



LUSAS

Engineering analysis and design software



LUSAS for Ground Engineering and Soil-Structure Interaction Modelling

LUSAS – The Company

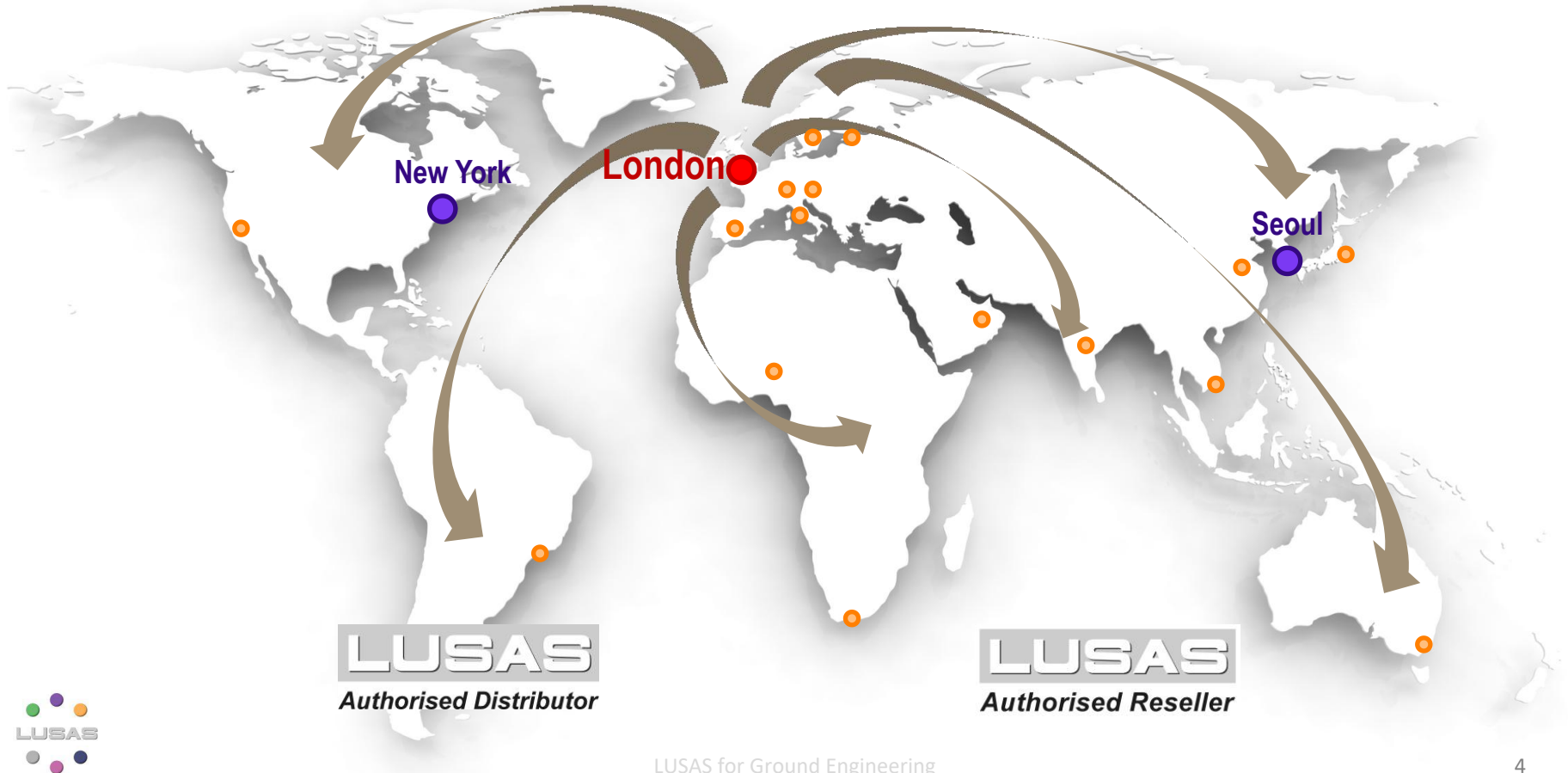
- Headquartered in the UK, with a global presence
- Over 30 years in the business, with origins in Imperial College, London
- Develops, markets and supports a range of LUSAS software products used in all engineering industries
- Also offers consultancy services



‘LUSAS’

**London University
Structural Analysis System**

Global coverage and support



*Civil and Structural
engineering*

*Bridge
engineering*

*Composites
engineering*

LUSAS

Engineering analysis and design software

*Specialist
Applications*

*Teaching and
Research*

*General mechanical
engineering*

For geotechnical and soil-structure interaction

LUSAS

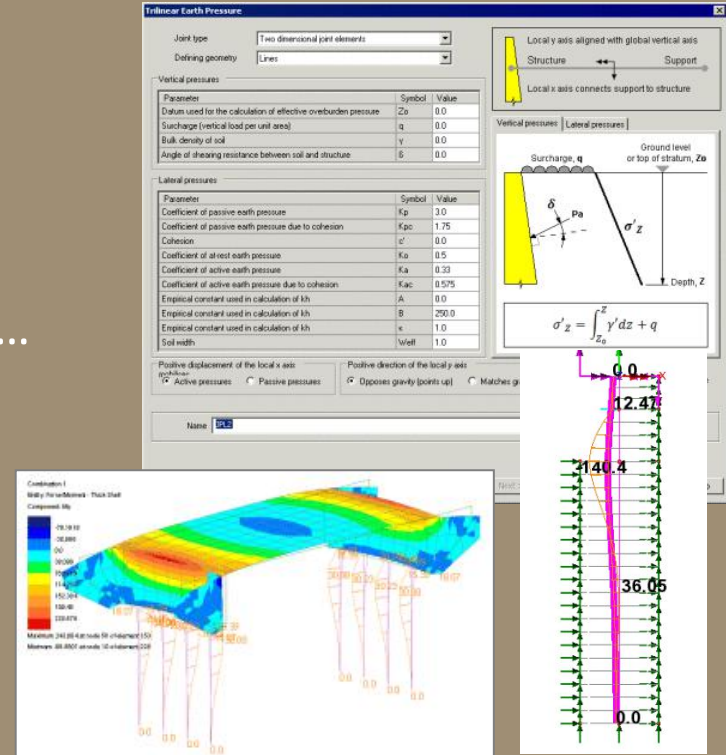
Bridge

Civil & Structural

Why use LUSAS for Geotechnics/SSI?

Model ground and structure in a single model

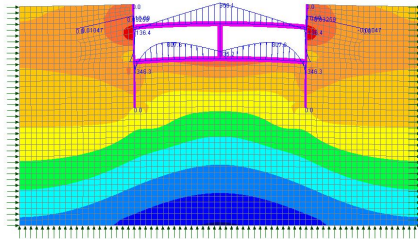
- Represent soil as continuums or interfaces (active / passive joints) and in 2D or 3D
- Nonlinear soil material models include Mohr Coulomb, Modified Cam Clay, Drucker-Prager...
- Water phase analysis for consolidation and seepage effects
- Time stage facilities for excavation and filling processes
- Linear and nonlinear soil dynamics



Application areas

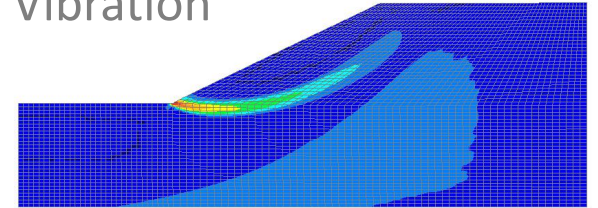
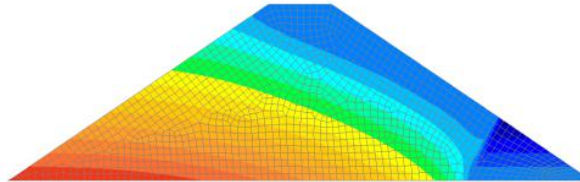
- Use for:

- Pad, Pile and Basement Foundations
- Tunnelling and Excavations
- Retaining Walls
- Integral Bridges
- Dams



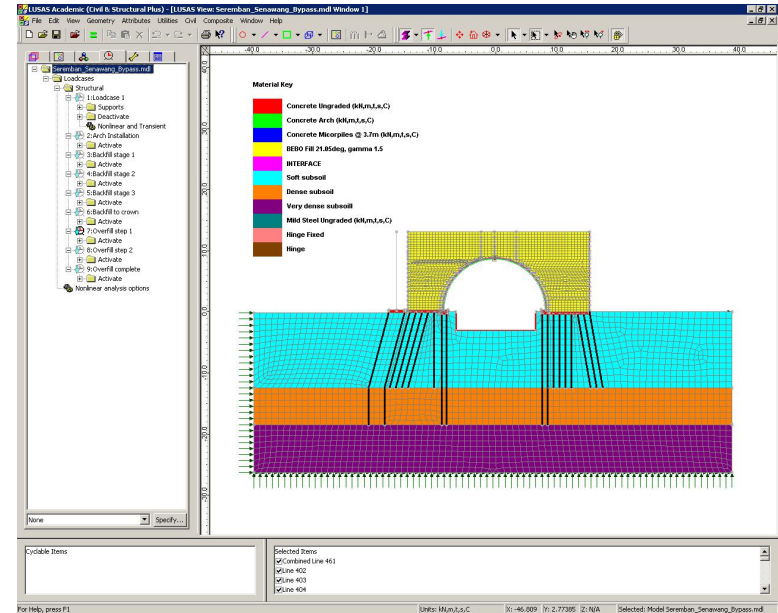
- To investigate:

- Bearing Capacity
- Overturning
- Stability
- Consolidation
- Seepage
- Vibration



Working with LUSAS

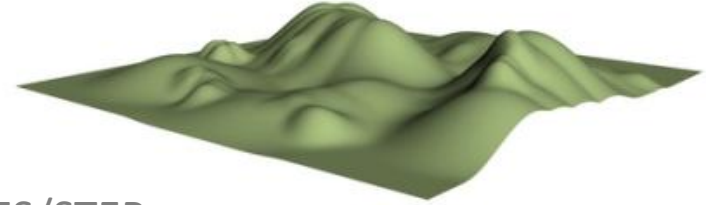
- Easy-to-use application-specific **Modeller**
- Fully integrated **Solver** which can be used independently.
- Models are formed of layers and are created using feature-based geometry methods (points, lines, surfaces, volumes)
- Easy to use mesh refinement capabilities
- Associative modelling provides an intelligent link between all model data



General modelling tools

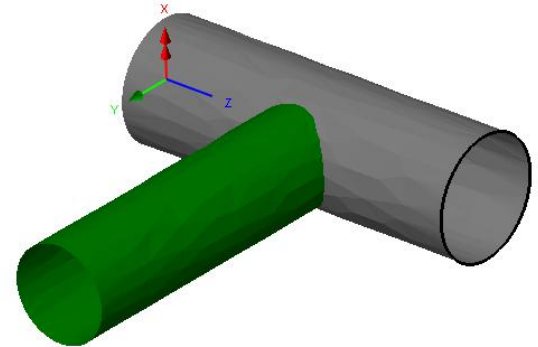
- CAD Import / Export

- Points and lines through DXF
- Points, lines, surfaces and volumes through IGES/STEP
- Triangulated surfaces from ground models through STL

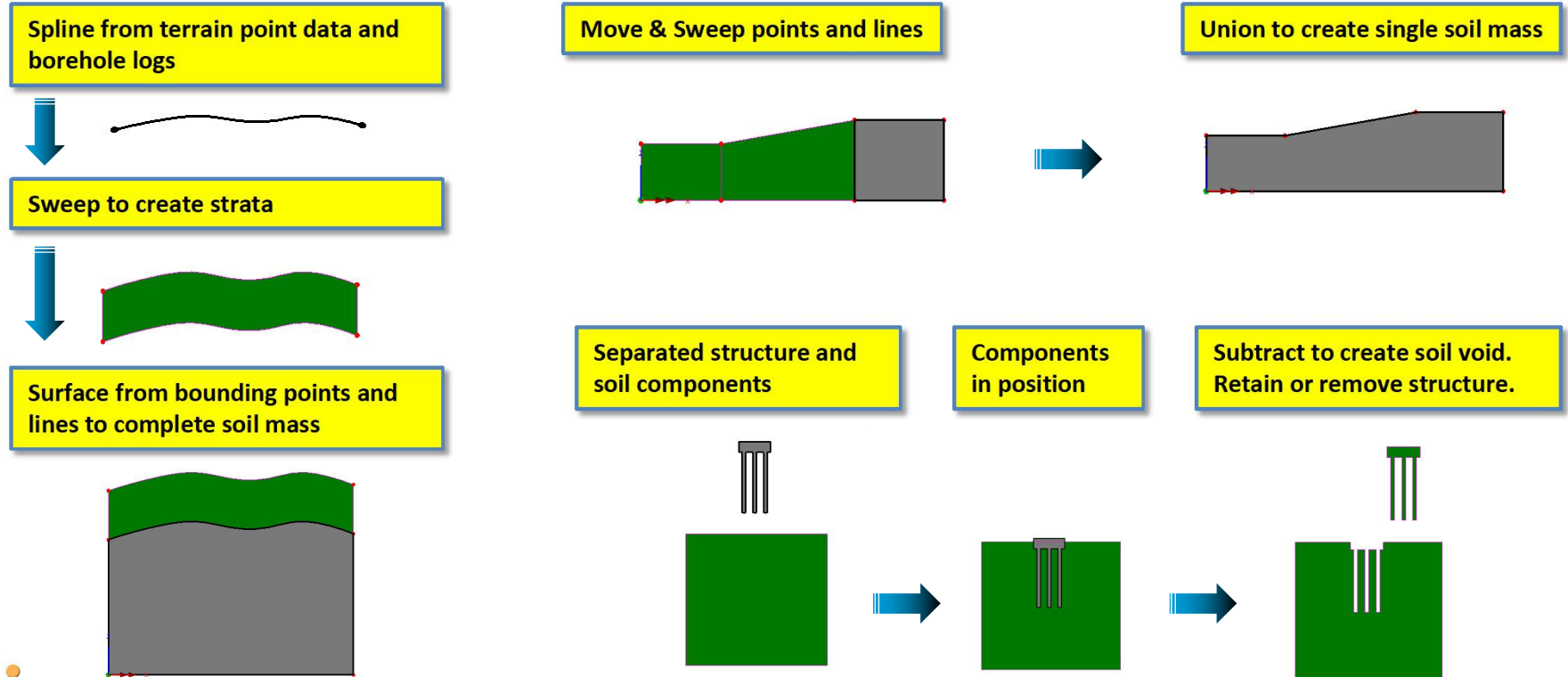


- Drawing Tools

- Snap to grids
- Arcs, Splines
- Copy, Mirror, Rotate, Scale, Transform
- Extrude, Intersect and Manifold
- Subtract, Union

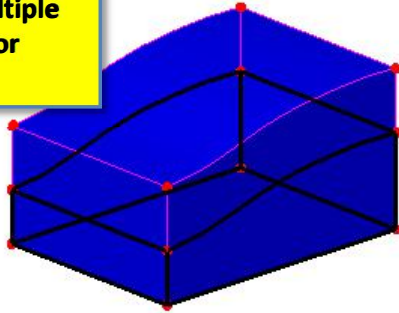


Example modelling in 2D

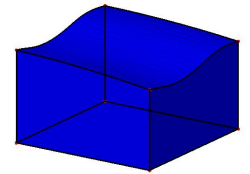
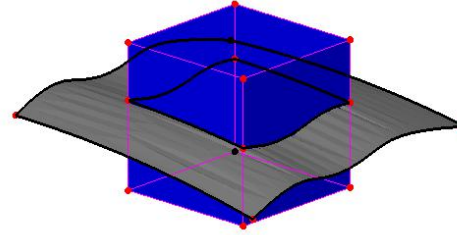


Example modelling in 3D

Surface sweeping for multiple volume creation, planar or curved



Intersection command for slicing of volumes, planar or curved.

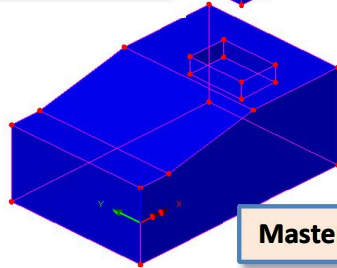
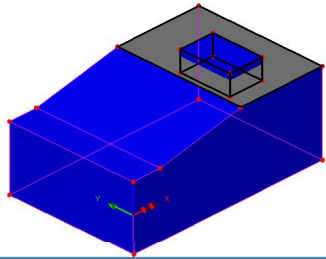


Tool Object

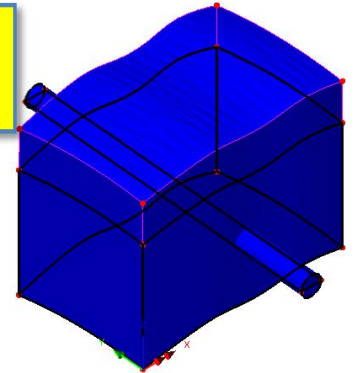


Intersection and subtraction commands for cylindrical surface with internal void through volume

