GTS NX功能介紹

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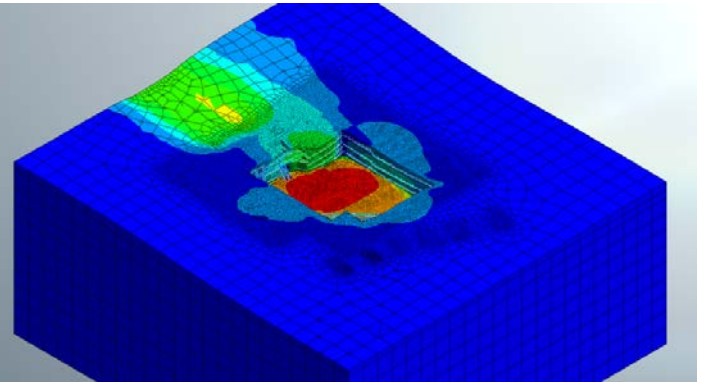
Contents

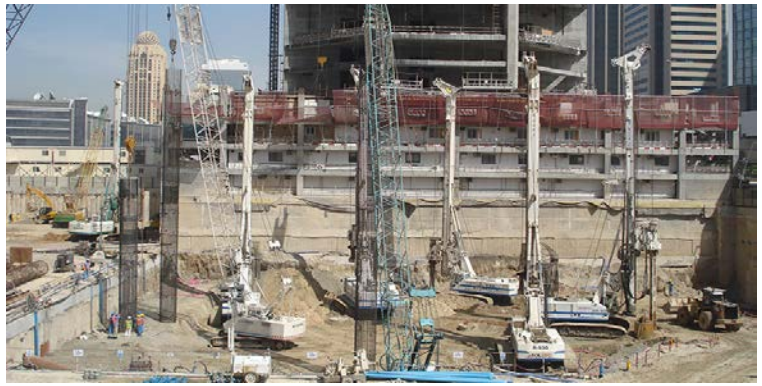
- Why MIDAS Geotech works for engineers
- What to do with GTS NX
- How to enhance the design process
- Case Study
- Fully integrated approach

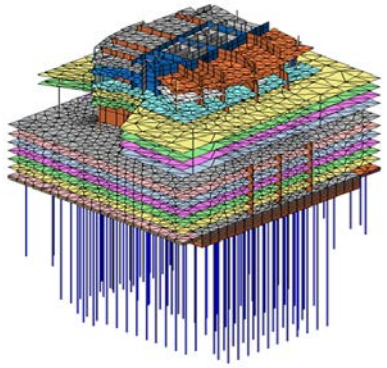
Why do the engineers suffer?

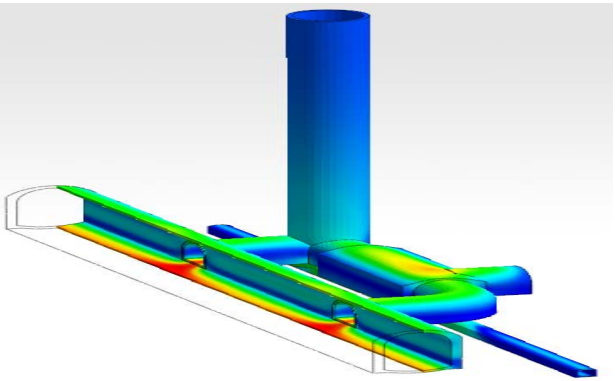
GTS NX will make your time efficient

Reasons for 3D



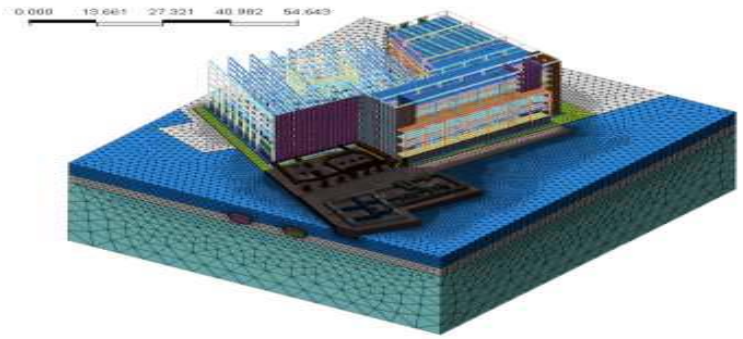


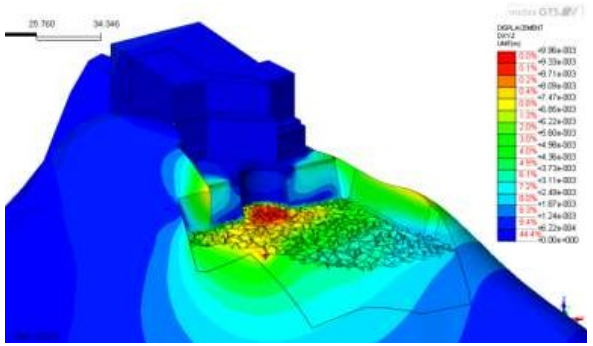


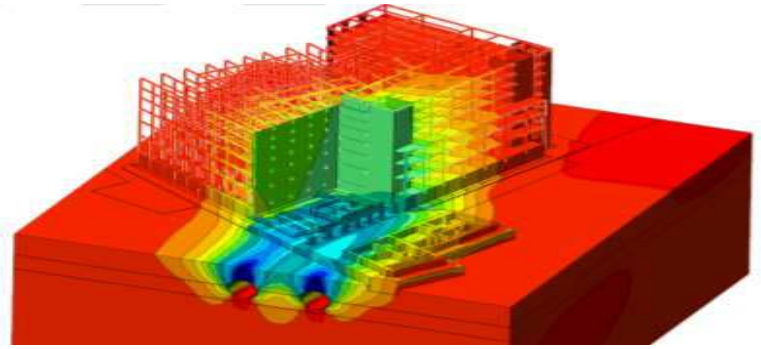


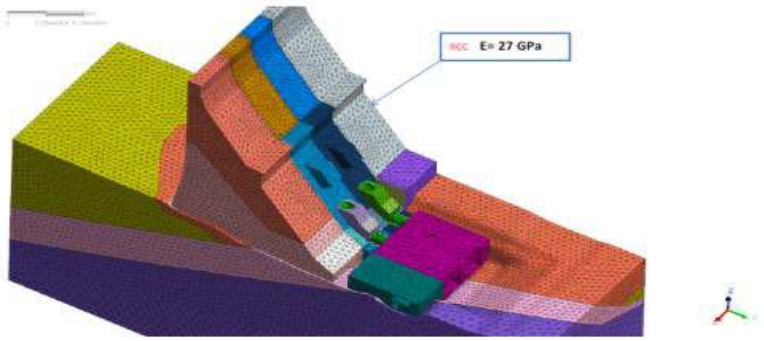
People in MIDAS Geotech

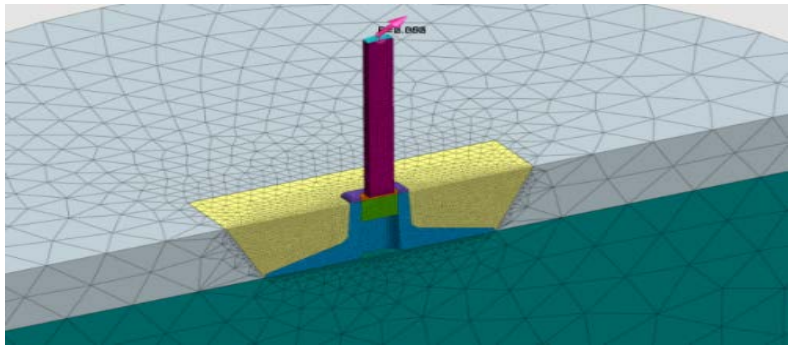
- Experts in 3D/2D geotechnical engineering
- Various experience with technical support and training

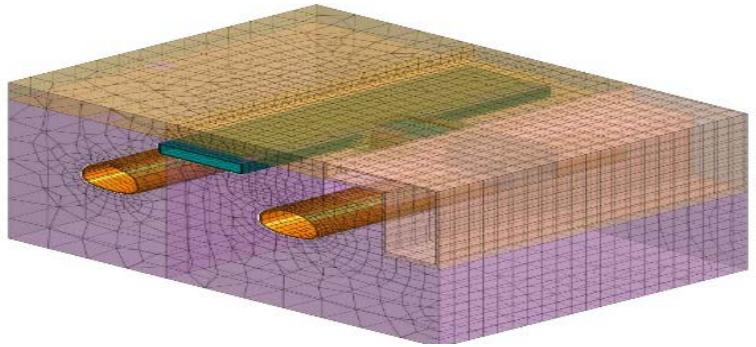






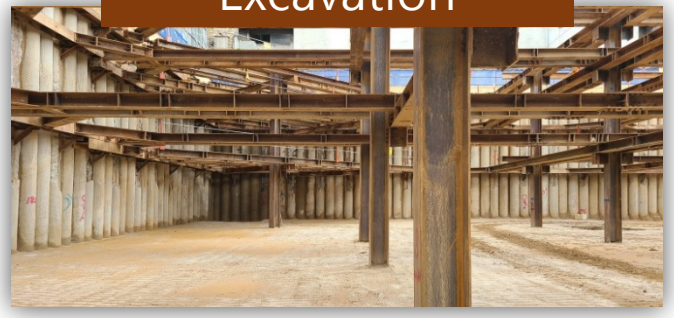






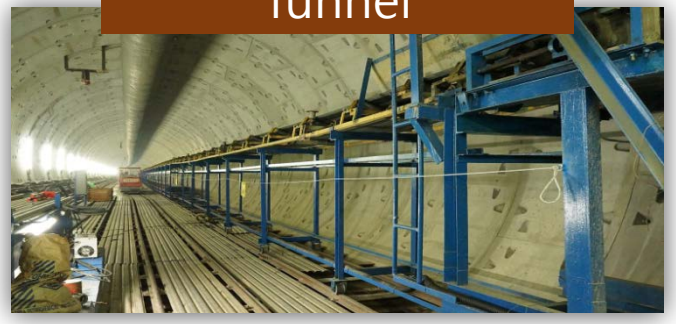
What to do w/ GTS NX

Excavation

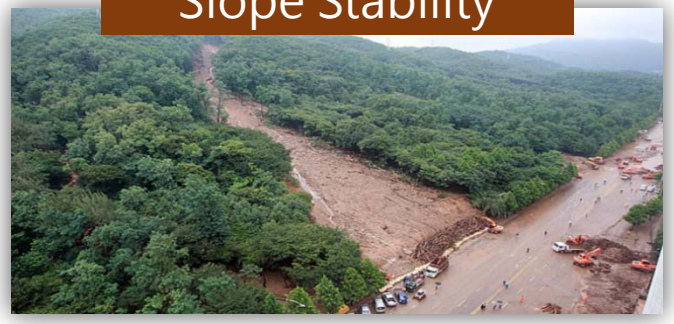


Pile

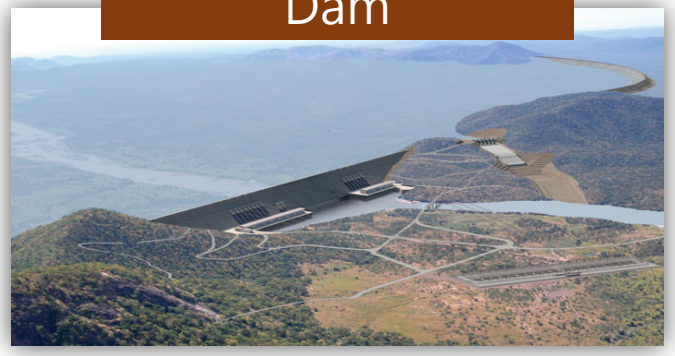
Tunnel



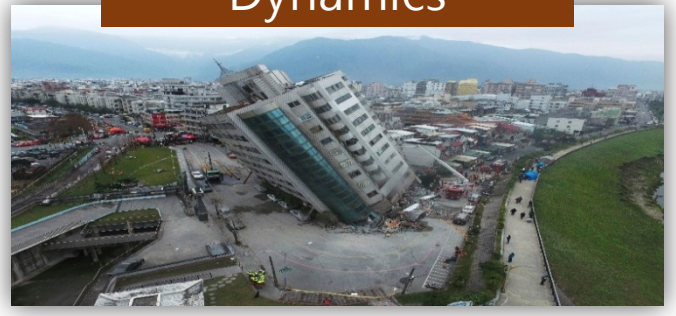
Slope Stability



Dam



Dynamics



Perform all kinds of analyses with GTS NX in One platform

- Linear static analysis
- Nonlinear static analysis

Static Analysis

- Stress (drained/undrained) analysis
- Seepage analysis for each stage
- Stress-seepage-slope coupled
- Consolidation analysis for each stage
- Fully coupled stress & seepage

Construction Stage Analysis

- Consolidation analysis
- Stress–seepage fully coupled analysis

Consolidation Analysis

Stress-Seepage Fully Coupled

Seepage Analysis

- Steady state seepage analysis
- Transient seepage analysis

Dynamic Analysis

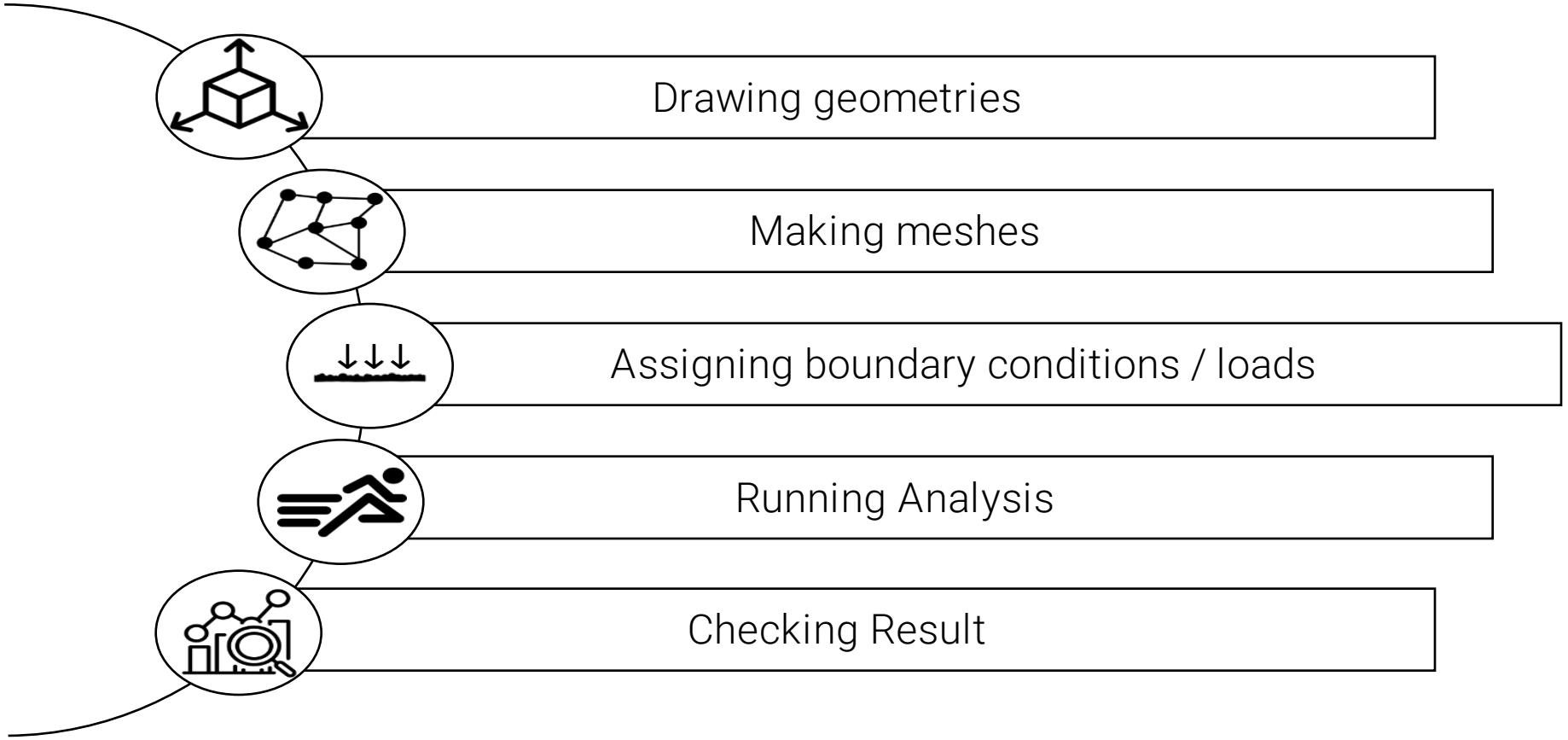
- Eigenvalue / Response Spectrum analysis
- Linear Time History (mode/direct methods)
- Nonlinear Time History analysis
- 1D/2D Equivalency Linear analysis
- Nonlinear time history + SRM Coupled

Slope Stability Analysis

- Strength Reduction Method (SRM)
- Strength Analysis Method (SAM)
- Construction stages Slope stability (SRM/SAM)

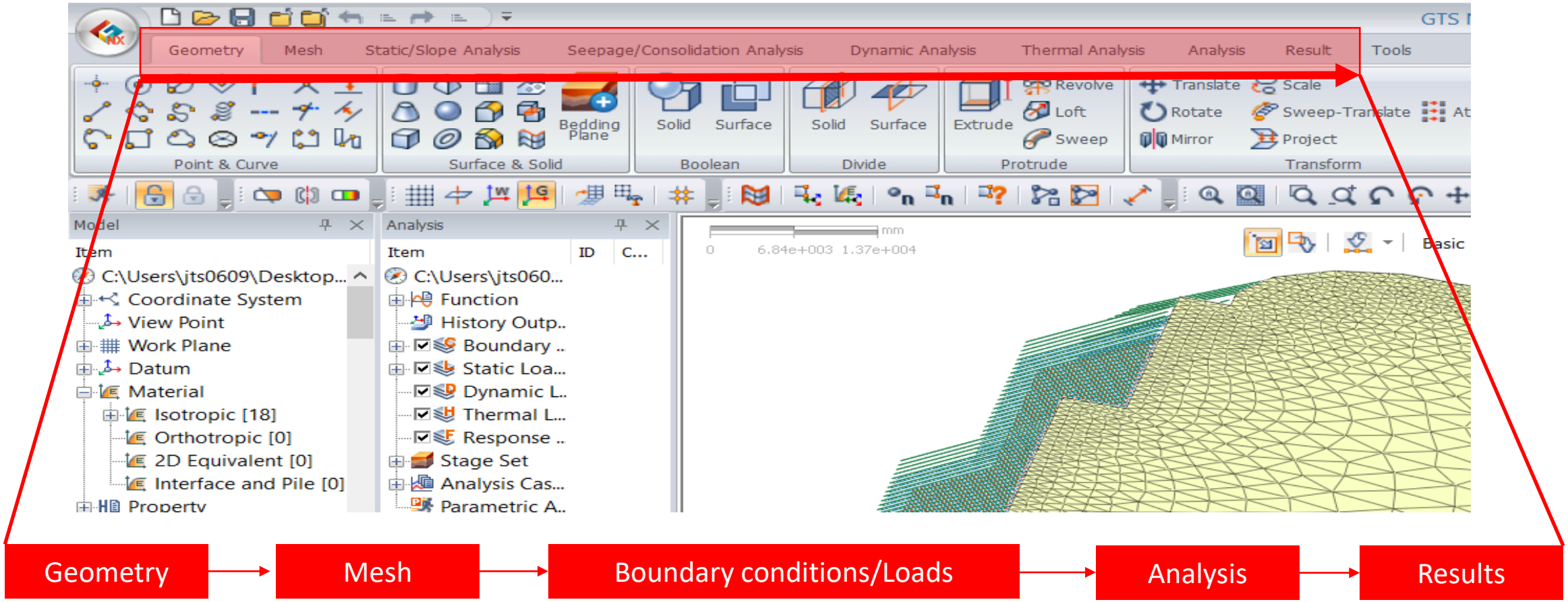
How to enhance your design process

- **Simple work-flow**



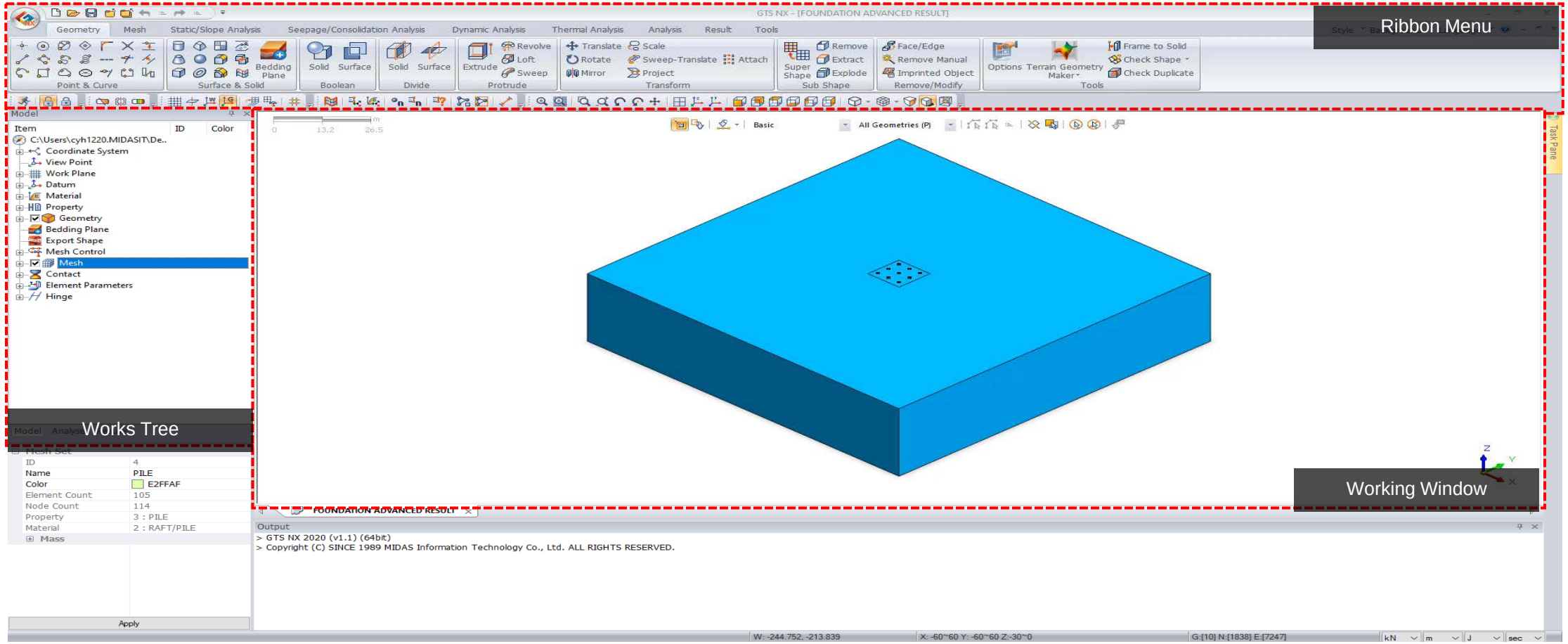
How to enhance your design process

- Simple work-flow



How to enhance your design process

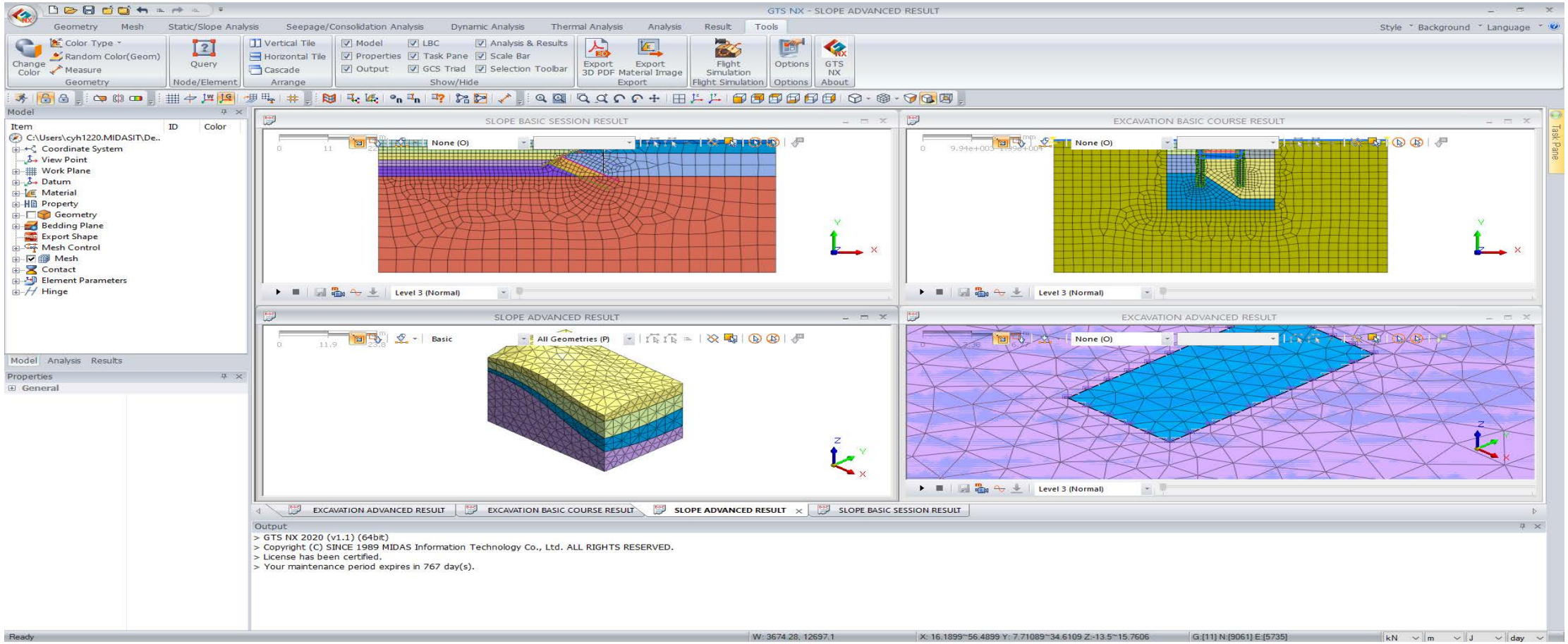
- **Graphical User Interface**



How to enhance your design process

- **Multi windows**

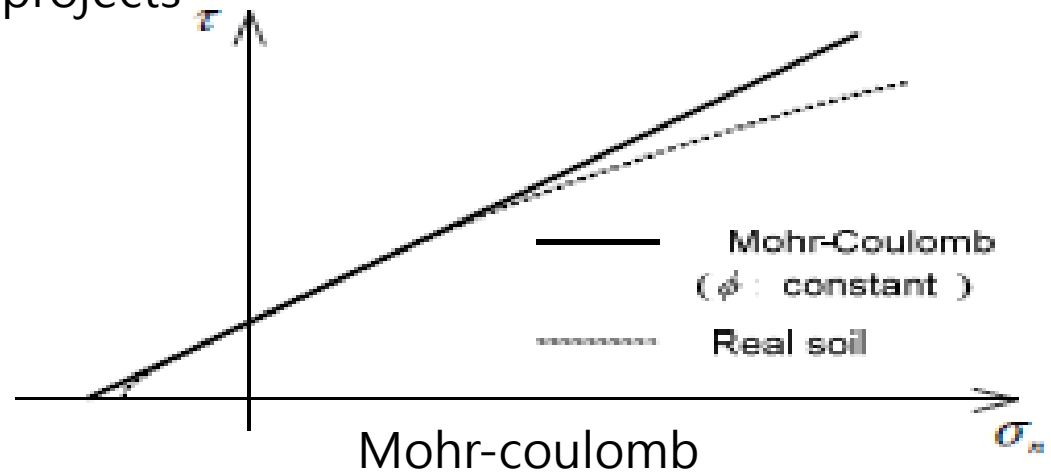
  Compare various sections or different approaches in one program window



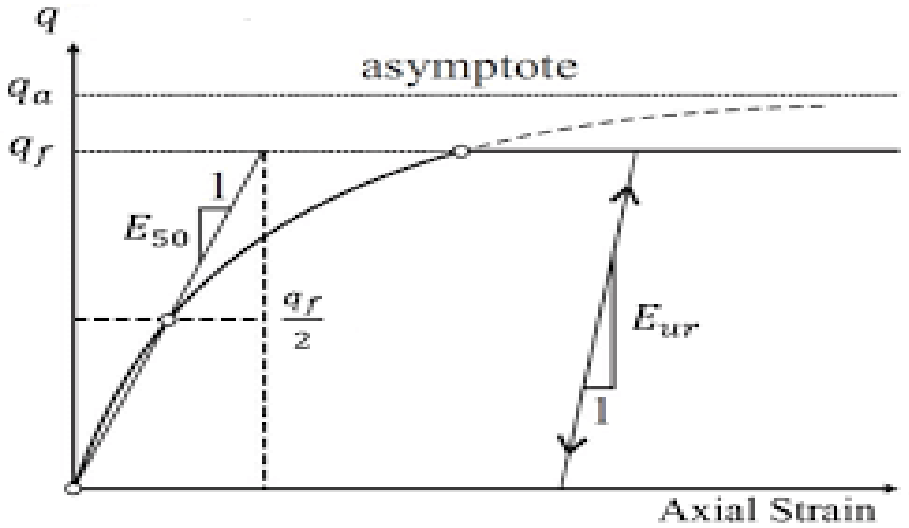
How to enhance your design process

- **Various constitutive soil model**
  Choose the appropriate soil model for your various projects

General	Mohr-Coulomb Hardening Soil (small strain stiffness)
Sand	Modified UBCSAND PM4Sand
Clay	**Soft soil (Creep)** Modified Cam Clay Sekiguchi-Ohta(Inviscid) Sekiguchi-Ohta(Viscid) Generalized SCLAY1S
Rock	**(Generalized) Hoek Brown** **Jointed Rock Mass** CWFS



Mohr-coulomb



Hardening soil

How to enhance your design process

- **Various element library**

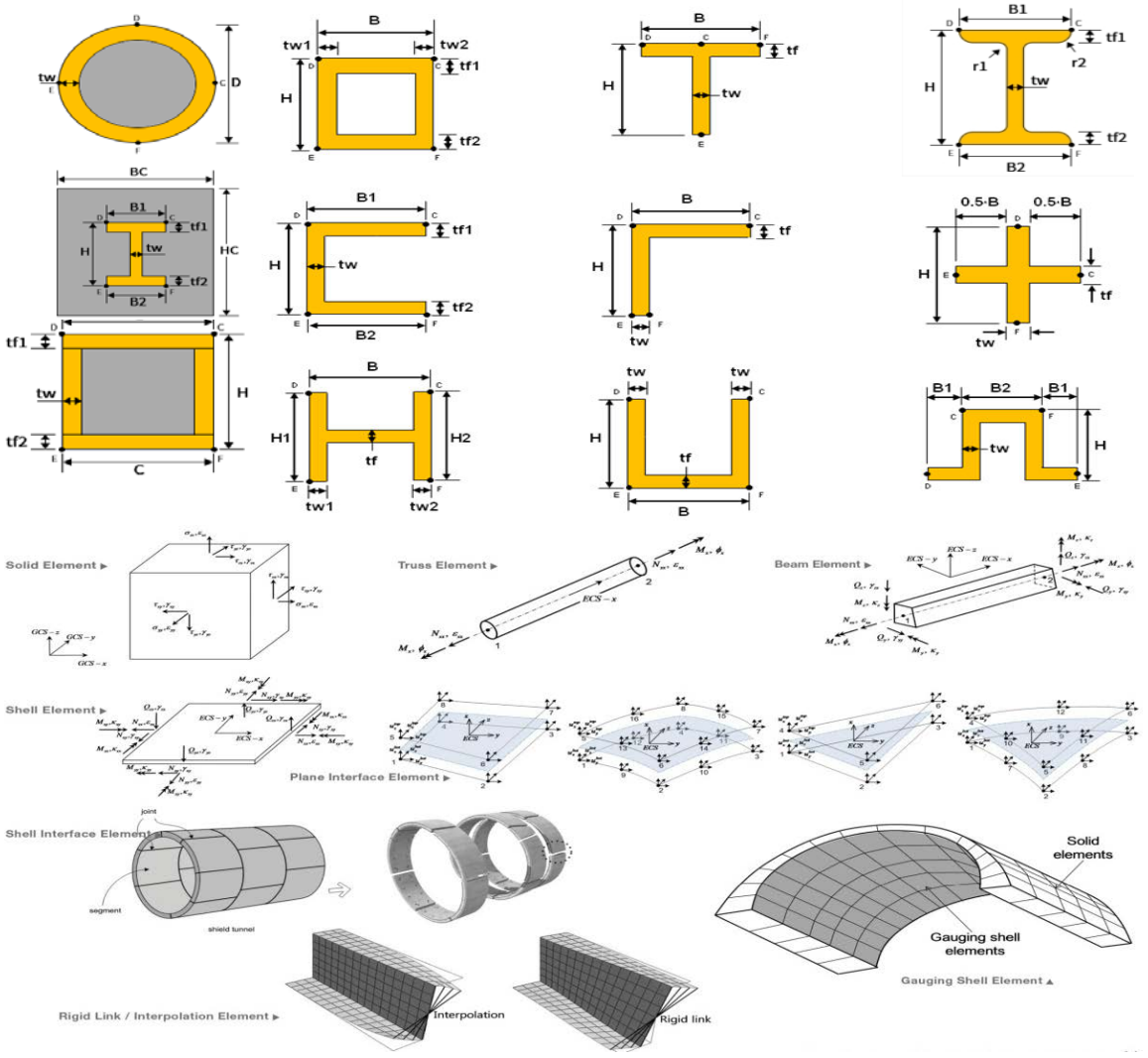
  Save time by just selecting the necessary elements from the prepared library

1D Element
Geogrid
Truss
Beam

2D Element
Shell
Gauging shell
Plane stress
Plane strain
Geogrid
Axisymmetric

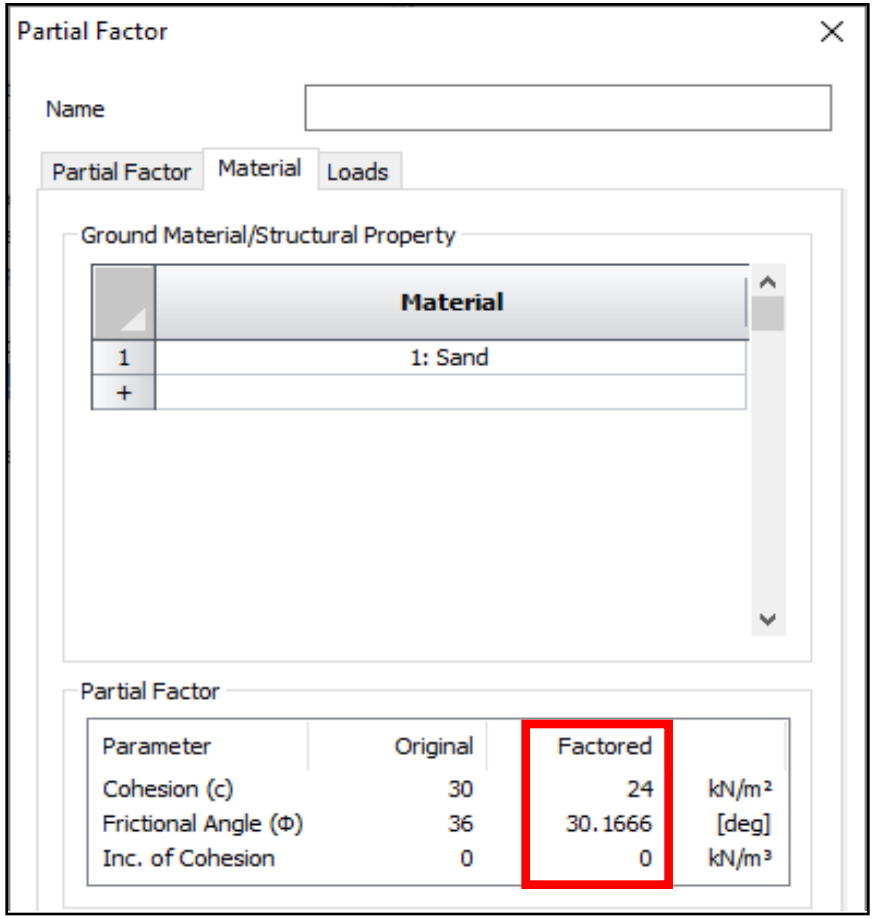
3D Element
Solid

Others
Interface
Elastic / Rigid link
Pile interface / Pile tip
User specified behavior



How to enhance your design process

- **More convenient Partial Factor design function**



2D analysis can use the **partial factor** function
which was development based on Euro Code 7.

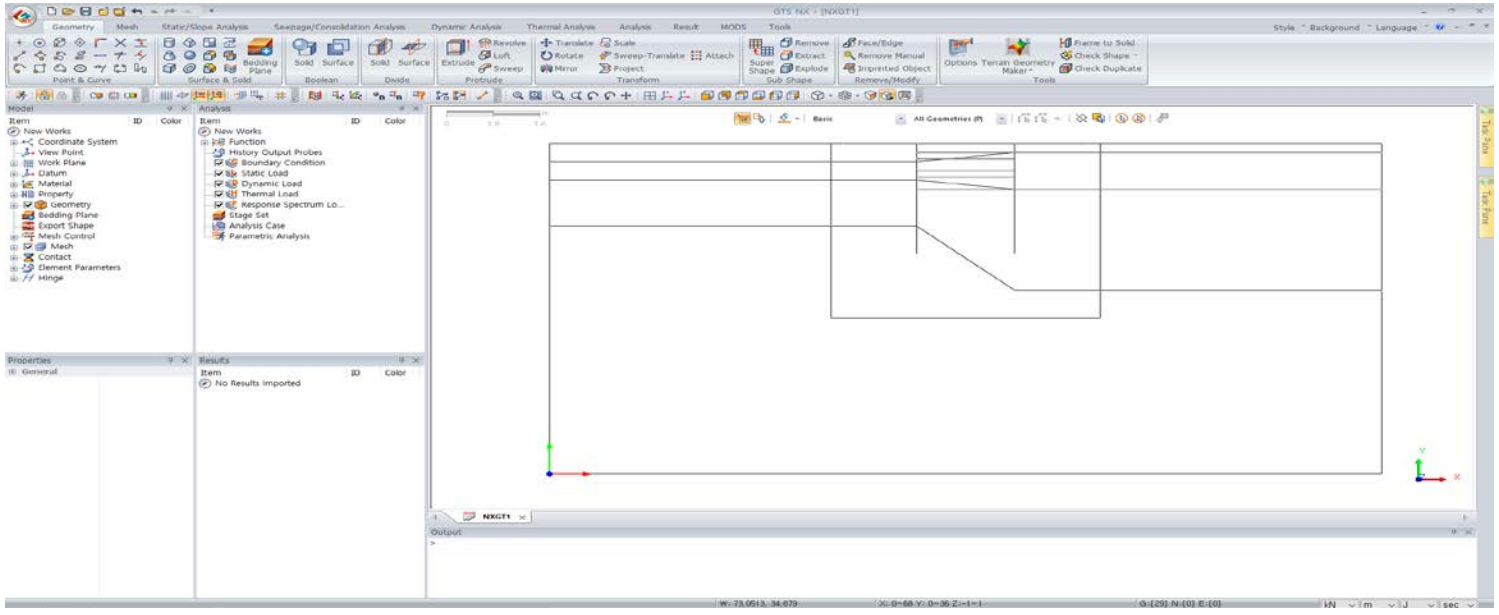
GTS NX is providing the database for this partial factor as below,
Design Approach 1 Combination 1
Design Approach 1 Combination 2
Design Approach 2
Design Approach 3

Directly checking the original and factored parameters

How to enhance your design process

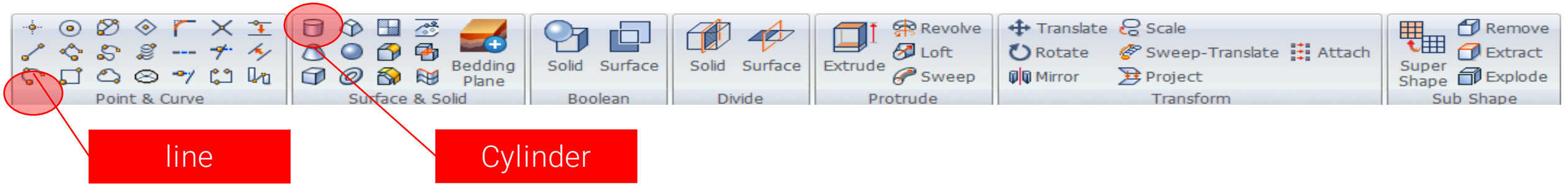
- **Perfect compatibility with CAD formats**

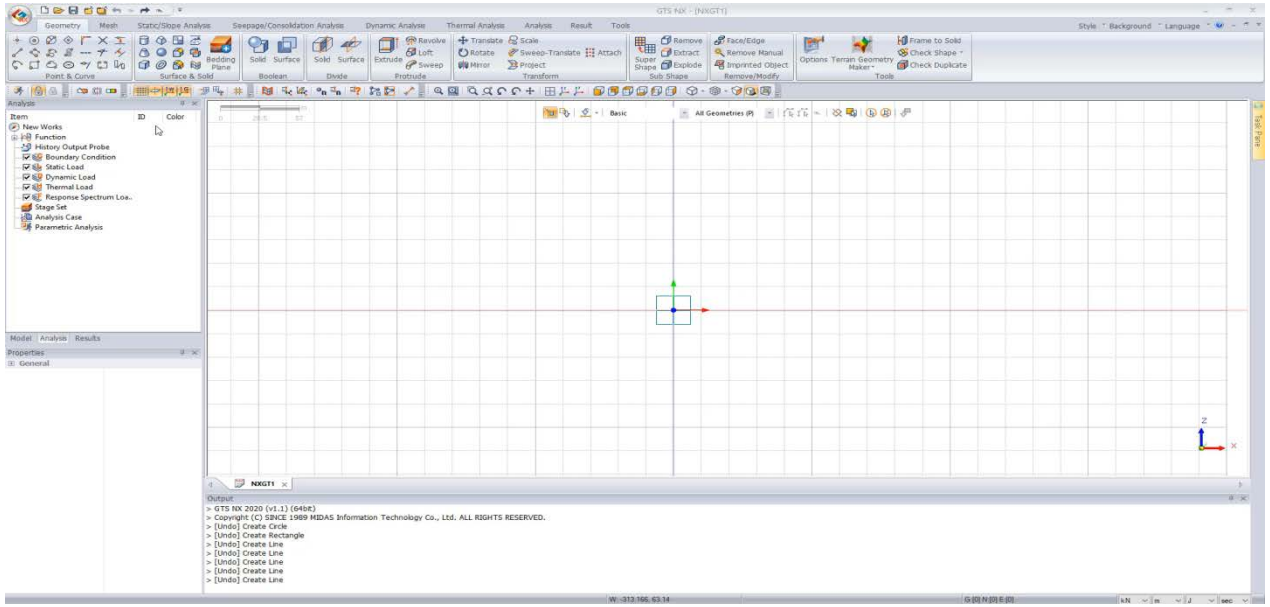
File format	Description
*.dwg	AutoCAD drawing files
*.dxf	AutoCAD drawing interchange files
*.x_t; *.xmt_txt; *.x_b; *.xmt_bin	Parasolid (9 to 29) files
*.sat; *.sab; *.asat; *.asab	ACIS (R1 to 2018 1.0) files
*.stp; *.step	STEP (AP203, AP214) files
*.igs; *.iges	IGES (Up to 5.3) files



