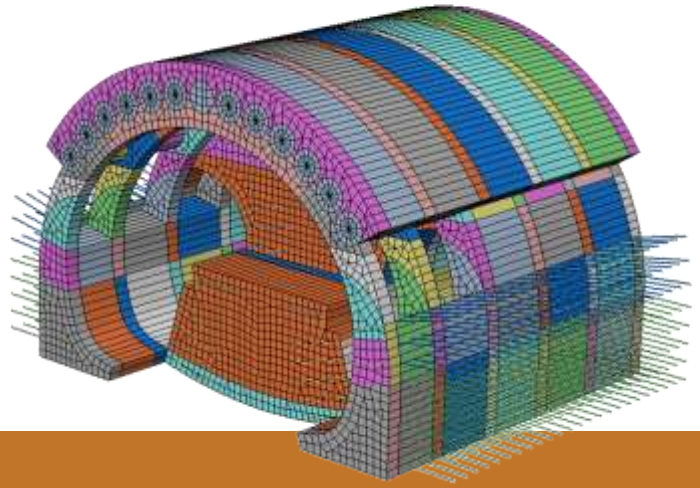


Geotechnical & Tunnel analysis System

midas GTS

MIDAS per l'Italia

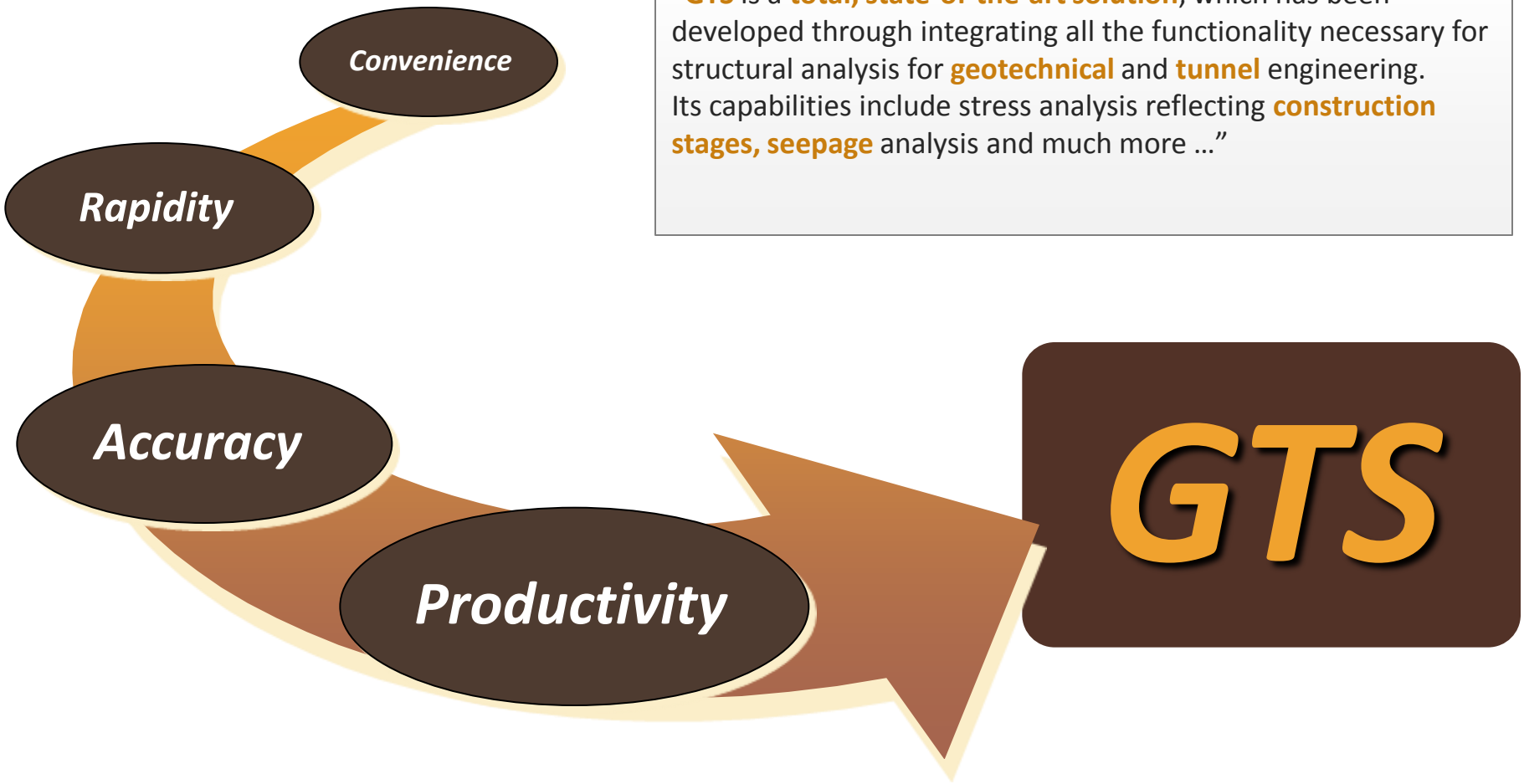
CSPFea s.c.

www.cspfea.net

www.csp-academy.net

www.structural-modeling.it

Overview



"**GTS** is a **total, state-of-the-art solution**, which has been developed through integrating all the functionality necessary for structural analysis for **geotechnical** and **tunnel** engineering. Its capabilities include stress analysis reflecting **construction stages, seepage** analysis and much more …"

MIDAS/FX+
(CAE Pre/Post-processor)
"Geometry & Mesh Modeling"

MIDAS/Civil
(Civil Structural Analysis System)
"Finite Element Analysis"

midas GTS

"Integrated Solution for Geotechnical & Tunnel Analysis"

- Multi-discipline Analysis (Structural, Seepage, …)
- Construction Stage
- Fast & Accurate Solver
- Geometry Modeling
- Auto-mesh Generation
- Huge Model Manipulation
- Realistic Visualization
- Report Generation
- …

Tunnel Analysis in Conjunction with Highly Complex Inter-connections

- Reflection of complex soil strata and terrain
- Tunnel exits, T-shape/y-shape connected parts, steep slopes, vertical & transverse shafts - main tunnel connections, etc.

Groundwater Seepage Analysis

- Steady-state/Transient Flow analysis for tunnels, dams, slopes, etc.
- Expanded applications from saturated zones to unsaturated zones using the Darcy's principle
- Application of unsaturated properties by user-defined curves in addition to van Genuchten and Gardner's theoretical equations

Effective Stress Analysis with Stress-Seepage Coupling

- Final normal state or time history analysis by construction stages
- Effective stress analysis with coupled pore water pressure - stress obtained from seepage analysis

Analysis of Embankment on Soft Soil and Consolidation

- Analysis of embanking in undrained conditions
- Production of pore water pressures and consolidated settlements by time stages

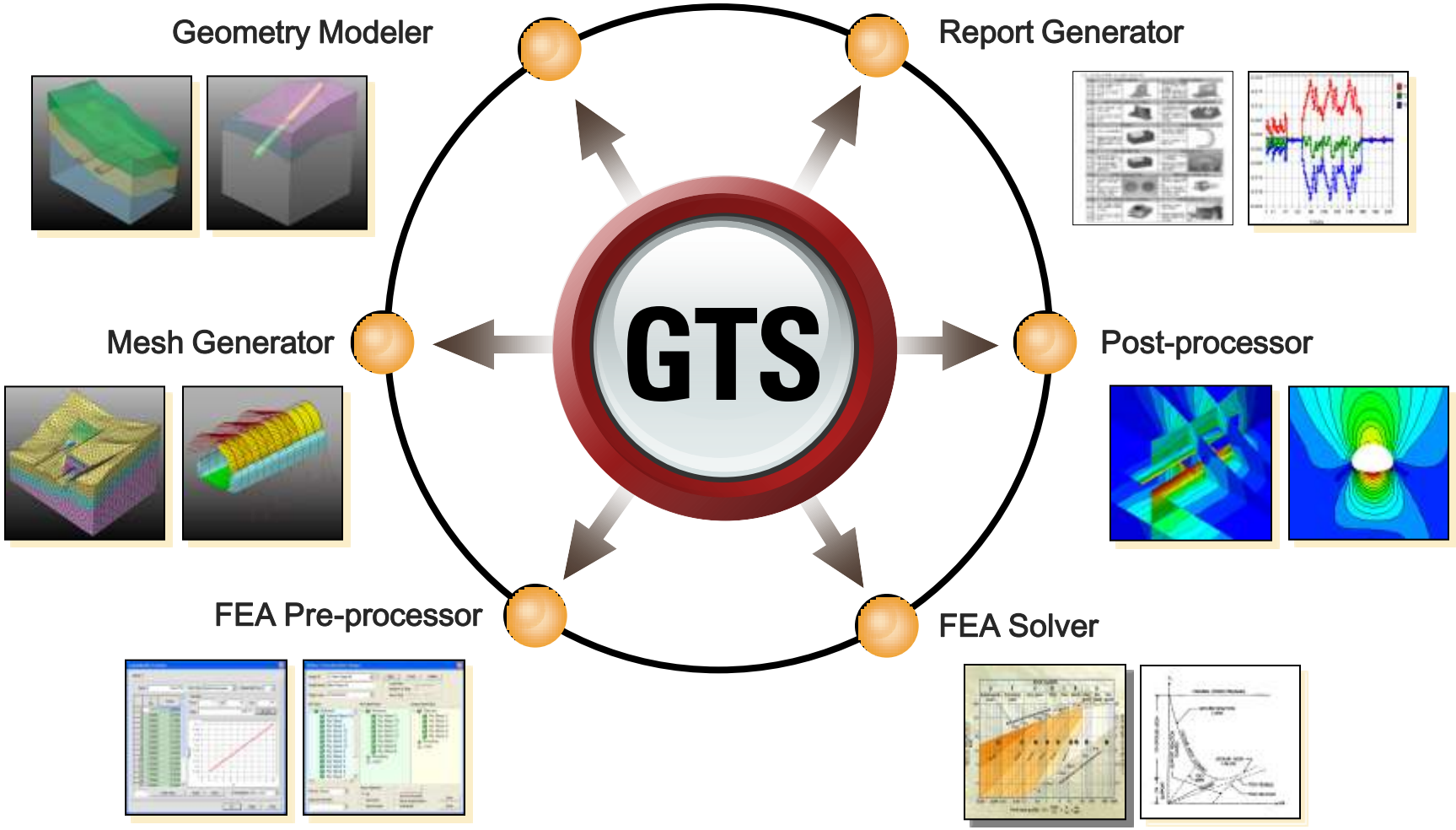
Analysis for Excavations and Temporary Structures

- Deep excavations for substructures of major structures (highrise buildings)
- Analysis for temporary structures reflecting existing structures such as subways

Earthquake, Blast and Vibration Analysis

- Various dynamic analyses for eigenvalues, response spectrums and time histories
- Built-in seismic wave database and auto-generation of seismic waves, and combination with the results of static analysis

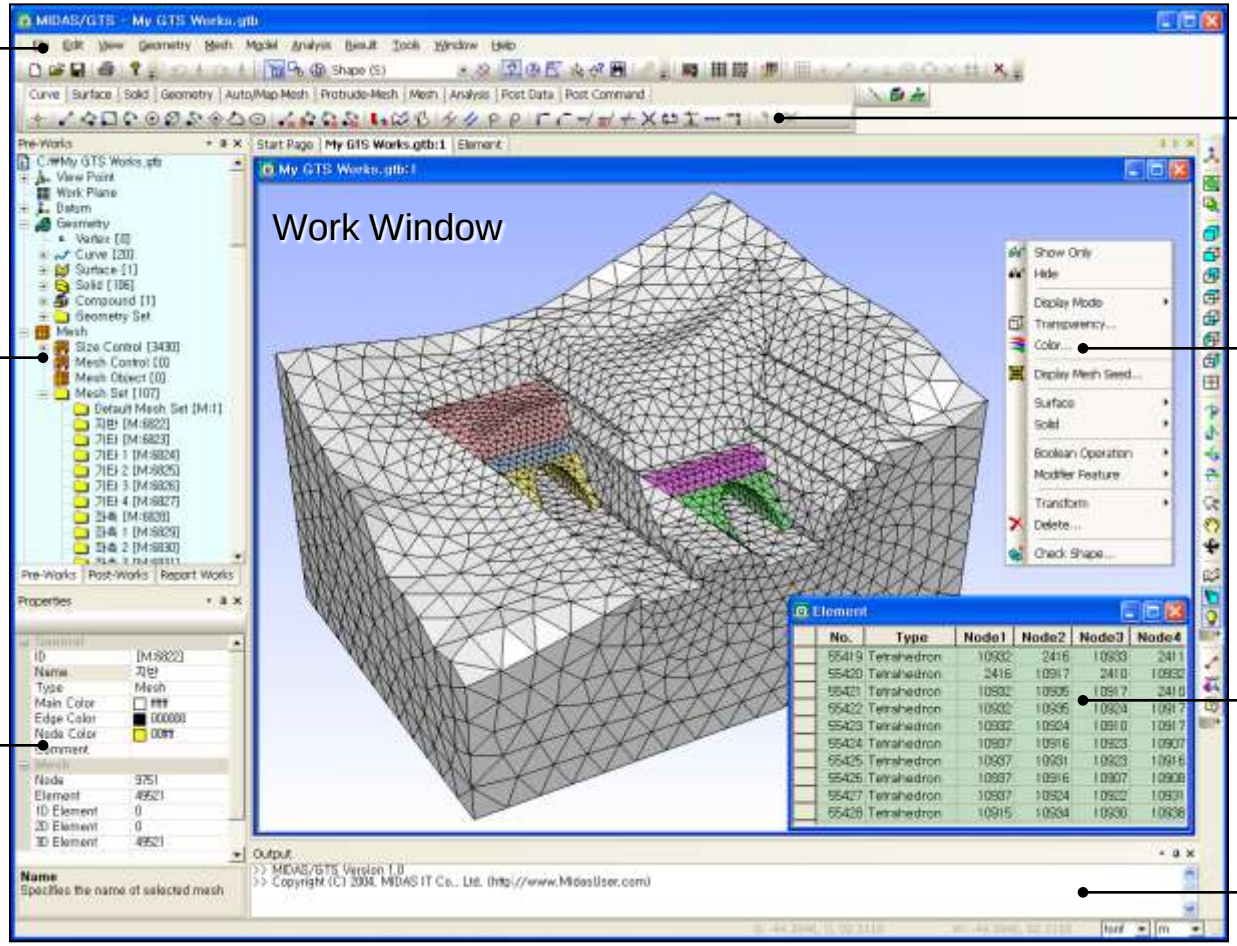
Lining Structural Analysis


Geometry Modeler
Report Generator
GTS
Mesh Generator
Post-processor
FEA Pre-processor
FEA Solver

Main Menu

Works Tree

Property Window



Tabbed Toolbar

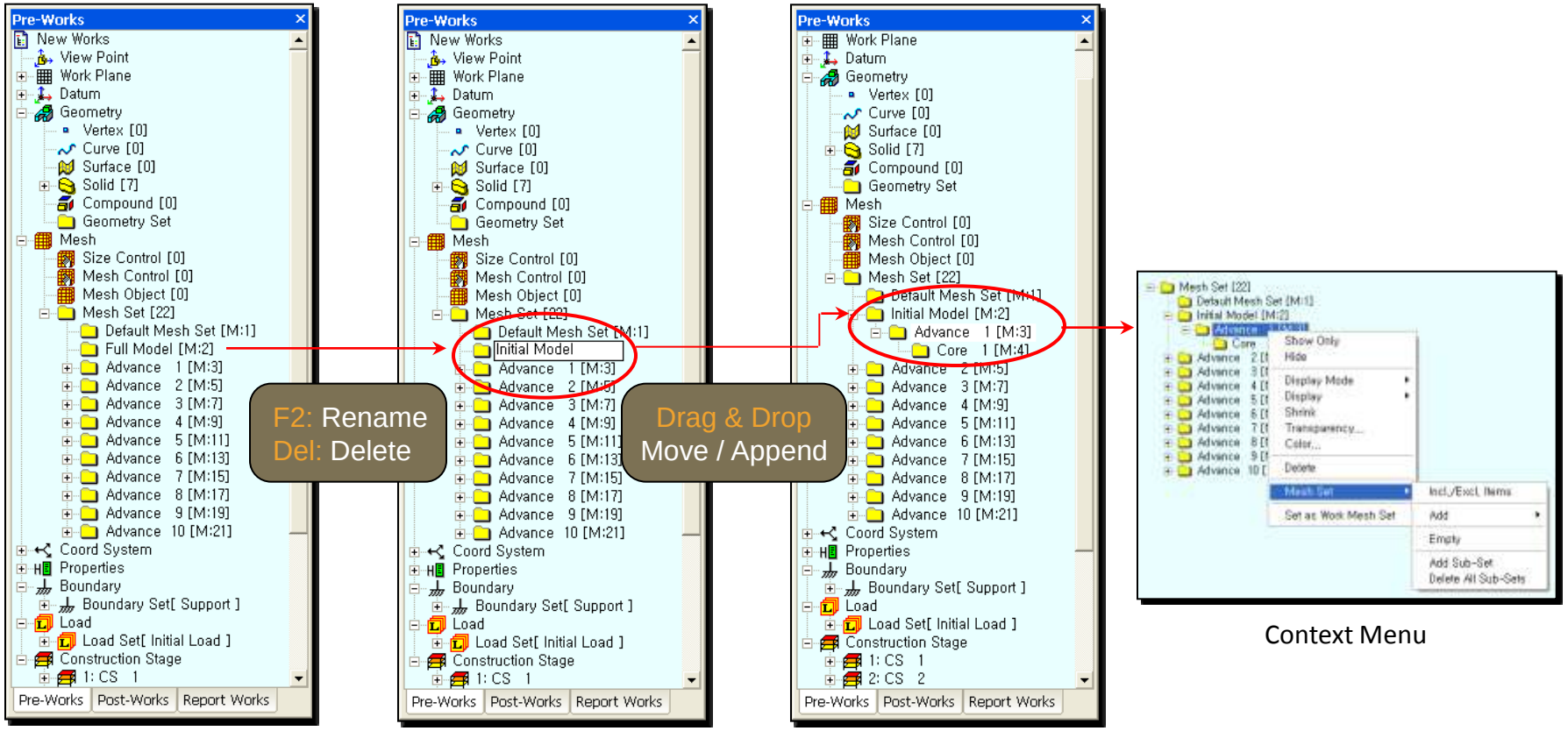
Context Menu

Table Window

Output Window

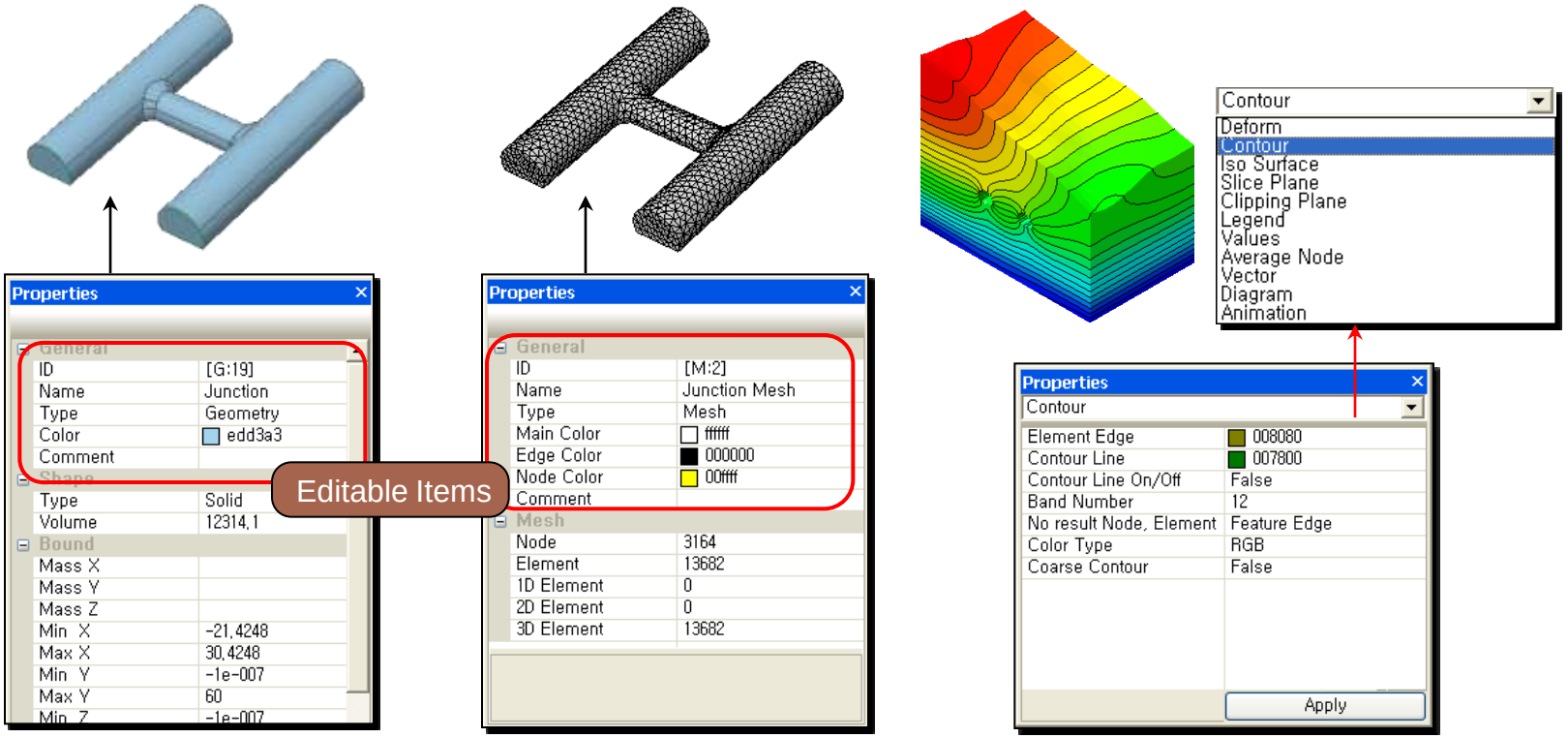
Developed based on Task-oriented Design Paradigm

- GTS' Works Tree displays geometry, mesh, analysis data and result data in a tree structure as Windows Explorer.
- Works Tree provides its own context menu and supports the convenient model management. Works Tree changes its form depending on the working mode.

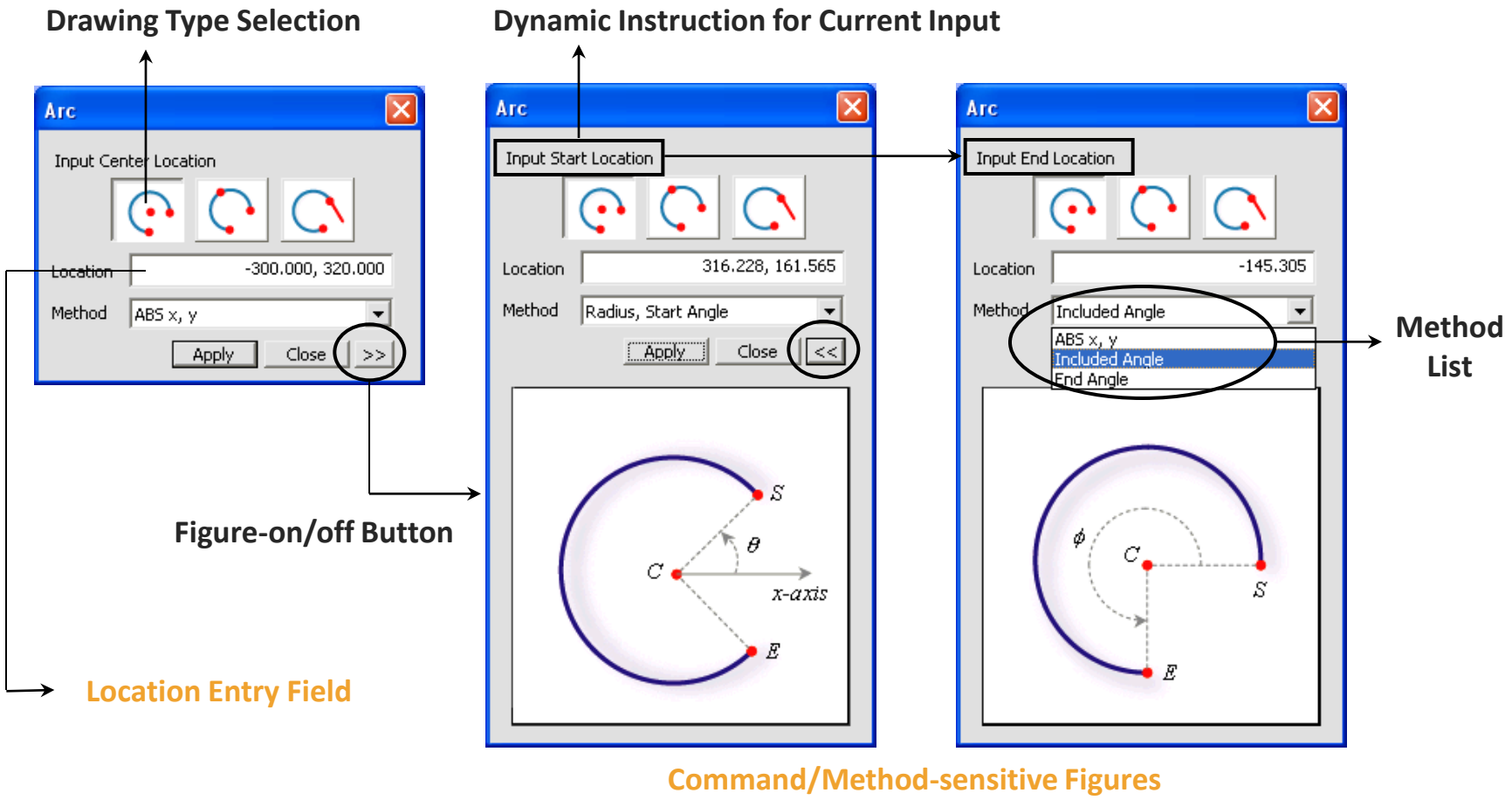


Context Menu

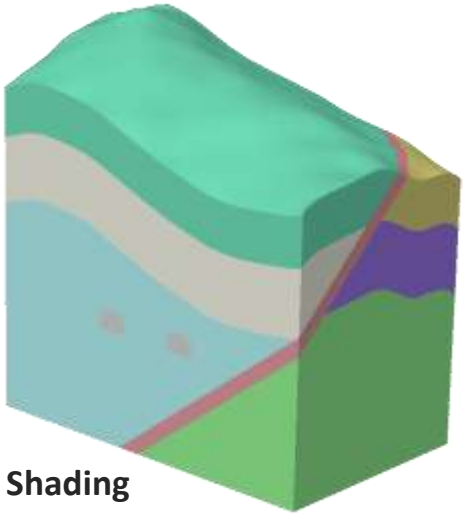
- GTS' **Property Window** provides various information of selected items and allows changing basic properties such as name, color, etc.
- In post-processing mode, Property Window is used as a control panel of the post-processing options.



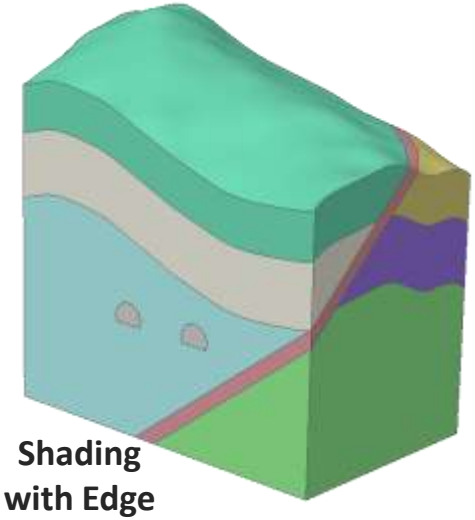
Information for Geometry | Information for Mesh | Post Control Panel



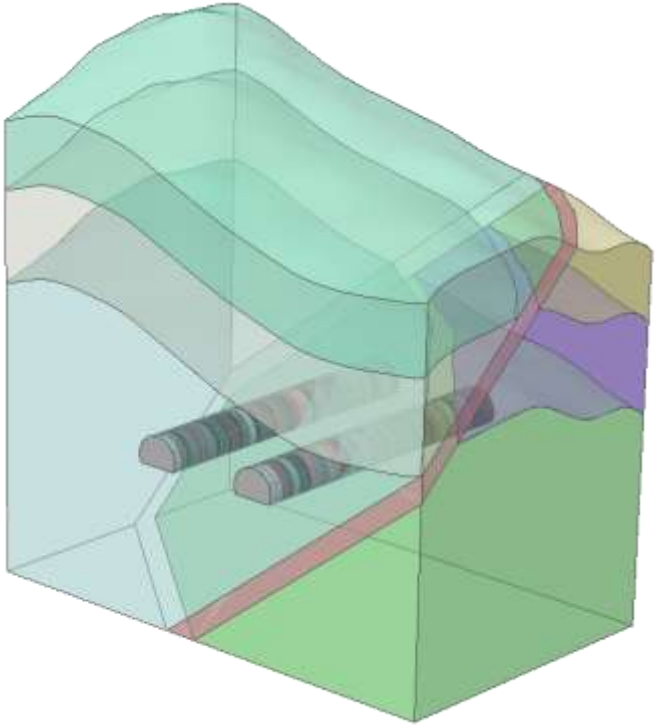
- Mouse Snap:
- Keyboard Input: Mathematical expressions can be used. <Ex> 100/2*sin(40)



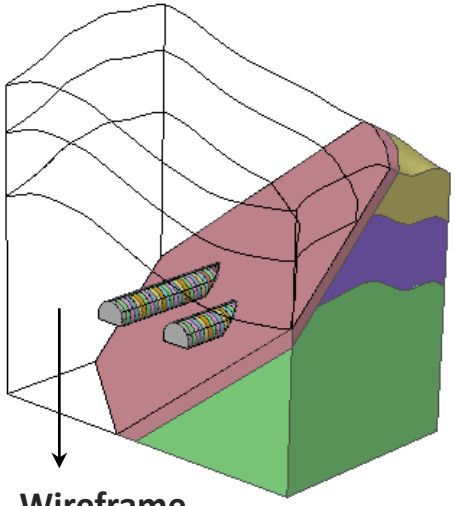
Shading



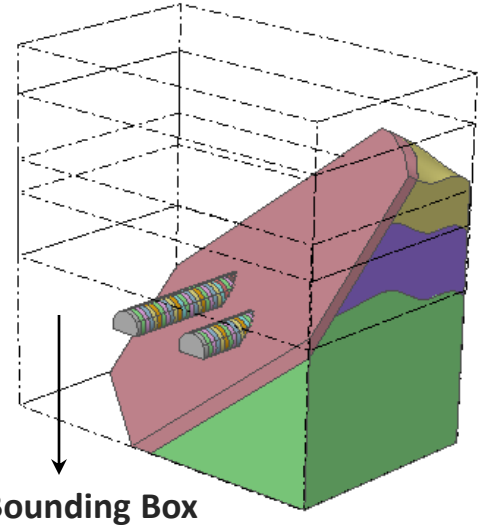
Shading
with Edge



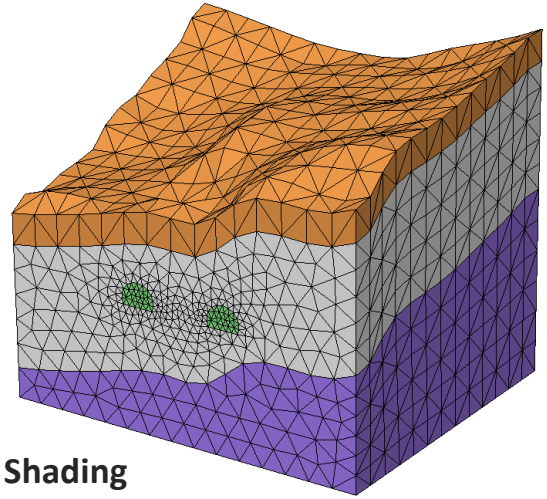
Shading with Edge + Transparency



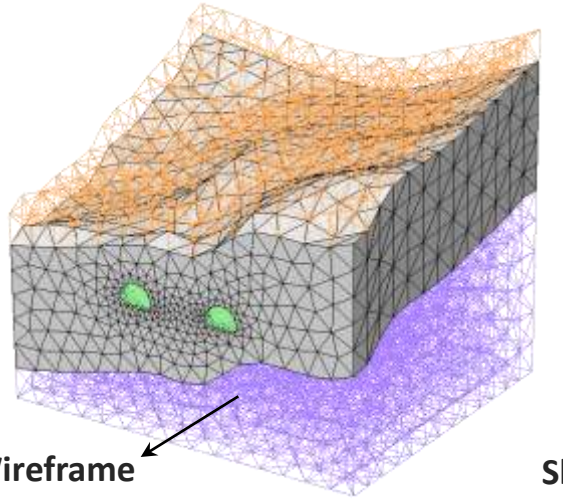
Wireframe



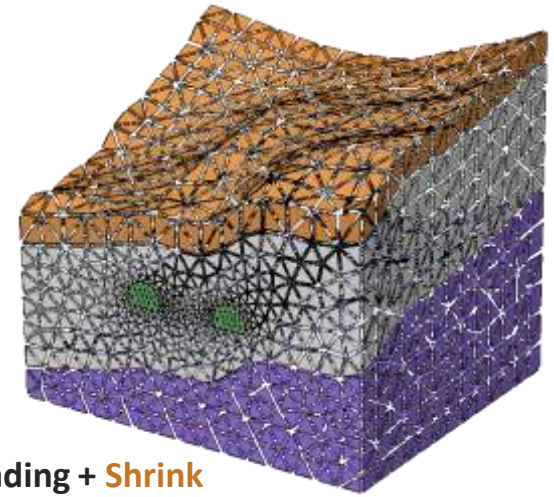
Bounding Box



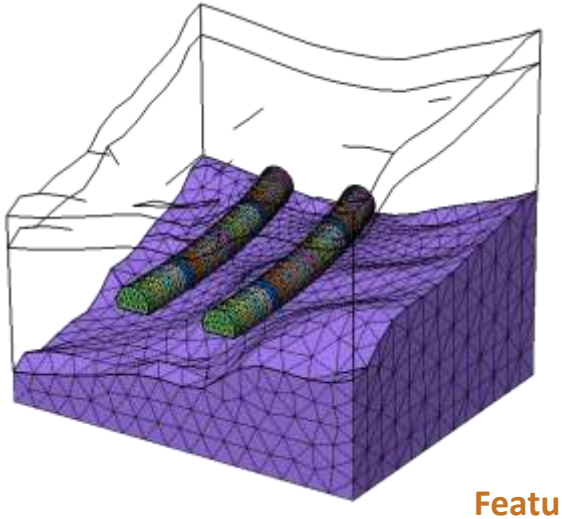
Shading

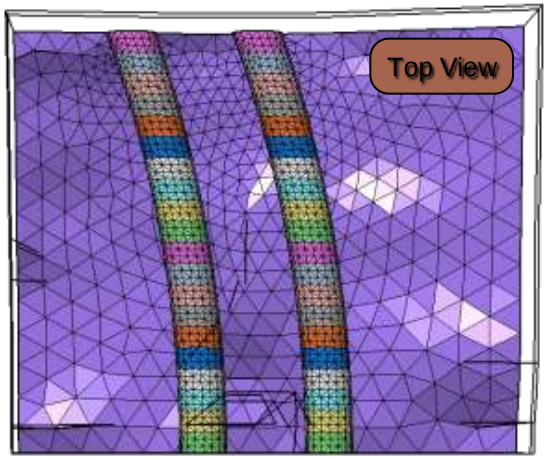


Wireframe

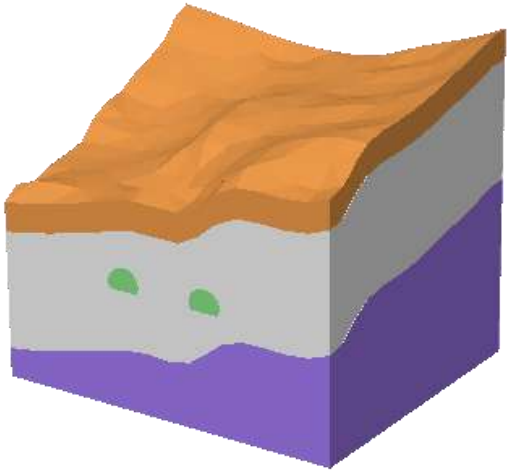


Shading + Shrink



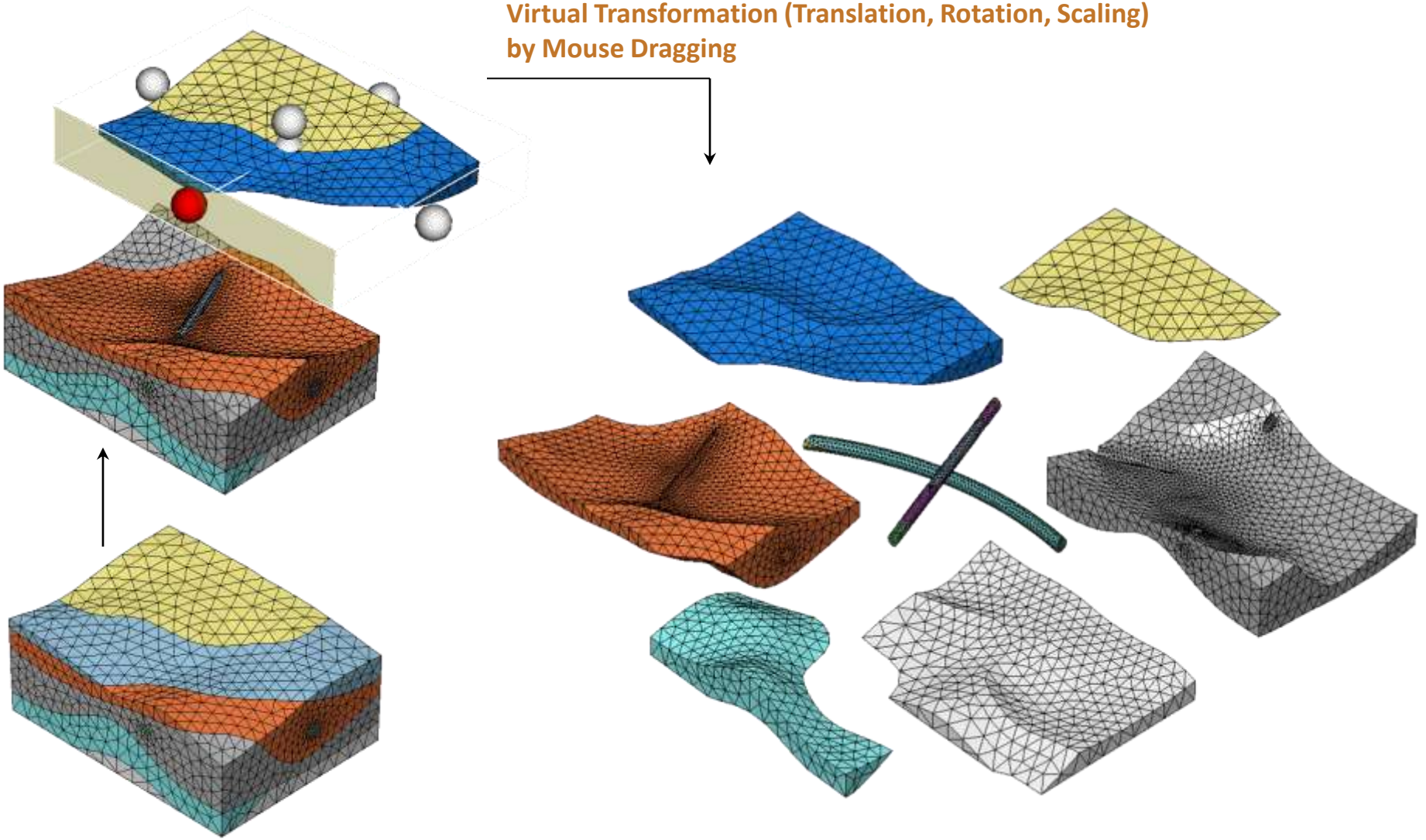


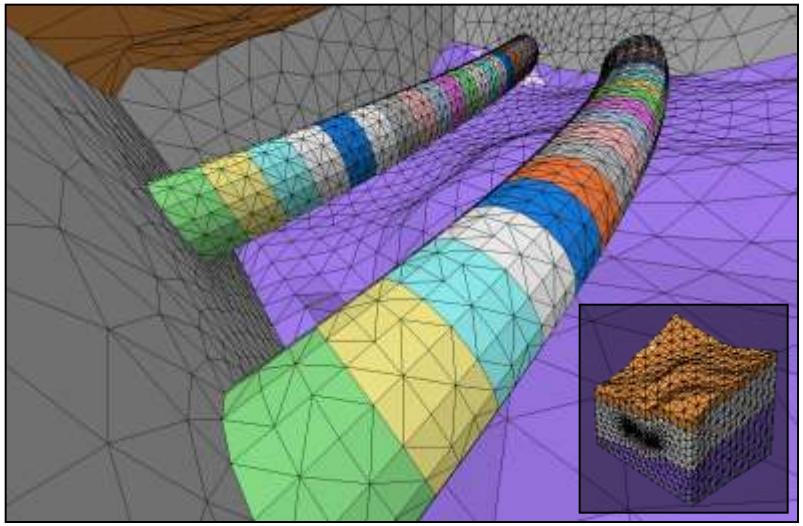
Feature Edge

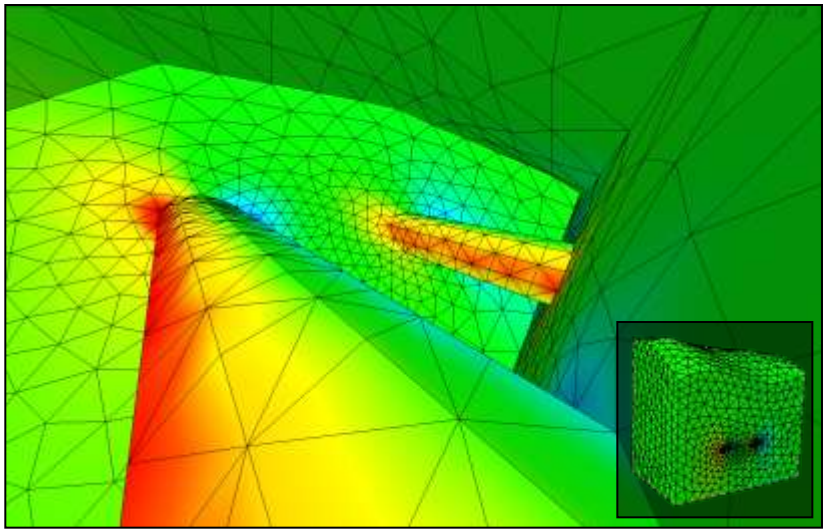


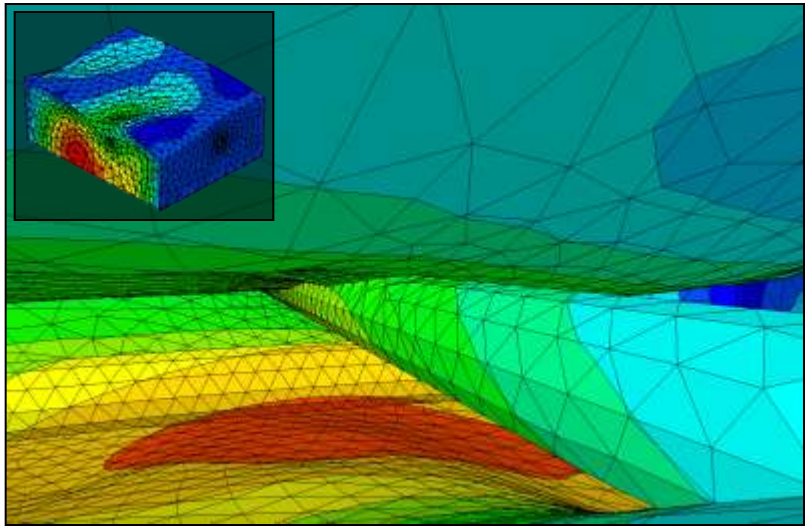
Shading + Hide Element Edge

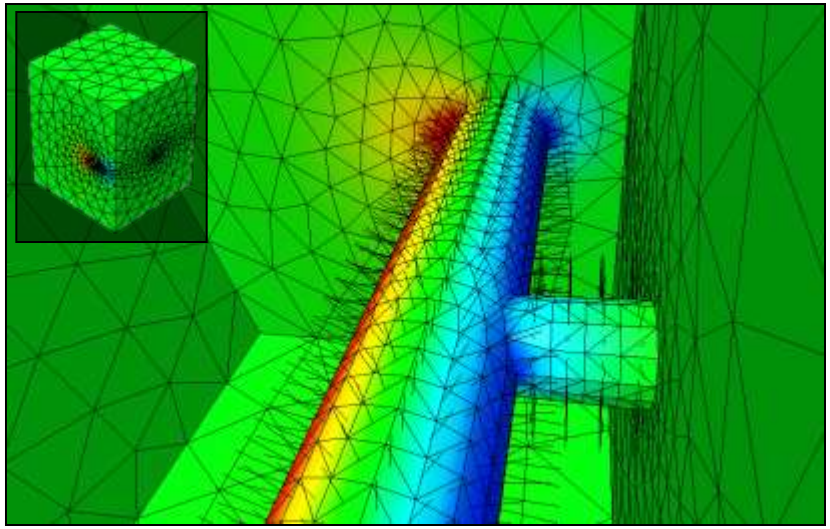
Virtual Transformation (Translation, Rotation, Scaling)
by Mouse Dragging

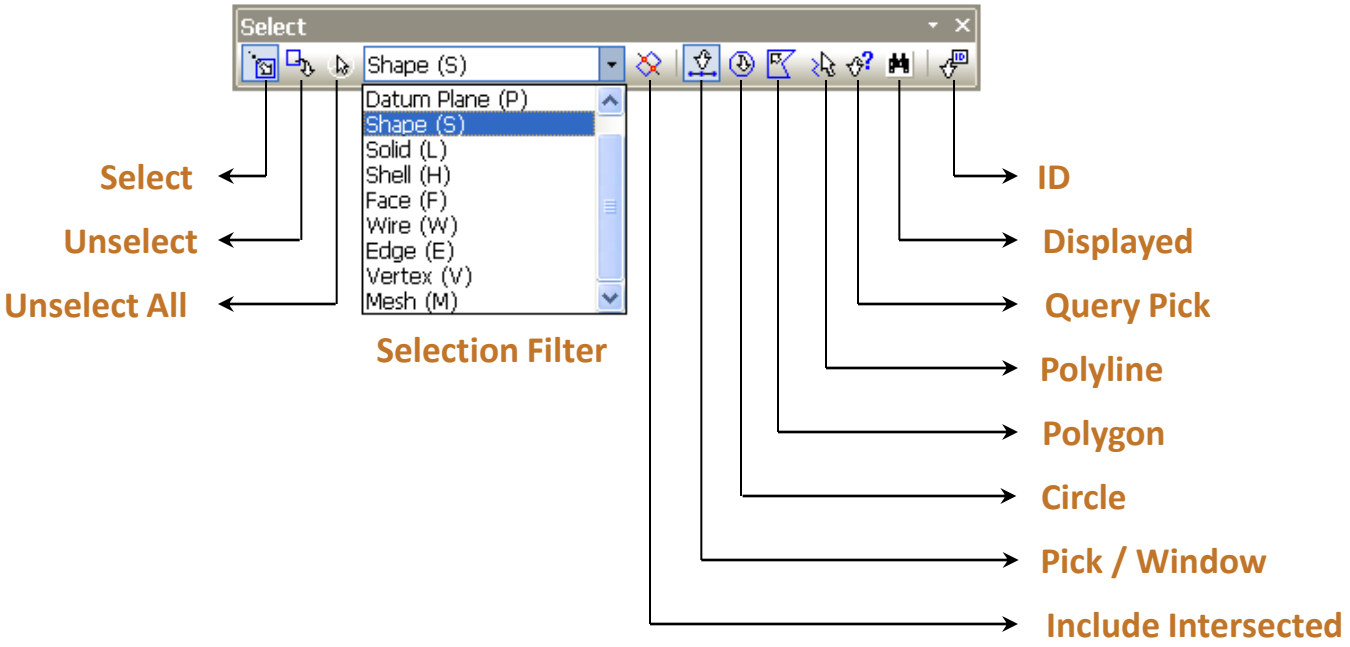


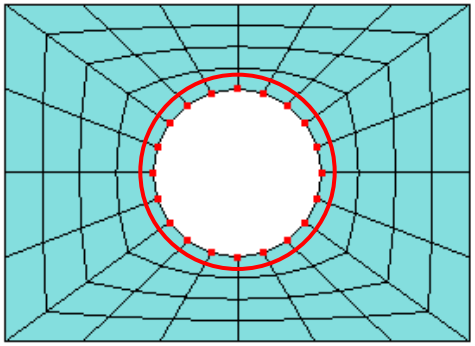




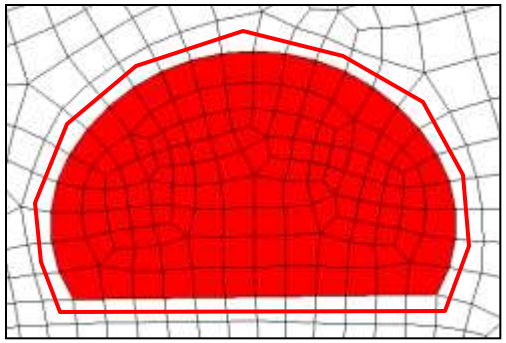




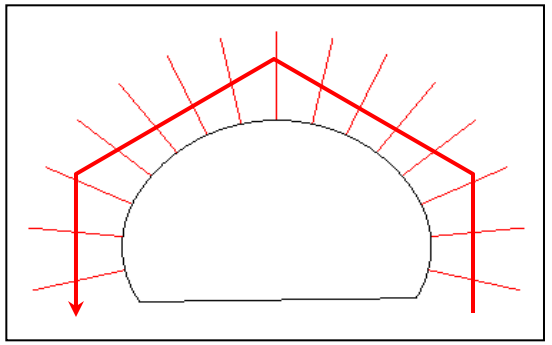




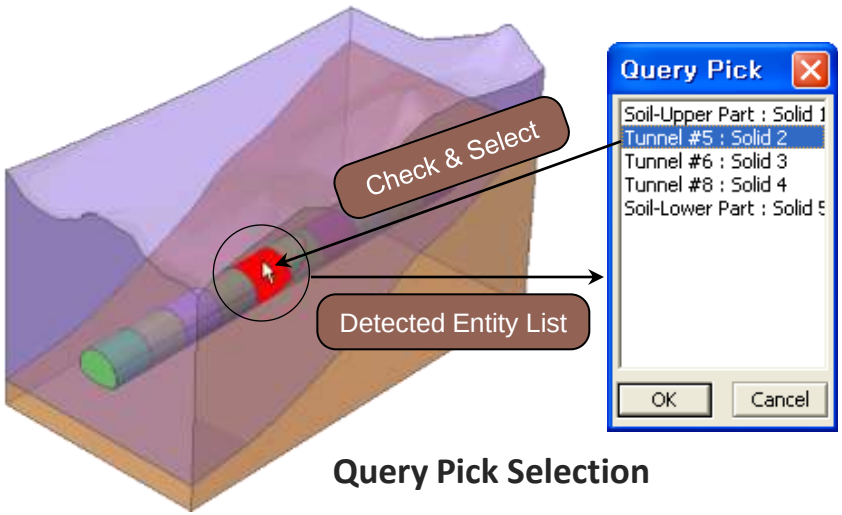
Circle Selection



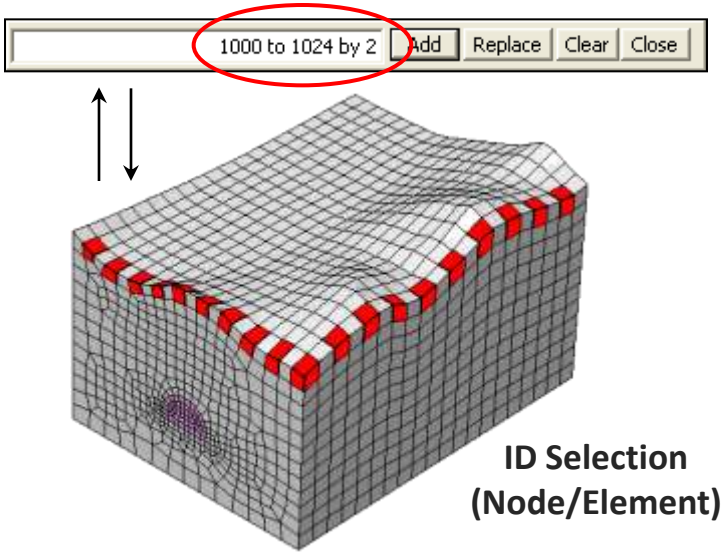
Polygon Selection



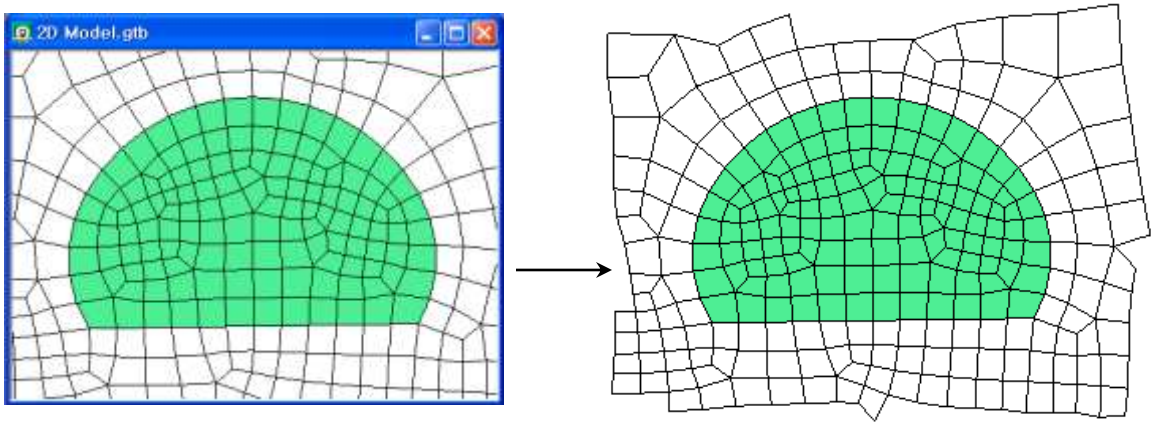
Polyline Selection



Query Pick Selection

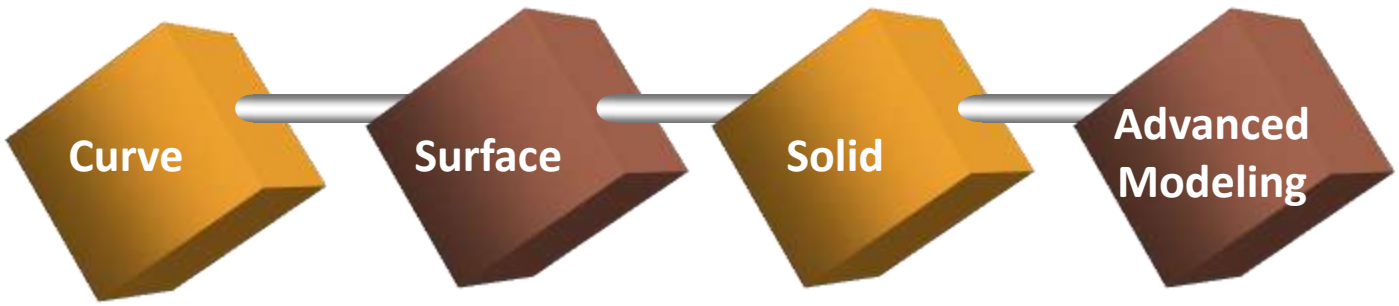


ID Selection (Node/Element)



Displayed Selection

Geometry Modeling



- Tunnel Section
- Line, Polyline
- Arc, Circle
- Polygon
- B-Spline
- Fillet, Chamfer
- Trim, Extend
- Intersect
- Offset, Tangent
- Break, Merge

…

- Plane Patch
- Coons Patch
- NURBS Patch
- Grid Patch
- Vertex Patch
- Fillet, Chamfer
- Sew, Fuse
- Trim, Divide
- Extend
- Imprint

…

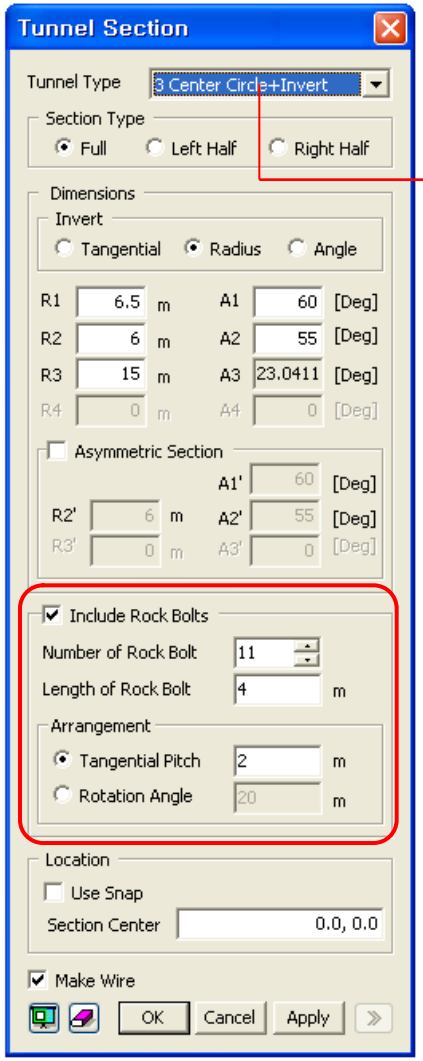
- Box, Wedge
- Cylinder, Cone
- Sphere, Torus
- Trim, Divide
- Embed
- Boolean Op. (Fuse, Cut, …)
- Stitch Surfaces

…

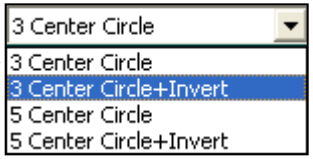
- Extrude
- Revolve
- Loft
- Sweep
- Fillet, Chamfer
- Offset, Draft
- Shelling
- Local Prism
- Check, Repair
- Transformation

…

- Advanced modeling functions can be used in surface & solid modeling.