Subtraction command for creation of voids

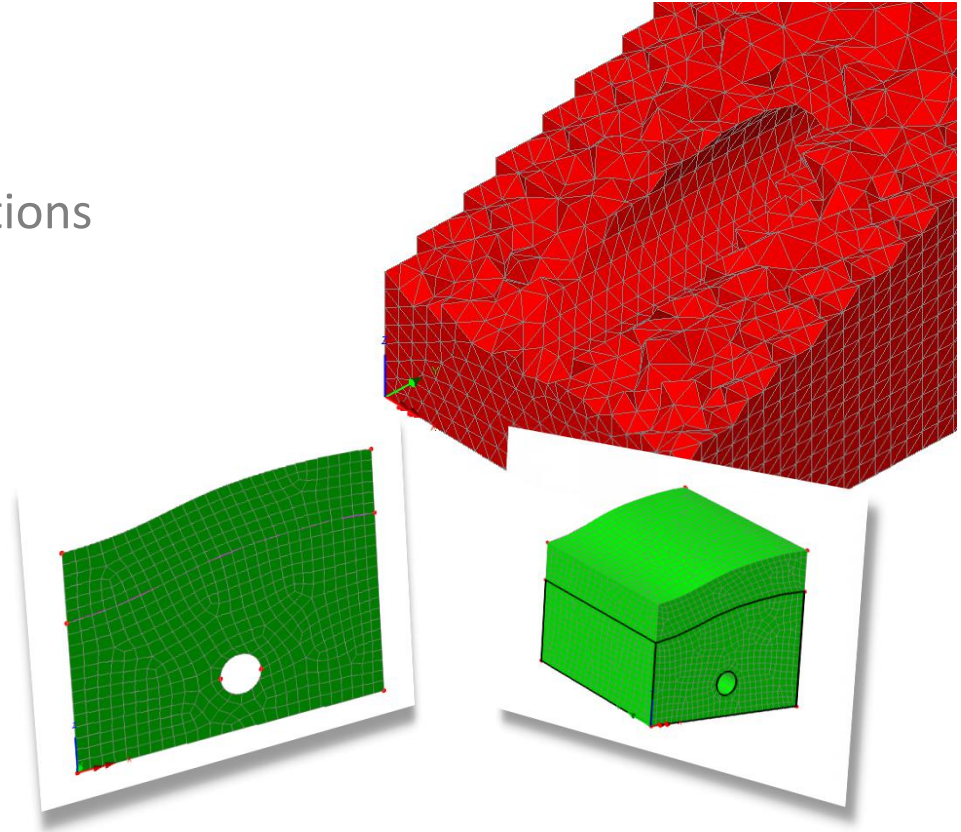


Master Object



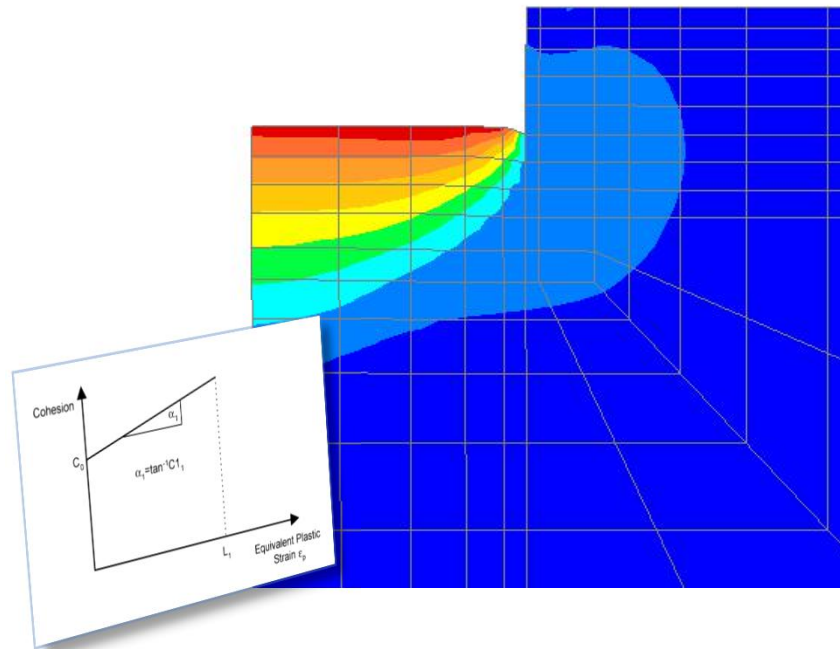
Meshing tools

- General Facilities:
 - Linear and Quadratic formulations
 - Mesh refinement
- 2D Meshing:
 - Quads and Triangles
- 3D Meshing:
 - Tetrahedral
 - Penta/Hexahedral



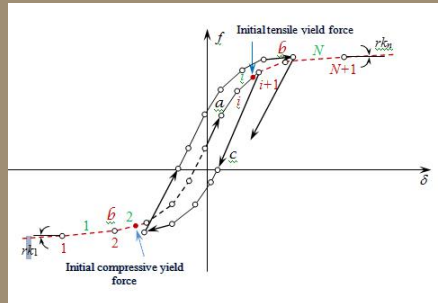
Soil and structural material models

- Constitutive Soils models
 - Tresca
 - Von Mises
 - Druker Prager
 - Mohr Coulomb
 - Cam Clay
- Structural Models
 - Concrete Cracking and Crushing
 - Steel yielding
- All models can incorporate strain hardening and softening



Boundary Modelling

- Modelling of soil-structure interface:
 - Linear springs
 - Non Linear (Active-Passive)
 - Hysteretic behaviour (cyclic loading / unloading)



Trilinear Earth Pressure

Joint type:

Defining geometry:

Vertical pressures

Parameter	Symbol	Value
Datum used for the calculation of effective overburden pressure	Zo	0.0
Surcharge (vertical load per unit area)	q	0.0
Bulk density of soil	γ	0.0
Angle of shearing resistance between soil and structure	δ	0.0

Lateral pressures

Parameter	Symbol	Value
Coefficient of passive earth pressure	Kp	3.0
Coefficient of passive earth pressure due to cohesion	Kpc	1.75
Cohesion	c'	0.0
Coefficient of at-rest earth pressure	Ko	0.5
Coefficient of active earth pressure	Ka	0.33
Coefficient of active earth pressure due to cohesion	Kac	0.575
Empirical constant used in calculation of kh	A	0.0
Empirical constant used in calculation of kh	B	250.0
Empirical constant used in calculation of kh	κ	1.0
Soil width	W _{eff}	1.0

Local y axis aligned with global vertical axis

Structure ← Support

Local x axis connects support to structure

Vertical pressures | Lateral pressures

Surcharge, q

Ground level or top of stratum, Zo

Depth, Z

σ'_z

δ

Pa

σ'_z = ∫_{Zo}^Z γ' dz + q

Positive displacement of the local x axis

Active pressures ☒ Passive pressures ☐

Positive direction of the local y axis

Opposes gravity (points up) ☒ Matches gravity (points down) ☐

☒ Consider angle of structure

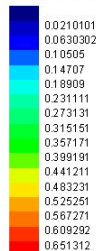
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< Back Next > Finish Cancel Apply Help

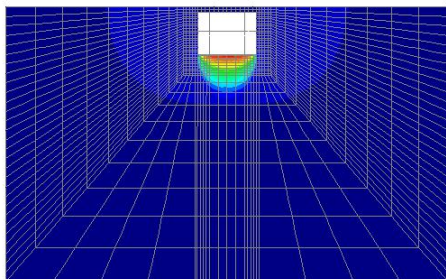
Deep excavations



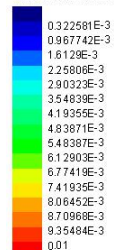
LOAD CASE = 24
Increment 24
RESULTS FILE = 1
DISPLACEMENT
CONTOURS OF RSLT



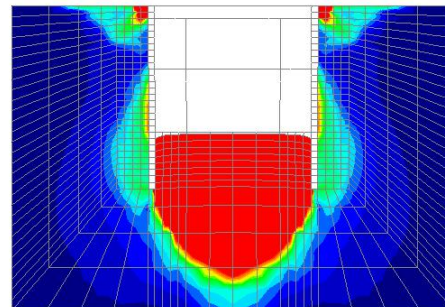
Max 0.6723 at Node 1432
Min 0.0000E+00 at Node 2848



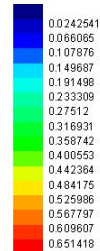
LOAD CASE = 22
Increment 22
RESULTS FILE = 1
PLASTIC STRAIN
CONTOURS OF EPE



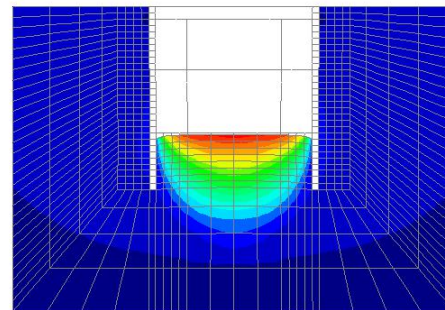
Max 0.4536 at Node 1408
Min 0.0000E+00 at Node 2079