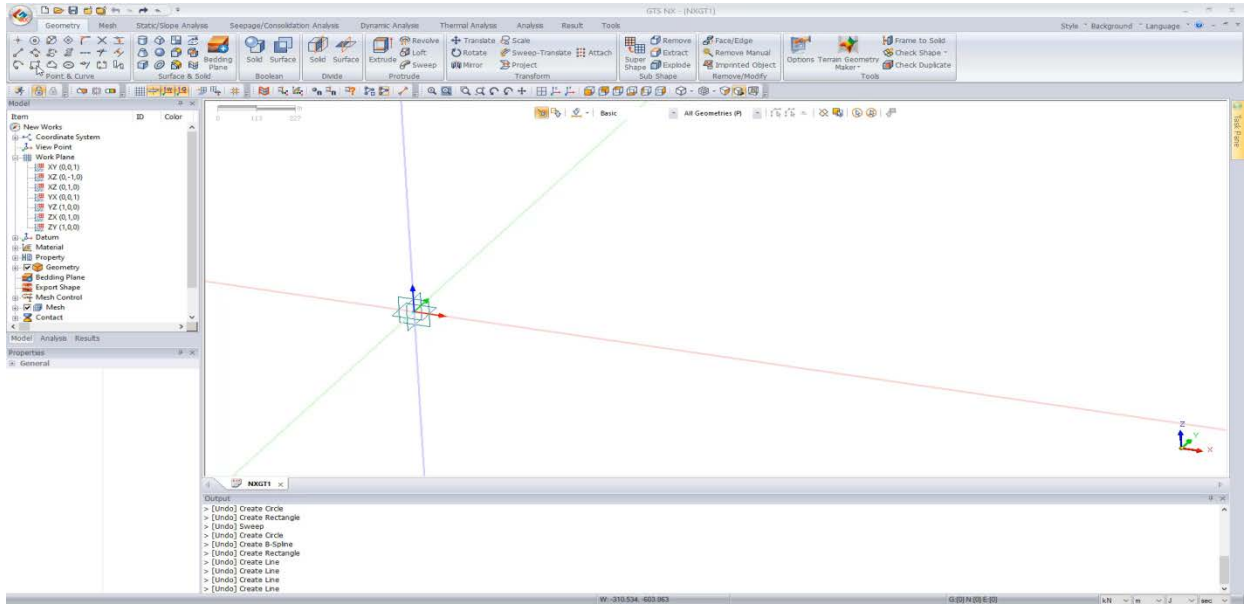
How to enhance your design process

- **Intuitive & Powerful geometry functions – extrude, sweep, boolean and etc.**





Line / Square / Circle



Extrude / Sweep

How to enhance your design process

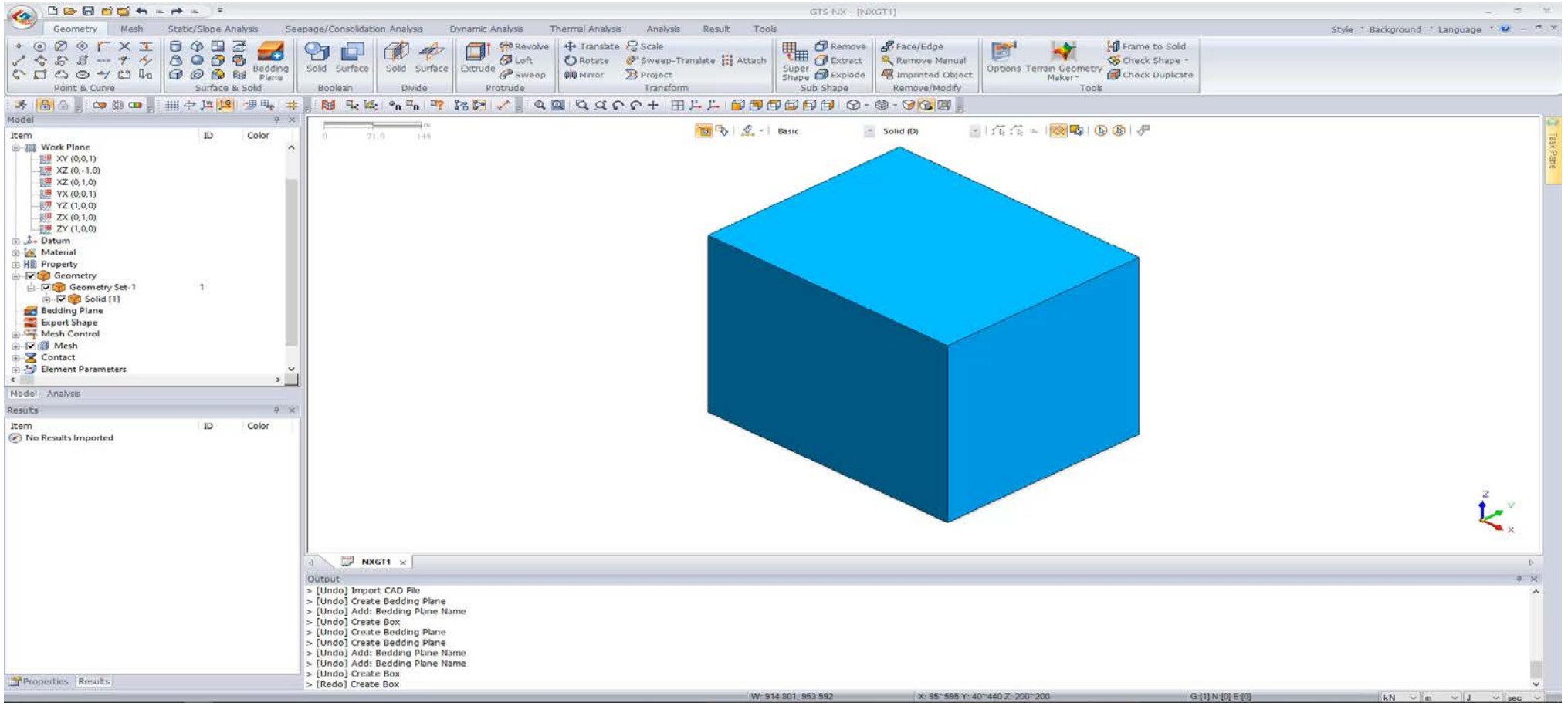
- **TGM & Bedding plane wizard**

  Easily create the surface of the site by simple topography import

How to enhance your design process

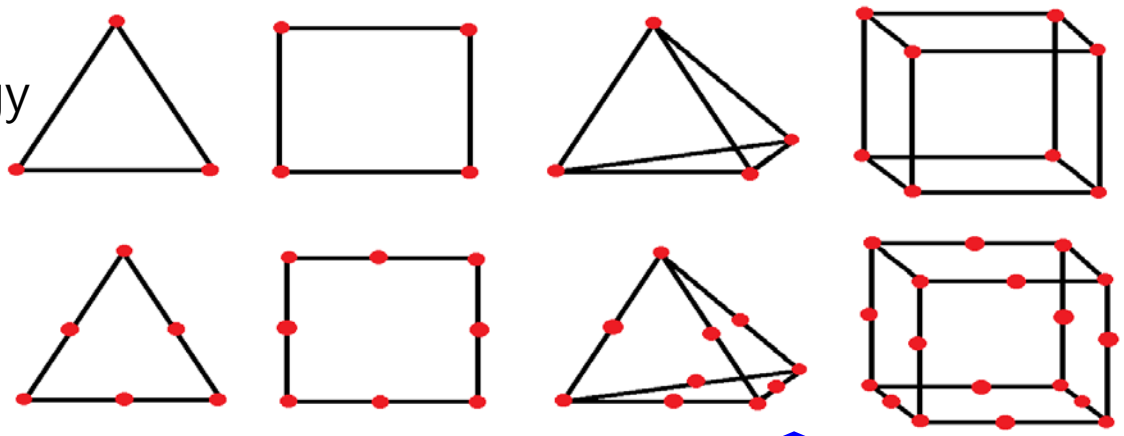
- **TGM & Bedding plane wizard**

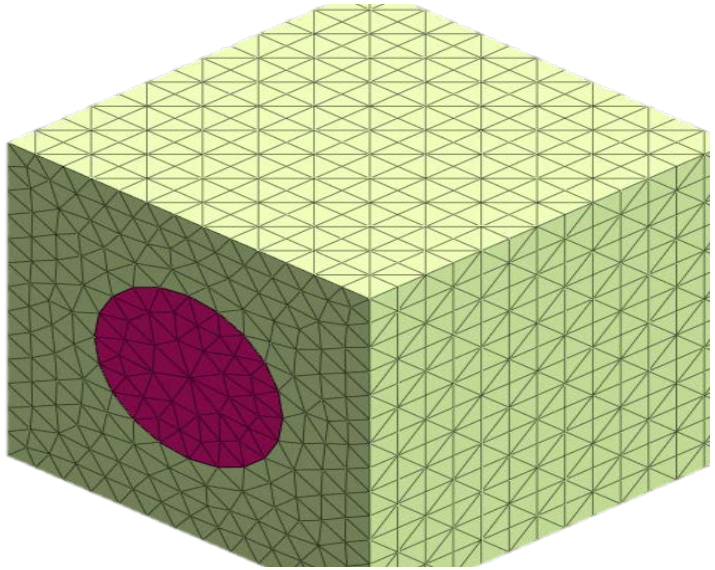
  Easily create the surface of the site by simple topography import



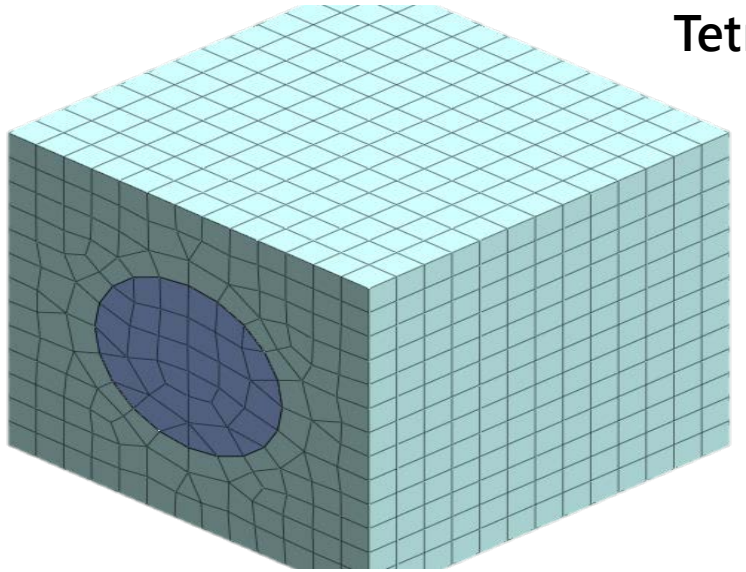
How to enhance your design process

- **TGM & Bedding plane wizard**
  Powerful meshing algorithm with Hybrid technology

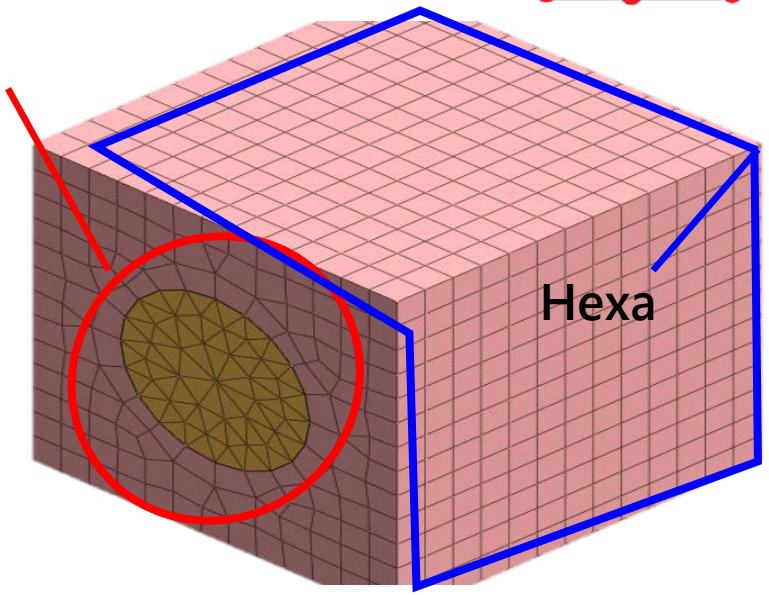




Tetrahedral



Hexahedral



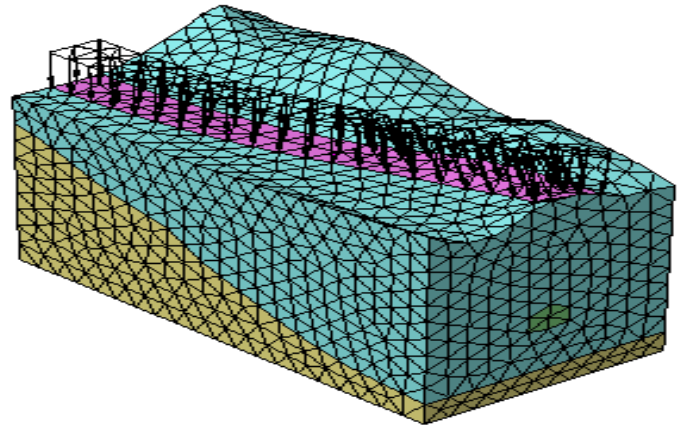
Tetra + Hexa(hybrid)

How to enhance your design process

- **Boundary conditions & Loads**

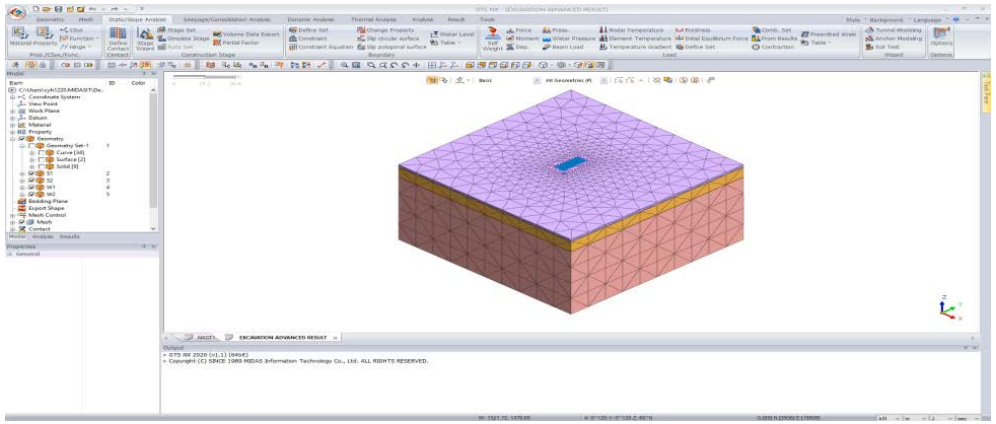
Boundary

Constraint
Change Properties
Review
Water level
Nodal Head
Surface Flux
Slip Circle/Polygonal Surface
Draining Condition
Non Consolidation
Transmitting



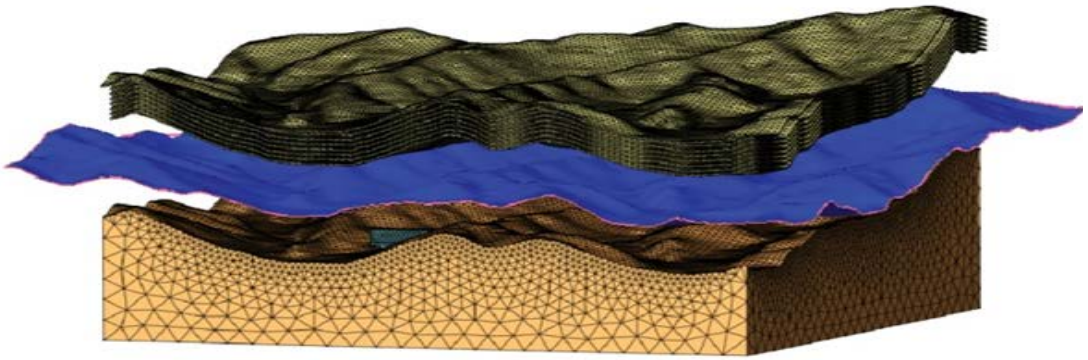
Loads

Self Weight
Force
Moment
Displacement
Pressure(Surcharge / Water)
Line Beam Load
Element Beam Load
Temperature
Pre-stress
Contraction
Initial Equilibrium Force
Combined Load
Response Spectrum
Ground Acceleration
Time Varying Static
Dynamic Nodal / Surface
Load to Mass
Train Dynamic Load Table

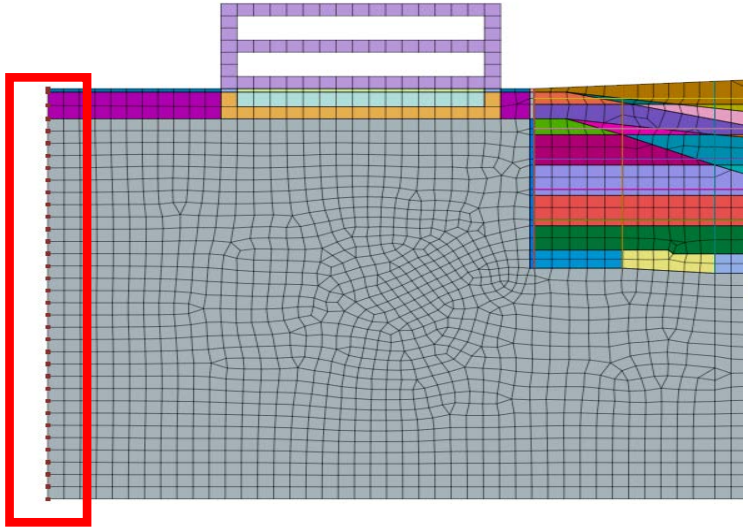


How to enhance your design process

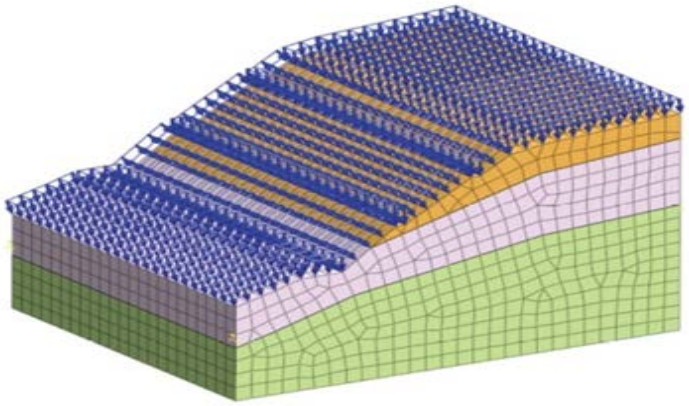
- **Water condition control – nodal head, line & surface flux, water level**



3D water level automatic generation



Nodal head for water level

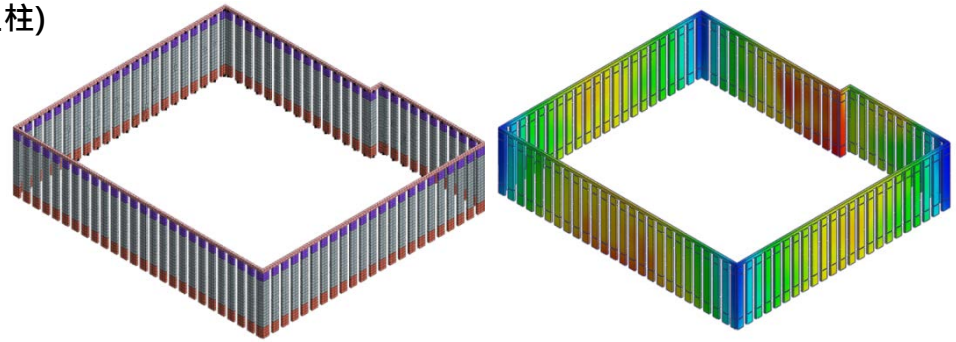


Rainfall intensity input

How to enhance your design process

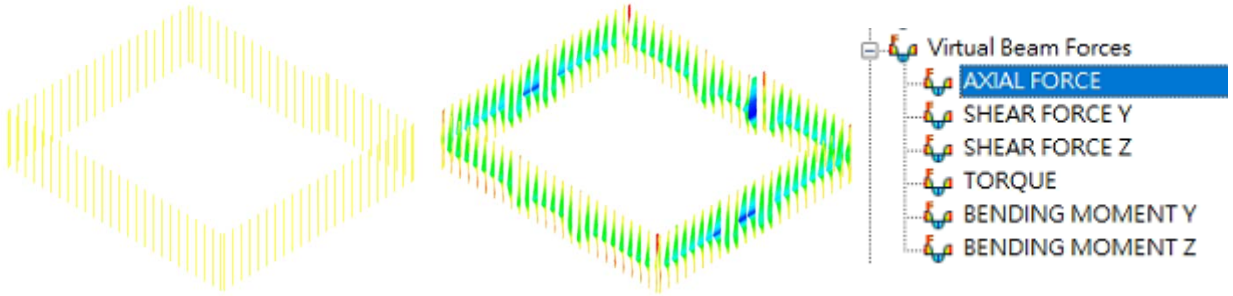
- **Easy check result – 1D/2D Equivalent Elements**

實體元素
(擋土柱)

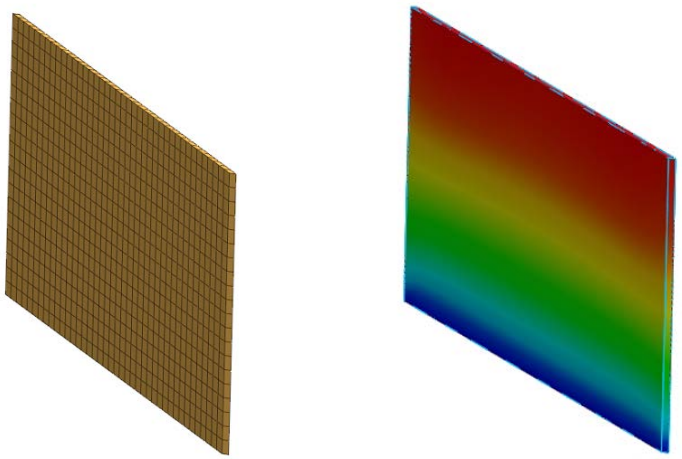


如何計算等效軸力?

虛擬梁(Virtual Beam)

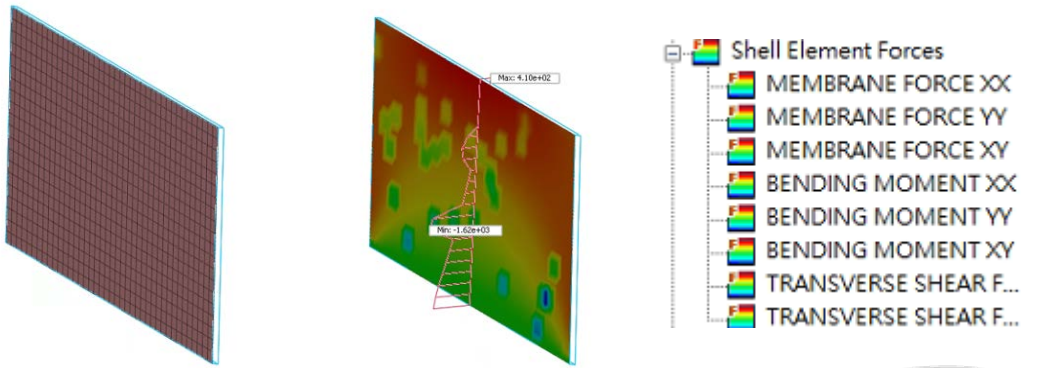


實體元素



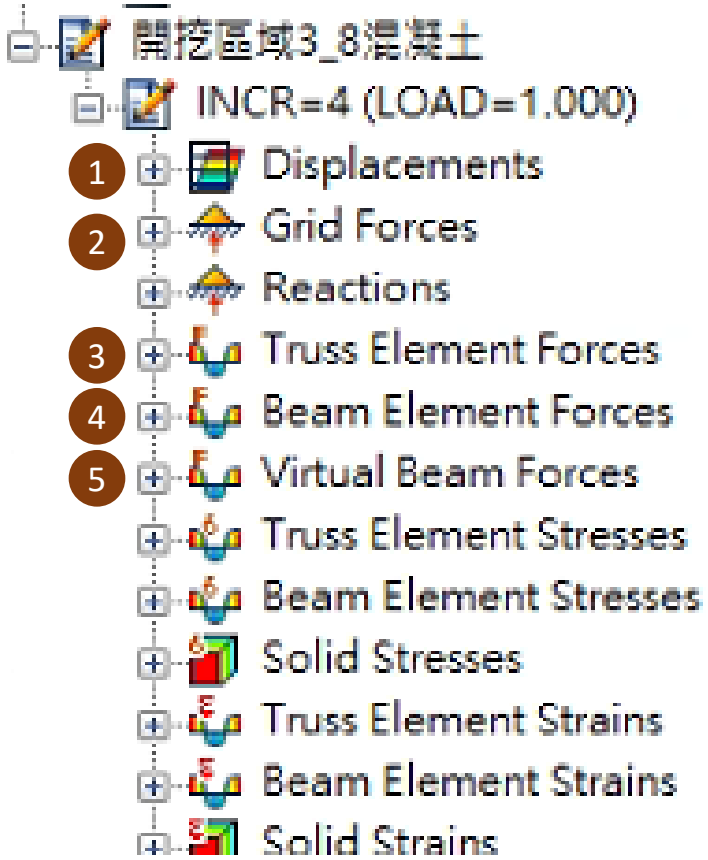
如何得到受力方向大小?

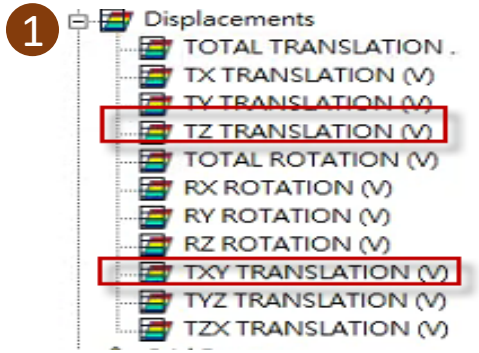
測量板(Gauging Shell)



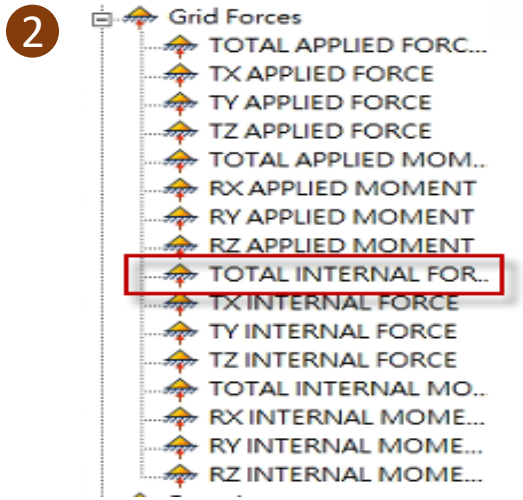
How to enhance your design process

- Easy check result - various types of results

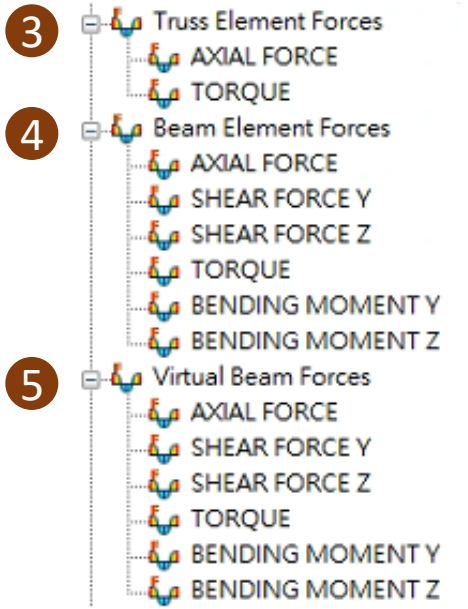




水平變位TXY
垂直變位TZ



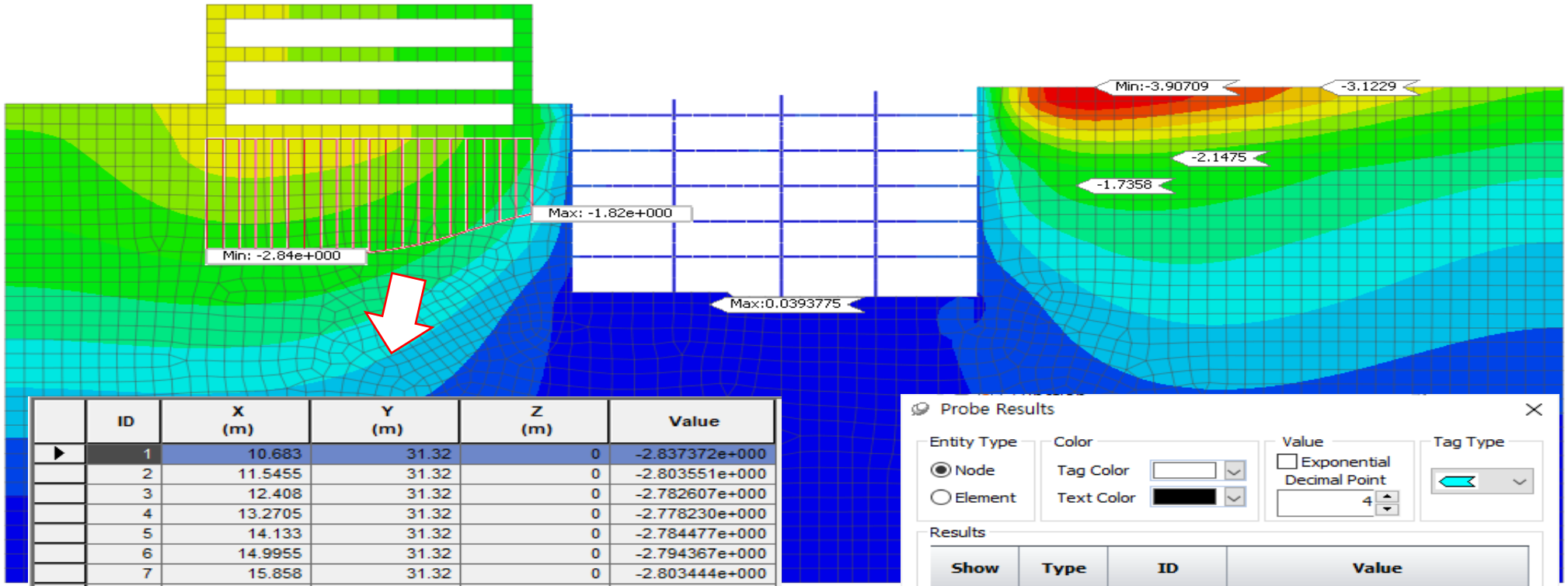
內力
Grid Force



軸力
Axial Force

How to enhance your design process

- **Easy check result - Probe**



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▶	1	10.683	31.32	0	-2.837372e+000
	2	11.5455	31.32	0	-2.803551e+000
	3	12.408	31.32	0	-2.782607e+000
	4	13.2705	31.32	0	-2.778230e+000
	5	14.133	31.32	0	-2.784477e+000
	6	14.9955	31.32	0	-2.794367e+000
	7	15.858	31.32	0	-2.803444e+000
	8	16.7205	31.32	0	-2.806896e+000
	9	17.583	31.32	0	-2.799891e+000
	10	18.4455	31.32	0	-2.781048e+000
	11	19.308	31.32	0	-2.748633e+000
	12	20.1705	31.32	0	-2.701343e+000
	13	21.033	31.32	0	-2.638357e+000
	14	21.8955	31.32	0	-2.559416e+000
	15	22.758	31.32	0	-2.462966e+000
	16	23.6205	31.32	0	-2.353056e+000
	17	24.483	31.32	0	-2.235005e+000
	18	25.3455	31.32	0	-2.114296e+000
	19	26.208	31.32	0	-1.999796e+000
	20	27.0705	31.32	0	-1.900160e+000
	21	27.933	31.32	0	-1.815394e+000

Probe Results

Entity Type: Node / Element

Color: Tag Color, Text Color

Value: Exponential, Decimal Point 4

Tag Type

Results

Show	Type	ID	Value
☑	Node	6838	-1.6844
☑	Node	6855	-3.5239
☑	Node	6328	-4.2087
☑	Node	6318	-4.2110
☑	Node	6308	0.8818
☑	Node	6289	0.9327
☐			

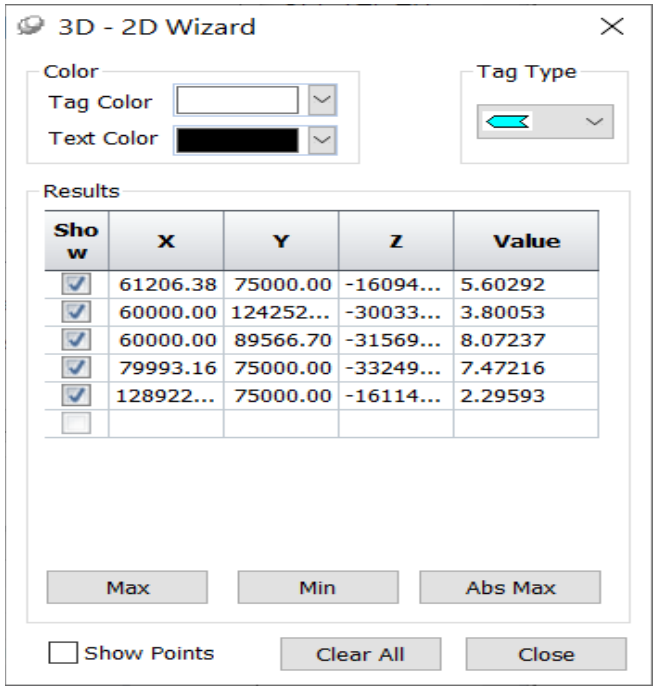
Max | Min | Abs Max | Clear All

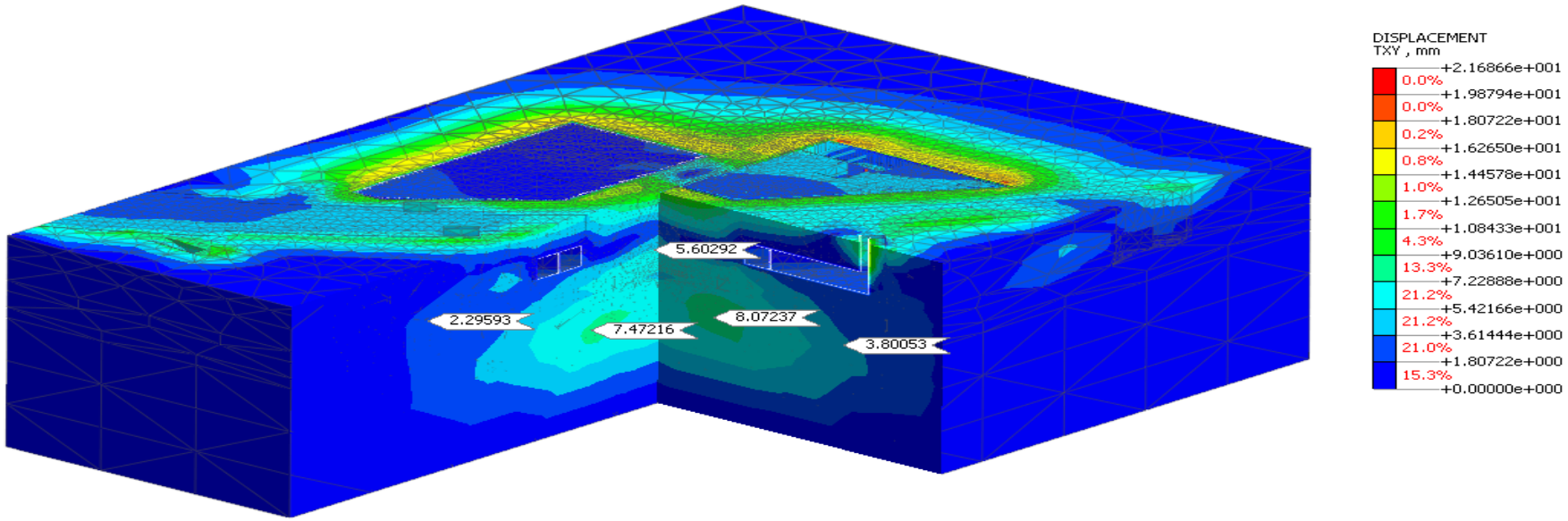
☐ Min/Max Value of Each Part

Close

How to enhance your design process

- **Easy check result – clipping & probe**





How to enhance your design process

- **Analysis results review by 3D PDF Report with out software license**

materials and properties with "**PDF**" format

Material

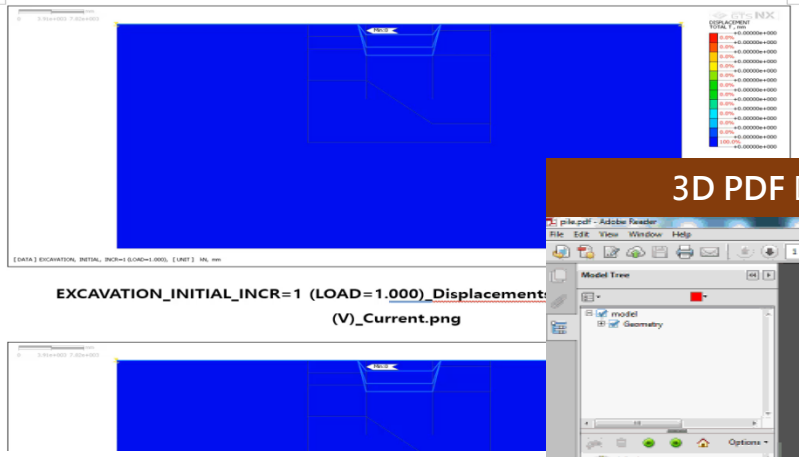
GTS NX

Elastic

Name	E (kN/mm²)	Inc. of Elastic (kN/mm³)	Inc. of E Ref. Height (mm)	v	γ (kN/mm³)	Ko	Thermal Coeff. (1/[T])	Molecular Vapor Diffusion Coeff. (mm/sec²)	Thermal Diffusion Enhancement	Damping Ratio
	γ_sat (kN/mm³)	e_o	kx (mm/sec)	ky (mm/sec)	kz (mm/sec)	Ss (1/mm)	Conductivity (W/(mm·[T]))	Specific Heat (J/(ton·[T]))	Heat Gen. Factor	
5:Conc'	28	0	0	0.15	2.4e-008	-	1e-006	0	0	0.05
	2.1e-008	0.5	0.01	0.01	0.01	5.2302133 3e-009	0	0	1	
6:Steel	205	0	0	0.15	7.4e-008	-	1e-006	0	0	0.05
	2.1e-008	0.5	0.01	0.01	0.01	5.2302133 3e-009	0	0	1	

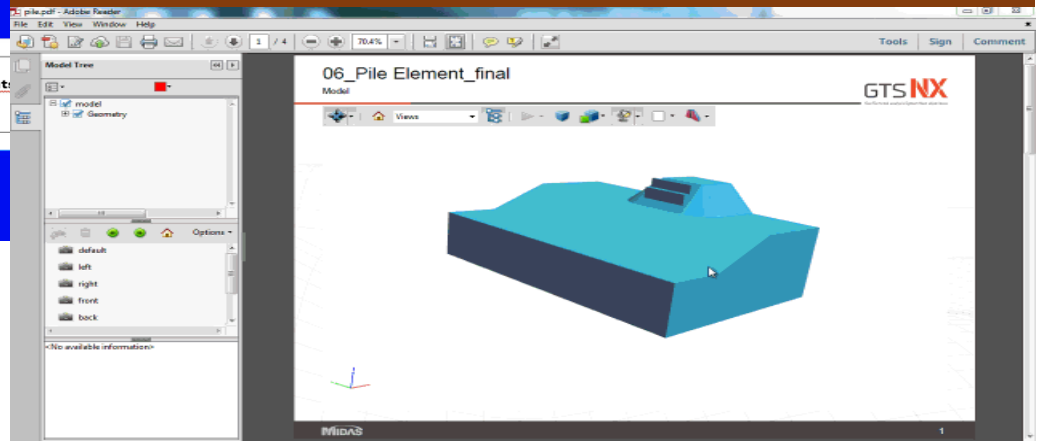
MIDAS

Results export with "**WORD**" format



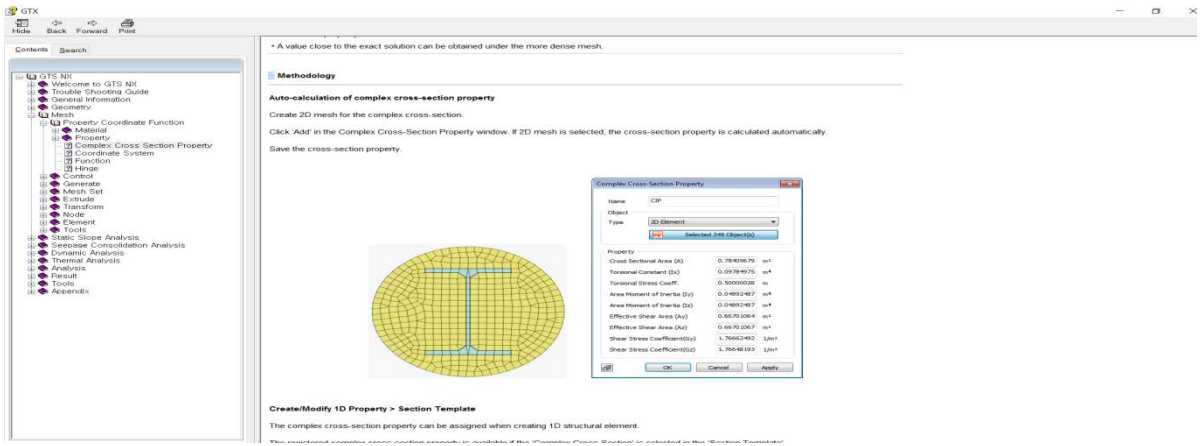
EXCAVATION_INITIAL_INCR=1 (LOAD=1.000)_Displacement
(V)_Current.png

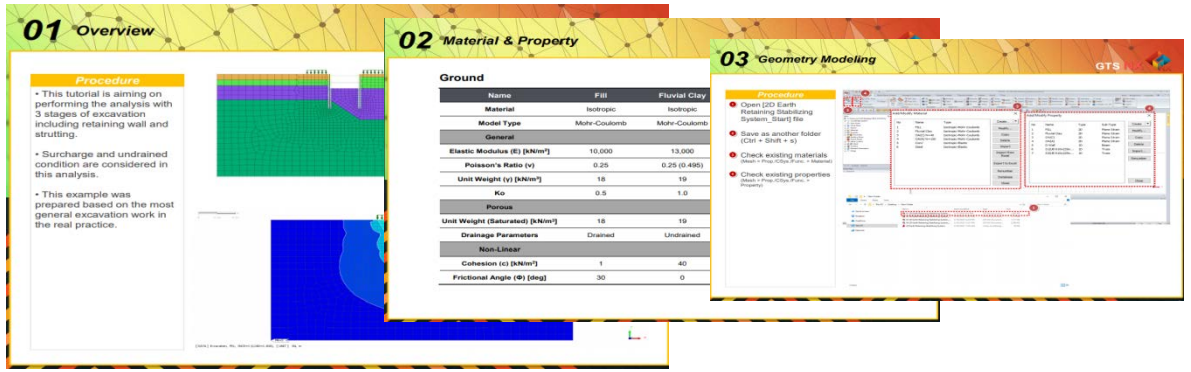
3D PDF Directly checking every results from 3D PDF



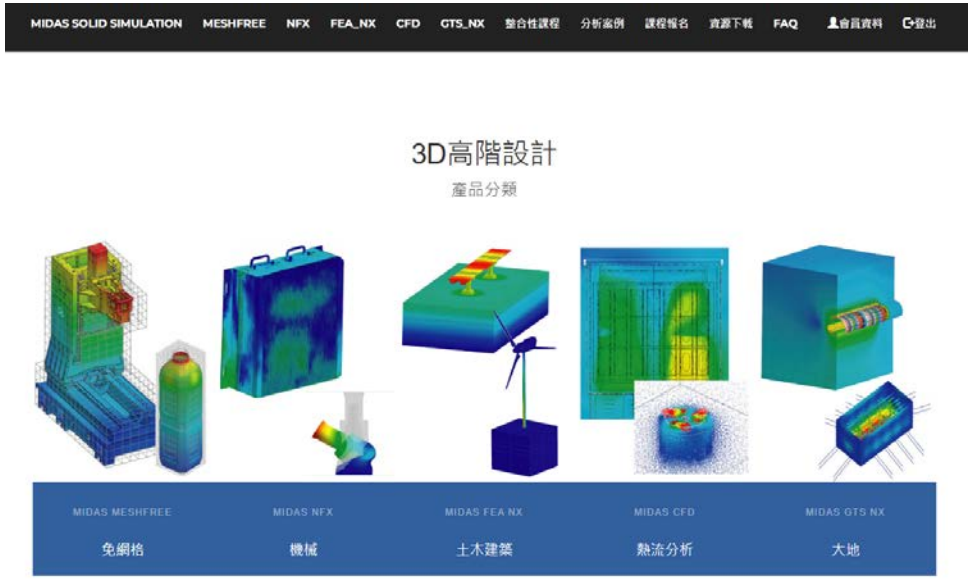
Technical support system

- Help manuals / Tutorials with various topics





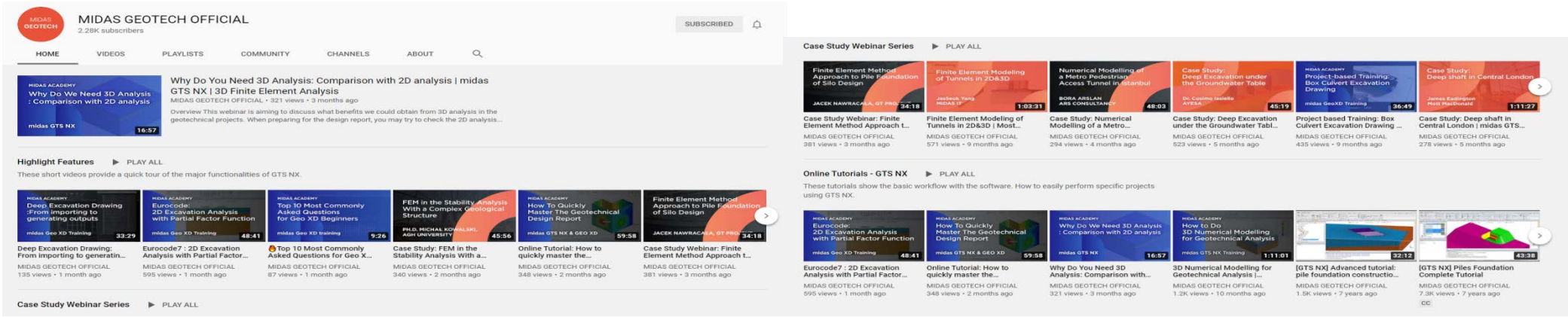
- Taiwan MIDAS Solid-Simulation website



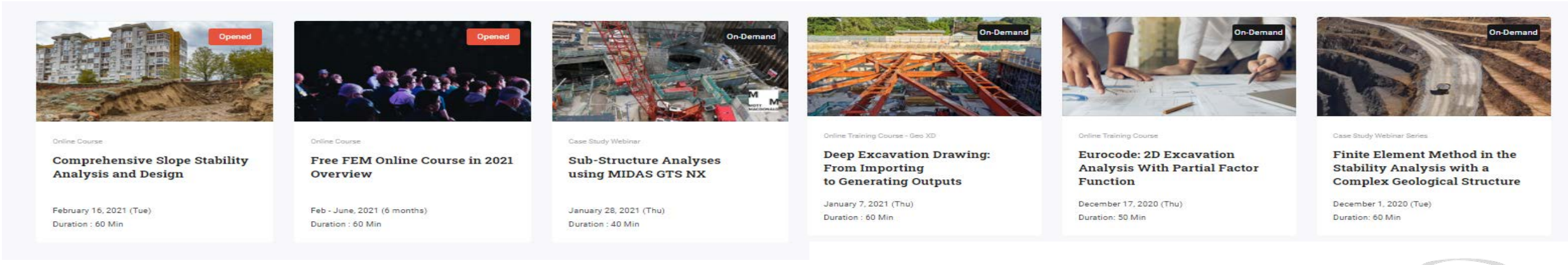
https://www.midasuser.com.tw/SolidSimulation/

Technical support system

- Various training video contents



- Training Program (Online Course / Case study)

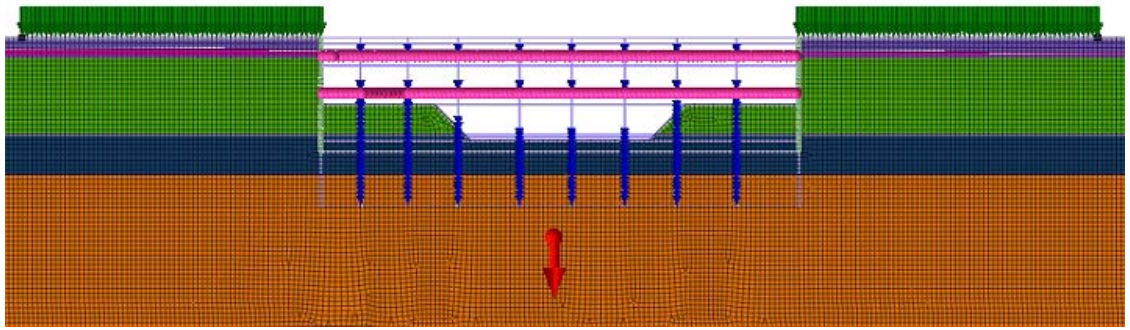


MIDAS Geotech has rich experience and know-how to grow the practical engineers

MIDAS
Case Study

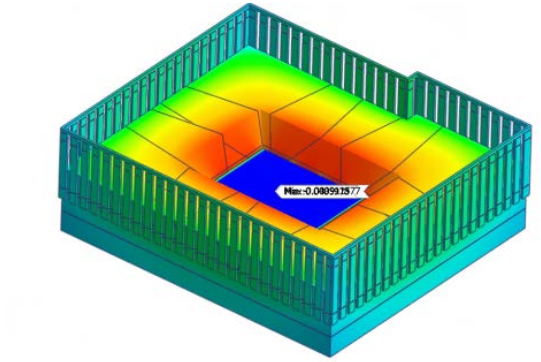
3D島式開挖

2D分析

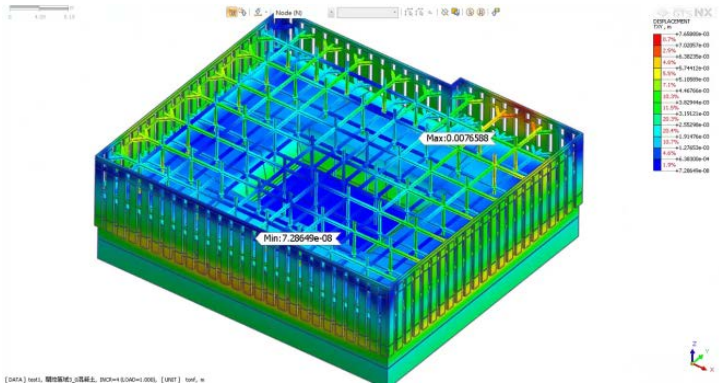


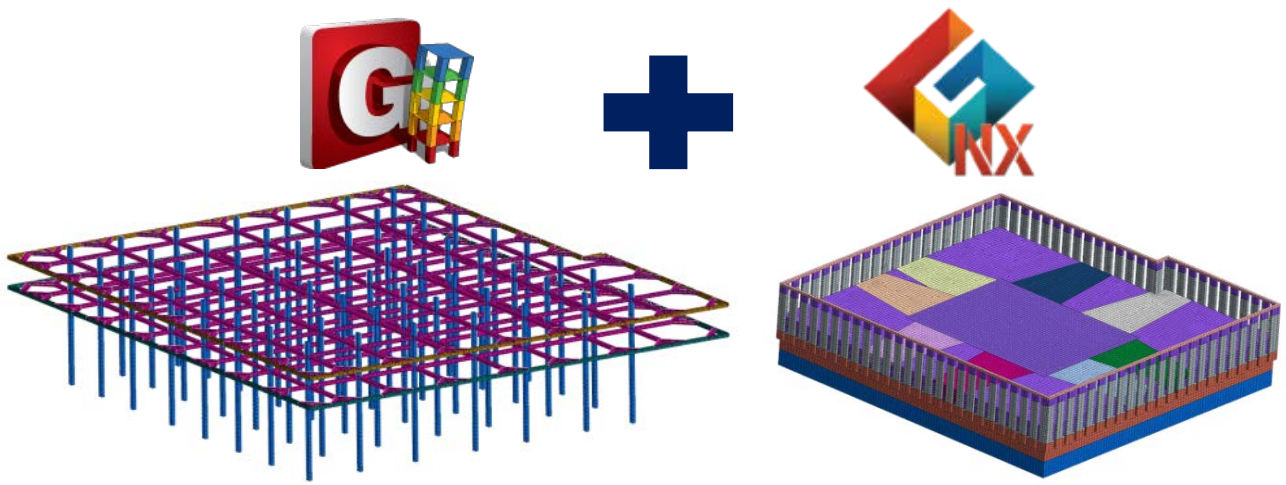
2D 建模只考慮模型的一個平面，縱向支撐、水平支撐和傾斜梁無法建模。

開挖面最大垂直位移 (m)