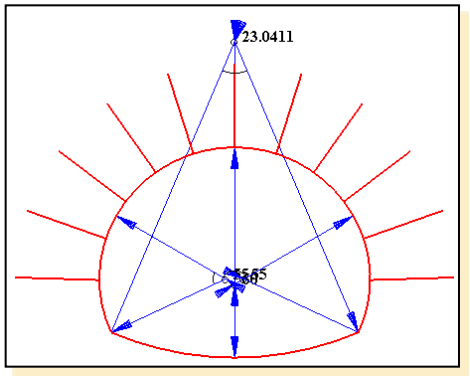


Tunnel Section



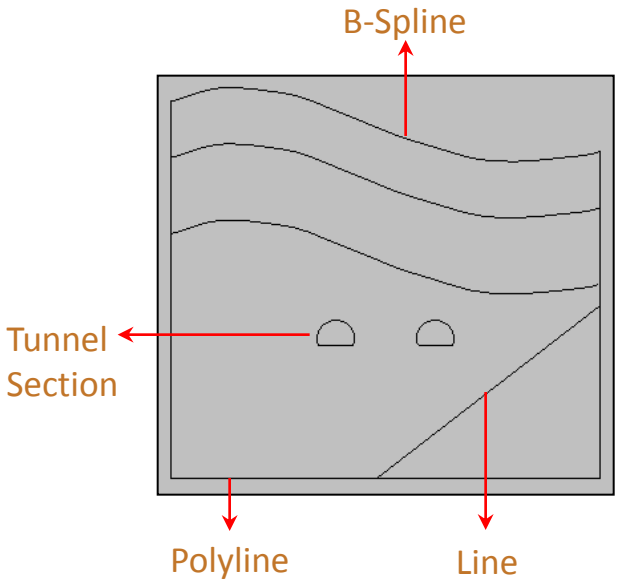
3C 3C+I

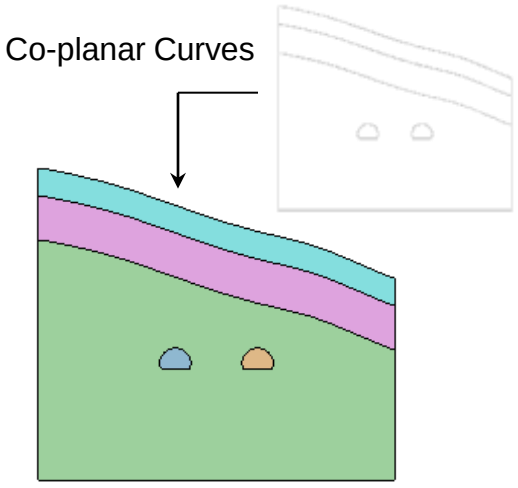
5C 5C+I



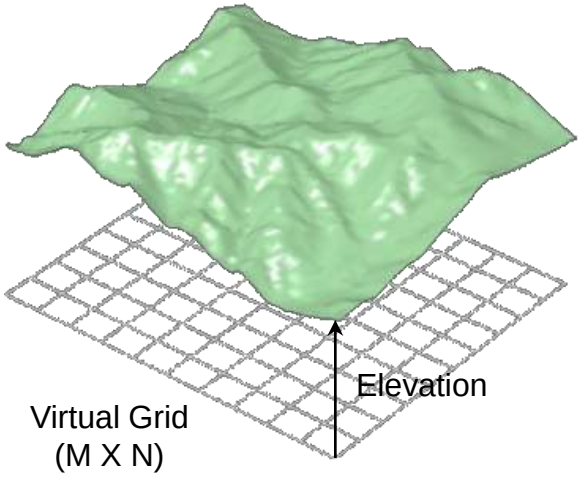
Curve Types

- Line
- Arc
- Circle
- Ellipse
- Parabola
- Hyperbola
- B-Spline
- Poyline
- Rectangle
- Polygon
- Profile
- Tunnel Section

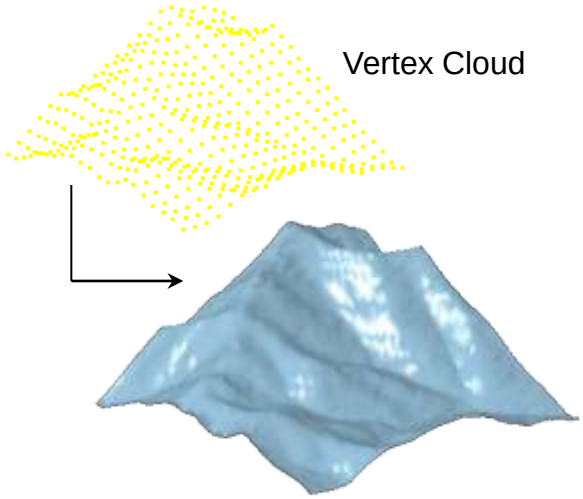




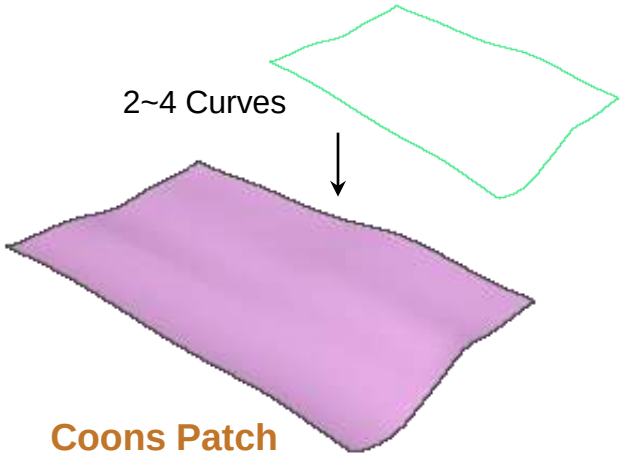
Plane Patch



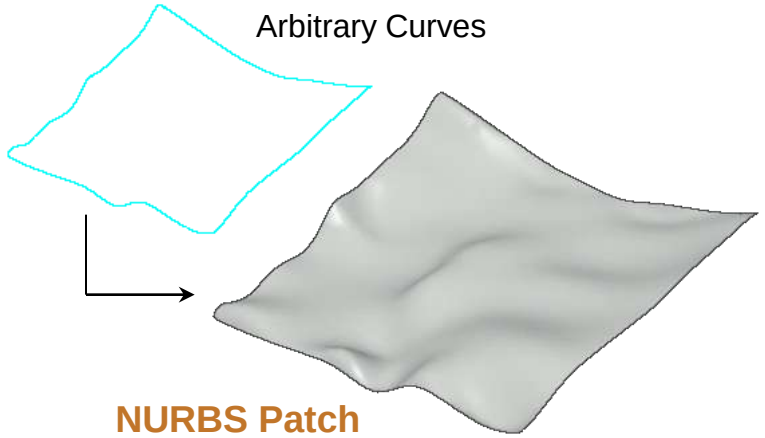
Grid Patch



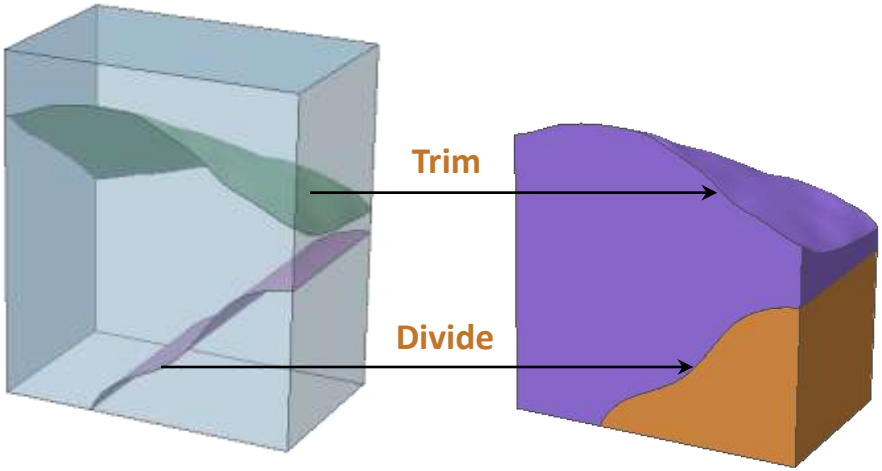
Vertex Patch

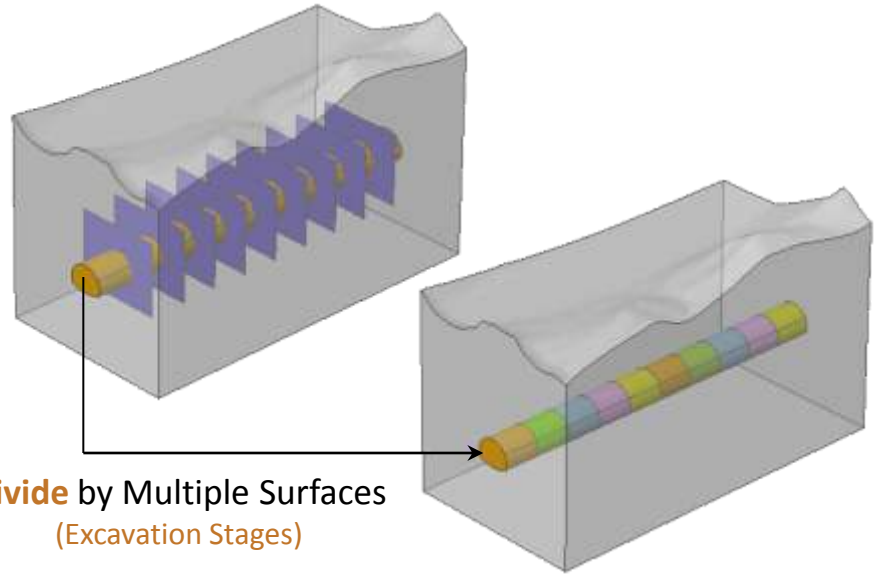


Coons Patch



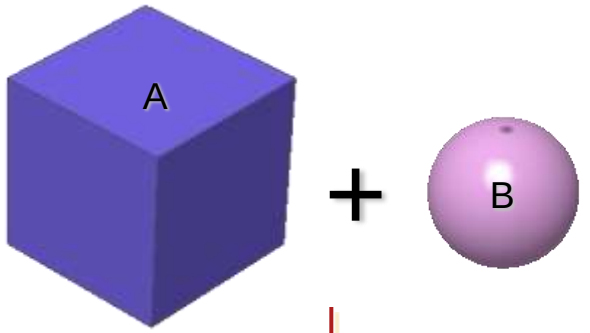
NURBS Patch

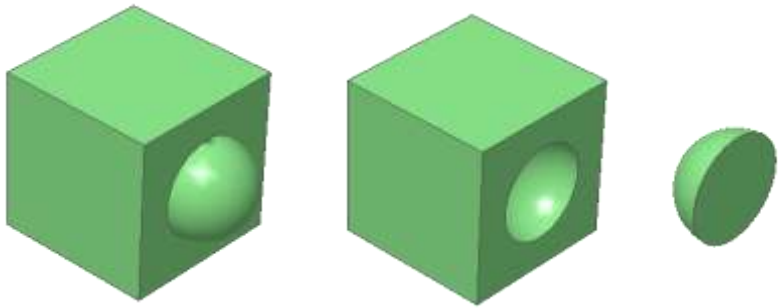




Divide by Multiple Surfaces
(Excavation Stages)

Boolean Operation



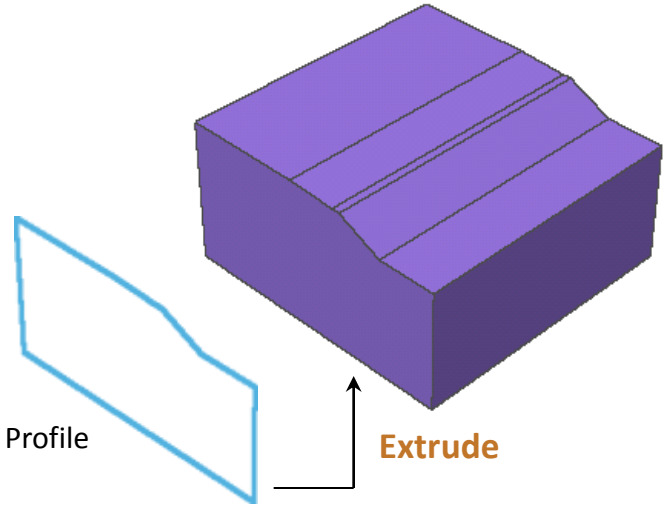


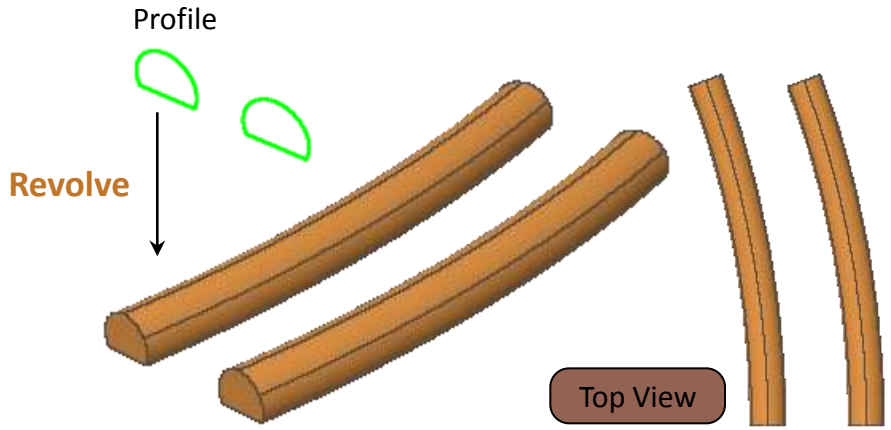
Fuse
(A ∪ B)

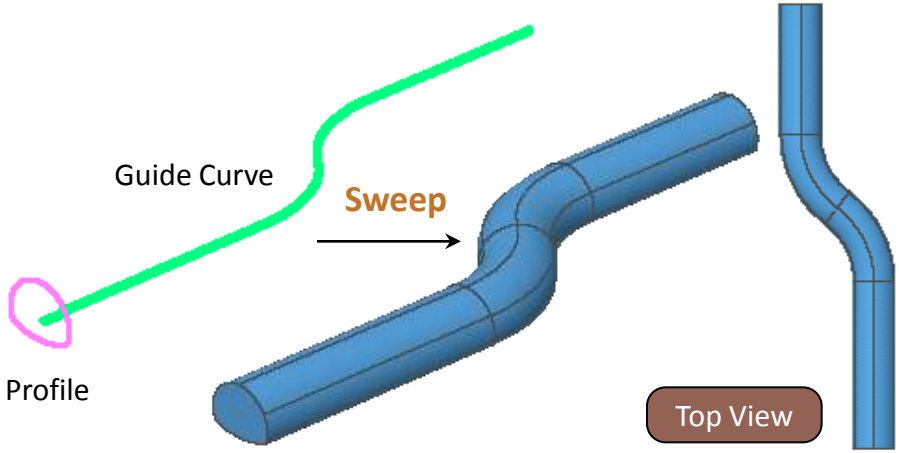
Cut
(A - B)

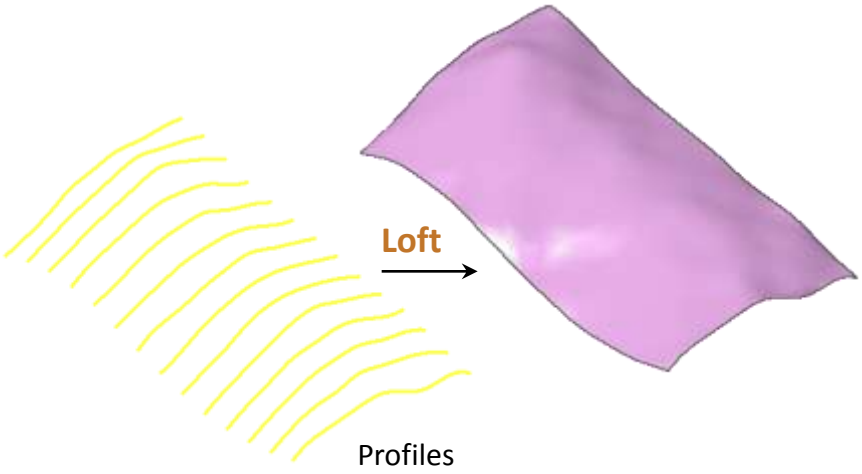
Common
(A ∩ B)

Generation

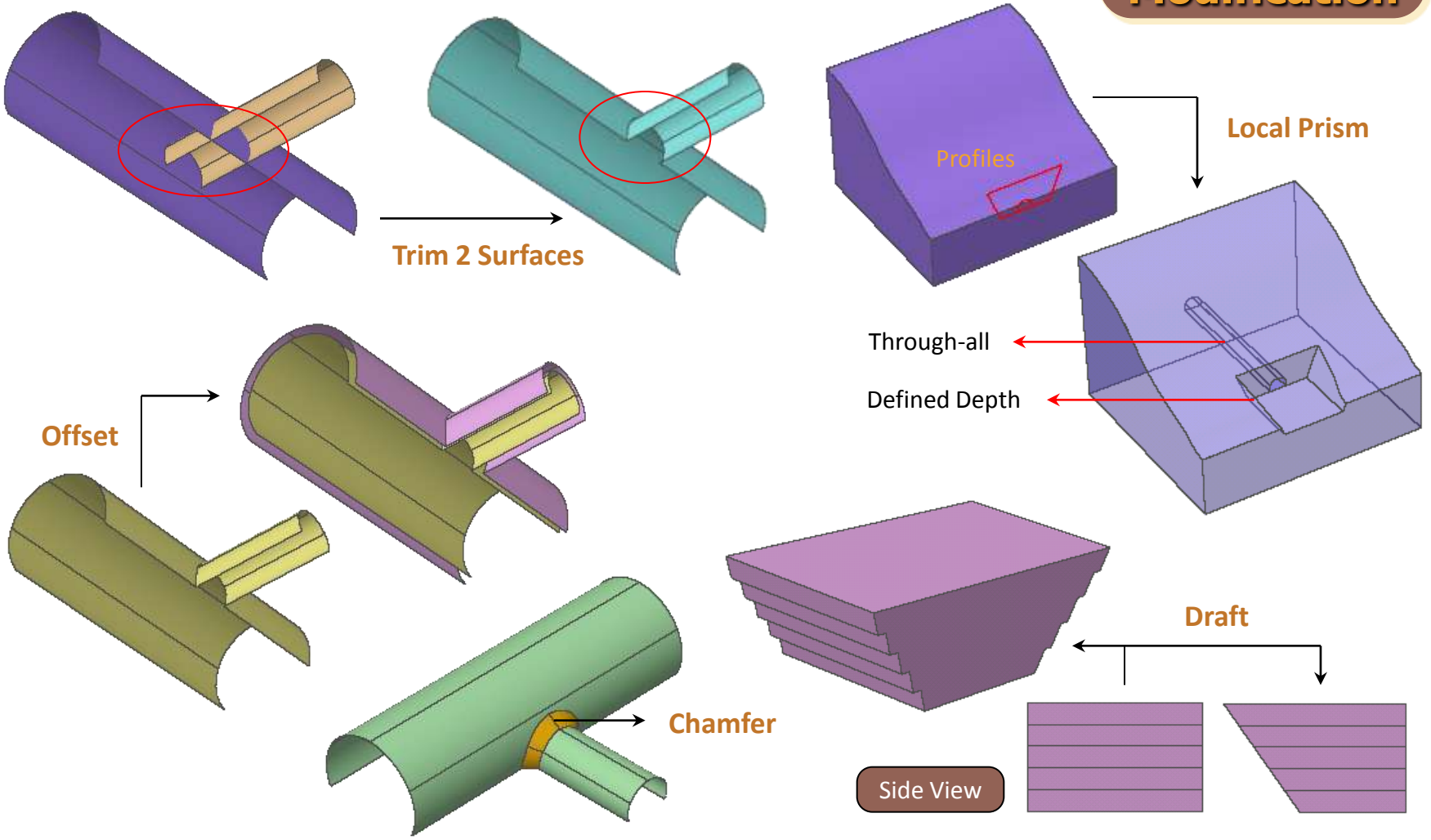

Profile
Extrude

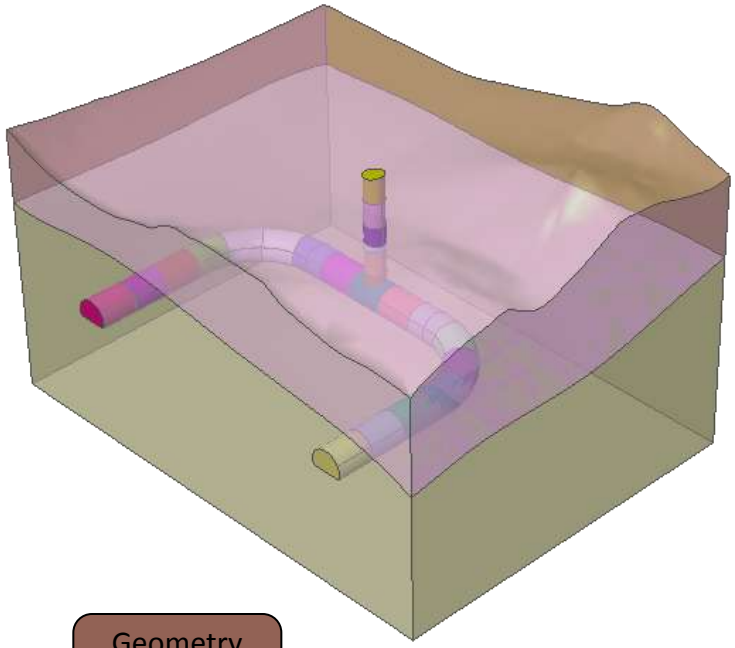

Profile
Revolve
Top View


Guide Curve
Sweep
Profile
Top View

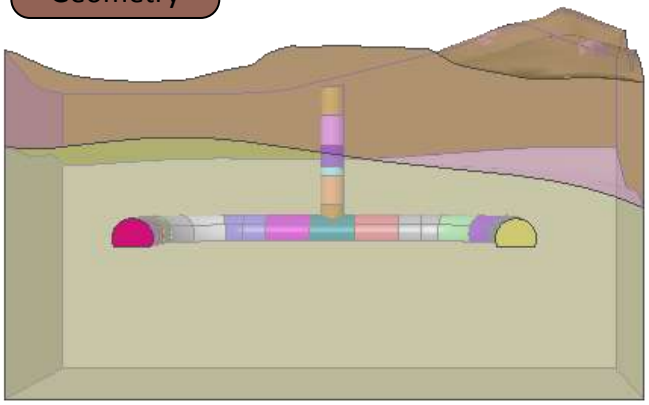

Loft
Profiles

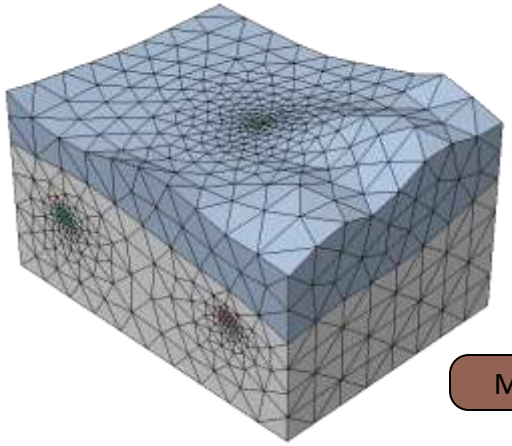
Modification

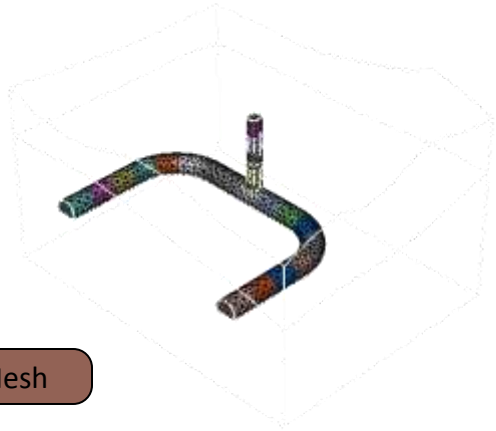




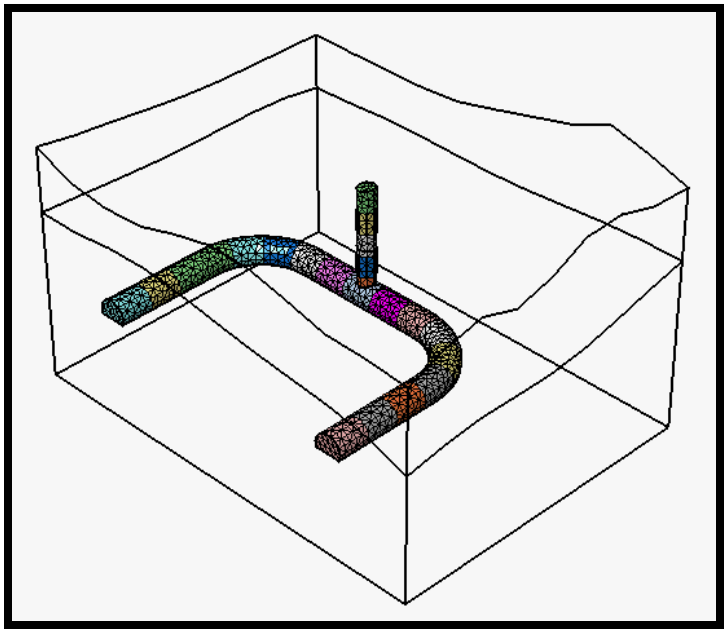
Geometry







Mesh



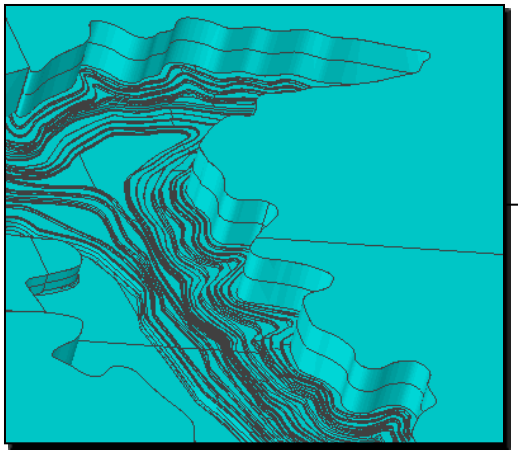
Construction Stage

Import (Geometry)

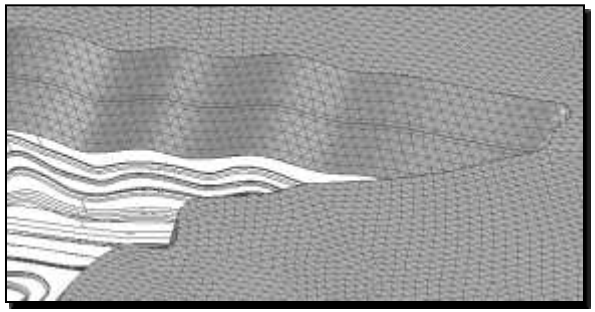
- STEP, IGES
- AutoCAD DXF (Wireframe)
- STL (Mesh)
- Nastran (Mesh)
- Optional Interfaces
  ACIS, Parasolid, DWG, etc.

Export (Geometry)

- STEP, IGES
- STL (Mesh)



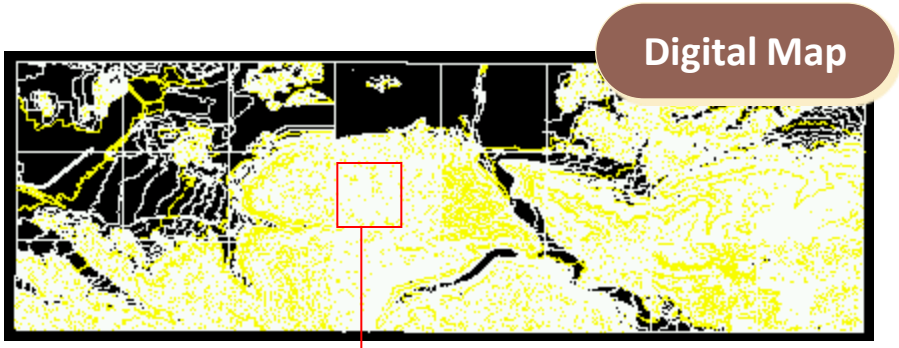
IGES Geometry

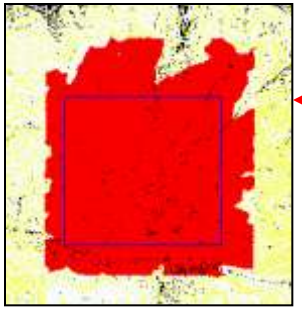


Generated Mesh

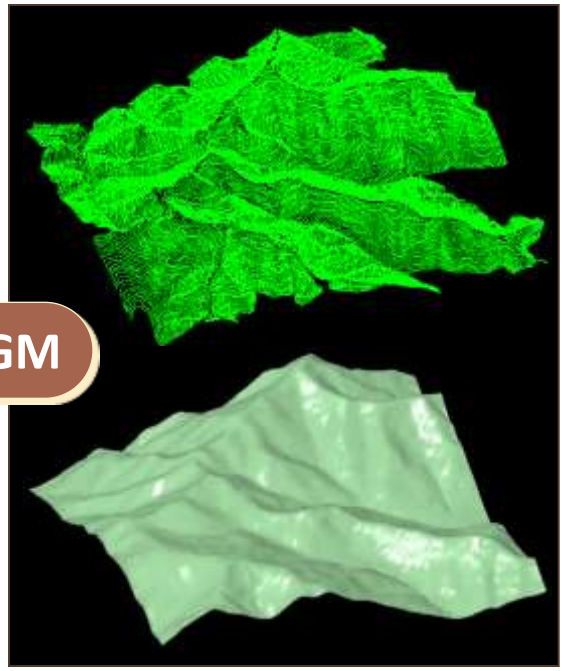
Standards for Data Exchange

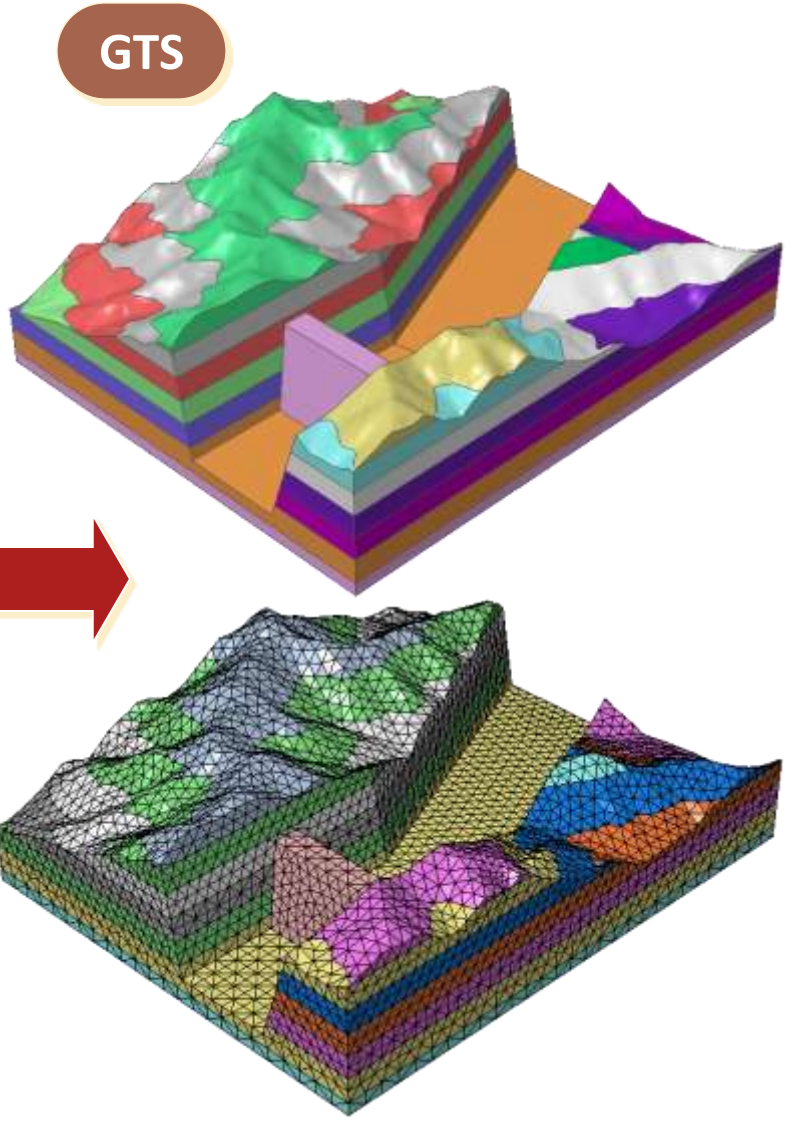
- STEP (STandard for the Exchange of Product Model Data)
- IGES (Initial Graphics Exchange Specification)
- STL (STereo Lithography) – De facto standard for RP





DXF Data





Specialized Module for Real Terrain Geometry

Advantage of Geometry-based Modeling Approach

1

Using the advanced geometric modeling functions, especially surface and solid modeling functions, modeling various real and complex terrain and/or stratum geometries can be accomplished very easily!

Flexible

2

Compared to manual operations, geometric modeling functions require fewer inputs. It does not require tedious information input like nodal coord's, element connectivity, etc. It just needs the least real geometric information!

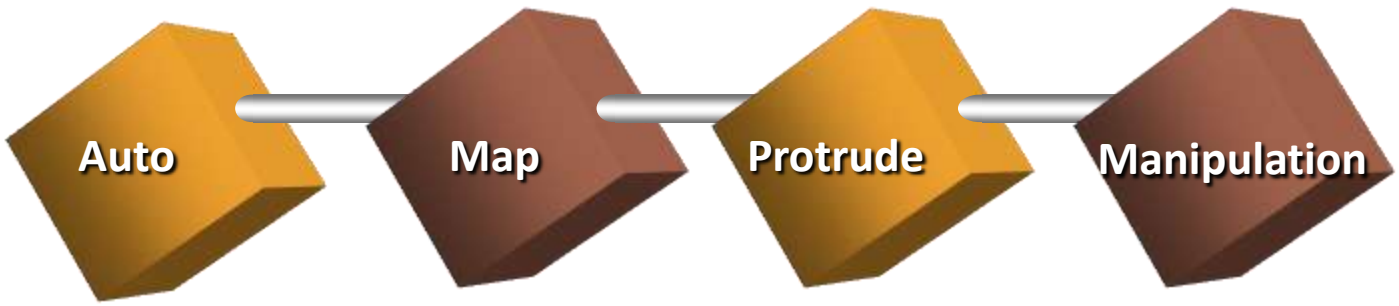
Convenient

3

Using the geometric modeling functions, the complex geometric operations like intersecting and dividing free-form surfaces can be performed in a matter of seconds. Exact solutions are obtained with no hassle!

Accurate

Mesh Generation



- Solid
- Surface
- Edge
- Planar Area
- 4-Curve Area
- 2D → 3D

Type

- Quadrilateral
- Combined
- Triangle

- Solid
- Surface
- k-Curve Area
- k-Face Volume
- 4-Node Area

...

- Extrude
- Revolve
- Project
- Fill
- Sweep

Object

- Geometry
- Element
- Node

- Create
- Extract
- Connection
- Change Para.
- Smooth
- Divide
- Check
- Quality
- Merge
- Transform

...

Loop Mesher

Direct Surface Mesher based on Looping Algorithm

Delaunay Mesher

Indirect Surface Mesher based on Delaunay Triangulation

Grid Mesher

Hybrid Surface Mesher based on Modified Grid-based Approach

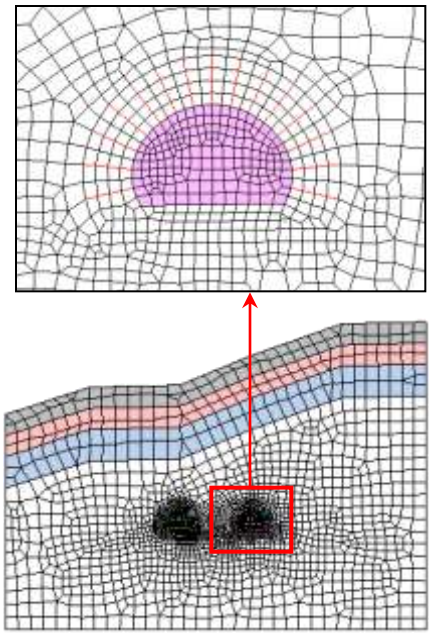
Tetra Mesher

Solid Mesher based on Delaunay Tetrahedralization & Advancing Front

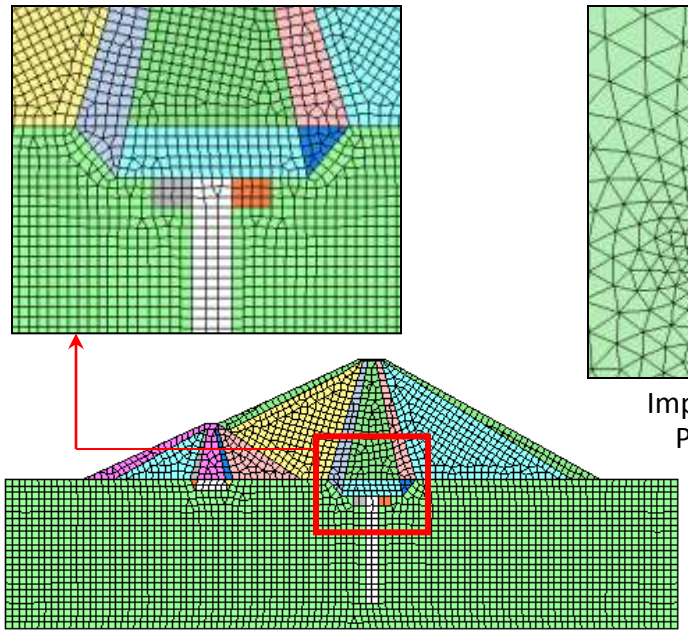
Map Mesher

Structured Surface/Solid Mesher based on Transfinite Interpolation

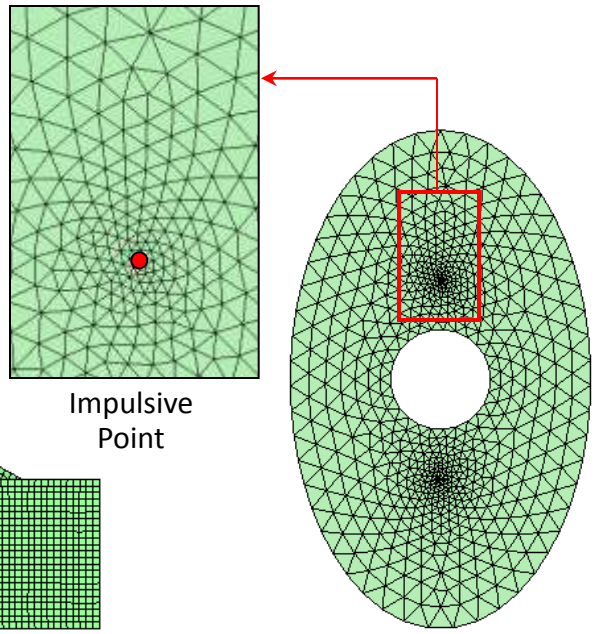
	Regularity Uniformity	Boundary Sensitive	Orientation Insensitive	Sizing Control (< 1/2)	Internal Curve/Point
Loop Mesher	○	○	○	○	△
Delaunay Mesher	△	○	○	○	○
Grid Mesher	○	○	△	×	○



Loop Mesher

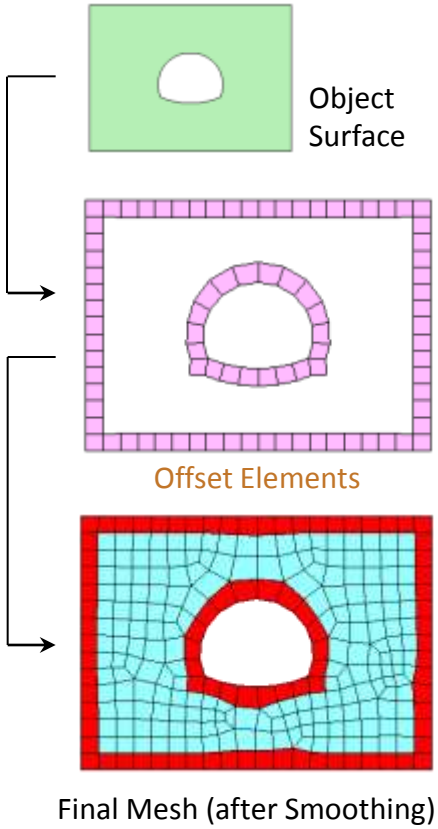


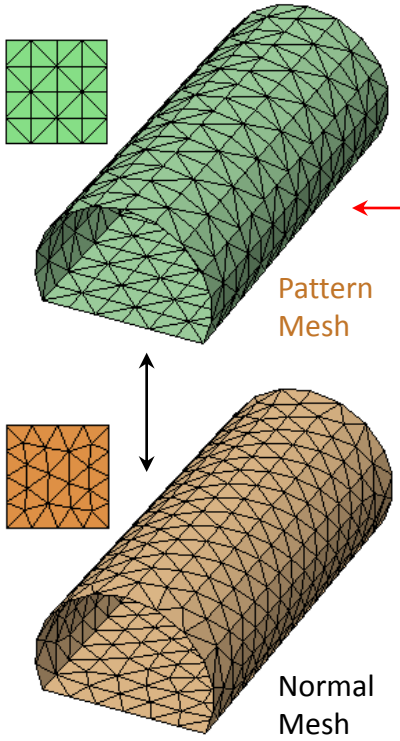
Grid Mesher

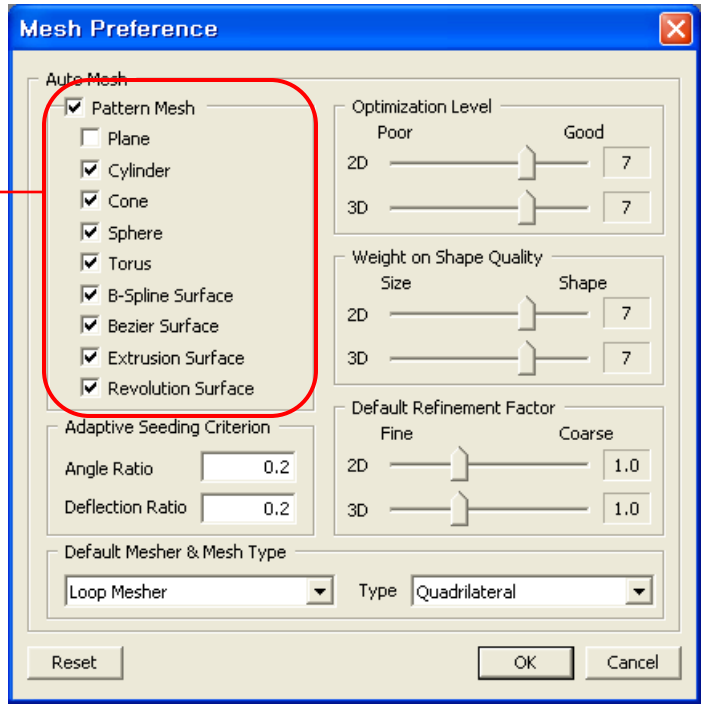


Delaunay Mesher

- GTS' surface meshers generate offset elements near boundary for best quality
- GTS provides a number of controls to manipulate mesh pattern & density, and generates optimum meshes required in practice.

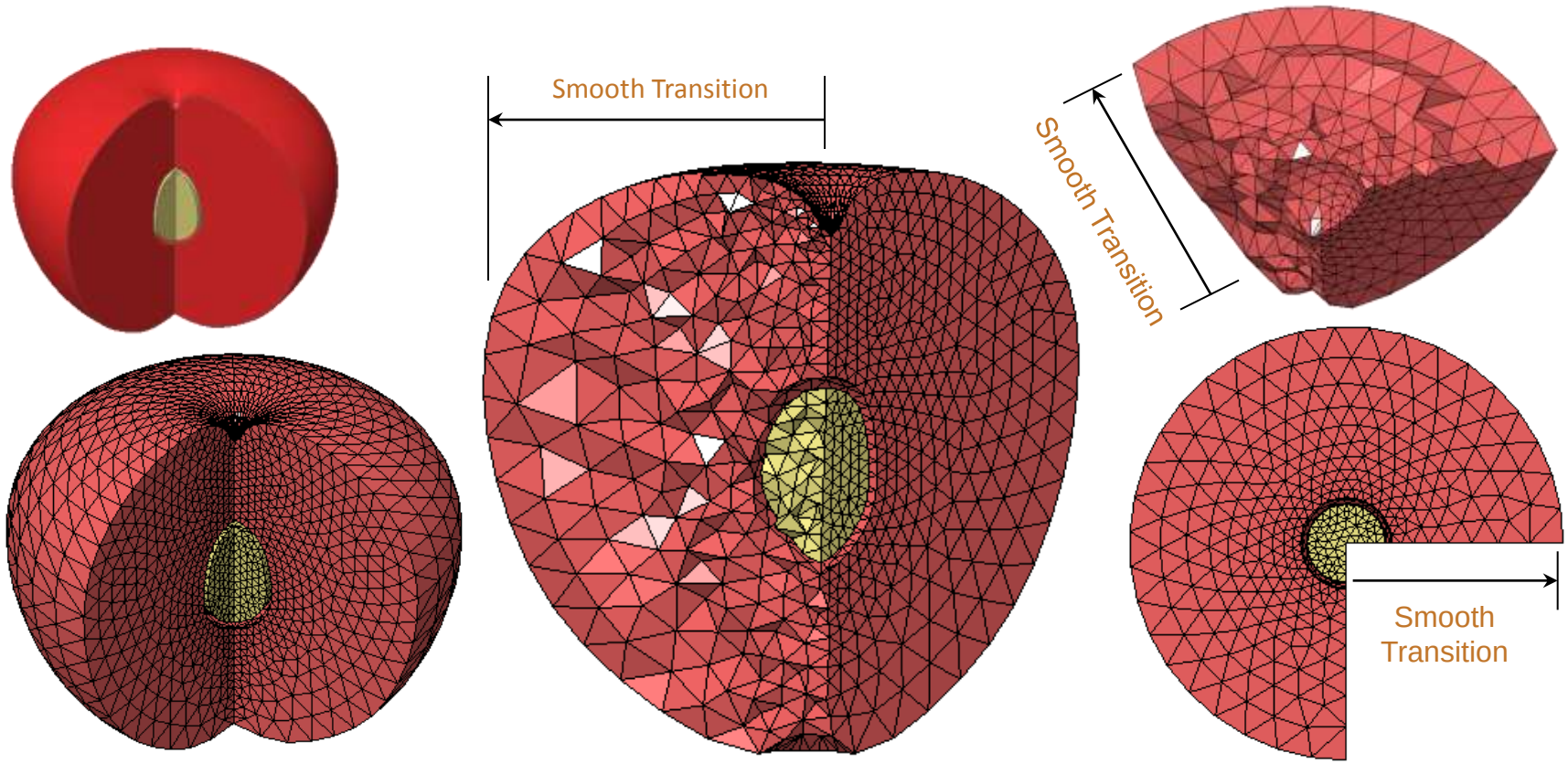




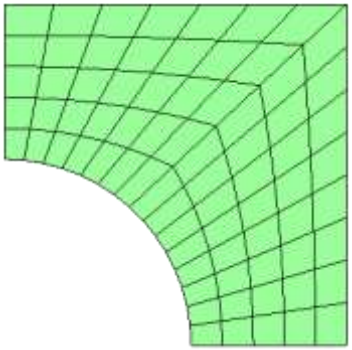


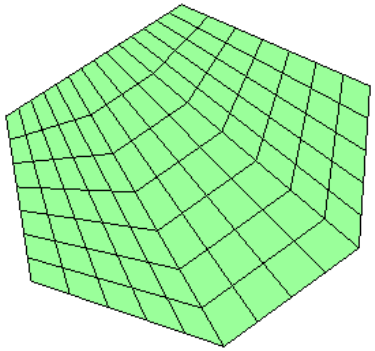
Mesh Preference

- GTS' Tetra Mesher auto-generates tetrahedral solid mesh with variable sizes in smooth transition. (200,000 Tetra's/min)
- GTS' Tetra Mesher is capable of including holes, curves and points that are present in/on solids.

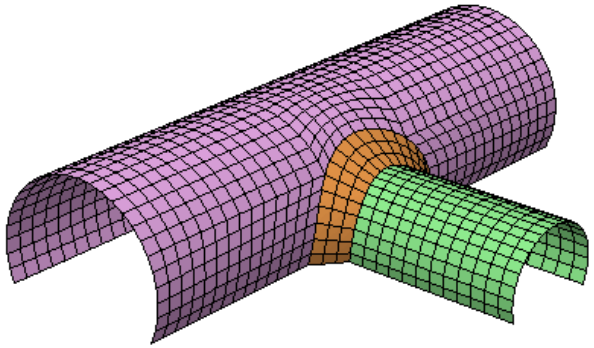


GTS' Map Mesher generates structured (regular & orthogonal) mesh both in surfaces and solids.