LOAD CASE = 22
Increment 22
RESULTS FILE = 1
DISPLACEMENT
CONTOURS OF RSLT

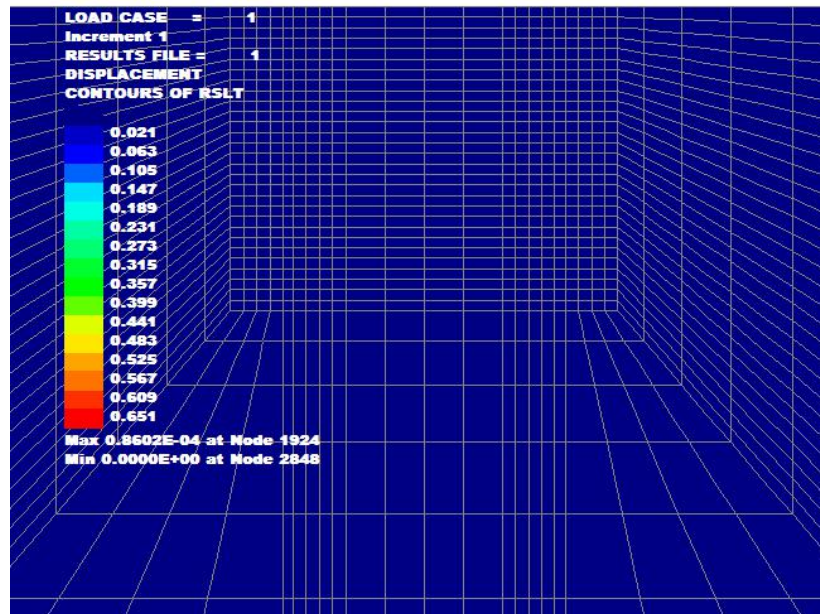


Max 0.6723 at Node 1432
Min 0.3349E-02 at Node 3055



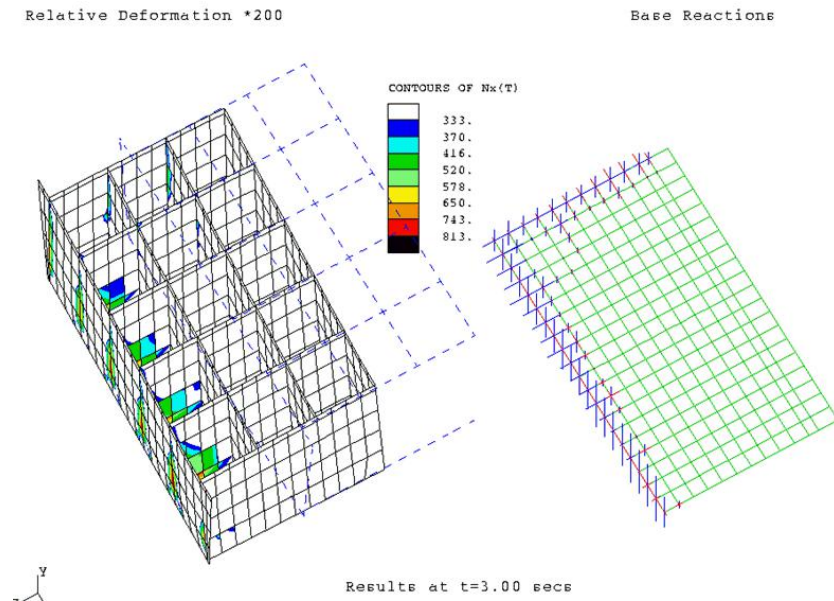
Deep excavations

- Construction sequence including temporary and permanent propping
- Design of wall and props in single model



Seismicity in soils

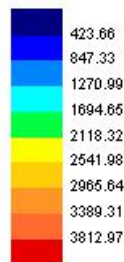
- Multiple seismic events
- Analysis of nonlinear reinforced concrete and soils
- Time-history of all stresses including contact stresses through event



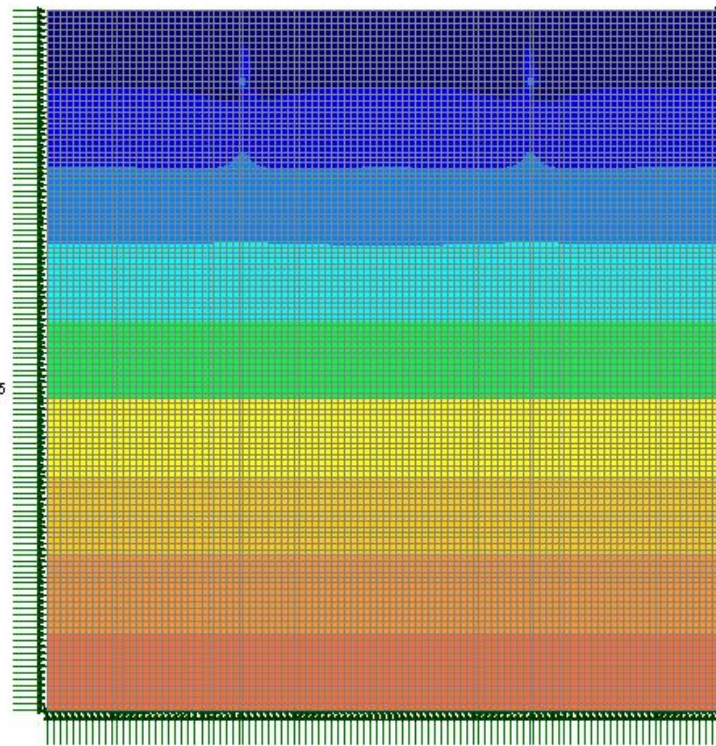
Rock bolting

- Excavation with rock bolts and gunite concrete wall

Loadcase: 1: Increment 1
Results file: Soil Excavation.mys
Entity: Stress - Plane Strain
Component: SE