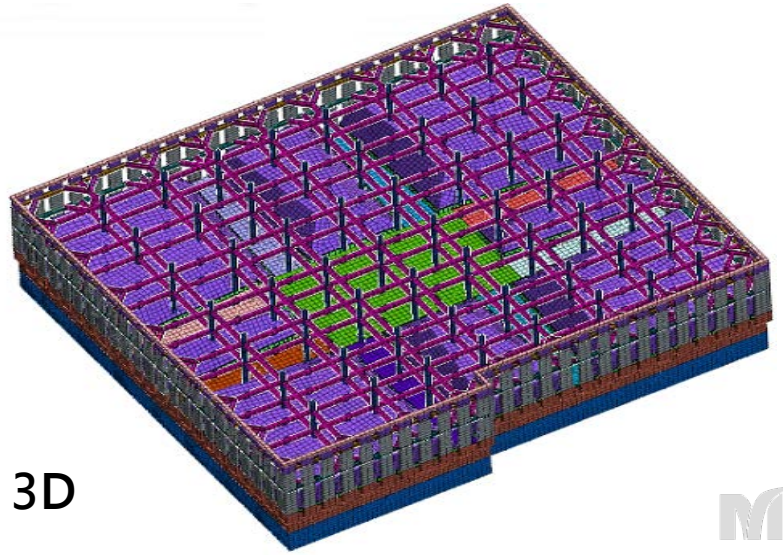


開挖面最大水平位移 (m)

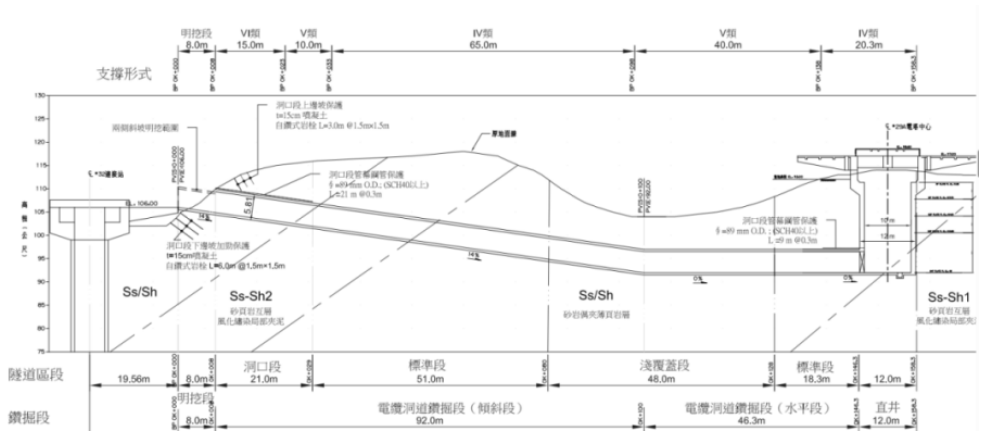




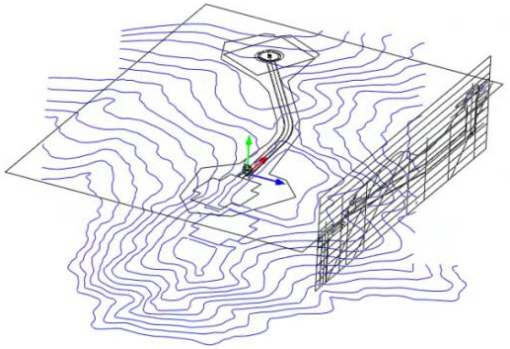
GEN+GTS 3D

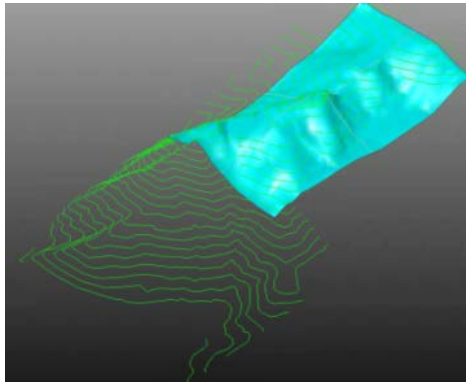


GTS NX NATM實例



MIDAS/TGM



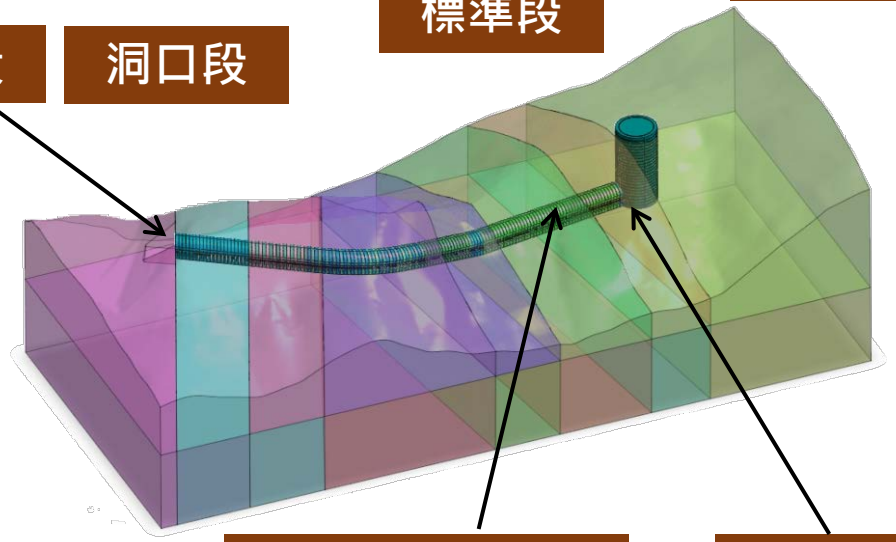


直井段

標準段

明挖段

洞口段

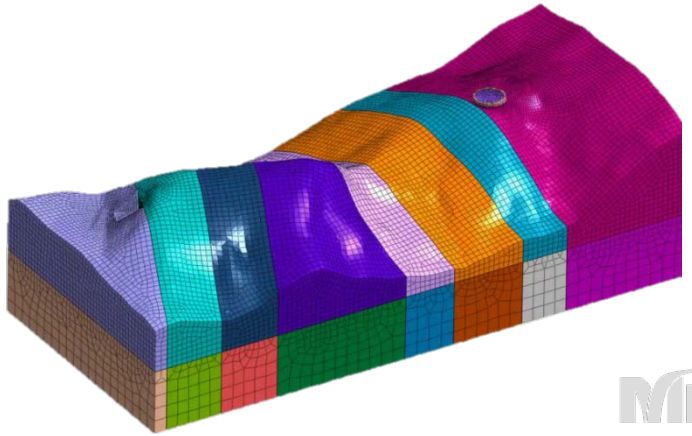


淺覆蓋標準段

標準段2

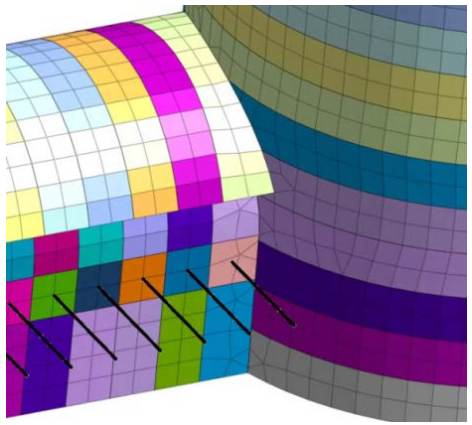
Hybird Mesher

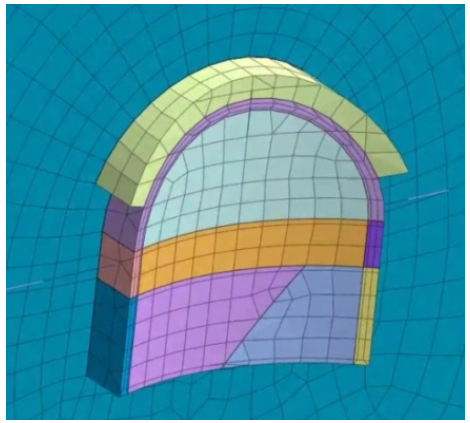
(六面體 + 五面體 + 四面體)



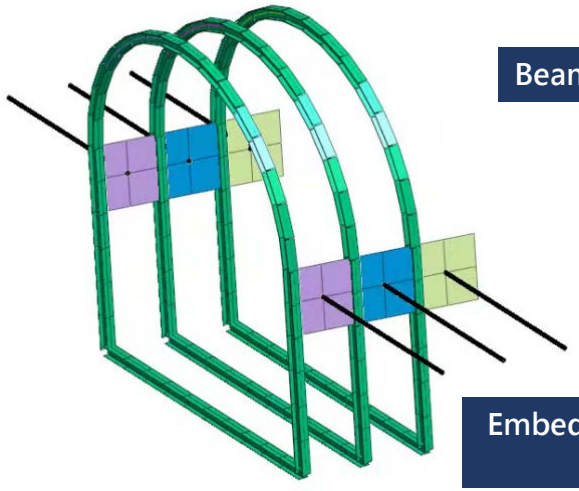
GTS NX NATM實例

GTS NX 混合網格/全共點建模





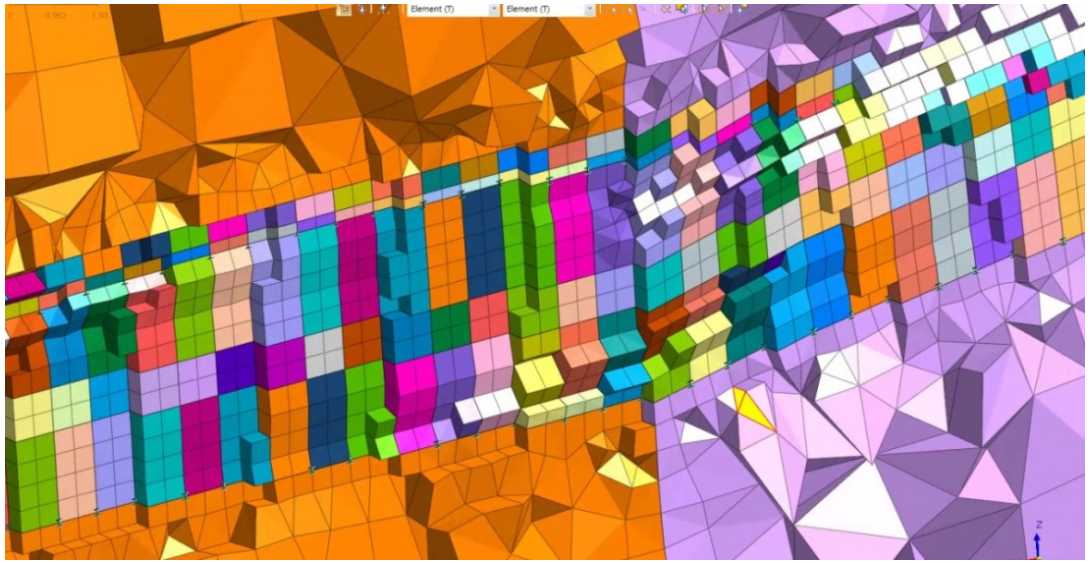
Shell Element(傳力裝置)



Beam Element(H型鋼)

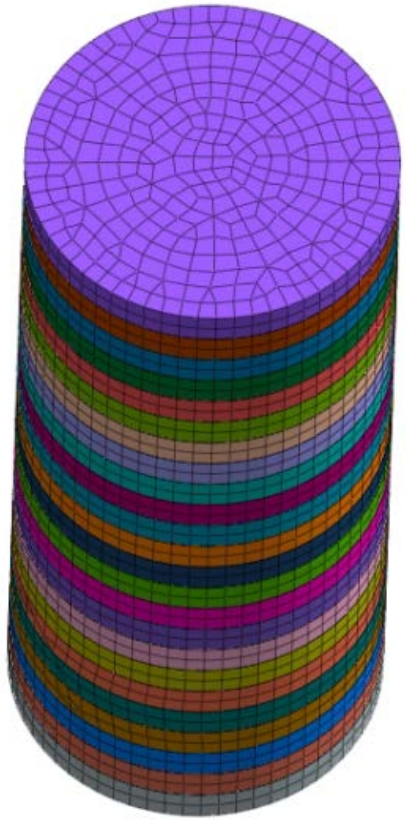
Embedded Truss Element (Rock Bolt)

GTS NX 混合網格/全共點建模

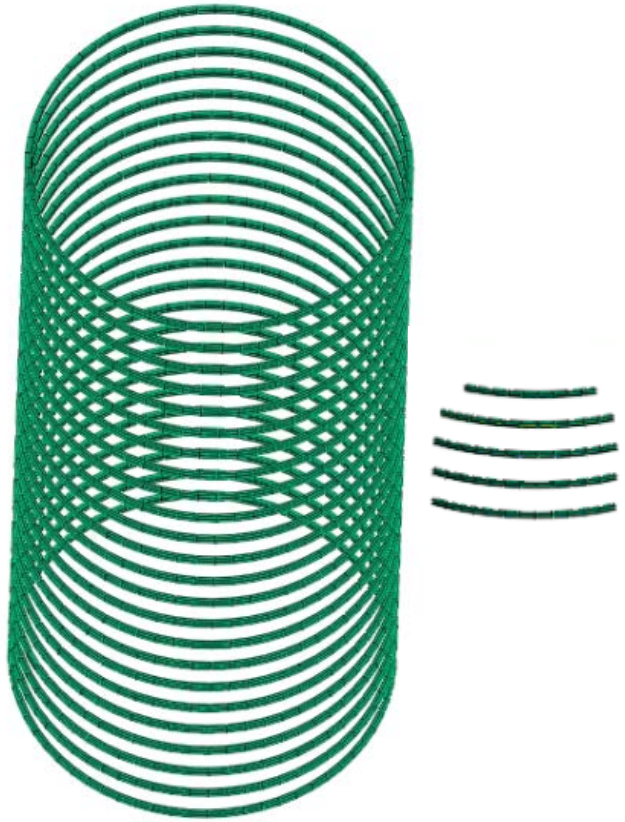


GTS NX NATM實例

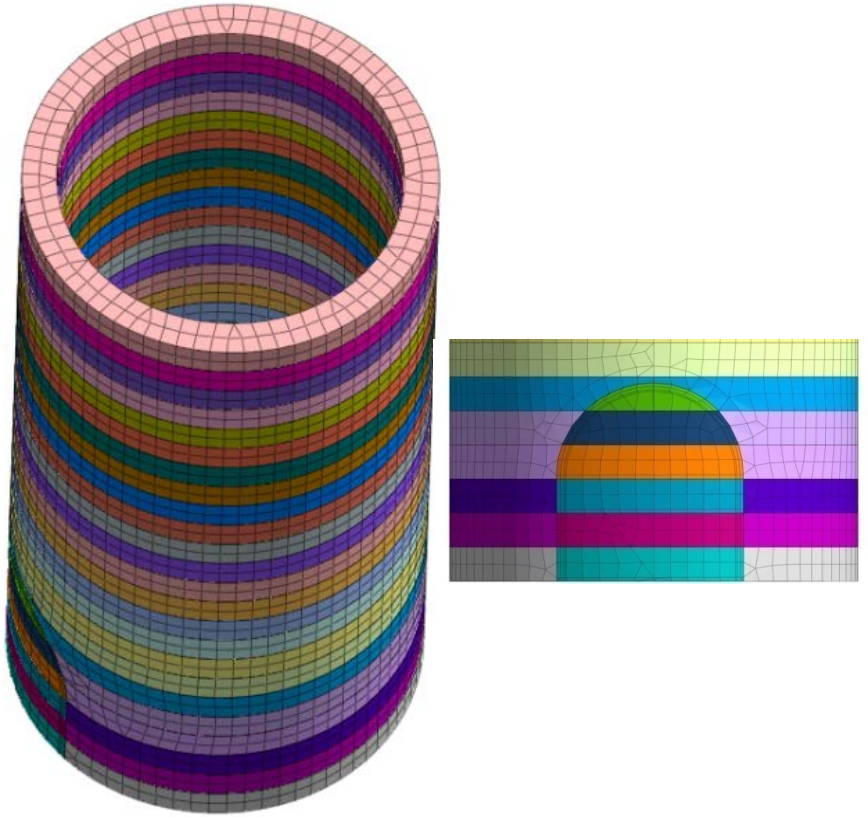
直井段



直井主開挖區



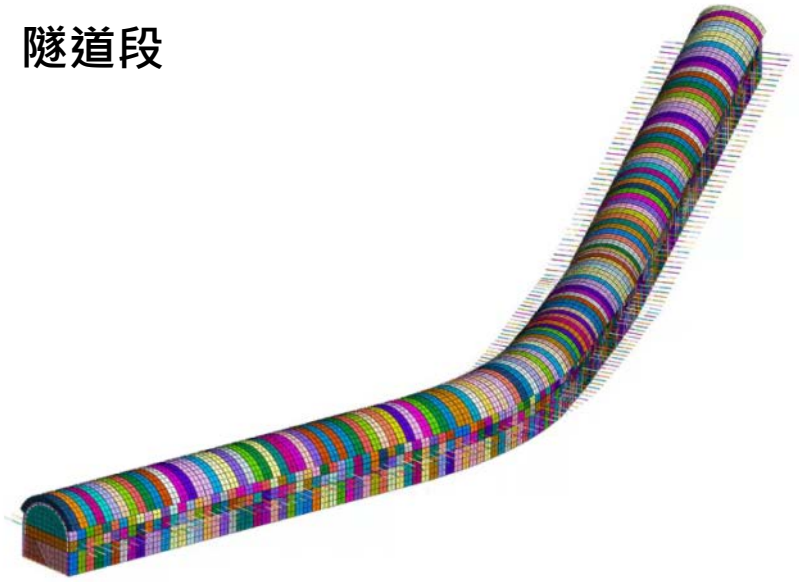
直井鋼支保



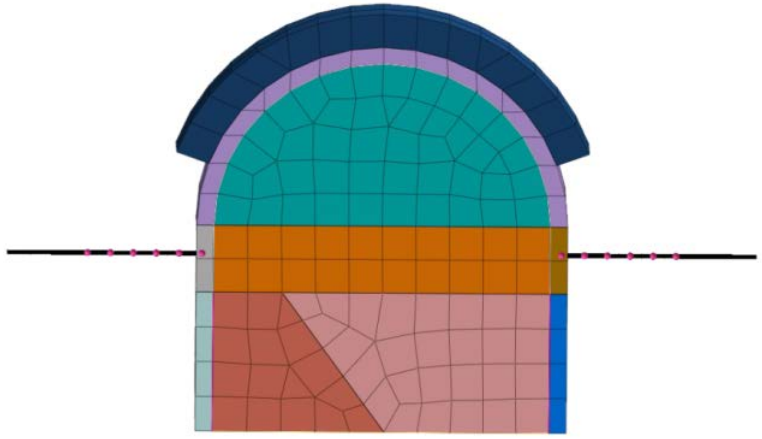
直井背填區

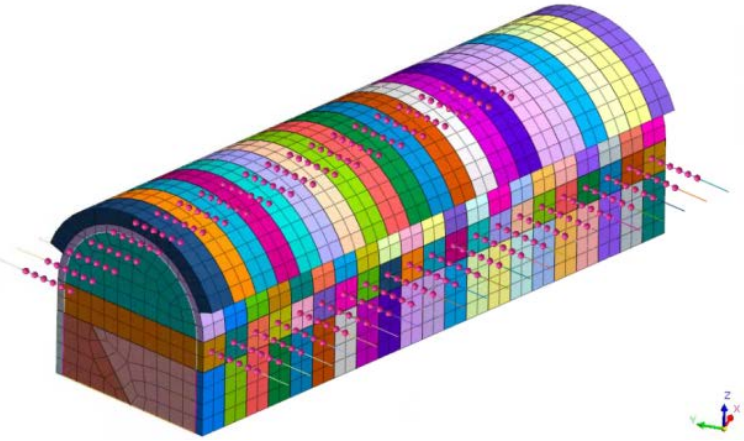
GTS NX NATM實例

隧道段

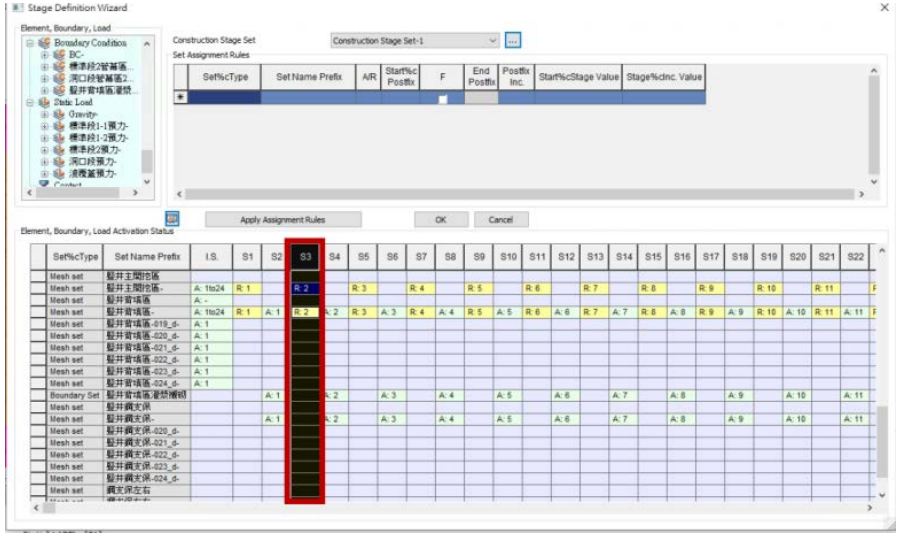


Anchors地錨（預力施加）

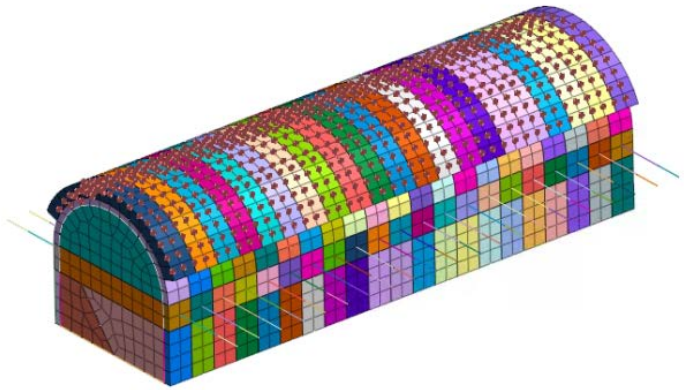




施工階段模組



管幕區變更材質



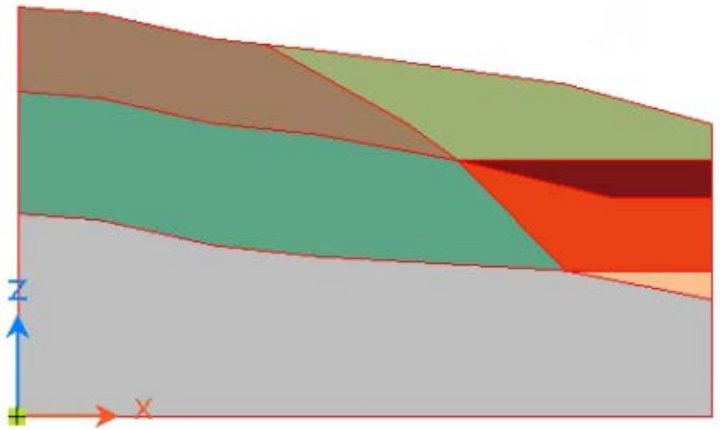
豎井背填灌漿和襯砌

GTS NX 邊坡穩定分析

- 2D分析 - 方法 1
  Limit Equilibrium Method(LEM)-極限平衡法 2D
- 2D分析 - 方法 2
  Stress Analysis Method (SAM)-應力分析法 2D
- 2D分析 - 方法 3
  Strength Reduction Method (SRM)-強度折減法 2D
- 3D分析
  Strength Reduction Method (SRM)-強度折減法 3D

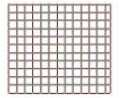
GTS NX 2D邊坡穩定分析

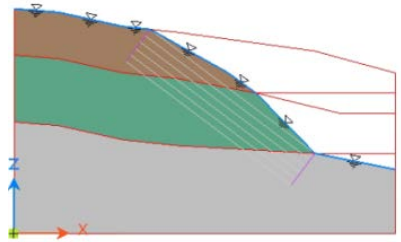
開挖後邊坡穩定性計算



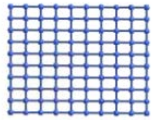
Weathered Soil
Weathered Rock
Soft Rock

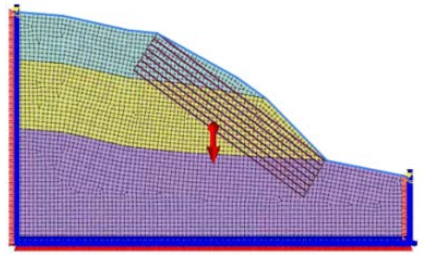
2D分析-方式1.LEM



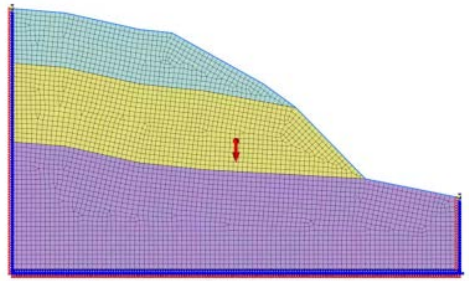


2D分析-方式2.SAM





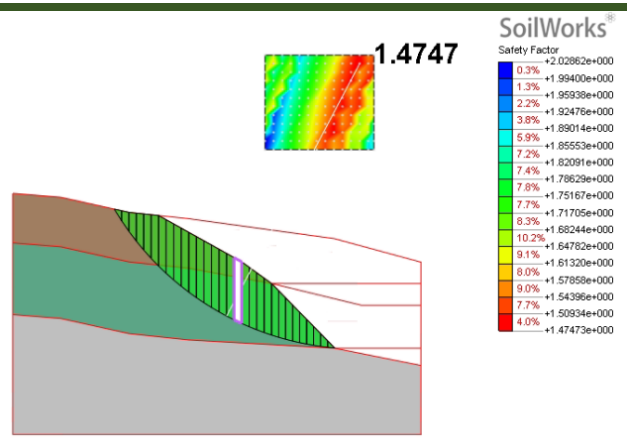
2D分析-方式3.SRM



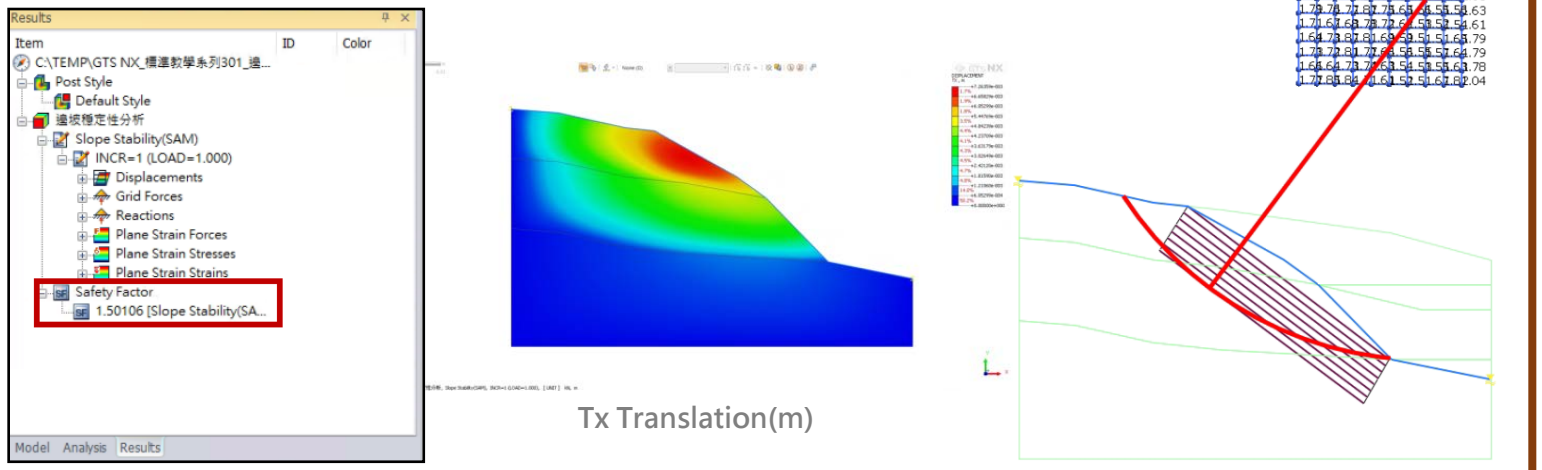
SRM：將邊坡地基材料的抗剪強度 (c , φ) 逐漸減小，直到計算過程中的發散點，此時假定發生了邊坡破壞，該點的最大強度折減率被認為是最小安全係數。

GTS NX 2D邊坡穩定分析

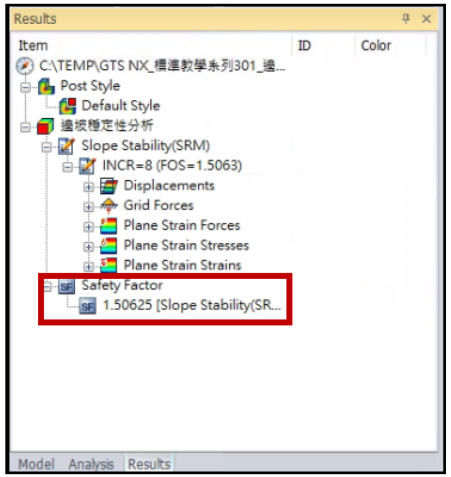
2D分析-方式1
LEM計算之安全係數1.4747



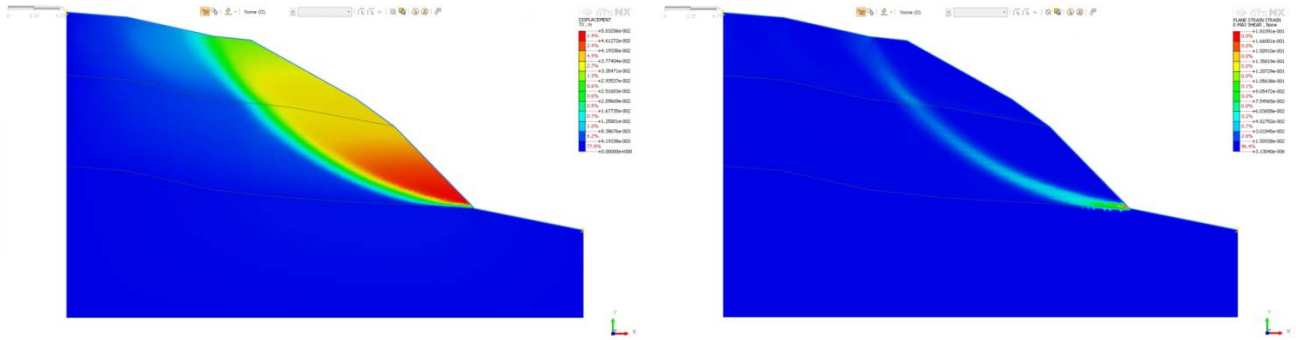
2D分析-方式2
SAM計算之安全係數1.50106



2D分析-方式3
SRM計算之安全係數1.50625



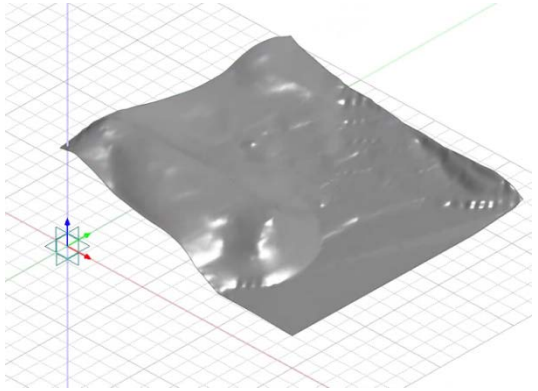
2D分析-方式3
SRM透過水平變形和最大剪切應變判斷破壞面



GTS NX 3D邊坡穩定分析

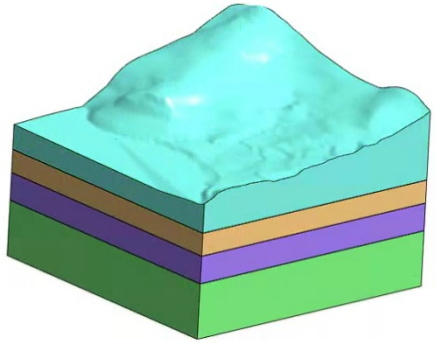
Strength Reduction Method (SRM)

3D地形面特徵

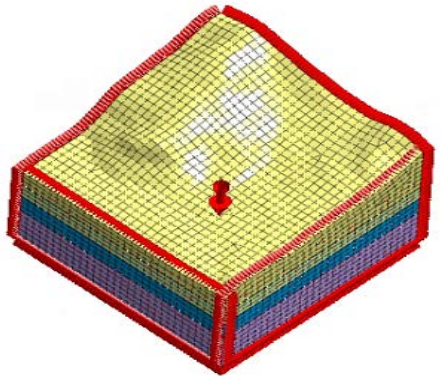


300m ×300m

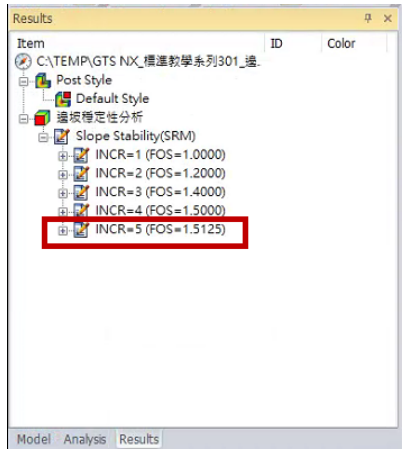
3D地形實體特徵

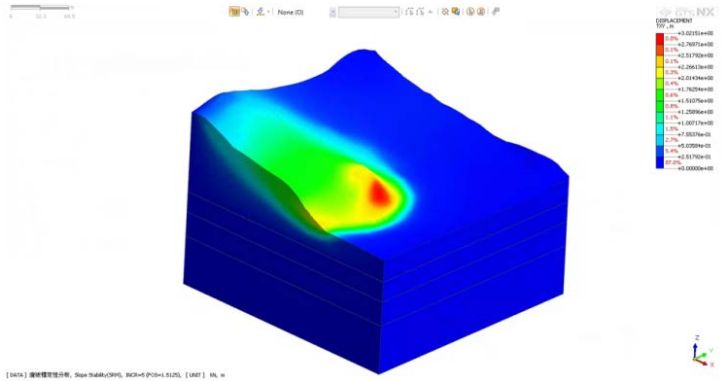


自重

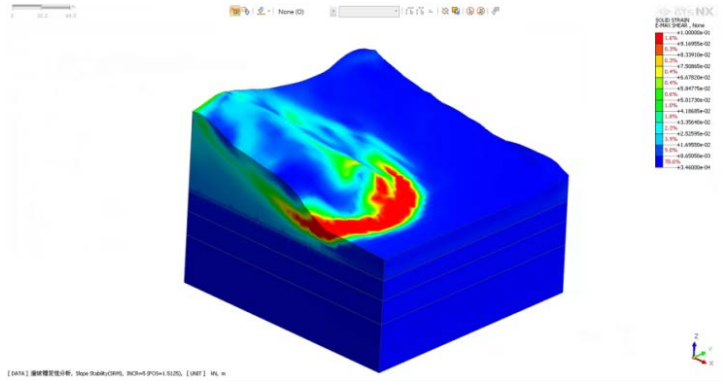


3D分析
SRM計算之安全係數1.5125



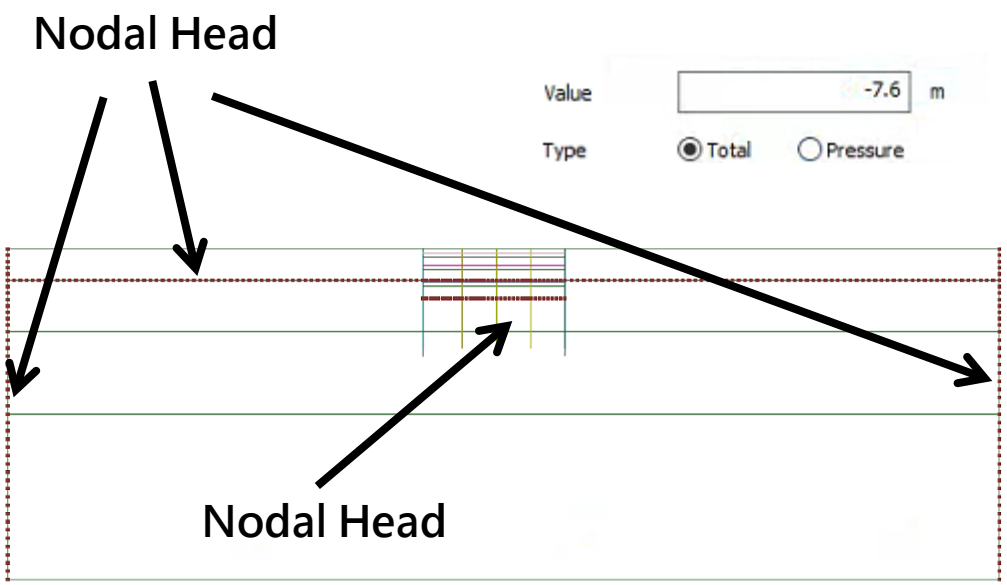


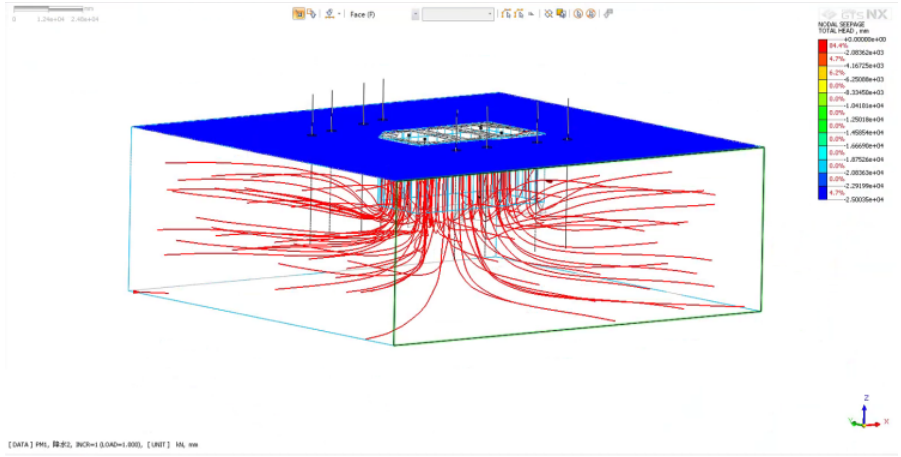
Tx Translation(m)