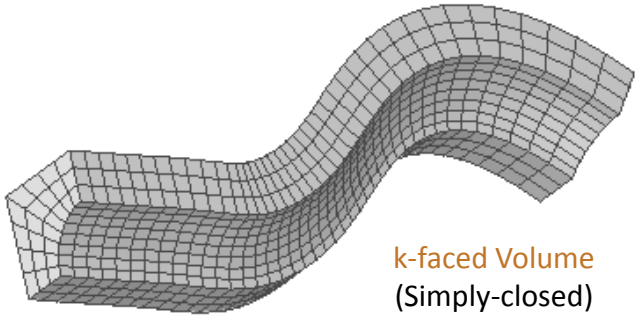




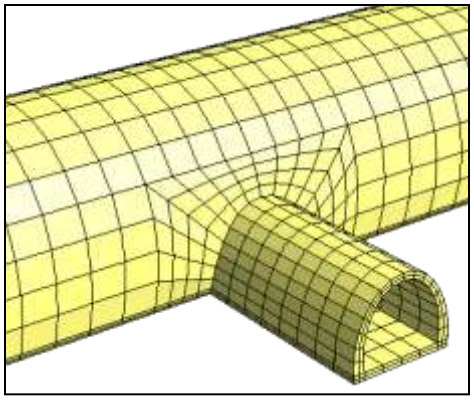
k-sided Area (Simply-connected)



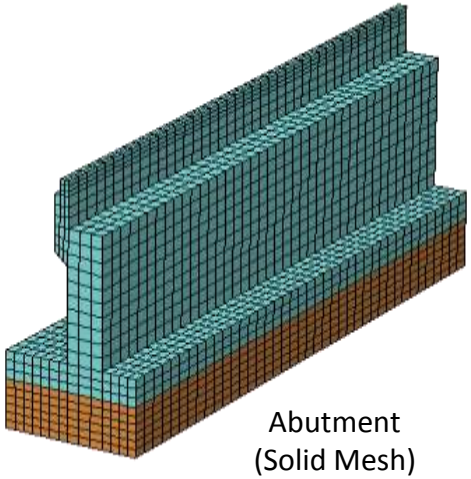
Tunnel Lining
(Surface Mesh)



k-faced Volume
(Simply-closed)

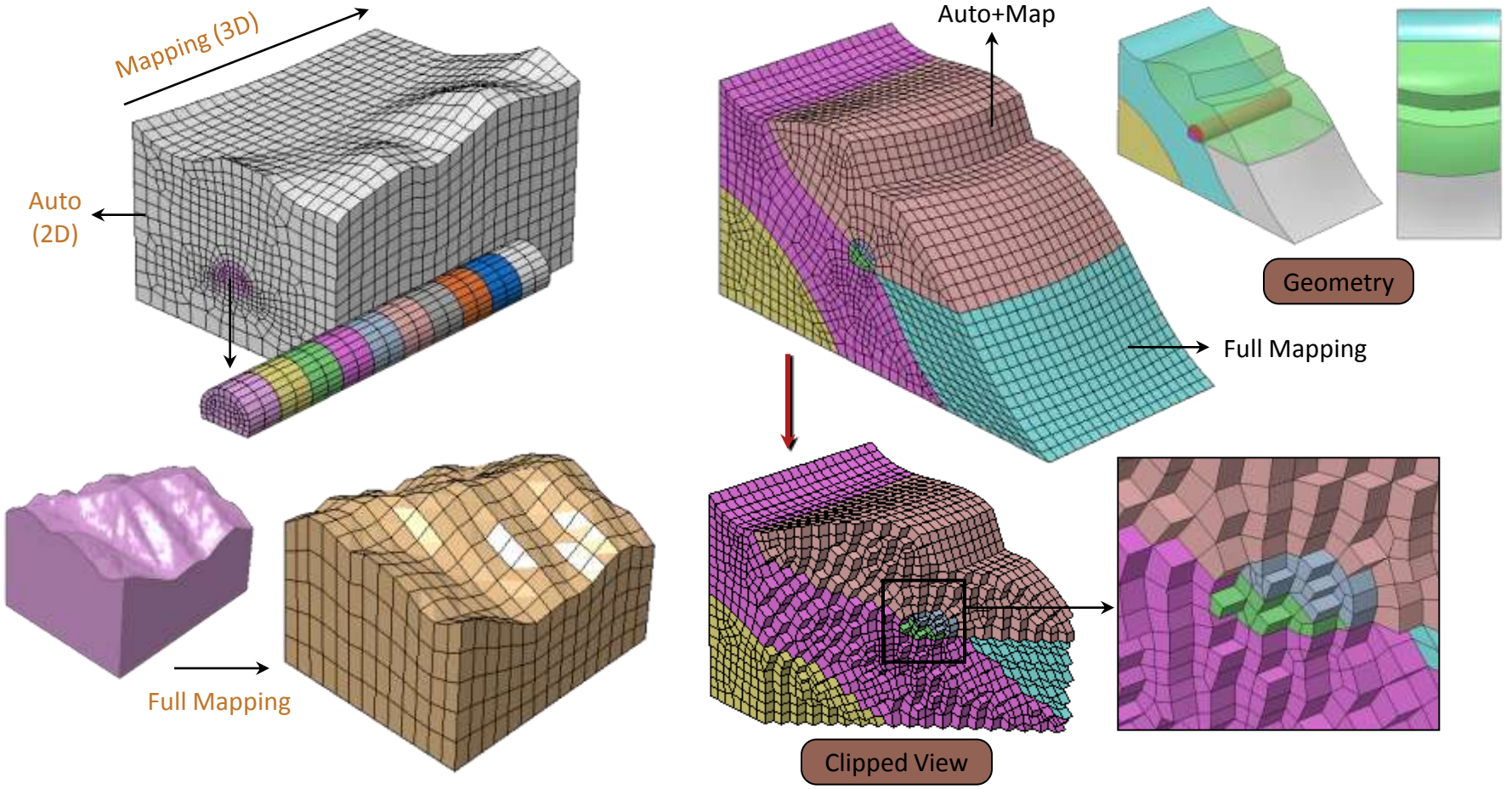


Tunnel - Junction
(Solid Mesh)

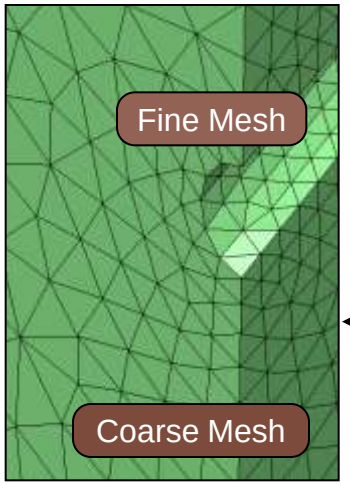


Abutment
(Solid Mesh)

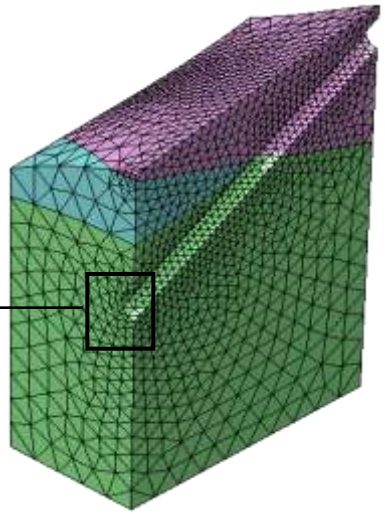
GTS' Solid Map Mesher generates hexa and/or penta mesh in simple solids by full mapping or combination (auto+map).



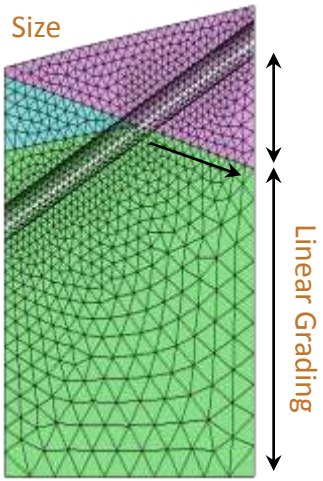
GTS provides various size control methods, **uniform size, division, linear grading (size & ratio and symmetry option)** and **refinement** option.



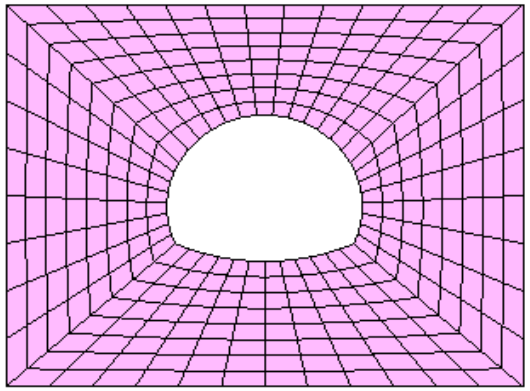
Smooth Transition



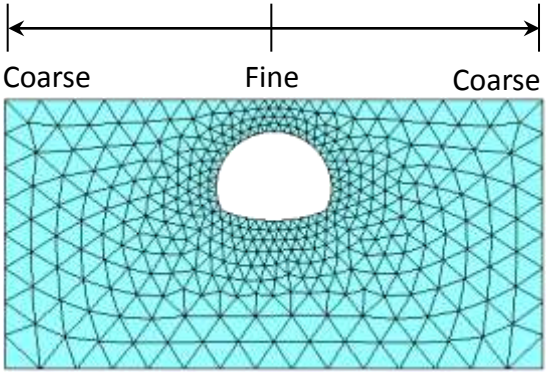
Uniform Size

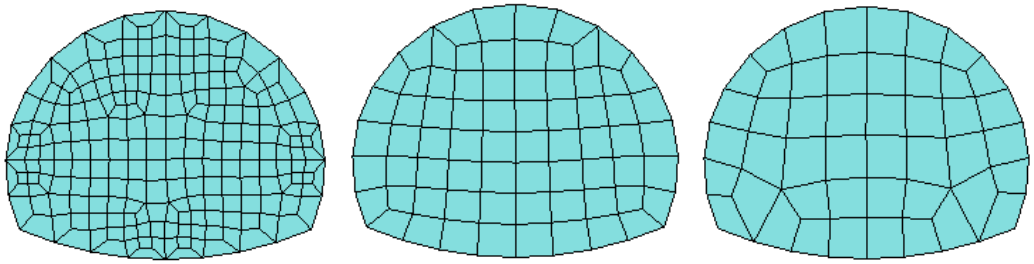


Division



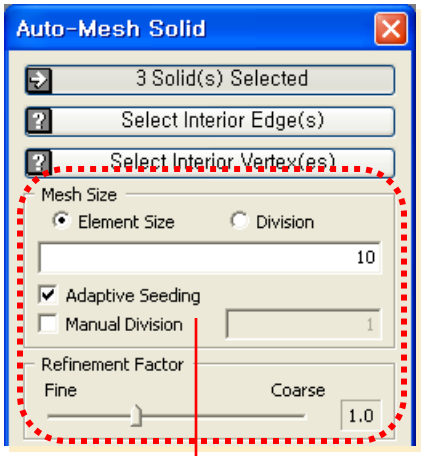
Linear & Symmetric Seeding

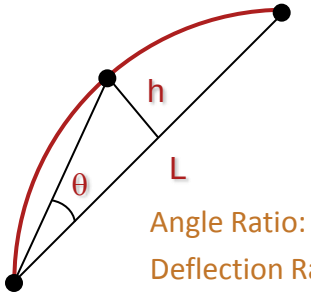




Refinement (50%) ← Normal → Refinement (120%)

GTS provides adaptive seeding function based on user-specified mesh size and geometric characteristics (curvature and feature).

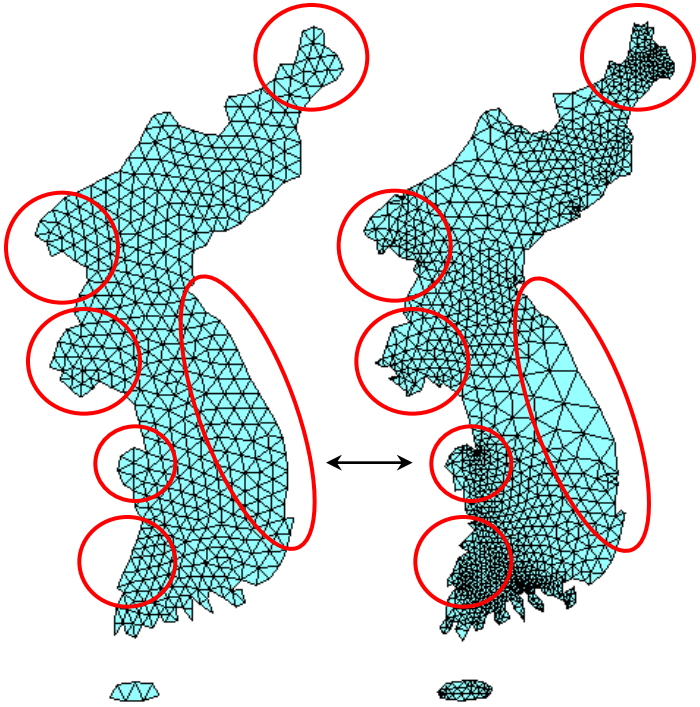




Angle Ratio: sin θ

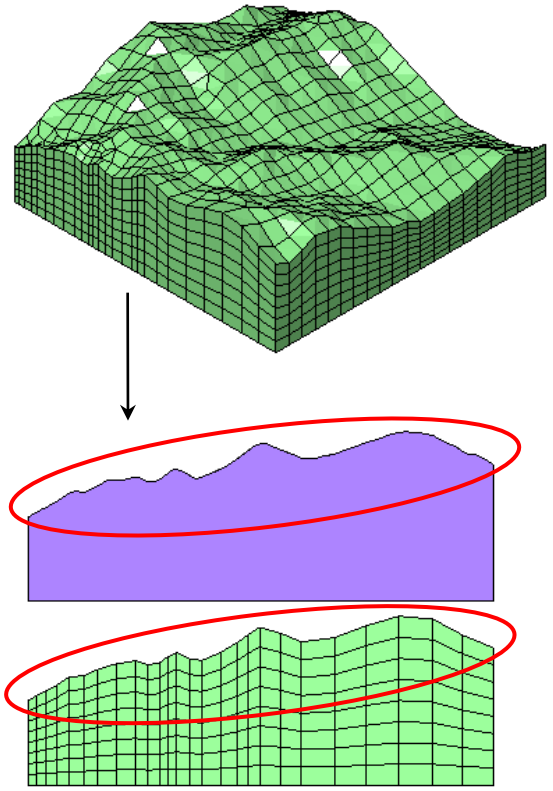
Deflection Ratio: h/L

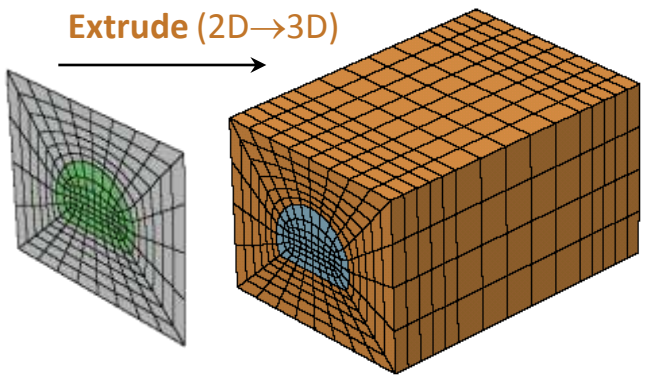
Adaptive Seeding

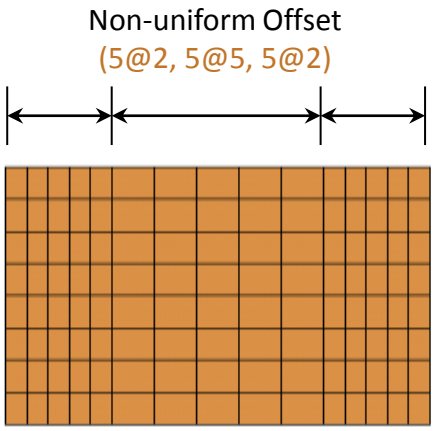


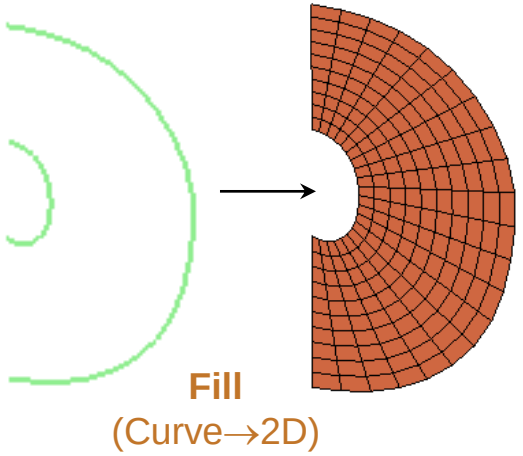
Normal Seeding (Uniform Size)

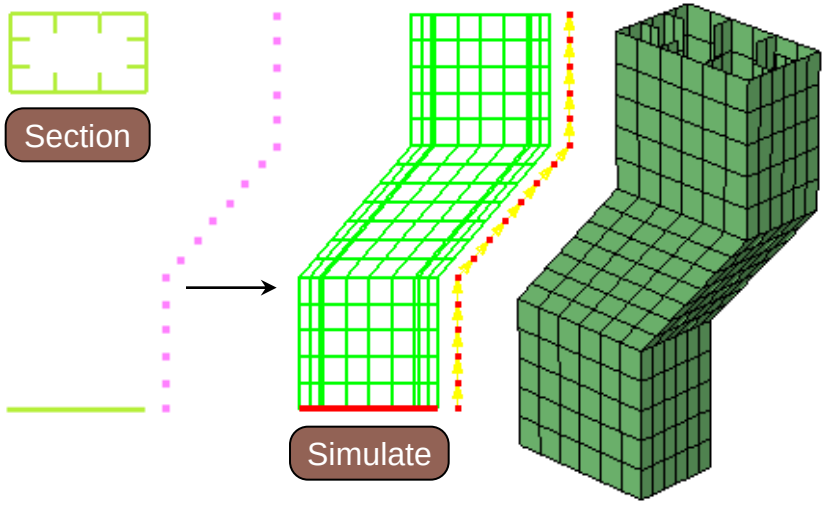
Adaptive Seeding

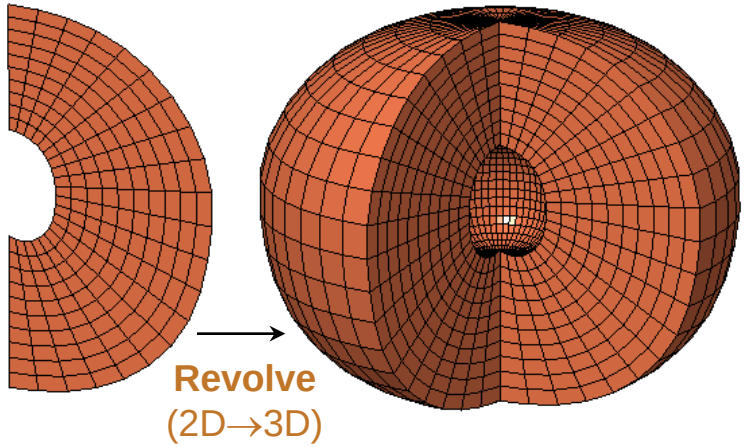



Extrude (2D→3D)

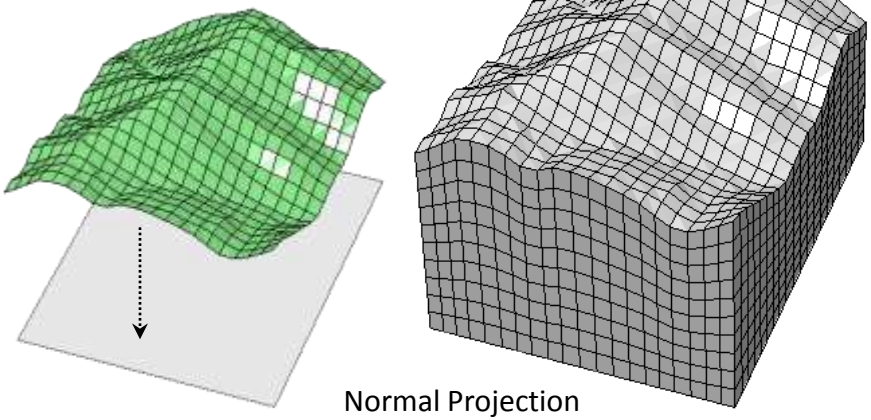

Non-uniform Offset
(5@2, 5@5, 5@2)


Fill
(Curve→2D)


Section
Simulate
Extrude thru Node Sequence (Curve→2D)

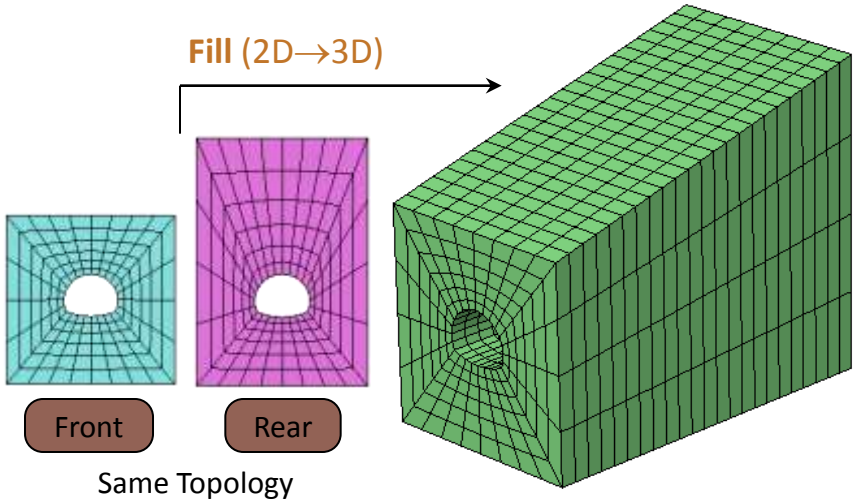

Revolve
(2D→3D)

Project (2D→3D)



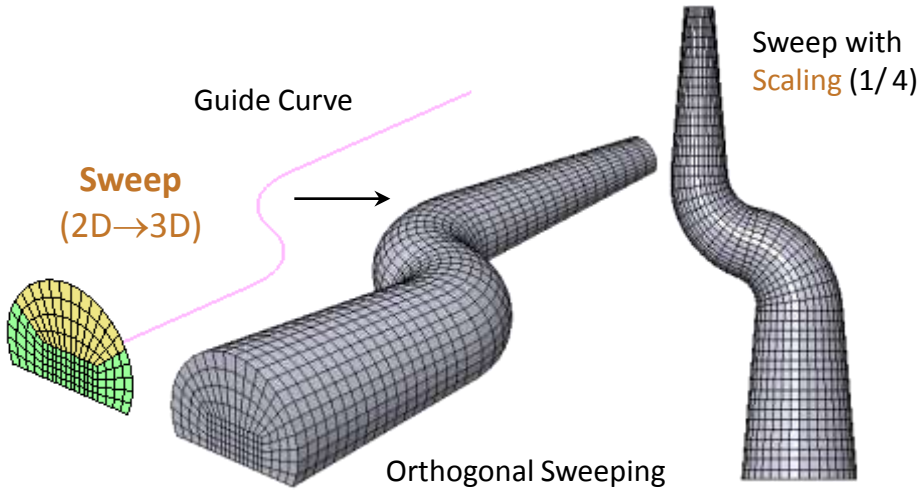
Normal Projection

Fill (2D→3D)



Same Topology

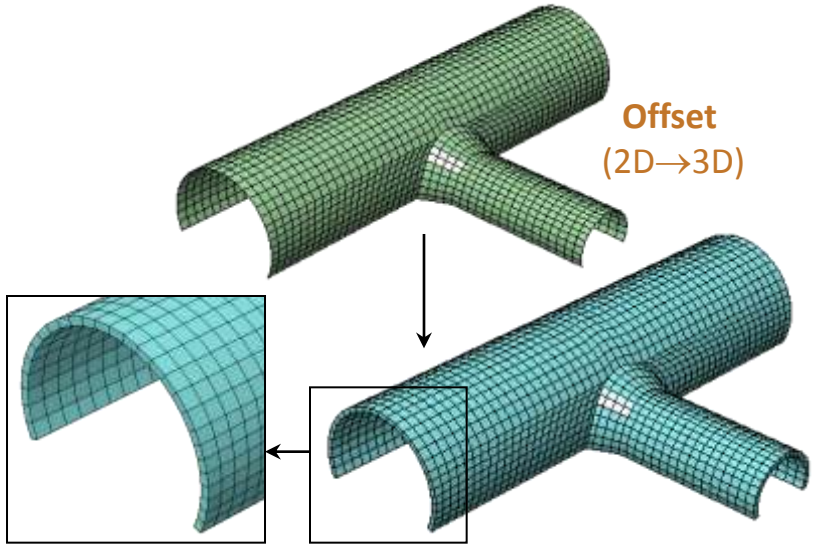
Sweep
(2D→3D)



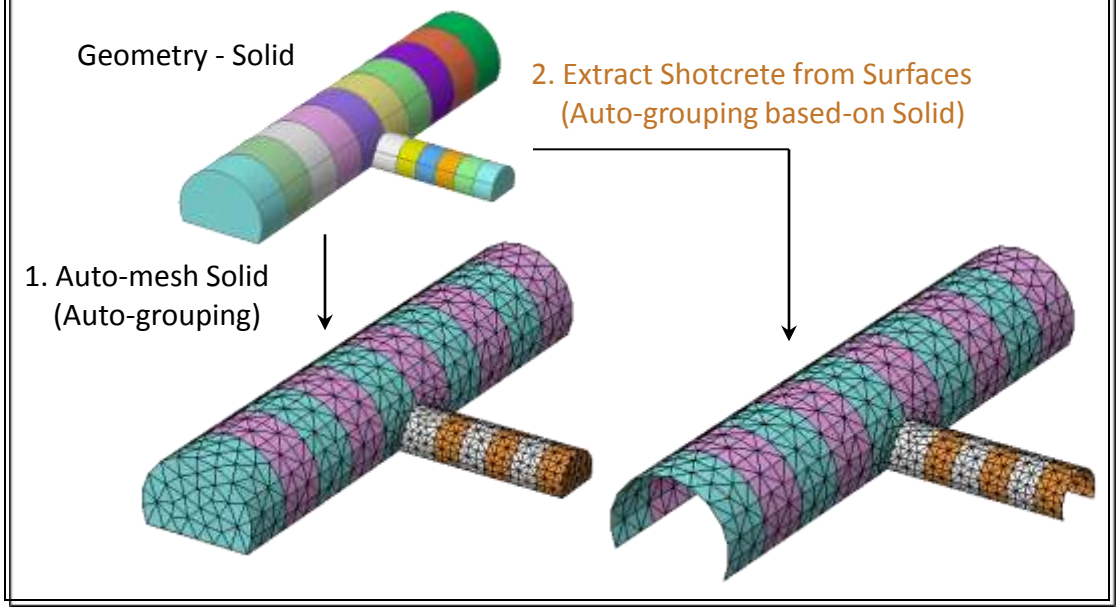
Orthogonal Sweeping

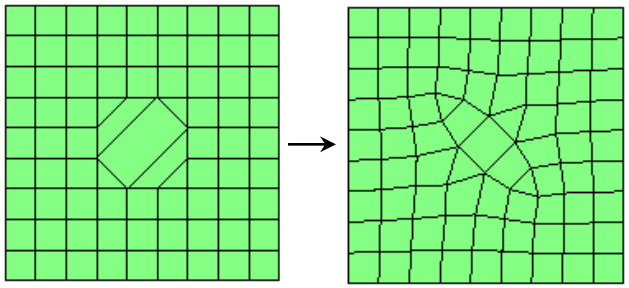
Sweep with
Scaling (1/ 4)

Offset
(2D→3D)

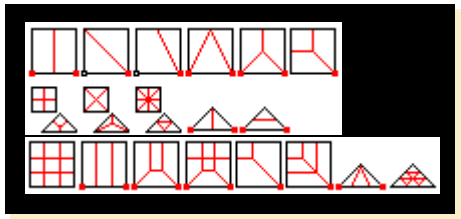


Extract Element



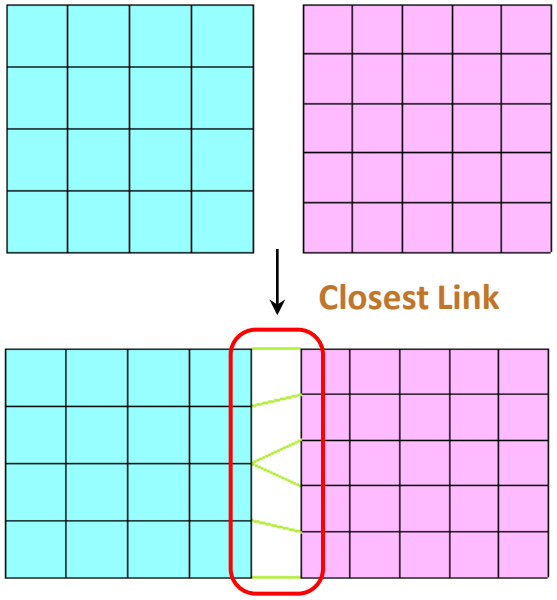


Smoothing (Laplacian/Winslow/Angle)



Divide Element
(2, 3-Refinement)

Mesh Connection



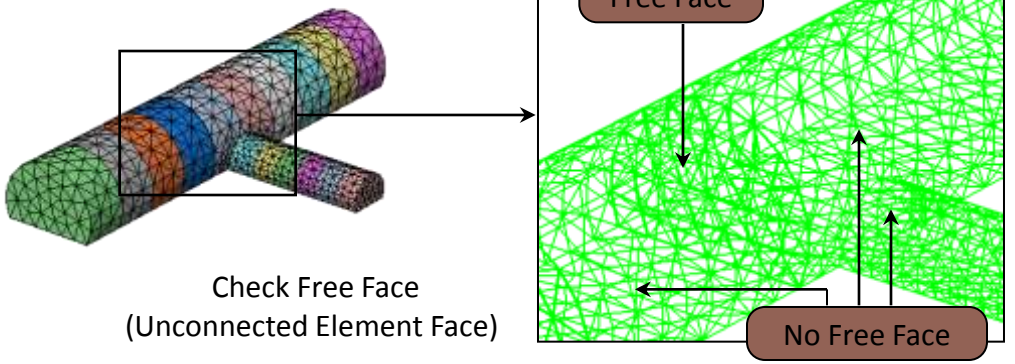
- Disconnect
- Link (Elastic, Rigid)
- Insert Interface Element
- Closest Link
- Coincident Link

Check & Verify

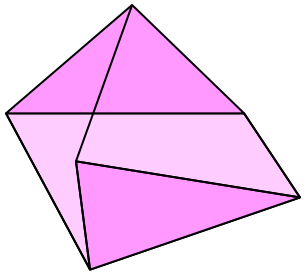
- Free Edges/Faces
- Check & Align ECS

Quality Assurance

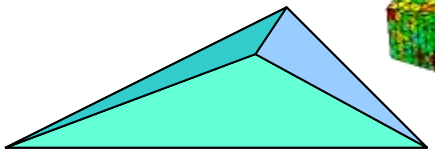
- Aspect Ratio
- Skew Angle
- Taper (2D)
- Warpage (2D)
- Jacobian Ratio
- Twist
- Collapse (Tetra)



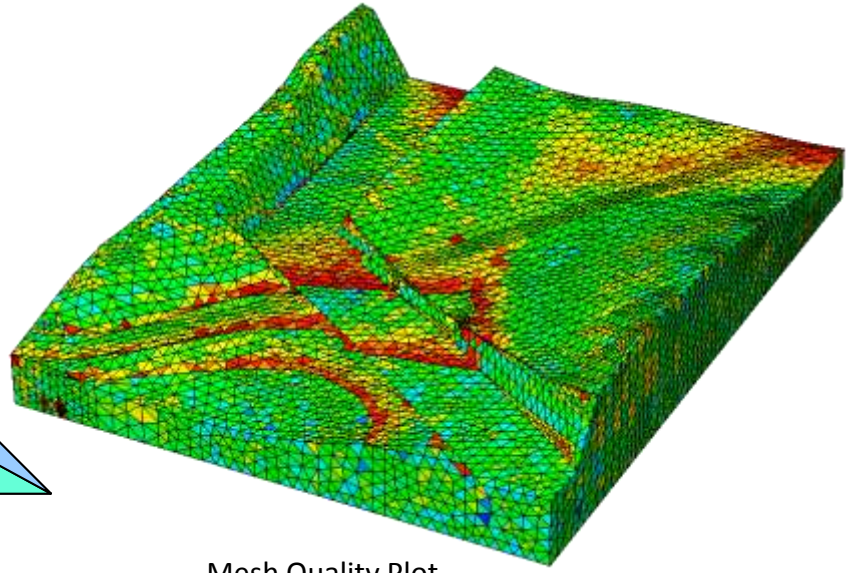
Check Free Face
(Unconnected Element Face)



Twisted Penta



Collapsed Tetra
(Near Zero Volume)



Mesh Quality Plot

Analysis & Tunnel Wizard

Static Analysis

- Linear/Non-linear Elastic Analysis
- Elasto-plastic Analysis
- Stress-Seepage Coupled Analysis
- Construction Stage Analysis
- Drain/Undrain Analysis
- Consolidation Analysis

Seepage Analysis

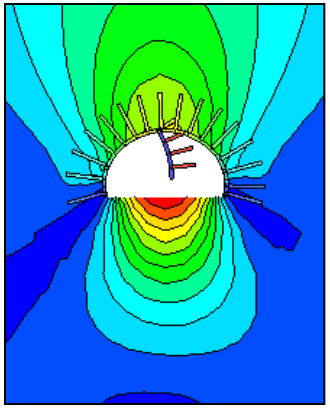
- Steady-state/Transient Analysis

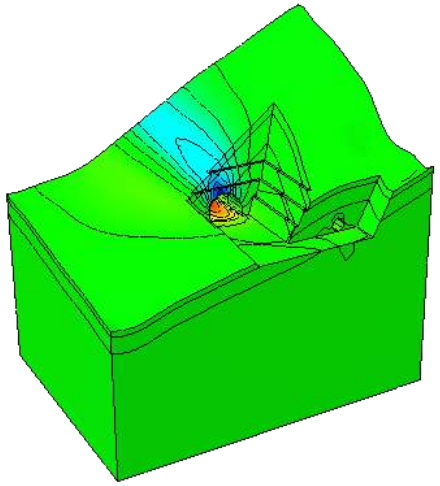
Dynamic Analysis

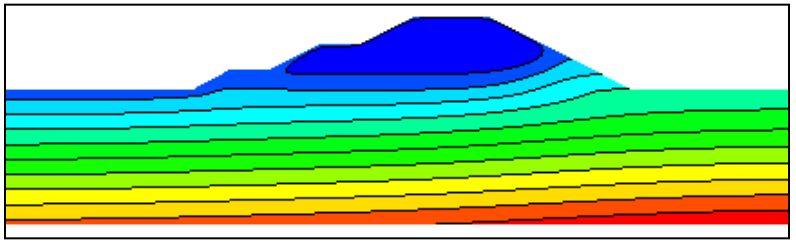
- Eigenvalue Analysis
- Response Spectrum Analysis
- Time History Analysis

Slope Stability Analysis

Non-linear Dynamic Analysis







Line Type

- Truss / Embedded Truss
- Beam
- Tension Only (Hook), Compression Only (Gap)
- Plot Only (Dummy for Modeling)

Plane Type

- Plate (Shotcrete, Lining)
- Plane Stress
- Plane Strain
- Axisymmetry
- Plot Only (Dummy for Modeling)

Solid Type

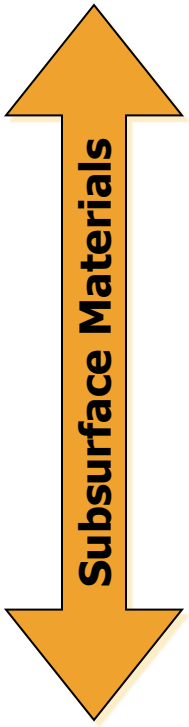
- Solid

Others

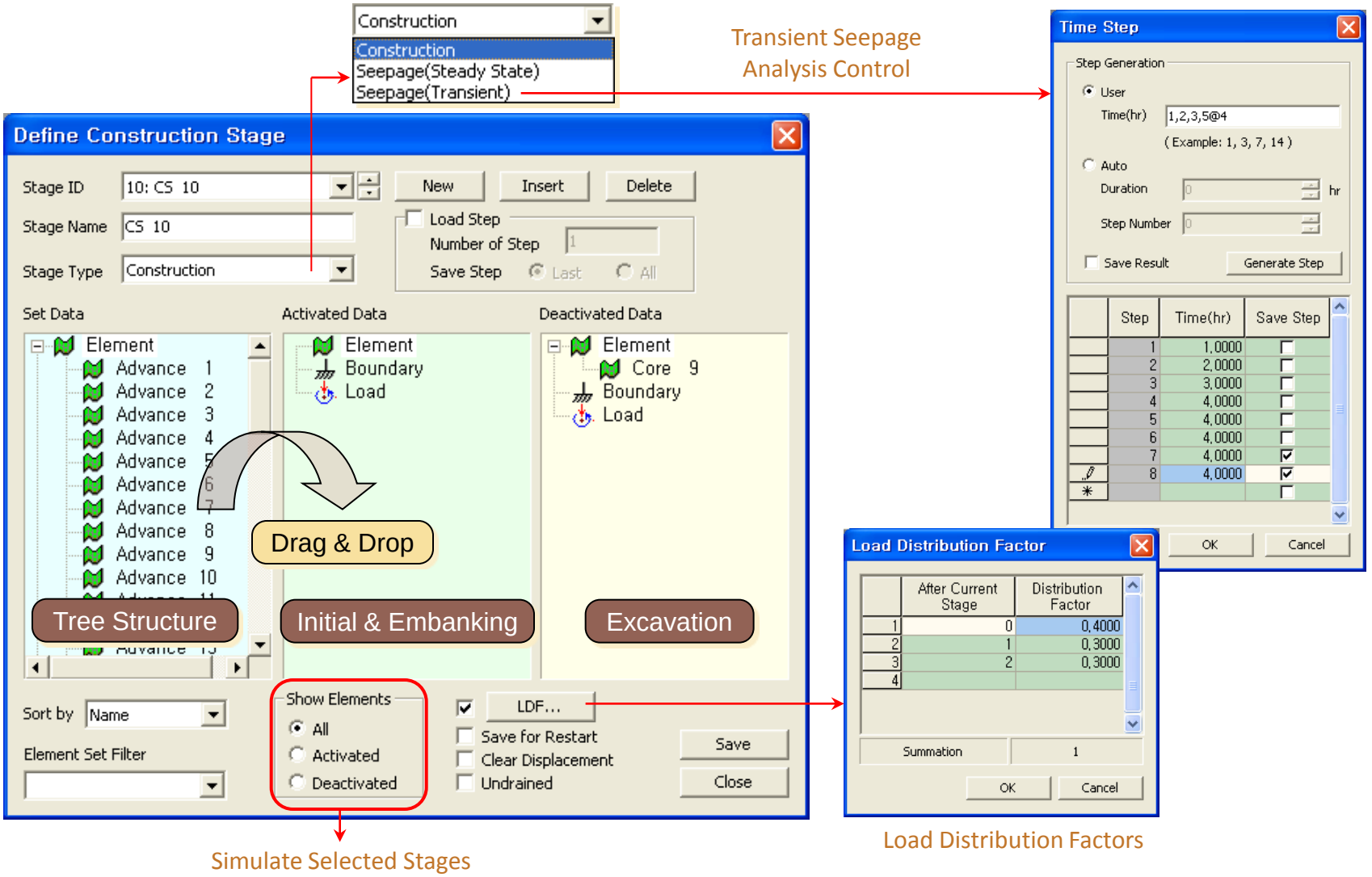
- Point Spring, Matrix Spring, Interface
- Elastic Link, Rigid Link

- GTS provides **linear** and **parabolic** types for **plate, plane stress** and **solid** elements.
- **In GTS, all elements can be created in 3 ways:**
  (1) auto/map-mesh generation, mesh protrusion and mesh connection
  (2) manual creation in GUI and/or table
  (3) import mesh data from other programs

GTS provides 15 material models as below :



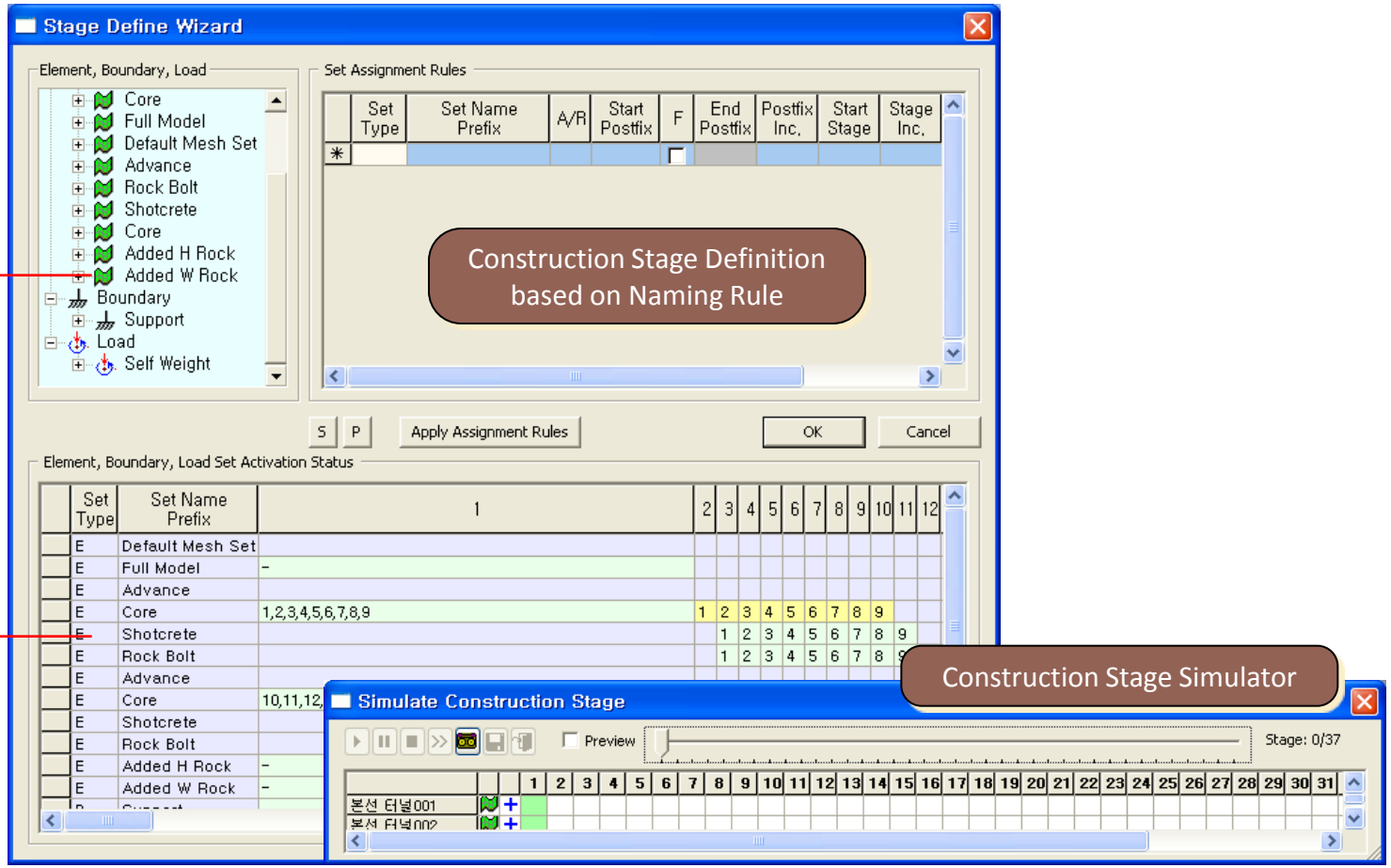
Material Model	Behavior
Linear Elastic	Most Simple
von Mises	Elasto-Plastic
Tresca	Elasto-Plastic
Mohr-Coulomb	Elasto-Plastic, Softening
Drucker-Prager	Elasto-Plastic
Transversely Isotropic	Anisotropic Elastic
Duncan-Chang	Hyperbolic, Nonlinear Elastic
Hoek-Brown	Elasto-Plastic
Jointed Rock	Anisotropic Elasto-Anisotropic Plastic
Cam-Clay, Modified Cam-Clay	Elasto-Plastic
Strain Softening	Strain Softening
2D/3D Interface	Elasto-Plastic, Frictional & Cohesive
London Clay	Jardine Model
User-defined Material	User-coded Subroutine (Fortran)


Construction
Construction
Seepage(Steady State)
Seepage(Transient)
Transient Seepage Analysis Control
Time Step
Step Generation
User
Time(hr)
1,2,3,5@4
(Example: 1, 3, 7, 14)
Auto
Duration
hr
Step Number
Save Result
Generate Step
Step
Time(hr)
Save Step
1 1,0000
2 2,0000
3 3,0000
4 4,0000
5 4,0000
6 4,0000
7 4,0000
8 4,0000
OK
Cancel
Define Construction Stage
Stage ID
10: CS 10
New
Insert
Delete
Stage Name
CS 10
Load Step
Number of Step
Save Step
Last
All
Stage Type
Construction
Set Data
Activated Data
Deactivated Data
Element
Advance 1
Advance 2
Advance 3
Advance 4
Advance 5
Advance 6
Advance 7
Advance 8
Advance 9
Advance 10
Element
Boundary
Load
Element
Core 9
Boundary
Load
Drag & Drop
Tree Structure
Initial & Embanking
Excavation
Sort by
Name
Element Set Filter
Show Elements
All
Activated
Deactivated
LDF...
Save for Restart
Clear Displacement
Undrained
Save
Close
Load Distribution Factor
After Current Stage
Distribution Factor
1 0 0,4000
2 1 0,3000
3 2 0,3000
4
Summation 1
OK
Cancel
Simulate Selected Stages
Load Distribution Factors

GTS provides semi-automatic method for the definition of construction stages using name pattern (base name + suffix number).

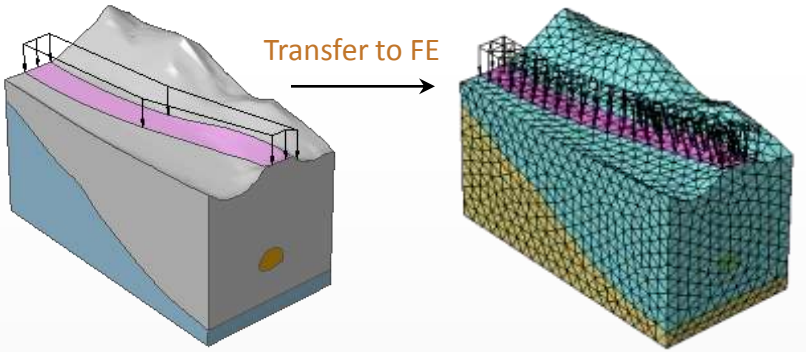
Tree Structure
- Mesh
- Load
- B.C.

Construction Chart



Load

- Self Weight
- Force, Moment
- Prescribed Displacement
- Pressure
- Line / Element Beam Load
- Nodal / Element Temperature, Temperature Gradient
- Prestress
- Nodal Mass
- Response Spectrum Analysis Data (including Various Design Spectrum Data)
- Time History Analysis Data
  - Time Forcing Function (including 54 Earthquake Acceleration Records)
  - Ground Acceleration
  - Time Varying Static Load
  - Dynamic Nodal Load, Dynamic Surface Load
  - Time History Result Function



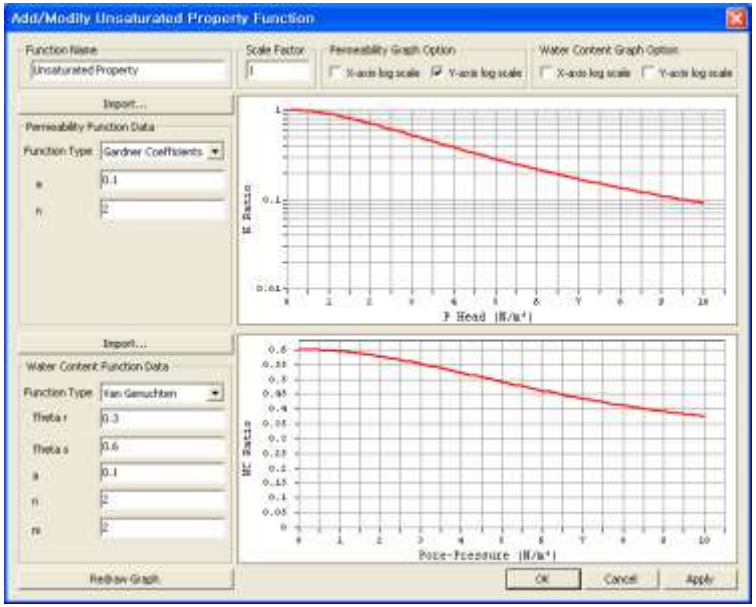
Pressure on Surface

Pressure on Element-Face

All loads can be applied both to FE and geometry.

Boundary Conditions

- Support
- Nodal Head
- Nodal Flux, Surface Flux
- Seepage Boundary Function
- Unsaturated Property Function
  - Permeability Function
    - Gardner Coefficients
    - Frontal Function
    - User Defined Function
  - Water Content Function
    - : van Genuchten, User Defined
- Beam End Release
- Plate End Release
- Change Material
- Change B.C. Set



Unsaturated Property Function

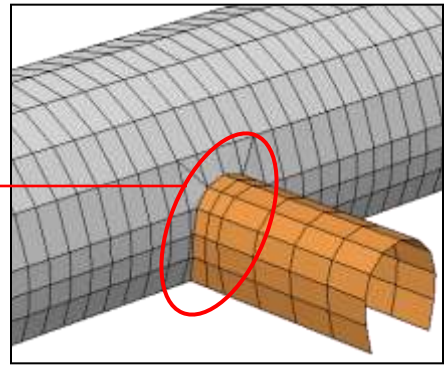


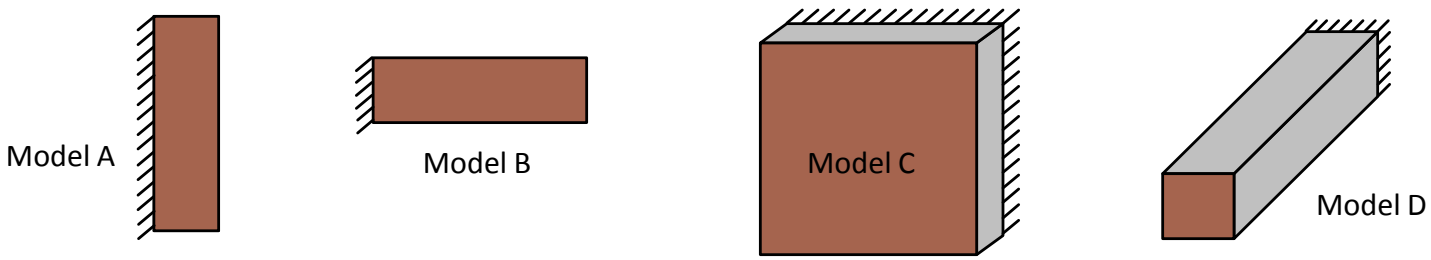
Plate End Release
(Junction of Shotcrete)

All boundary conditions can be applied both to FE and geometry.

GTS uses **multi-frontal sparse Gaussian solver** as a system equation solver.

Multi-frontal sparse Gaussian solver is one of the fastest solvers in the iterative solving of large solid models in non-linear analysis.

GTS also provides two **iterative solvers, PCG (Pre-conditioned Conjugate Gradient), GMRES (General Minimal RESidual)**.



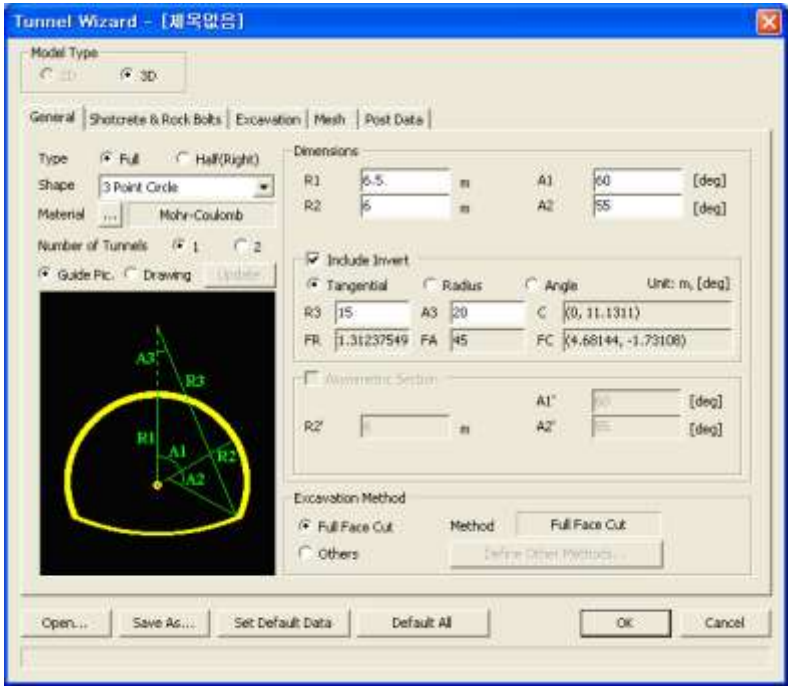
	Model A	Model B	Model C	Model D
Element Type	Plate	Plate	Solid	Solid
No. of Elements	30,000	30,000	29,400	31,740
No. of DOFs	180,180	186,000	90,738	106,200
Solution Time [sec]	**16**	**17**	**137**	**297**

Solution Time of Multi-frontal Solver

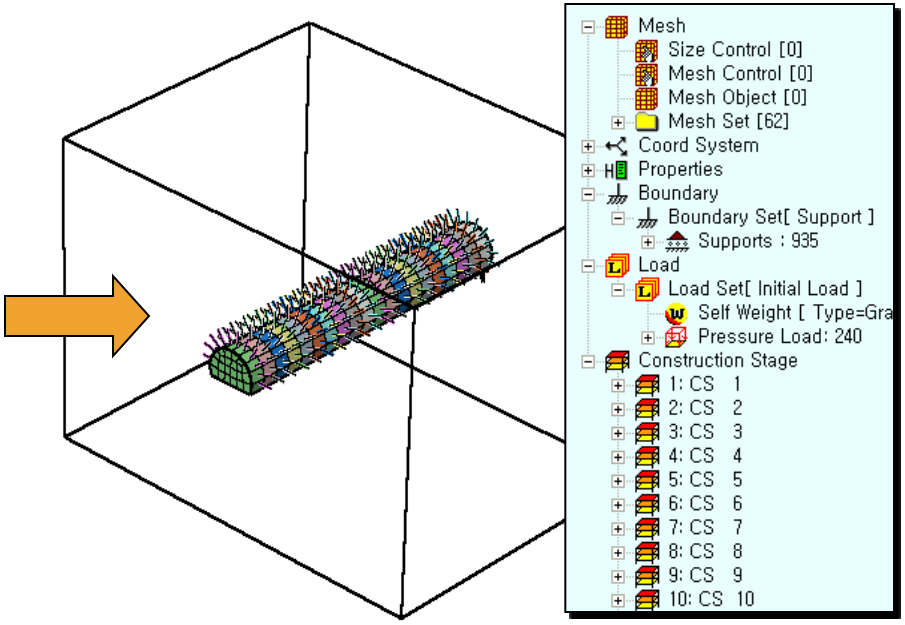
GTS provides **Tunnel Modeling Wizard** for simple and regular-type 3D tunnel models.

Tunnel Modeling Wizard automatically generates full analysis data, **mesh, loads, boundary conditions** and **construction stages**, from the user-defined parameters.

Tunnel Modeling Wizard also provides its **own file I/O service** to help users accelerate modeling works for similar models and build their own tunnel templates.