Maximum 3.81554E3 at node 12545
Minimum 2.5665 at node 8538

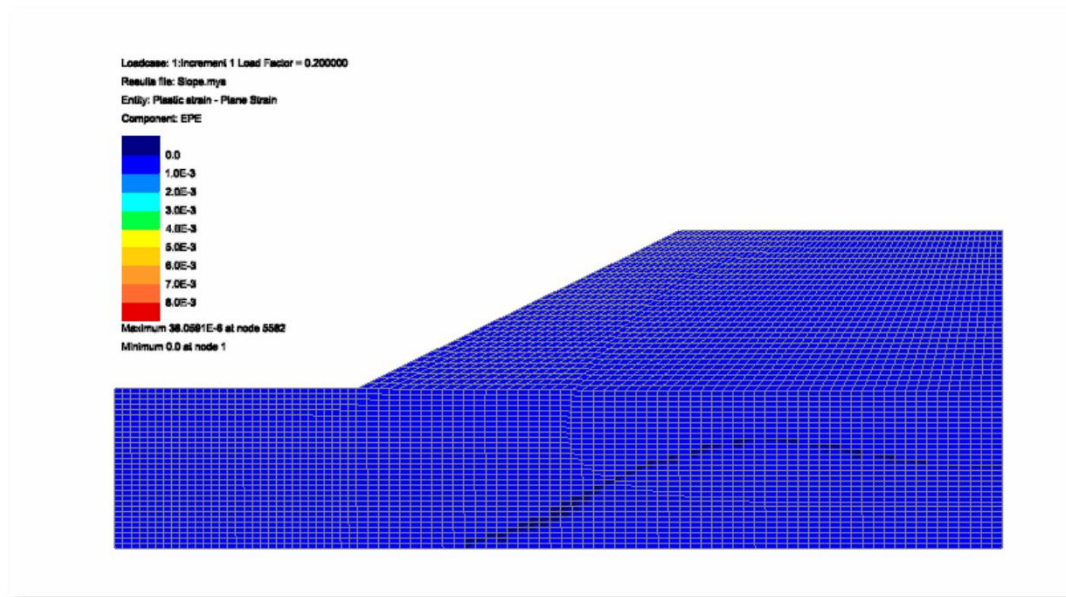


Stability of embankments

- Formation of slip circle

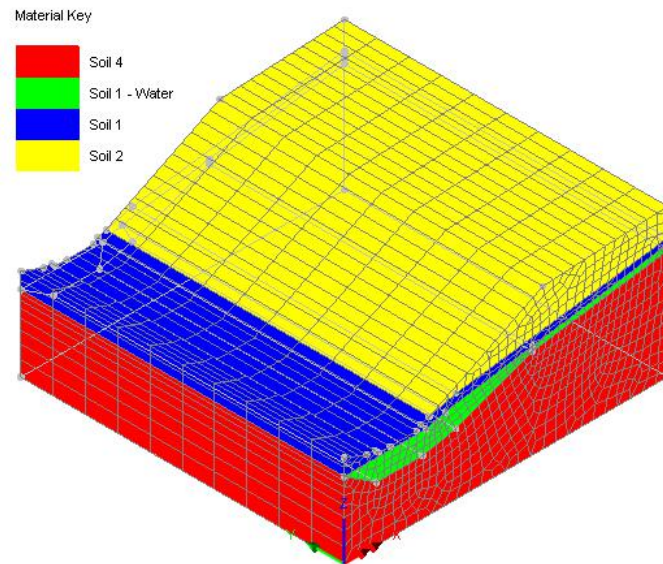
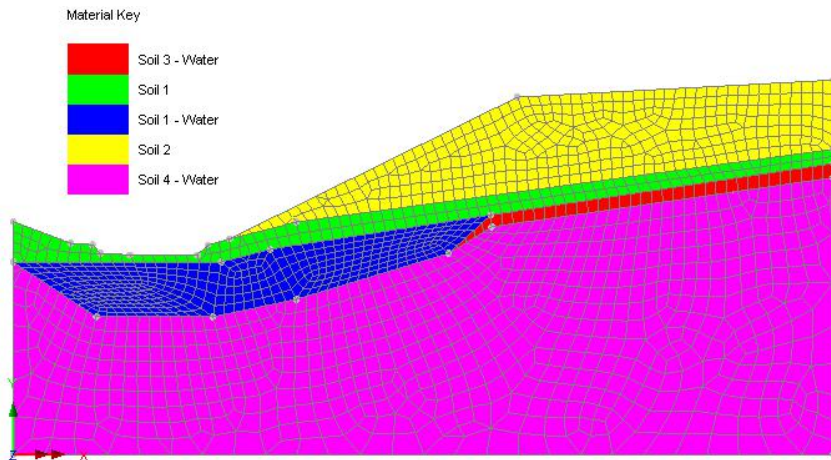


Sevenoaks slip in Weald clay



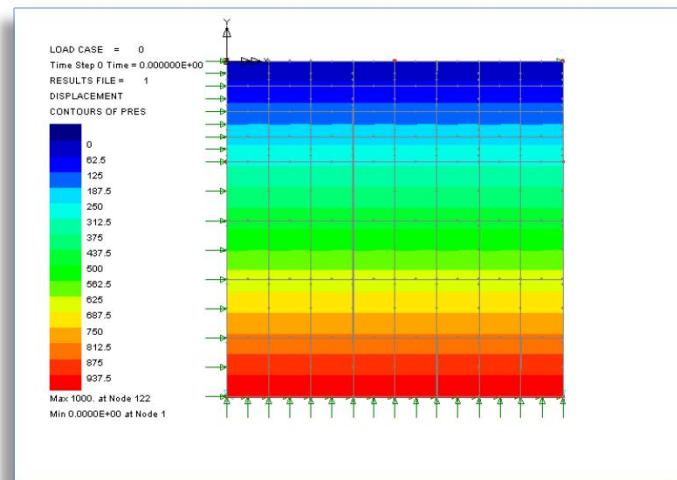
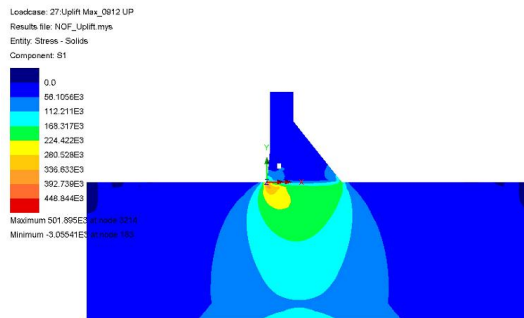
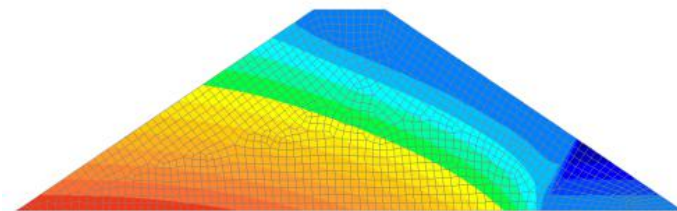
Stability of embankments

- Formation of slip circle and strata in 2D and 3D



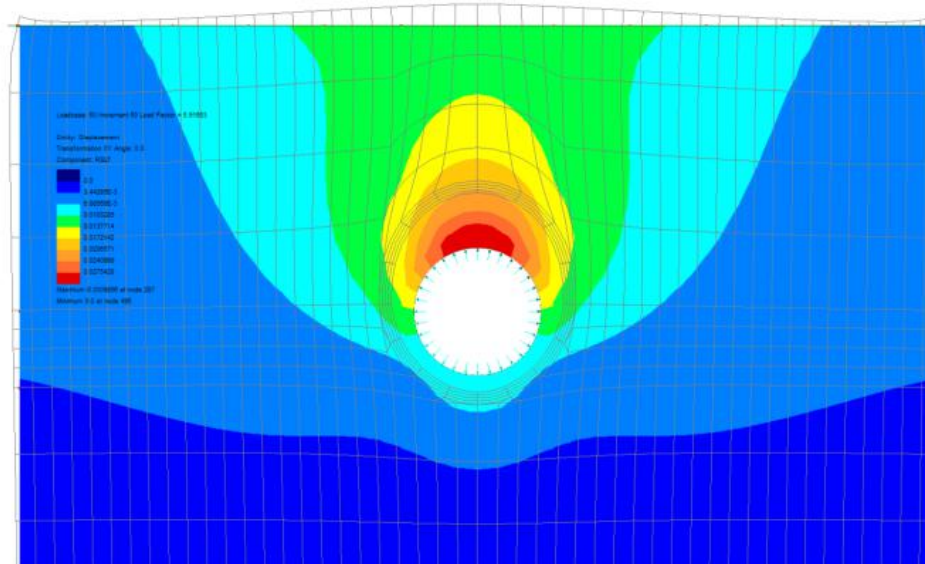
Consolidation and Seepage

- Consolidation
 - Pore-Water pressure
 - equalisation with time
 - 2D and 3D
- Seepage
 - Dams
 - Dewatering



Tunnelling

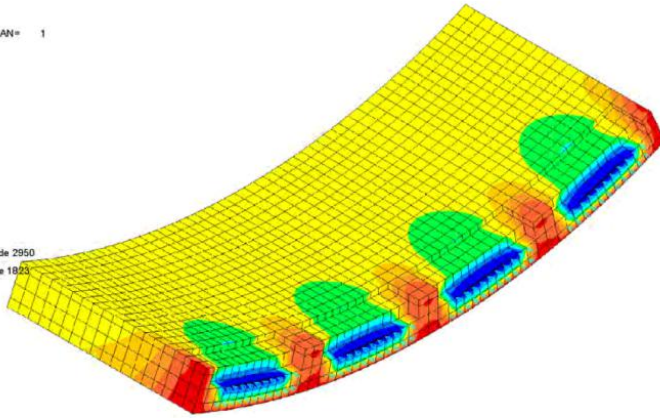
- Analysis of vertical displacement of backfill in tunnel with increased pressure



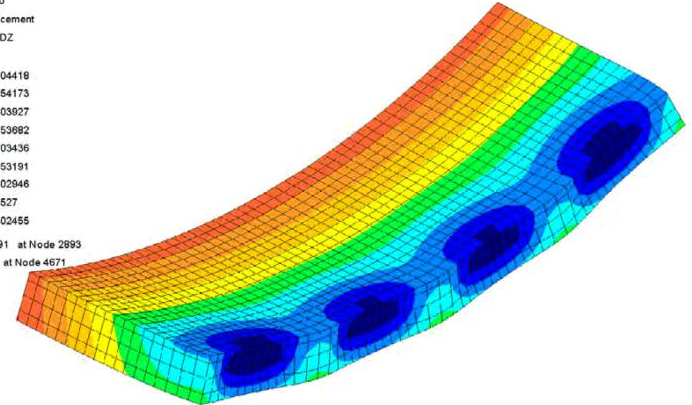
Tunnel Linings

- Longitudinal stress and displacement in tunnel segment under service load

Loadcase: 19
Title: Increment 19 Load Factor = 1.00000
Results File: 0
Entity: Stress
RESULTS CARTESIAN= 1
Component: Sz
-17.854
-15.8222
-13.3905
-11.1587
-8.92698
-6.69524
-4.46349
-2.23175
0.0
Max 1.80982 at Node 2950
Min -18.4759 at Node 1823