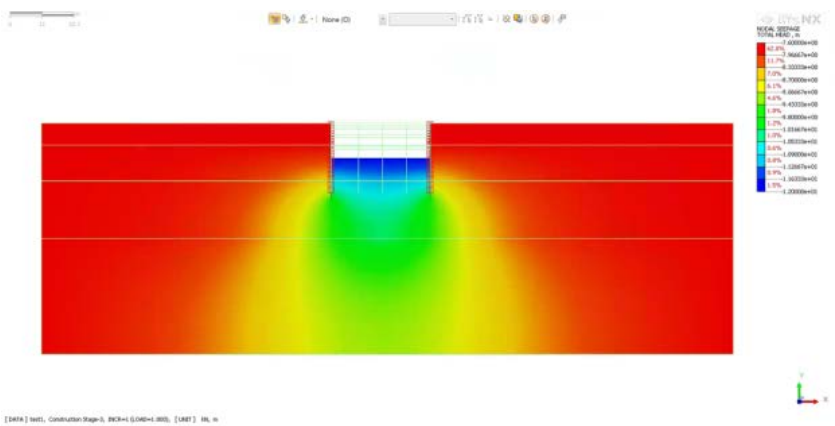
Maximum Shear Strain

GTS NX-降水井模擬

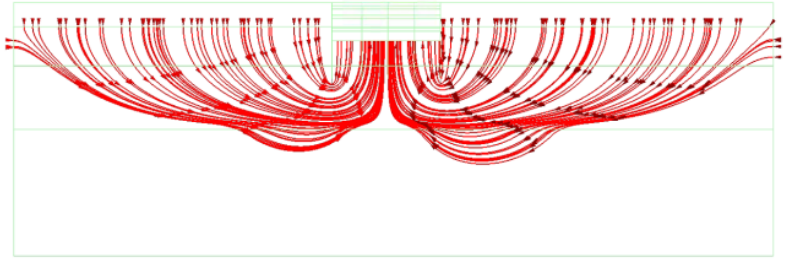




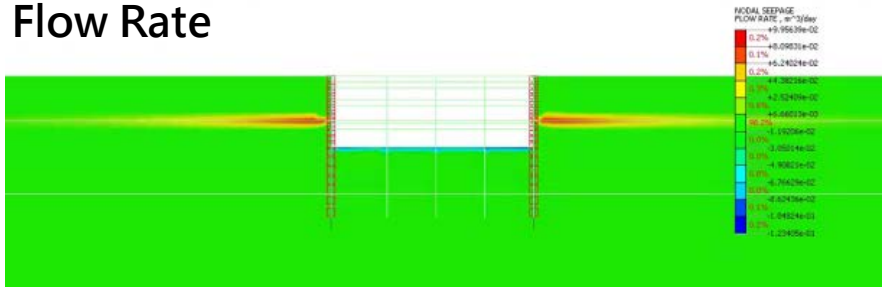
Total Head



Flow Path

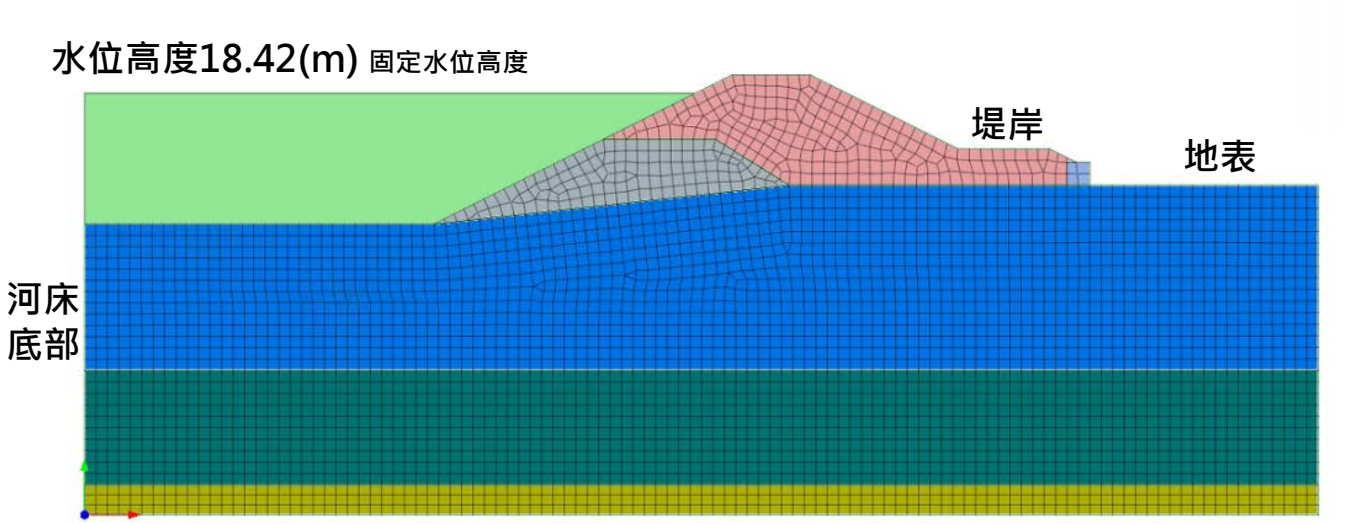


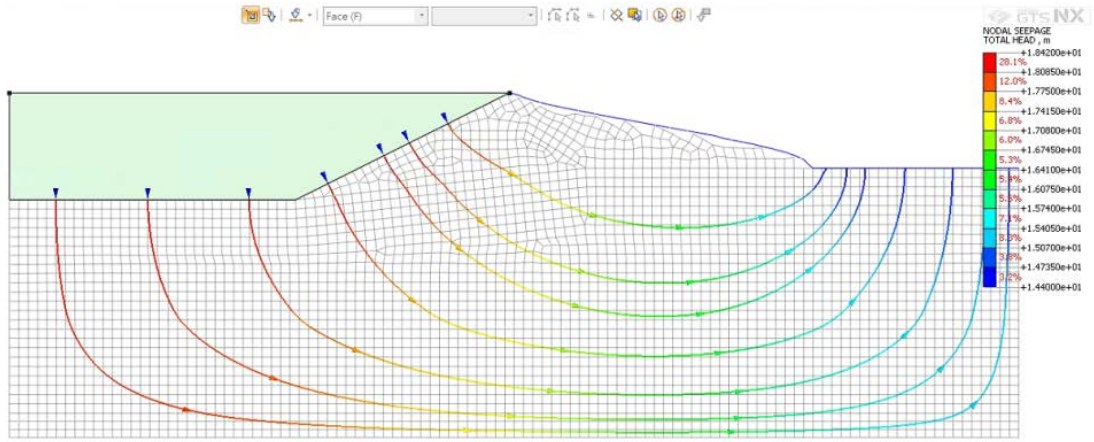
Seepage Flow Rate



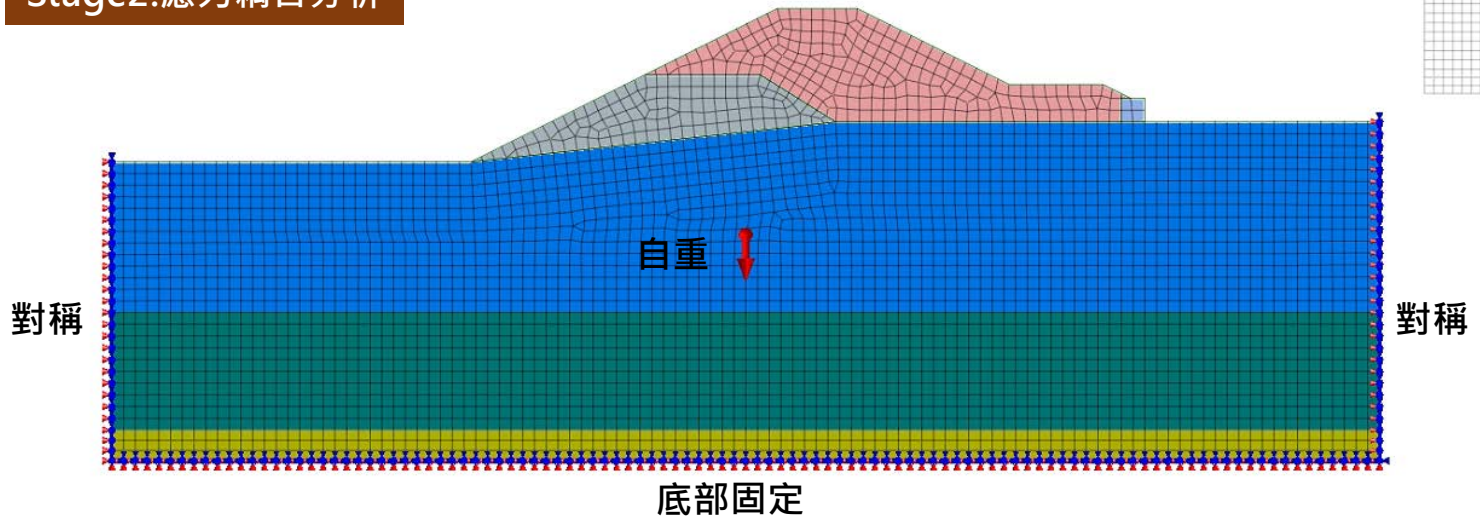
GTS NX-滲流應力耦合分析

Stage1.滲流分析



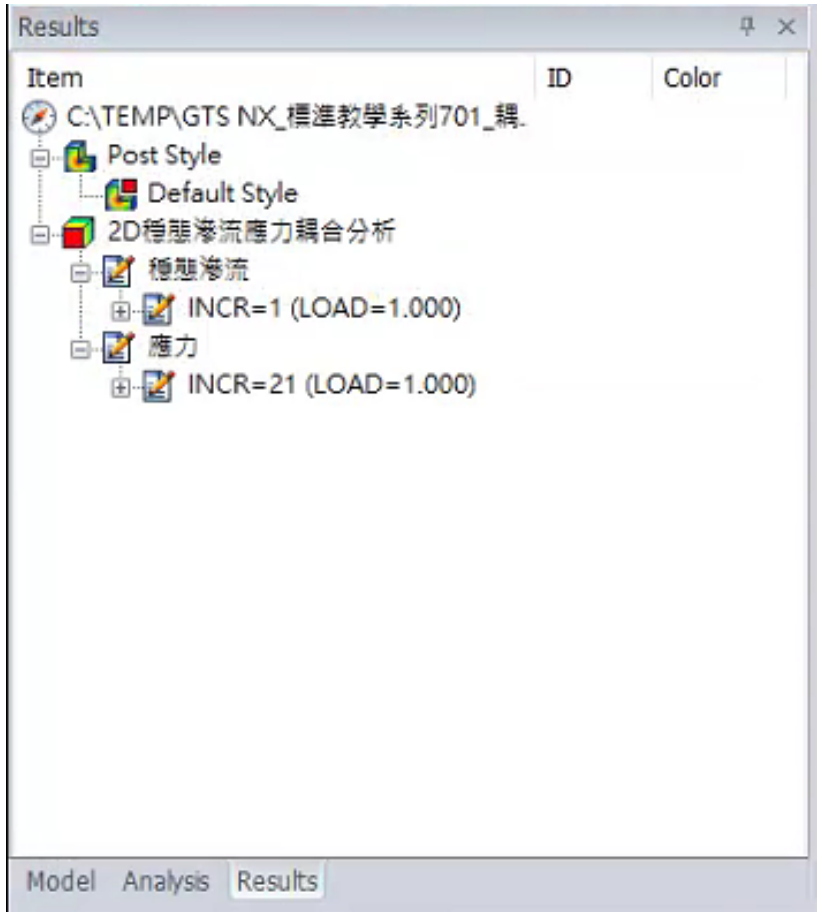


Stage2.應力耦合分析



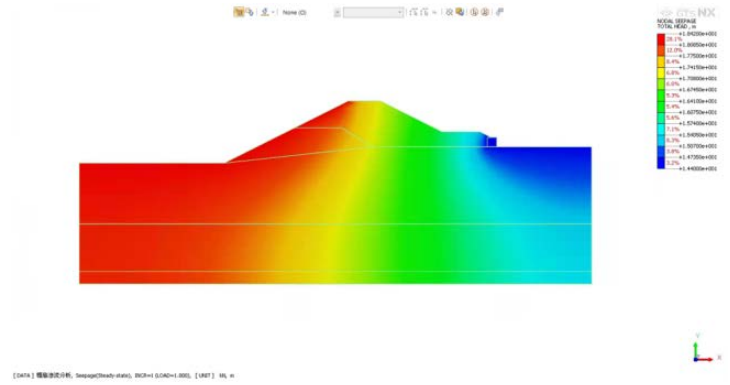
GTS NX-滲流應力耦合分析

Results
穩態滲流 INCR=1：滲流結果
應力 INCR=21：應力結果

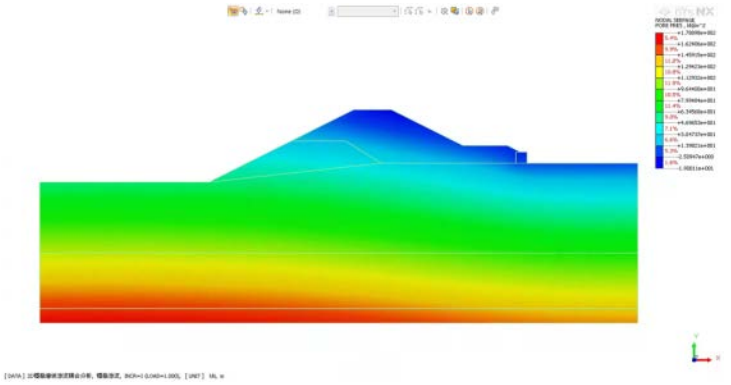


滲流結果

Total Head(m)

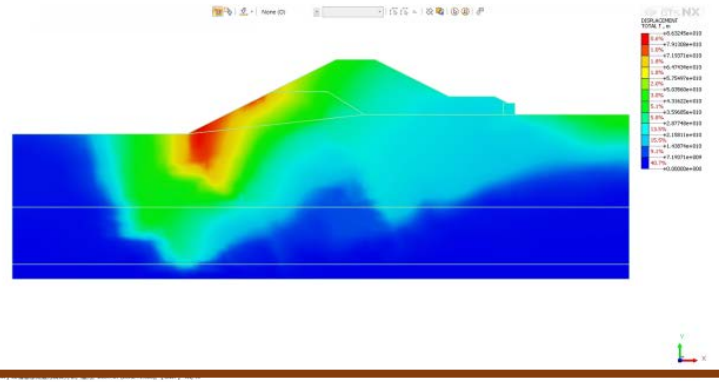


Pore Pressure(KN/m²)

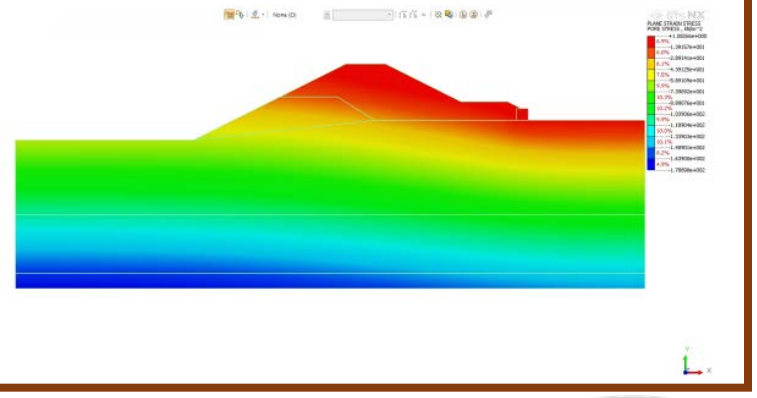


應力結果

Displacement Total(m)

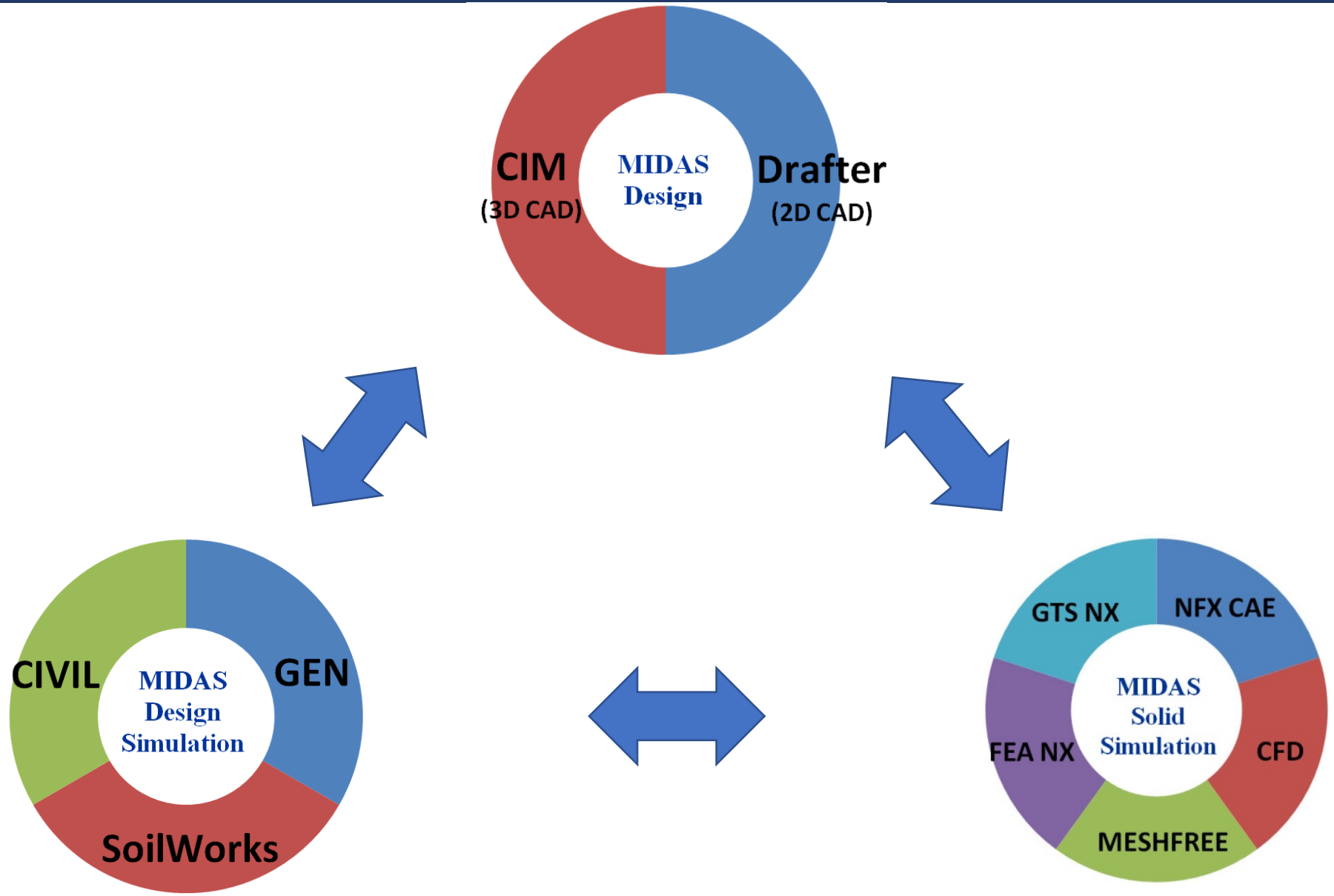


Pore Stress(KN/m²)



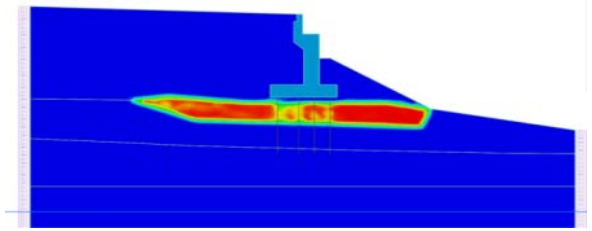
MIDAS
整合性介紹

MIDAS 整合性

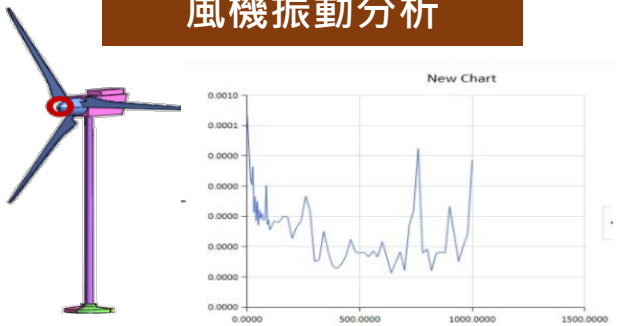

CIM
(3D CAD)
MIDAS
Design
Drafter
(2D CAD)
CIVIL
MIDAS
Design
Simulation
GEN
SoilWorks
GTS NX
NFX CAE
FEA NX
MIDAS
Solid
Simulation
CFD
MESHFREE

Solid Total Solution

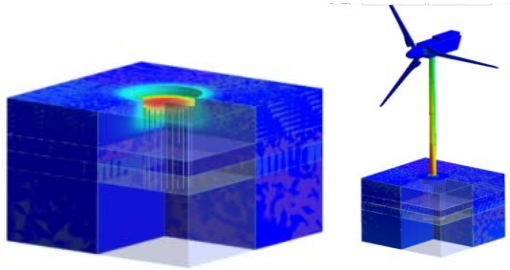
土壤液化分析



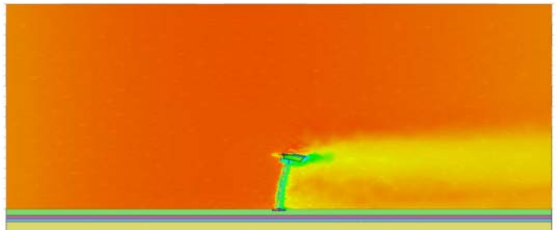
風機振動分析



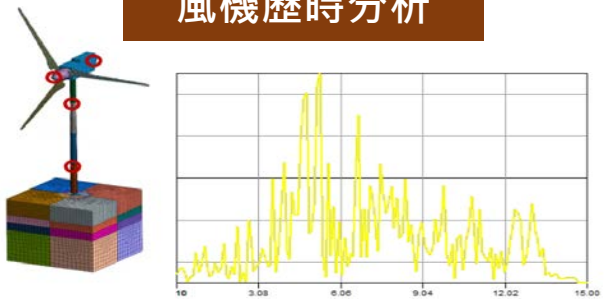
風機安裝施工階段分析

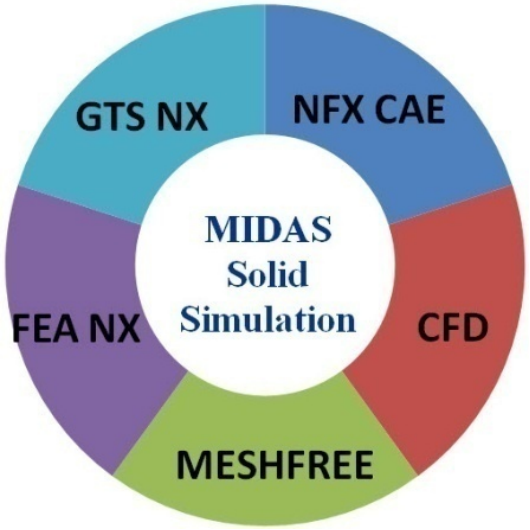


風機流固耦合分析

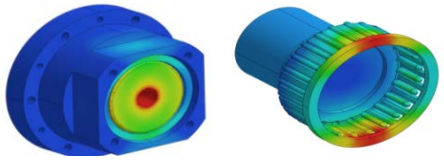


風機歷時分析

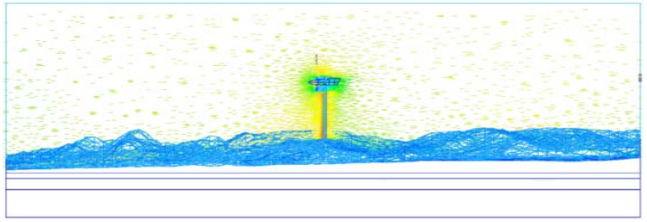




齒輪組分析

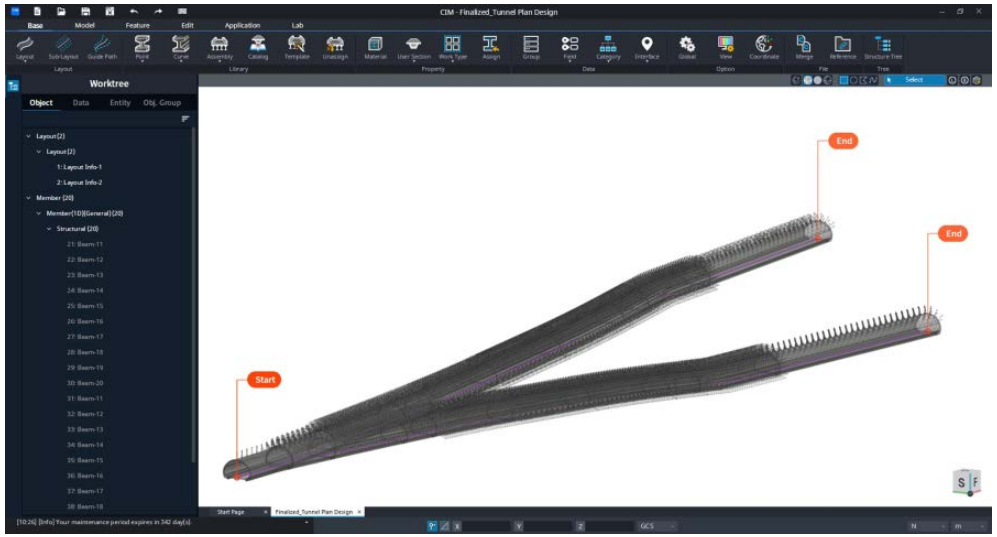


風機地形風場分析

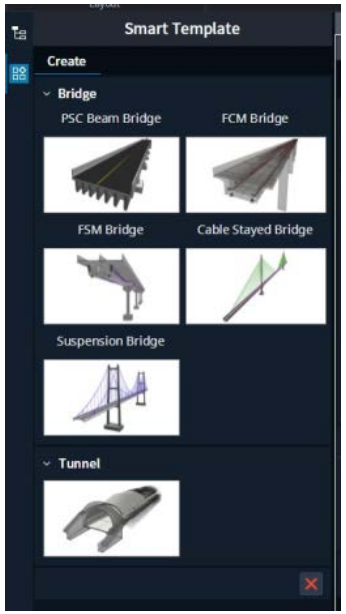


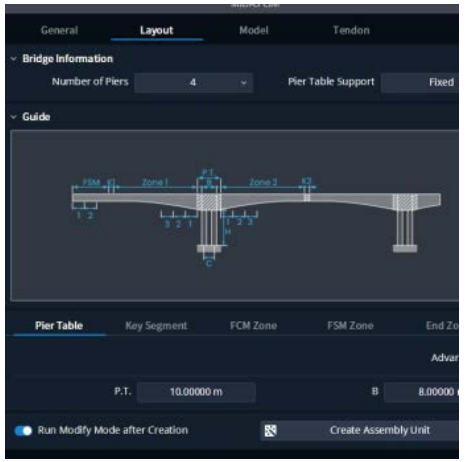
CIM+GTS 3D 模型整合

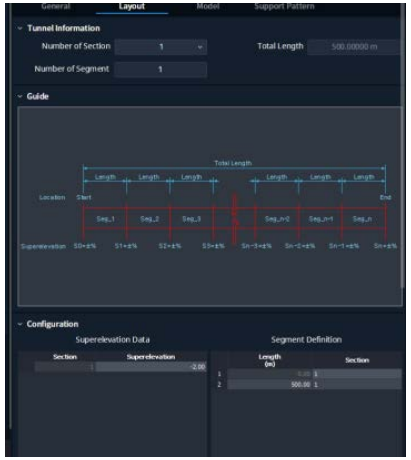
CIM-3D模型隨路線線形自動變更



Bridge & Tunnel Wizard

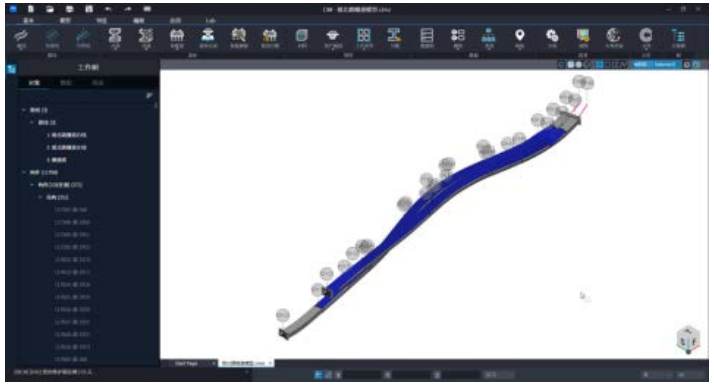




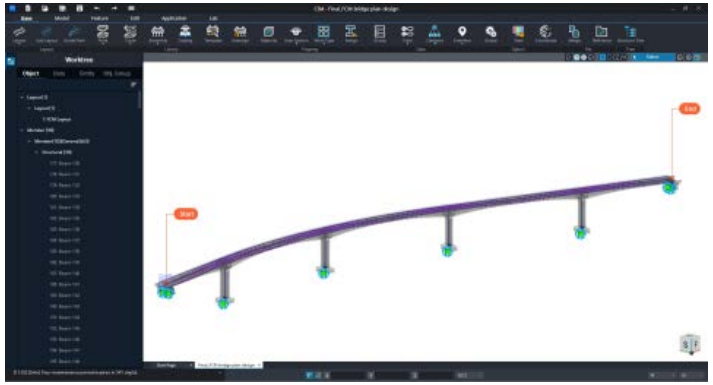


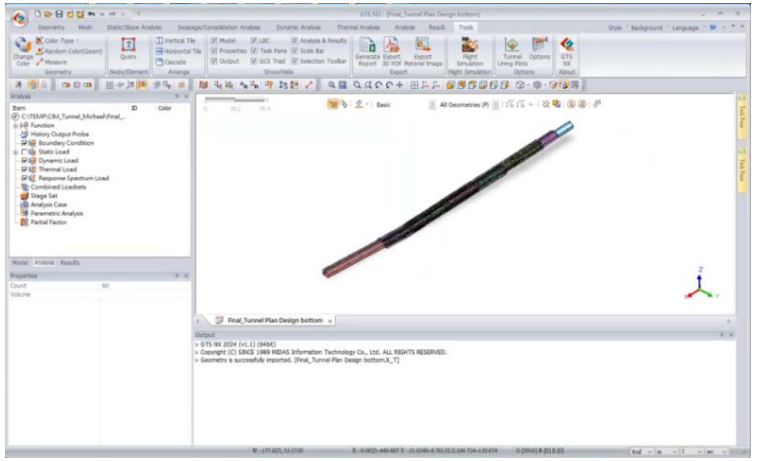
CIM+GTS 3D 模型整合

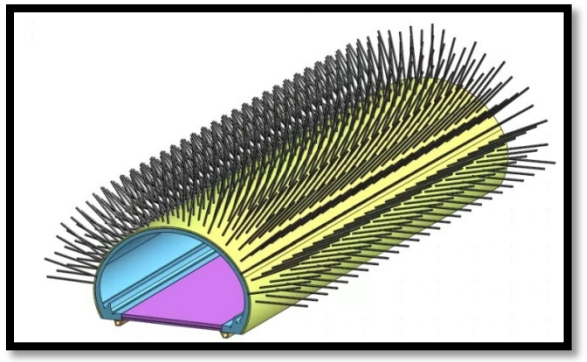
Tunnel

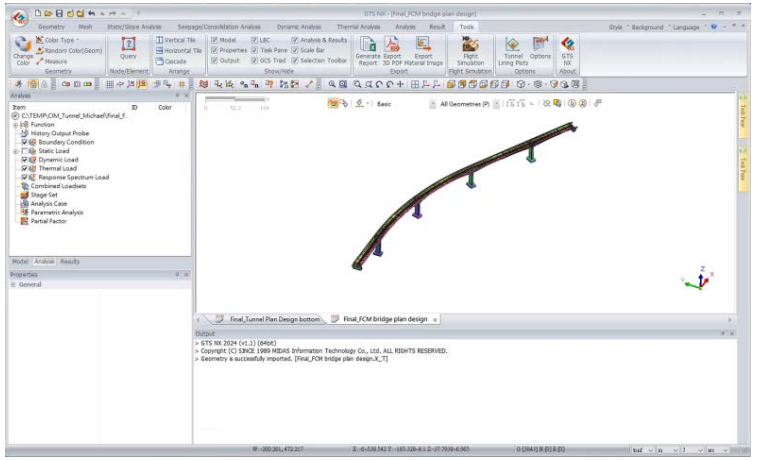


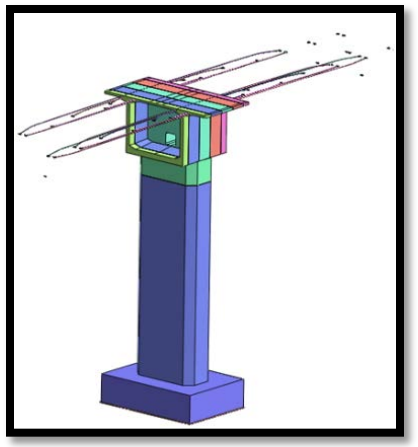
Bridge





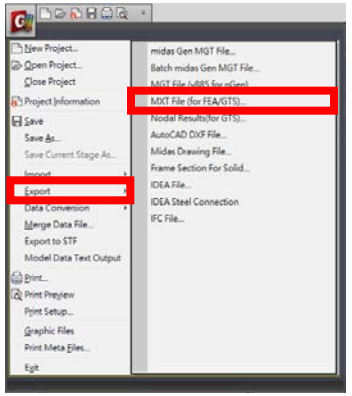


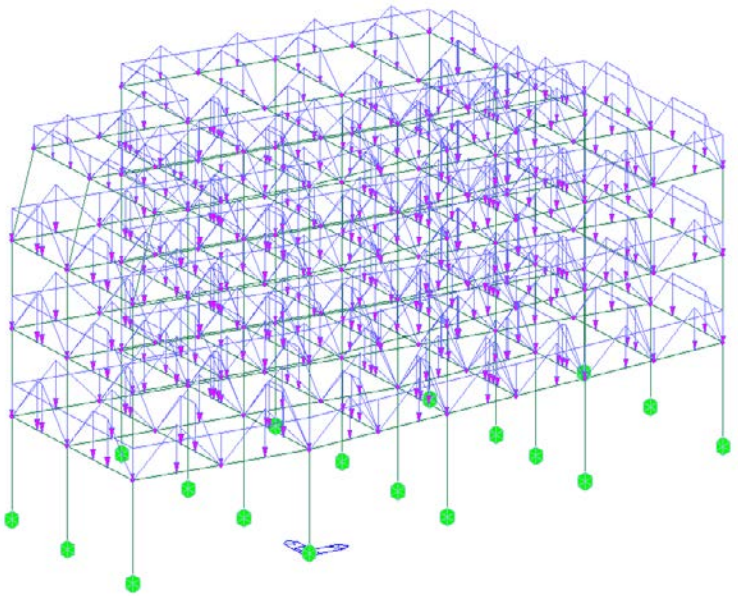


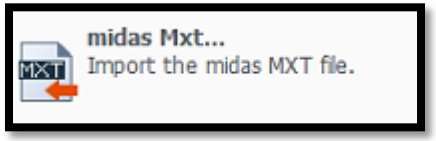


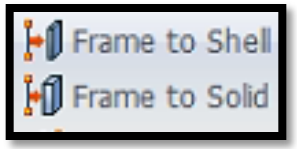
CIM&GTS NX
實體特徵直接轉換

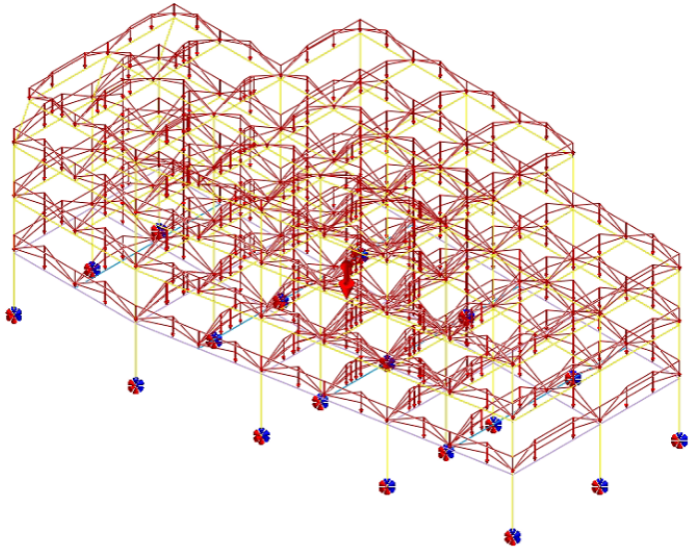
GTS NX & Gen 結構互制分析



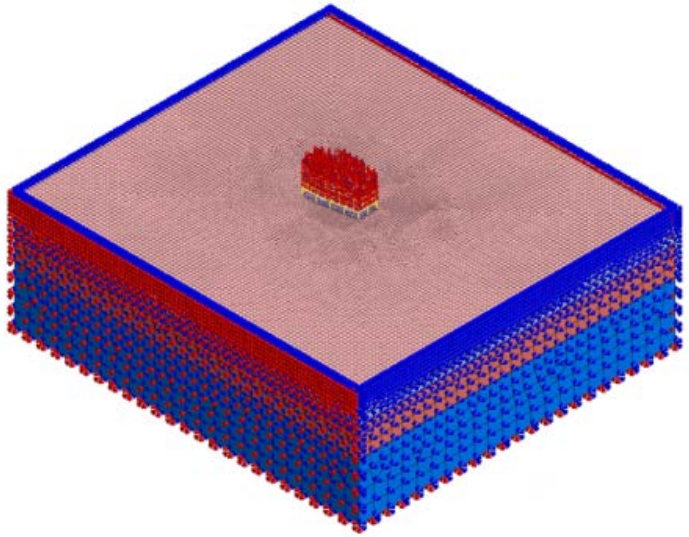


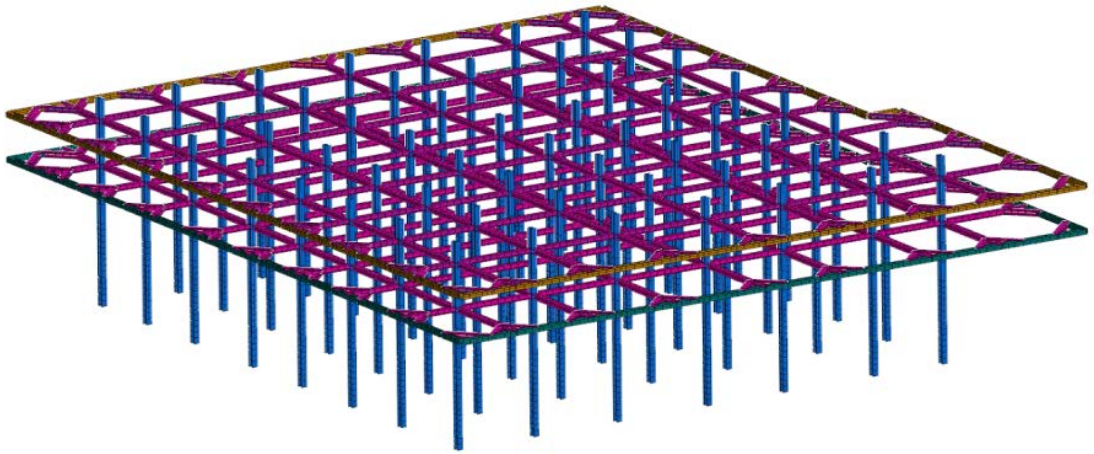


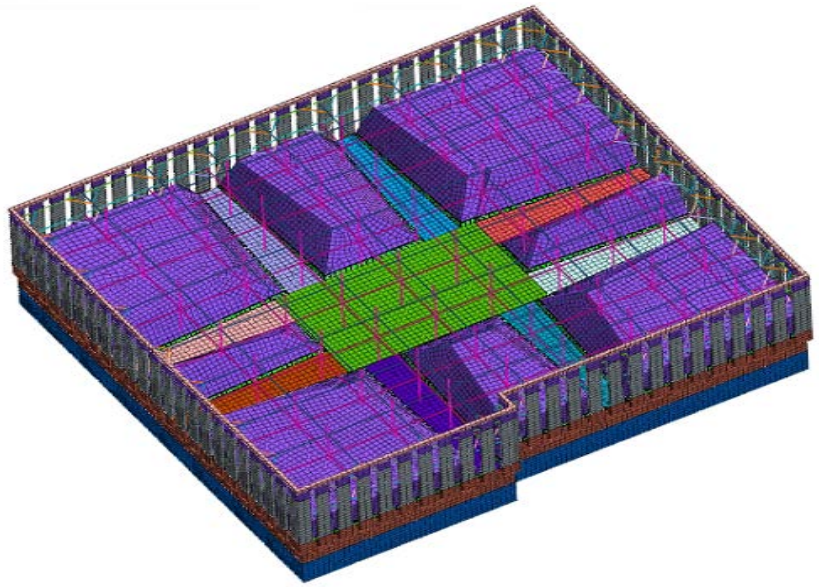


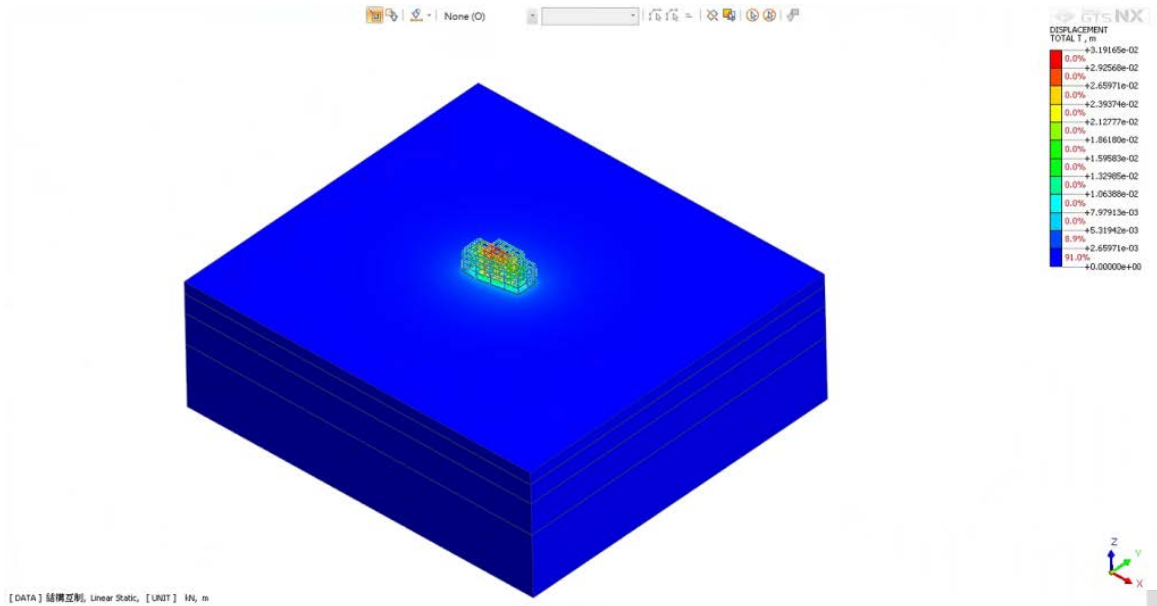


GTS NX & Gen 結構互制分析



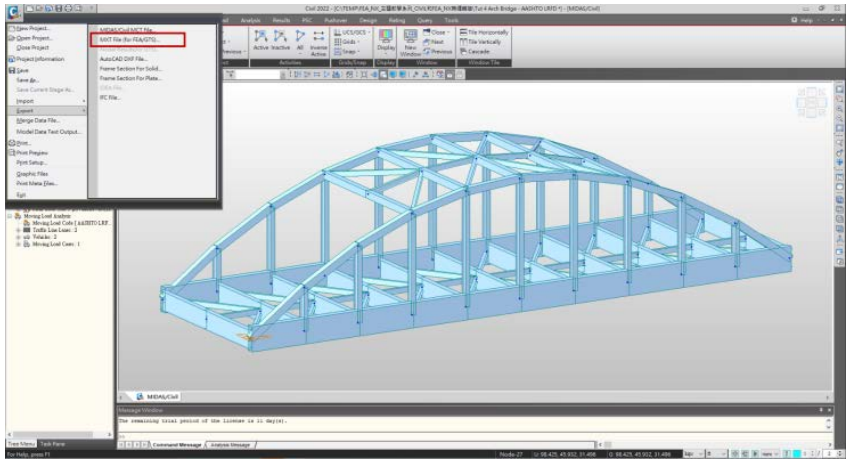


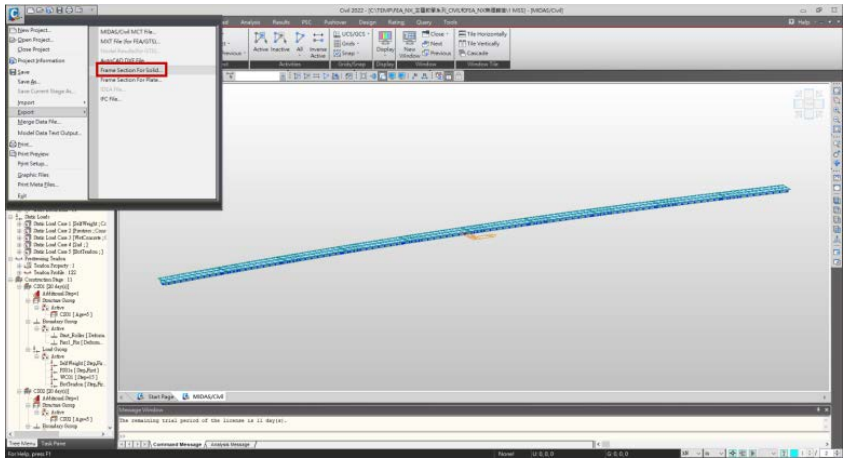




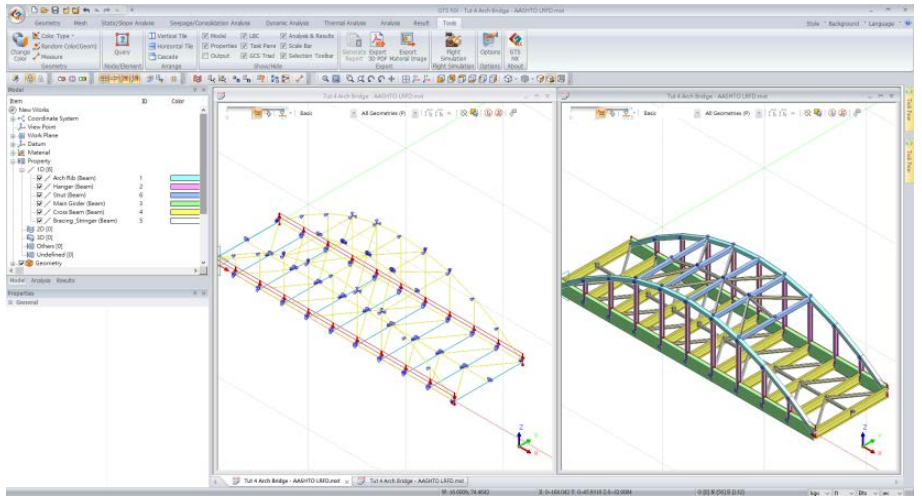
GTS NX+CIVIL無縫轉換

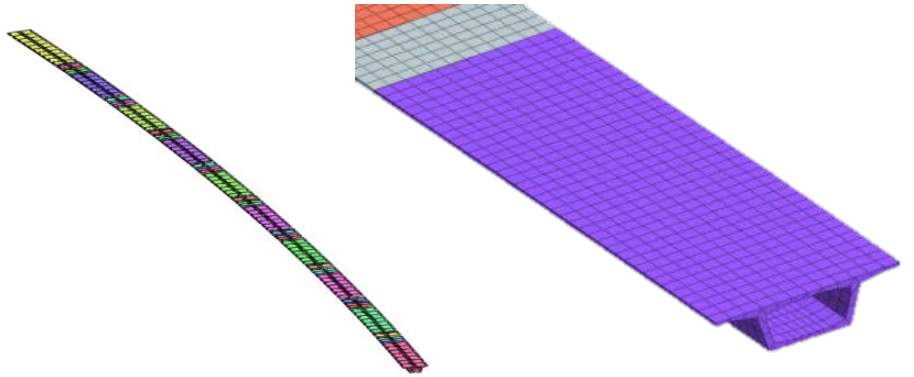
匯出MXT Files(*.mxt)檔案格式





元素&特徵無縫轉換





Thank you.