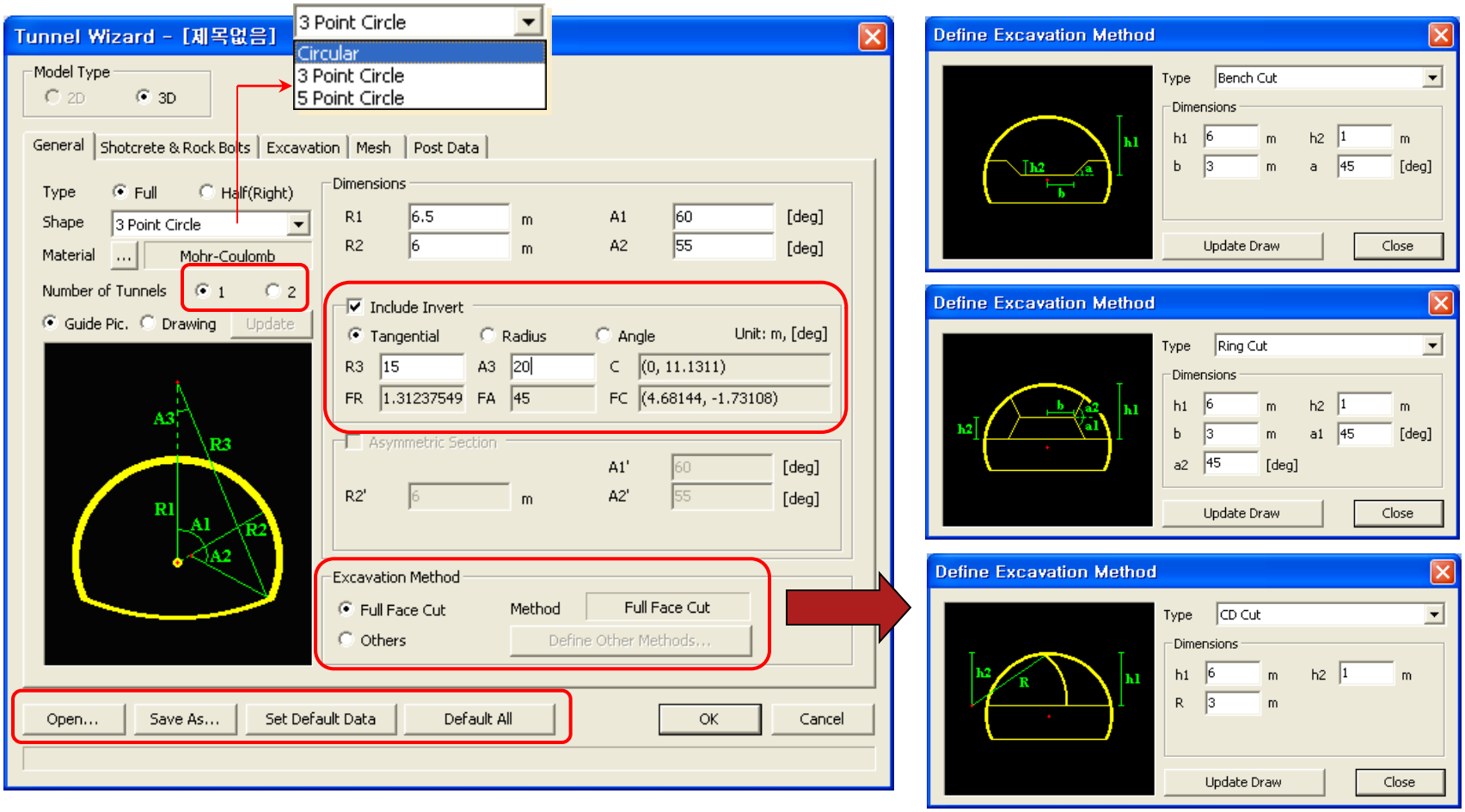


Tunnel Modeling Wizard



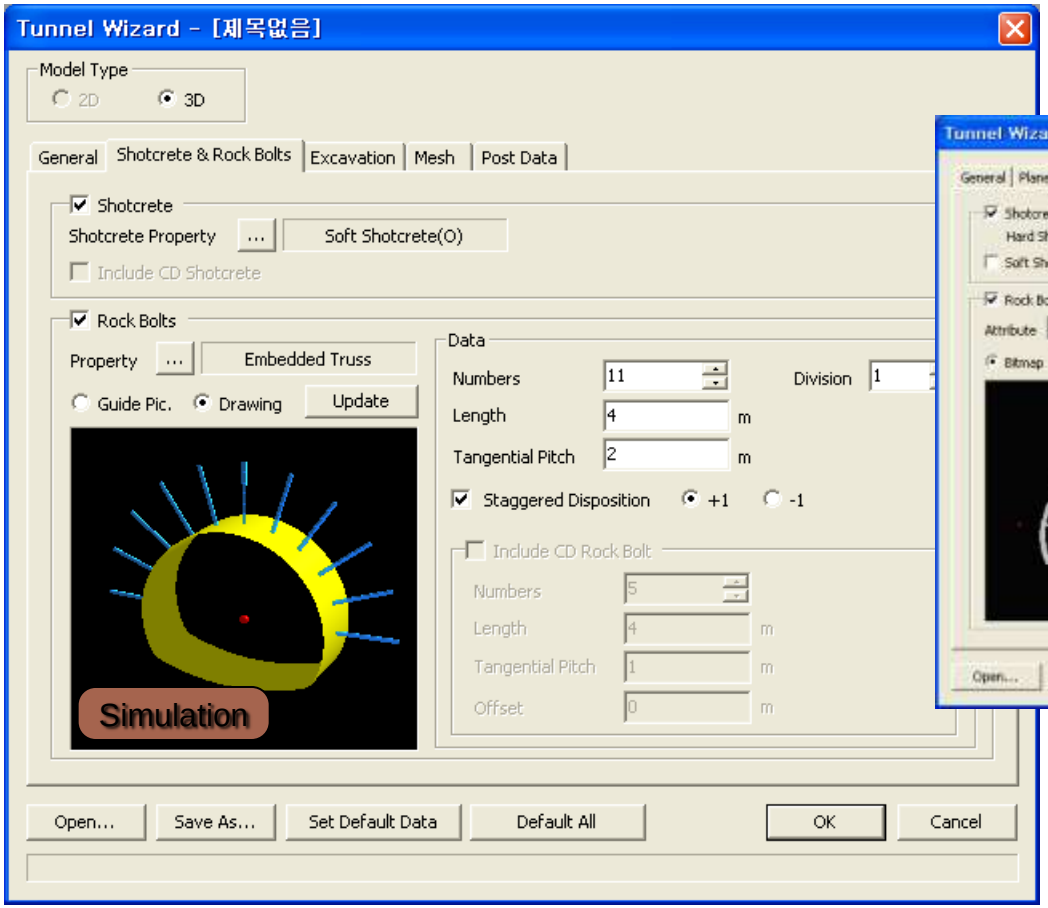
Generated Analysis Model (Mesh, LBC, CS, etc.)

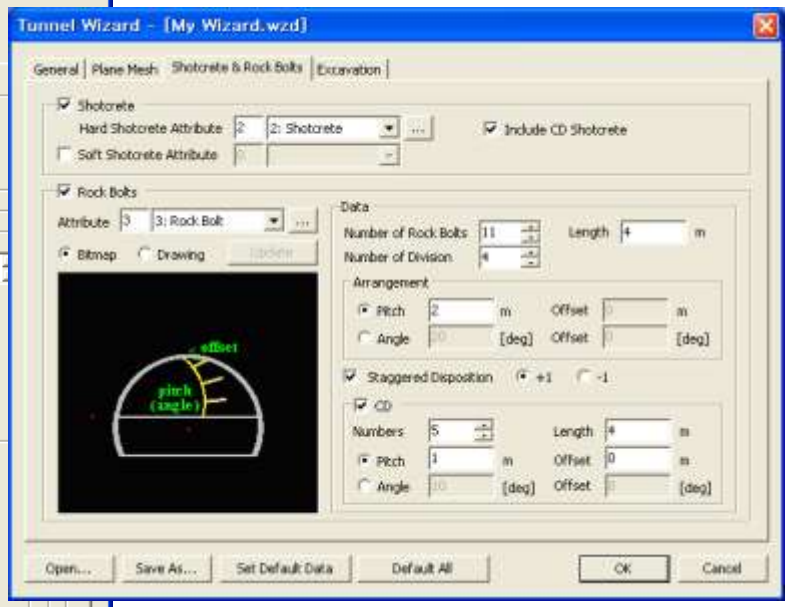
Step 1



Step 1: Define Number of Tunnels, Section Shape and Excavation Shape

Step 2



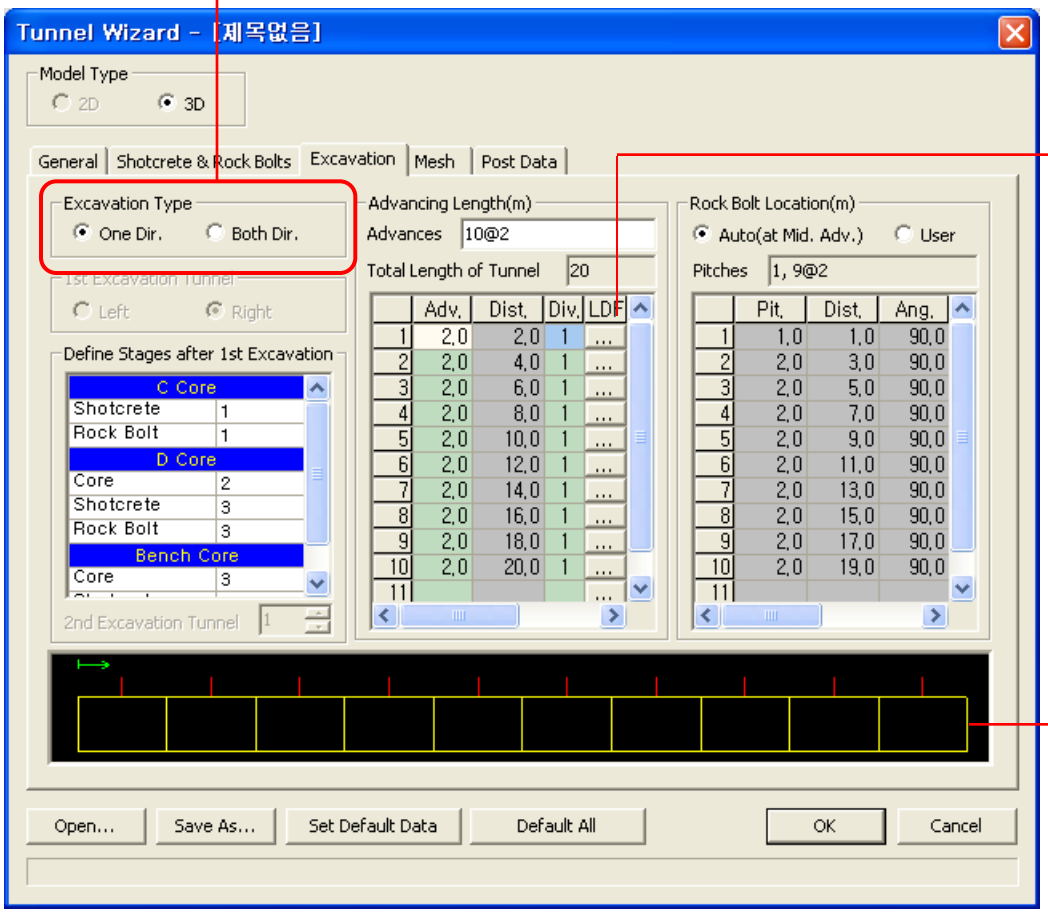


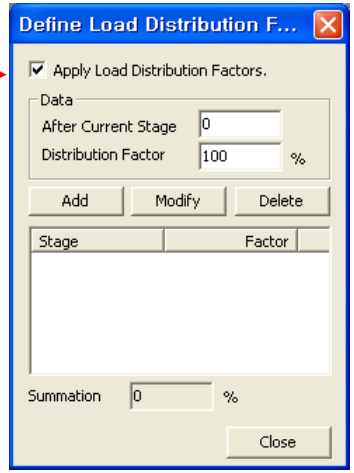
Options for CD Cut Type

Step 2: Define Shotcrete and Rock Bolts

Step 3

Excavation Type



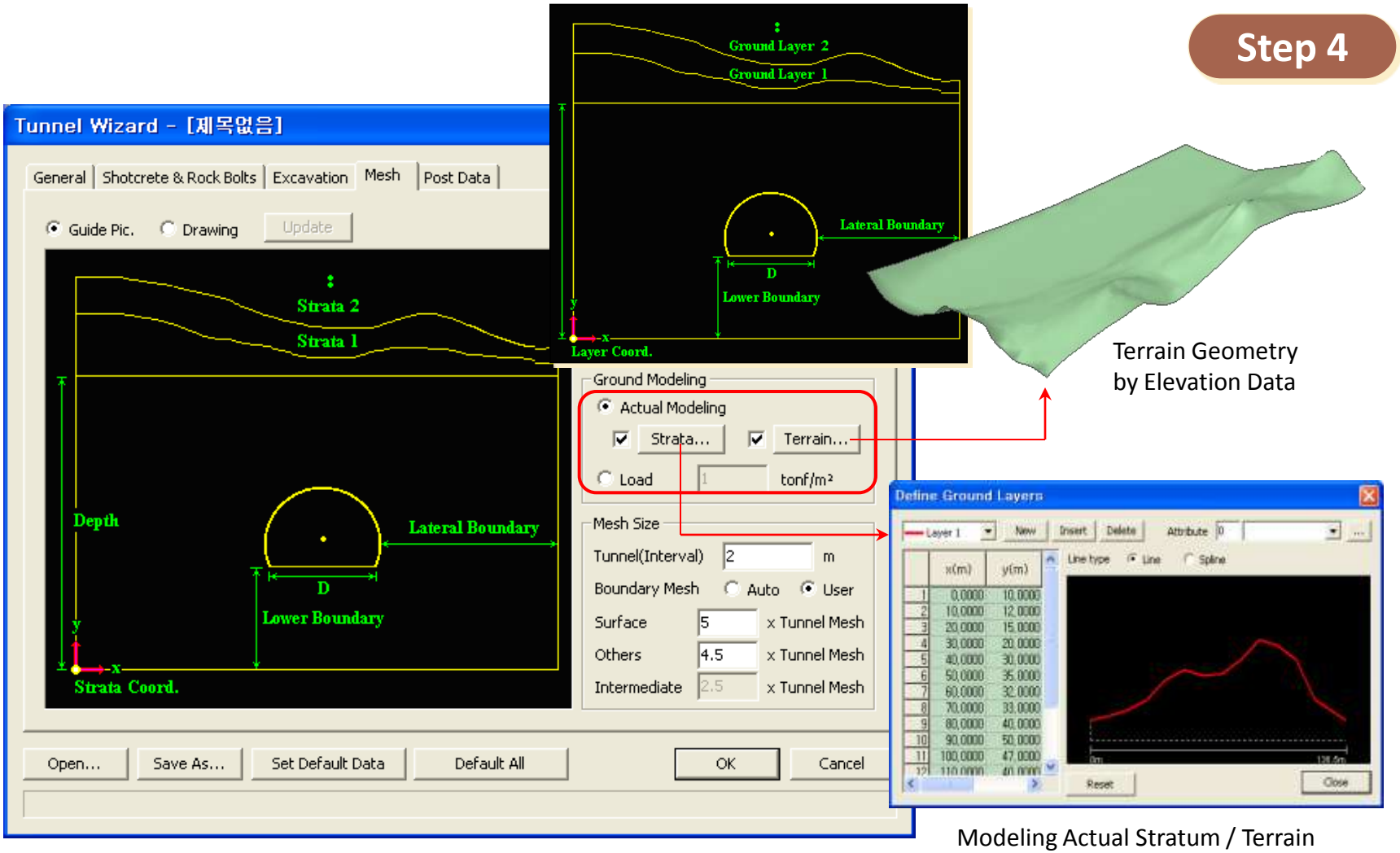


Define Load Distribution Factors

Simulation: Excavation & Rock Bolts

Step 3: Define Construction Stages (Excavation Type & Advance, etc.)

Step 4

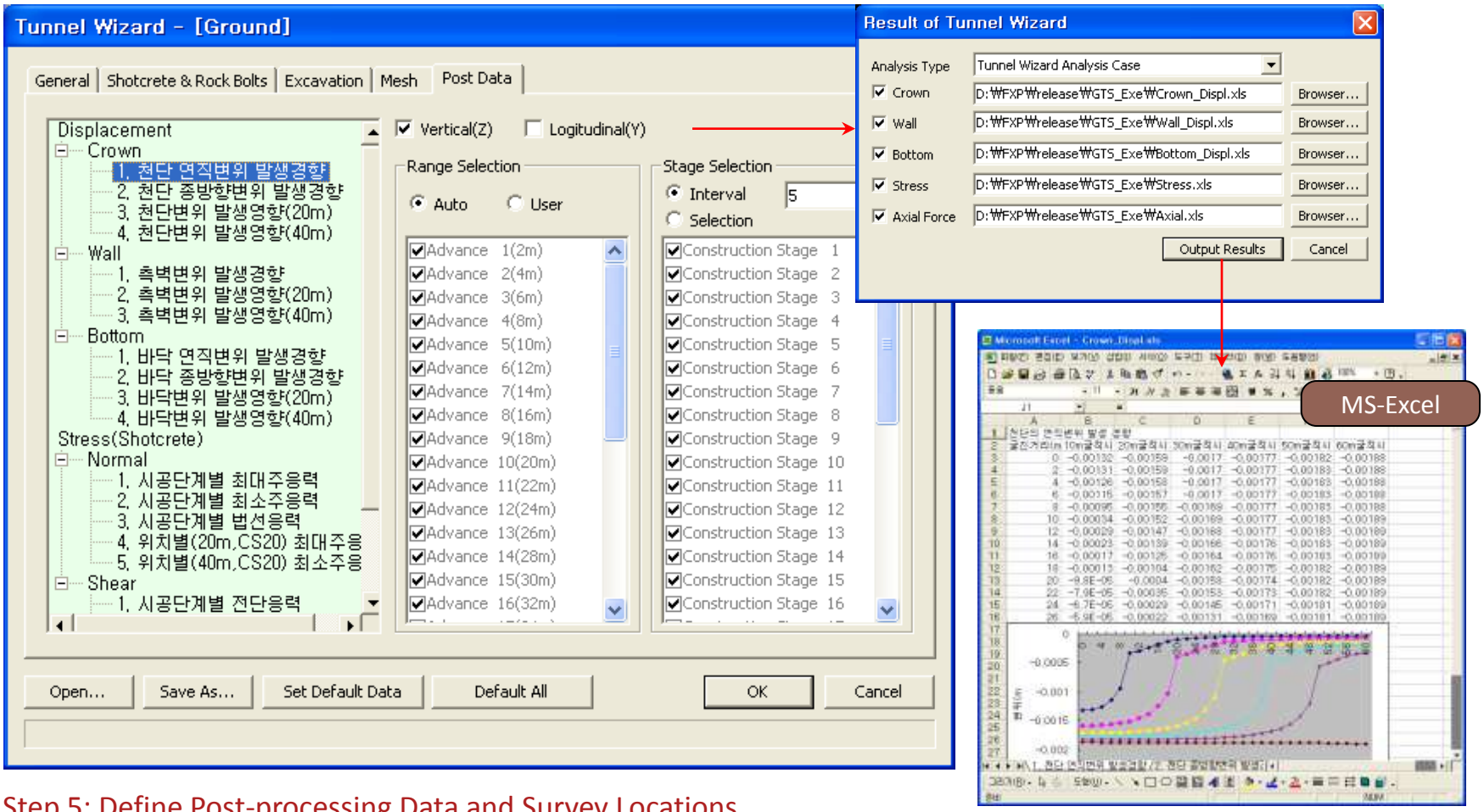


Terrain Geometry
by Elevation Data

Modeling Actual Stratum / Terrain

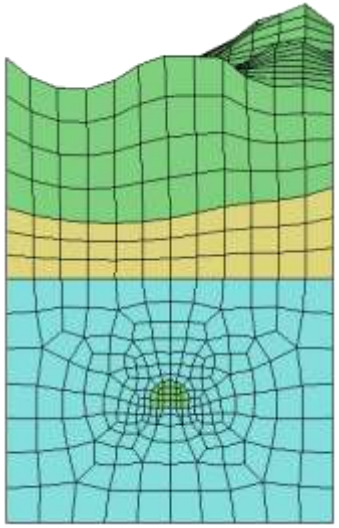
Step 4: Check Section Mesh and Define Strata & Terrain Geometries

Step 5

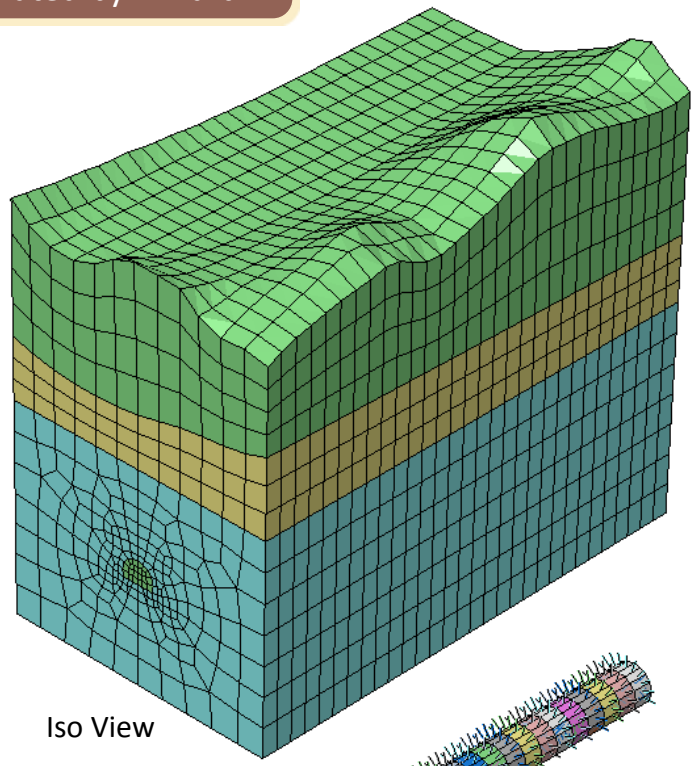


Step 5: Define Post-processing Data and Survey Locations

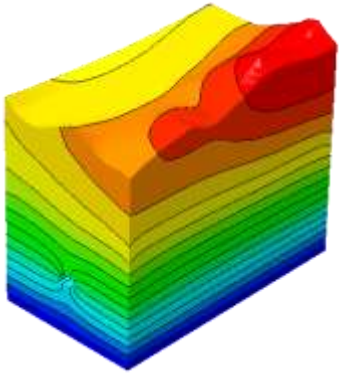
Complete Model Generated by Wizard

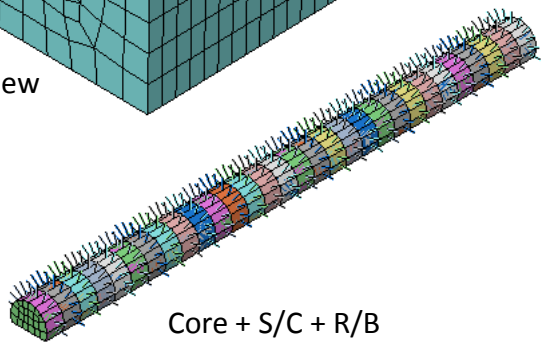


Front View



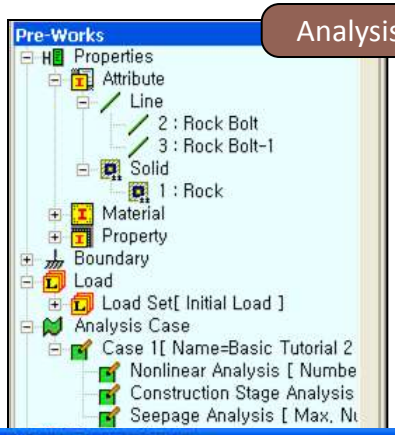
Iso View



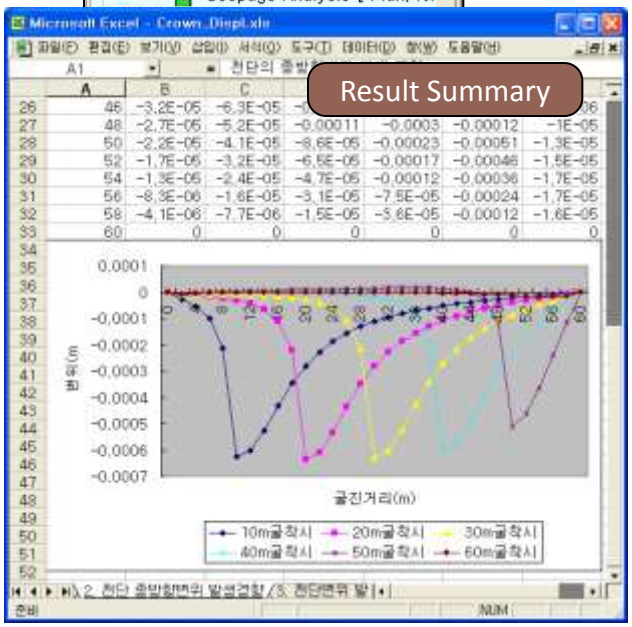


Core + S/C + R/B

Analysis Data



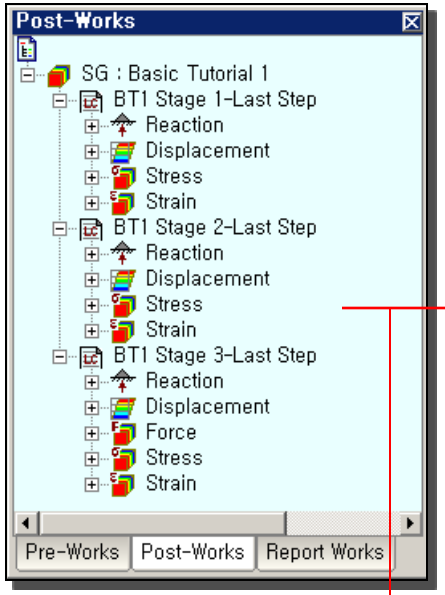
Result Summary



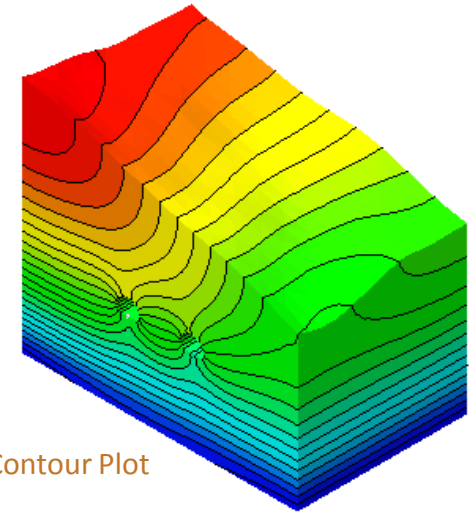
Post-processing

Complete Support for Visualization and Interpretation

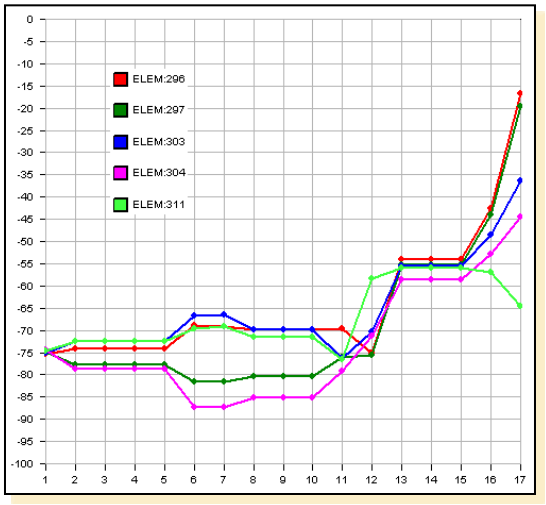
- Flexible User-control on Legends, Colors, Fonts, Magnification, etc.
- Multiple Plots, Graphs and Tables in Multiple Windows
- Deformed Shape Combined with Undeformed Shape (including Mode Shape)
- Local Plots defined by Geometrical Topology or User-selection
- Contour Plots and Animations (AVI)
- Iso-value Lines (2D) and Surfaces (3D)
- Clipping Planes and Slice Lines/Planes
- Partitioned Plots
- History Plots in Various Graphs and Animations (AVI)
- Result Values in MS-Excel compatible Tables
- Result Probe and Extraction
- Result Extraction for Construction Stage Analysis and Time History Analysis
- Screen-shots in WMF, BMP, PNG Picture Formats
- State-of-the-art Reports Generated by XML and HTML



Works Tree



Contour Plot



Result Graph

Node	T1	T2	T3
1	0.004394	0.000727	-0.004332
2	0.004824	-0.002044	-0.004367
3	0.006663	-0.004990	-0.004402
4	0.003325	0.000601	-0.003268
5	0.003477	-0.001071	-0.003307
6	0.004475	-0.002950	-0.003352
7	0.002358	0.000509	-0.002299
8	0.002311	-0.000262	-0.002296
9	0.002561	-0.001090	-0.002311
10	0.000667	0.000349	-0.000564
11	0.007416	-0.002552	-0.006962
12	0.004516	0.000760	-0.004451

Result Table

MS-Excel

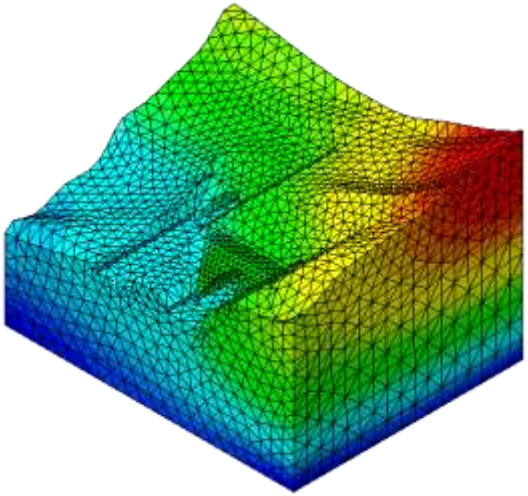
	A	B	C	D
1	1	0,004394	0,000727	-0,004332
2	2	0,004824	-0,002044	-0,004367
3	3	0,006663	-0,00499	-0,004402
4	4	0,003325	0,000601	-0,003268
5	5	0,003477	-0,001071	-0,003307
6	6	0,004475	-0,00295	-0,003352
7	7	0,002358	0,000509	-0,002299

■ Soil Stress Analysis

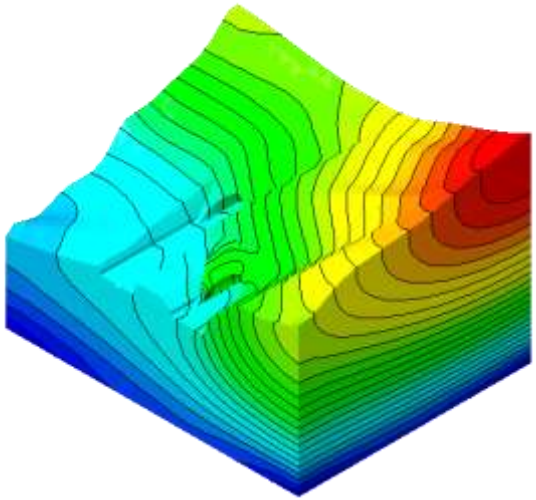
- Displacement
- Force (Truss, Embedded Truss), Moment (2D Shorcrete)
- Reaction
- **Stress (Soil, Shotcrete, Rock Bolt)**
  - Total: Sxx, Syy, Szz, Sxy, Syz, Sxz
  - Effective: Sxx, Syy, Szz, Sxy, Syz, Sxz
  - Principal Stresses (P1, P2, P3)
  - Pore Pressure
  - Mean Effective, Mean Total
  - **Safety Factor**
  - **Yield Ratio**
- **Strain**
  - Exx, Eyy, Ezz, Exy, Eyz, Exz
  - Principal Strains (E1, E2, E3)
  - Max Shear Strain
  - Deviatoric Strain
  - Volumetric Strain

■ Seepage Analysis

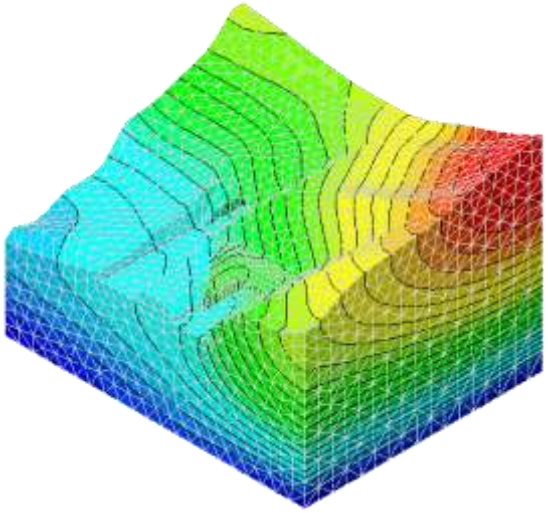
- Velocity
- Pressure, Total Head
- Head Gradient
- Flow



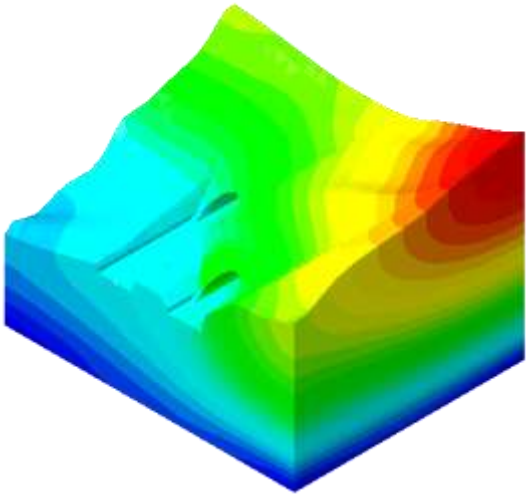
Contour with Mesh



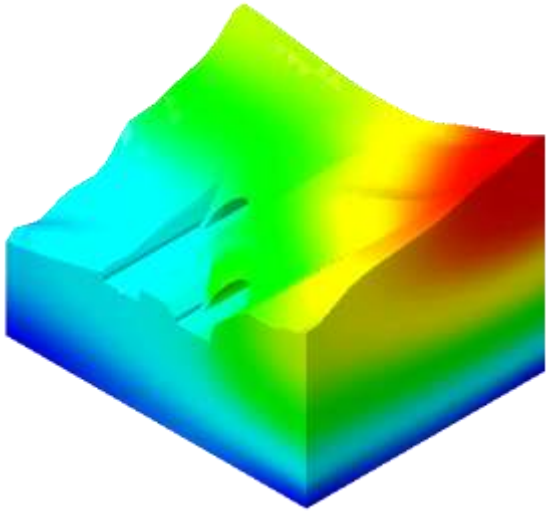
Contour with Iso-line



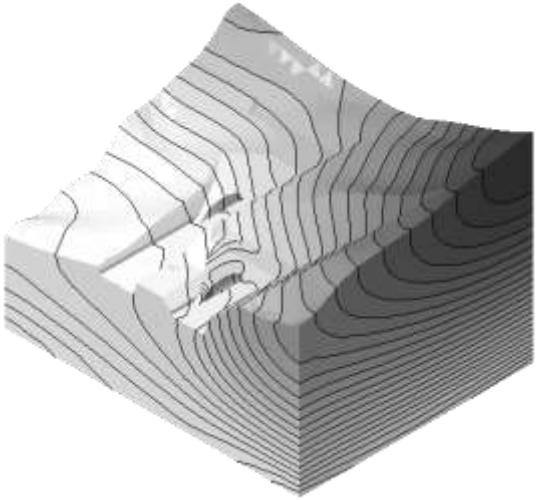
Contour with Mesh & Iso-line



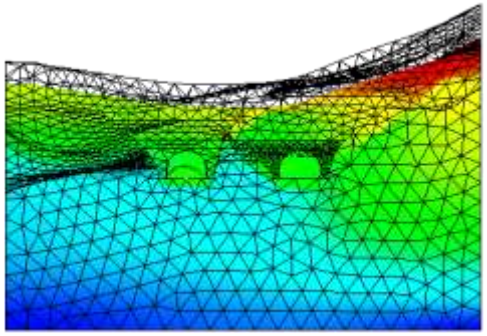
Contour without Mesh



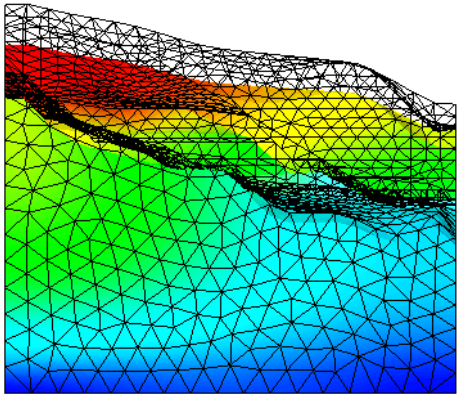
Gradient Contour



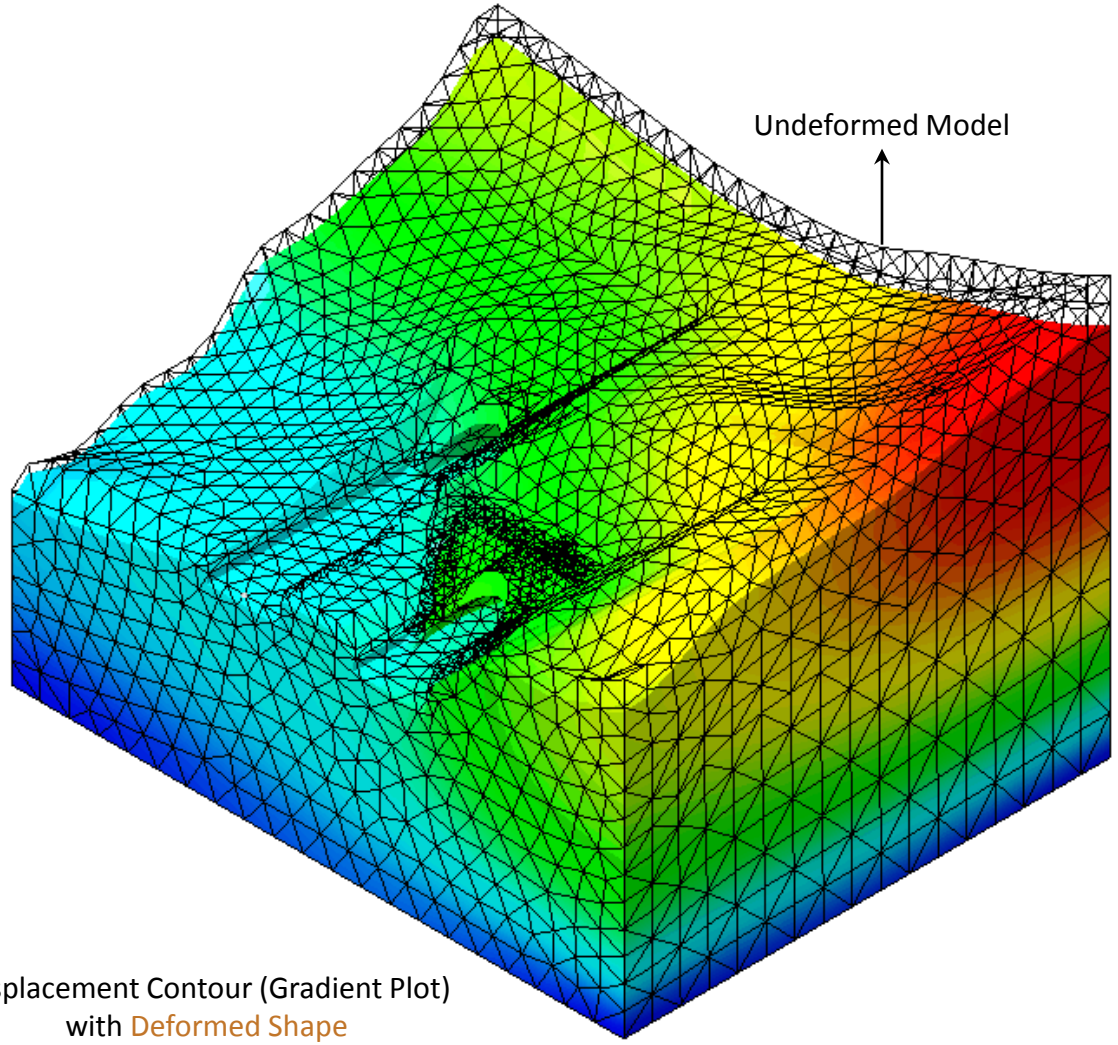
Gray Contour



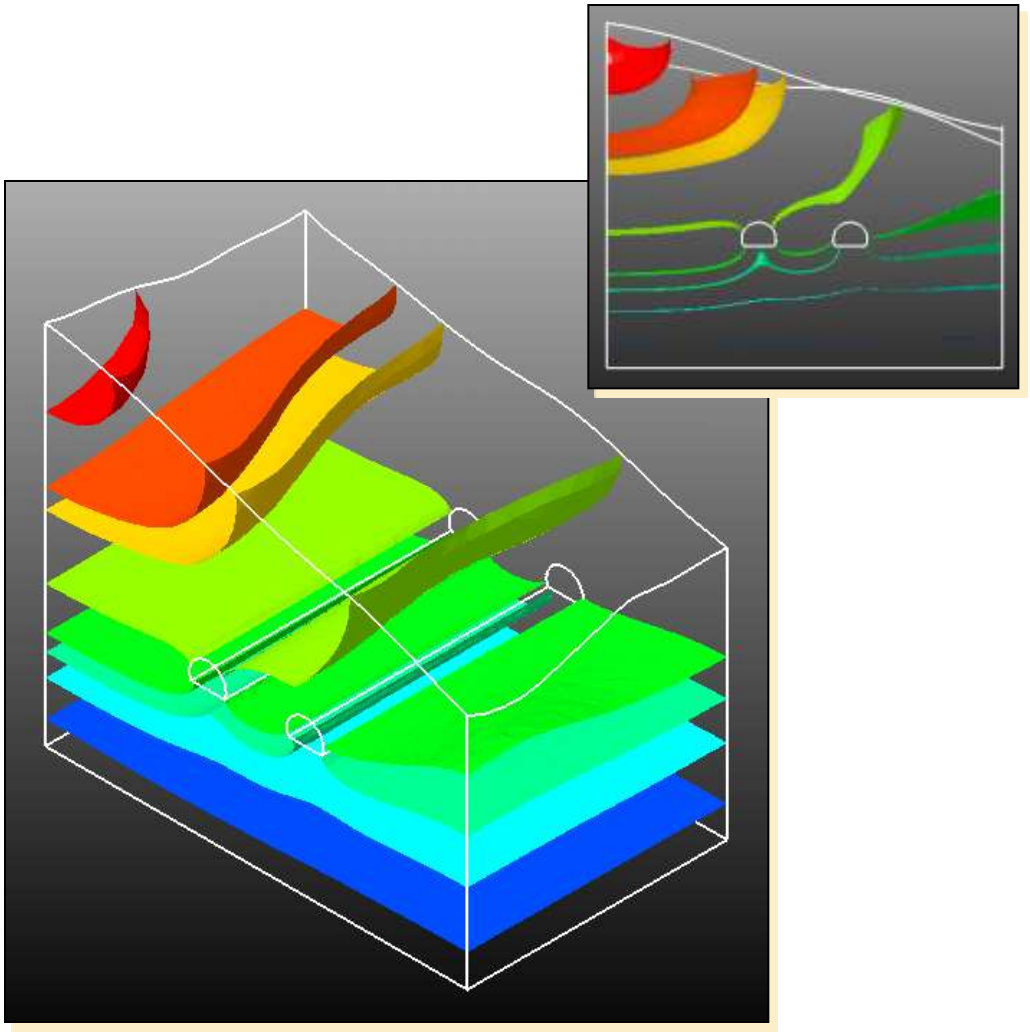
Front View



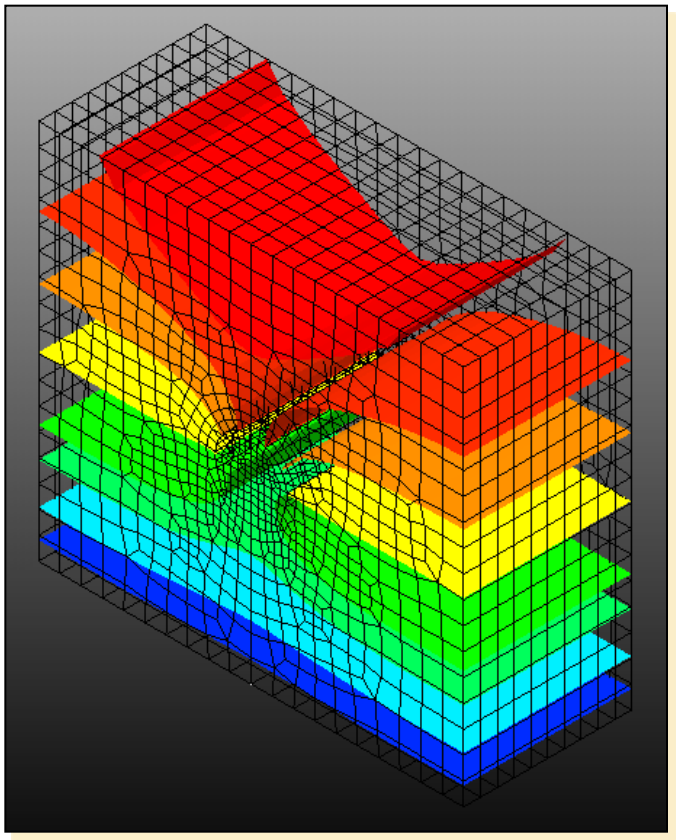
Side View



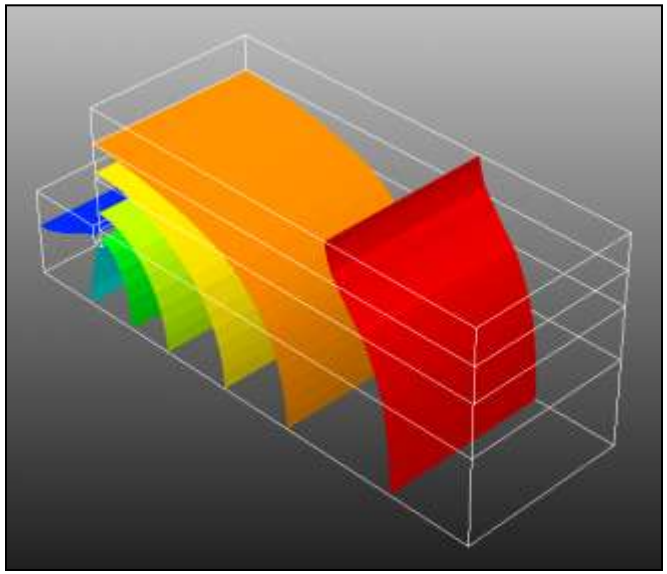
Displacement Contour (Gradient Plot)
with Deformed Shape



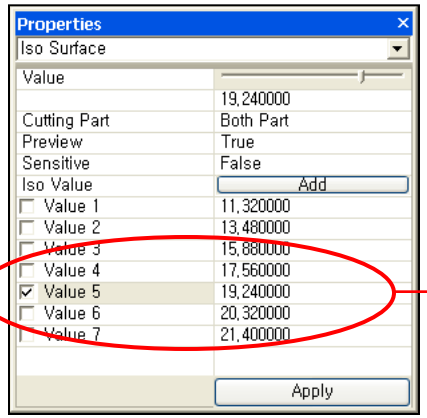
Multiple Iso-surfaces with Feature-Edge



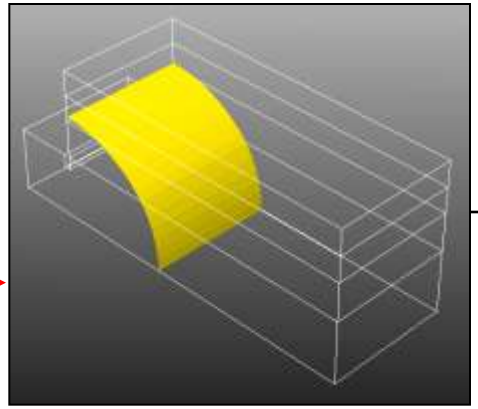
Multiple Iso-surfaces with Mesh

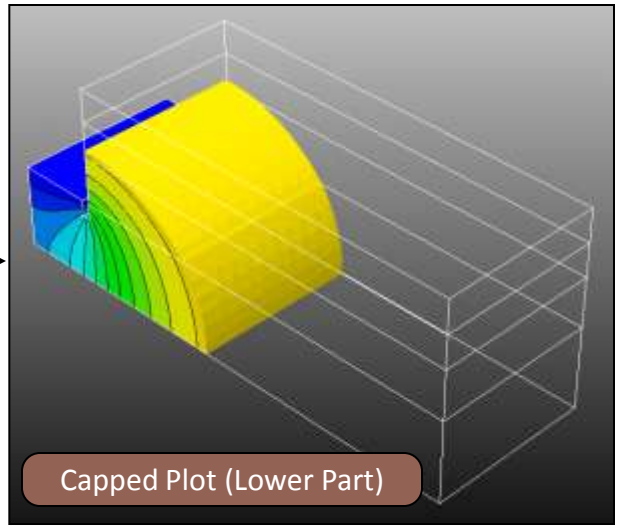


Original Iso-surface Plot (Multiple Plots)

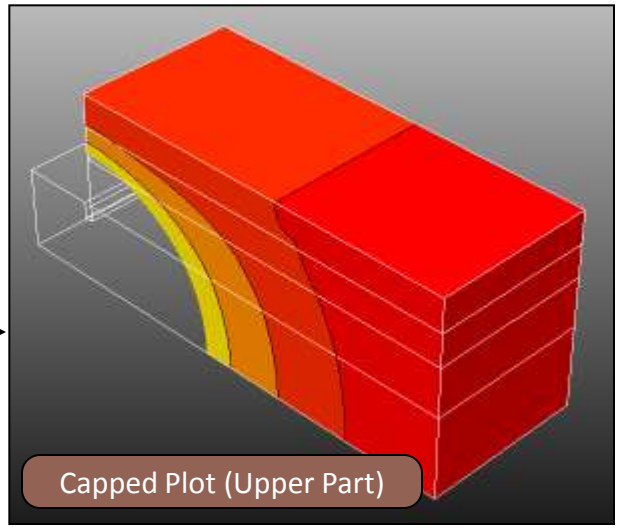


Base Iso-surface

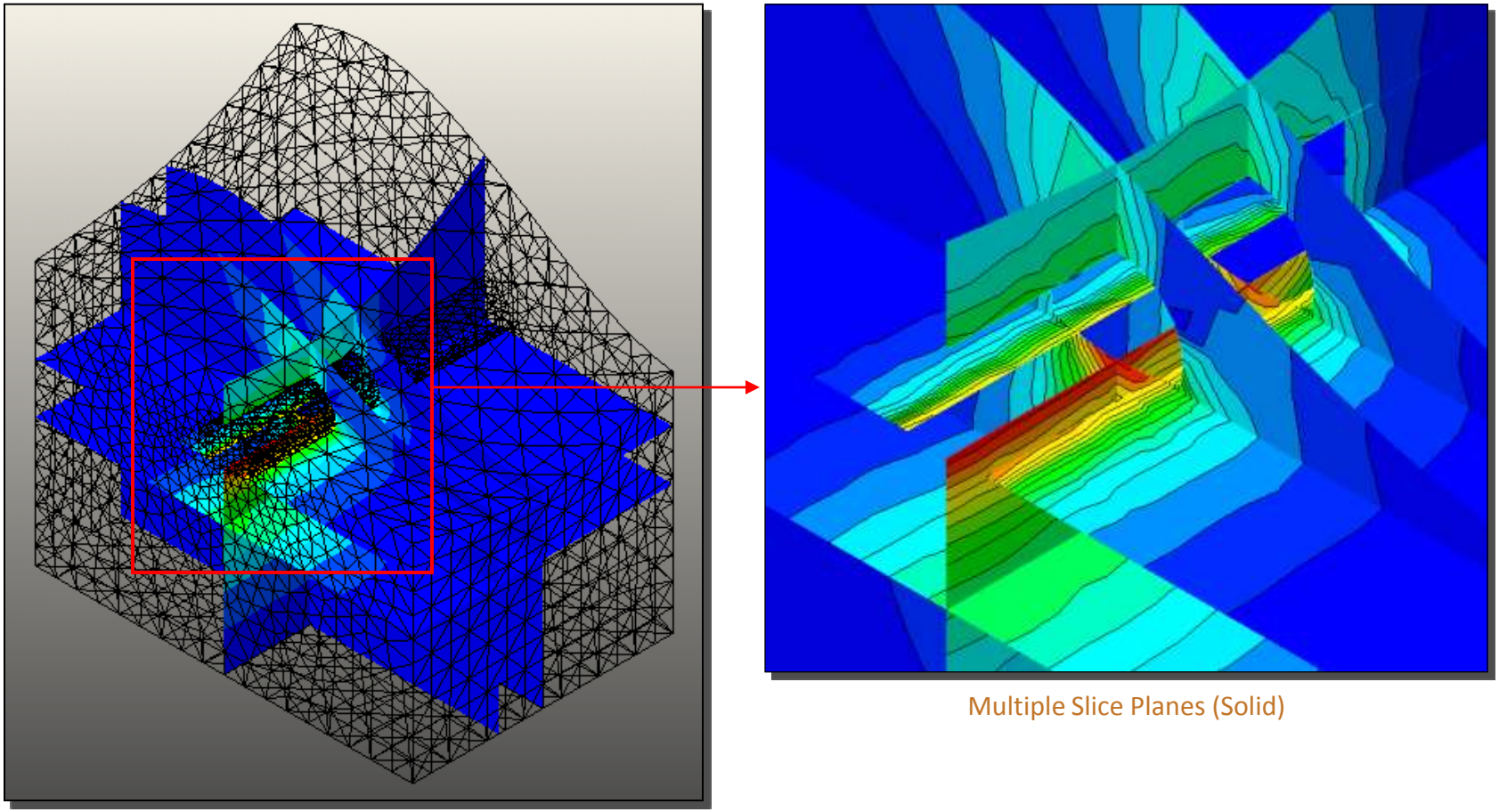




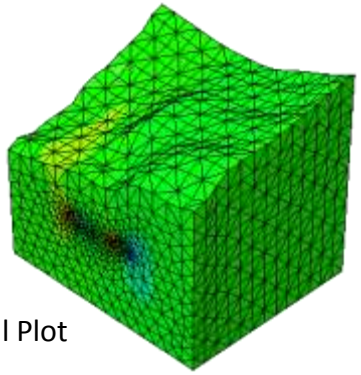
Capped Plot (Lower Part)



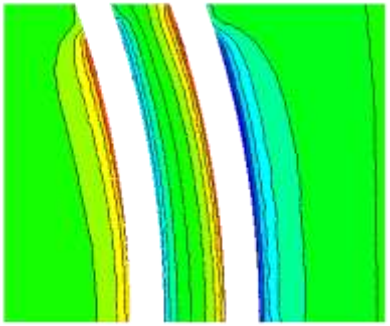
Capped Plot (Upper Part)