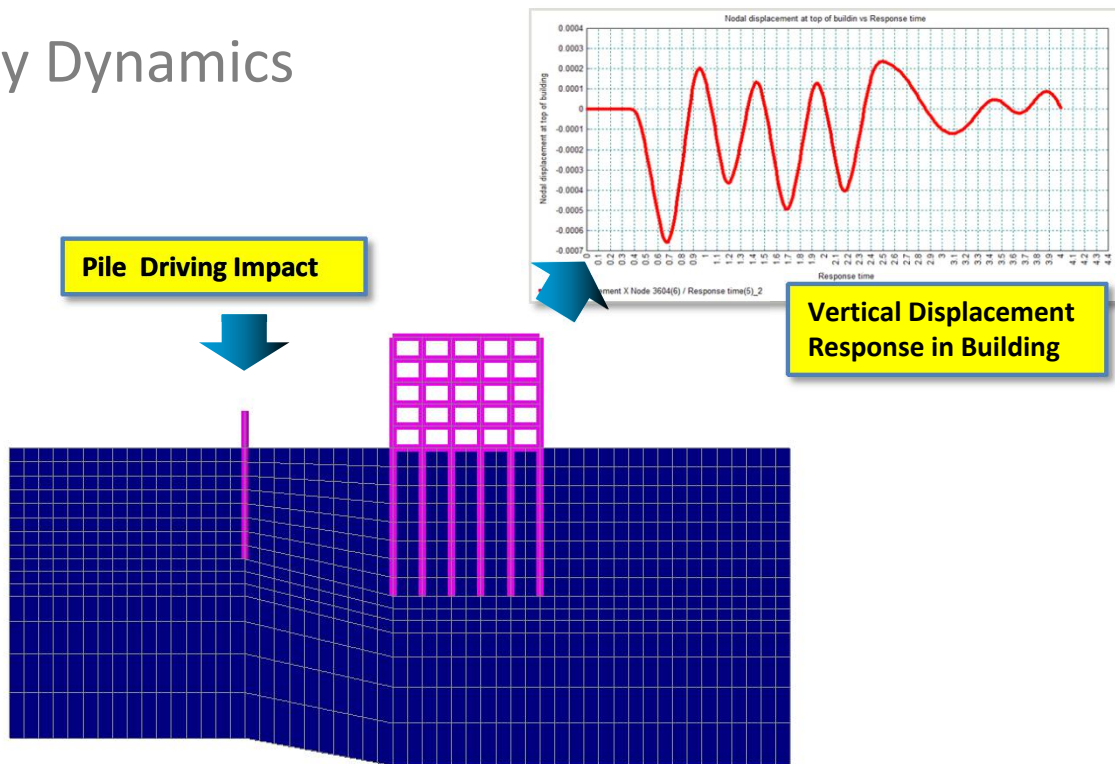


Loadcase: 19
Title: Increment 19 Load Factor = 1.00000
Results File: 0
Entity: Displacement
Component: Dz
-0.904418
-0.854173
-0.803927
-0.753682
-0.703436
-0.653191
-0.602946
-0.5527
-0.502455
Max -0.486491 at Node 2893
Min -0.9387 at Node 4671



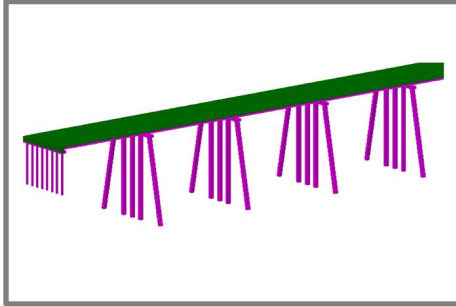
Soil-Structure Vibration

- Modal and Time History Dynamics
- Material damping
- Nonlinear behaviour
 - Soil plasticity
- Boundary behaviour
 - Spring/damping



As used on these projects...

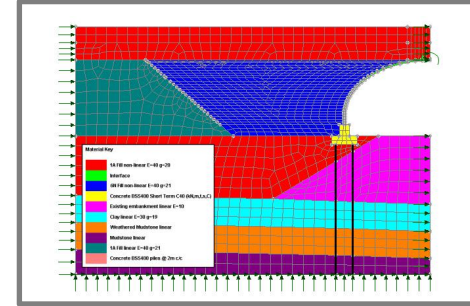
Click images to see projects



Bodcau Bayou Bridge



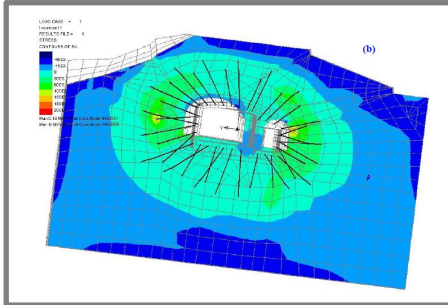
Götatunneln



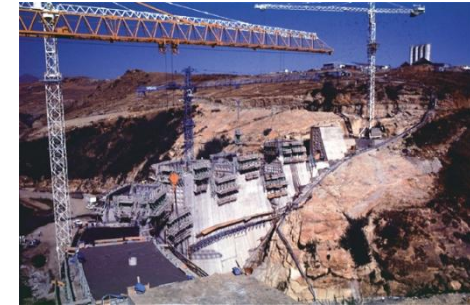
Sperritt Tunnel



Devonport Royal Dockyard



Söderström Tunnel

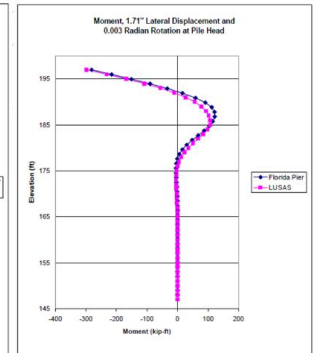
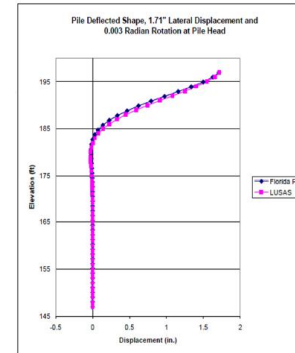
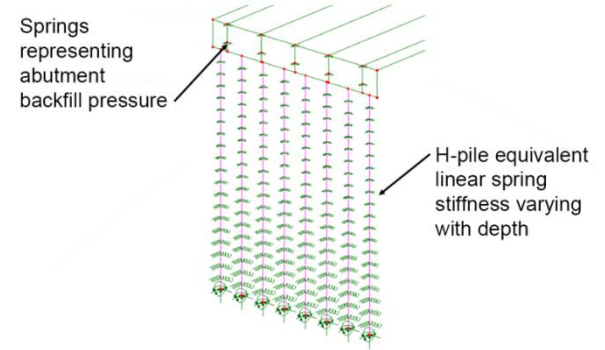
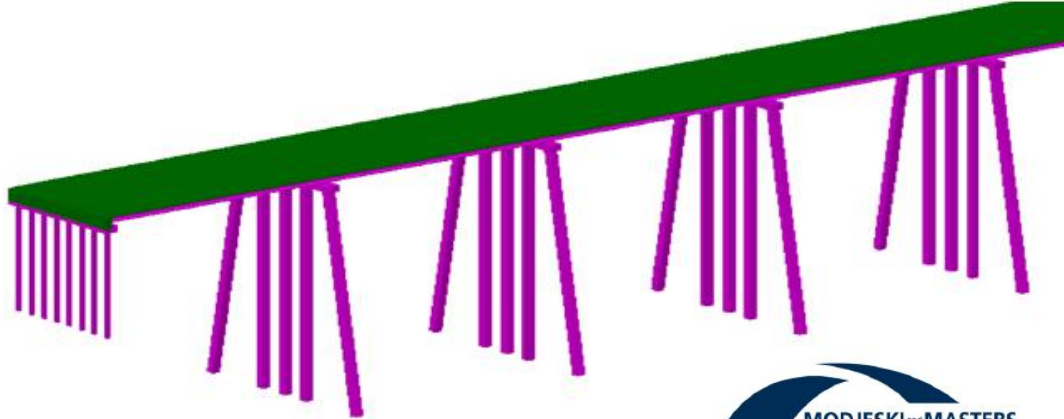
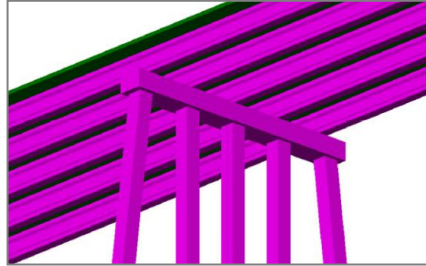
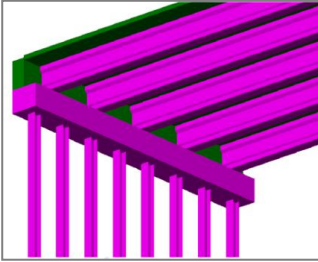