GTS NX
2D Excavation with Retaining System

Lesson 01

Midas Taiwan

Tutorial video with
English – Chinese subtitle

GTX NX 2D Excavation with Retaining System

Reference: Midas GTX NX Tutorials

Interface Wizard

▶ **Interface Wizard equation from Midas GTX NX manual:**

$K_n = E_{oed,i} / t_v$

$K_t = G_i / t_v$

$C_i = R \times C_{soil}$

Here,

$E_{oed,i} = 2 \times G_i \times (1-v_i)/(1-2 \times v_i)$

$G_i = R^2 \times G_{soil}$

$G_{soil} = E/(2(1+v_{soil}))$

Where,

K_n: Normal Stiffness Modulus

K_t: Shear Stiffness Modulus

t_v: Virtual Thickness Factor

R: Strength Reduction Factor

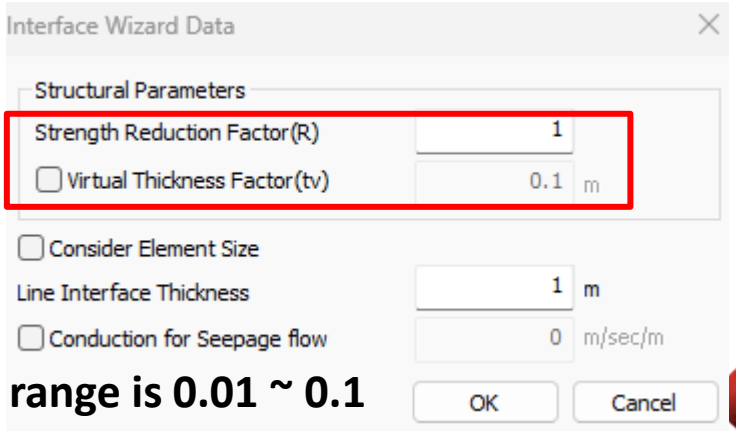
C_i: Interface Cohesion

Kn (Normal stiffness modulus) is the elasticity modulus for **bonding and un-bonding behavior** in the normal direction to the interface element

Kt (Shear stiffness modulus) is the elasticity modulus for **slip behavior** in the normal direction to the interface element

▶ **Strength Reduction factor (R)**

- Sandy soil/ Steel material: R= 0.6 ~ 0.7
- Clay/ Steel material: R= 0.5
- Sandy soil/ Concrete: R= 1.0 ~ 0.8
- Clay/ Concrete: R= 1.0 ~ 0.7



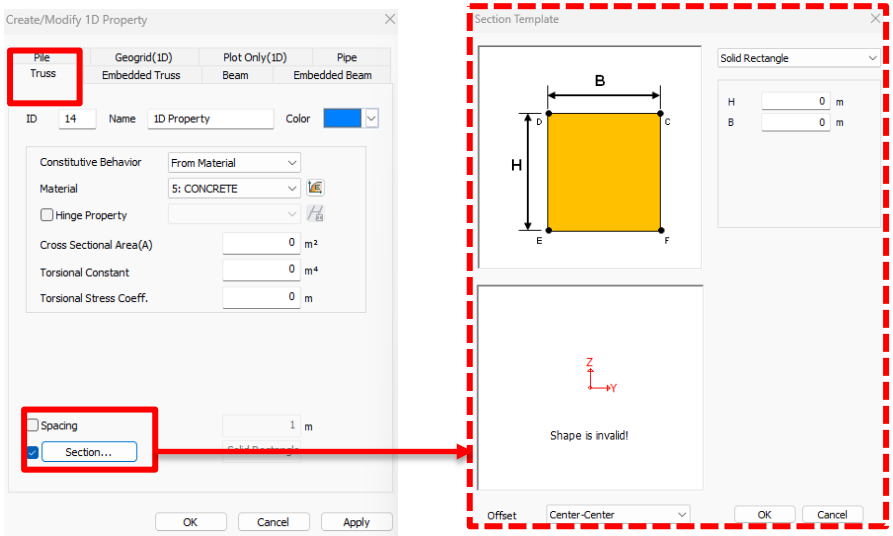
The general **Virtual Thickness Factor range is 0.01 ~ 0.1**
(If the stiffness is high, use a smaller value)

2D Element
(Beam element/ Truss element)

▶ **Beam and Truss element comparison:**

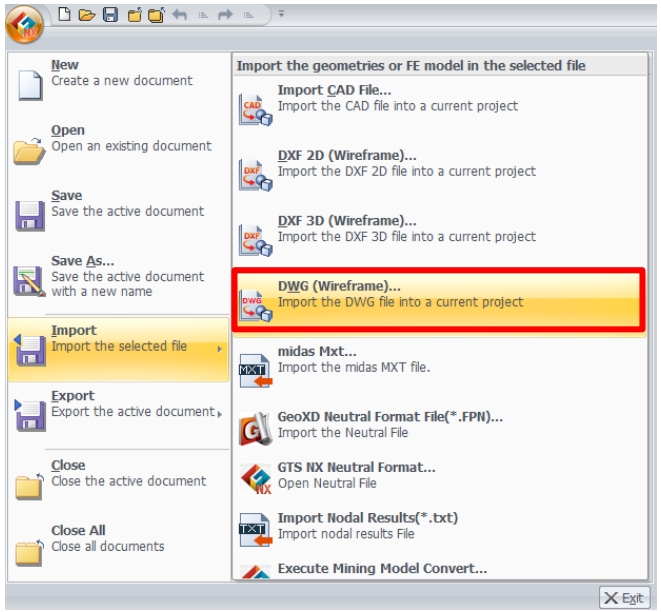
Feature	Truss Element	Beam Element
Resists Axial Force	✅ Yes	✅ Yes
Resists Bending	❌ No	✅ Yes
Resists Shear	❌ No	✅ Yes
Resists Torsion	❌ No	✅ Yes
Degrees of Freedom (DOF)	3 per node (UX, UY, UZ)	6 per node (UX, UY, UZ, RX, RY, RZ)
Transfers Moments	❌ No	✅ Yes
Typical Application	Trusses, cables	Beams, frames

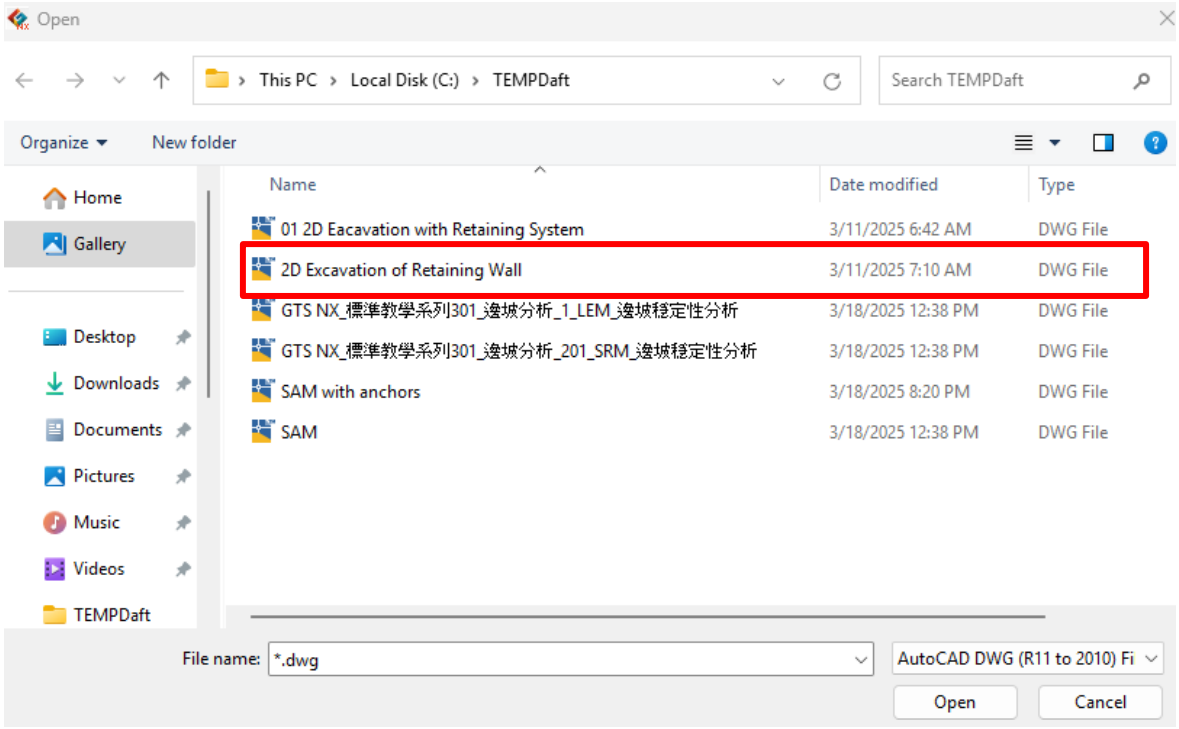
E.g., Truss element input by library section

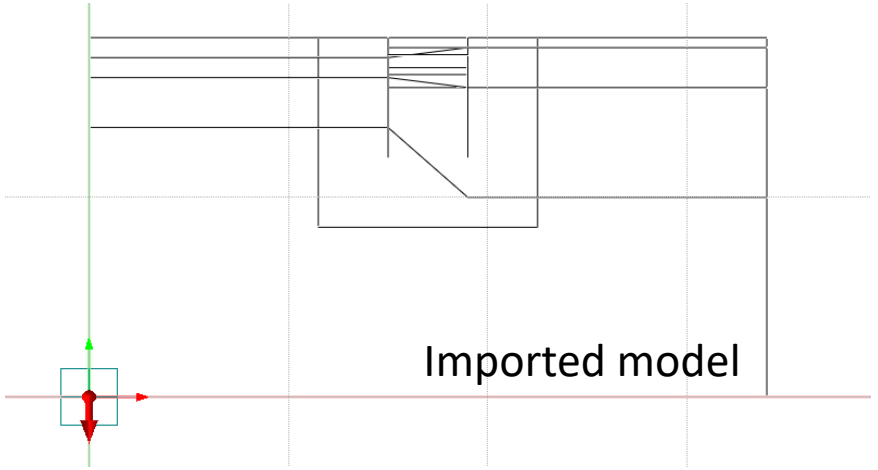


Note: Input the spacing for considering the strength differences between 2D and 3D

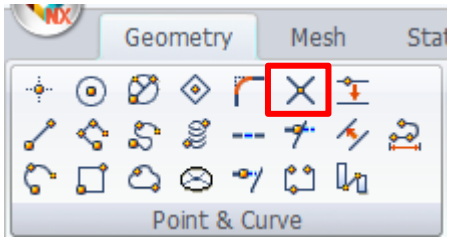
2D model import

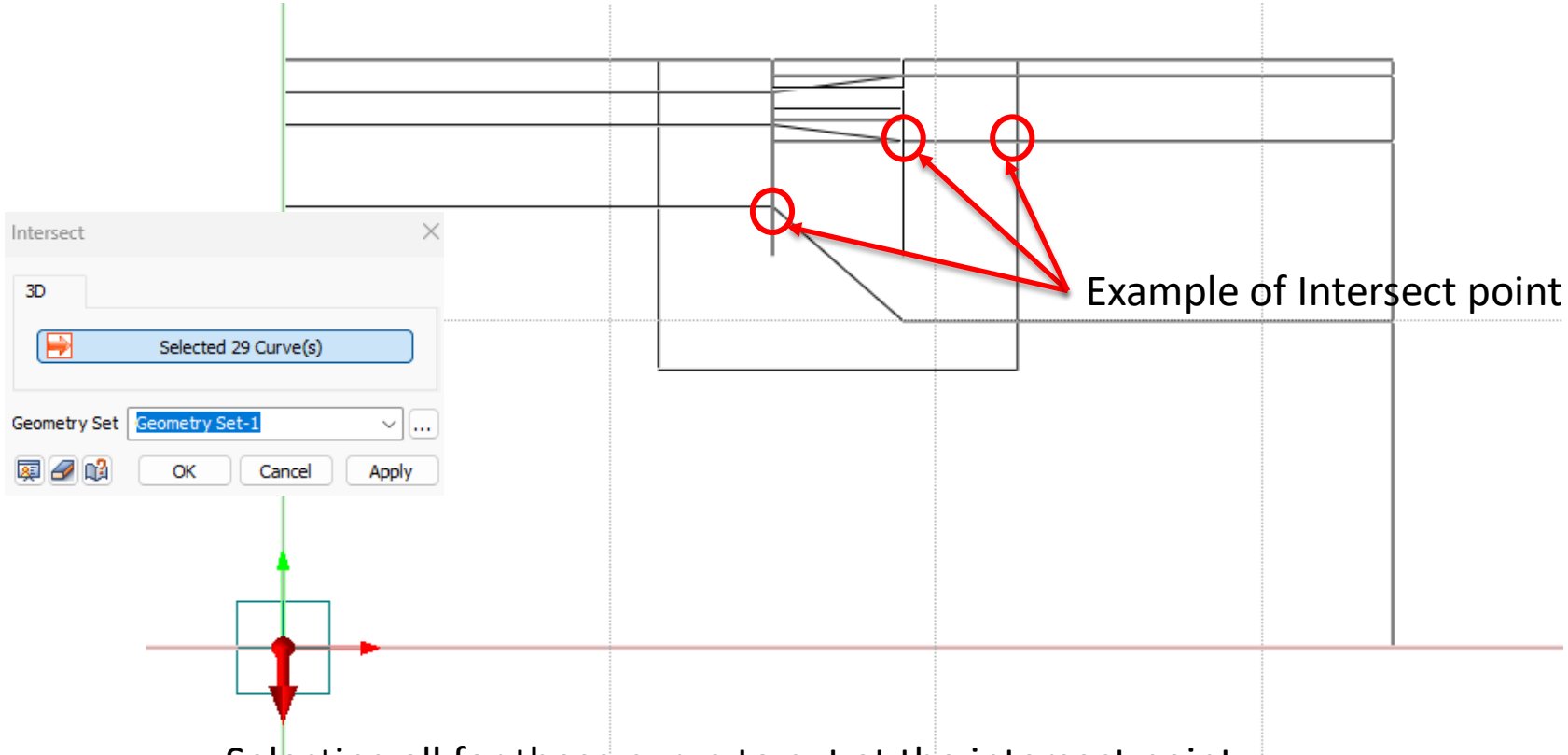






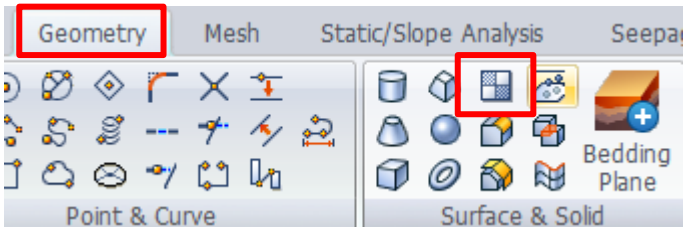
Intersect function



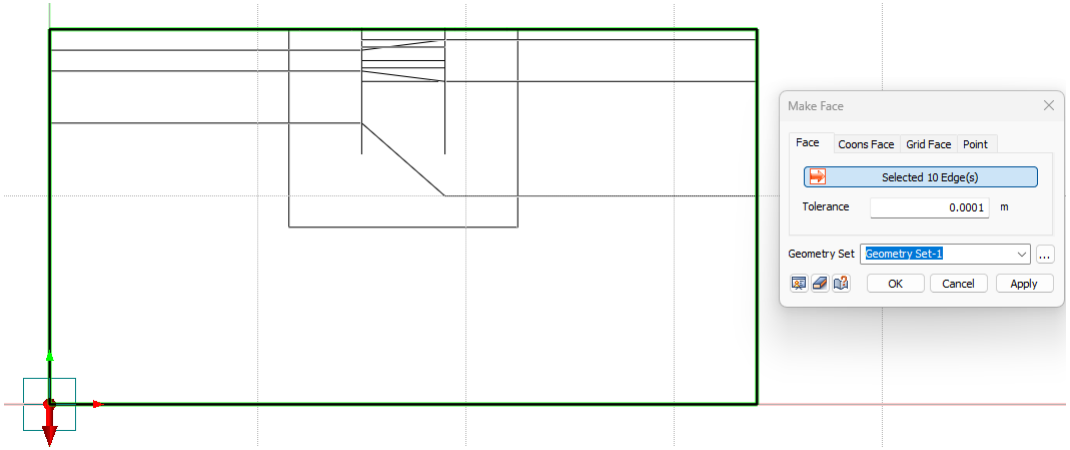


Selecting all for these curve to cut at the intersect point

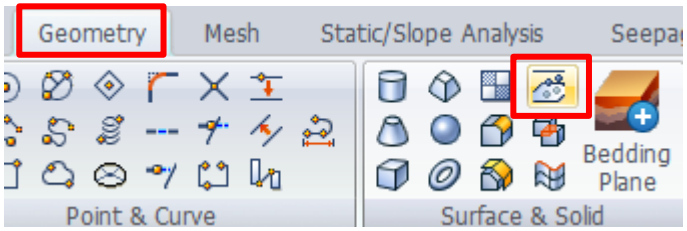
Creating geometry area



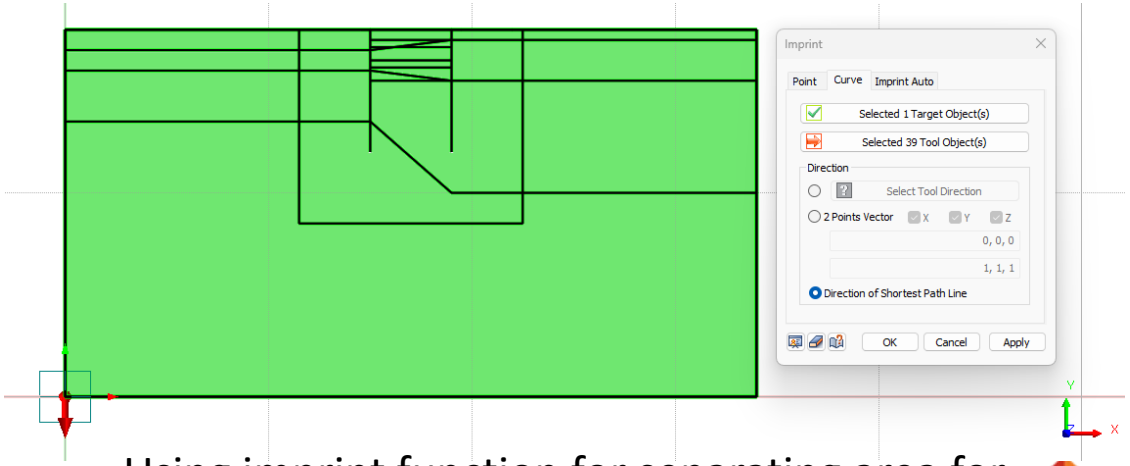
Make face function



Selecting the outside line for 'Target object'

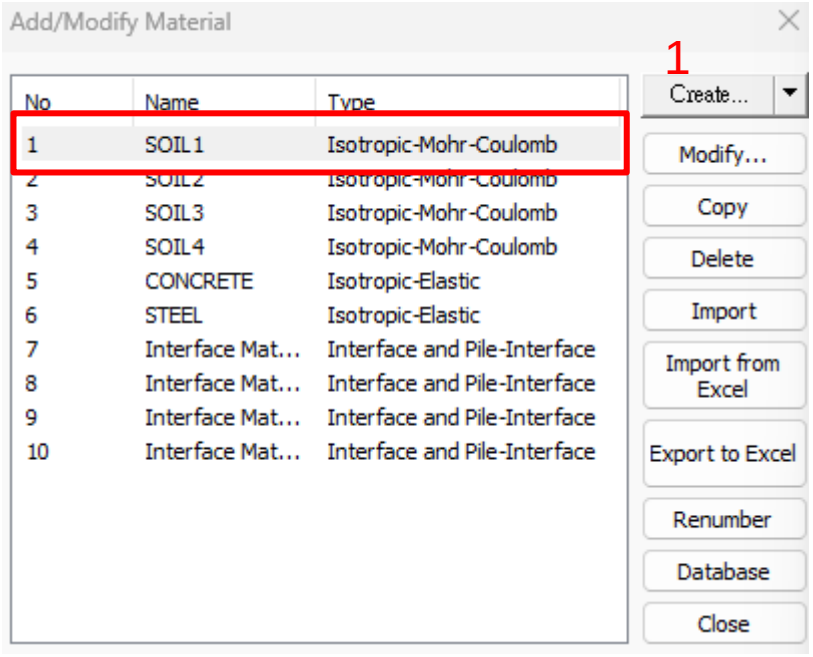


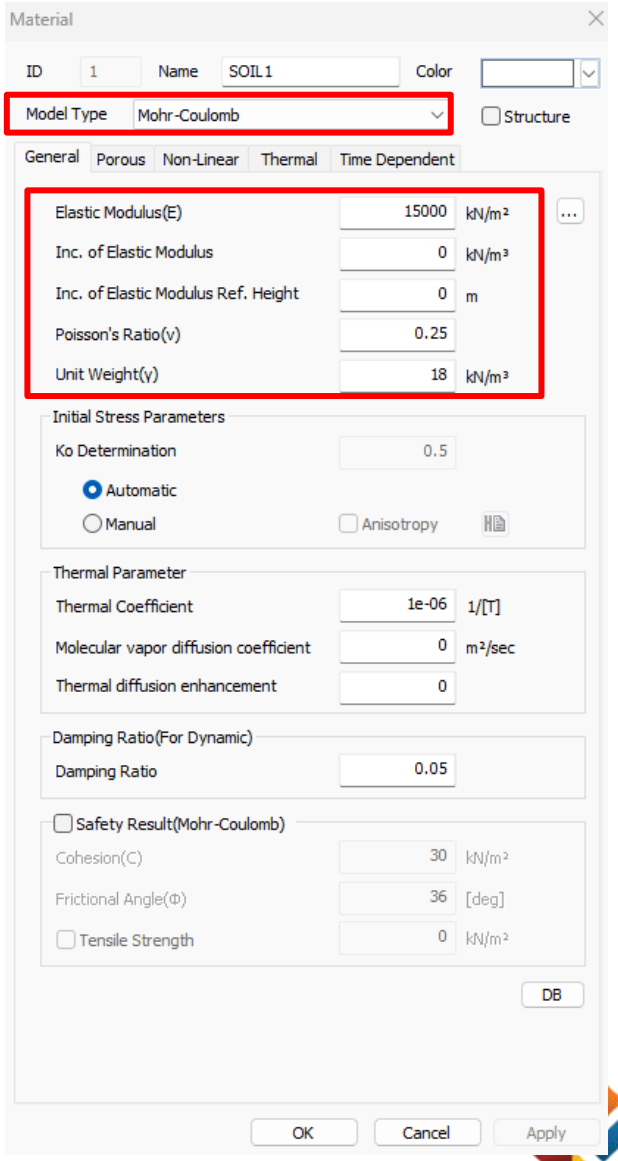
Imprint function

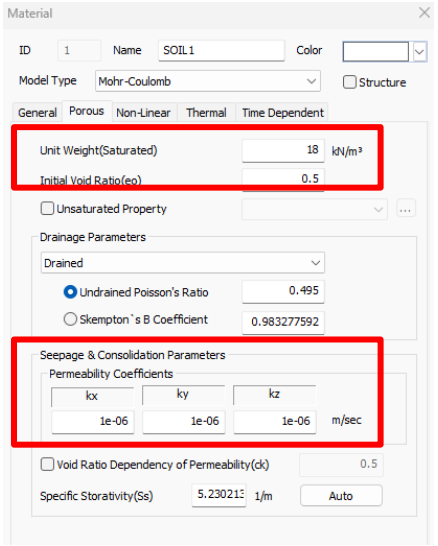


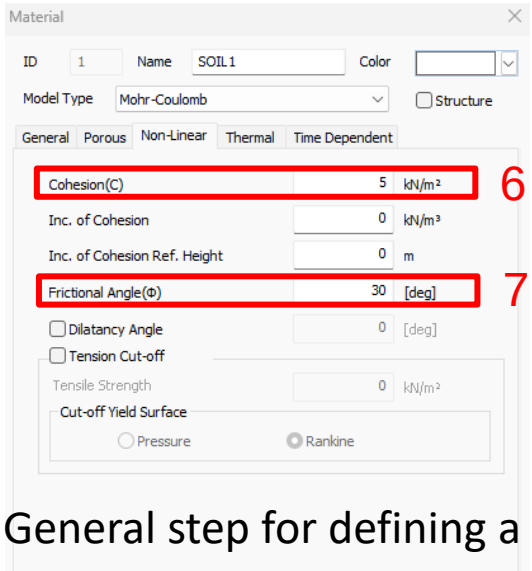
Using imprint function for separating area for the next mesh set step

Soil material



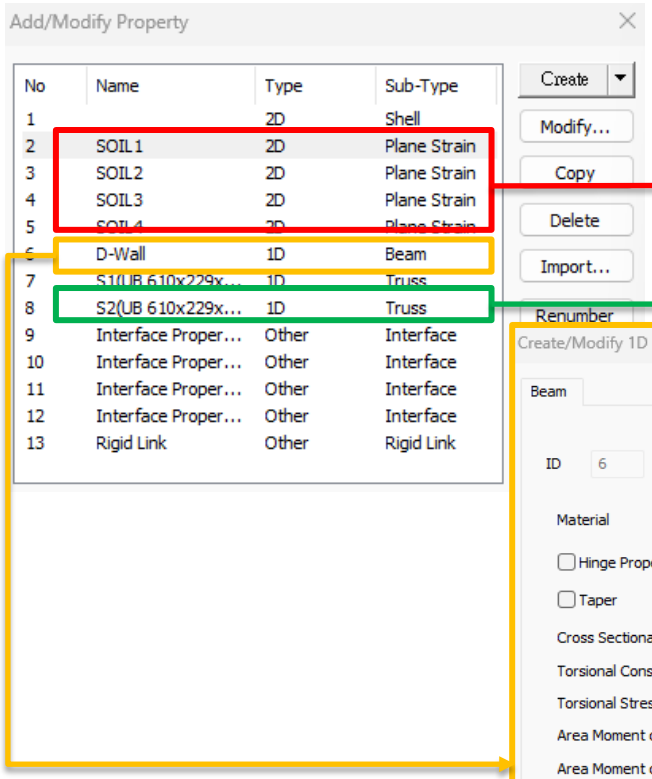


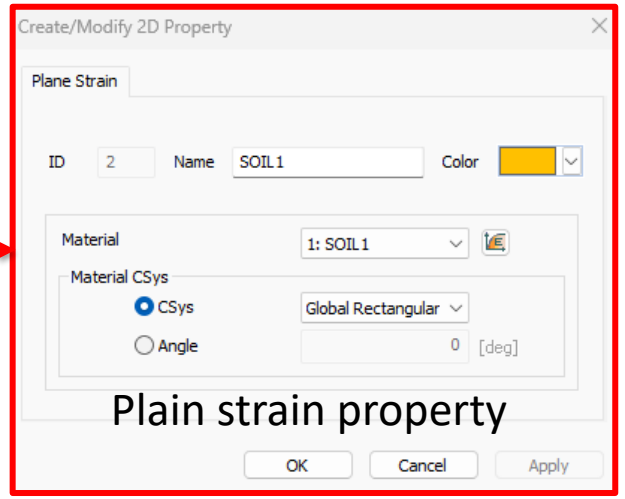




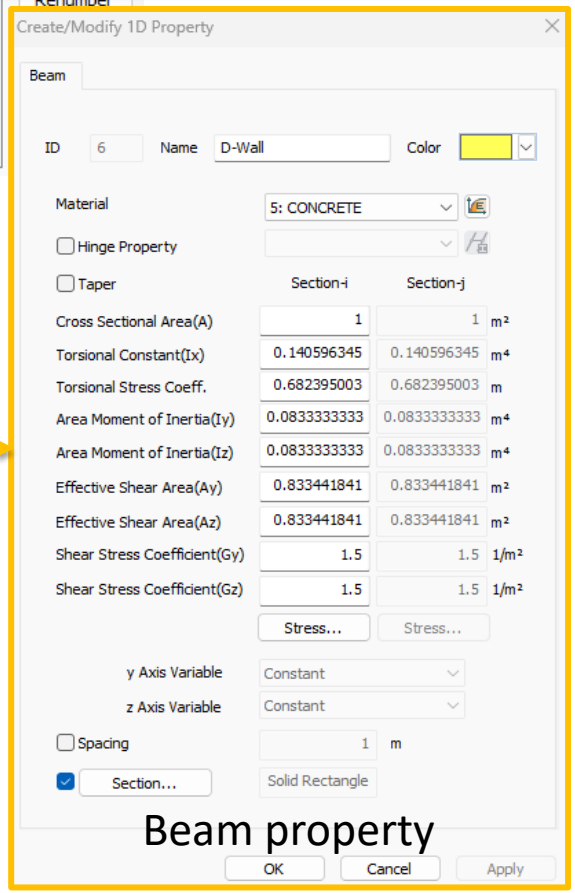
General step for defining a specific soil material

Soil property

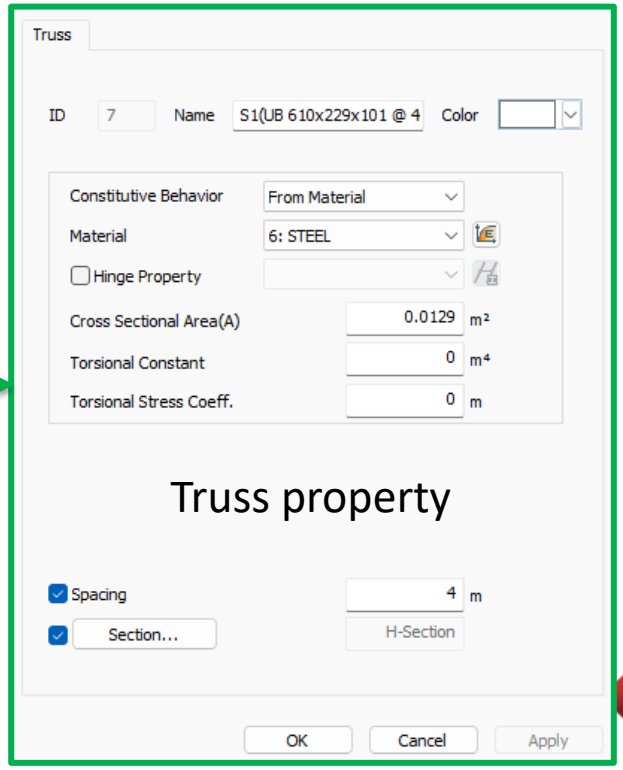




Plain strain property



Beam property



Truss property

Soil property

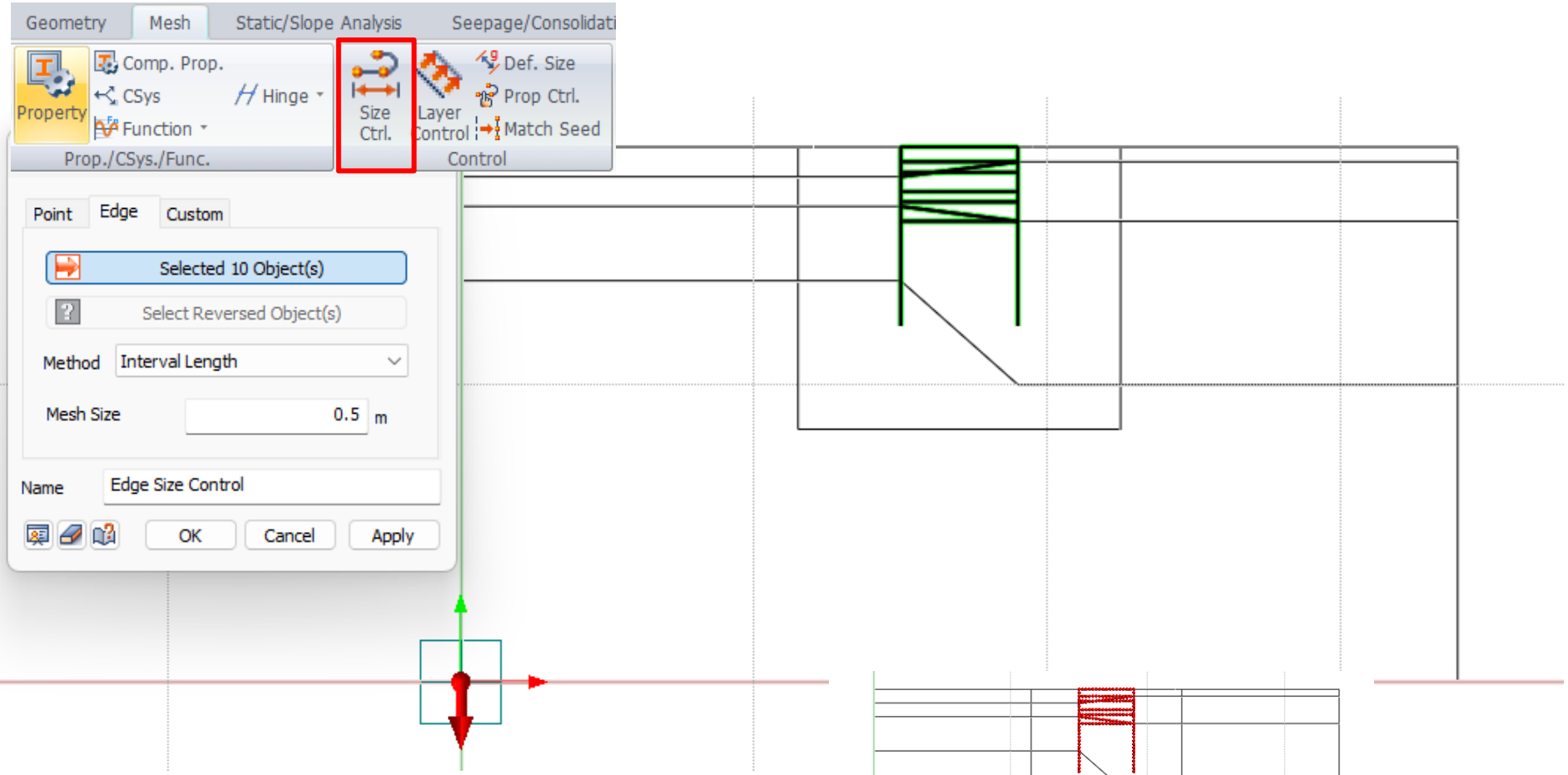
▶ Ground property

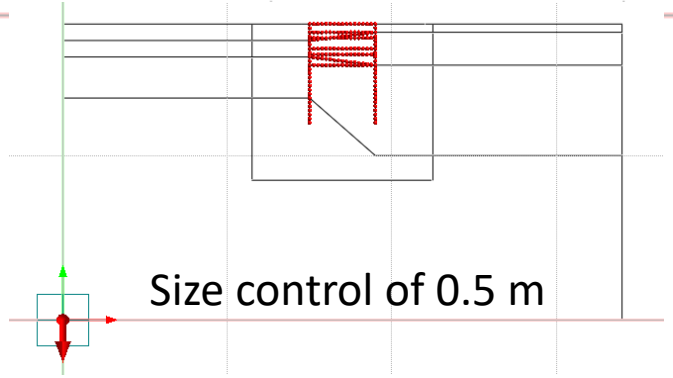
Name	Interface (SOIL 1)	Interface (SOIL 2)	Interface (SOIL 3)	Interface (SOIL 4)	SOIL 1	SOIL 2	SOIL 3	SOIL 4
Type	Other	Other	Other	Other	2D	2D	2D	2D
Model Type	Interface	Interface	Interface	Interface	Plane Strain	Plane Strain	Plane Strain	Plane Strain
Interface Type	Line	Line	Line	Line				
Material	SOIL 1	SOIL 2	SOIL 3	SOIL 4	SOIL 1	SOIL 2	SOIL 3	SOIL 4

▶ Structure property

Name	D-Wall	S1	S2
Type	1D	1D	1D
Model Type	Beam	Truss	Truss
Material	CONCRETE	STEEL	STEEL
Section	Solid Rectangle	H-Section	H-Section
Section Size	1x1m @ 1m c/c	UB 610x229x101 @ 4m c/c	UB 610x229x101 @ 4m c/c

Mesh size control

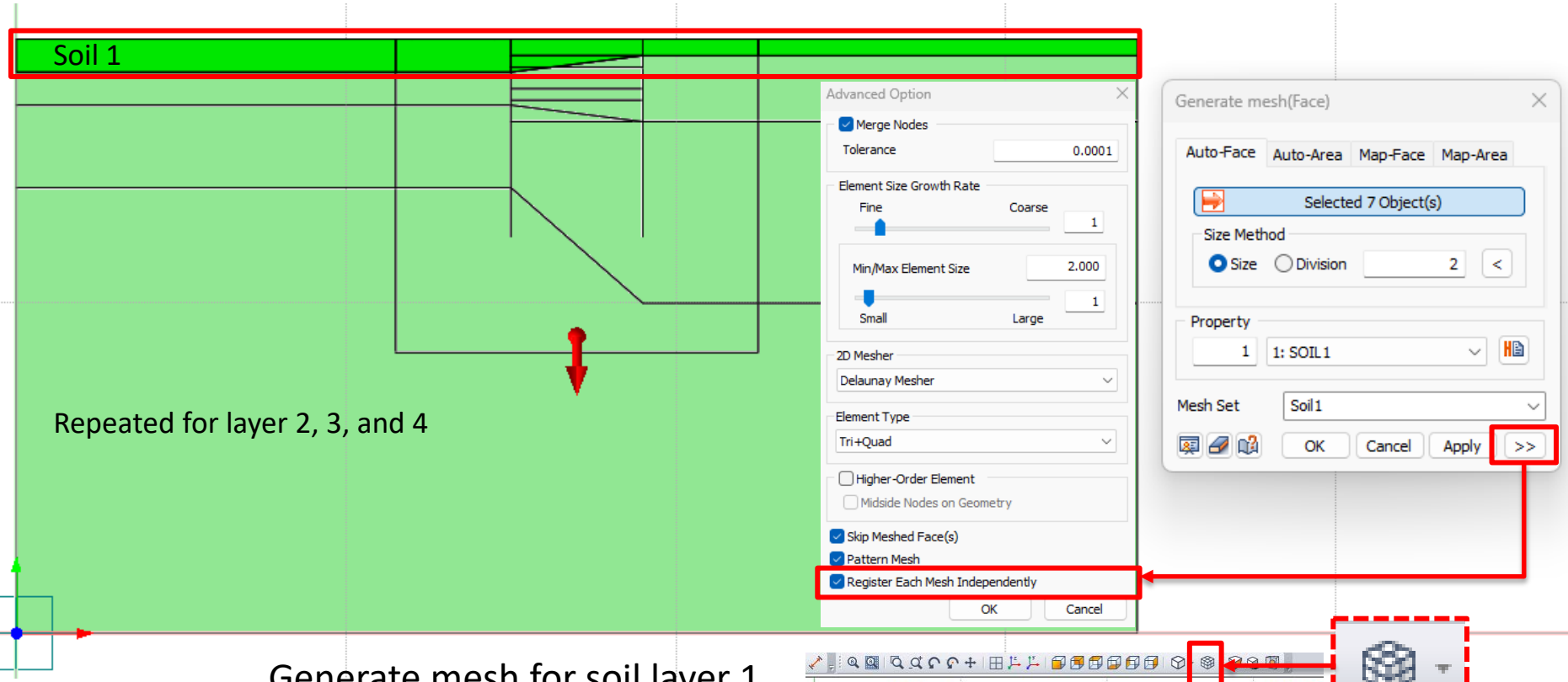




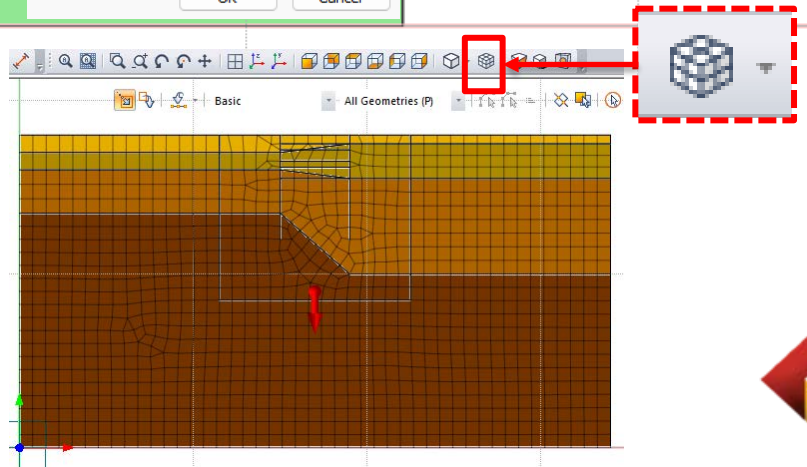
Mesh size control to increase the accuracy in plastic area

Size control of 0.5 m

Generate mesh



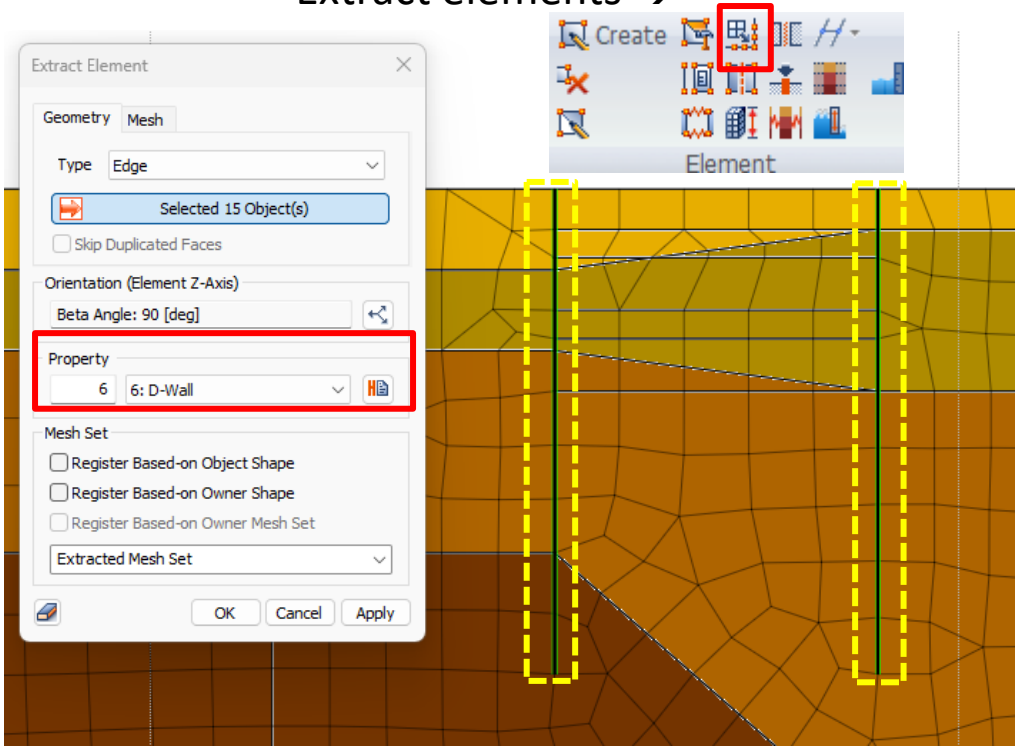
Generate mesh for soil layer 1



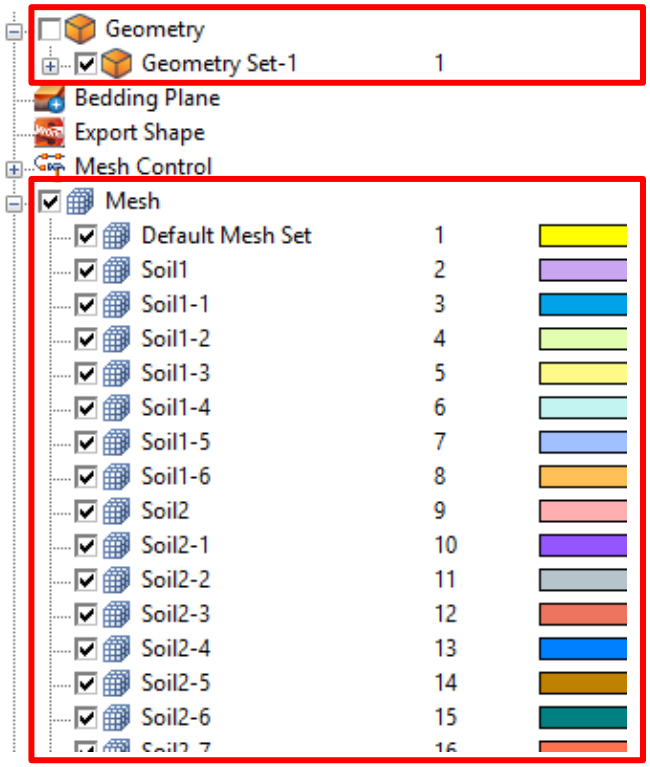
To show ‘Property color’
Display Mode (Mesh) → Property color

Create & Extract elements

Extract elements →



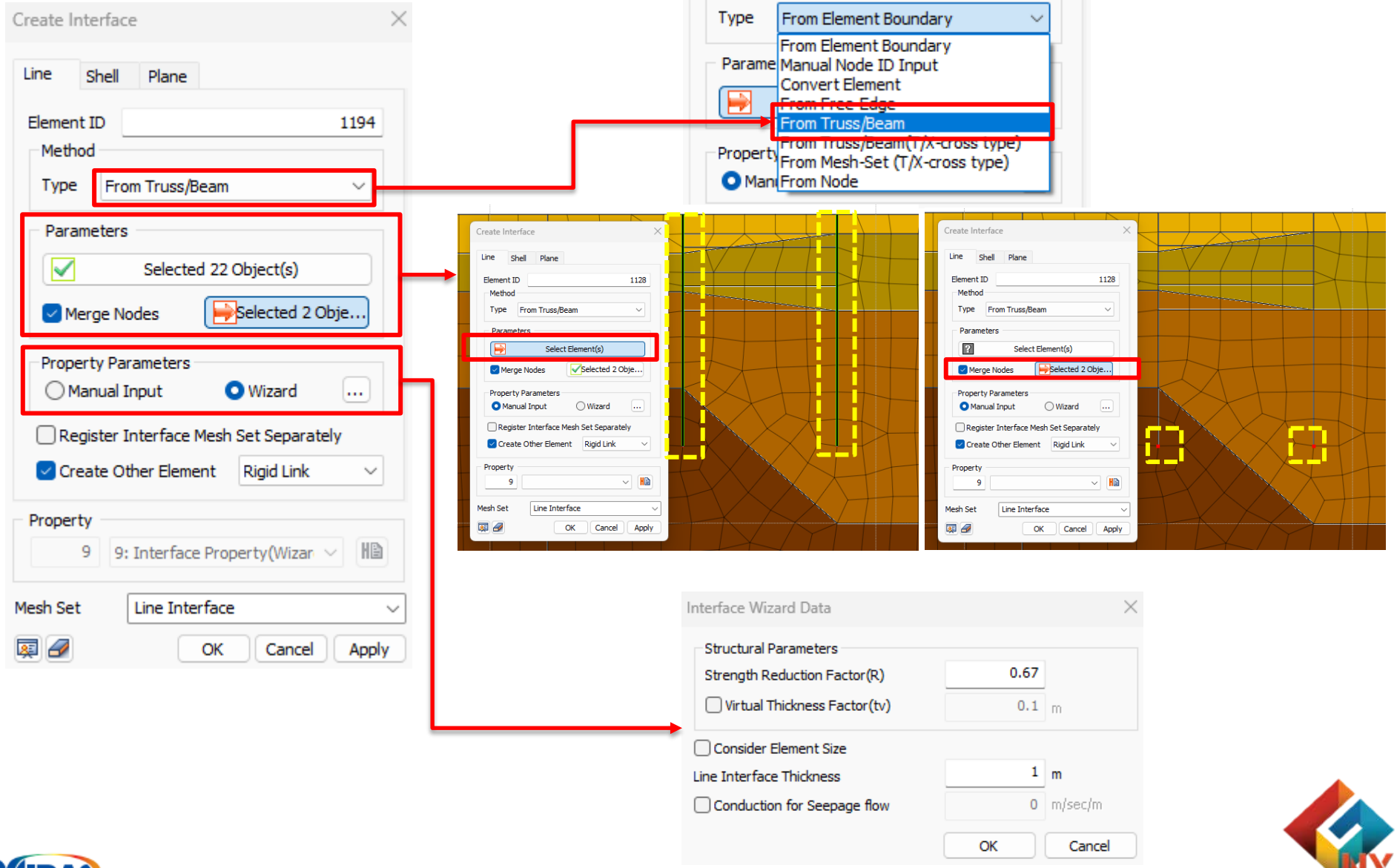
‘Extract elements’ for retaining wall



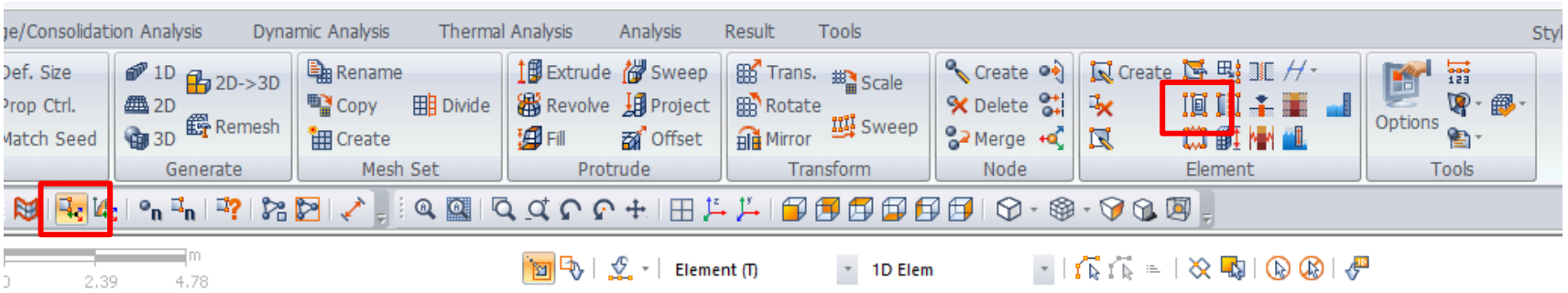
Note: By using the ‘Extract Elements’ function, there is needed to open geometry and corresponding mesh set

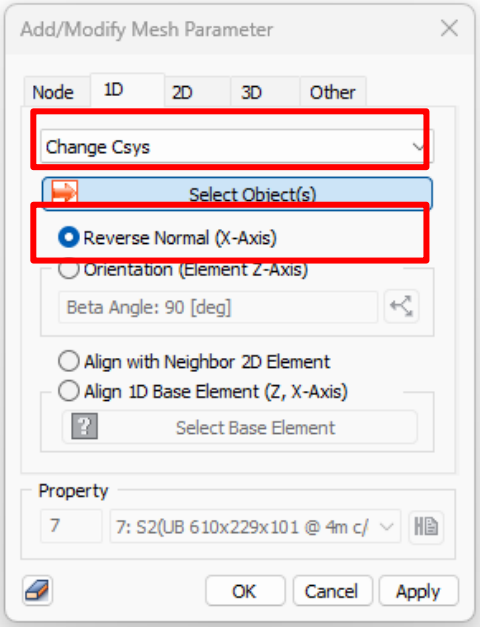
Create interface element

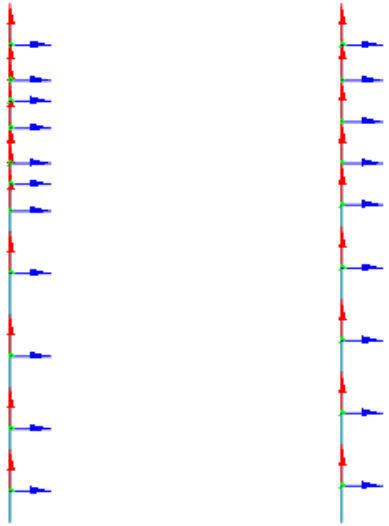
(Wizard interface)