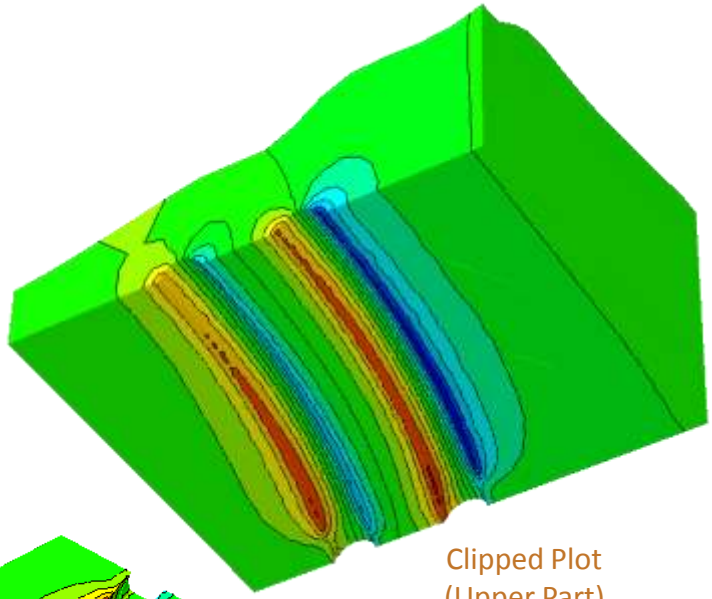
Multiple Slice Planes (Solid)



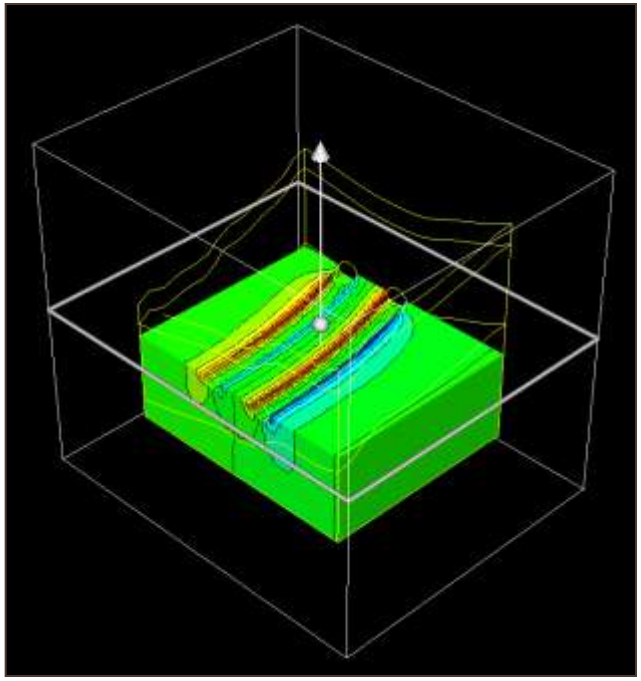
Original Plot



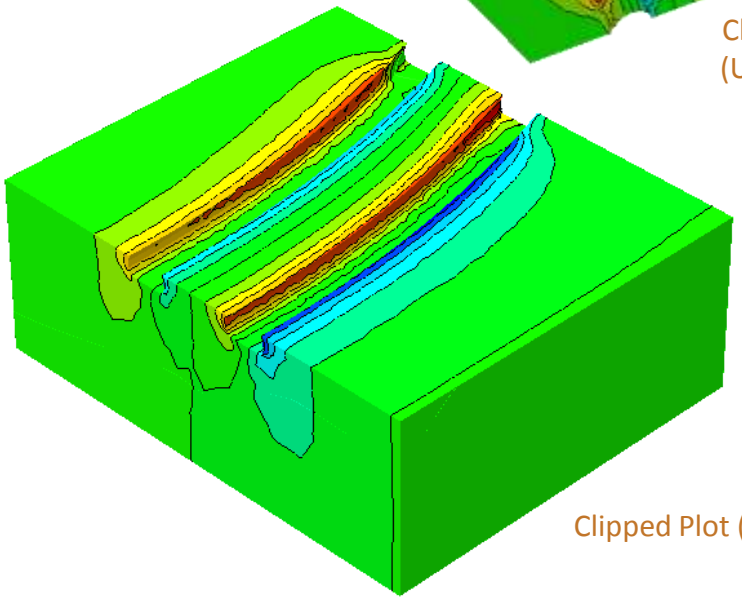
Curved Tunnel (Slice Plot)



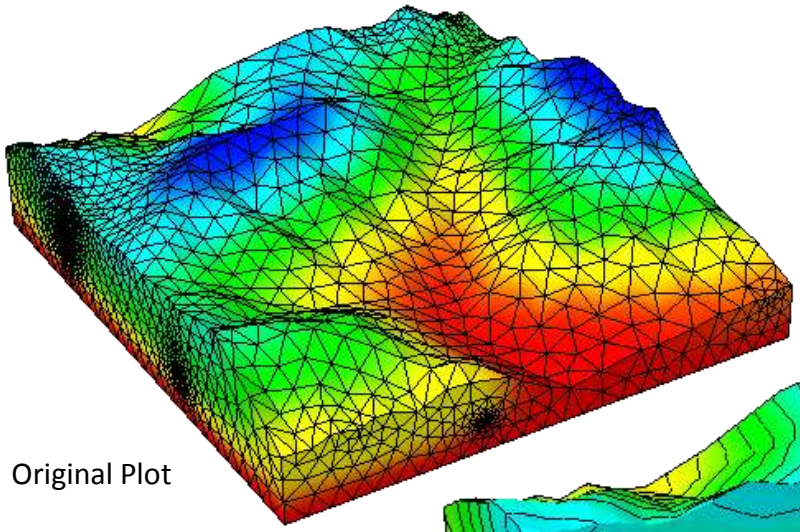
Clipped Plot
(Upper Part)



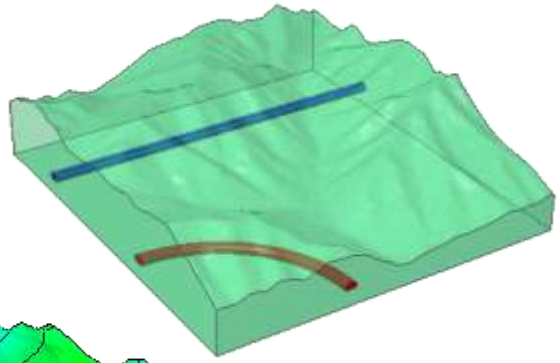
Clipping Plane Definition by Mouse Dragging

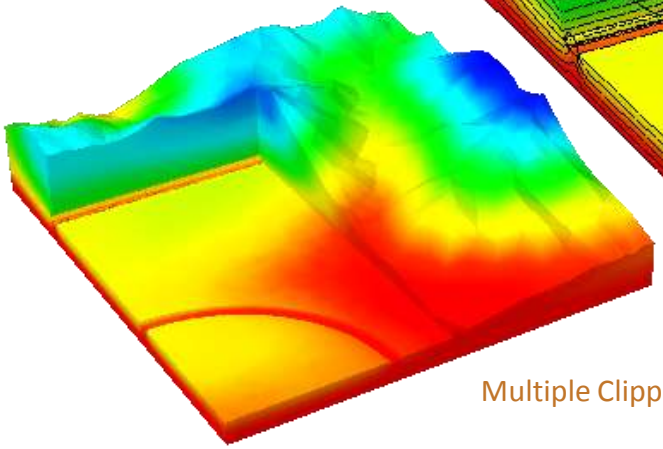


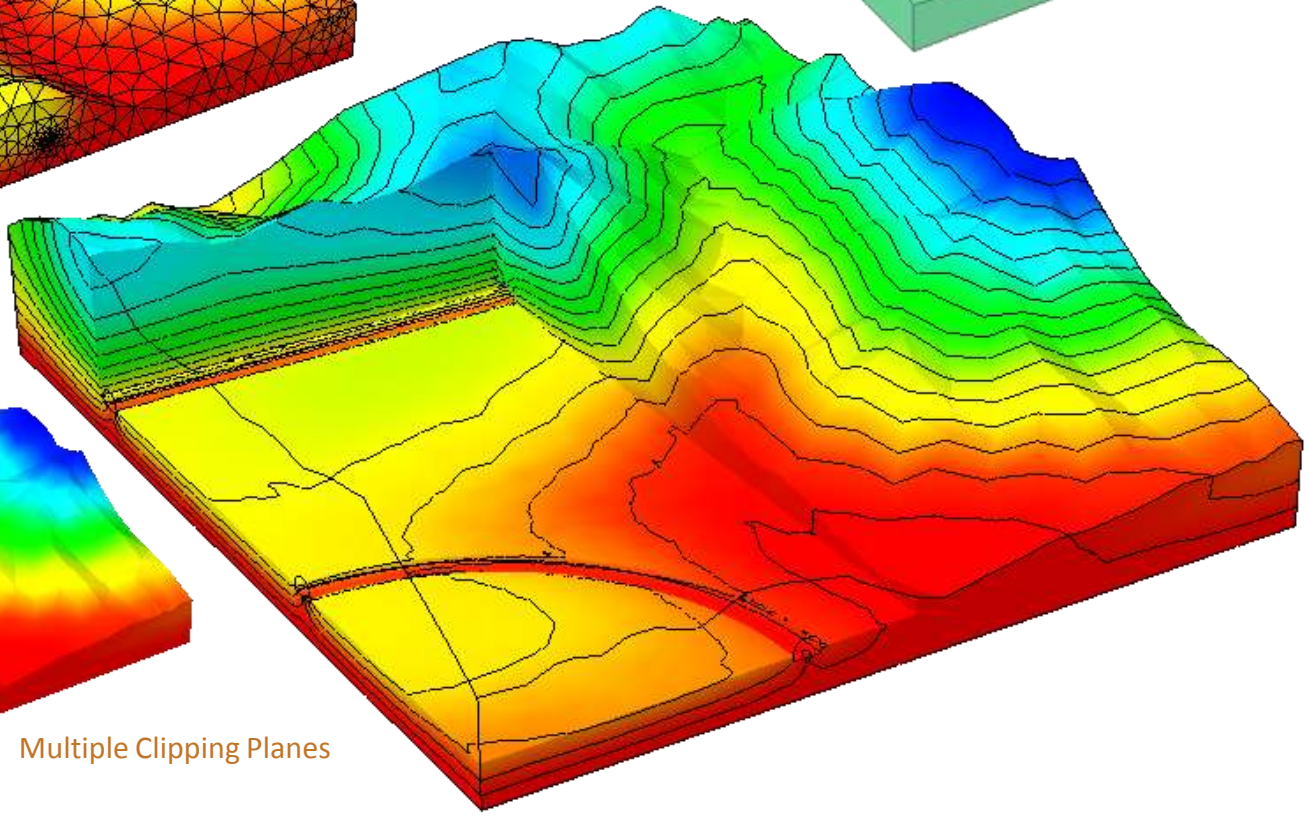
Clipped Plot (Lower Part)



Original Plot



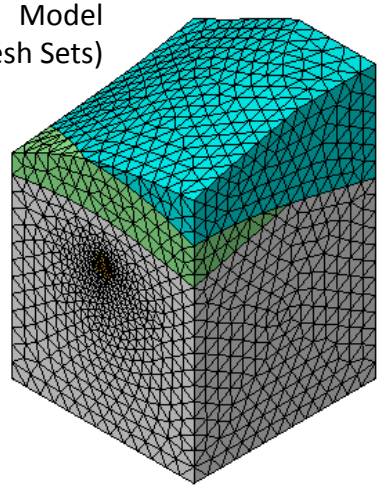


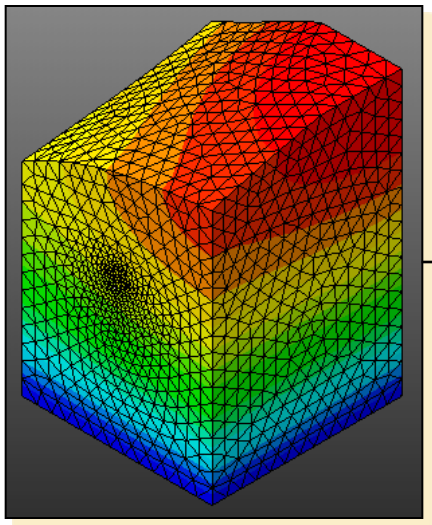


Multiple Clipping Planes

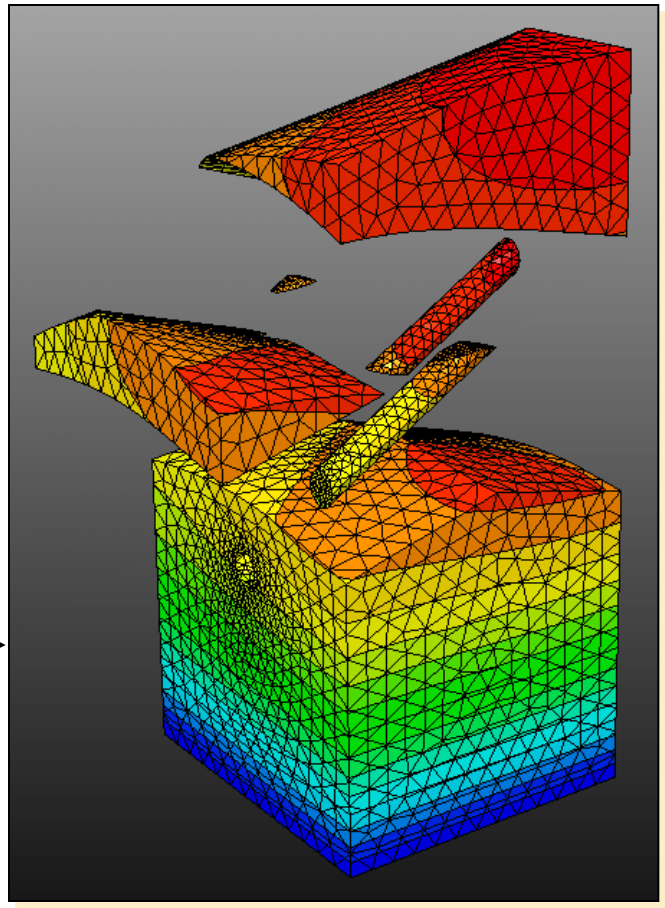
Mesh Set based Partition

Model
(6 Mesh Sets)

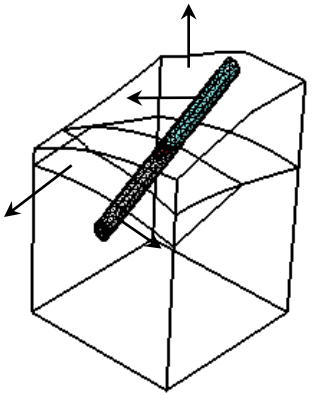




Original Plot

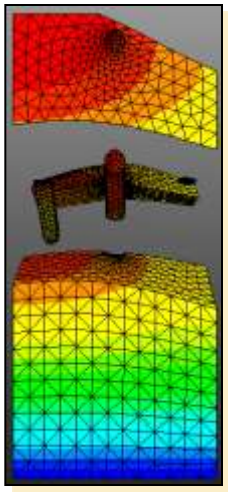


Partitioned Plot

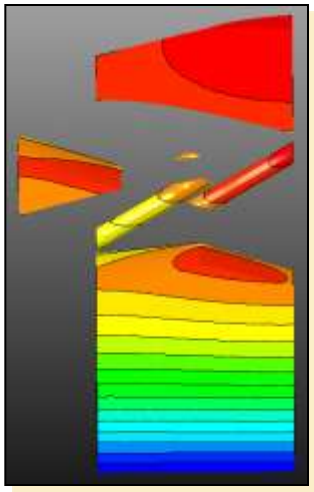


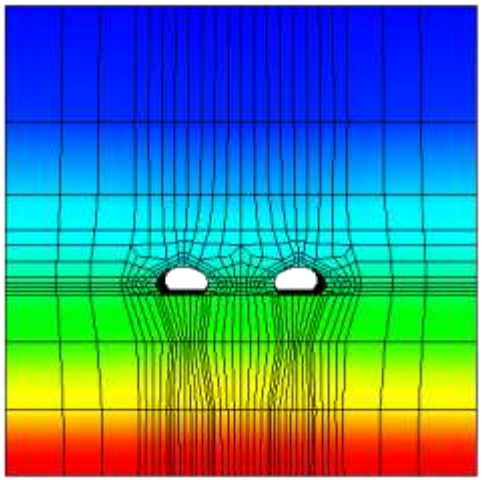
Detach mesh sets by mouse dragging

Front View

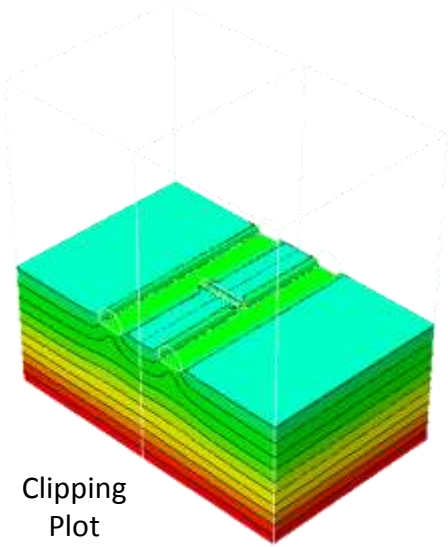


Side View

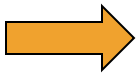




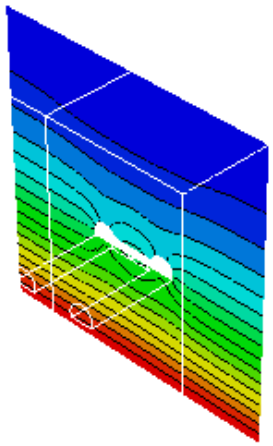
Mirrored Contour with Deformed Shape



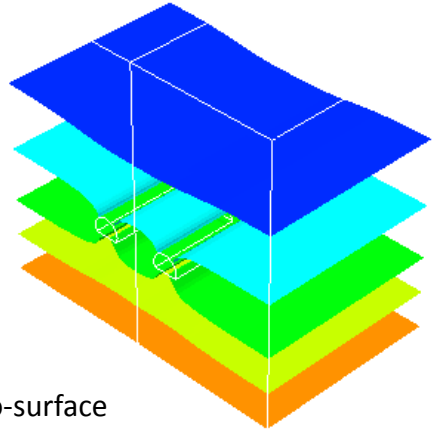
Clipping Plot



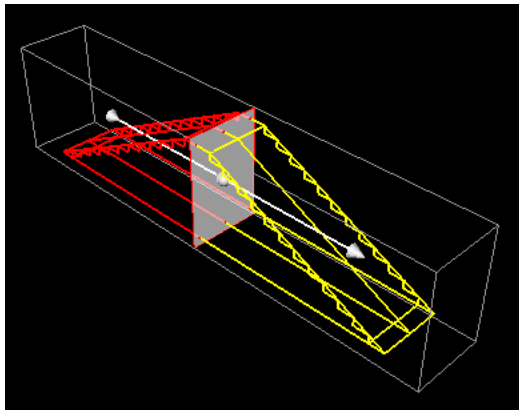
Symmetric Model

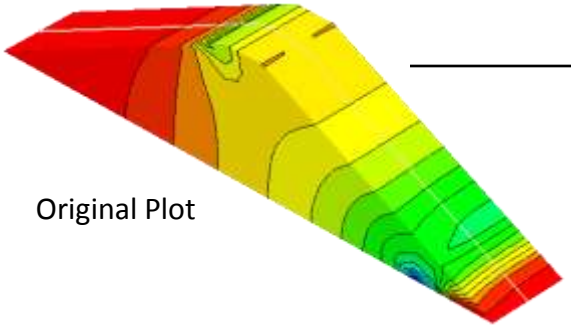


Slice Plot

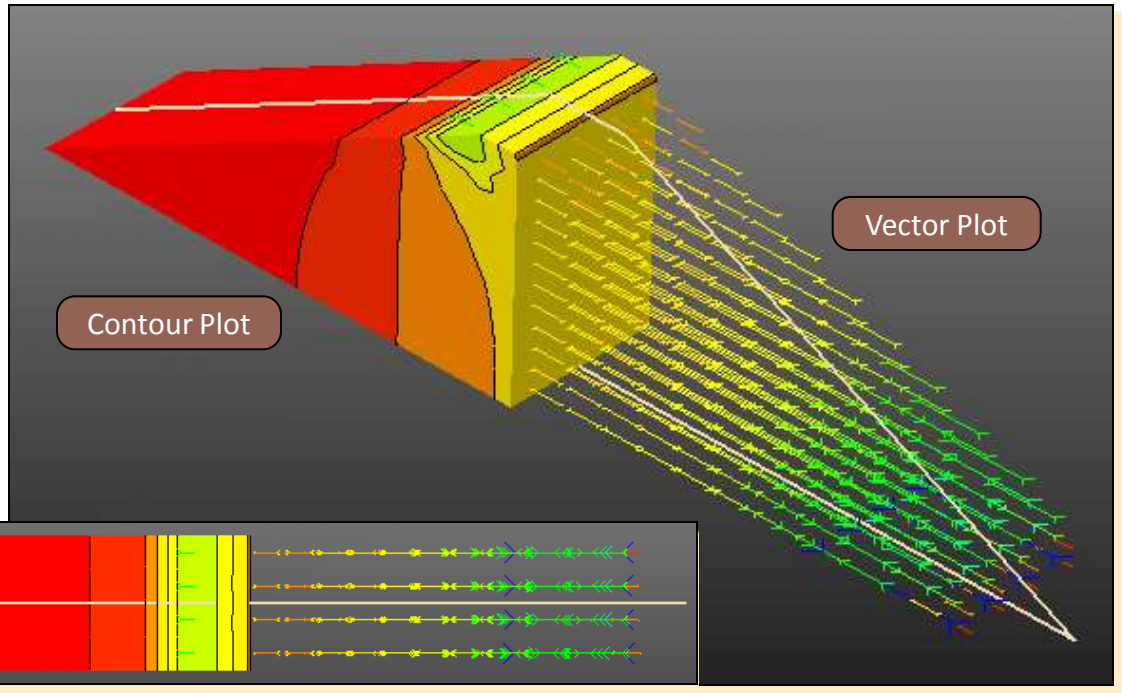


Iso-surface Plot

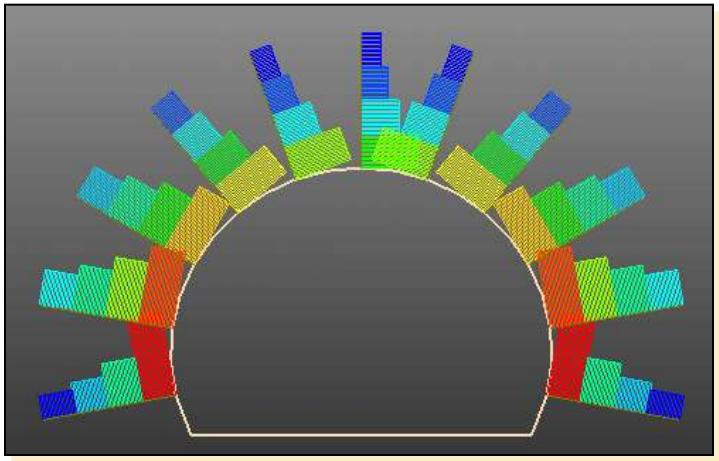




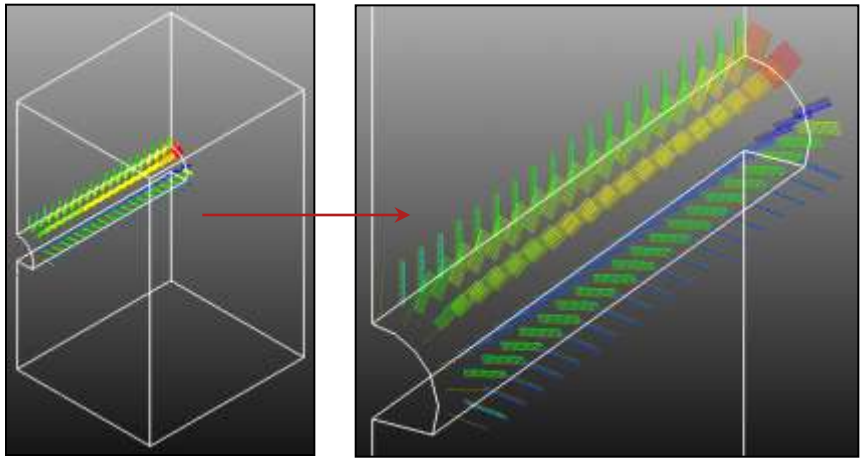
Original Plot



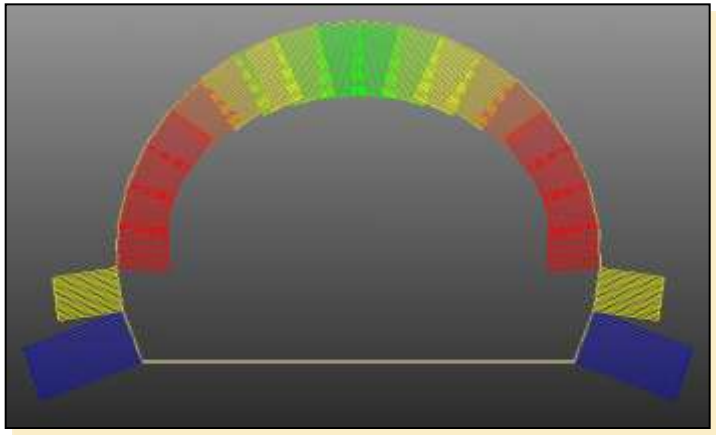
Clipped Contour Plot + Vector Plot



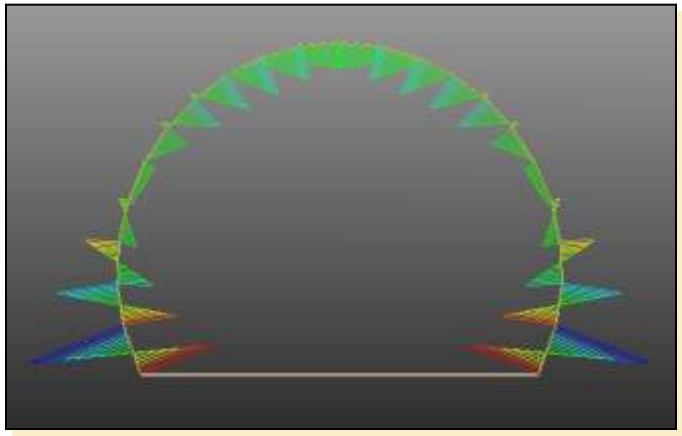
Axial Force of 2D Embedded Trusses (R/B)



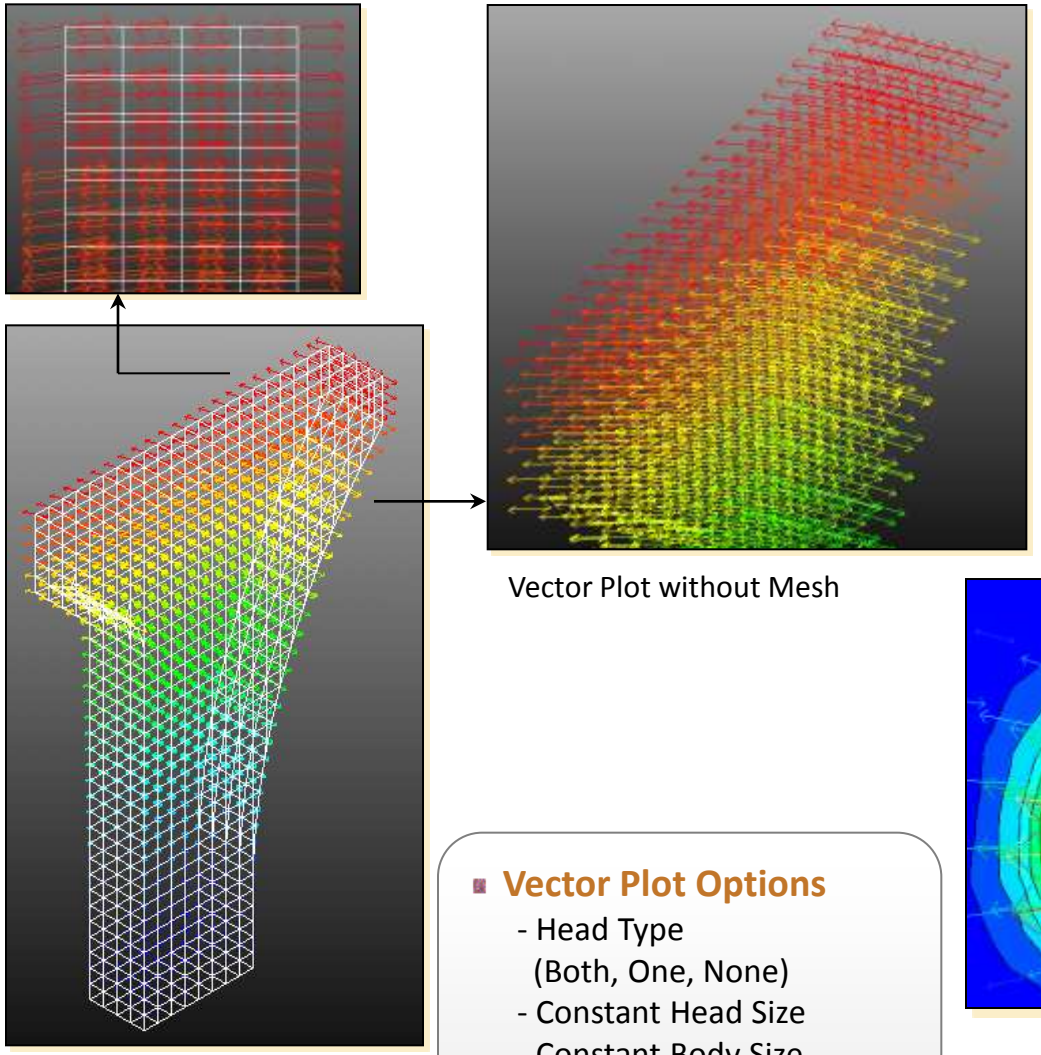
Axial Force of 3D Embedded Trusses (R/B)



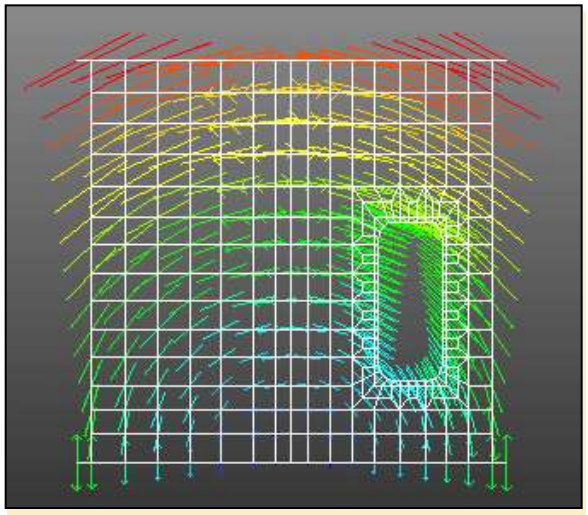
Beam Force Diagram (2D Shotcrete)

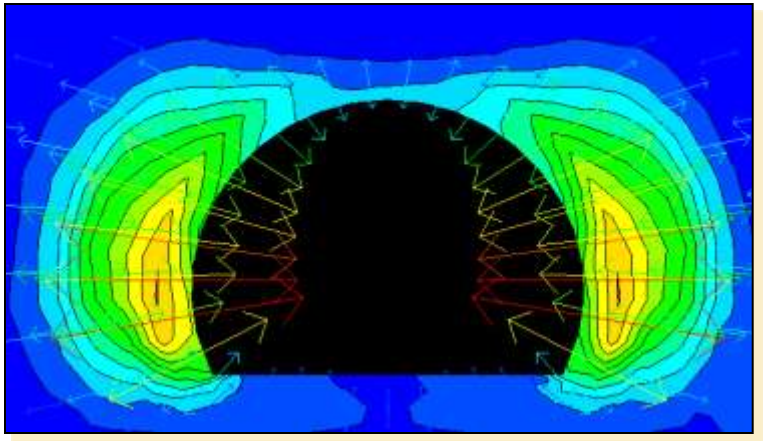


Beam Moment Diagram (2D Shotcrete)



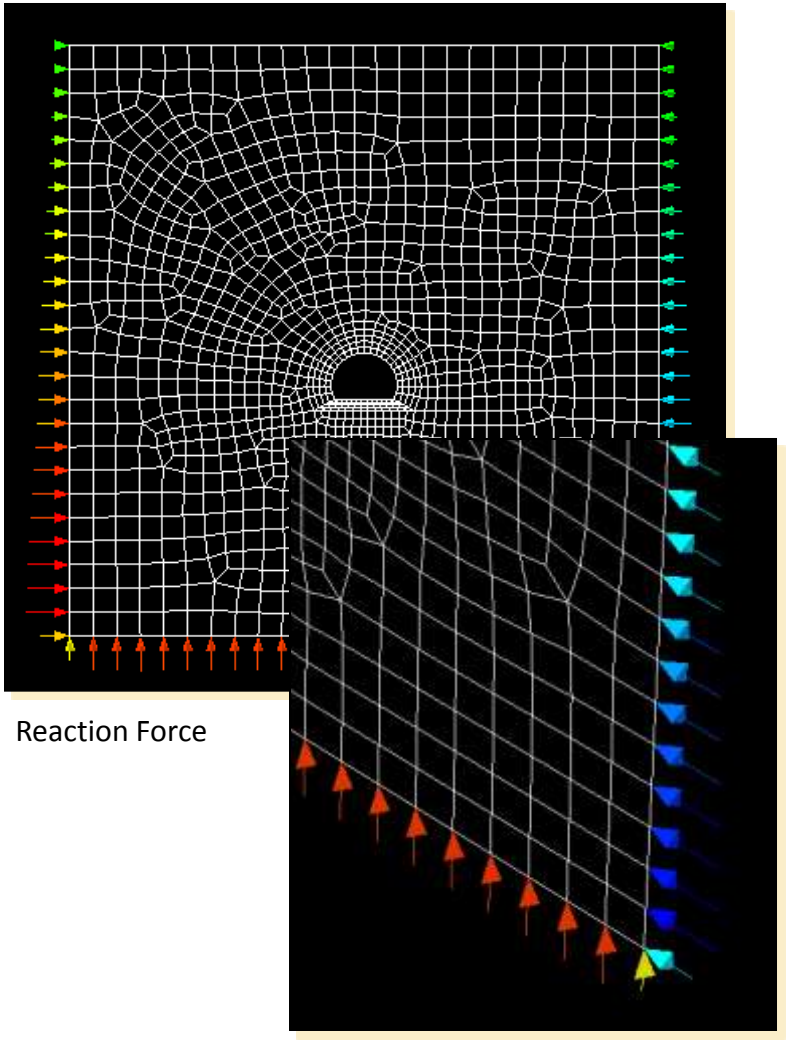
Vector Plot without Mesh



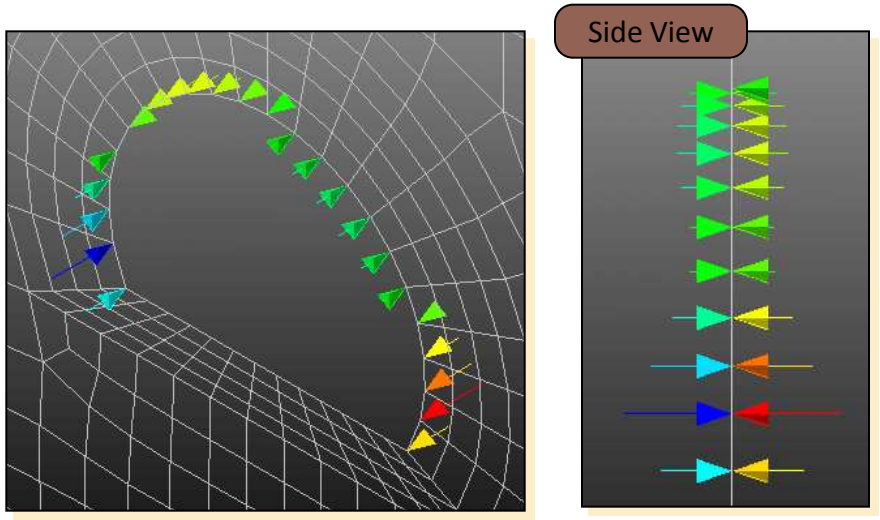


Vector Plot on Contour (Principal Strain)

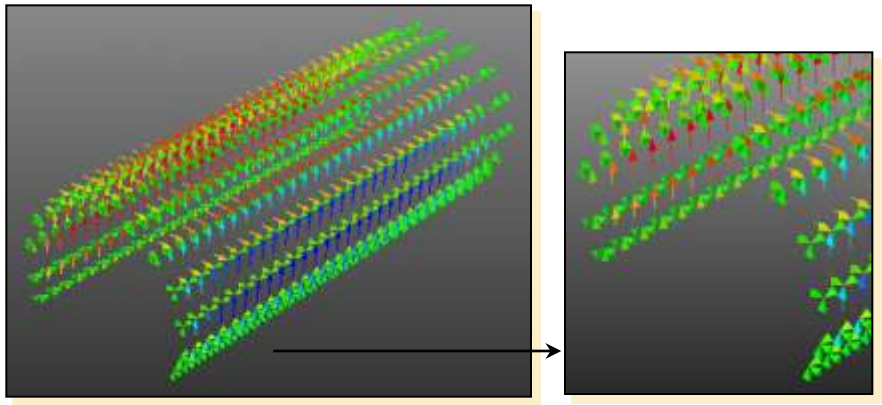
- **Vector Plot Options**
  - Head Type (Both, One, None)
  - Constant Head Size
  - Constant Body Size



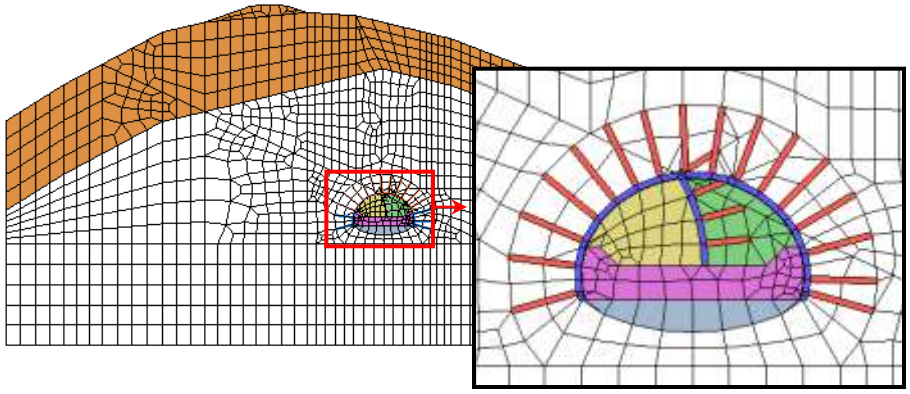
Reaction Force

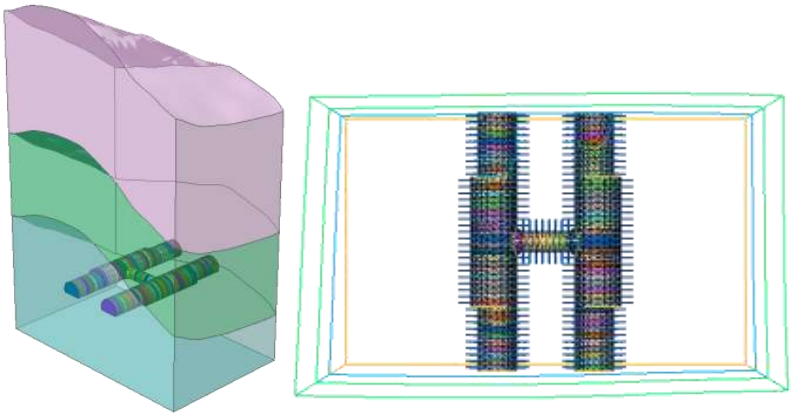


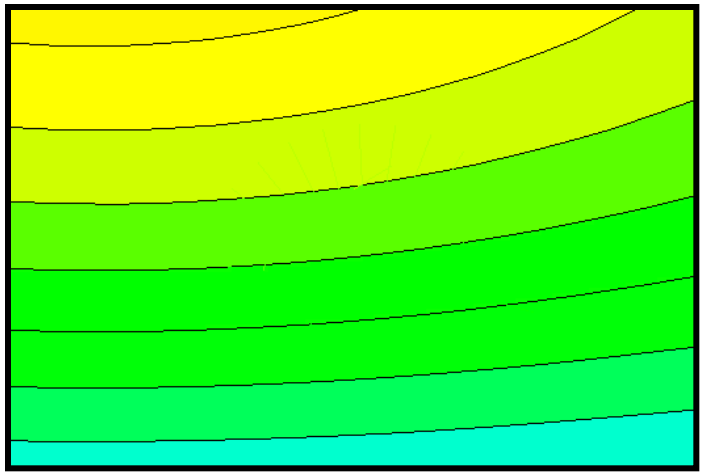
Reaction Moment (2D Shotcrete)



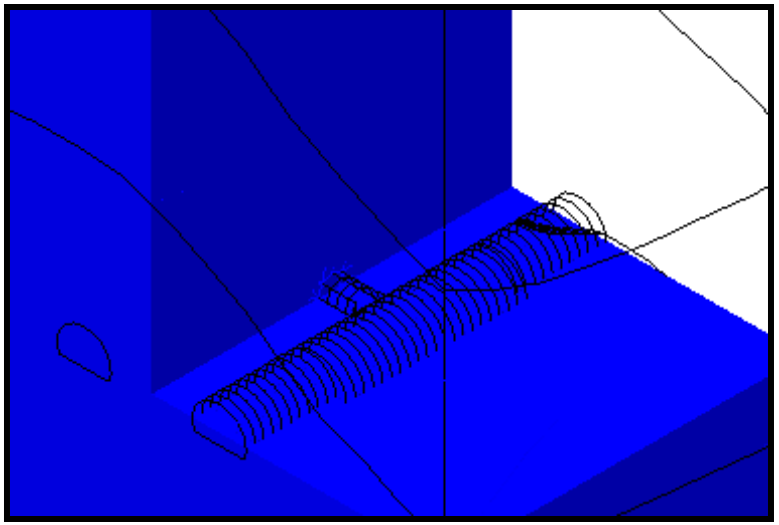
Reaction Moment (3D Shotcrete)





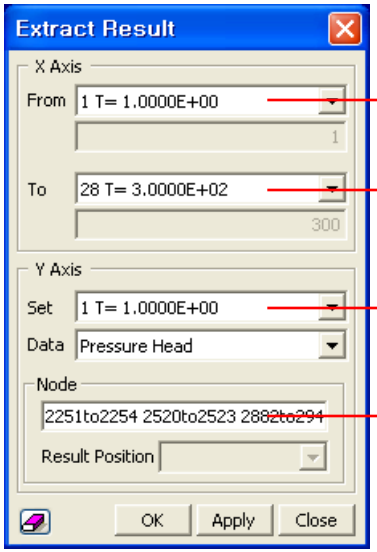


2D Construction Stage Analysis



3D Construction Stage Analysis
(Clipped Plot)

Click Animation to Start…

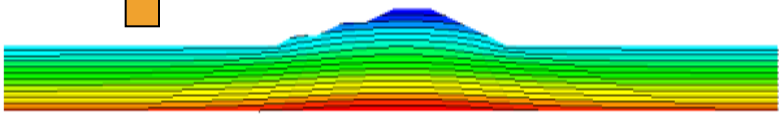


Start Stage / Time

End Stage / Time

Stage / Output Set
Result Type

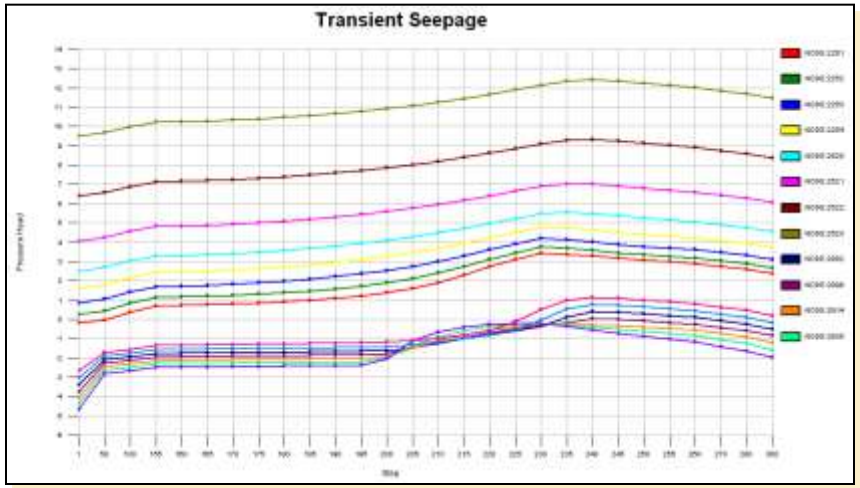
Node / Element IDs



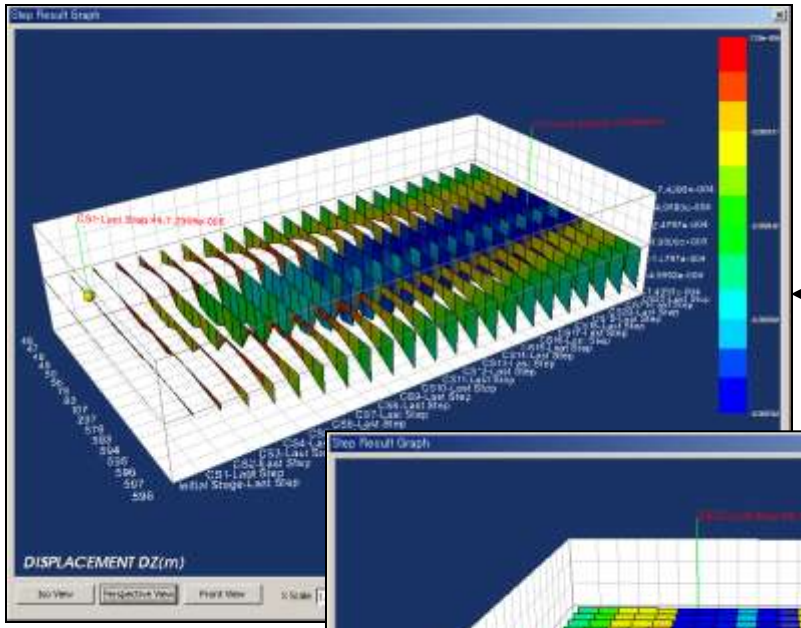
Transient Seepage Result (Pressure Head)

MS-Excel compatible Table
(Time & Nodal Pressure Head)

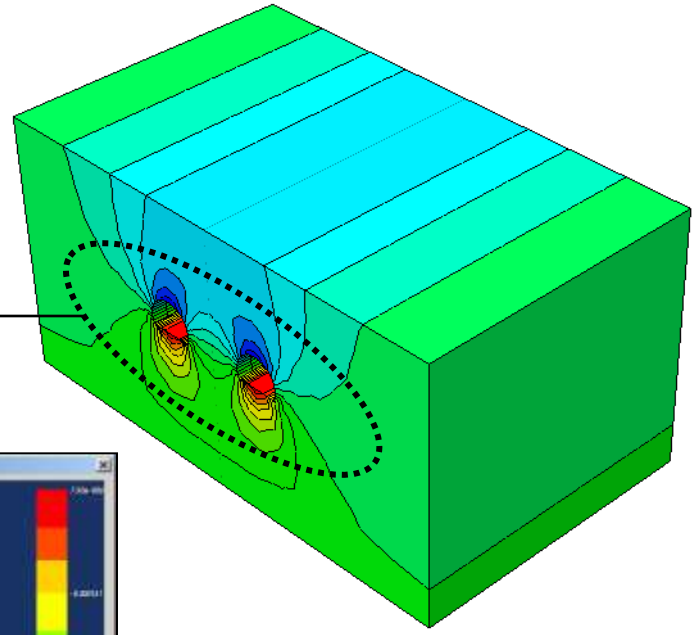
Graph (Time vs. Pressure Head)

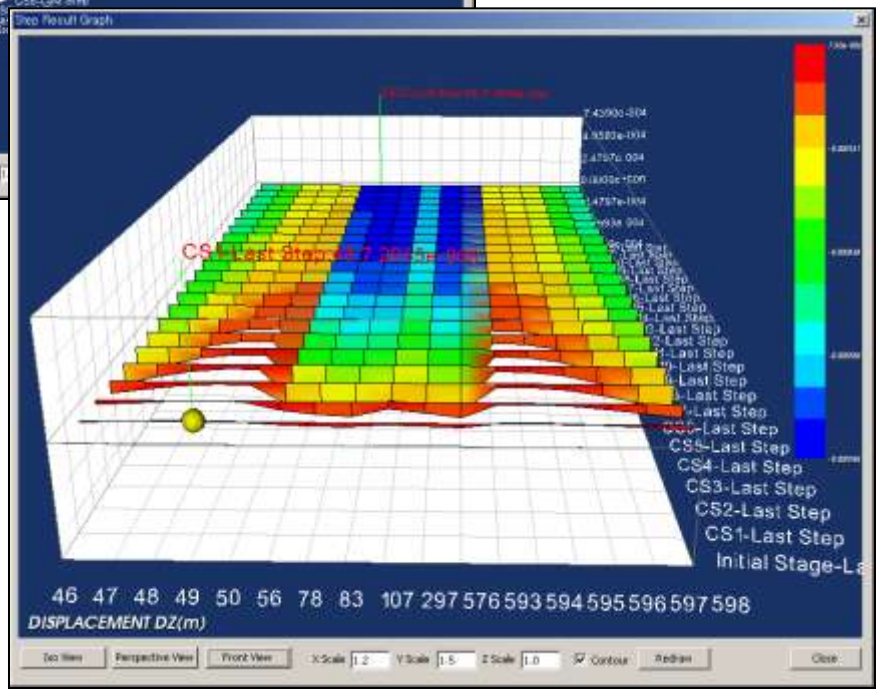


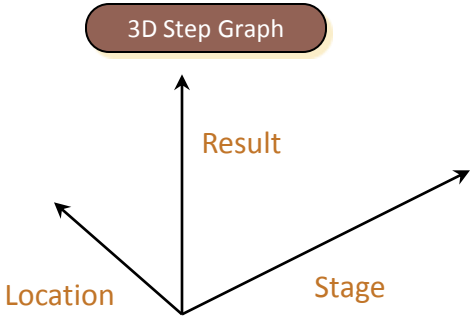
- **Results can be extracted based on:**
- Construction Stage
- Time (Time History / Transient Seepage Analysis)
- Coordinates (User-defined Coordinate Sys.)