Muela Dam



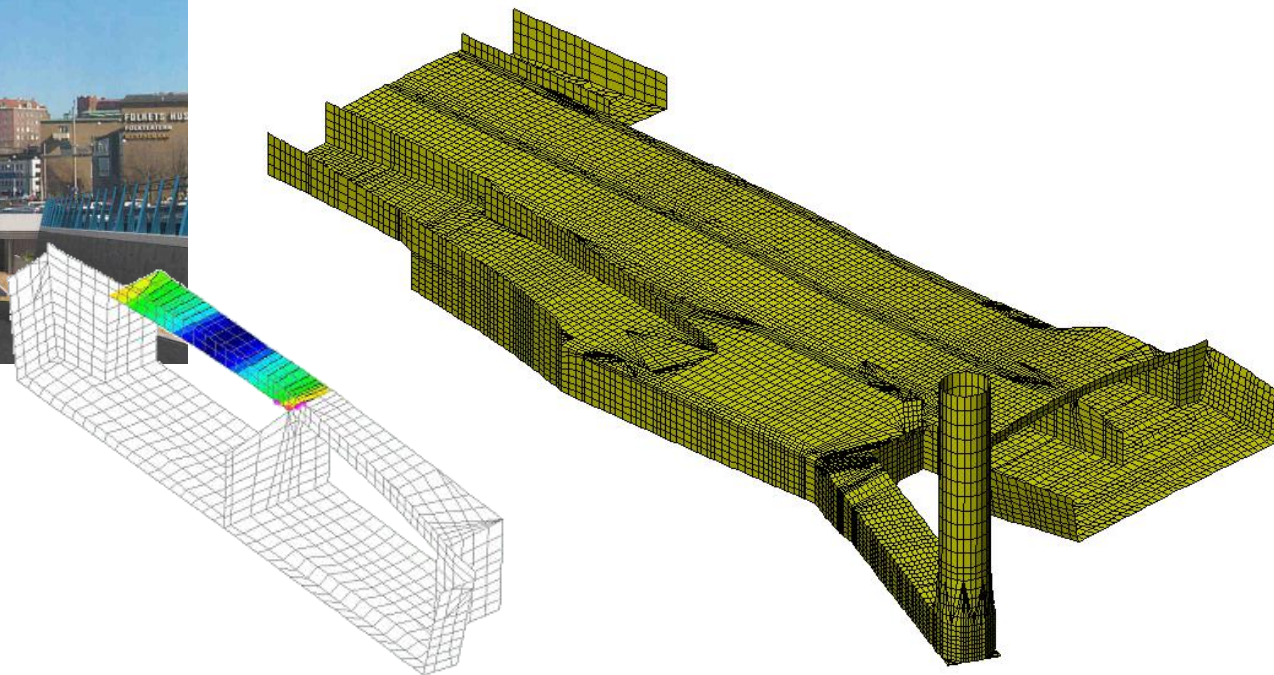
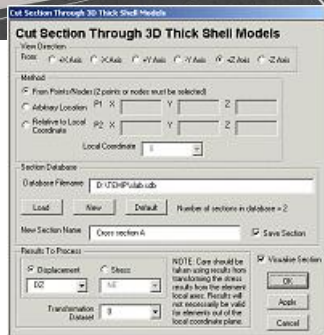
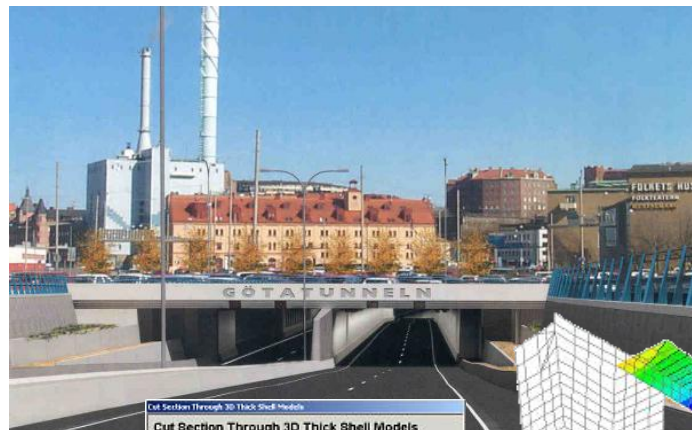
As used on

Bodcau Bayou bridge



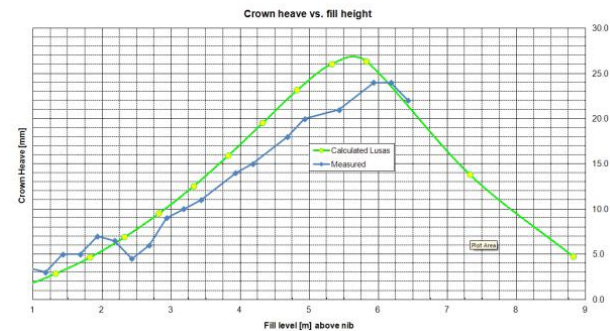
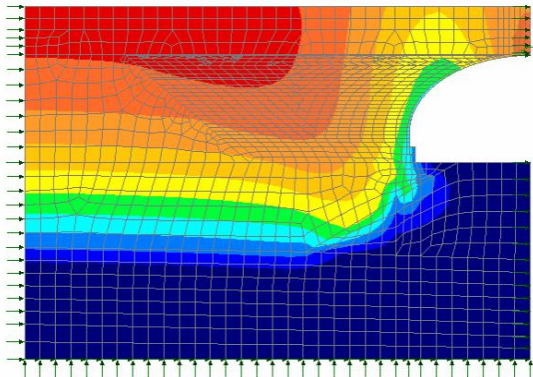
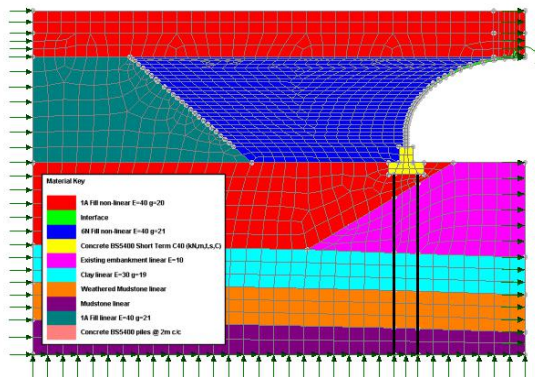
As used on

Gota tunnel



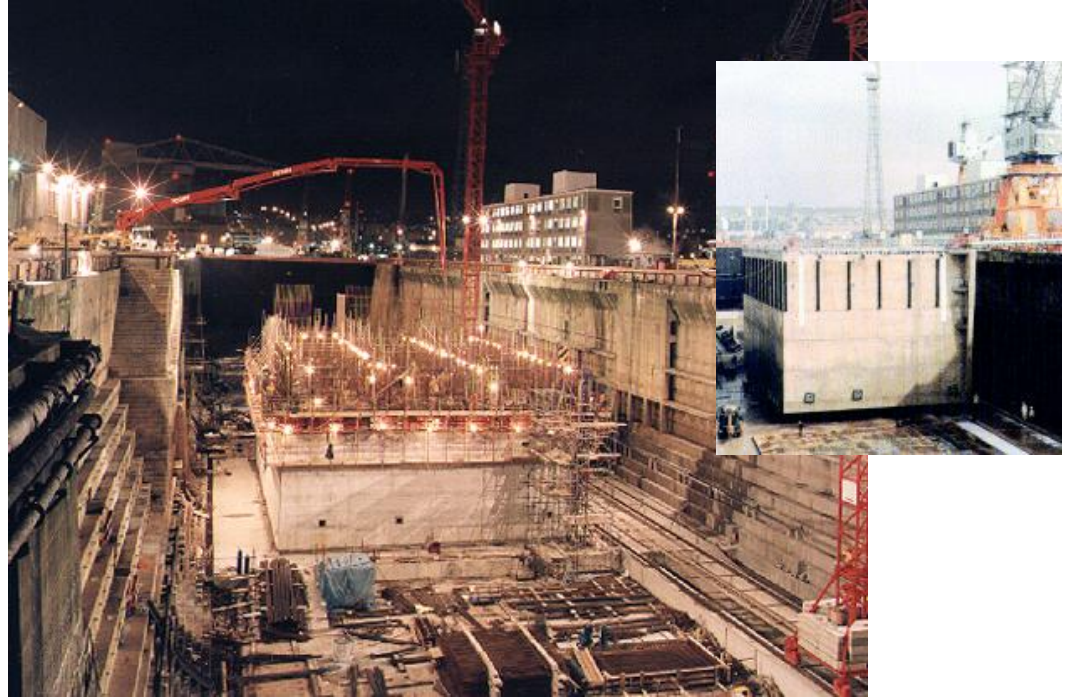
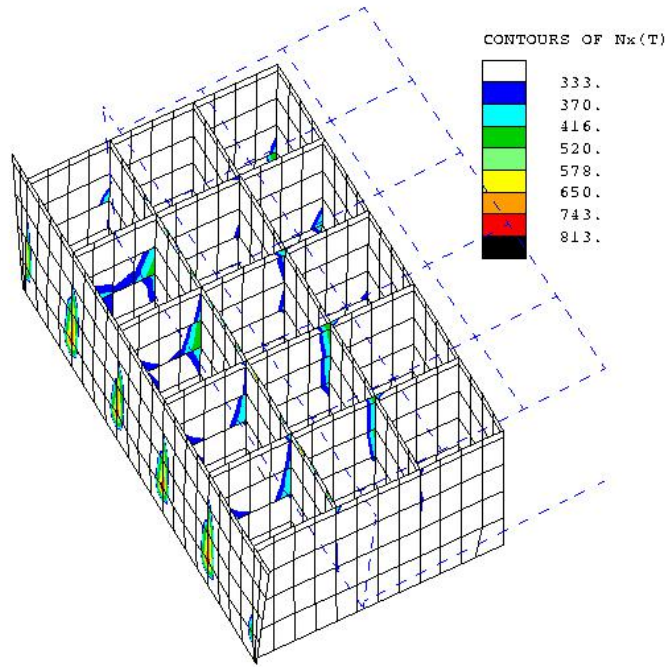
As used on