Adjusting the RW local axis

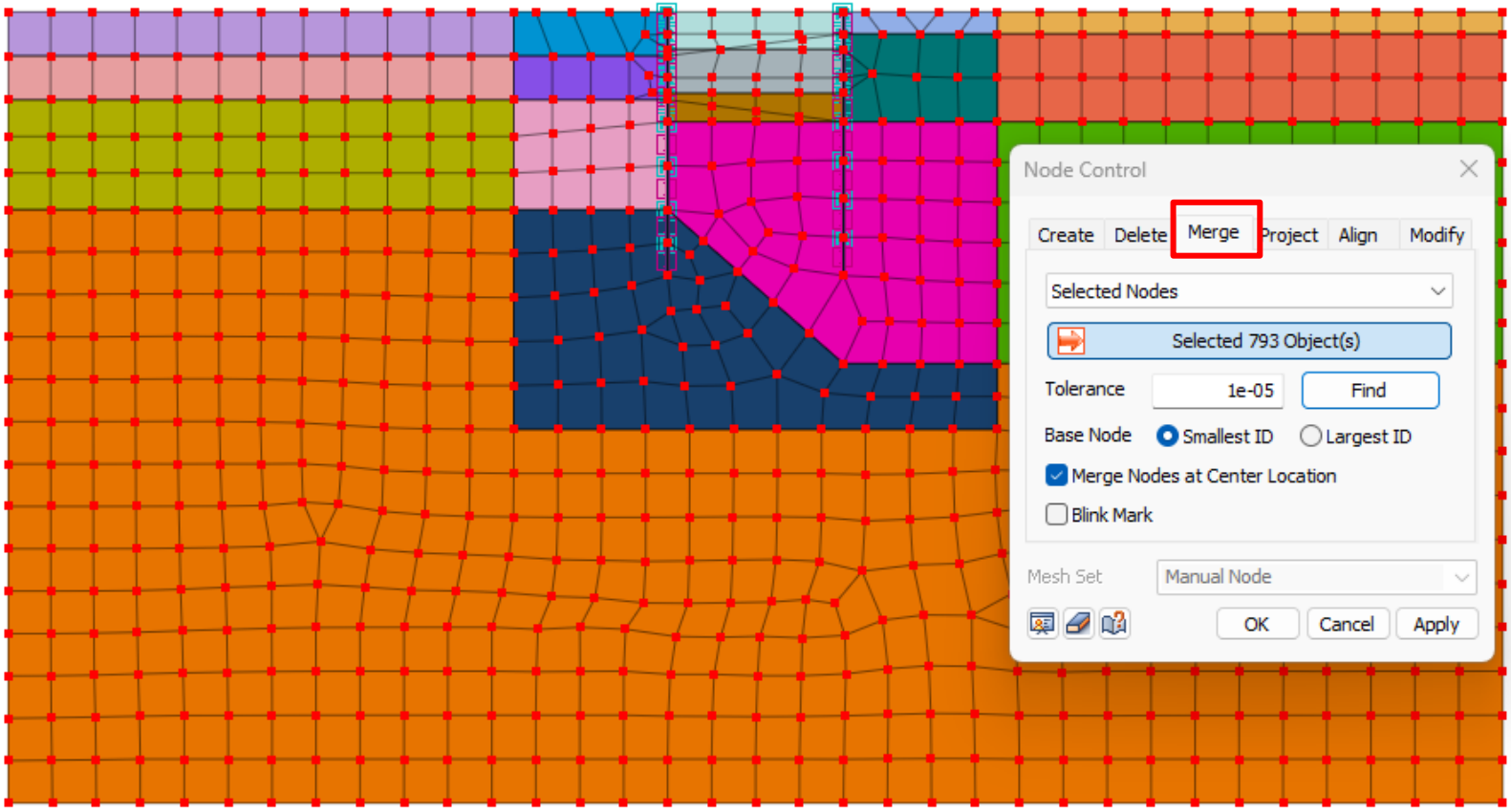






Changing the axis of the local retaining wall axis

Merge node

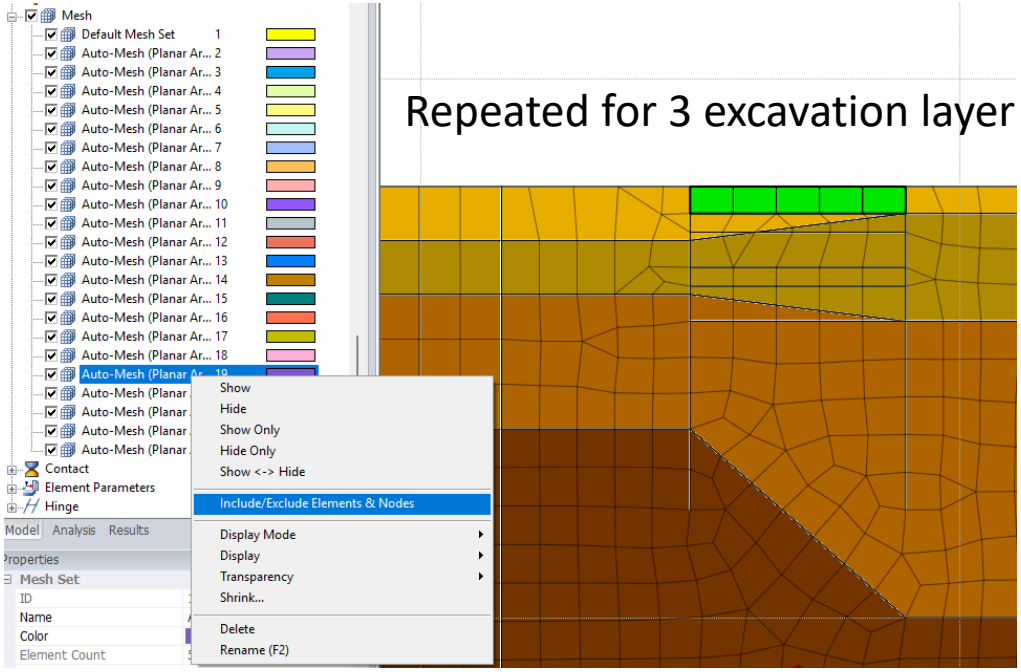


Checking the merge node function for interface

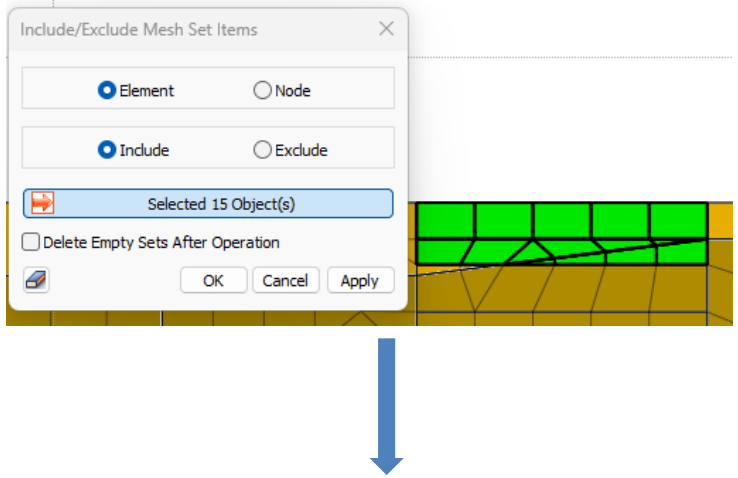
Selecting all nodes → Mesh → Node → Merge → Find

Group mesh set

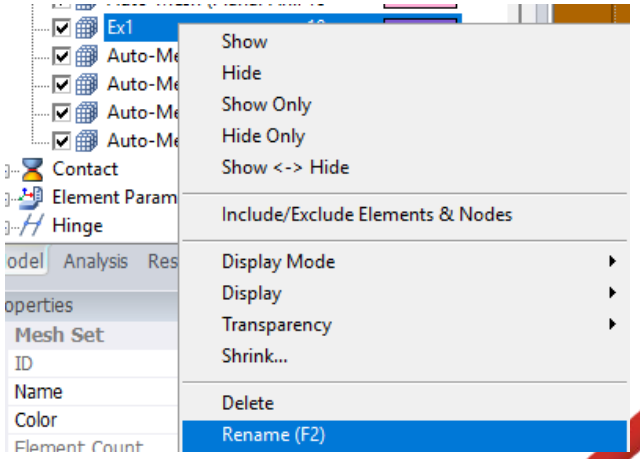
Model tree



Repeated for 3 excavation layer

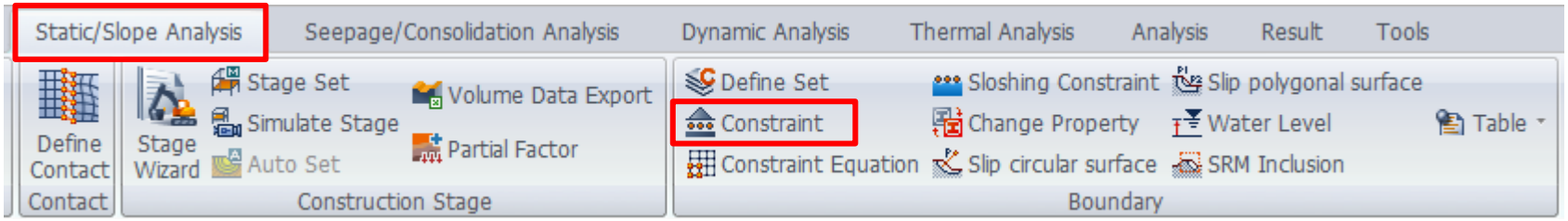


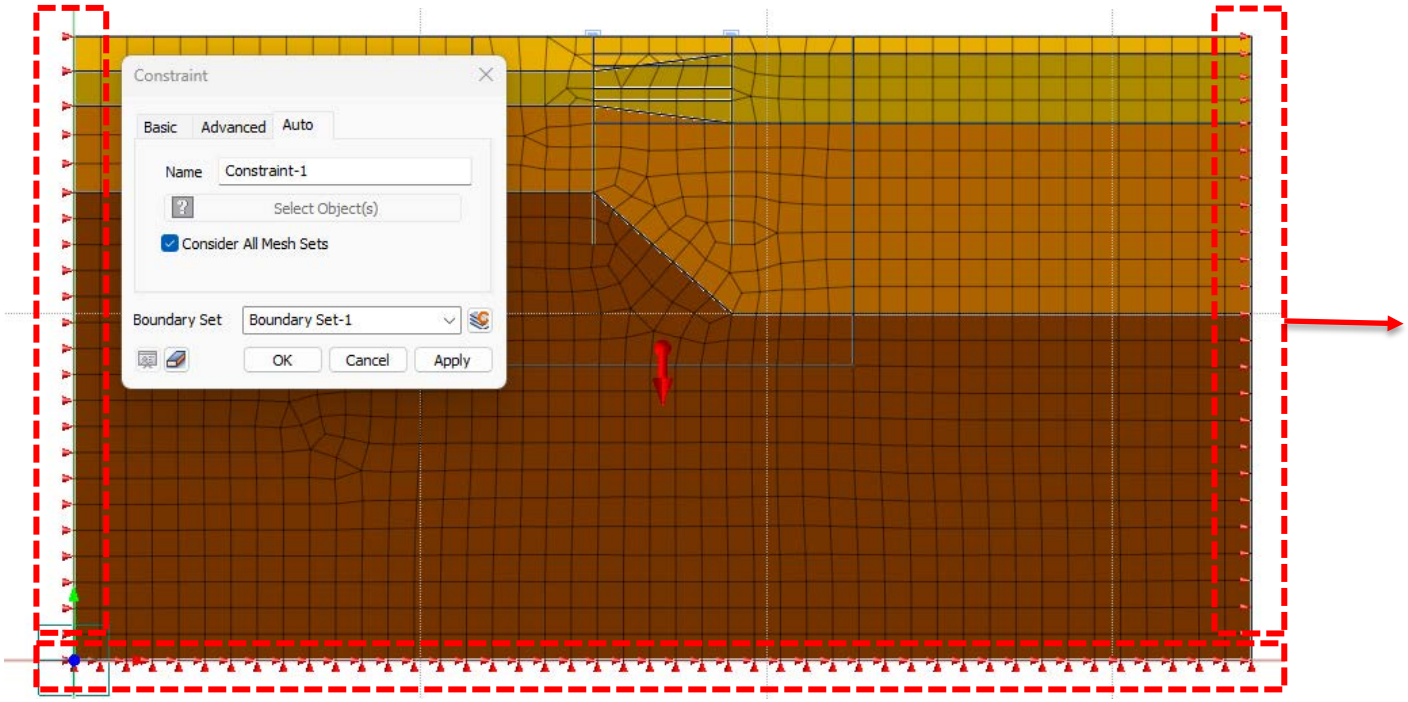
Selecting ‘Include/Exclude Elements & Nodes’



Rename the group mesh set to control the excavation layer

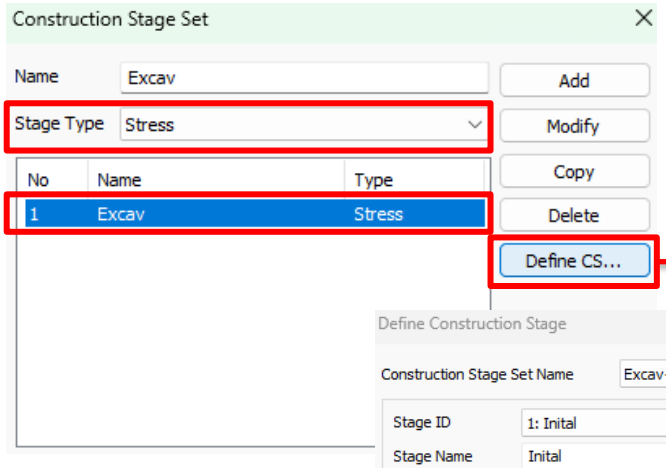
Boundary condition





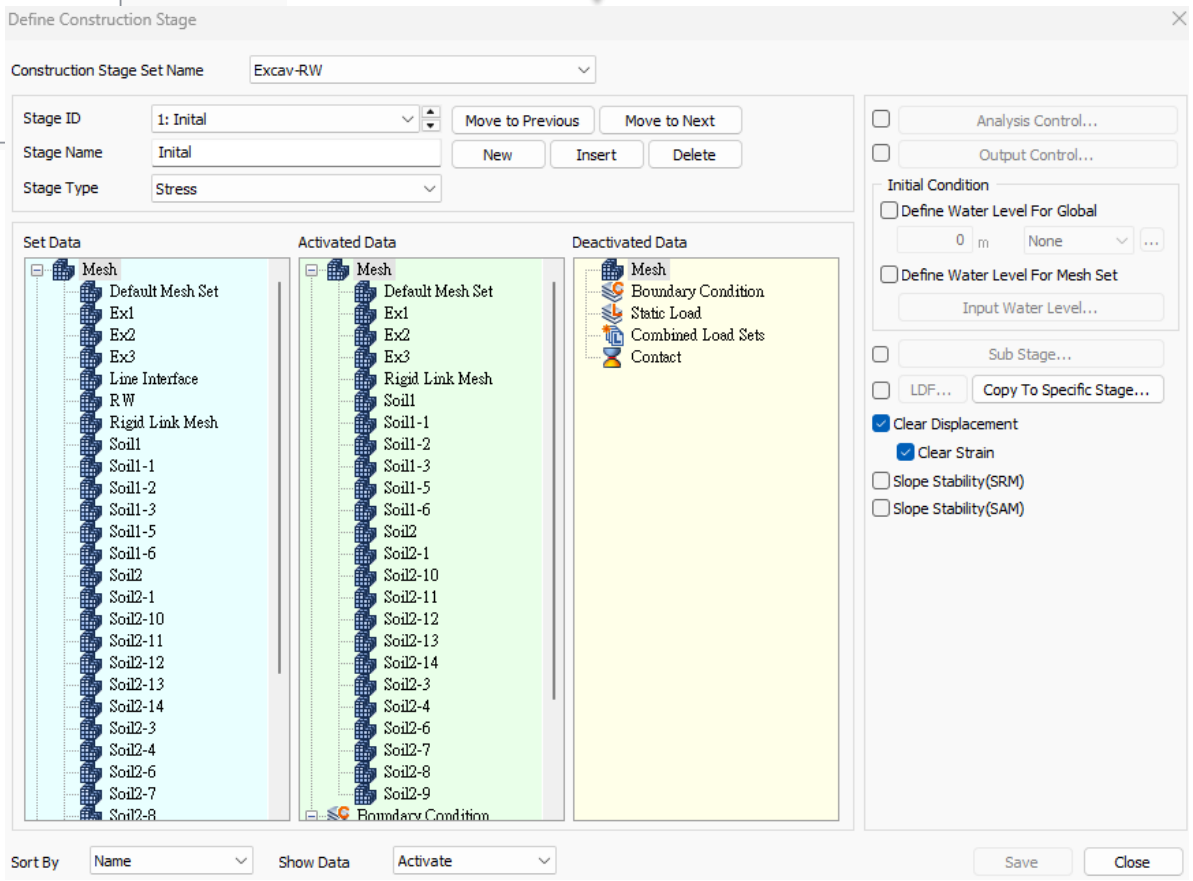
Creating a 2D boundary condition

Construction stage set

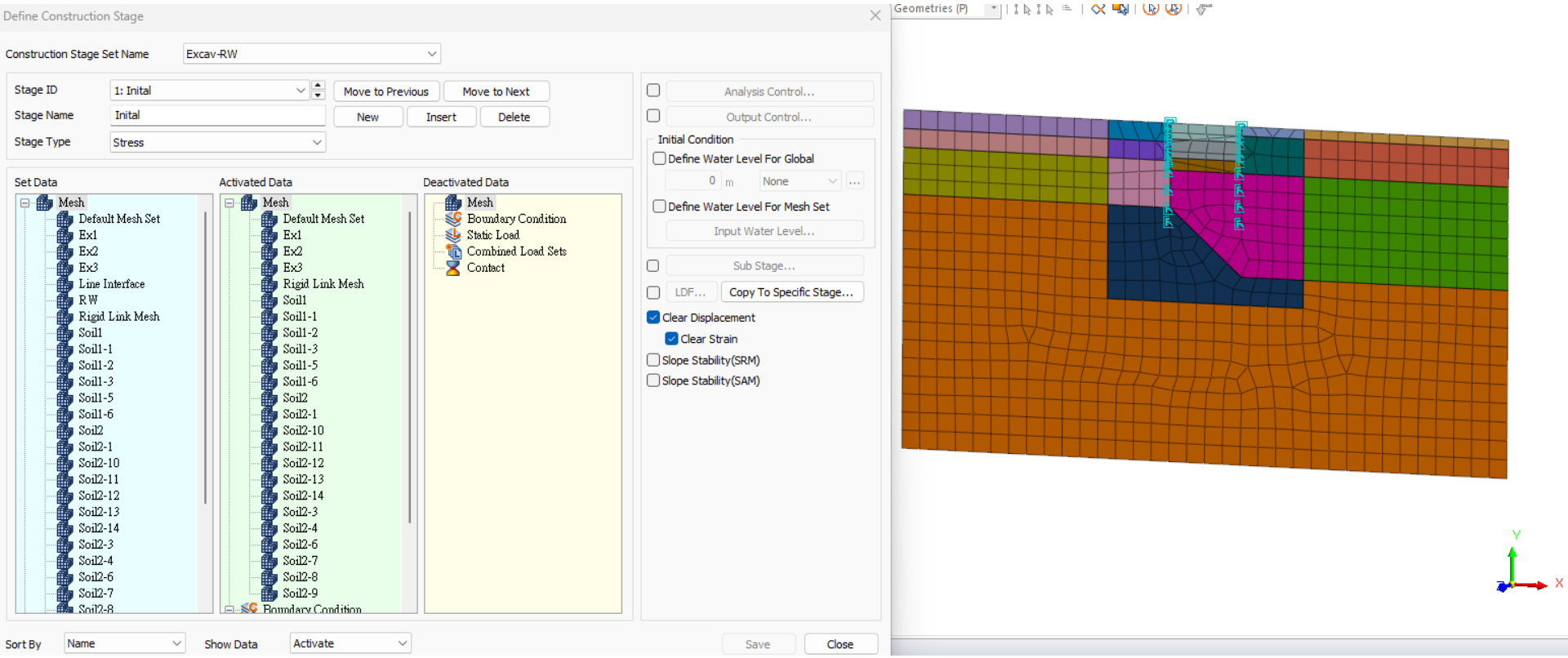


Define construction stage:

Stage Name → Set Data → Initial condition → Save → New

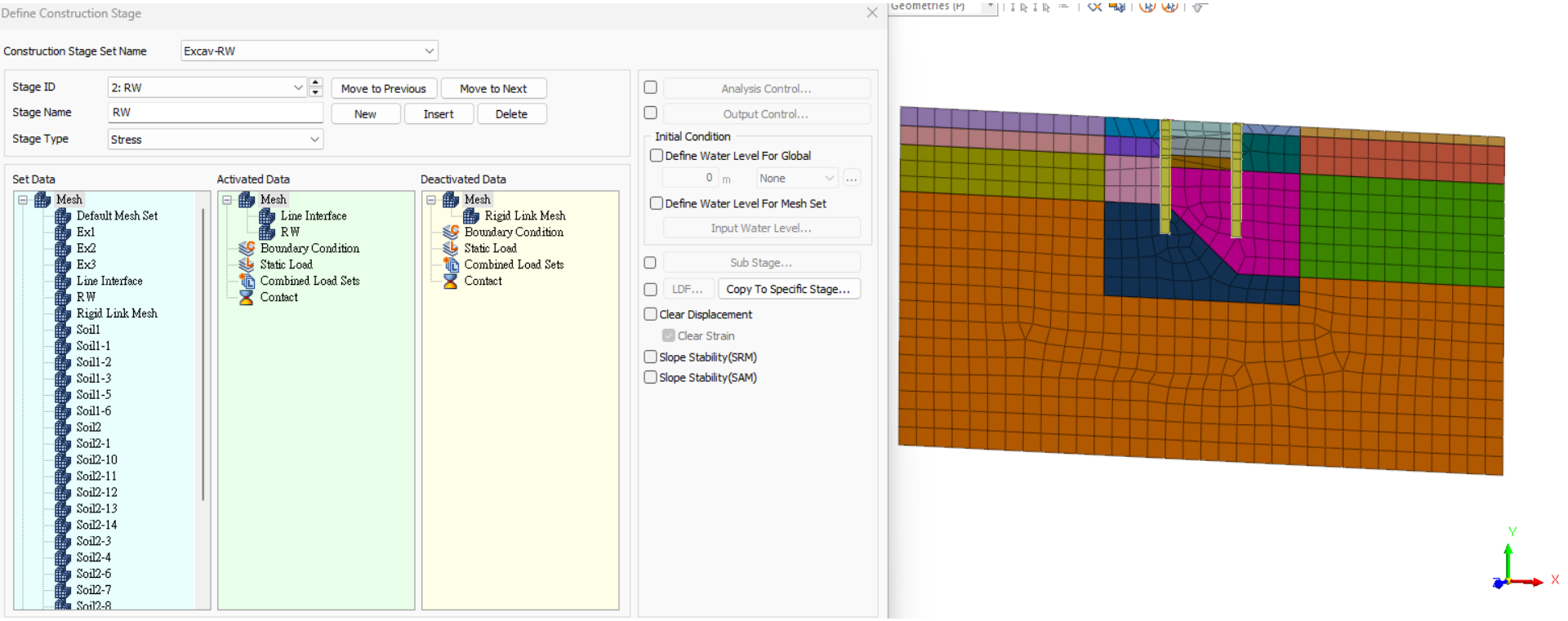


Stage 1. Initial



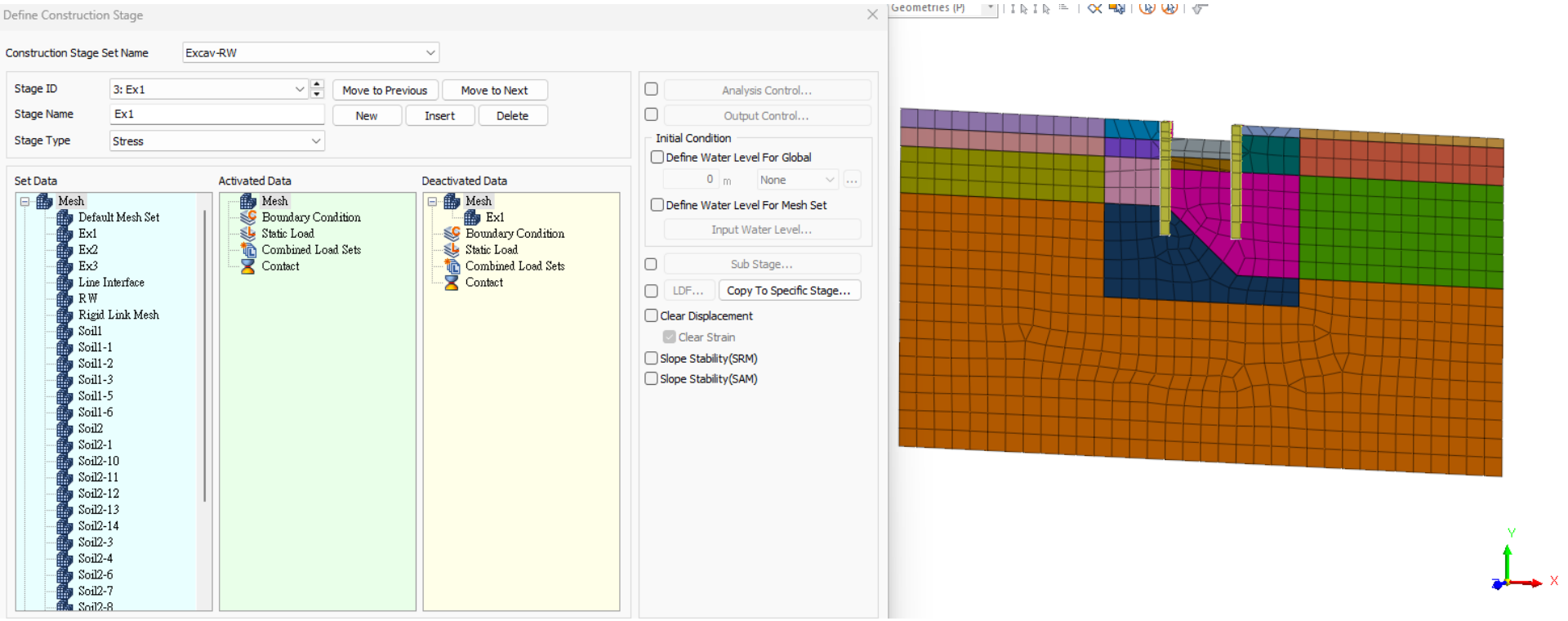
Stage 1. Input the initial condition

Stage 2. Install RW



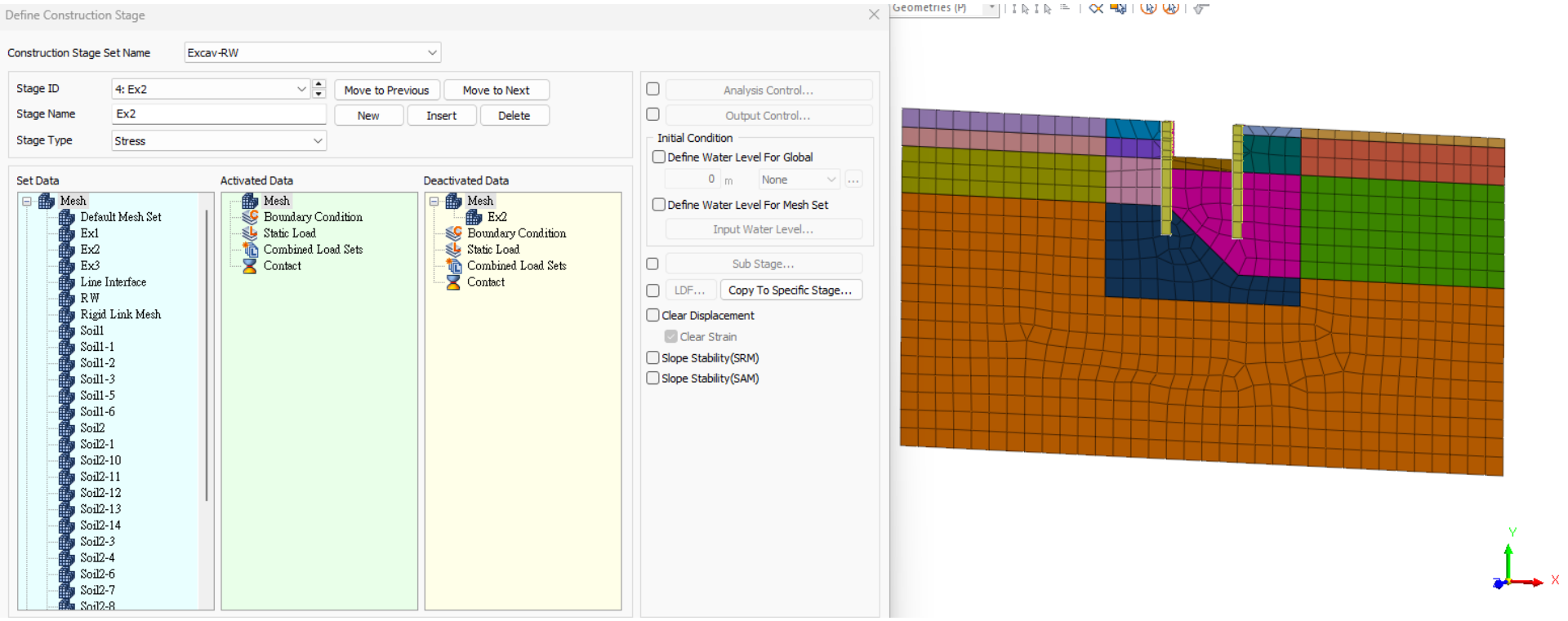
Stage 2. Install the retaining wall

Stage 3. Excavation for layer 1



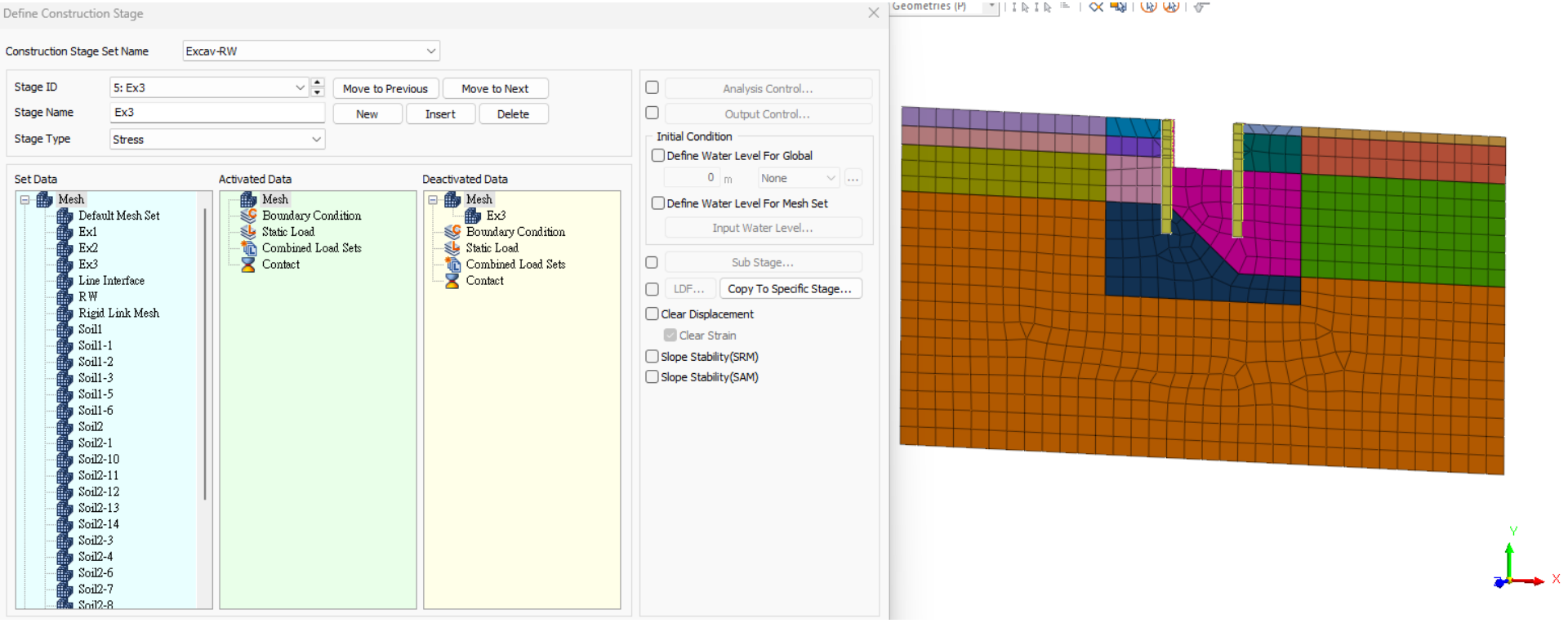
Stage 3. Excavation for layer 1

Stage 4. Excavation for layer 2



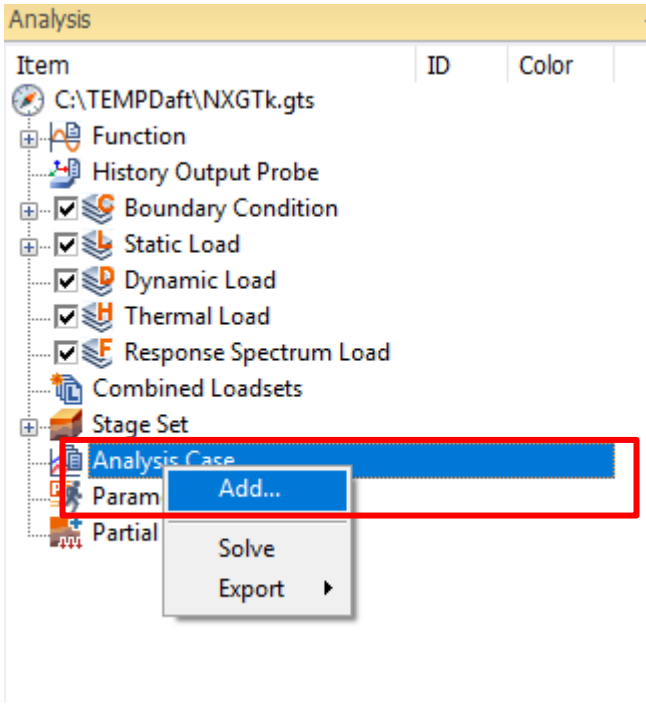
Stage 4. Excavation for layer 2

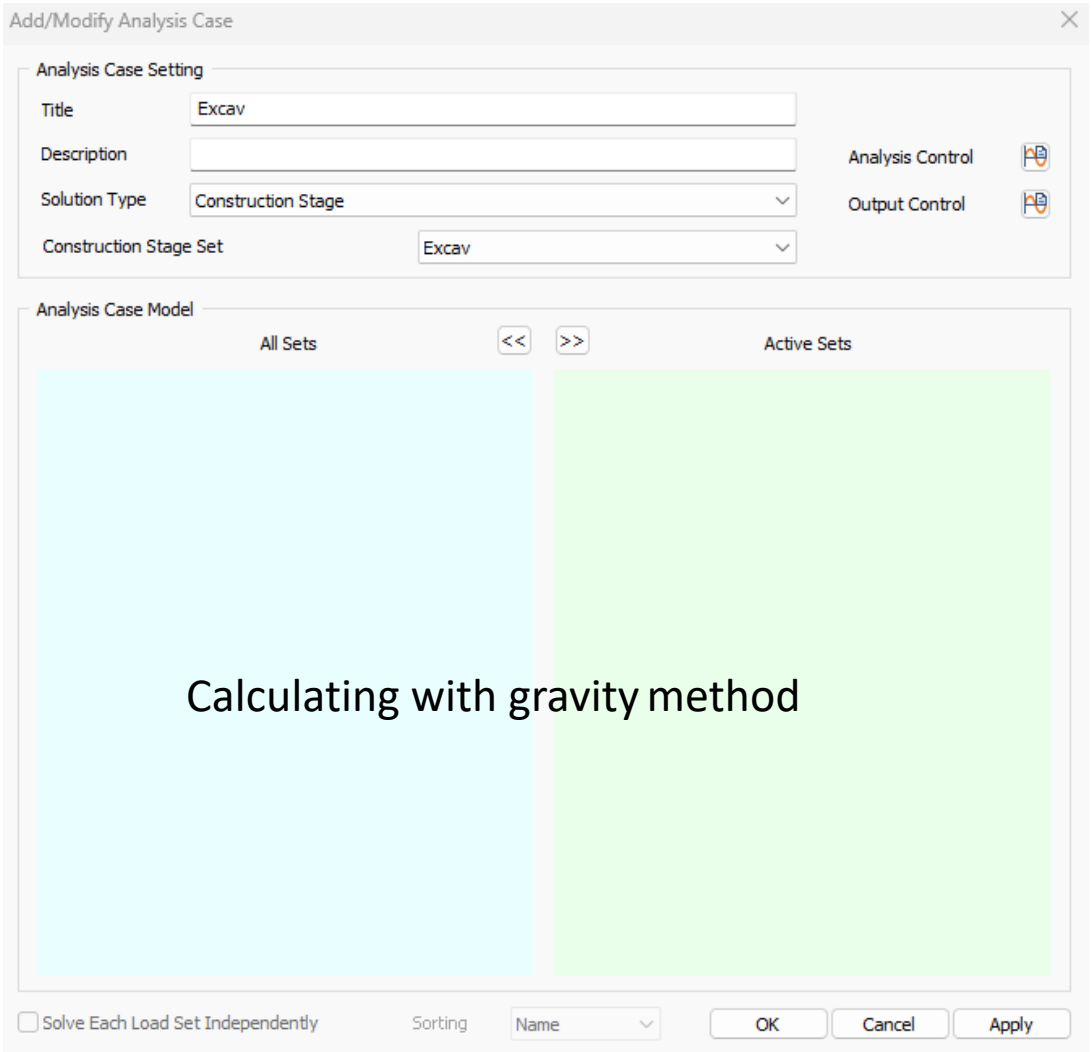
Stage 5. Excavation for layer 3



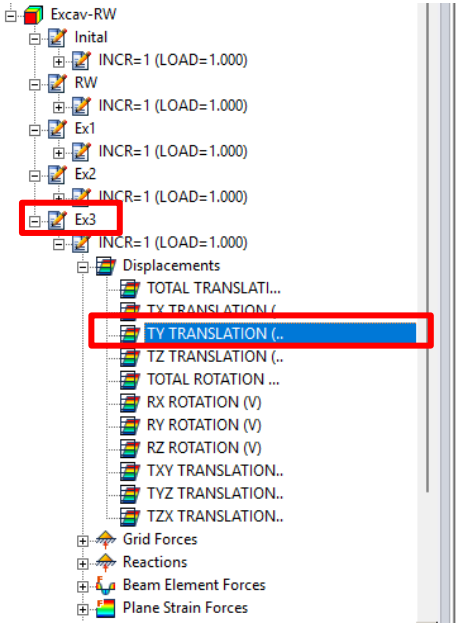
Stage 5. Excavation for layer 3

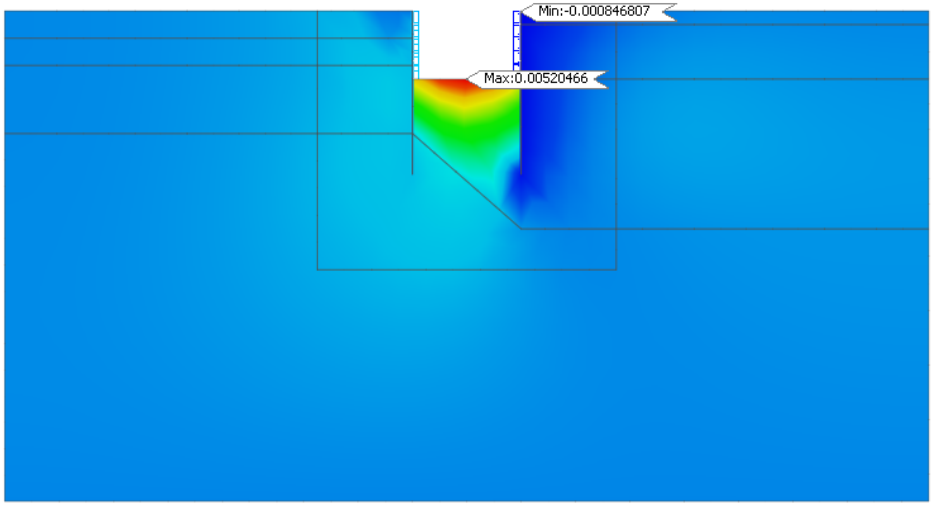
Analysis control



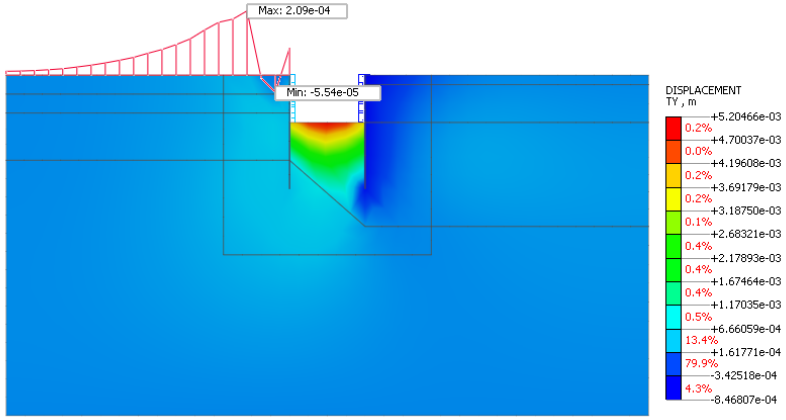


Result – Vertical displacement

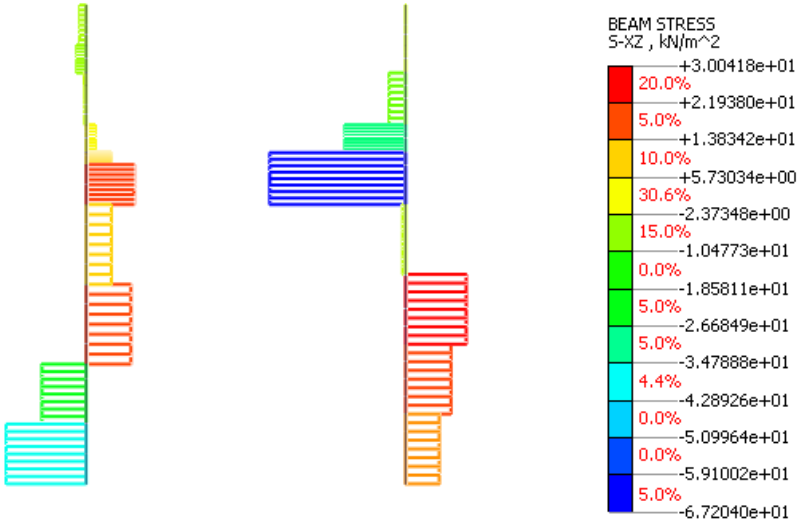




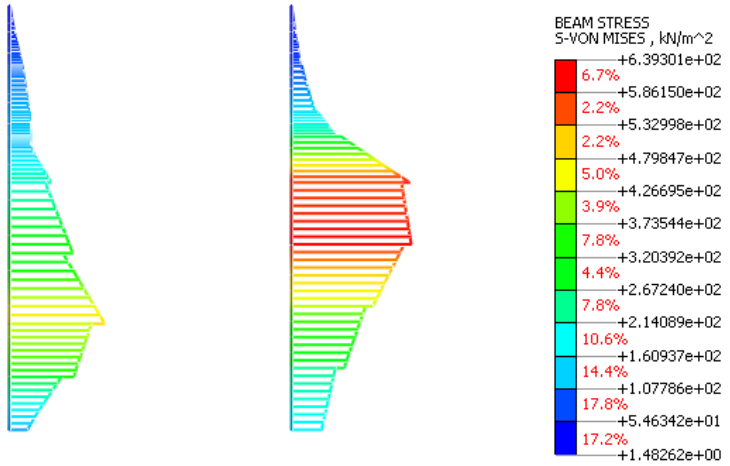
Result → Advanced → Cutting Diagram



Result – Forces in RW



Shear force in RW
(Beam stresses → S-XZ)

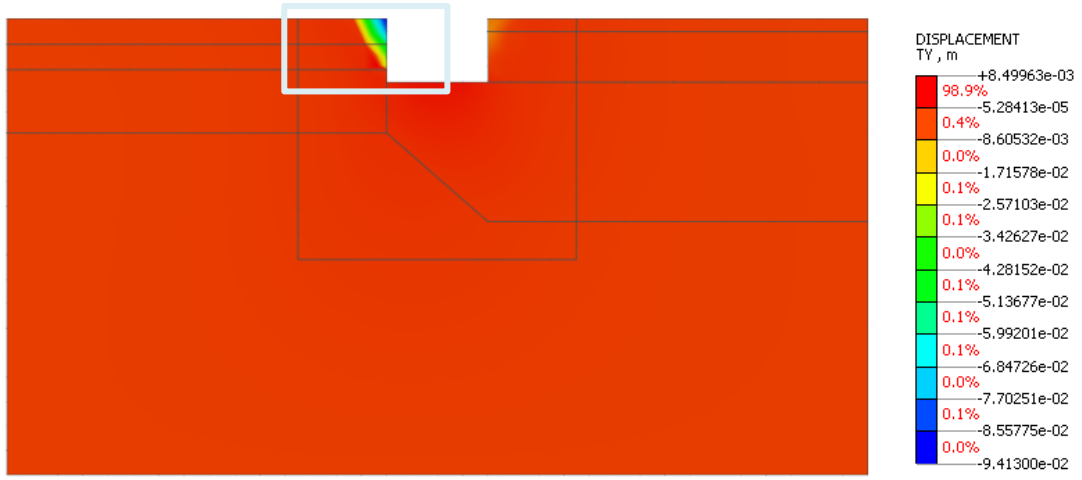


Bending moment in RW
(Beam stresses → S-VON MISES)

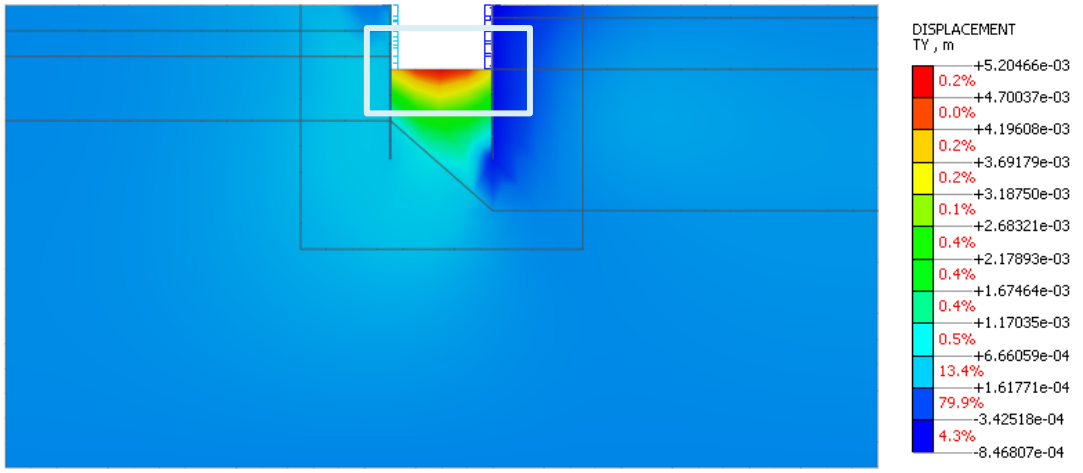
Result – Comparison

(Displacement with & without RW)

Total displacement without RW



Total displacement with RW



→ There is a change in maximum displacement due to the installation of the retaining wall


Thank you!