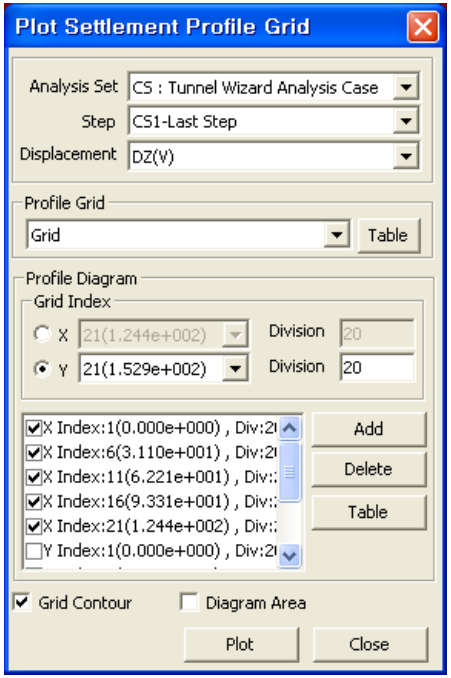


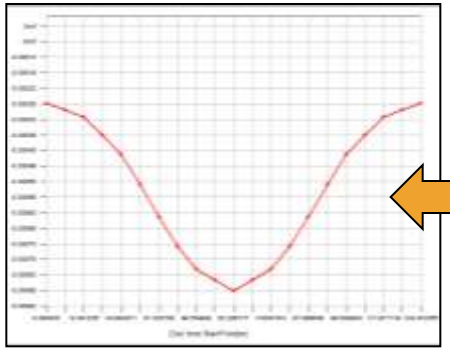
3D Step Graph



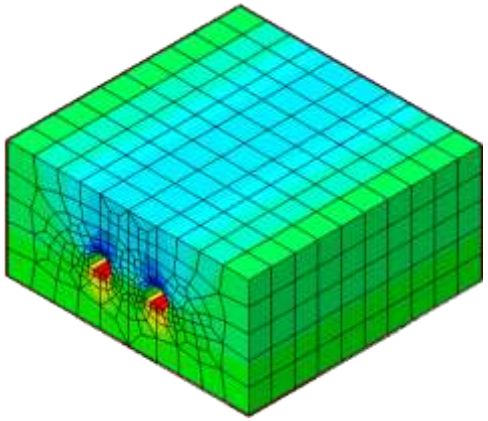




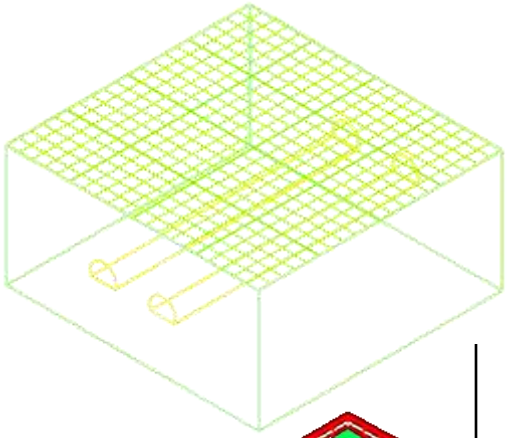


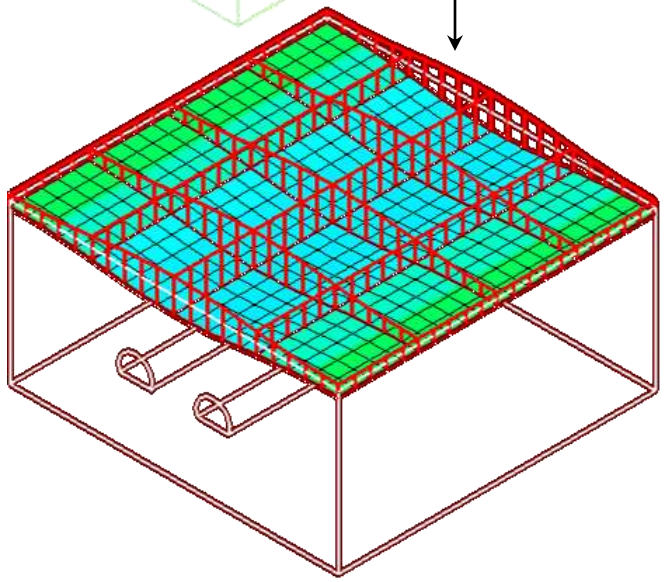


Mesh & Displacement Contour



Define Settlement Grids

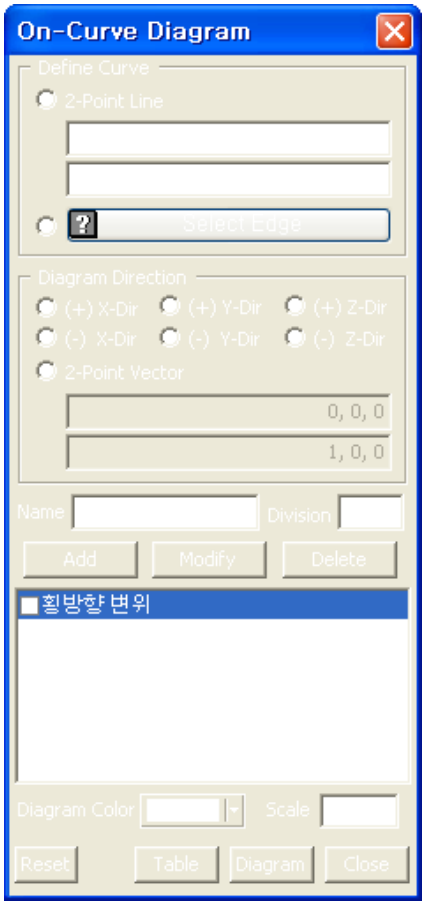


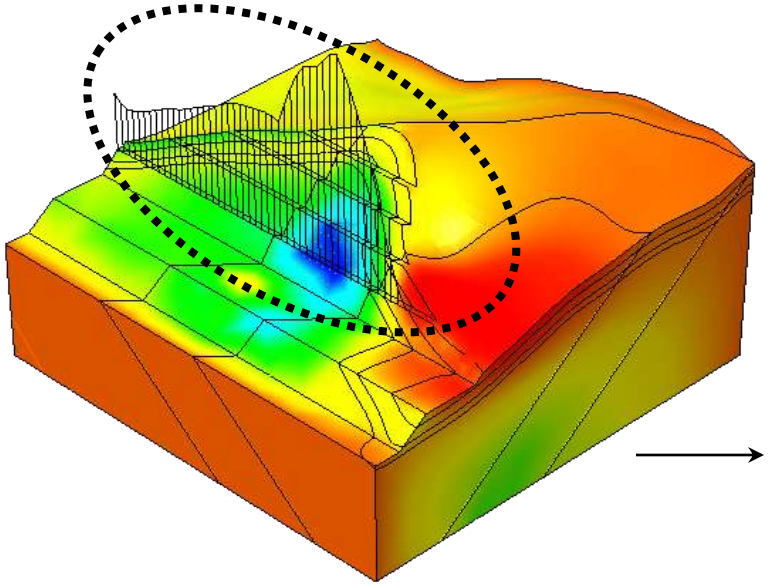


Settlement Profile (3D Plane, 2D Line)

	No	Dist. from Start Point (m)	Displacement (m)	Incline
▶	1	0,000000	-0,000278	0,000000
	2	6,220618	-0,000300	-0,000004
	3	12,441235	-0,000322	-0,000002
	4	18,661853	-0,000380	-0,000003
	5	24,882471	-0,000442	-0,000003
	6	31,103089	-0,000540	-0,000003
	7	37,323706	-0,000643	-0,000003
	8	43,544324	-0,000739	-0,000002
	9	49,764942	-0,000813	-0,000001
	10	55,985560	-0,000847	-0,000001
	11	62,206177	-0,000881	-0,000001
	12	68,426795	-0,000847	0,000000
	13	74,647413	-0,000813	0,000000
	14	80,868030	-0,000739	0,000001
	15	87,088648	-0,000643	0,000001
	16	93,309266	-0,000540	0,000001
	17	99,529884	-0,000442	0,000001
	18	105,750501	-0,000380	0,000001
	19	111,971119	-0,000322	0,000001
	20	118,191737	-0,000300	0,000000
	21	124,412355	-0,000278	0,000000

Settlement (MS-Excel Compatible Table)

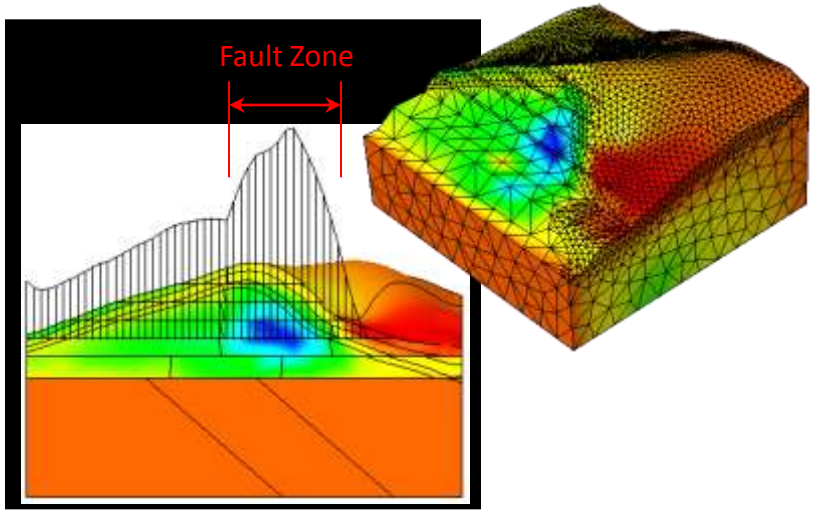




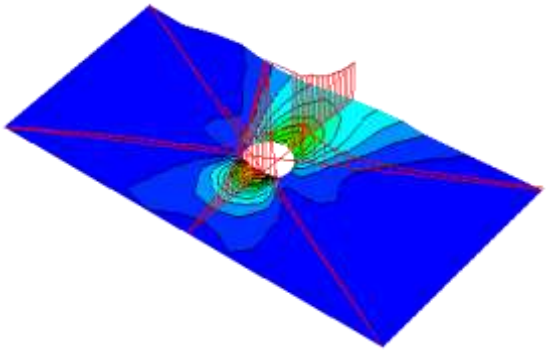
3D On-Curve Graphs on Contour Plot

ID	X (m)	Y (m)	Z (m)	Value
1	102,13	34,75	182,00	0,0001
2	100,09	34,75	182,00	0,0001
3	98,05	34,75	182,00	0,0001
4	96,01	34,75	182,00	0,0000
5	93,96	34,75	182,00	-0,0001
6	91,92	34,75	182,00	-0,0003
7	89,88	34,75	182,00	-0,0005
8	87,84	34,75	182,00	-0,0008
9	85,79	34,75	182,00	-0,0011
10	83,75	34,75	182,00	-0,0014
11	81,71	34,75	182,00	-0,0017
12	79,66	34,75	182,00	-0,0019
13	77,62	34,75	182,00	-0,0021
14	75,58	34,75	182,00	-0,0022
15	73,54	34,75	182,00	-0,0024
16	71,49	34,75	182,00	-0,0024

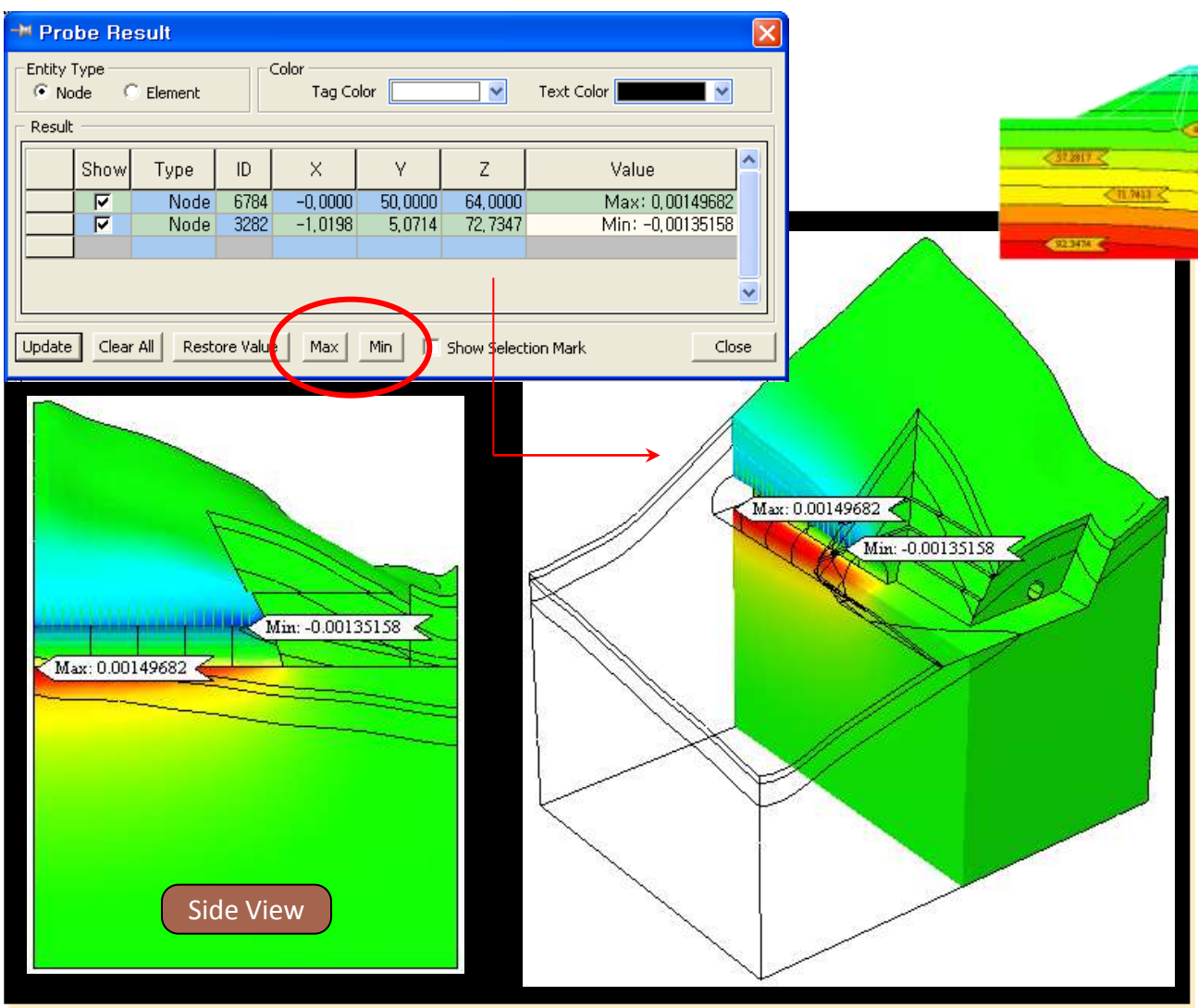
Result Data at User-Specified Sampling Points

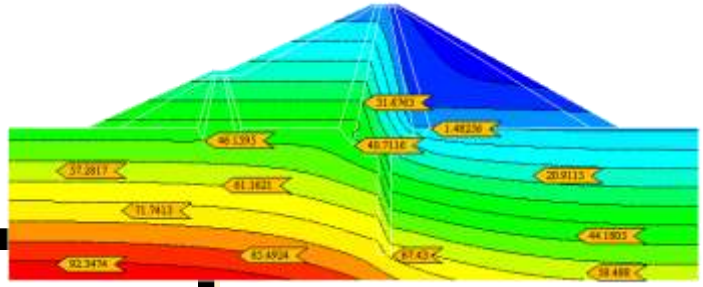


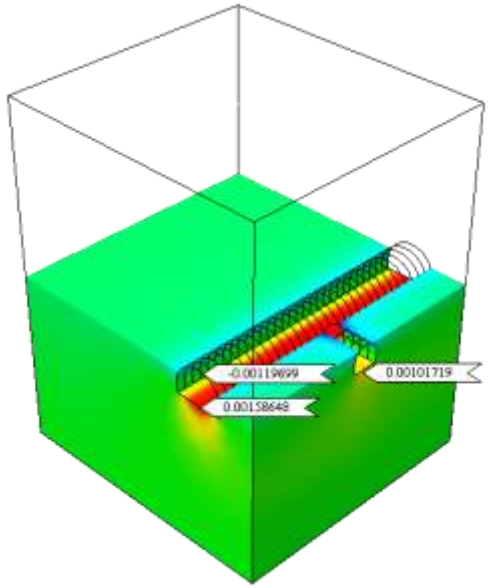
Front View

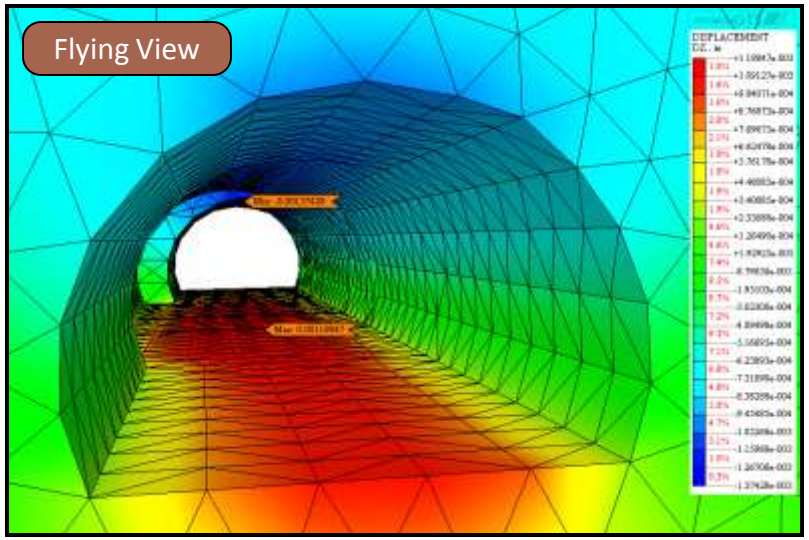


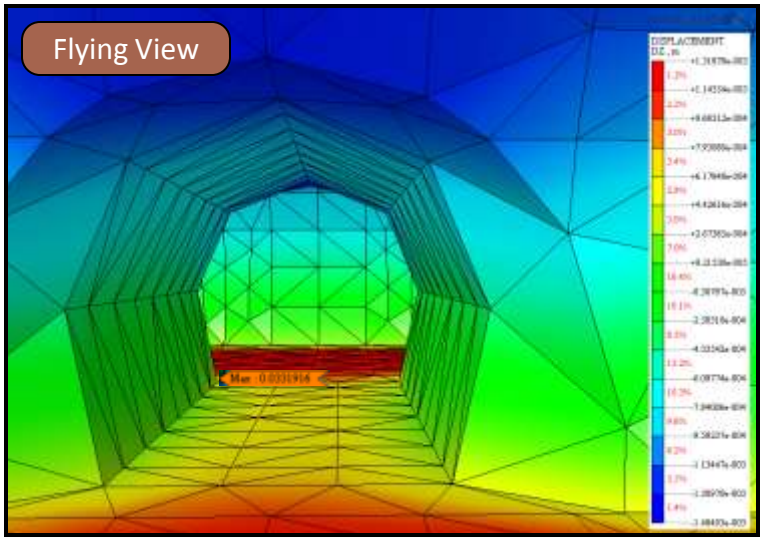
2D On-Curve Graphs on Contour Plot

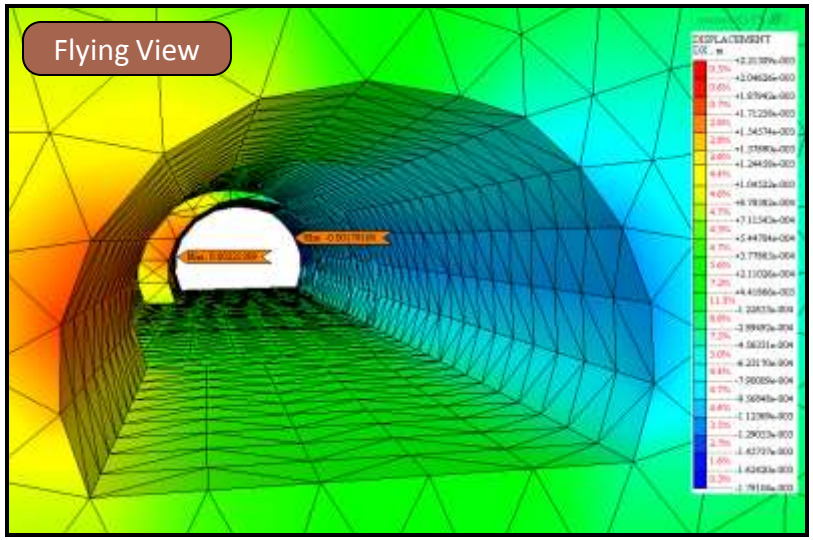

Probe Result
Entity Type
Node
Element
Color
Tag Color
Text Color
Result
Show
Type
ID
X
Y
Z
Value
Node
6784
-0,0000
50,0000
64,0000
Max: 0,00149682
Node
3282
-1,0198
5,0714
72,7347
Min: -0,00135158
Update
Clear All
Restore Value
Max
Min
Show Selection Mark
Close
Min: -0.00135158
Max: 0.00149682
Side View
Max: 0.00149682
Min: -0.00135158

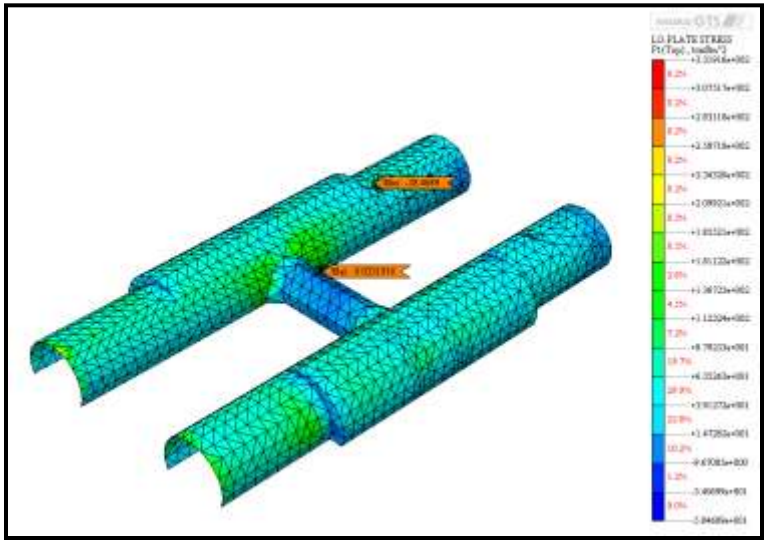




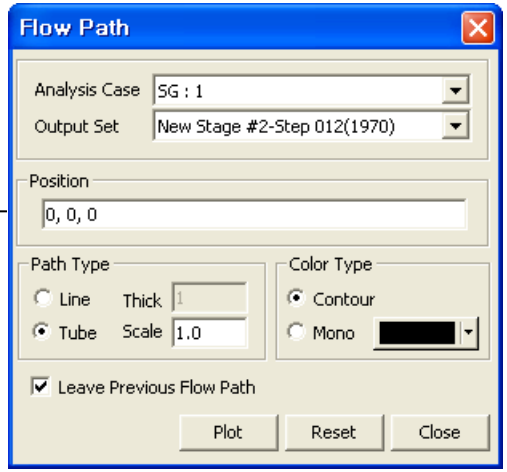

Flying View


Flying View

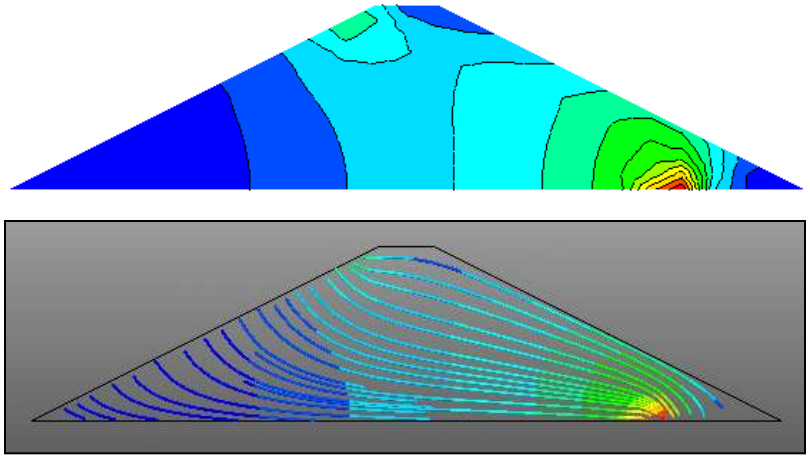

Flying View



Flow Path

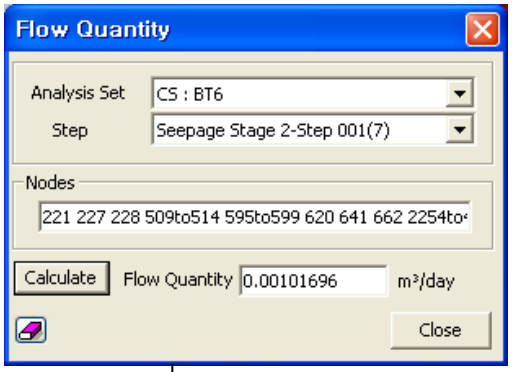


Click Survey Position in Work Window

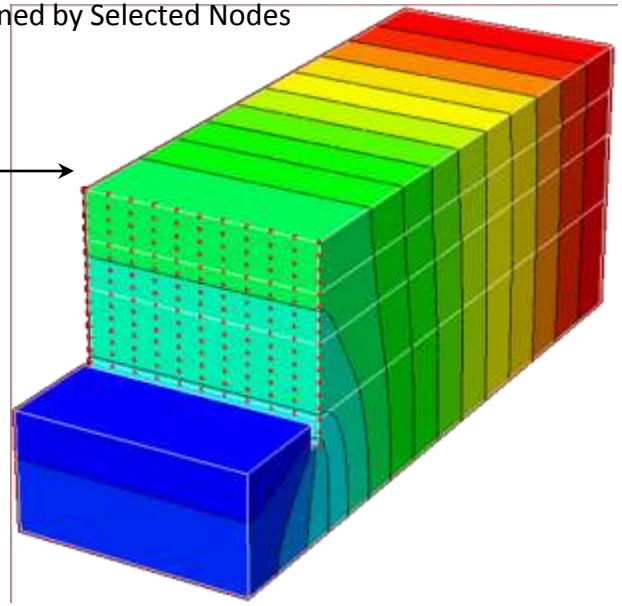


Flow Patch on 2D Dam Model

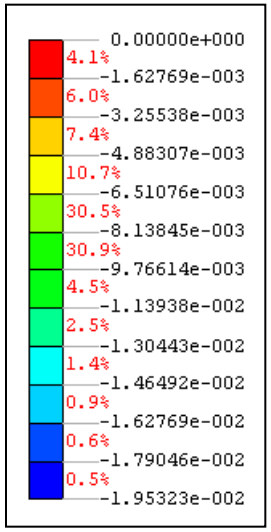
Flow Quantity

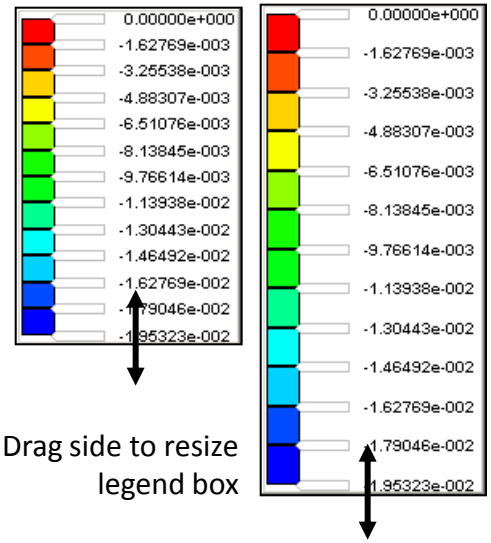


Calculates Flow Quantity
at Arbitrary Plane
Defined by Selected Nodes

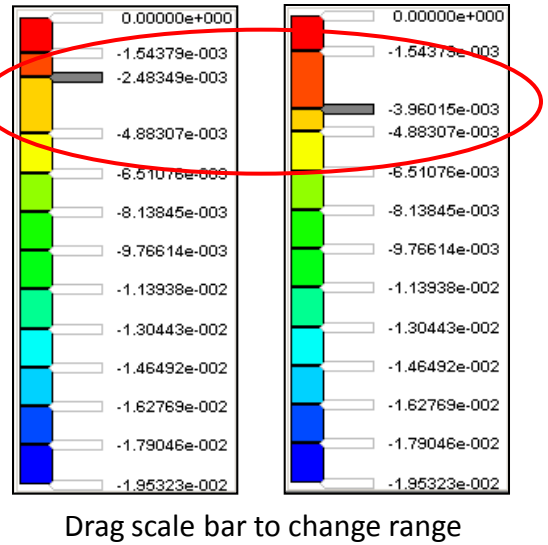


In GTS, legends can be controlled for position, size, format and range (including min/max value) by mouse dragging.

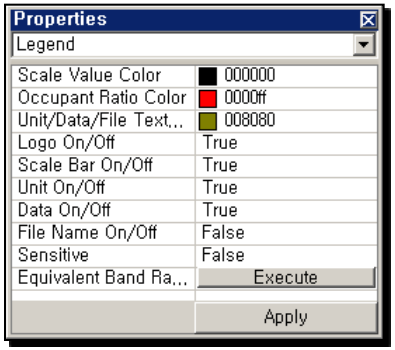




Drag side to resize legend box



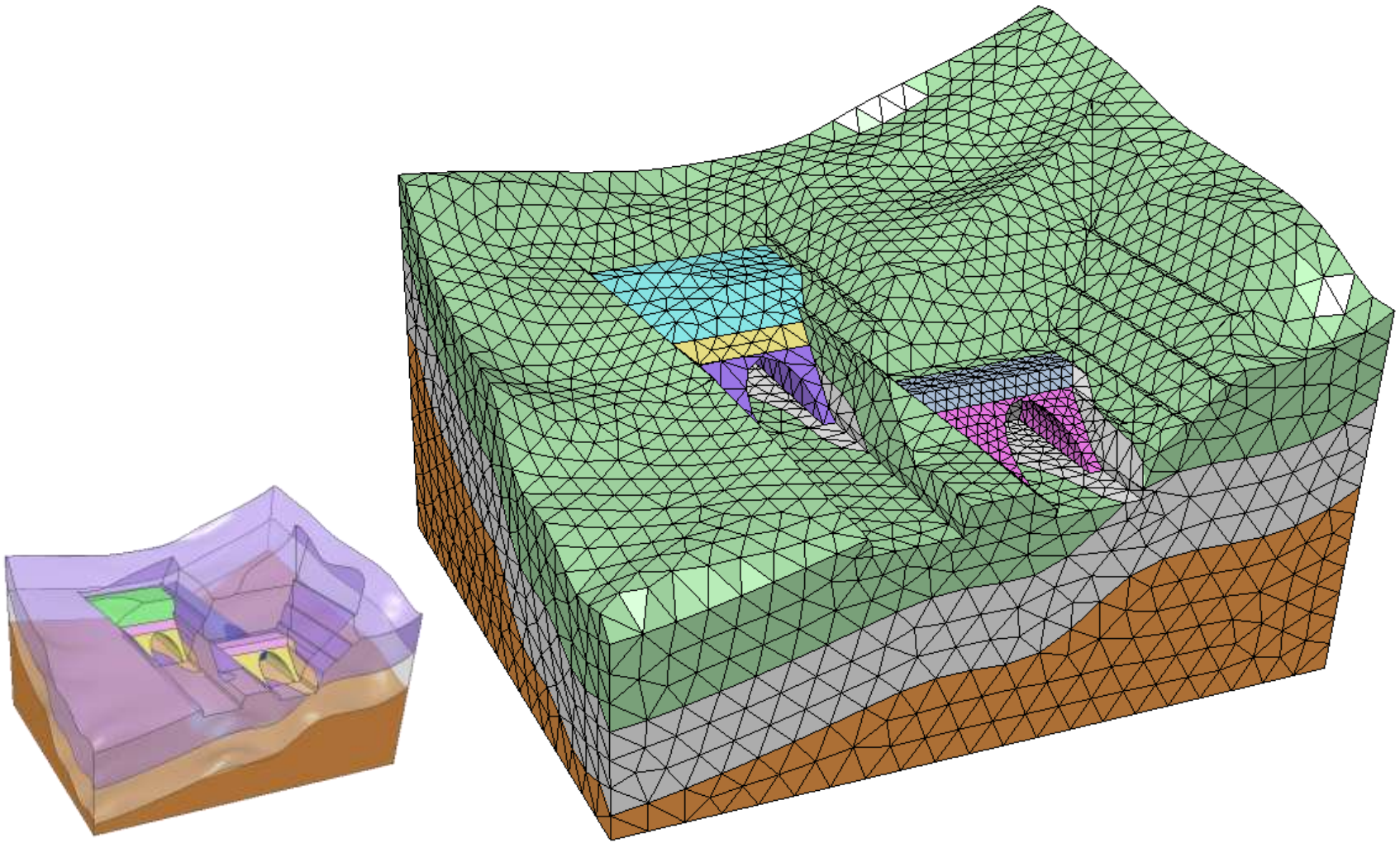
Drag scale bar to change range

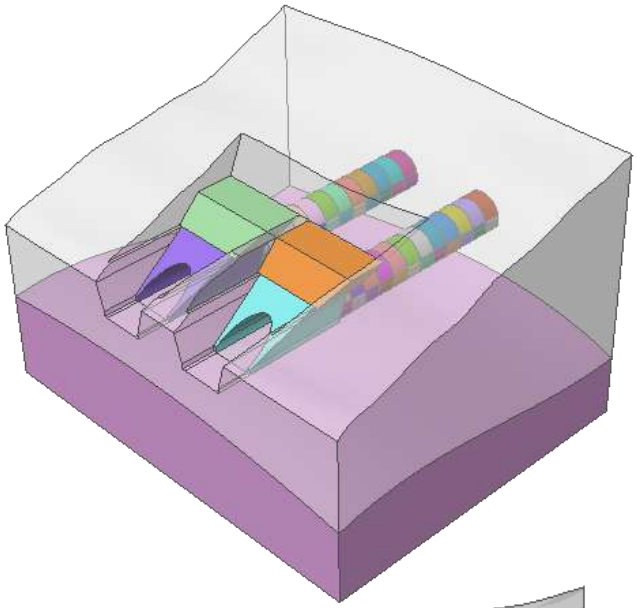


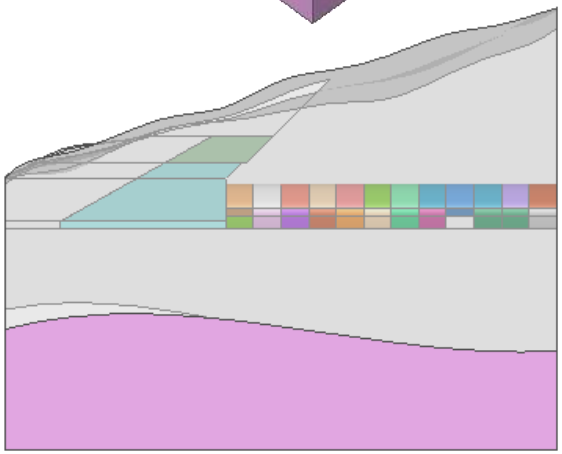
Property Window (Legend Option)

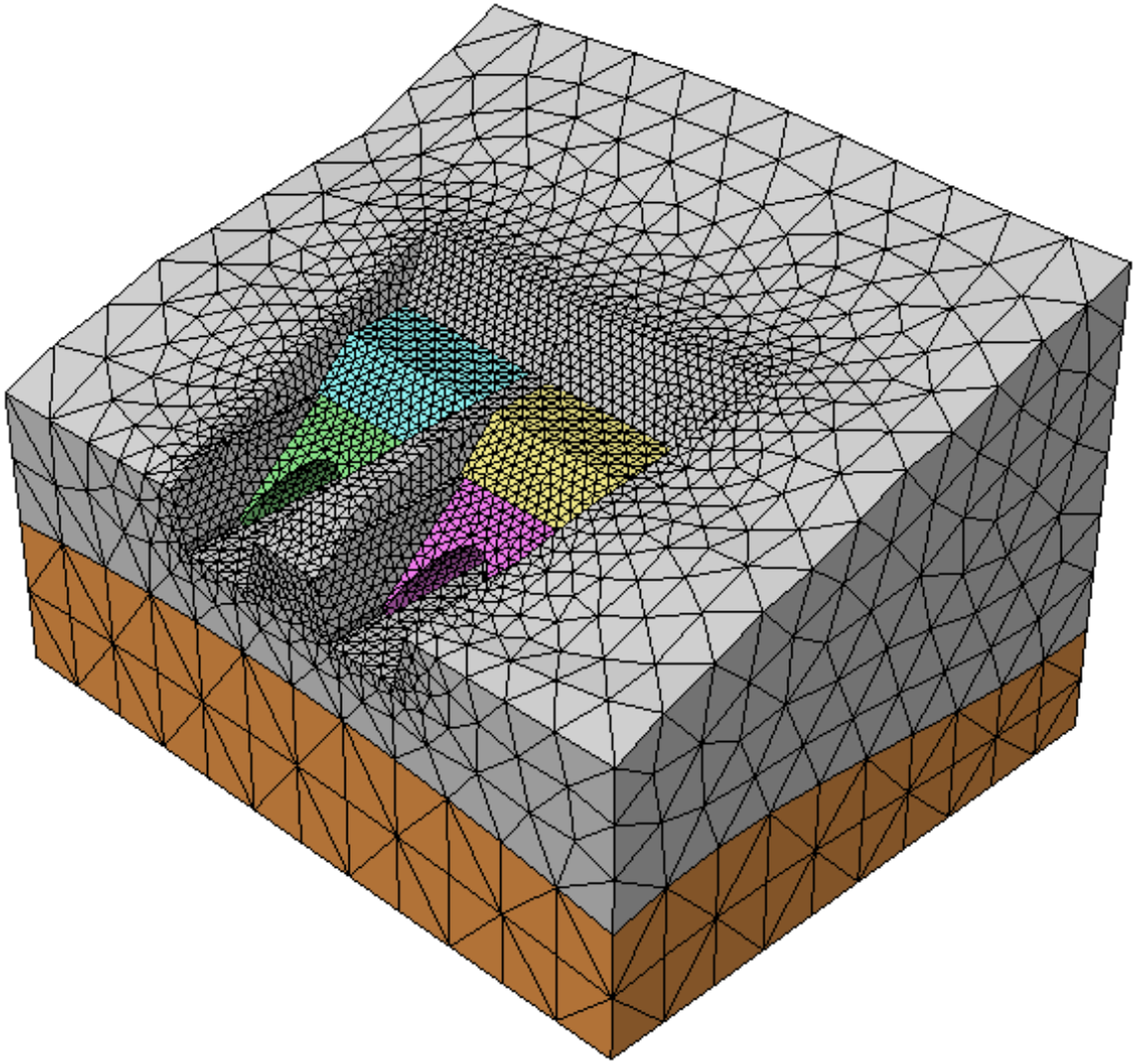
- **Legend Options:**
  - Color (Value, Ratio, Description)
  - Logo
  - Range (including Min/Max/Zero)
  - Format (Fixed/Scientific, Width)