Sperritt tunnel

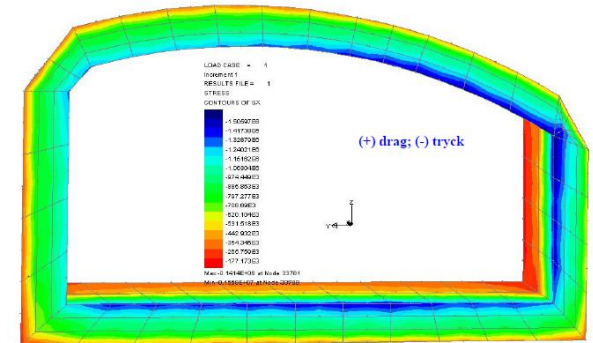
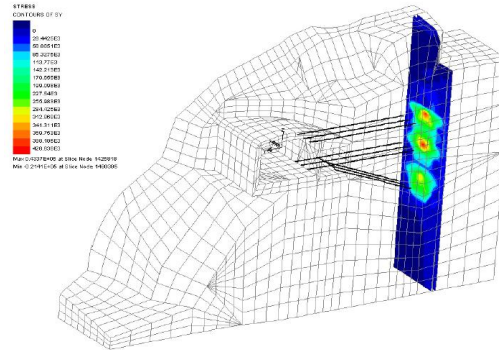
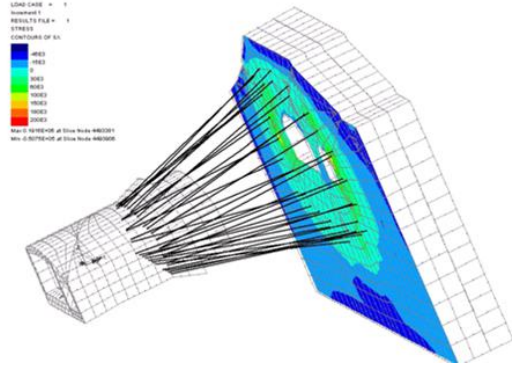
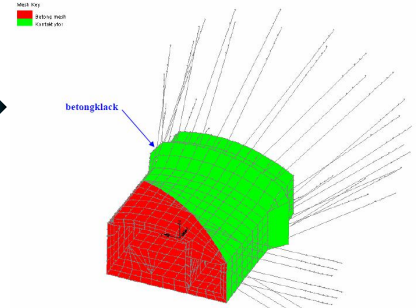
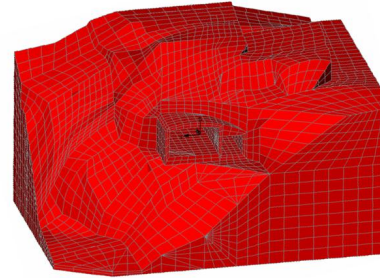
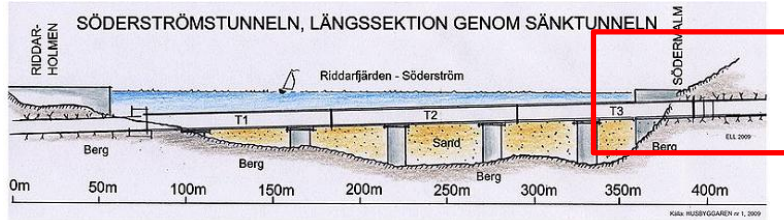


As used on

Devonport Royal Dockyard

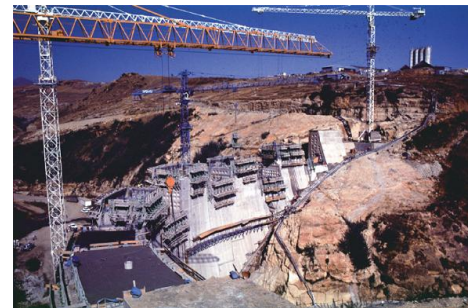
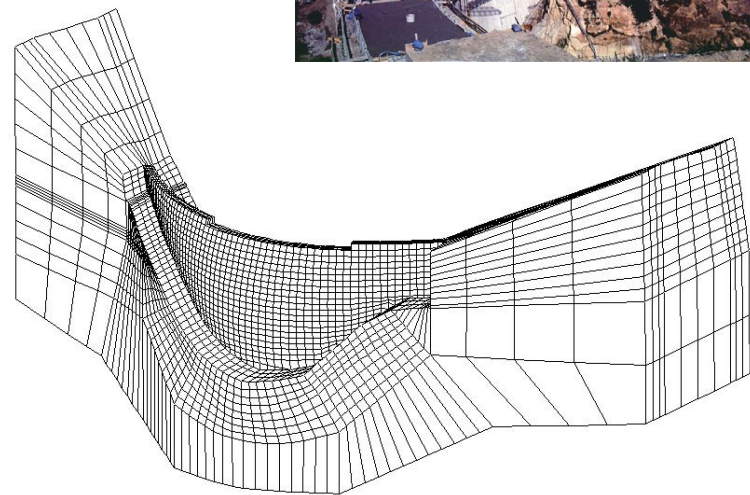
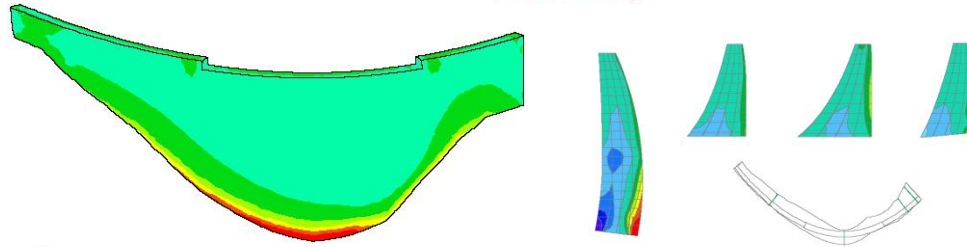
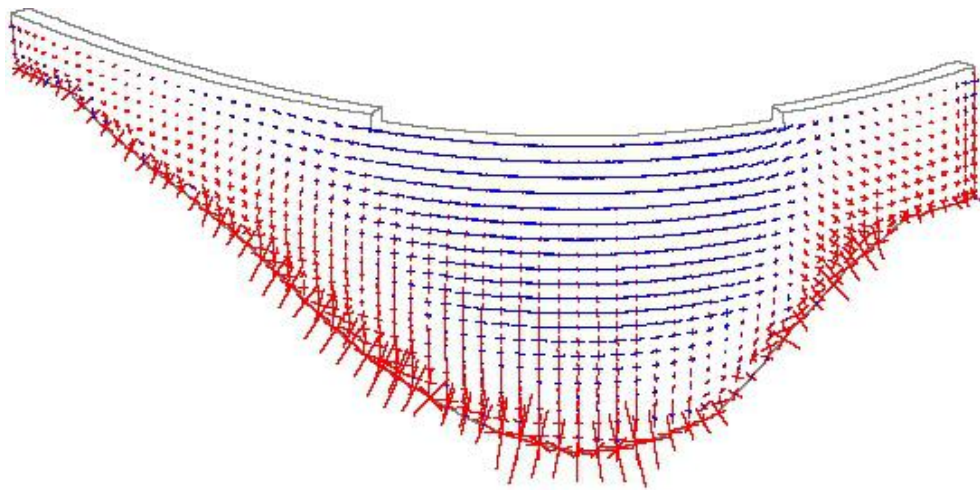


Soderstrom tunnel



As used on

Muela dam



Key advantages of using LUSAS

- Detailed soil and structure models can be analysed in a single program e.g. springs, 2D or 3D, linear or nonlinear
- Any geometry of soil strata can be modelled
- Time-dependent (consolidation/dewatering etc) modelling
- Excavation/backfill of soil, and staged construction
- Extensive soil and structural material models
- Contact and interface modelling
- Can model dynamic effects in soil/structure interaction

Thank you for watching this presentation on...



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*Civil and Structural
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*Bridge
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*Composites
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Engineering analysis and design software

*Specialist
Applications*

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