GTS NX
3D Excavation with Retaining System

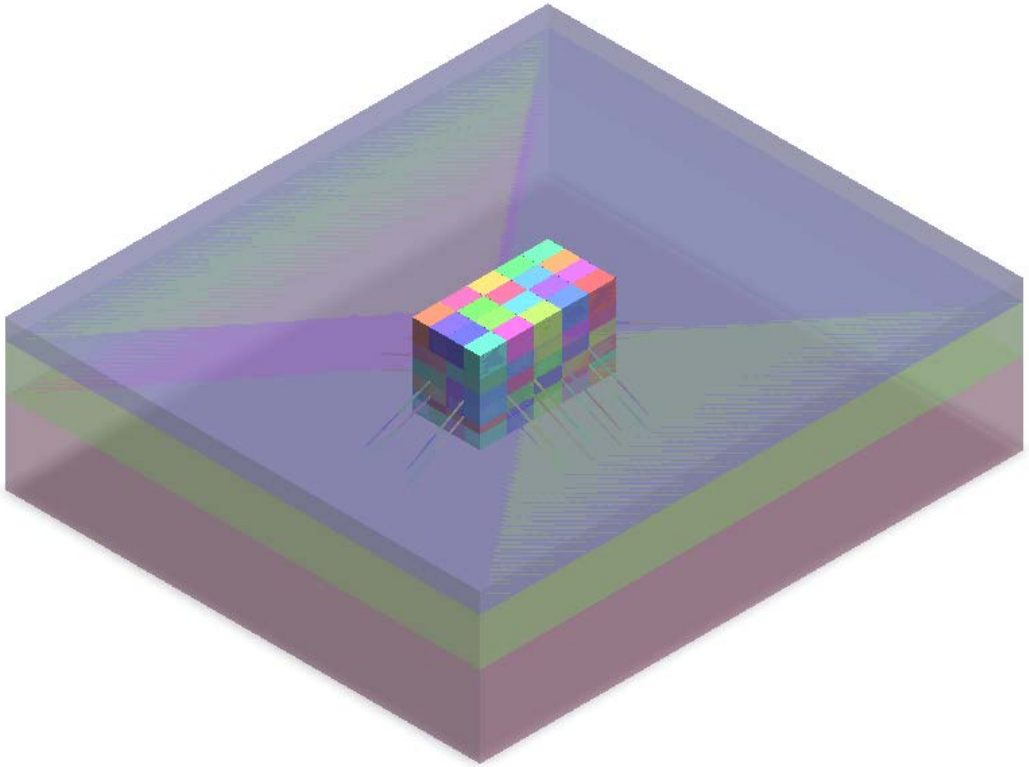
Lesson 02

Midas Taiwan

Reference: Midas GTX NX Tutorials

Project case overview

GTS NX
Geo-Technical analysis System New eXperience

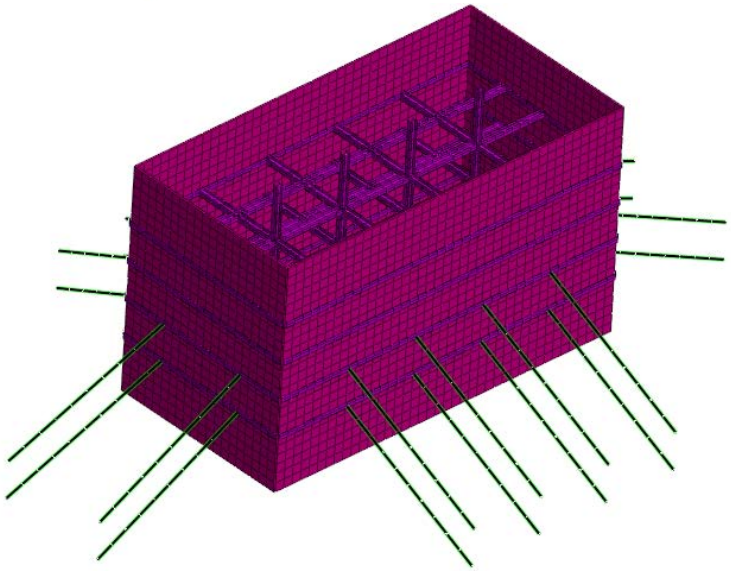


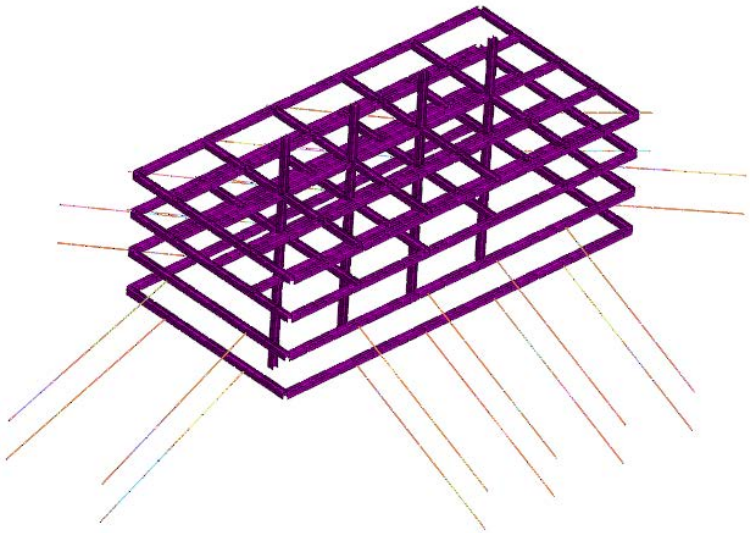
Project overview:
Rectangular Excavation : 10 x 20m
Depth: 12m

Soil Property Overview:
3m of Buried Layer
7m of Colluvium
12m of Weathering soil

Project case overview

GTS NX
Geo-Technical analysis System New eXperience





Structural Elements Overview:

1. Retaining Wall - All throughout the excavation faces
2. King Post - 4 pcs laid along the centerline of the longitudinal distance
3. Prestressed Anchors - 8 pcs per longitudinal face; 4 pcs per transverse face
4. Braces - 4 sets starting from the first excavation layer
5. Struts - 2 sets starting from the first excavation layer

Design Flow

GTS NX
Geo-Technical analysis System New eXperience

Pre-processing

1. Geometry / Model setup
2. Material and Properties
3. Boundary Conditions
4. Mesh generation
    - Geotechnical elements
    - Structural Elements

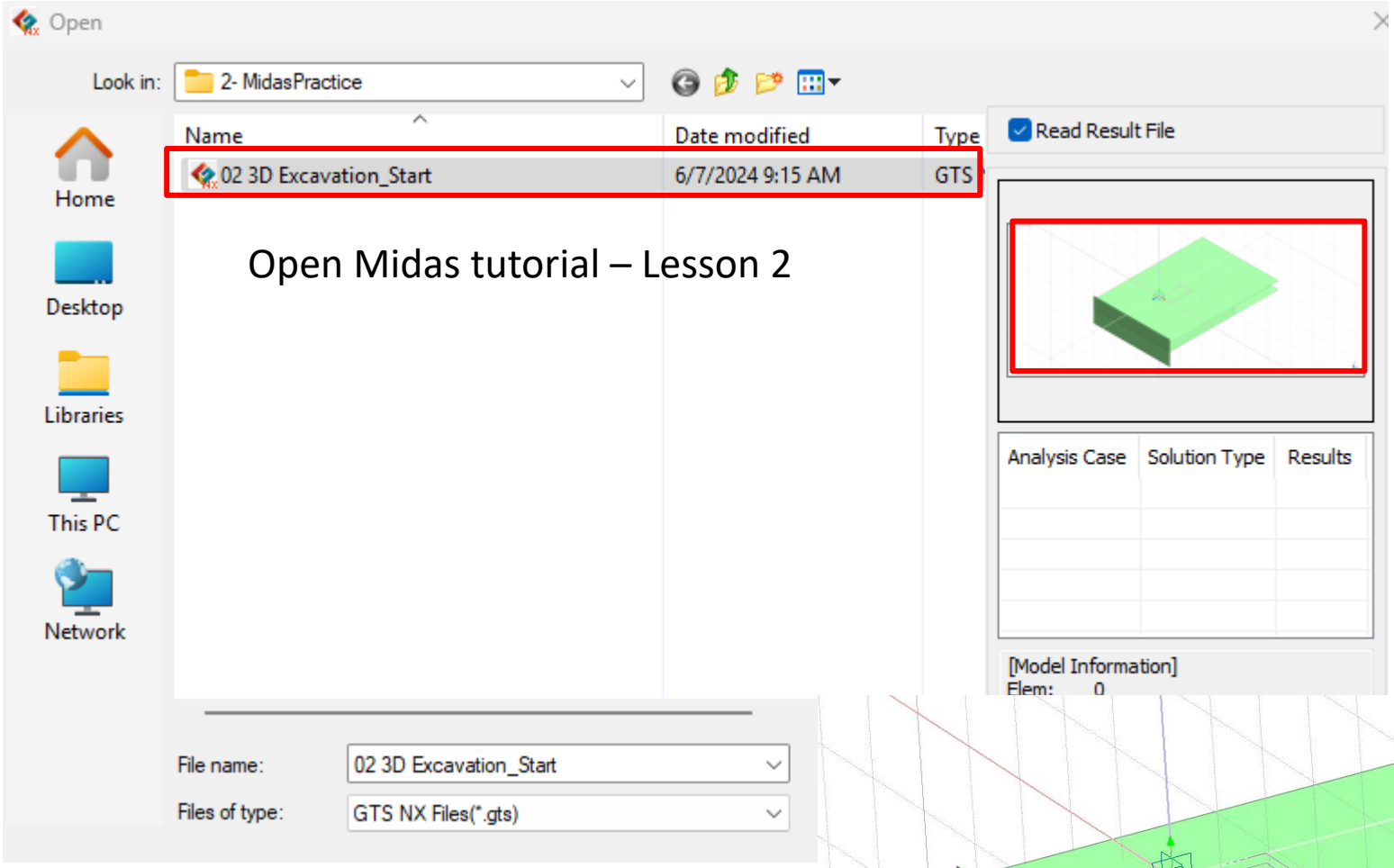
Solving

1. Analysis Case
    - Linear
    - Non-linear
    - Construction Stage
    - Slope Stability
    - Etc.
2. Stage Sets
3. Analysis Control Settings
    - Dynamic settings
    - Thermal settings
    - Age settings
    - Non linearity
    - Etc.

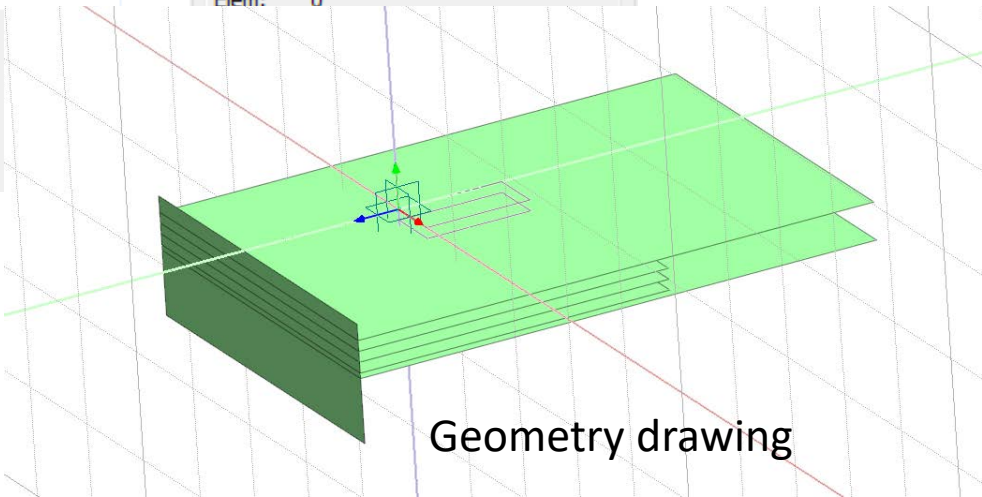
Post Processing

1. Data Validation
2. Result Interpretation
3. Analysis Presentation
    - Graphs
    - Contour plots
    - Animations
4. Data Exports
    - Data Transfer
    - System Integration

Open model

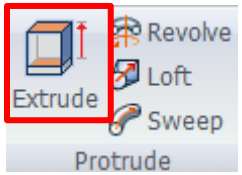


Open Midas tutorial – Lesson 2

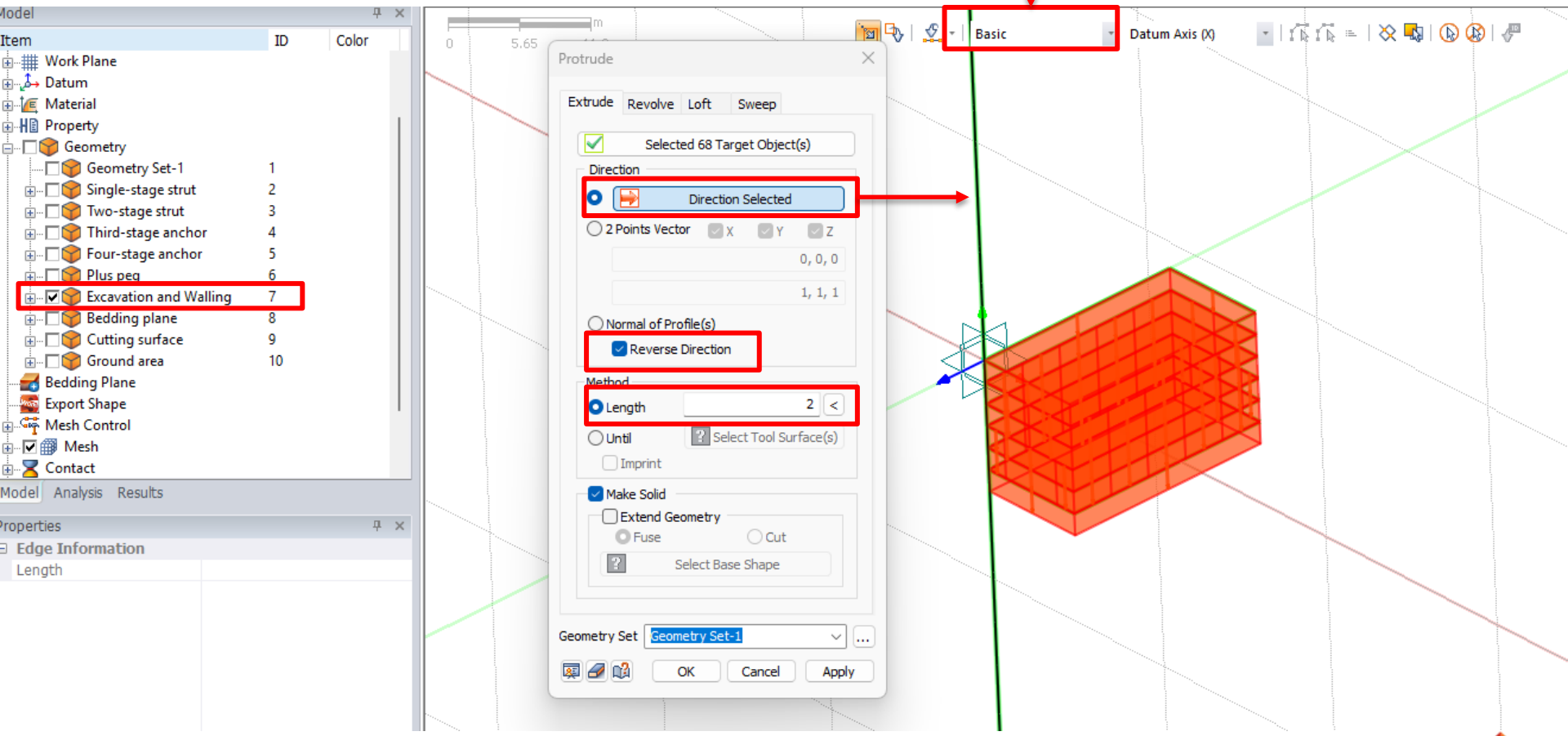


Geometry drawing

Geometry modeling – Excavation area

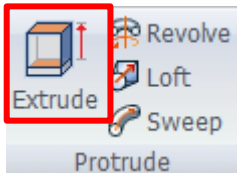


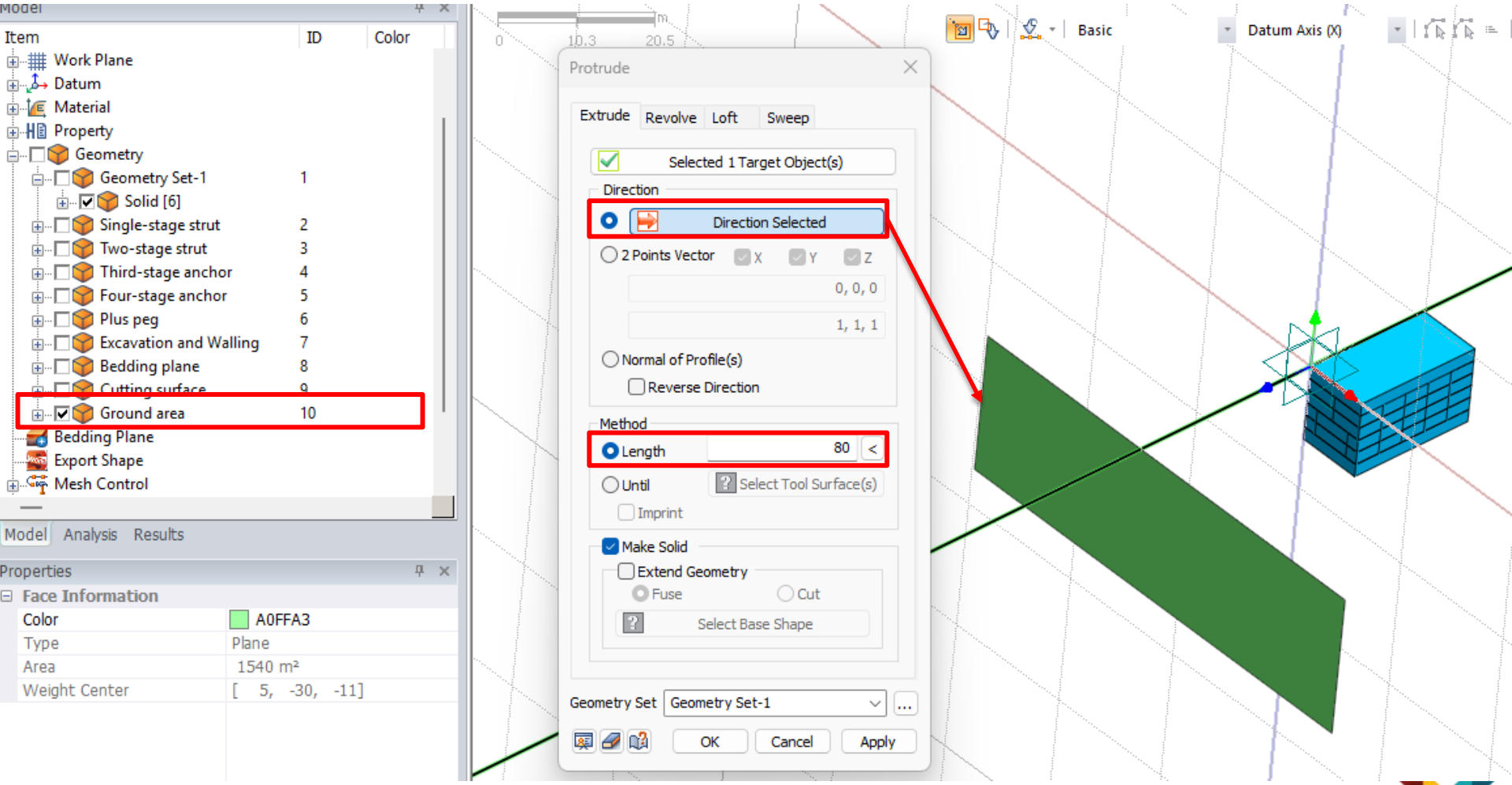
Change into ‘Edge’, then ‘Select All’



Extruding excavation area

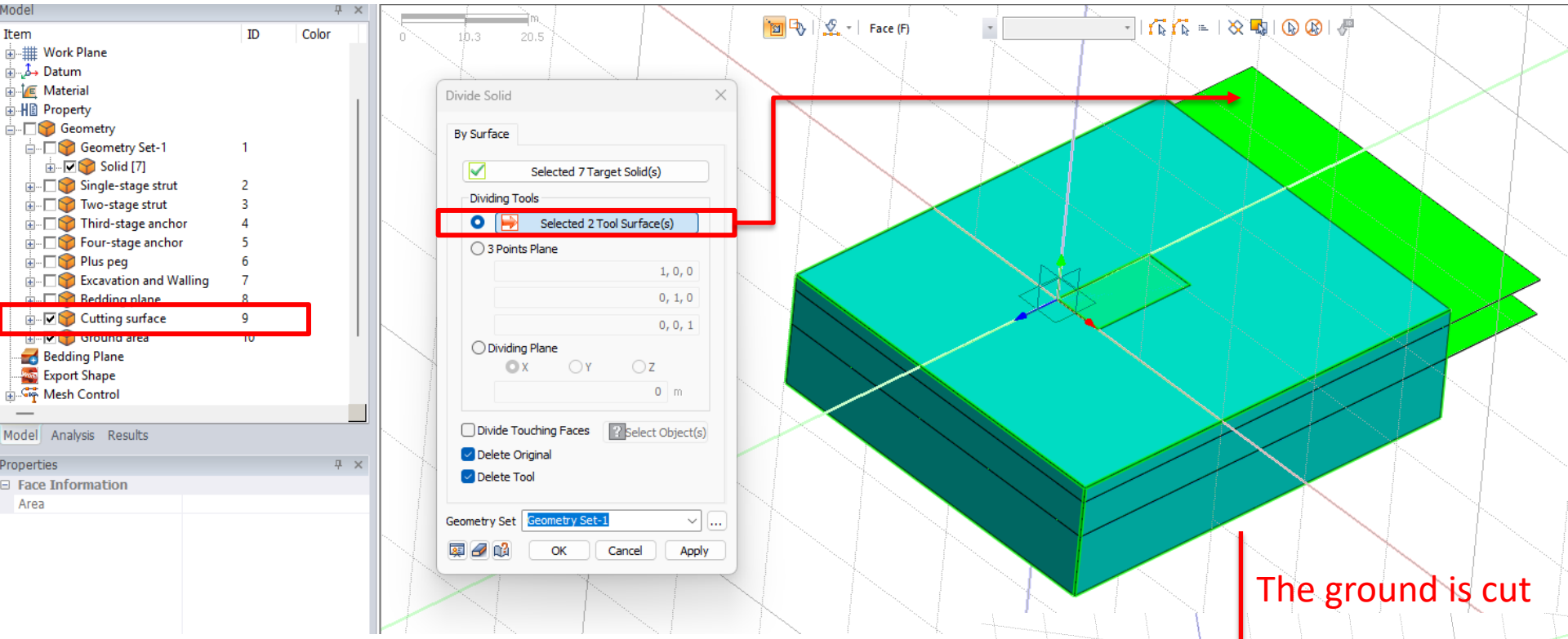
Geometry modeling – Ground





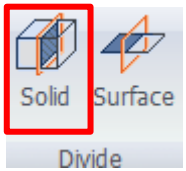
Ground area

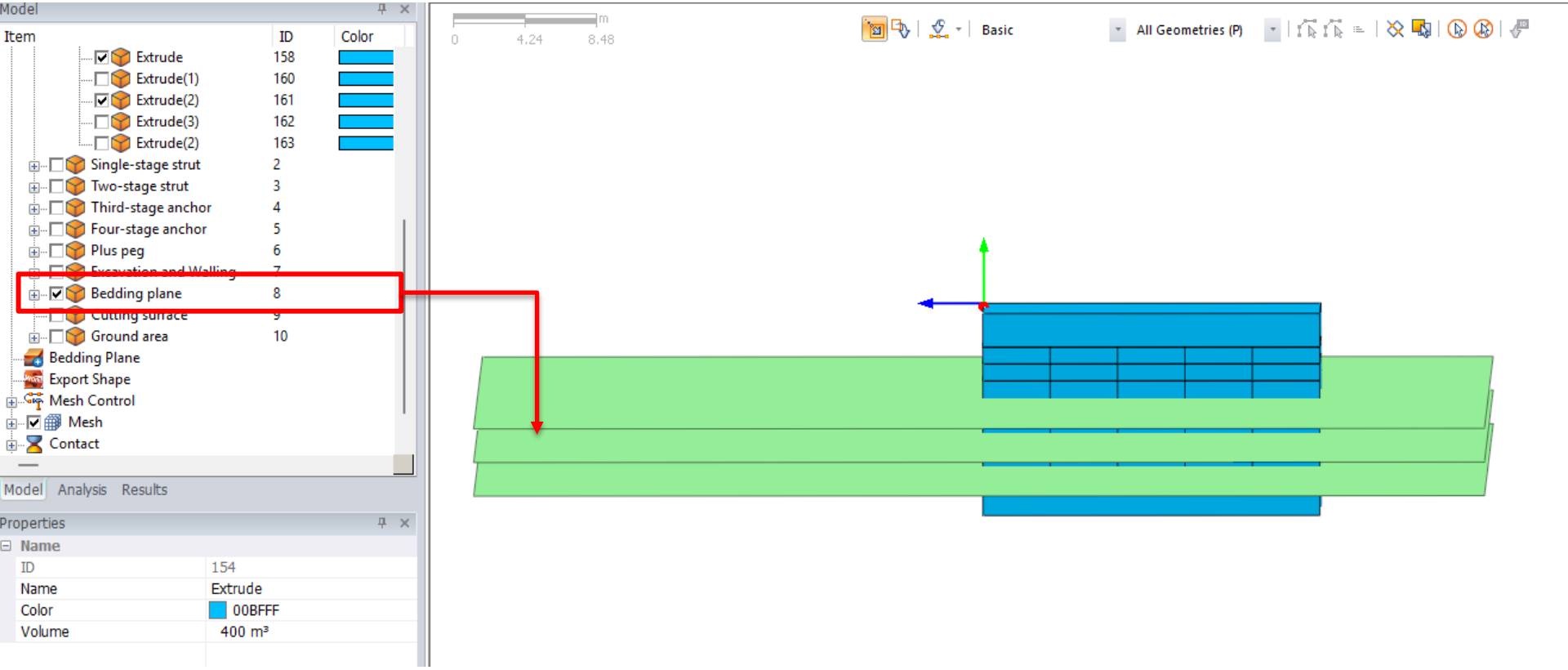
Cutting ground surface



Cutting surface for ground by ‘Divide solid’ function

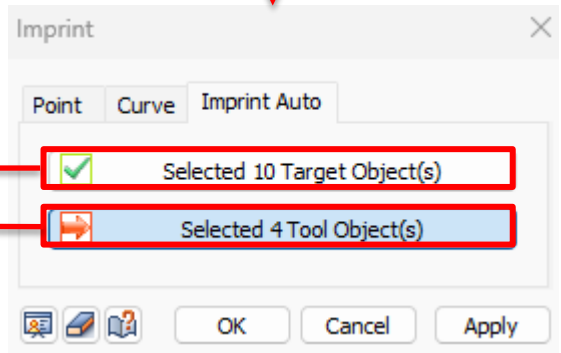
Bedding plane





Bedding plane for excavation area by ‘Divide solid’ function

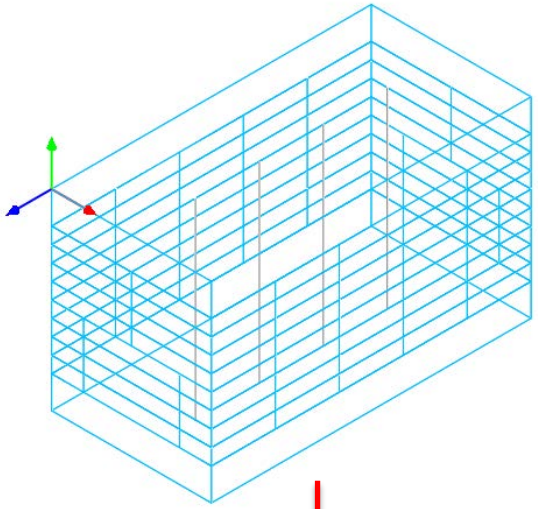
Imprint for ‘Plug pegs’



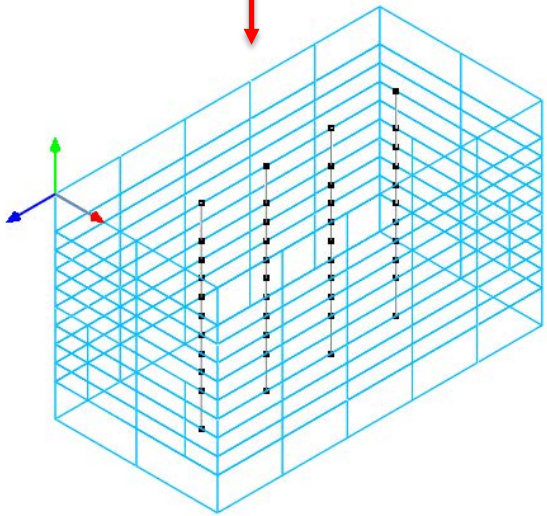
Excavation area

Plug pegs

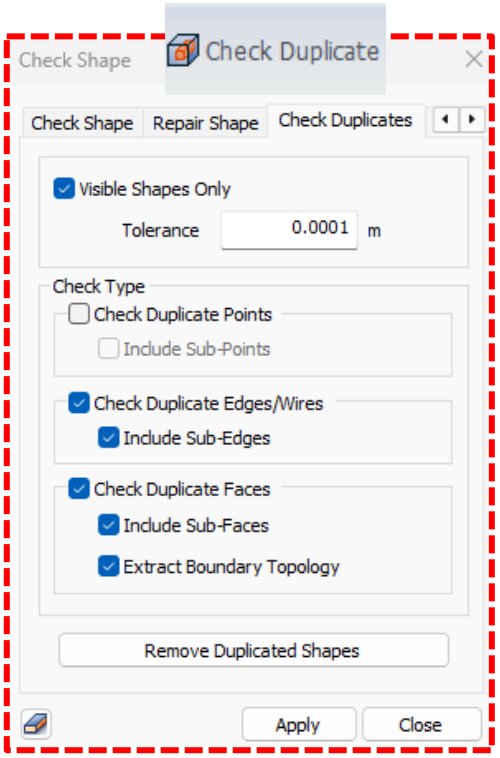
‘Imprint’ for creating node at different surface in excavation area



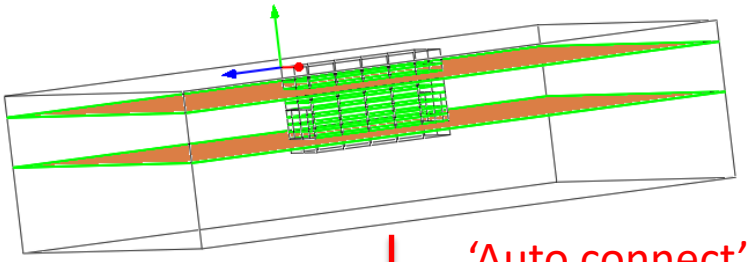
Before and After using ‘Imprint’



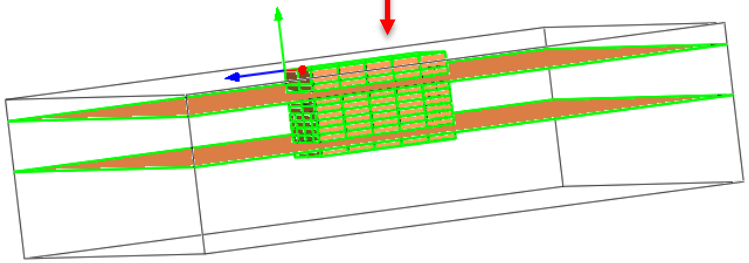
Check duplicate – Auto connect

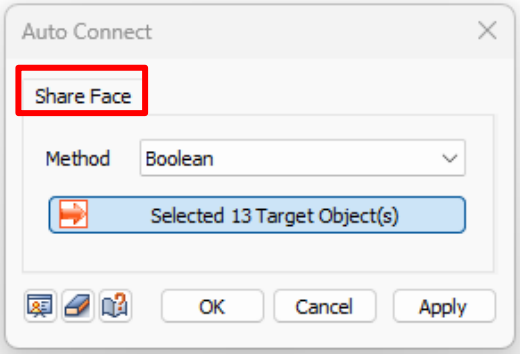


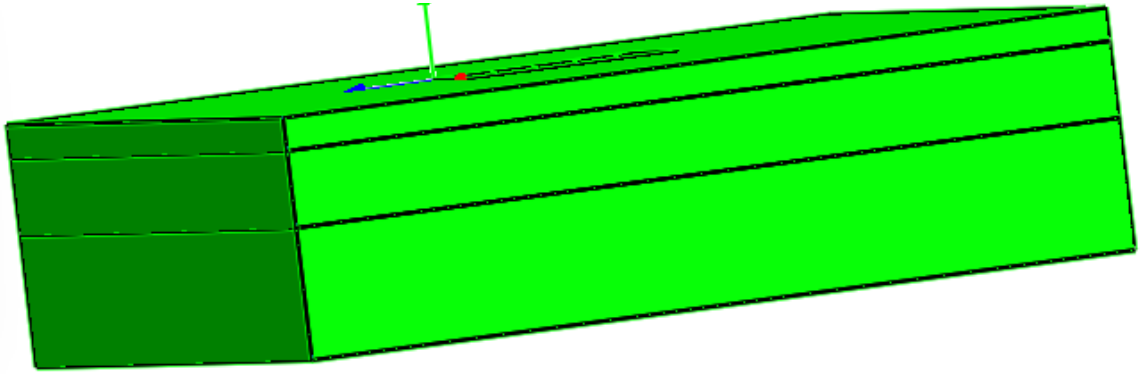
Auto connect



'Auto connect' for creating share surface







Material

▶ Ground material

Name	Buried layer	Colluvium	Weathering soil
Material	Isotropic	Isotropic	Isotropic
Model Type	Hardening Soil	Hardening Soil	Hardening Soil
Poisson's Ratio	0.333	0.306	0.384
Unit Weight	16	17	20
K0	0.5	0.441	0.74
Unit Weight (Saturated)	20	20	22
Initial Void Ratio	0.5	0.5	0.5
Drainage Parameters	Drained	Drained	Drained
Permeability	1	1	1
E50ref	22,000	43,000	150,000
Eoedref	22,000	43,000	150,000
Eurref	66,000	129,000	450,000
Failure Ratio	0.9	0.9	0.9
Reference Pressure	12	47	110
Power of Stress Level Dependency	0.5	0.5	0.5
Friction Angle	30	34	38
K0nc	0.5	0.441	0.384
Dilatancy Angle	0	4	5
Cohesion	5	10	15

▶ Structure material

Name	Structure material 1	Structure material 2
Material	Isotropic	Isotropic
Model Type	Elastic	Elastic
Elastic Modulus	210,000,000	200,000,000
Poisson's Ratio	0.3	0.3
Unit Weight	76.98	76.98

Reference: Midas GTX NX Tutorials – Lesson 2

Property

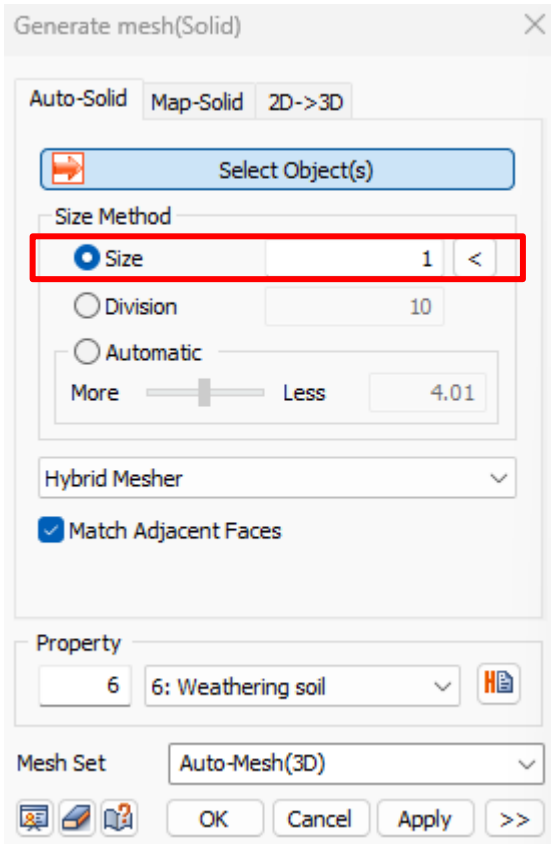
▶ Ground material

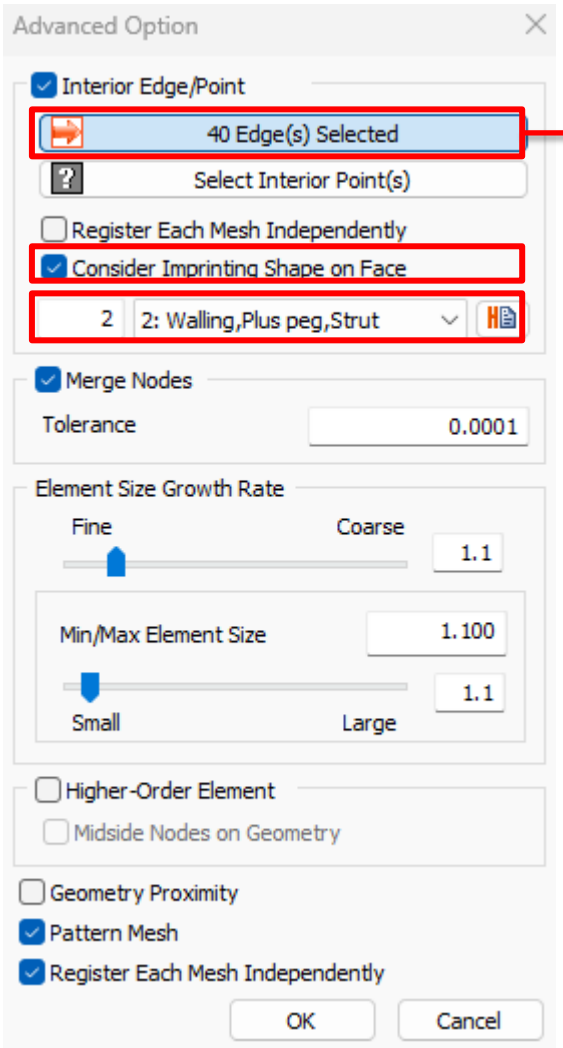
Name	Interface (Buried layer)	Interface (Colluvium)	Interface (Weathering Soil)	Buried layer	Colluvium	Weathering Soil
Type	Other	Other	Other	3D	3D	3D
Model Type	Interface	Interface	Interface	-	-	-
Interface Type	Face	Face	Face	-	-	-
Material	Buried layer	Colluvium	Weathering Soil	Buried layer	Colluvium	Weathering Soil

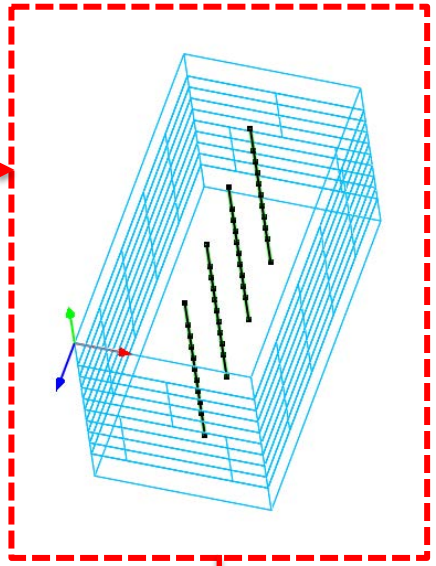
▶ Structure material

Name	Sheet Pile	Walling, Plus peg, Strut	Anchor
Type	2D	1D	1D
Model Type	Shell	Beam	Embedded Truss (linear elasticity)
Material	Structure material 1	Structure material 1	Structure material 2
Section	-	H-Section	Solid Round
Section Size	Uniform Thickness : 0.1	300x300x10/15	0.025

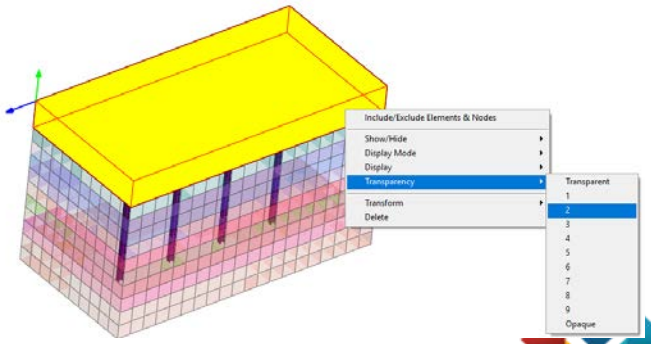
3D mesh – Excavation area





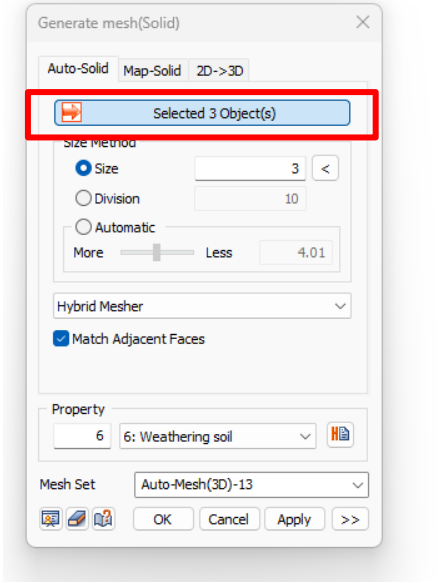


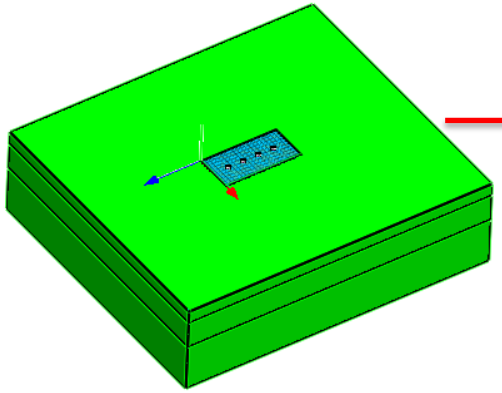
''Transparency' display mode



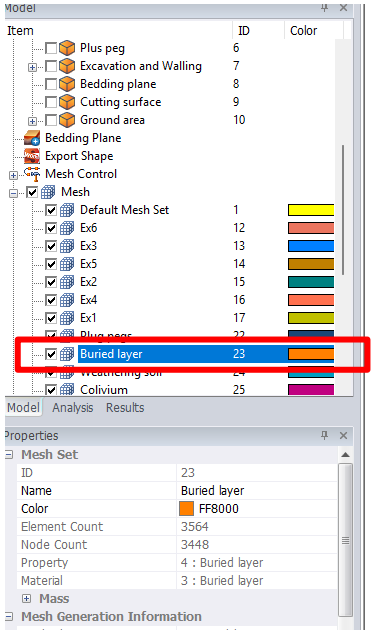
- Generate meshes with nodes connected to interior edges