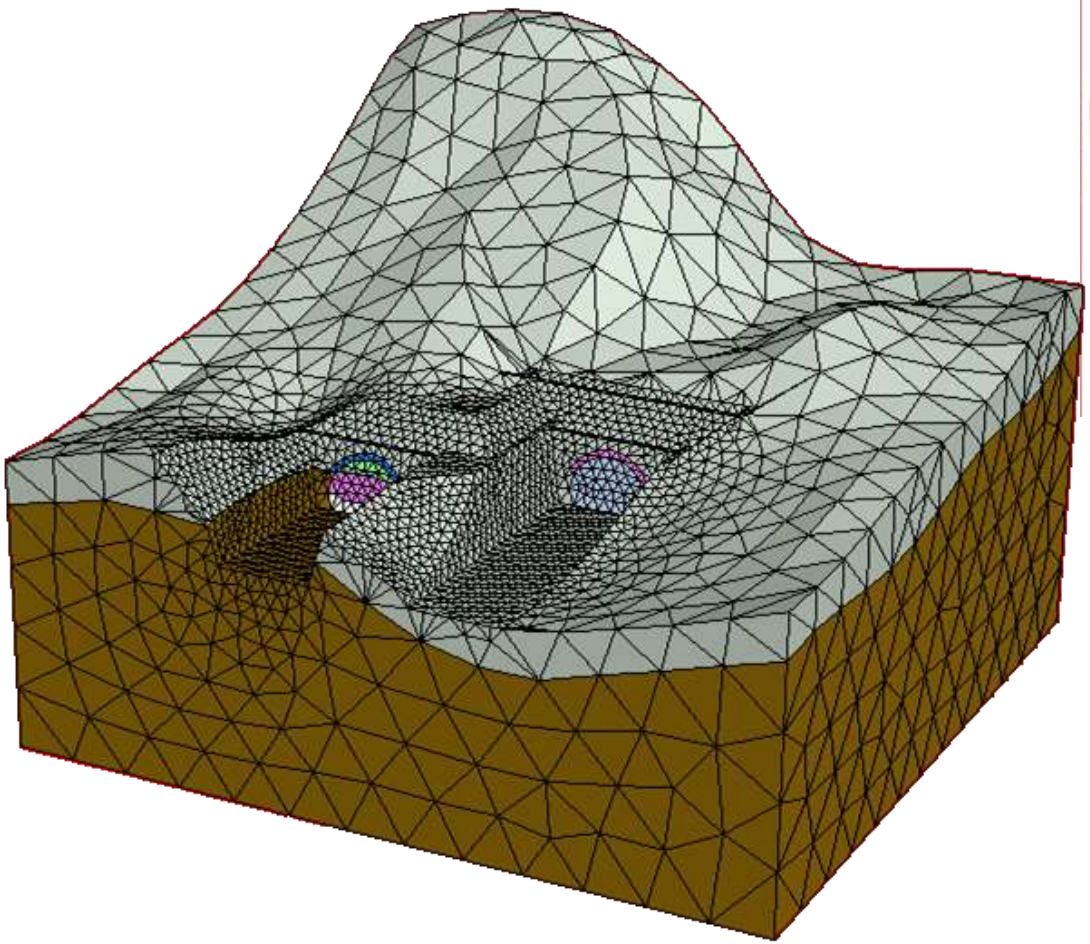
Applications

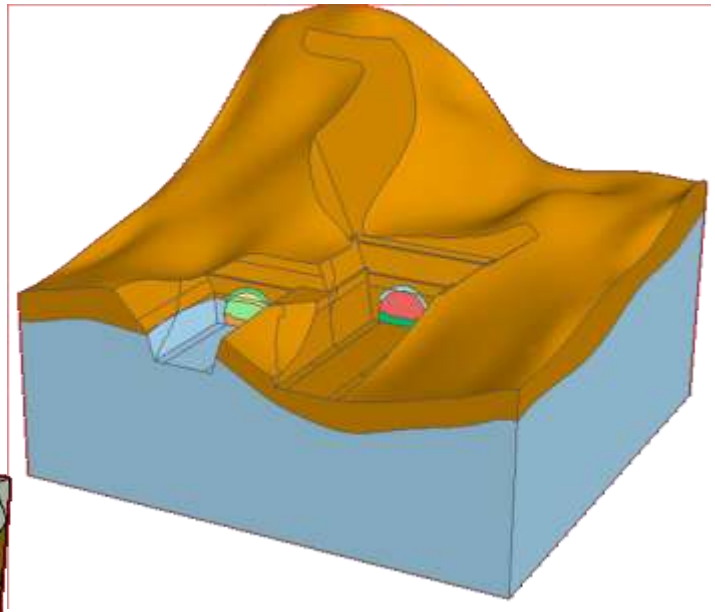


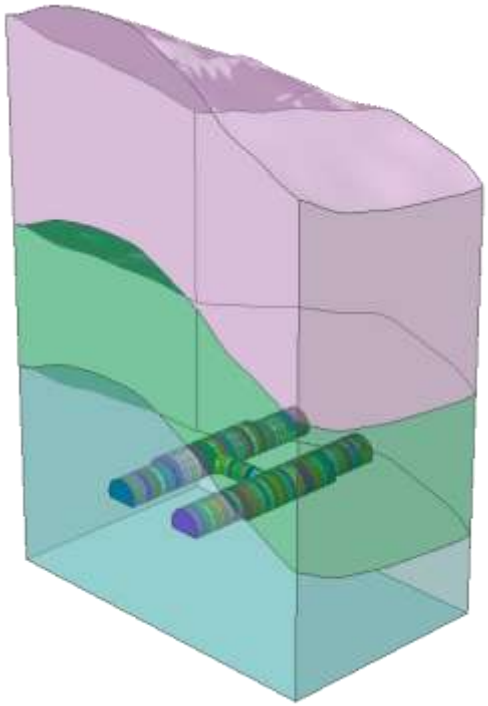


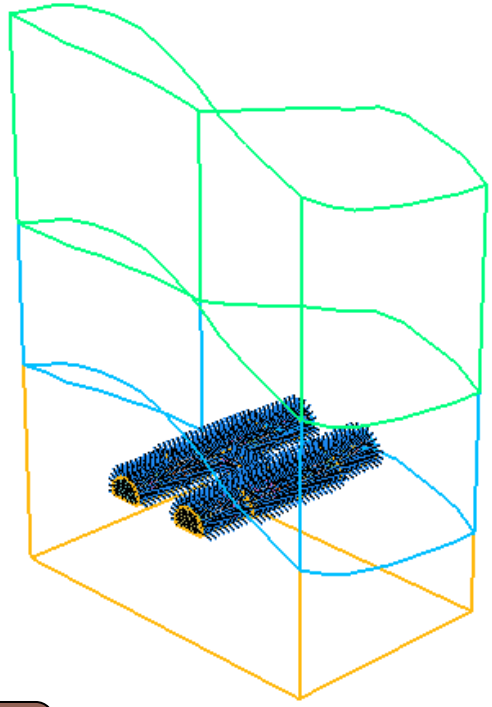


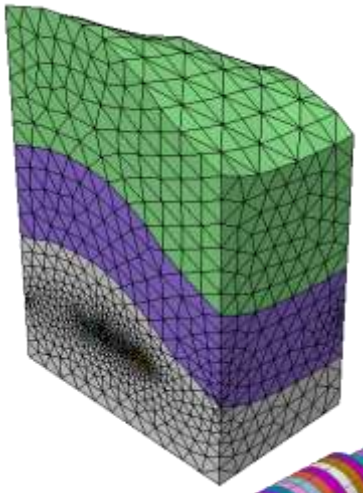


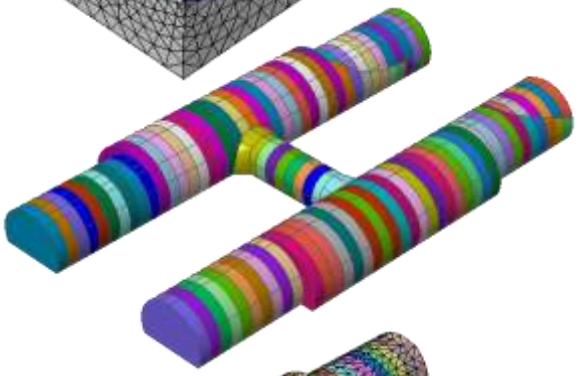


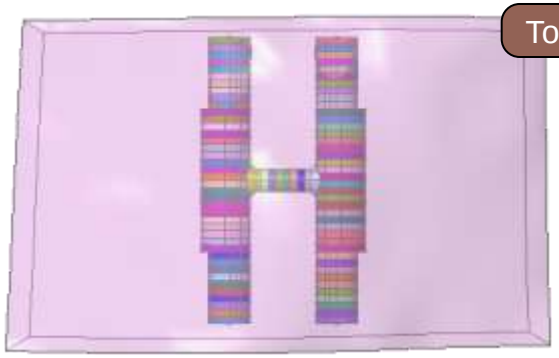




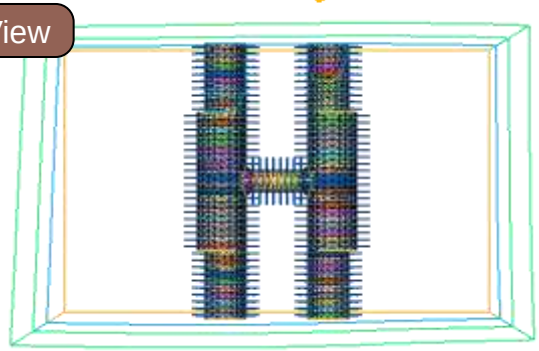


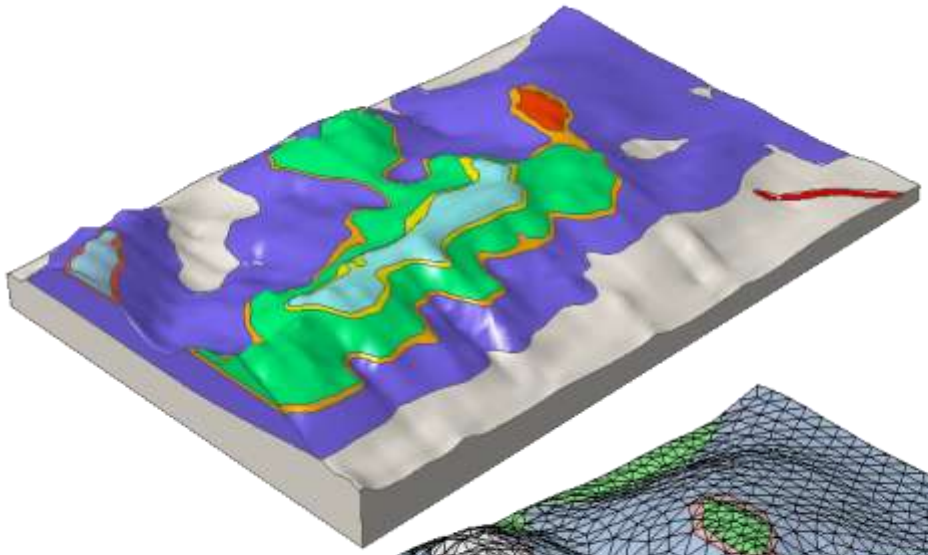


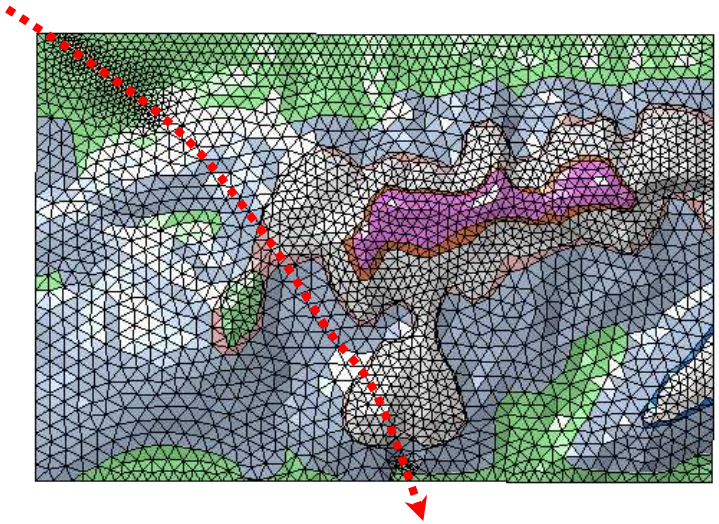


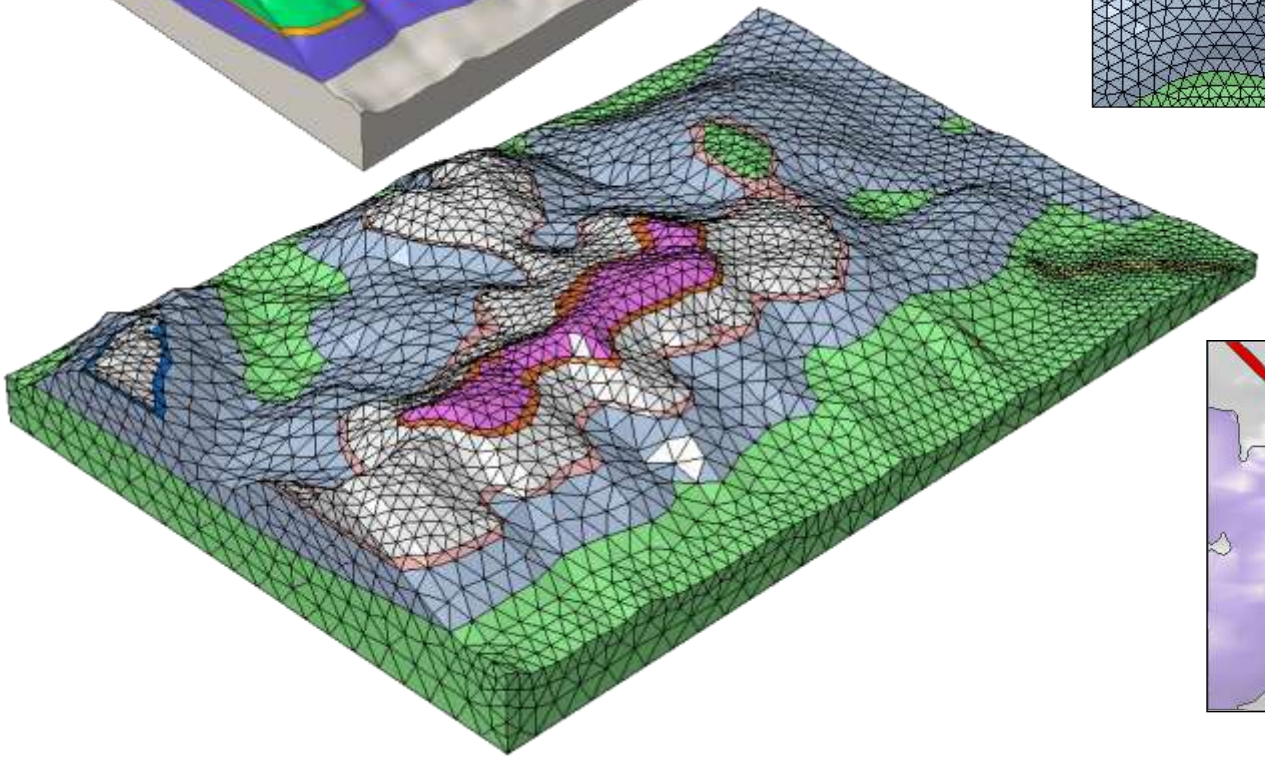


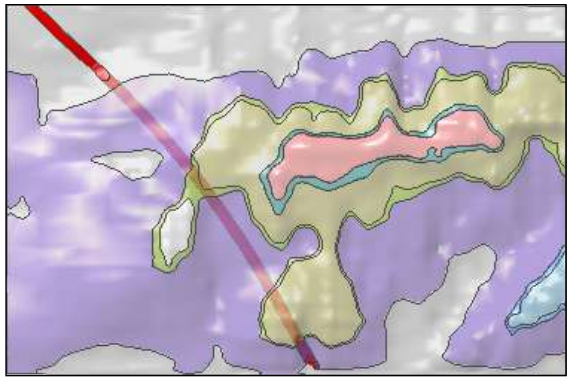
Top View

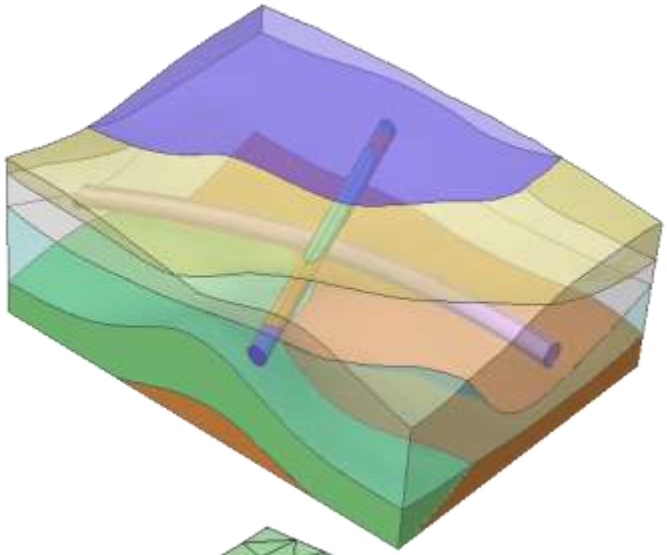


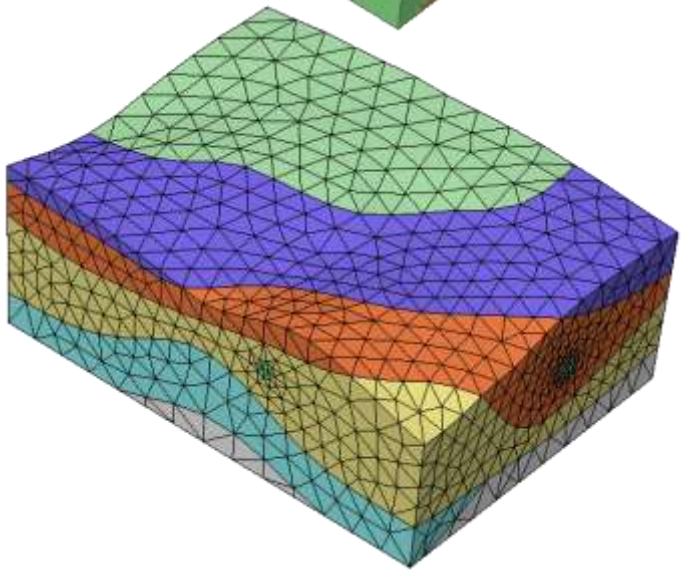


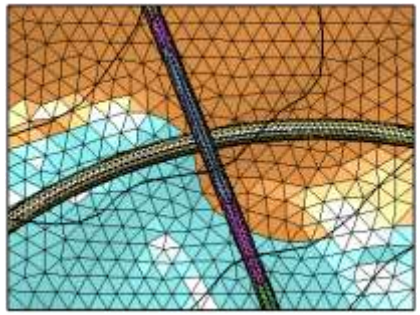


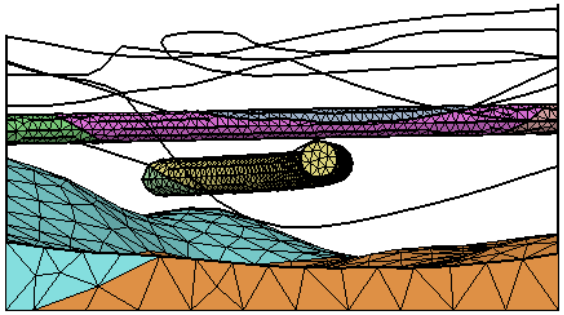


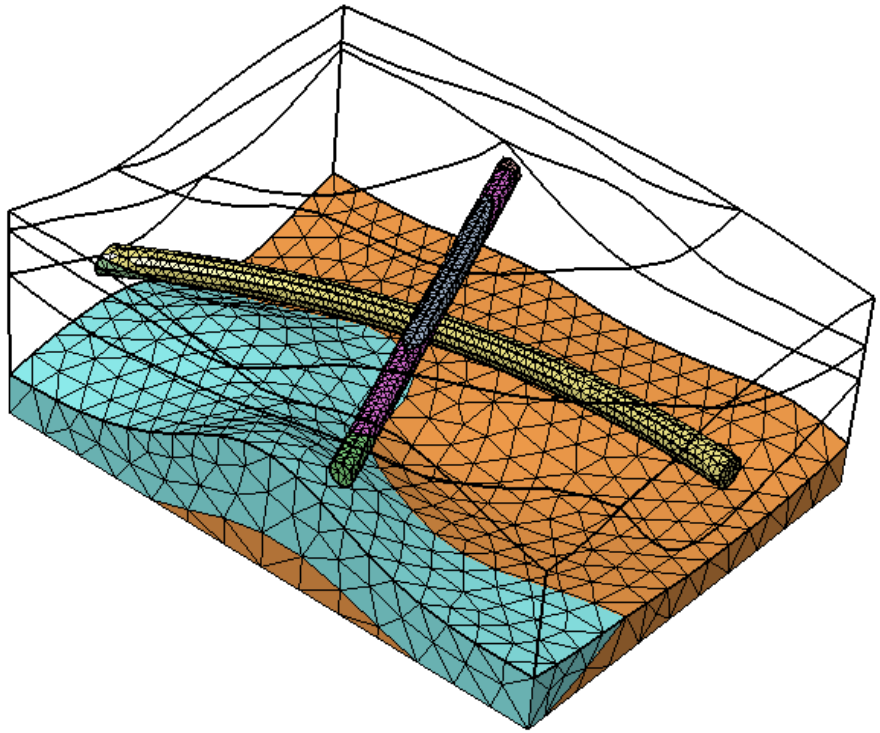


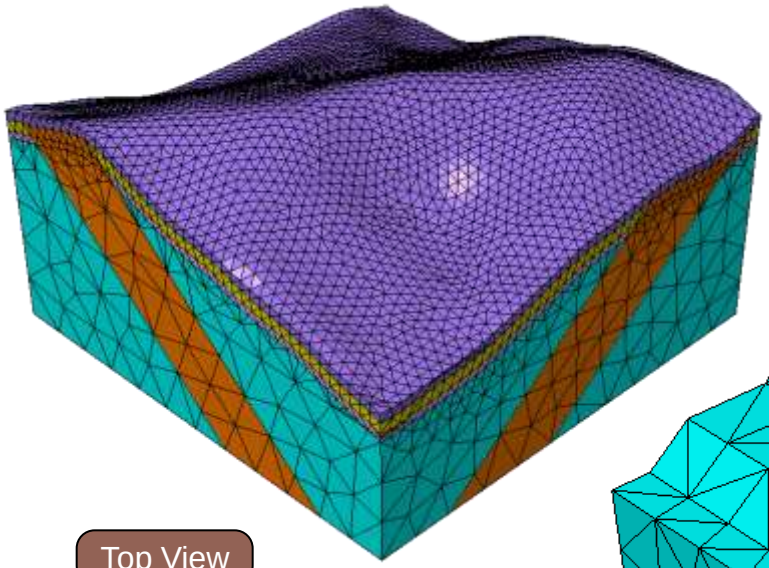




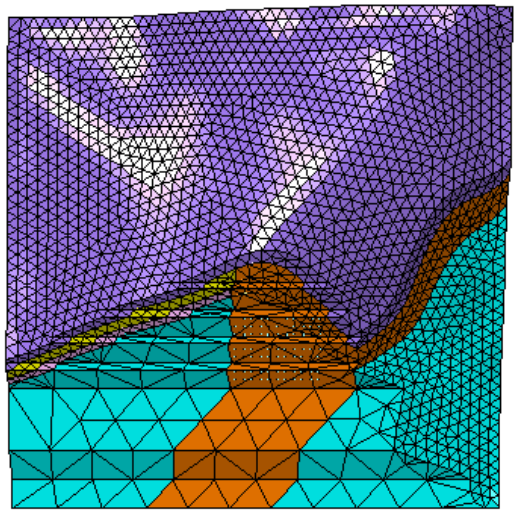


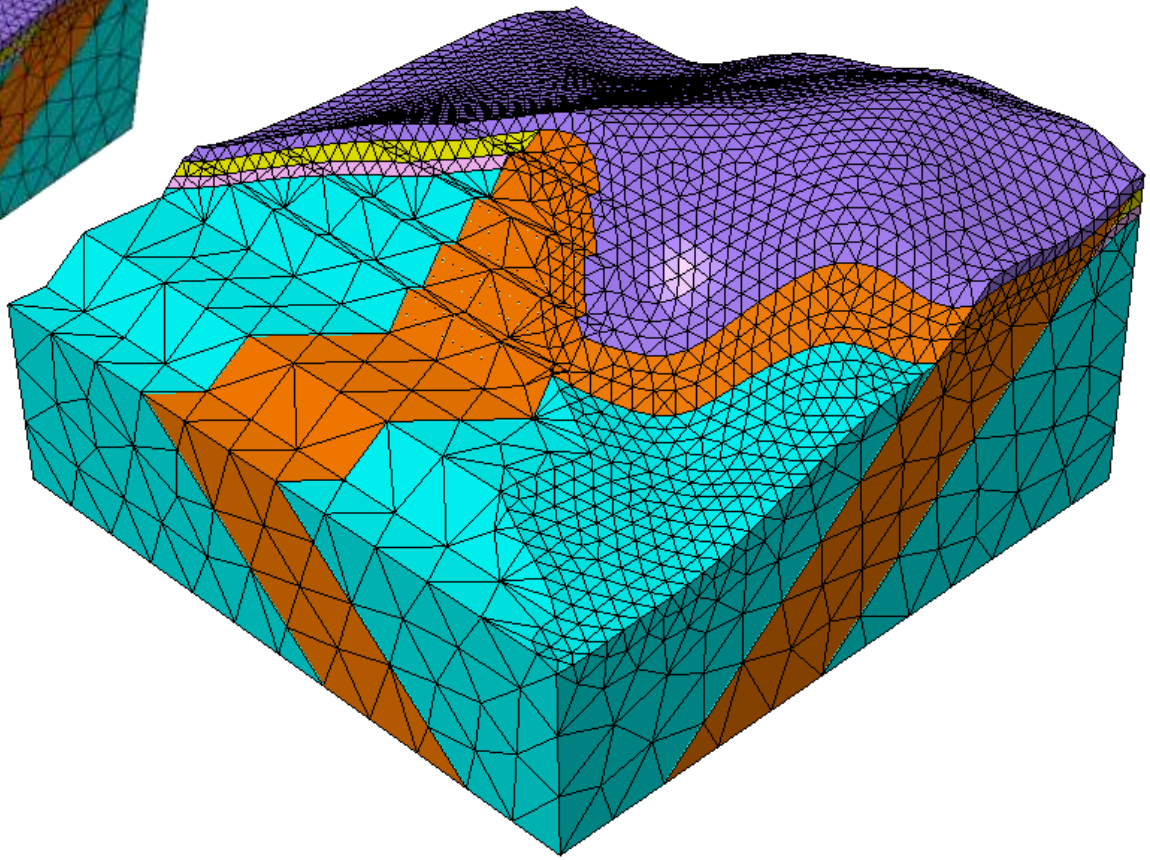


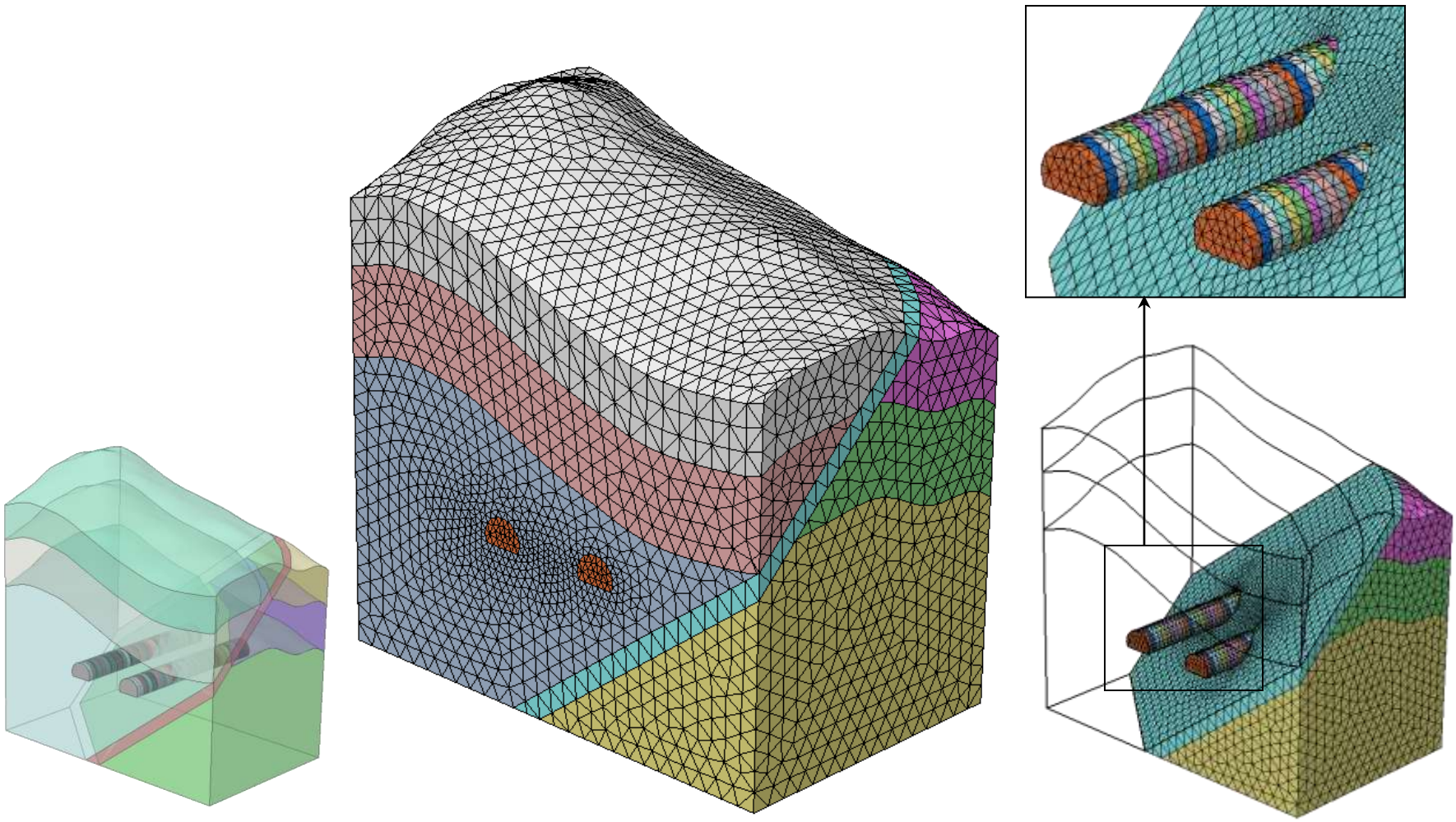


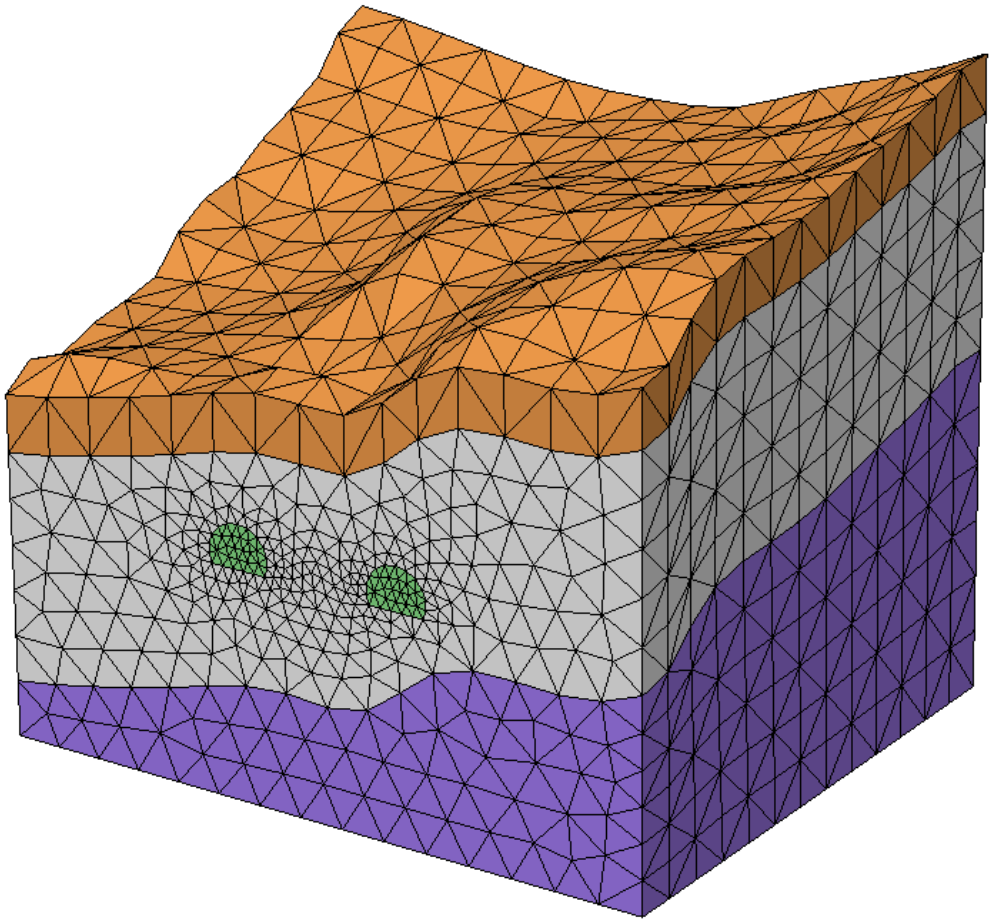


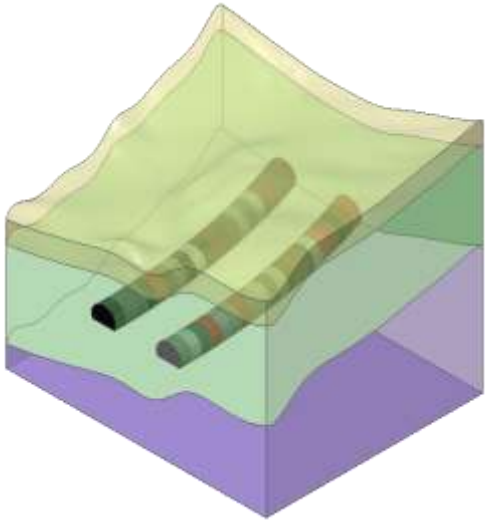
Top View

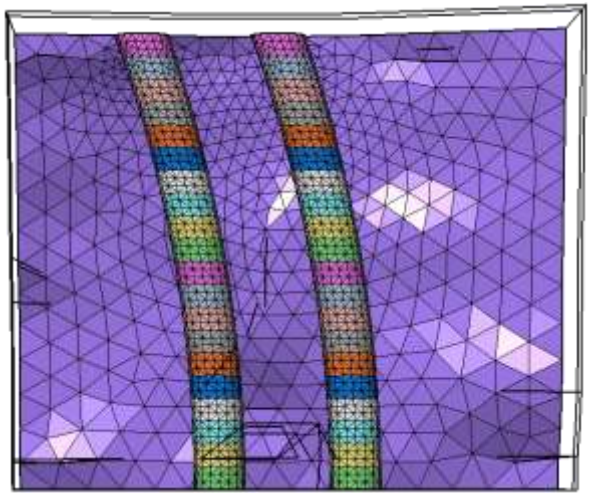


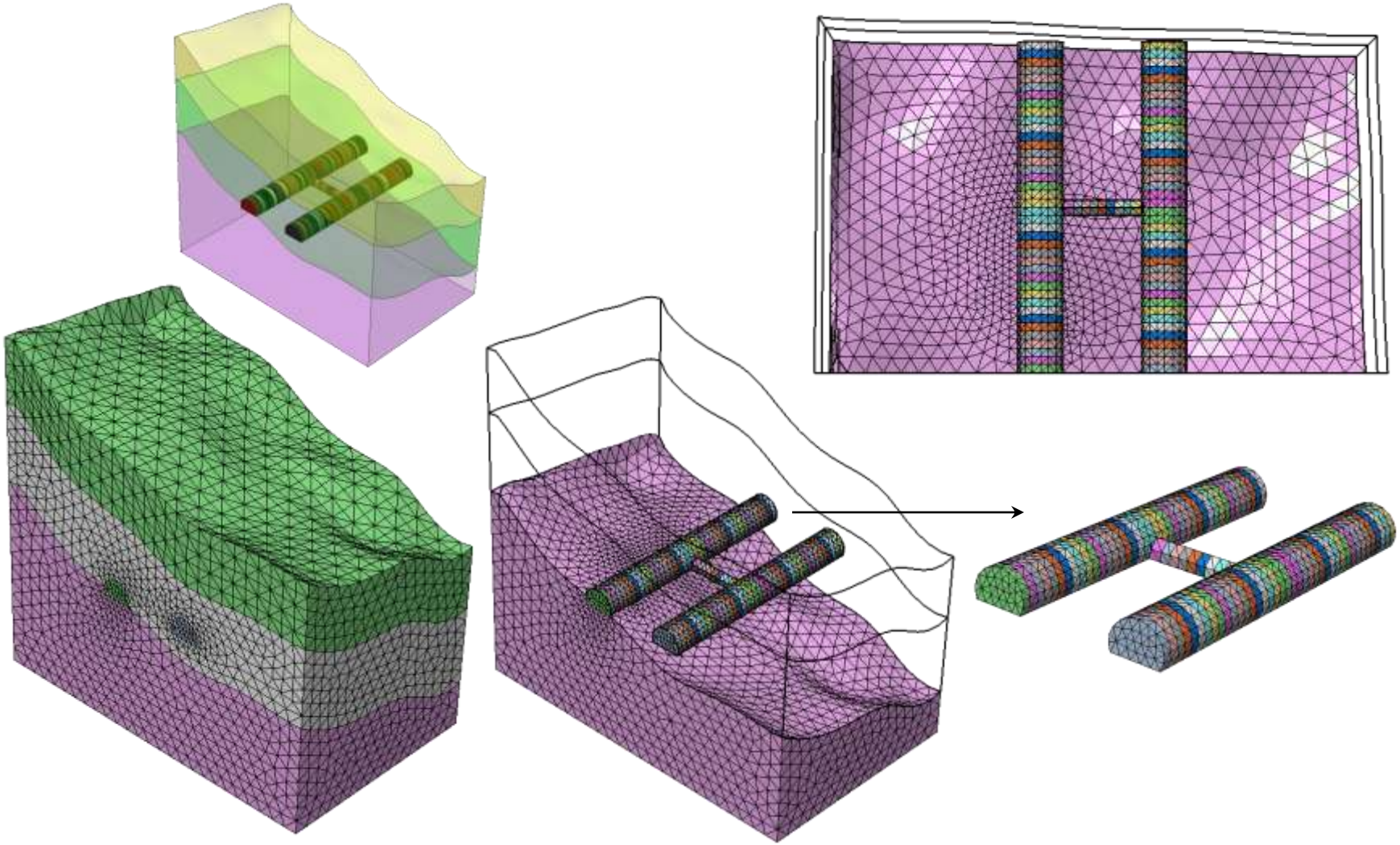


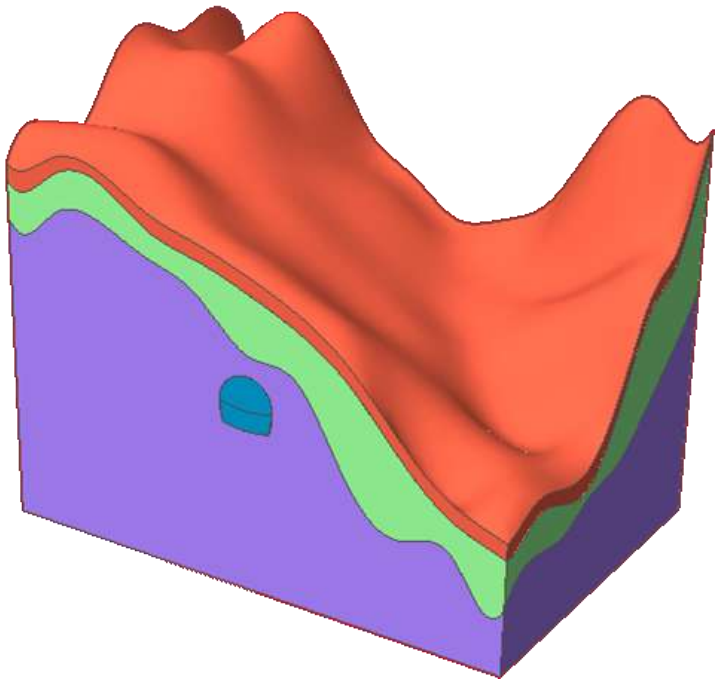


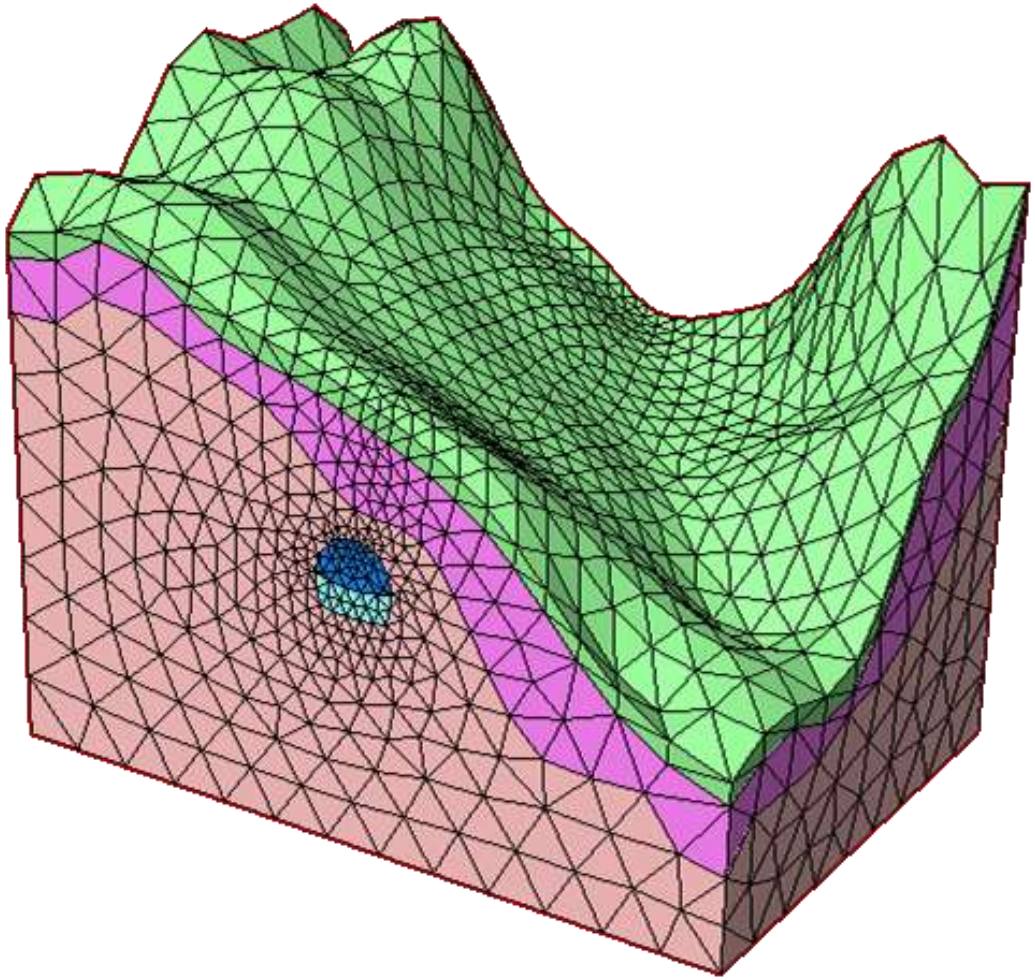


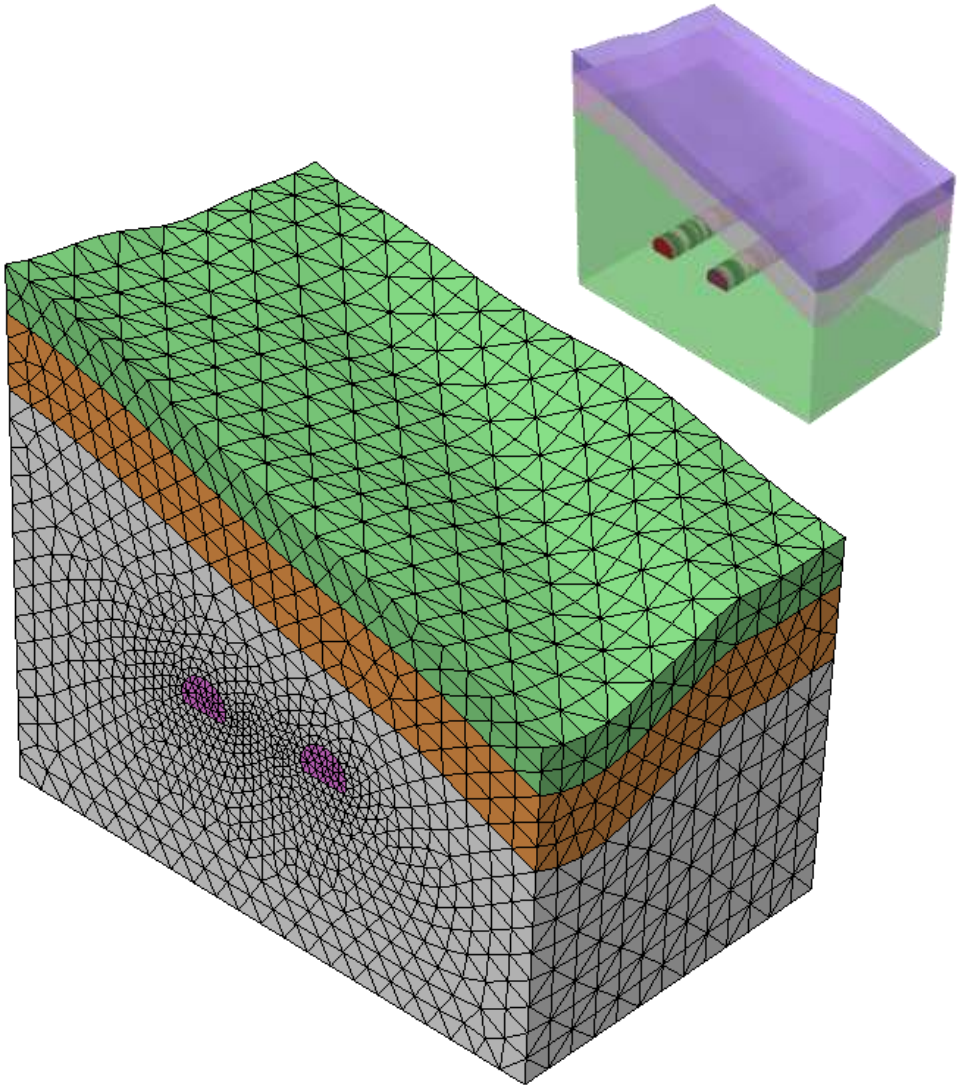


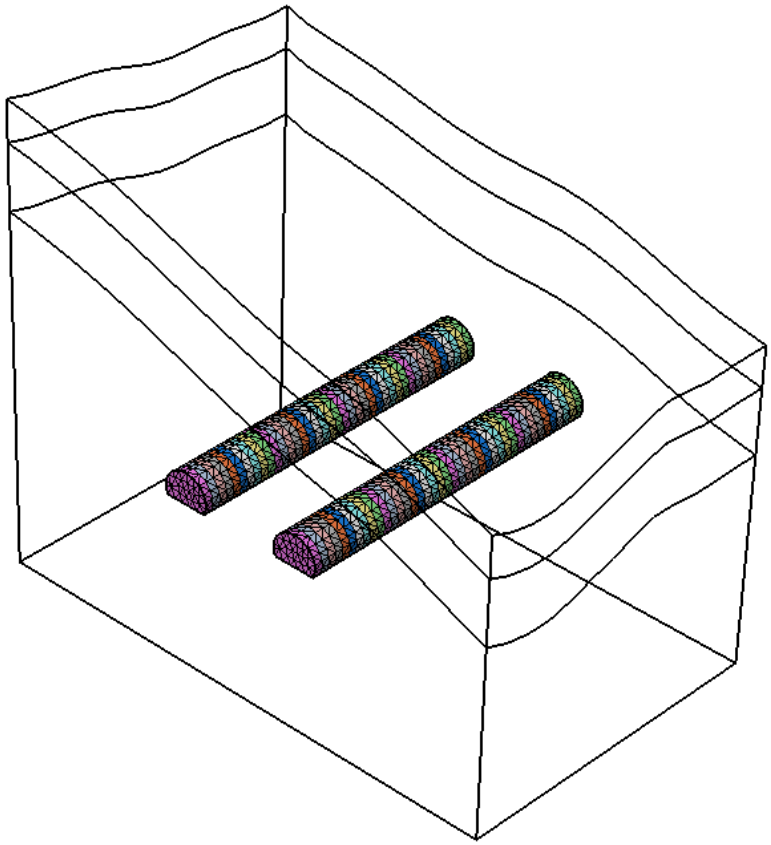


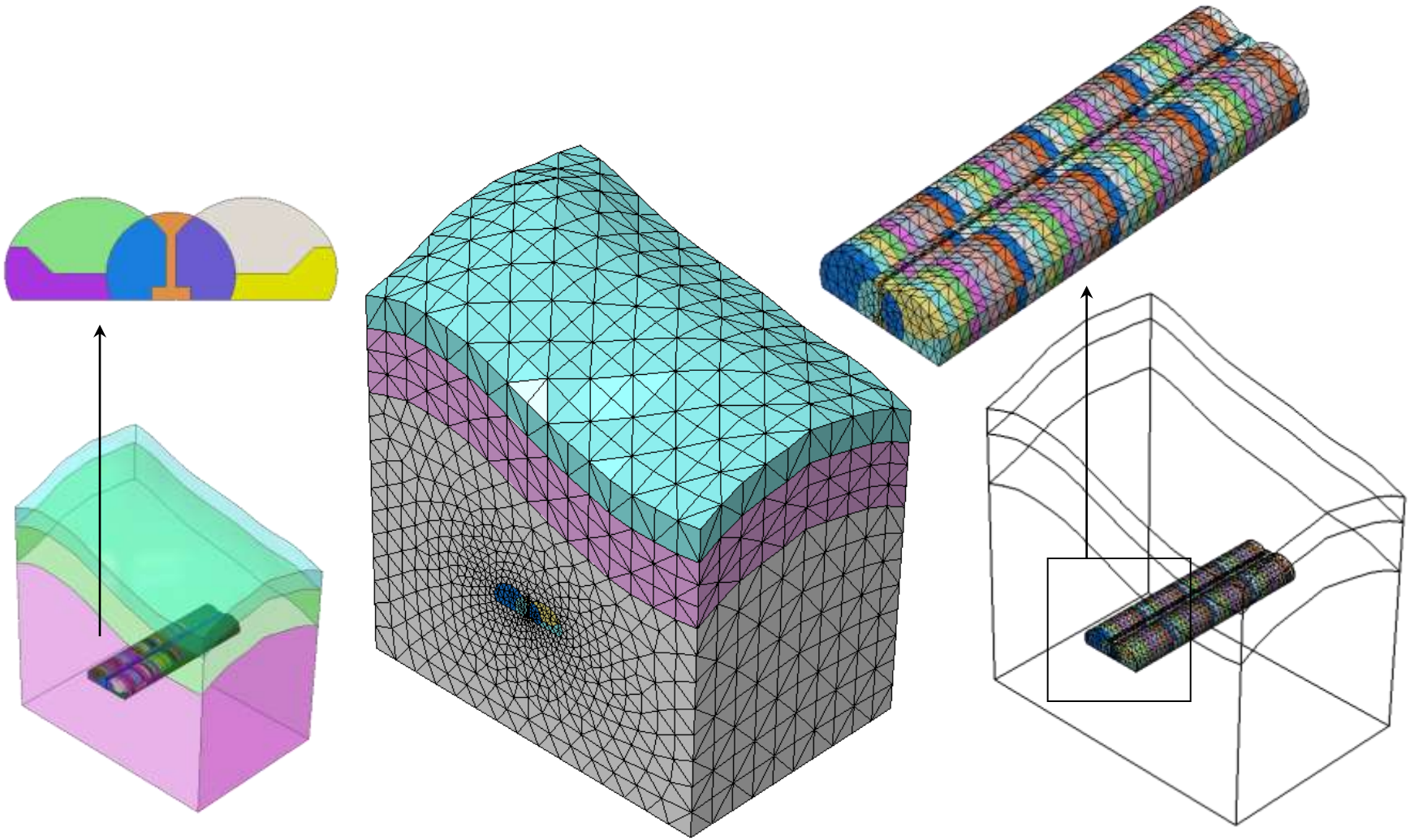


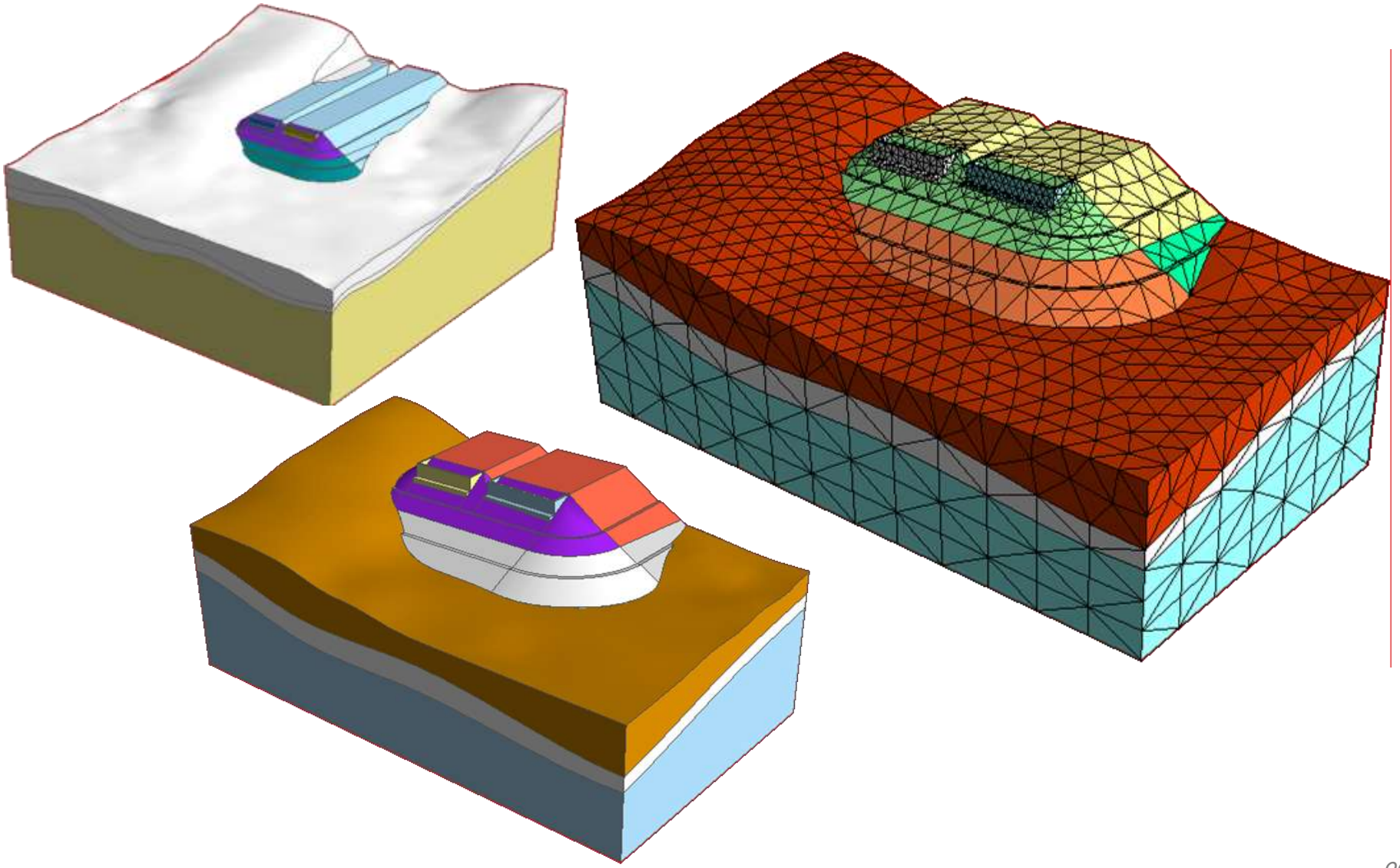


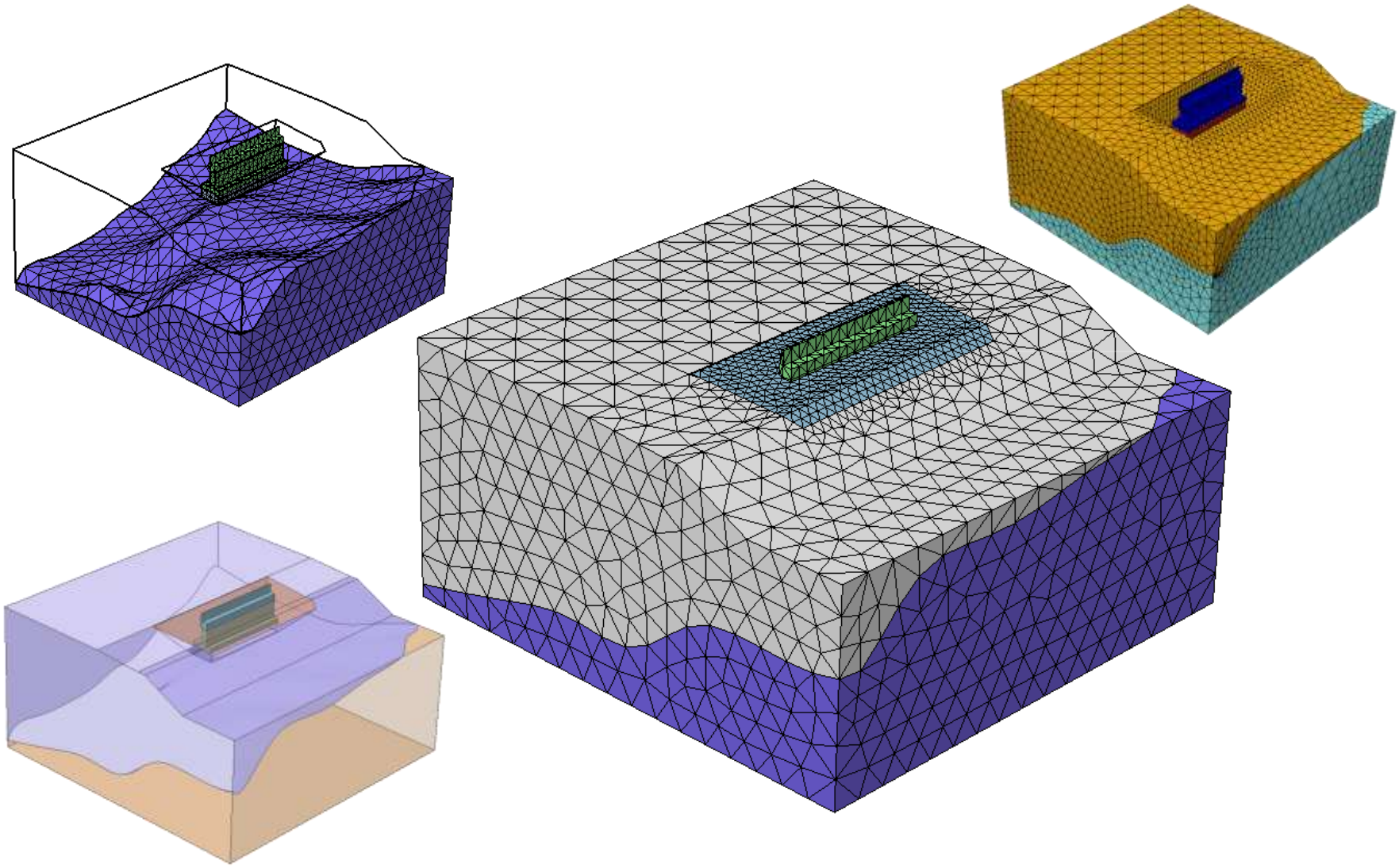


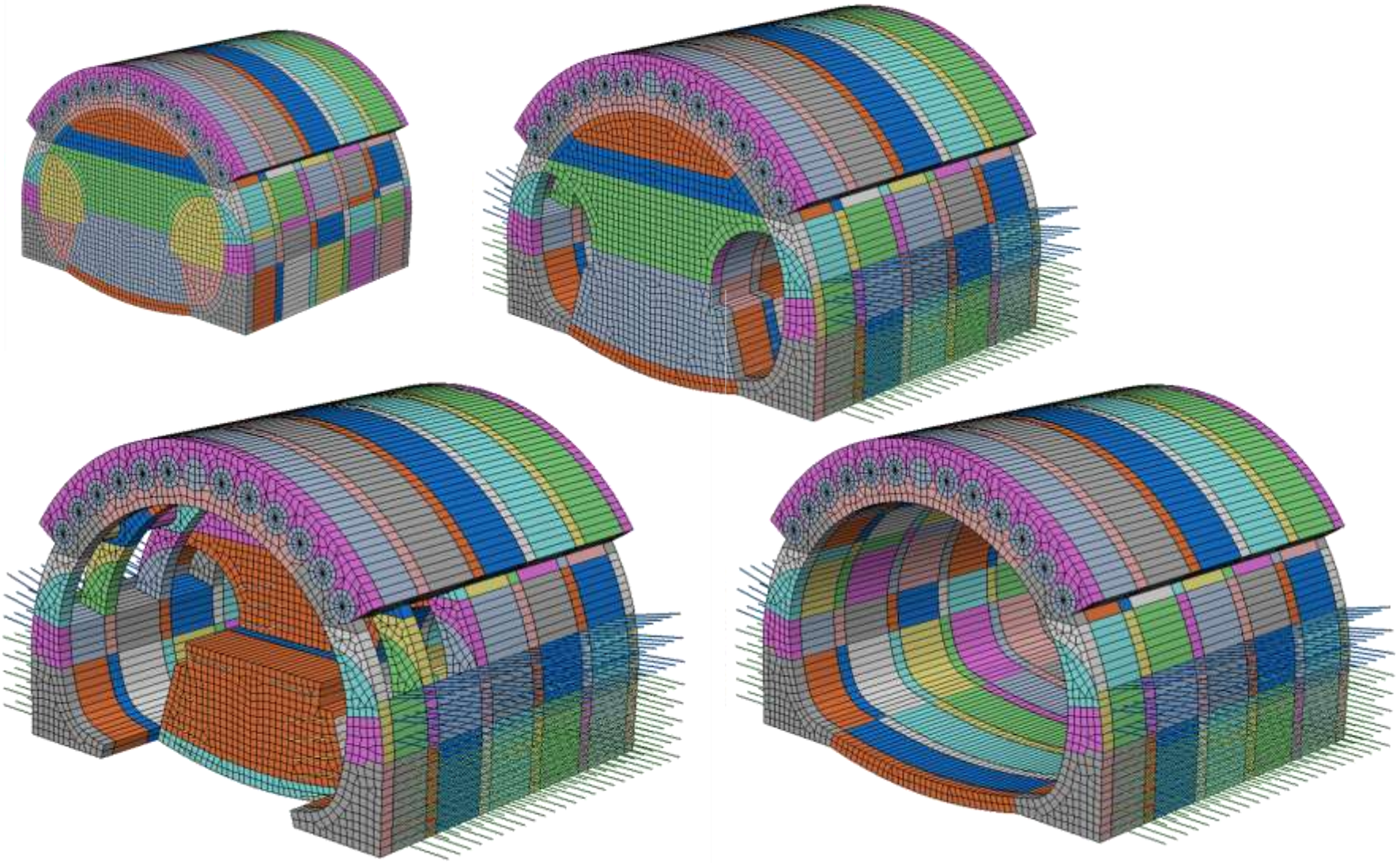




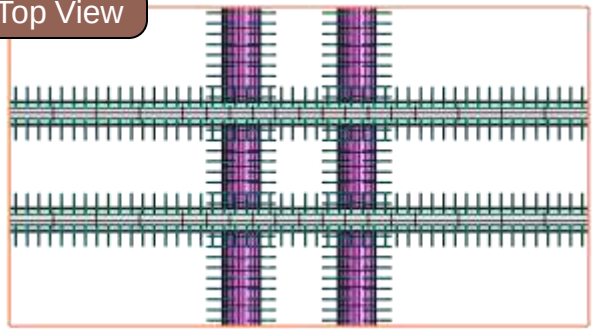




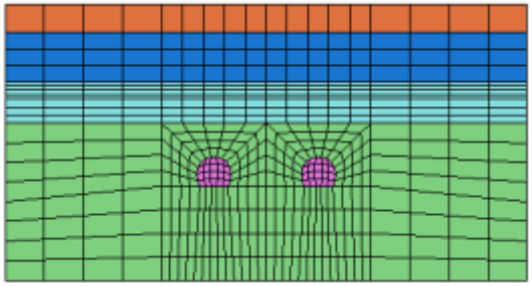


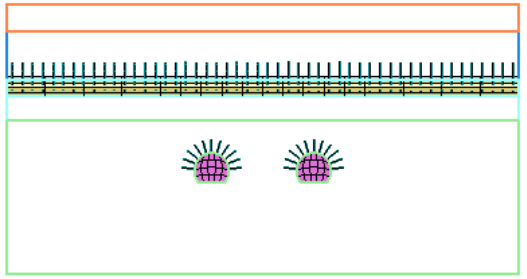


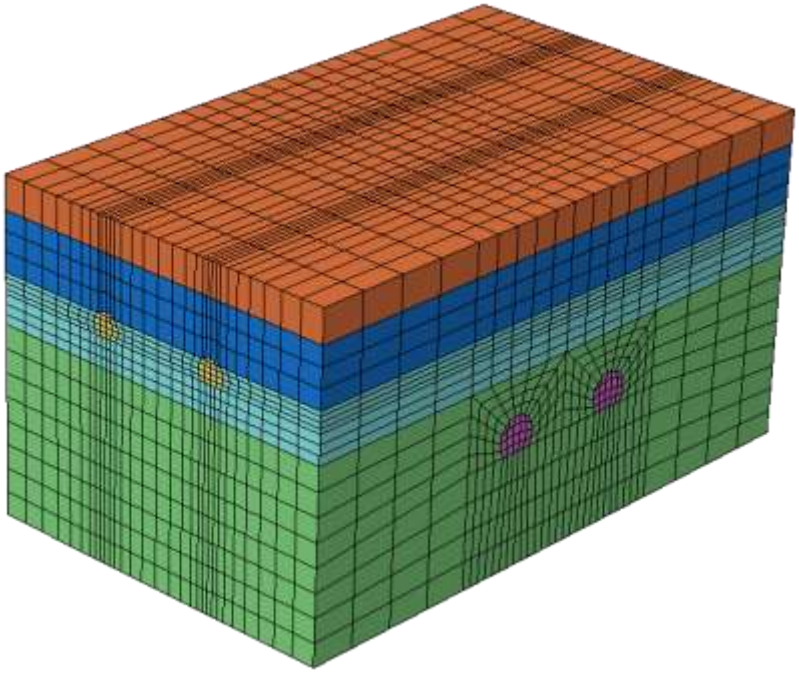
Top View

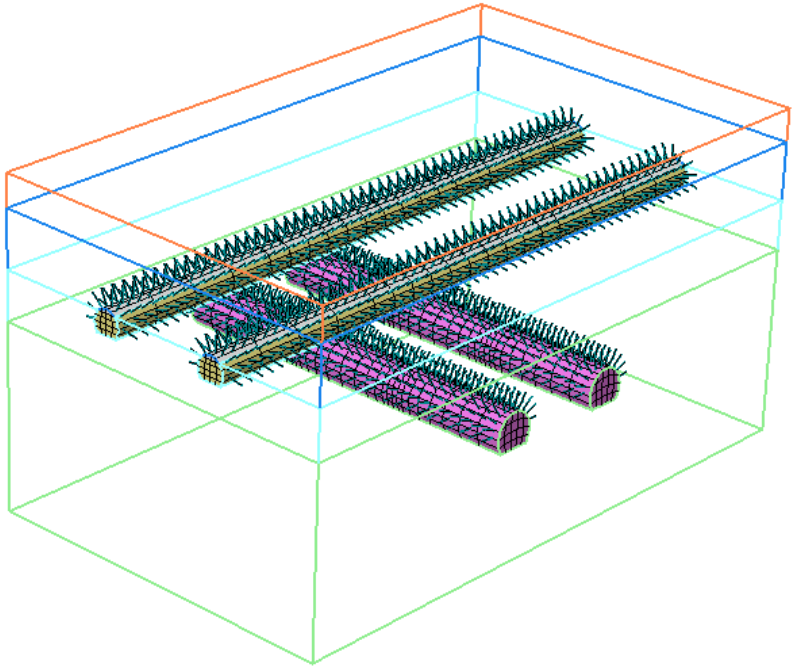


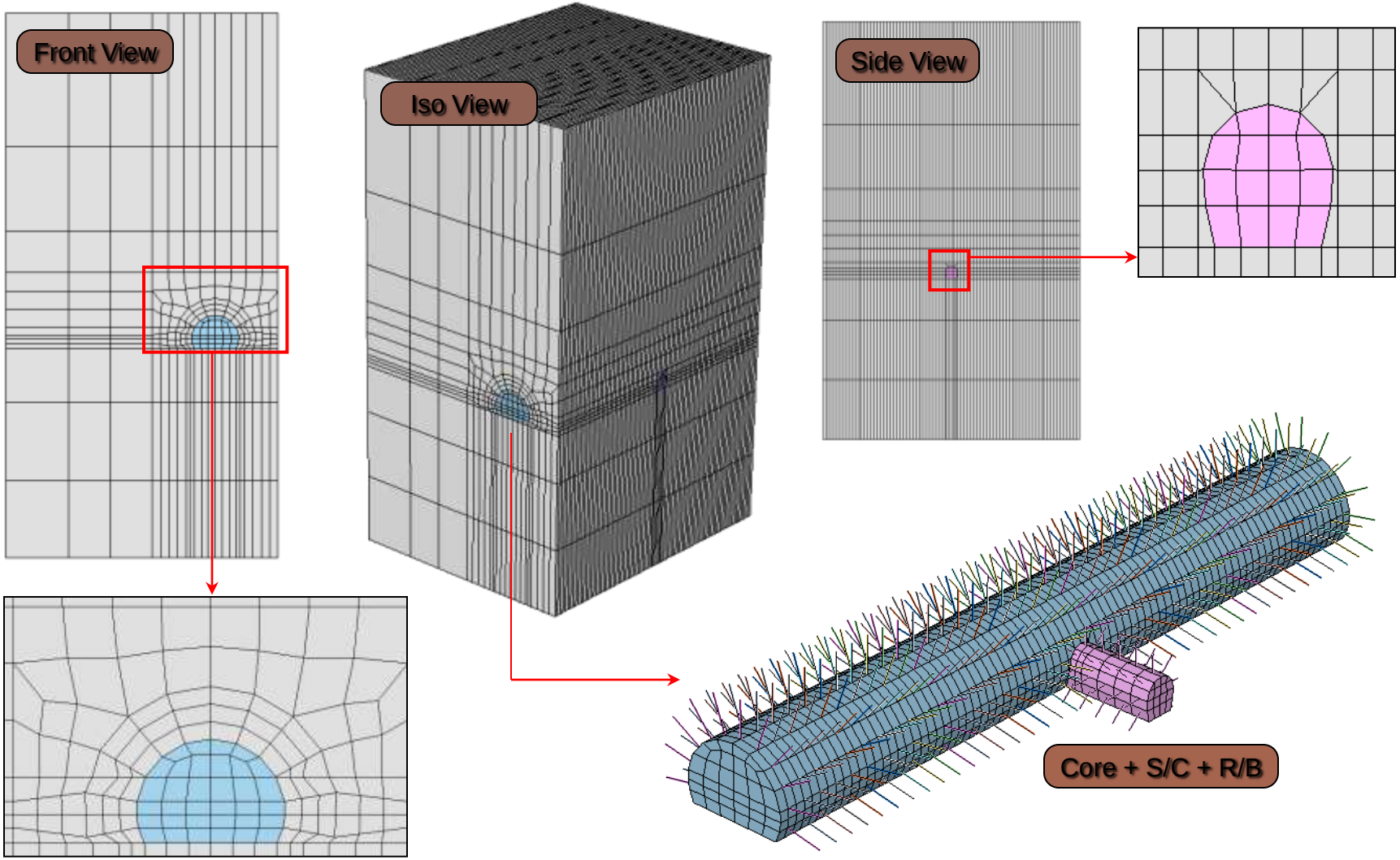
Side View

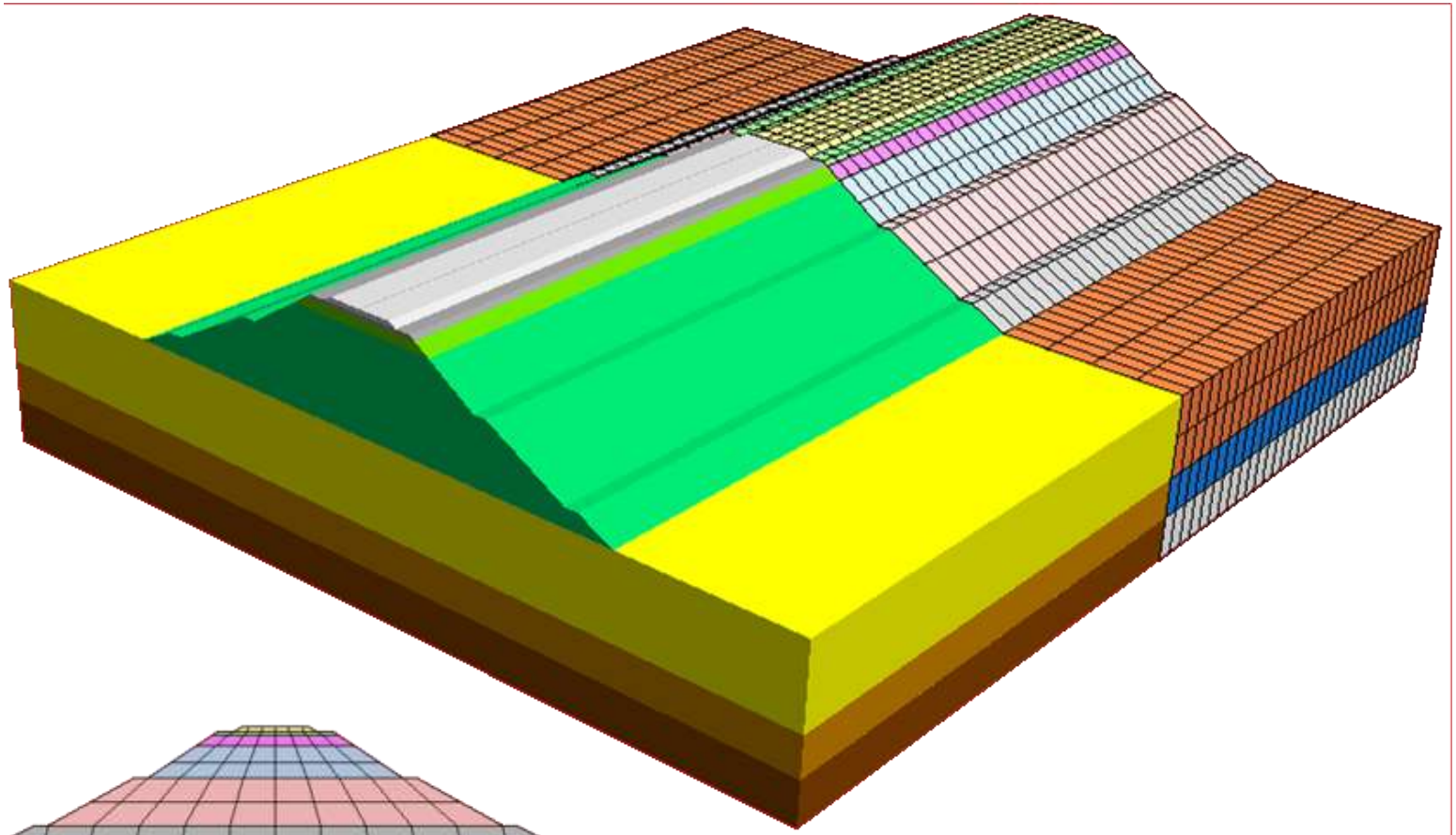


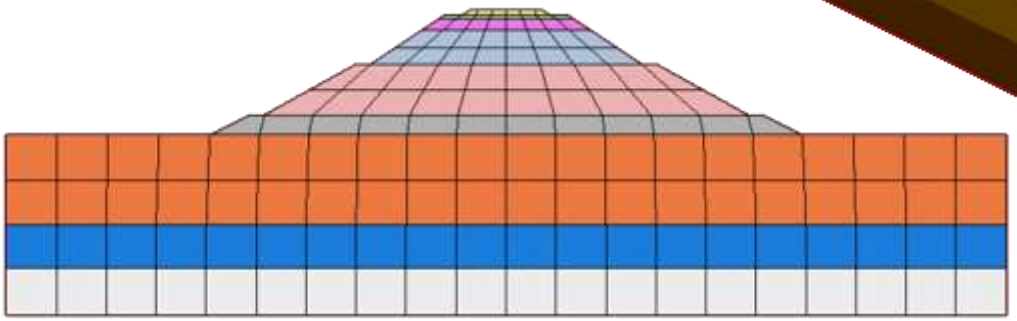


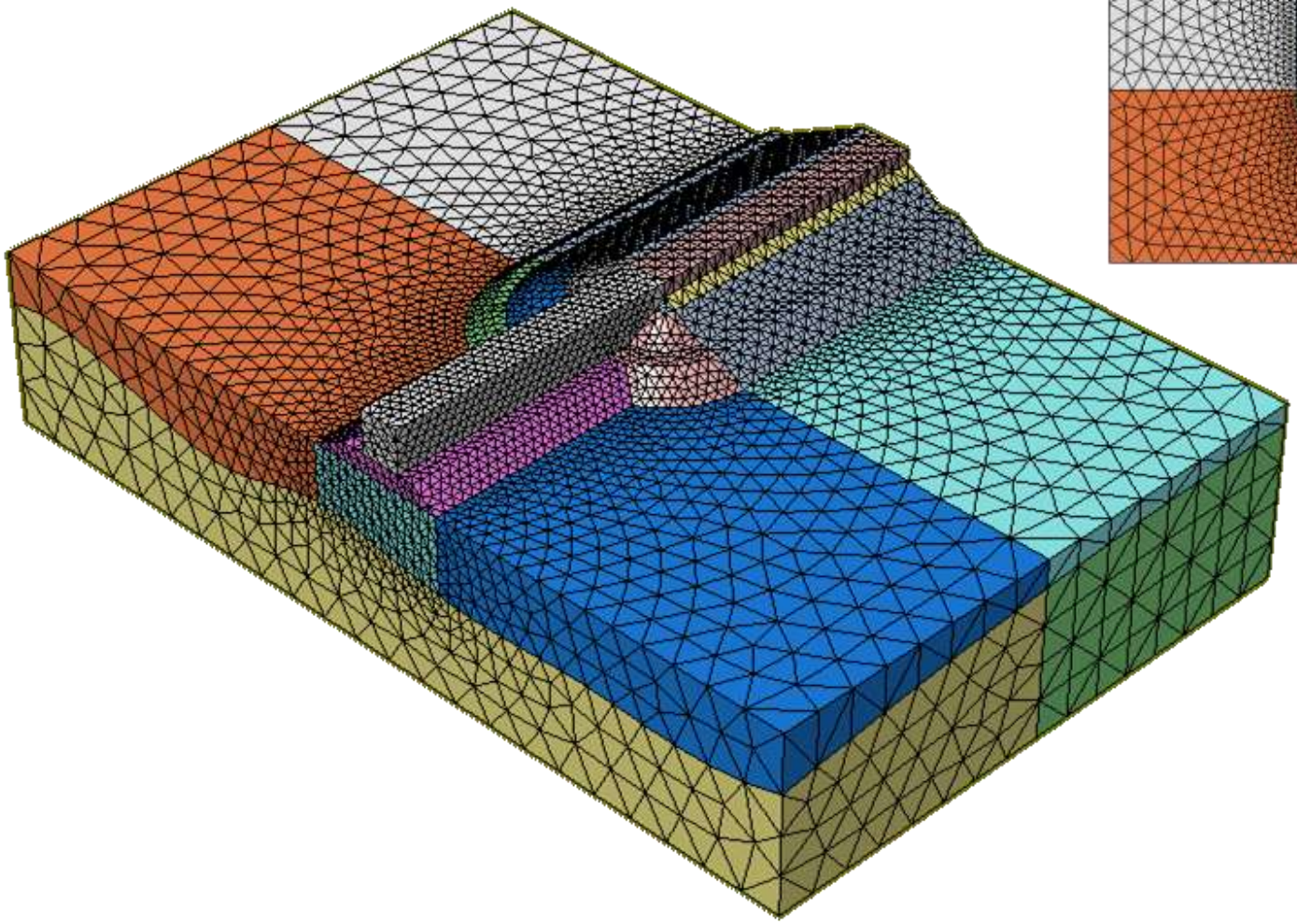


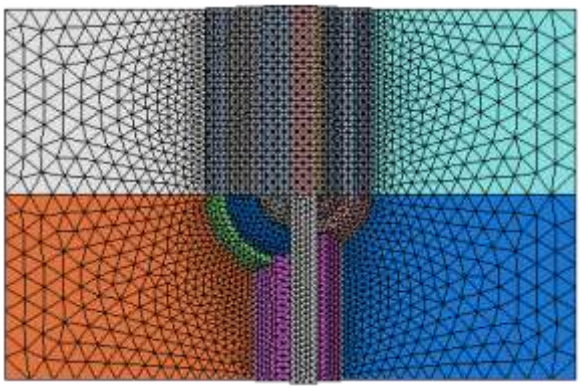


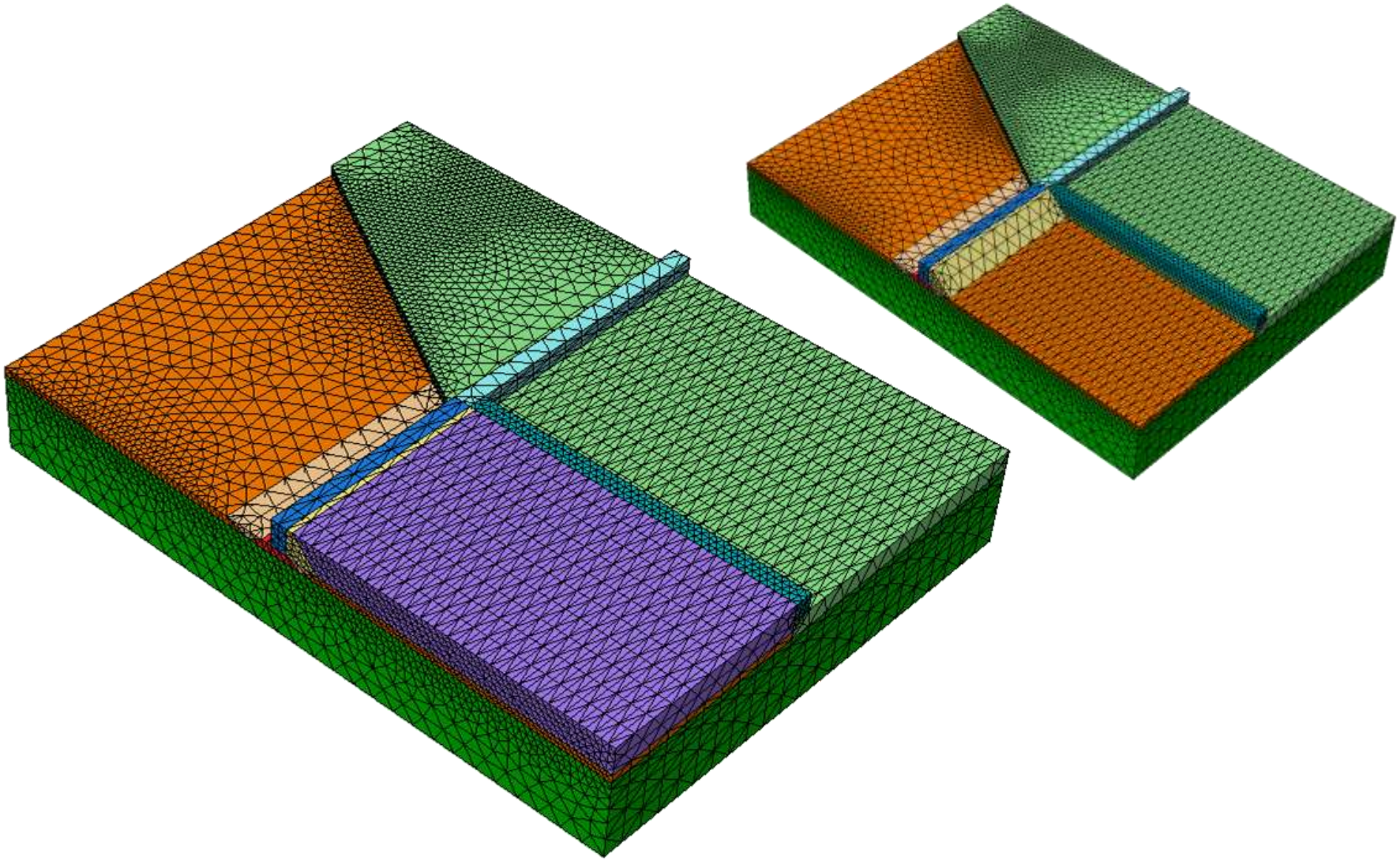

Front View
Iso View
Side View
Core + S/C + R/B

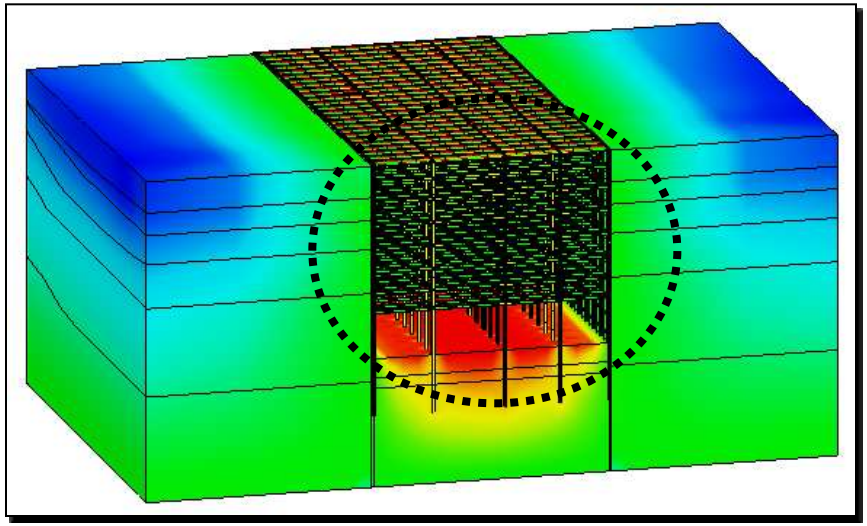


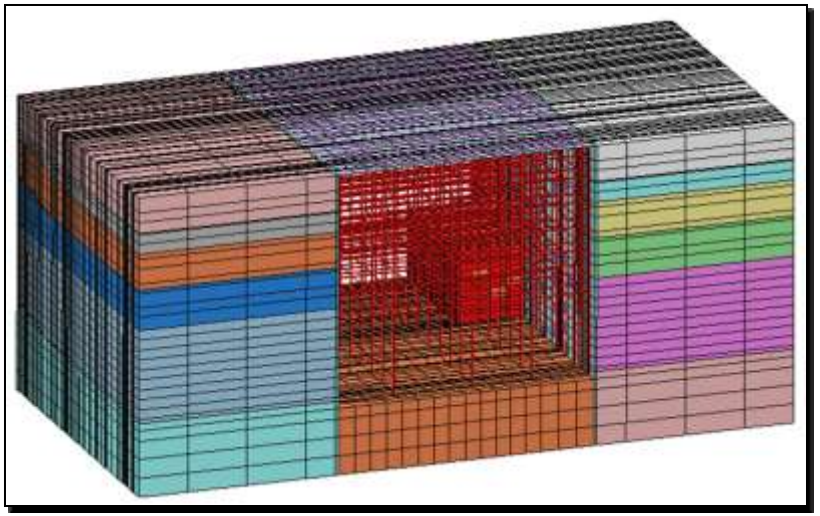


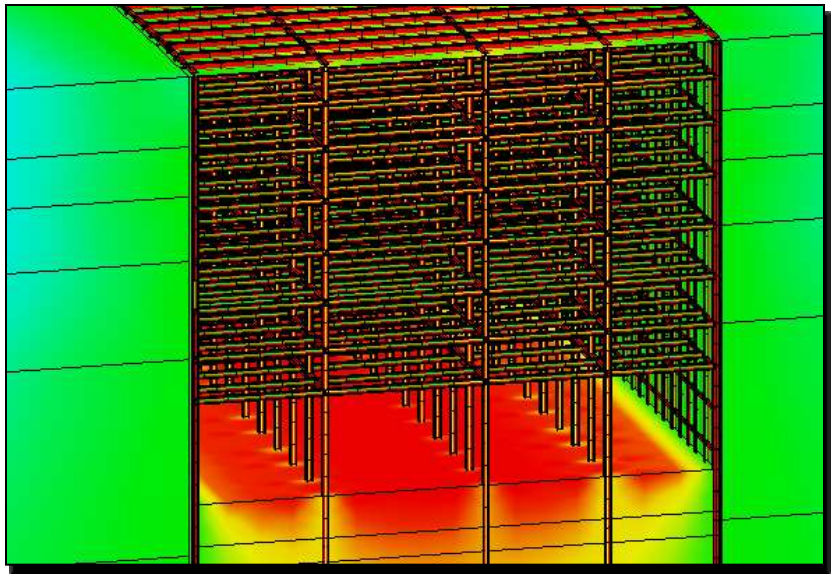


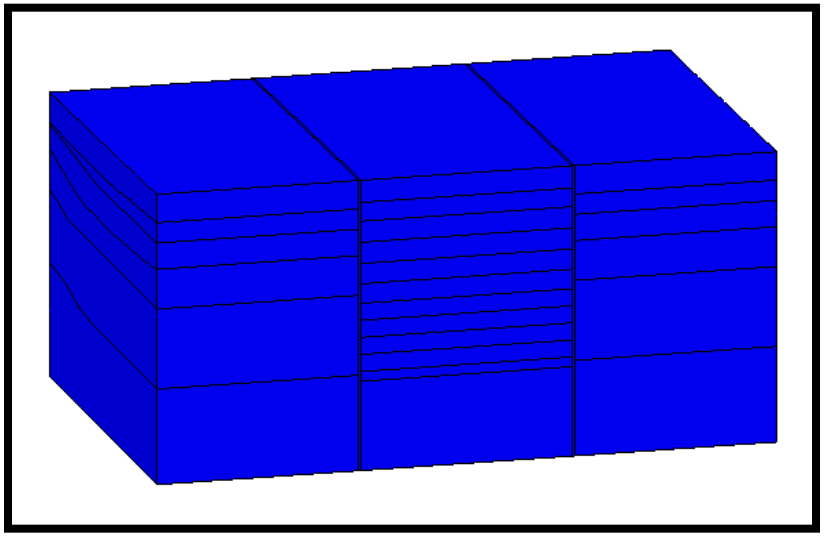




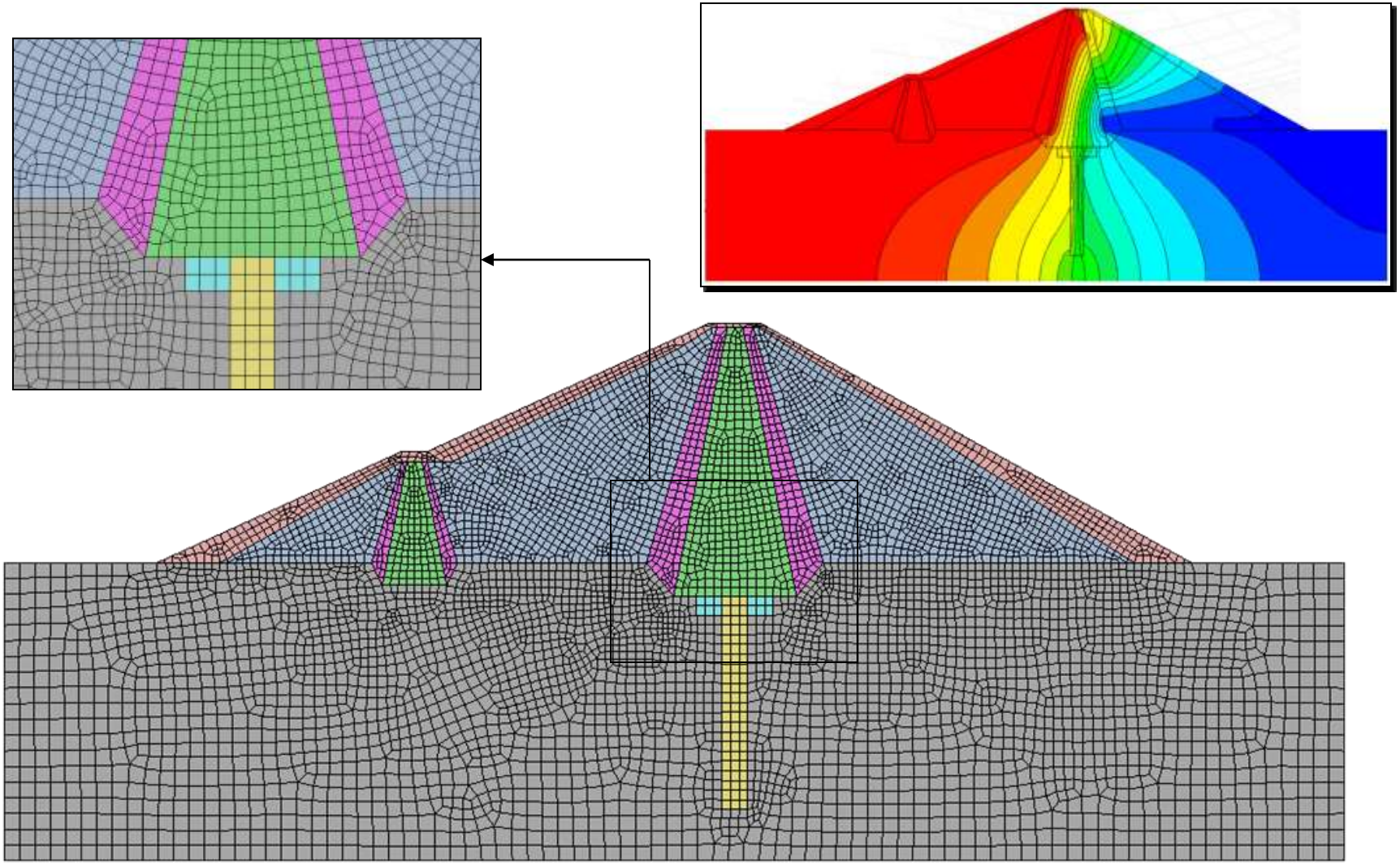


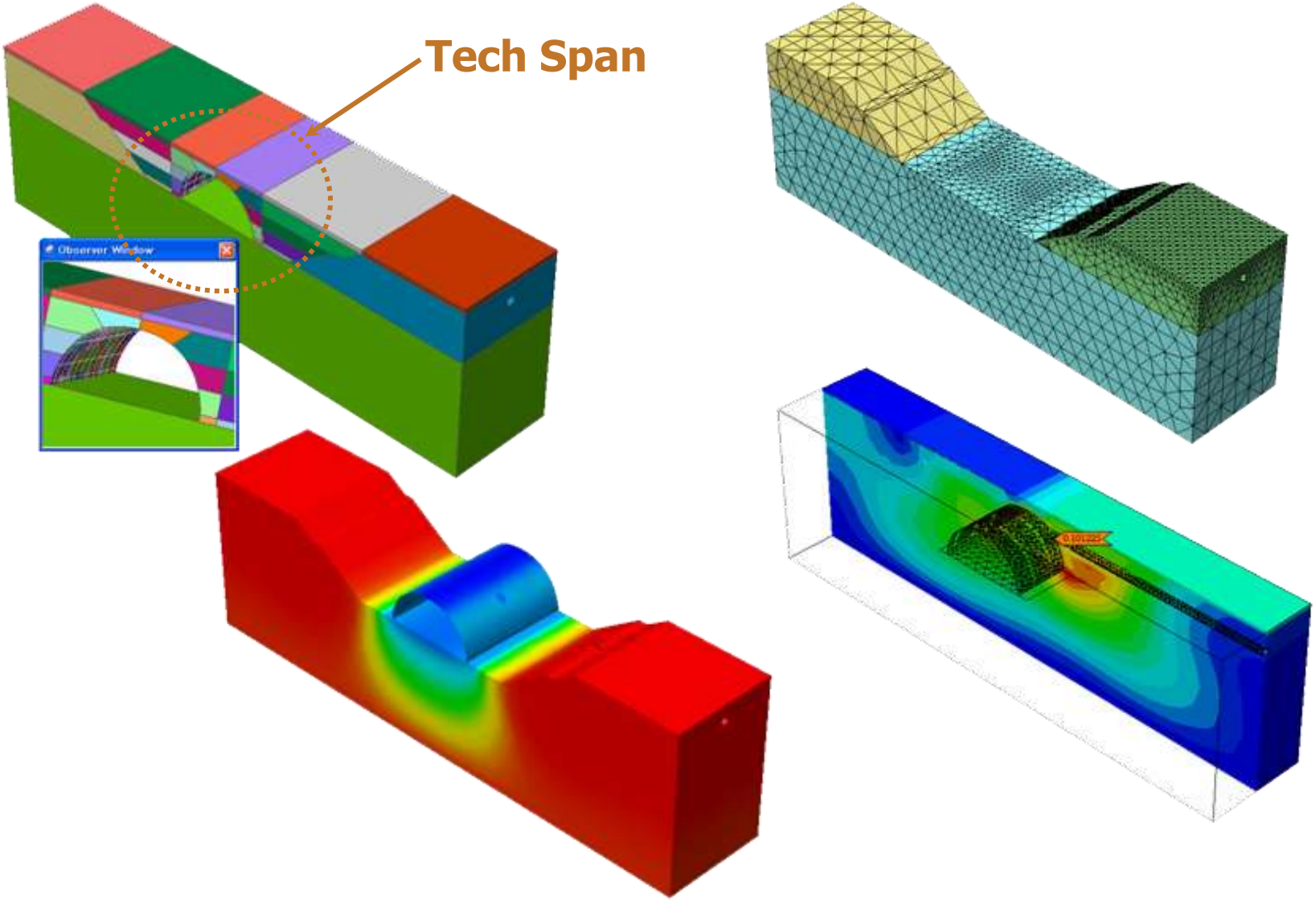


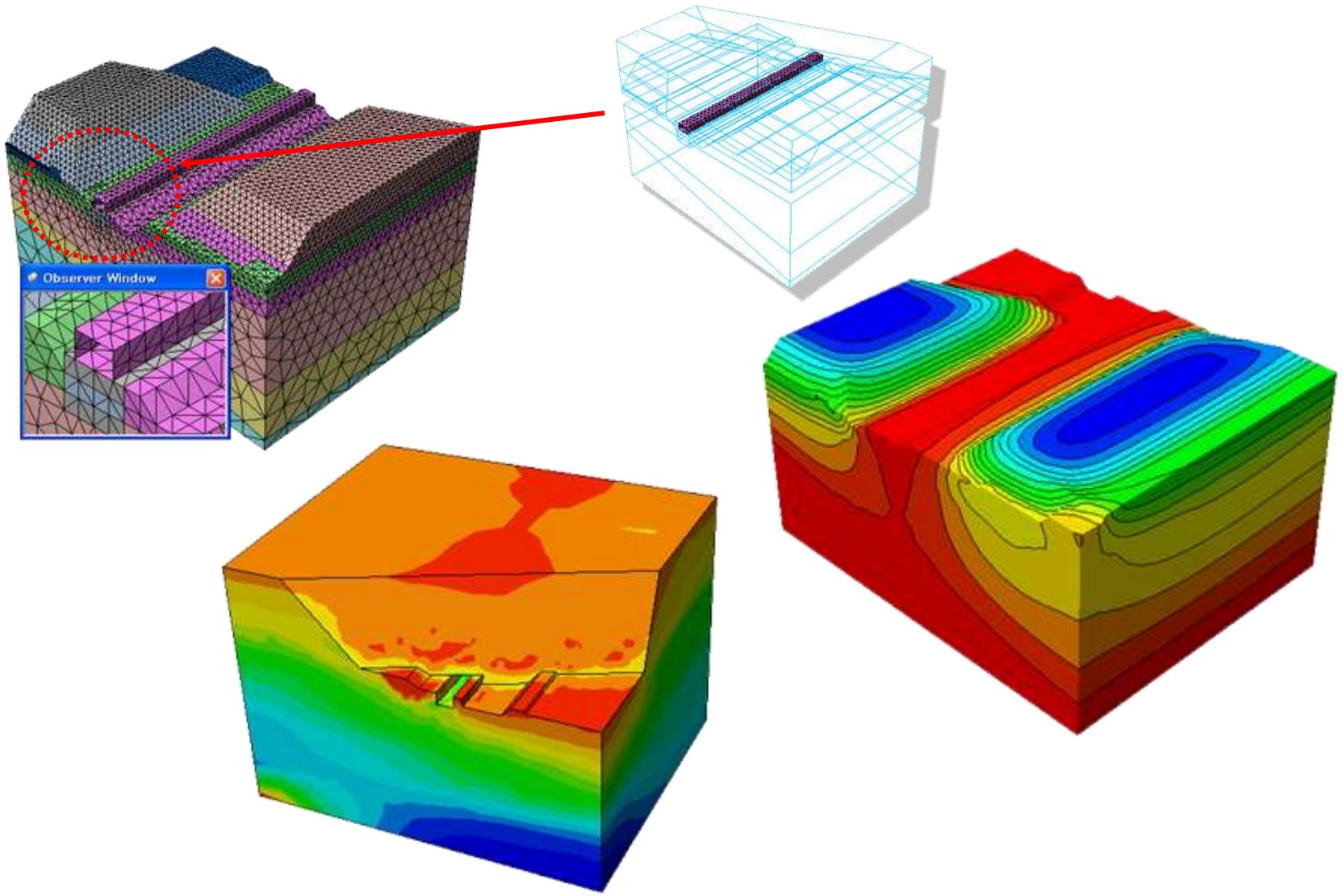


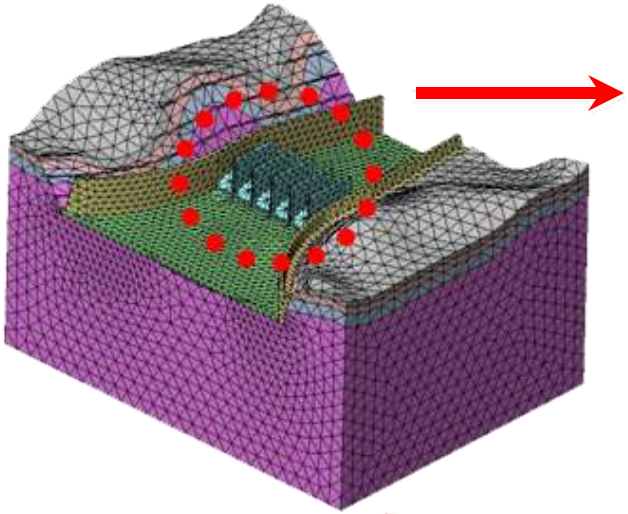


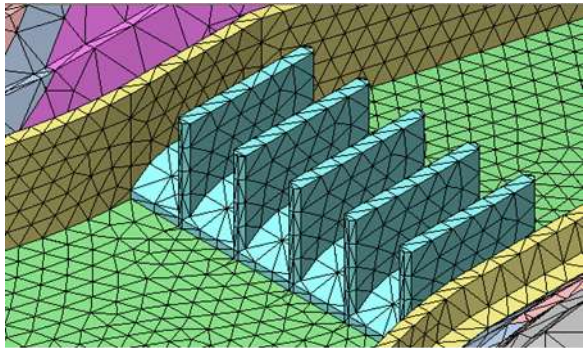
3D Construction Stage Analysis

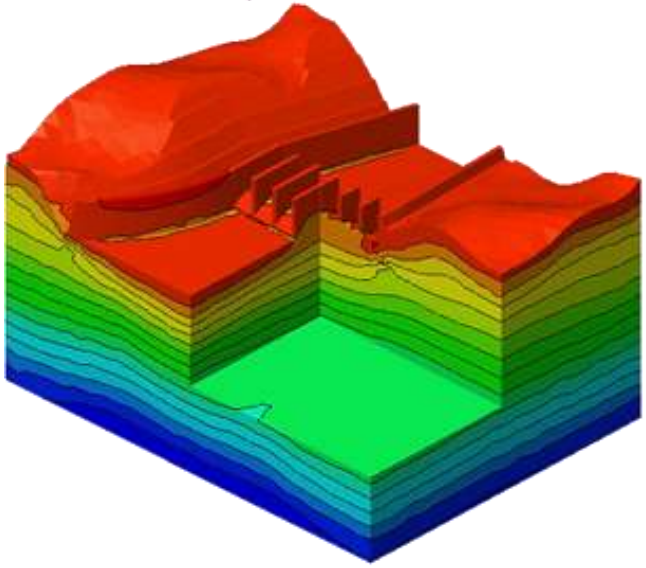


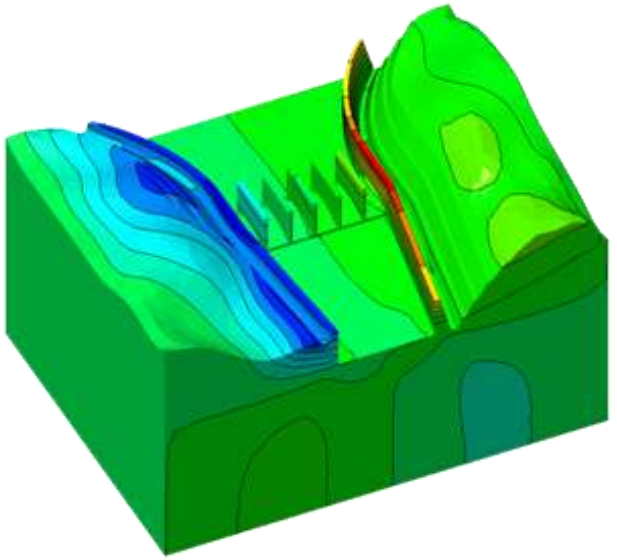

Tech Span
Observer Window

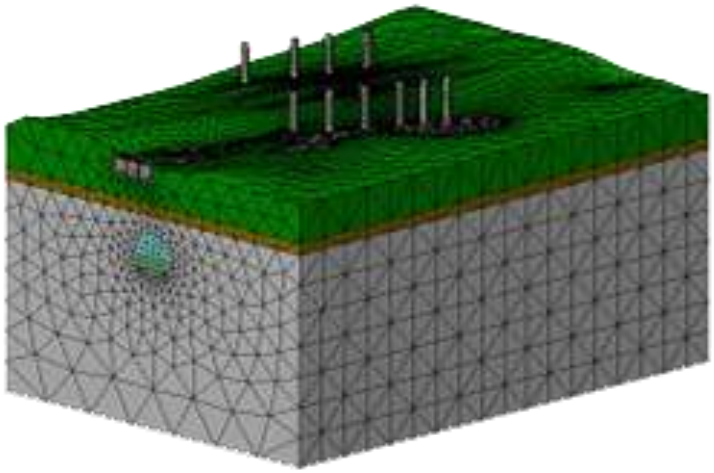

Observer Window

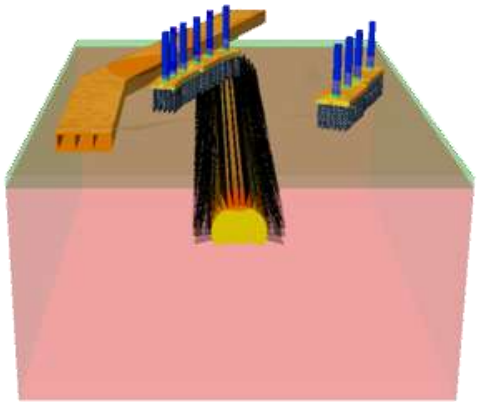


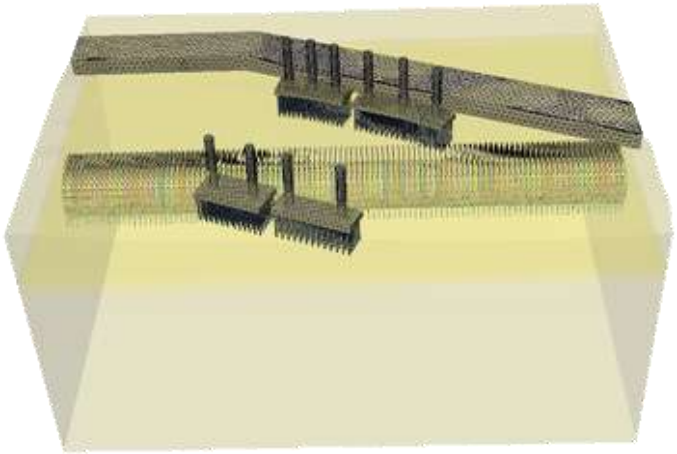


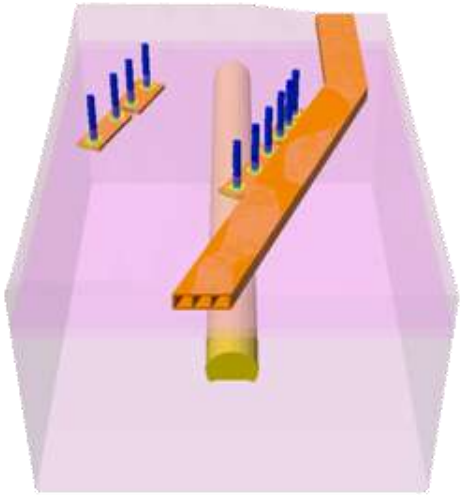


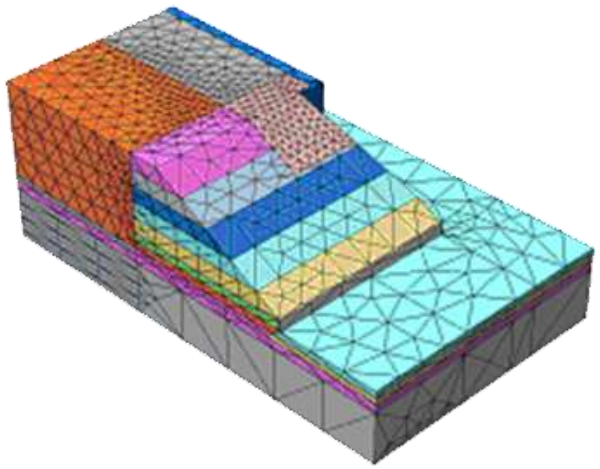


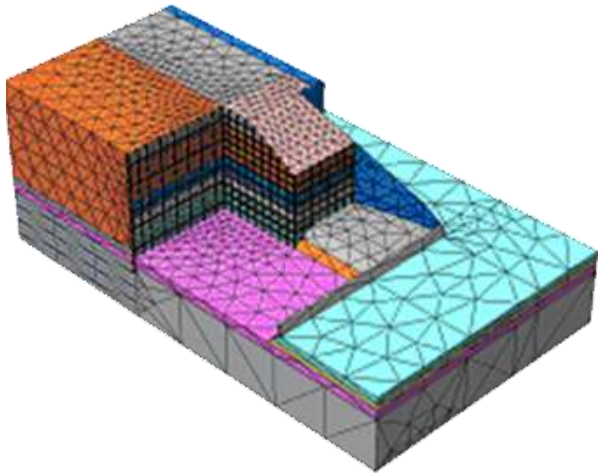


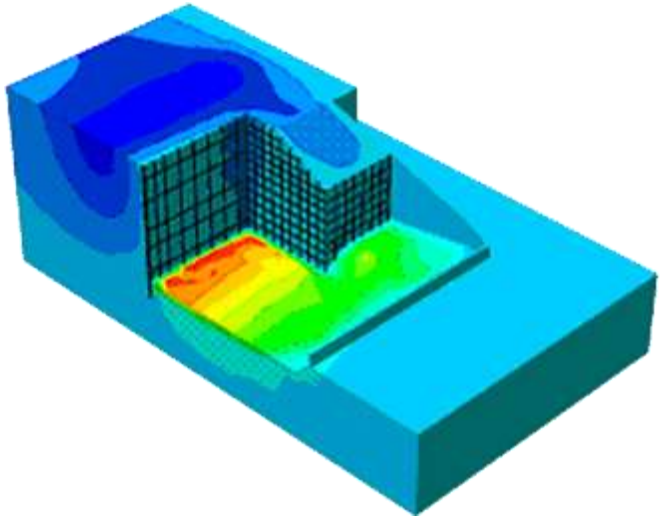


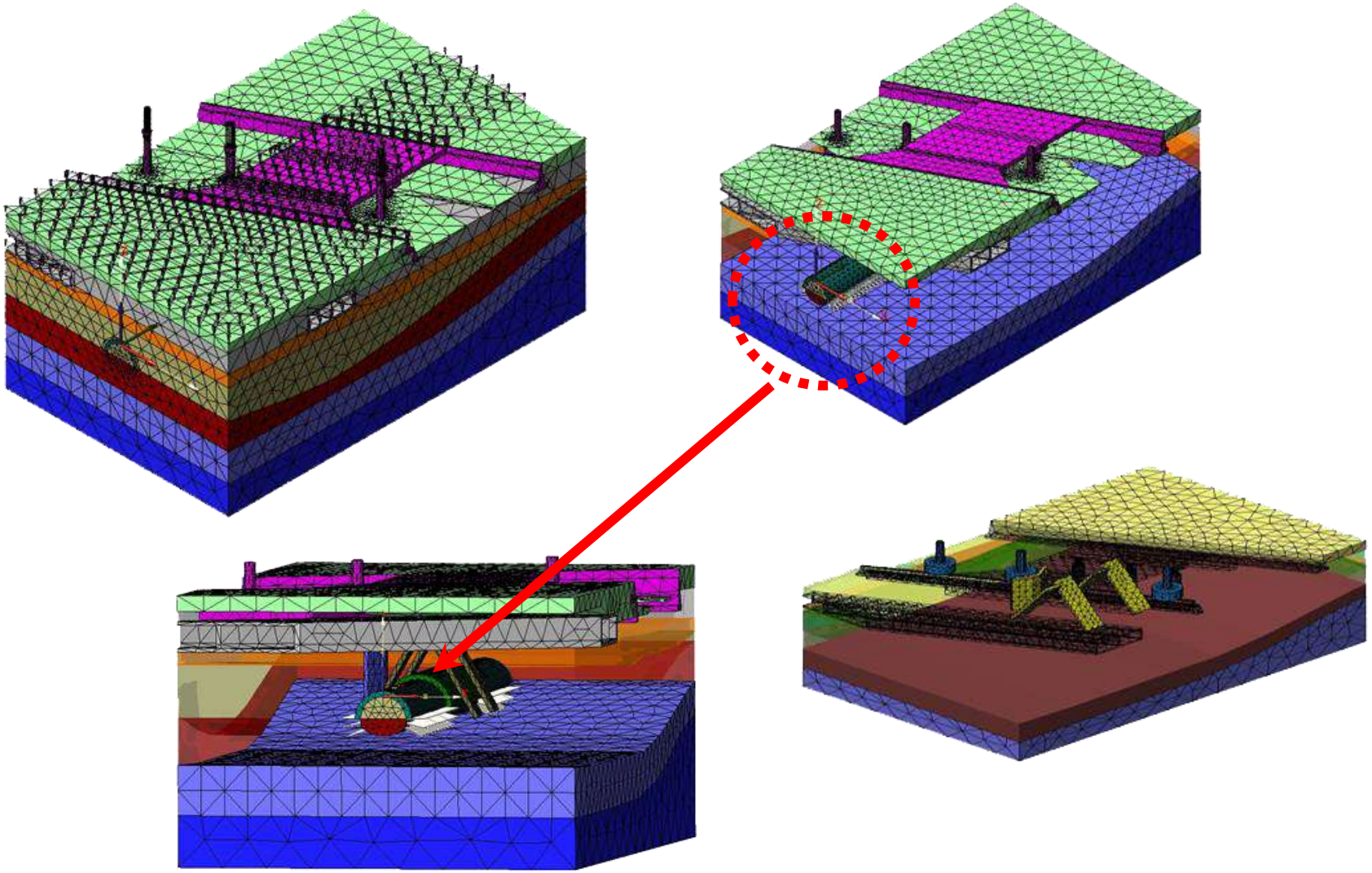


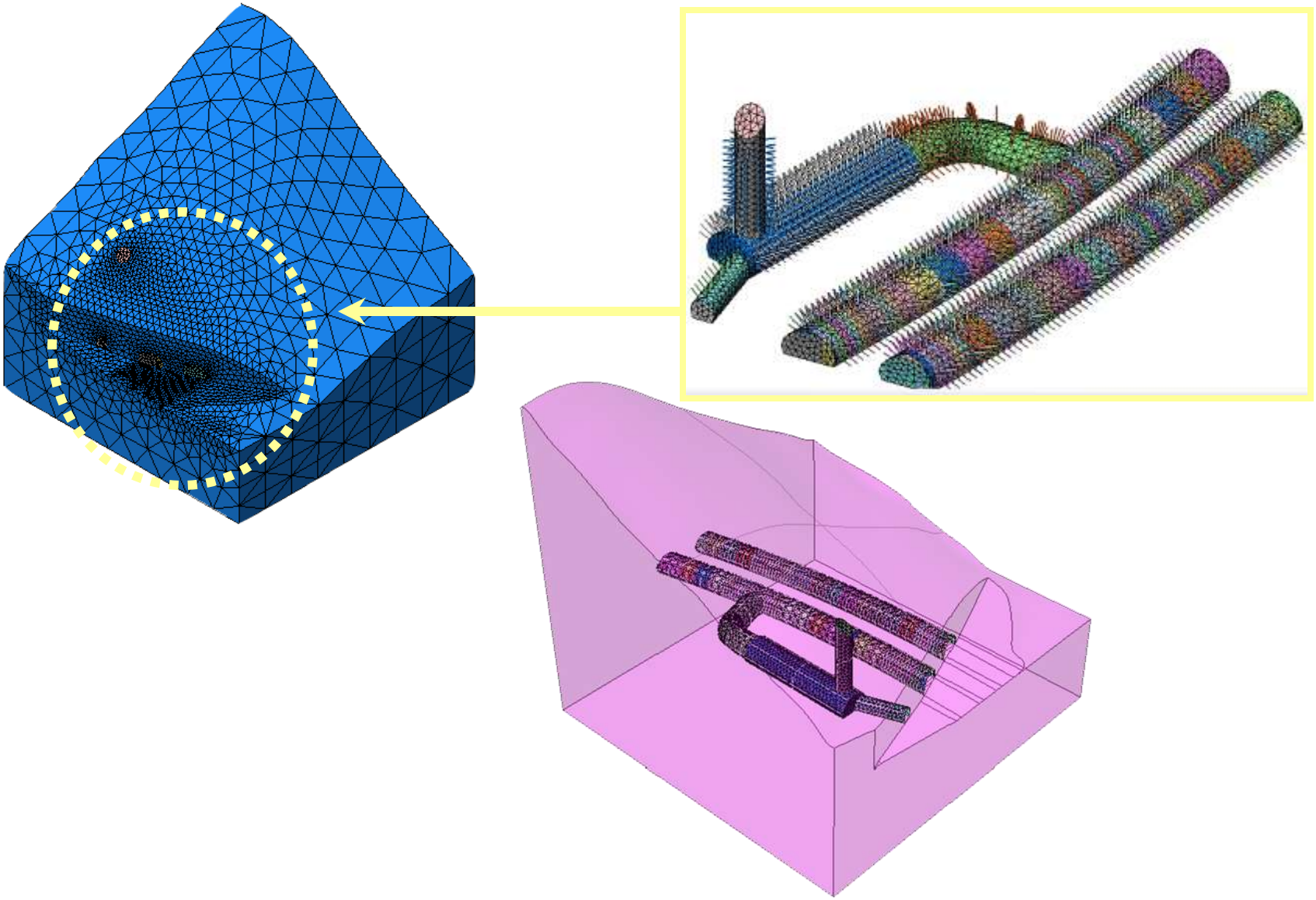


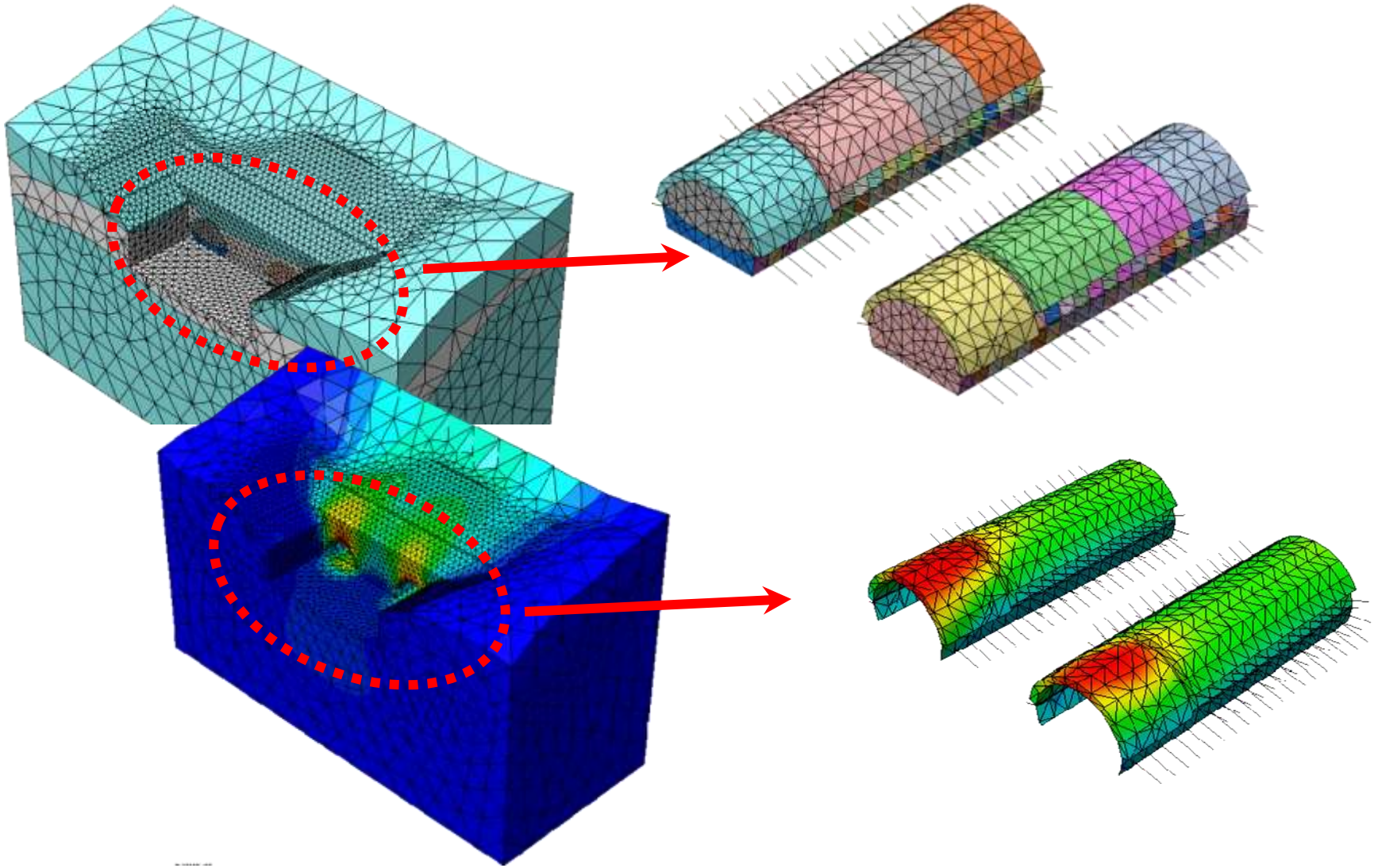


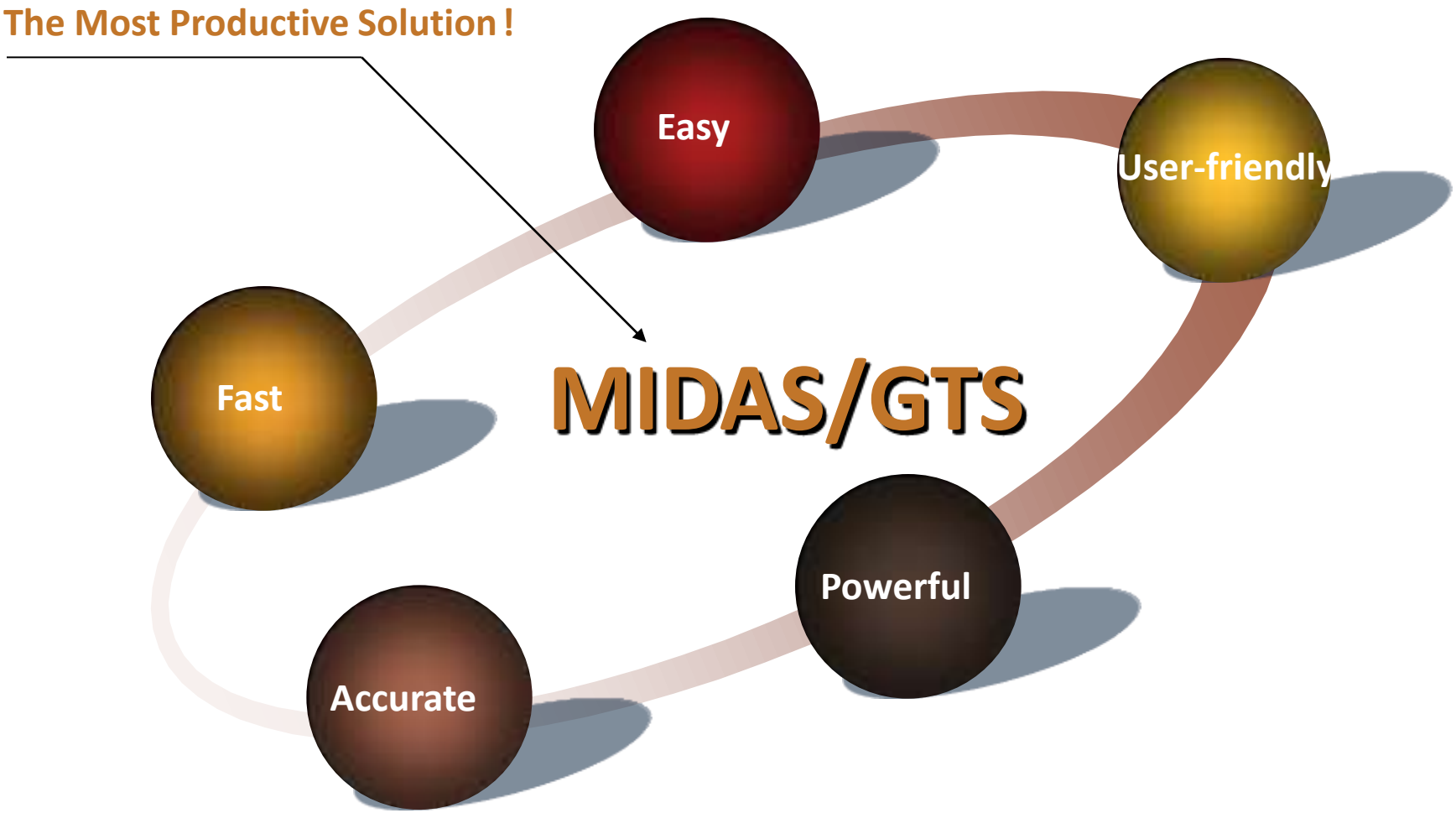




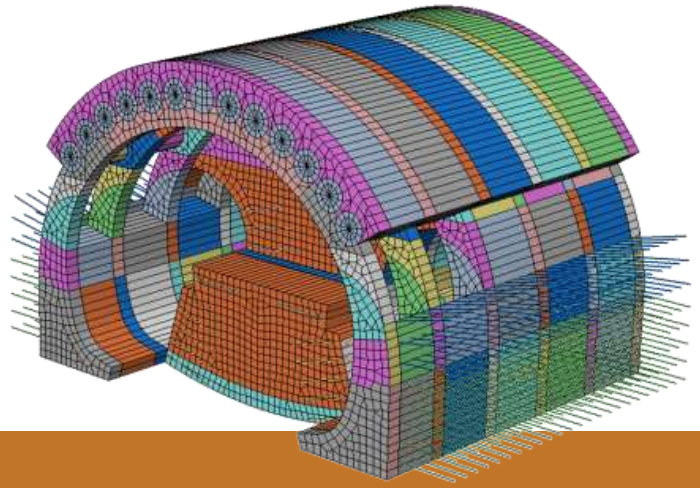







The Most Productive Solution !
Easy
User-friendly
Fast
MIDAS/GTS
Powerful
Accurate

Thank You!



Geotechnical & Tunnel analysis System

midas GTS