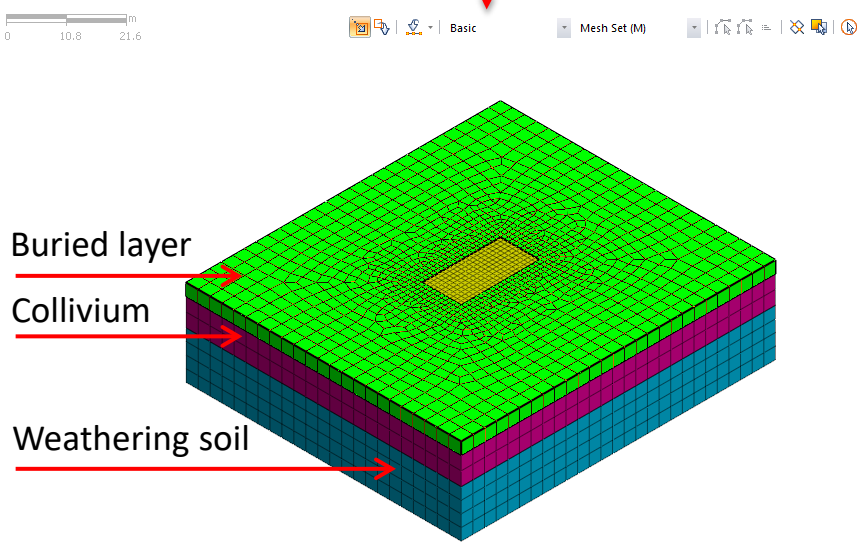
3D mesh - Ground



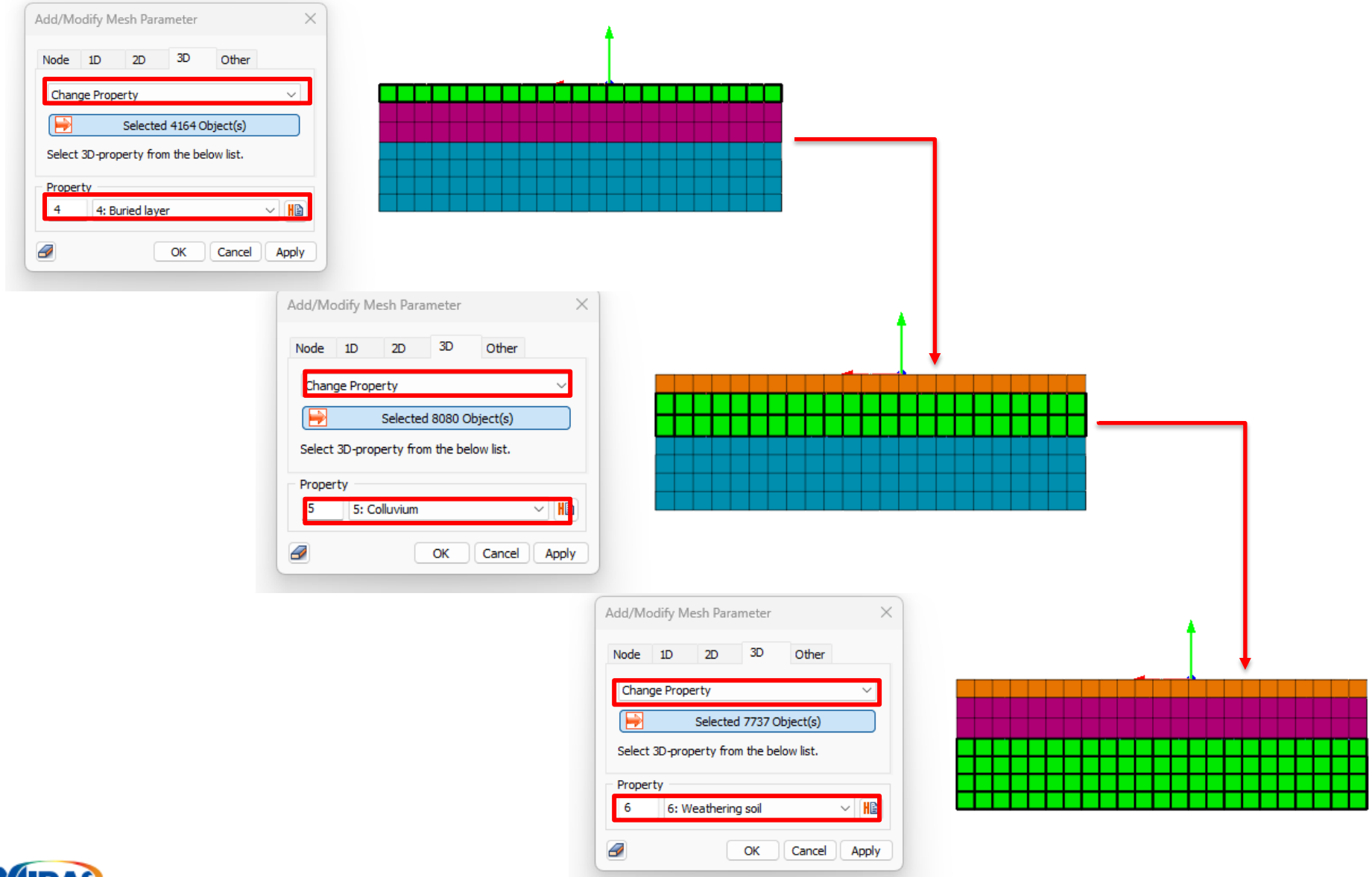


Need to Change property

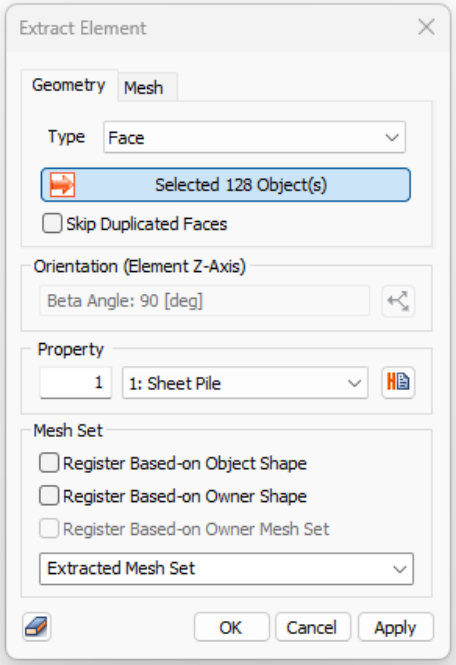


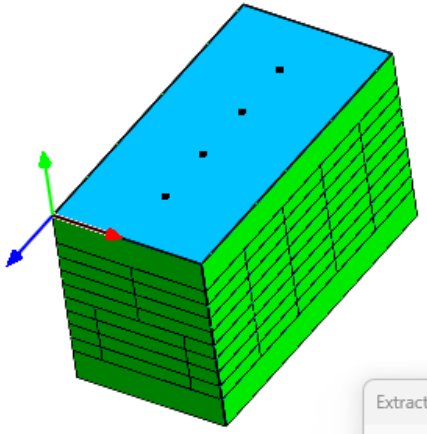


Change property – Ground

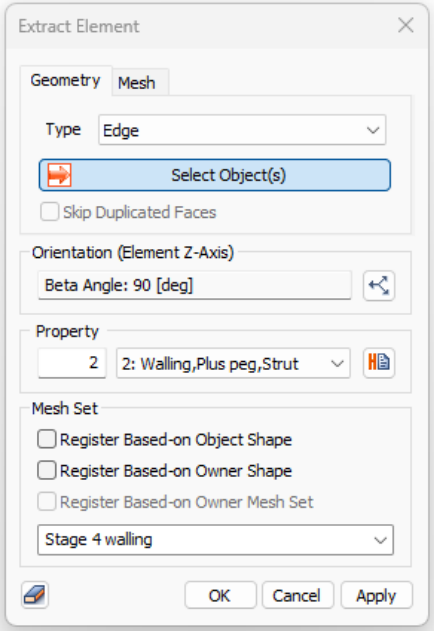


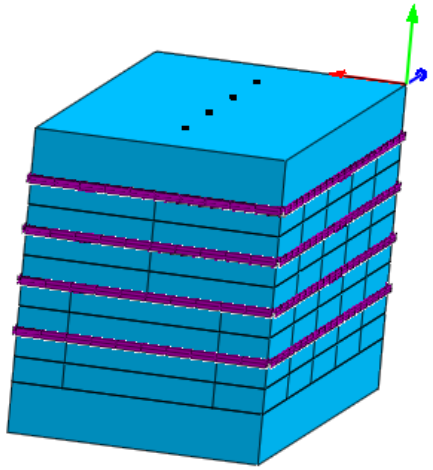
Extract elements for RW, Walling





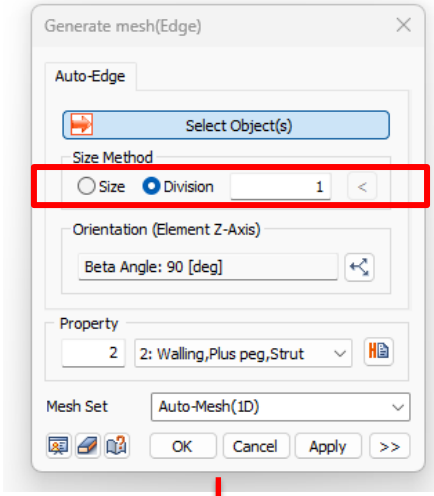
▼ Extracting walling from ‘Edge’ geometry

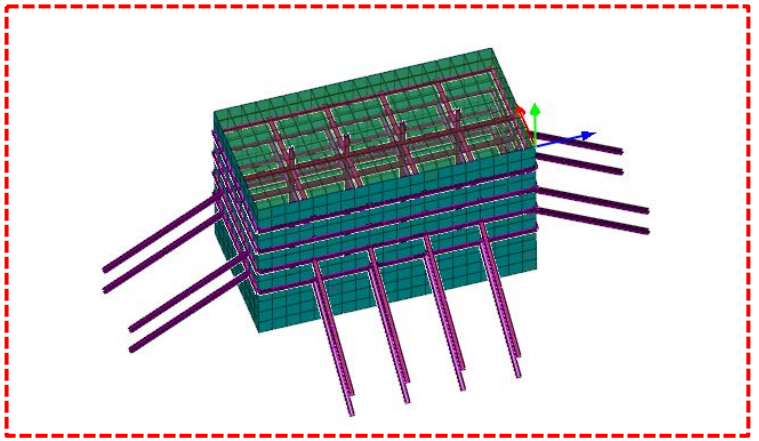




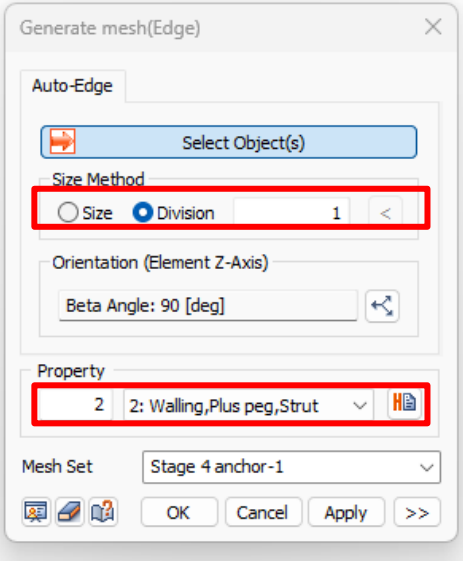
▲ Extracting sheet pile from ‘Face’ geometry

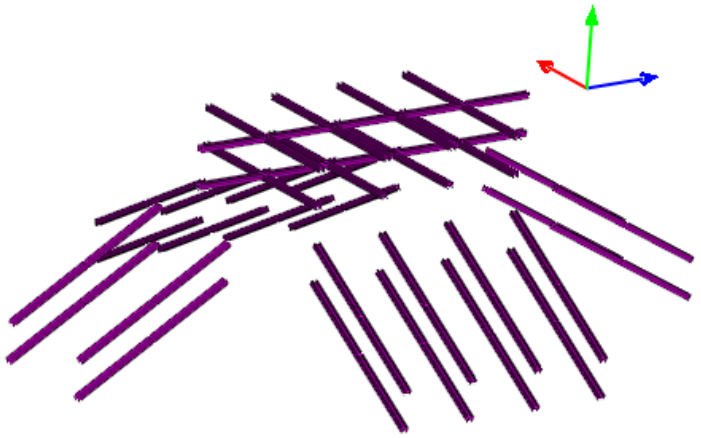
1D mesh – Struts & Anchors





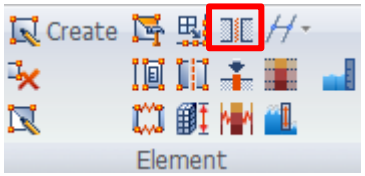
▲ Image of supporting and RW after meshing



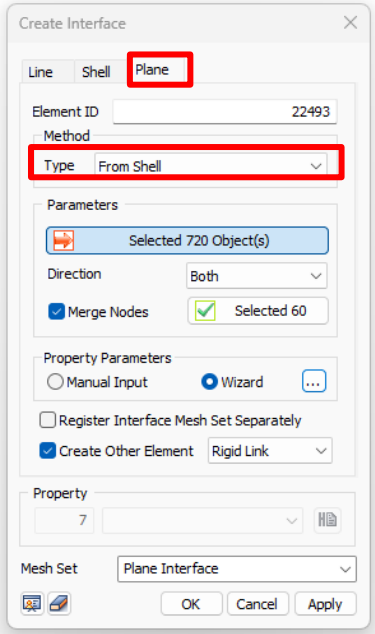


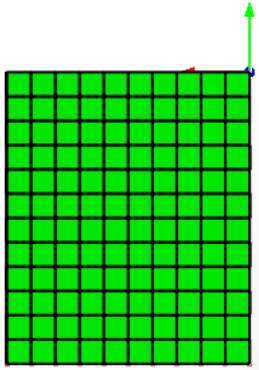
▲ Meshing Struts and Anchors

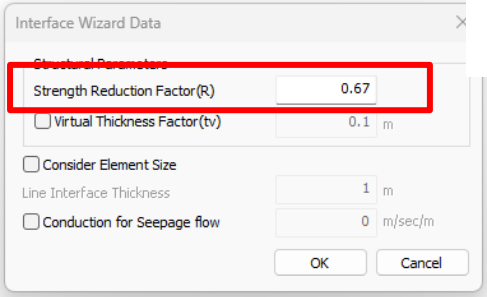
Plane interface

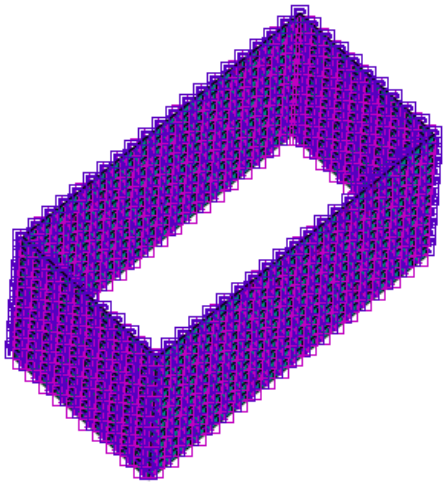


Selecting ‘Interface’

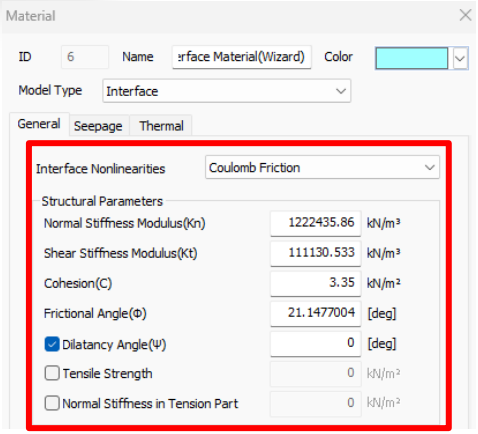








Interface is created



→ ‘Interface’ is created for each soil material by GTX Wizard

Interface Wizard

▶ **Interface Wizard equation from Midas GTX NX manual:**

$K_n = E_{oed,i} / t_v$

$K_t = G_i / t_v$

$C_i = R \times C_{soil}$

Here,

$E_{oed,i} = 2 \times G_i \times (1-v_i)/(1-2 \times v_i)$

$G_i = R^2 \times G_{soil}$

$G_{soil} = E/(2(1+v_{soil}))$

Where,

K_n: Normal Stiffness Modulus

K_t: Shear Stiffness Modulus

t_v: Virtual Thickness Factor

R: Strength Reduction Factor

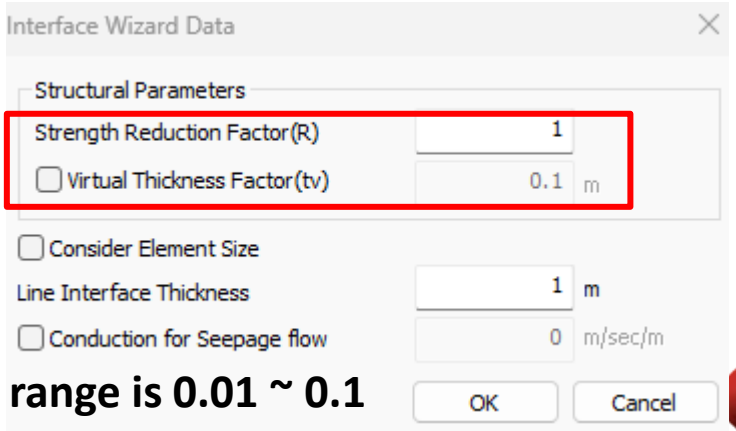
C_i: Interface Cohesion

Kn (Normal stiffness modulus) is the elasticity modulus for **bonding and un-bonding behavior** in the normal direction to the interface element

Kt (Shear stiffness modulus) is the elasticity modulus for **slip behavior** in the normal direction to the interface element

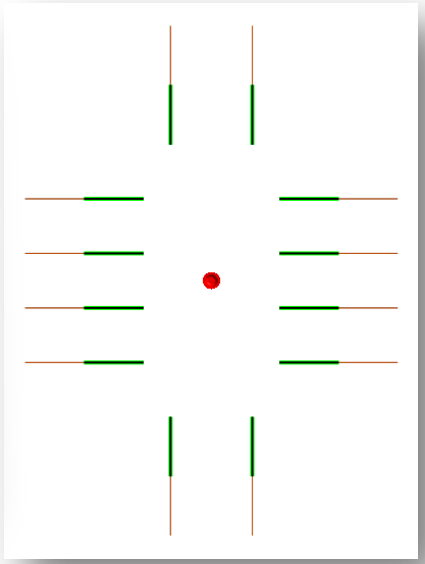
▶ **Strength Reduction factor (R)**

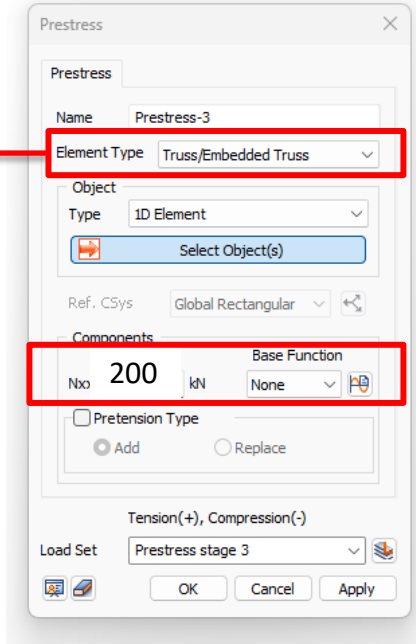
- Sandy soil/ Steel material: R= 0.6 ~ 0.7
- Clay/ Steel material: R= 0.5
- Sandy soil/ Concrete: R= 1.0 ~ 0.8
- Clay/ Concrete: R= 1.0 ~ 0.7

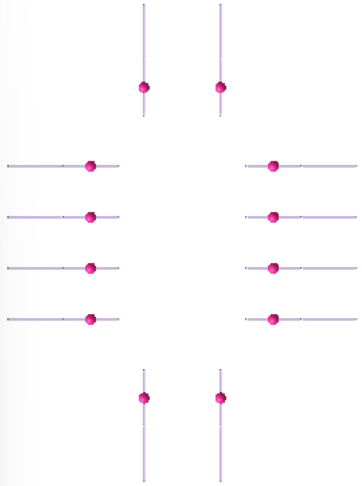


The general **Virtual Thickness Factor range is 0.01 ~ 0.1**
(If the stiffness is high, use a smaller value)

Prestressed - Anchors





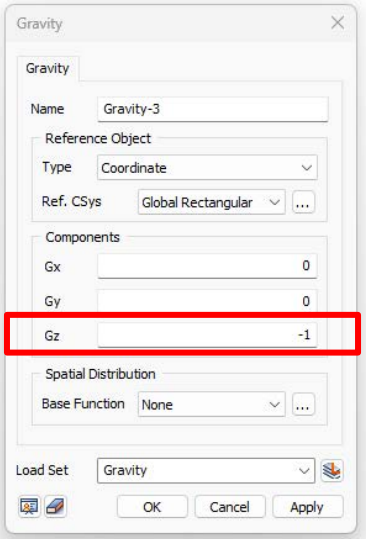


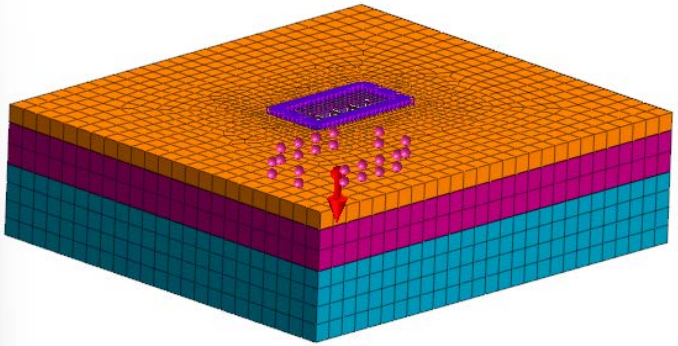
Selecting the length of anchors should add a prestressed load

Prestressed: 200 kN

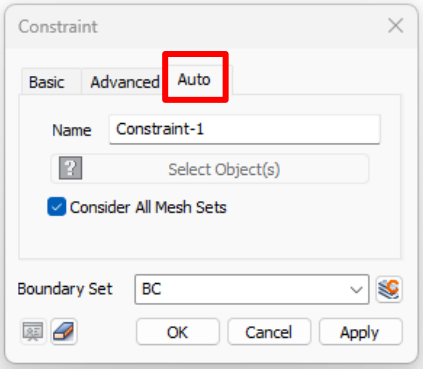
Gravity – Boundary conditions

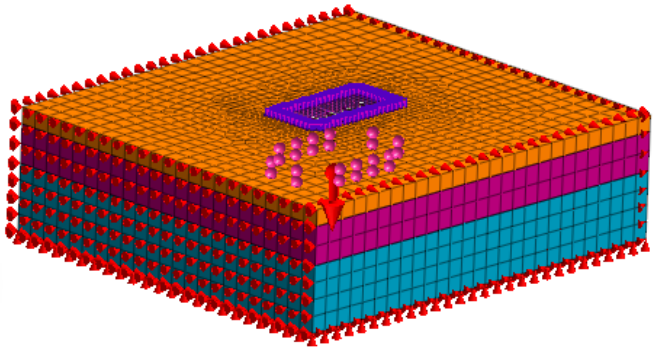
▶ Assigning gravity



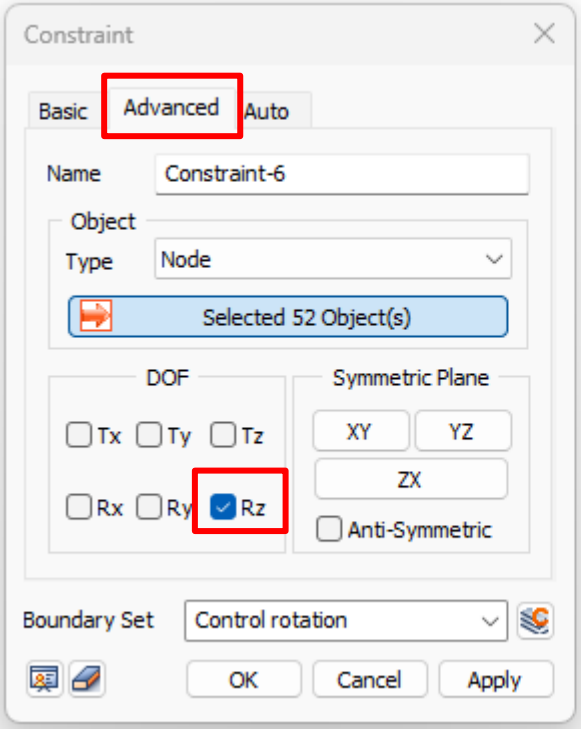


▶ Assigning boundary condition

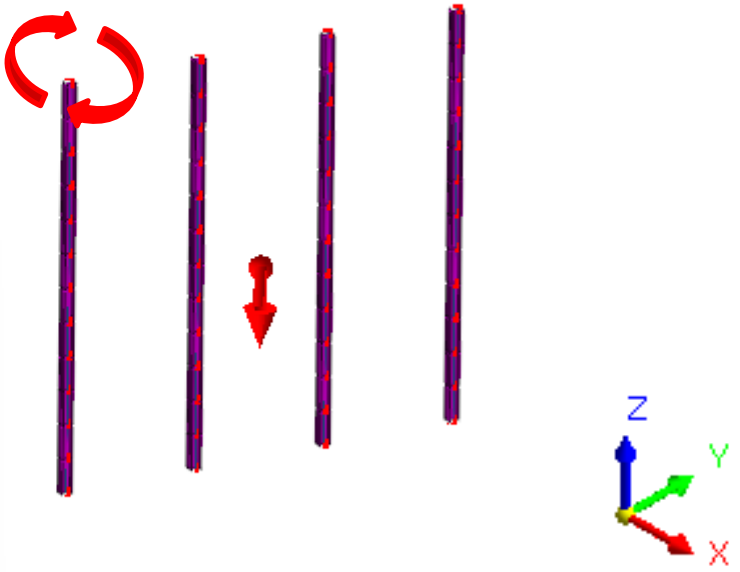




Rotation constraint

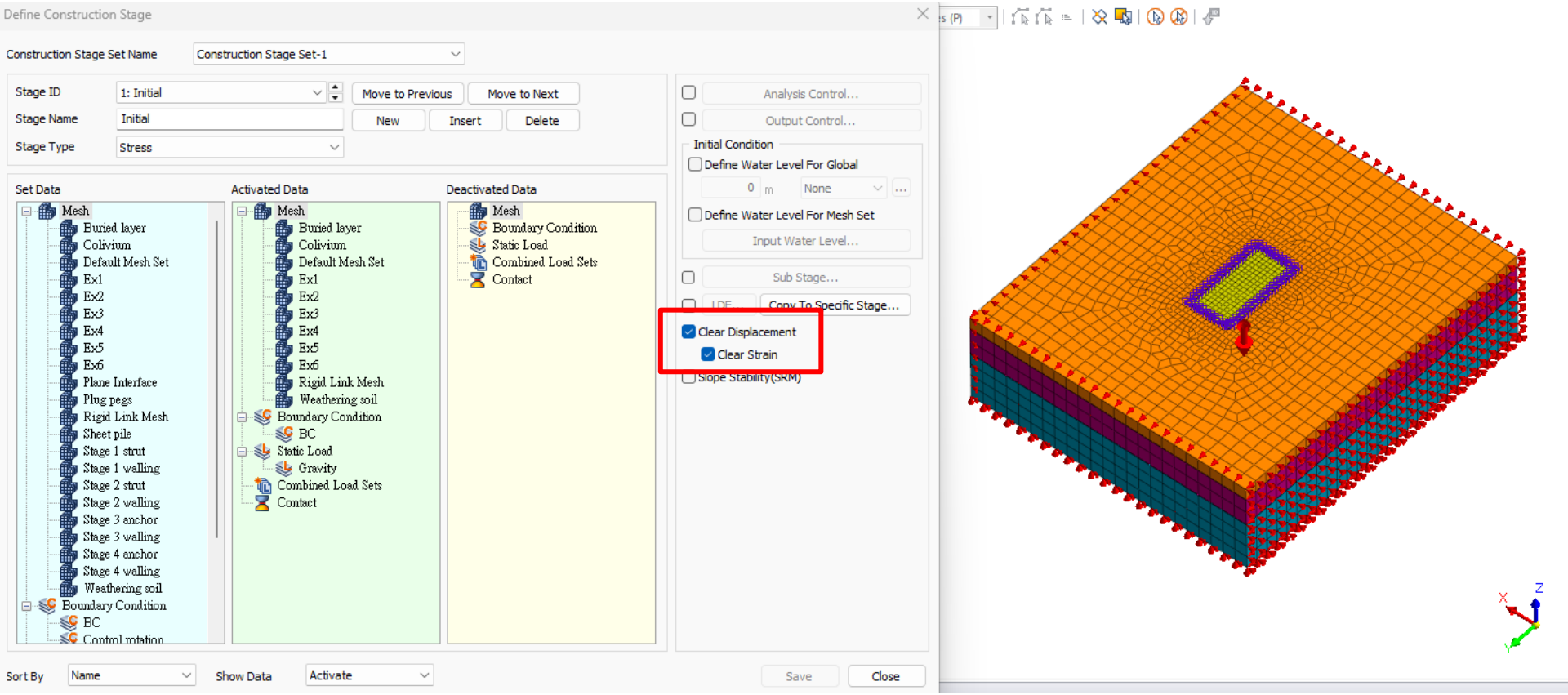


▼ Preventing ‘Rz’ rotation



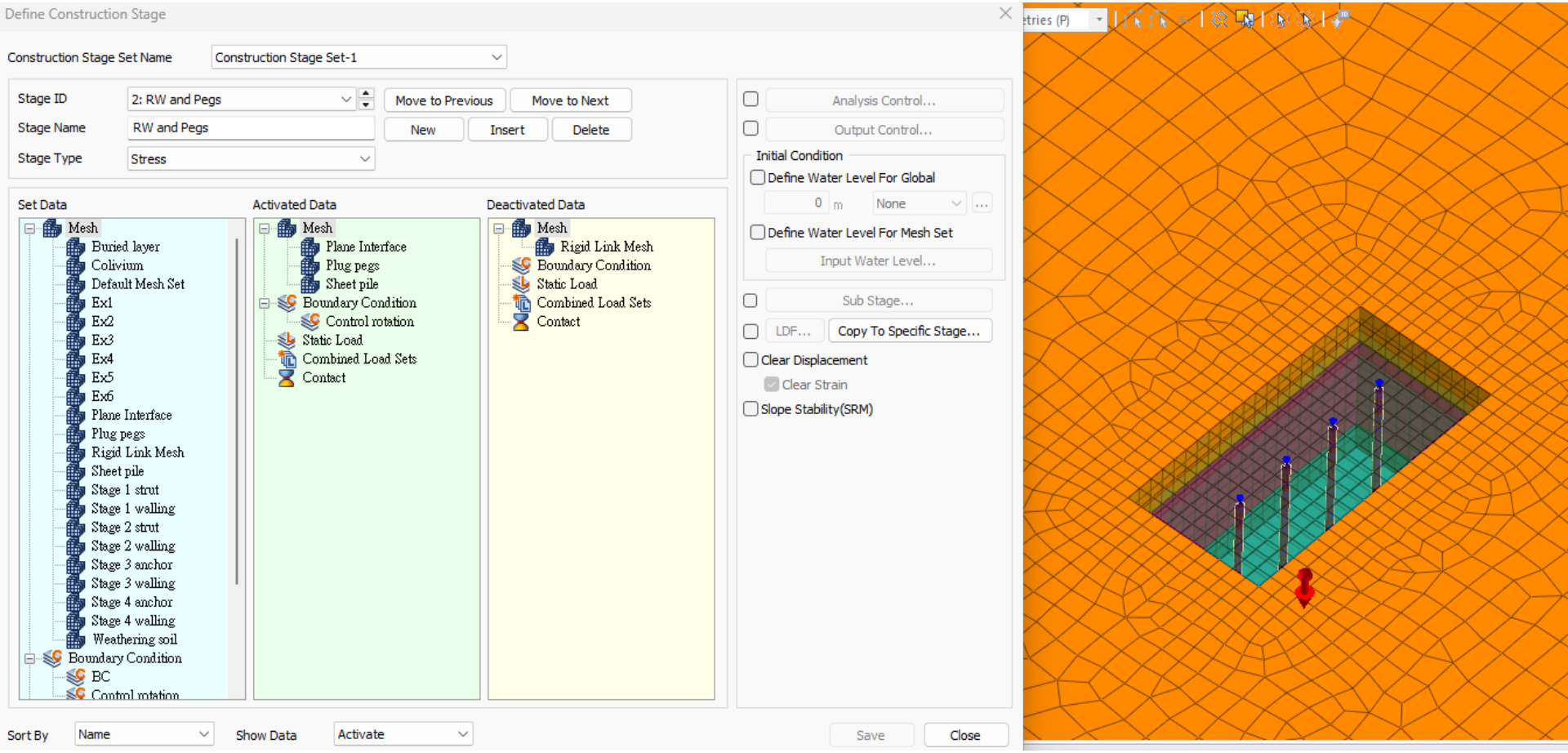
→ The deformation or rotation is constrained to prevent the degree of freedom errors

Define CS – Stage 1



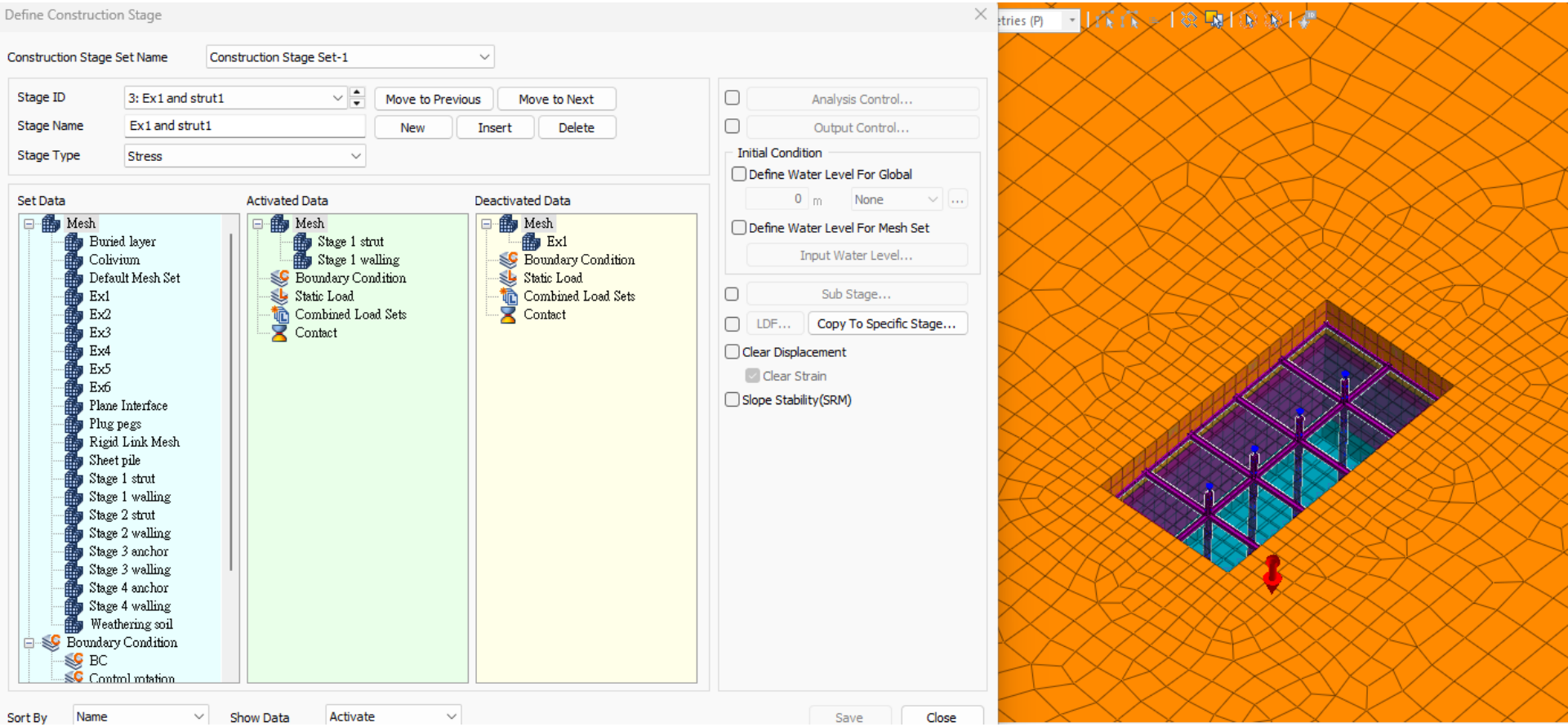
Stage 1. Initial conditions

Define CS – Stage 2



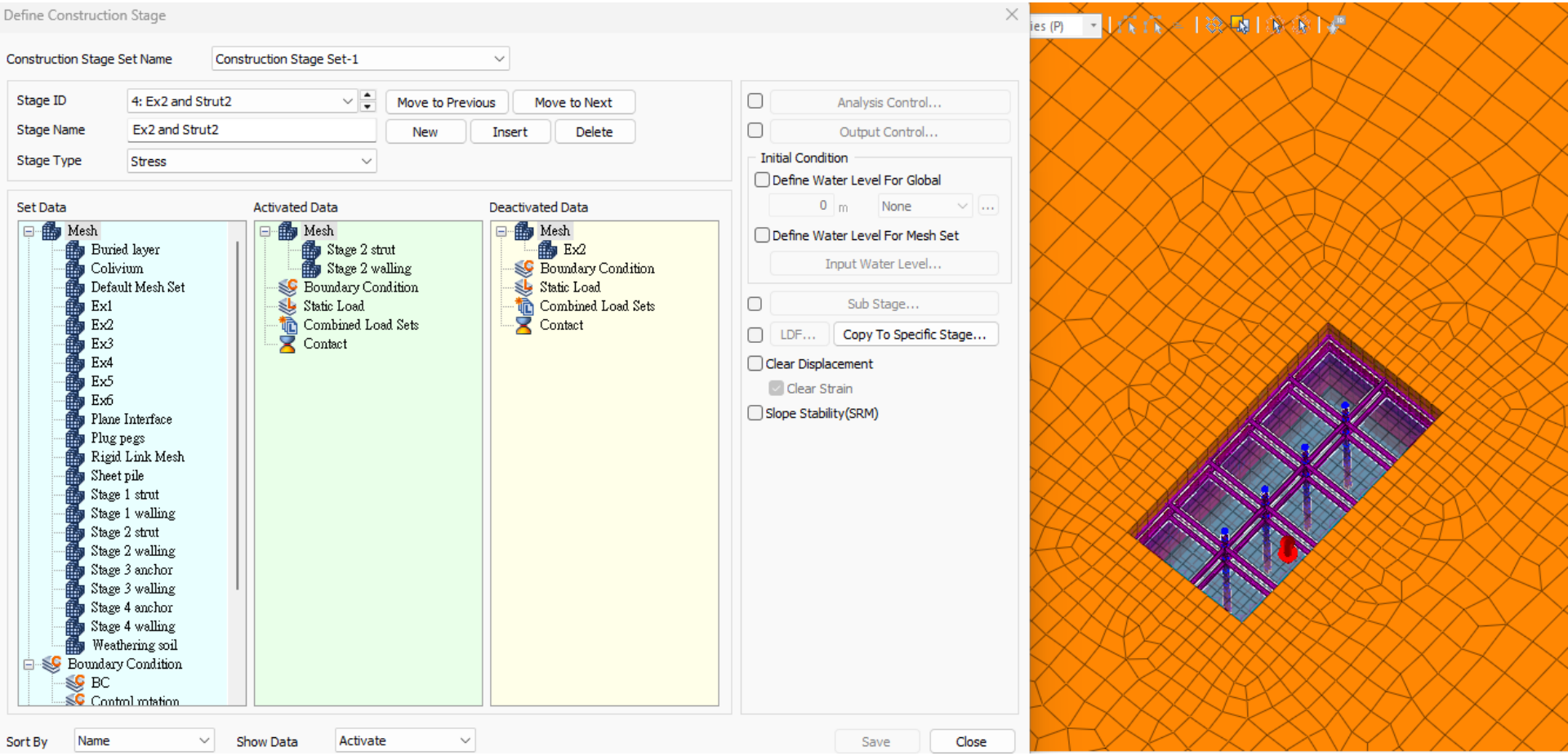
Stage 2. Install sheet pile and plug pegs

Define CS – Stage 3



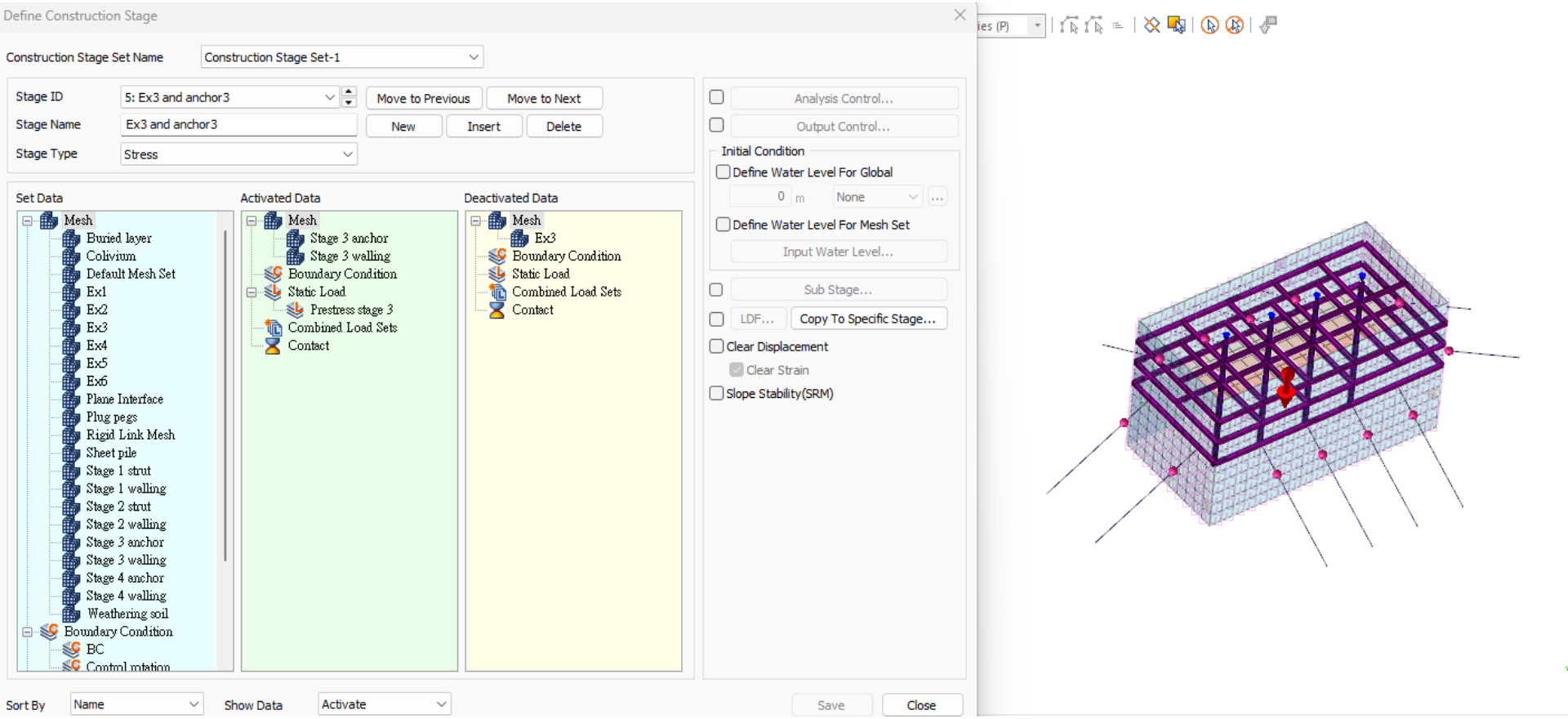
Stage 3. Excavation layer 1 and Installation strut layer 1

Define CS – Stage 4



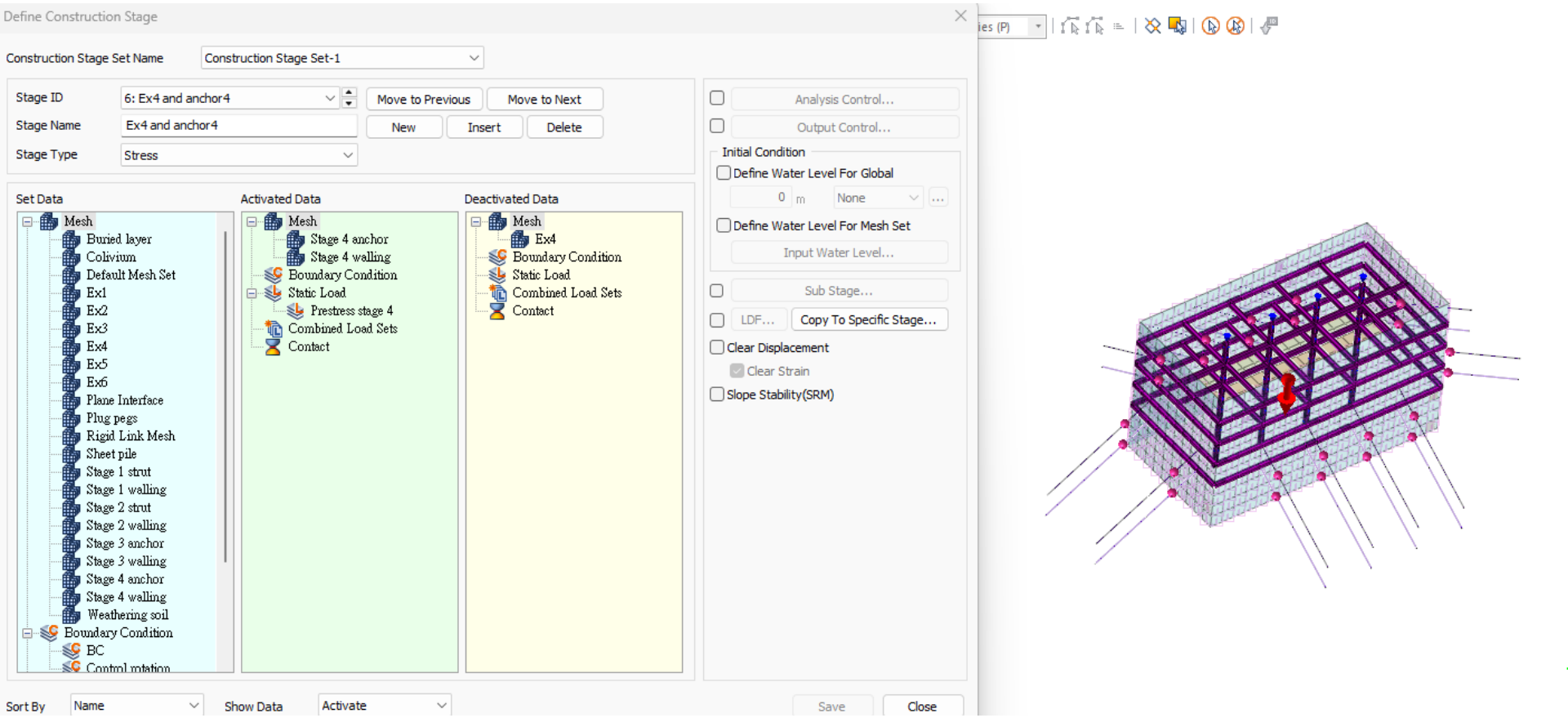
Stage 4. Excavation layer 2 and Installation strut layer 2

Define CS – Stage 5



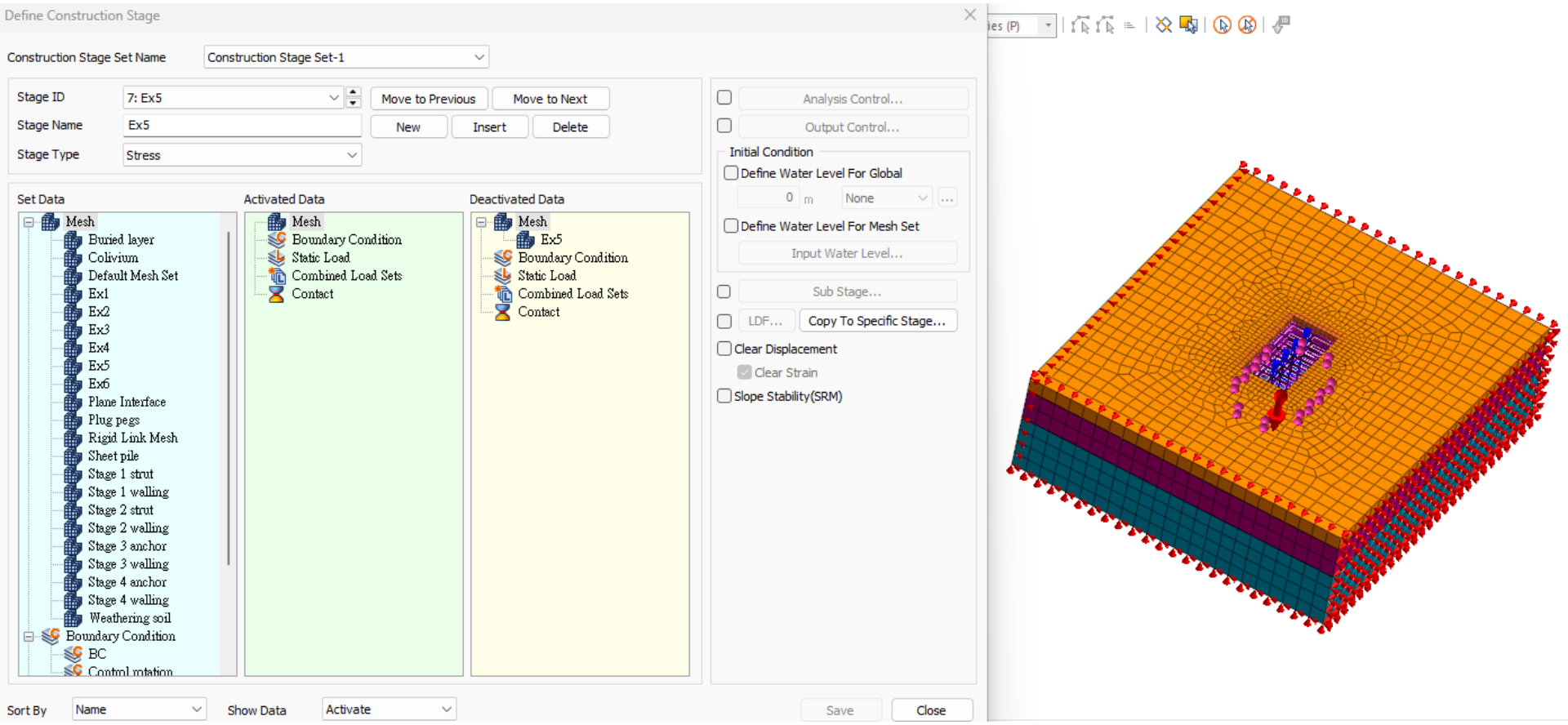
Stage 1. Excavation layer 3 and Installation strut layer 3

Define CS – Stage 6



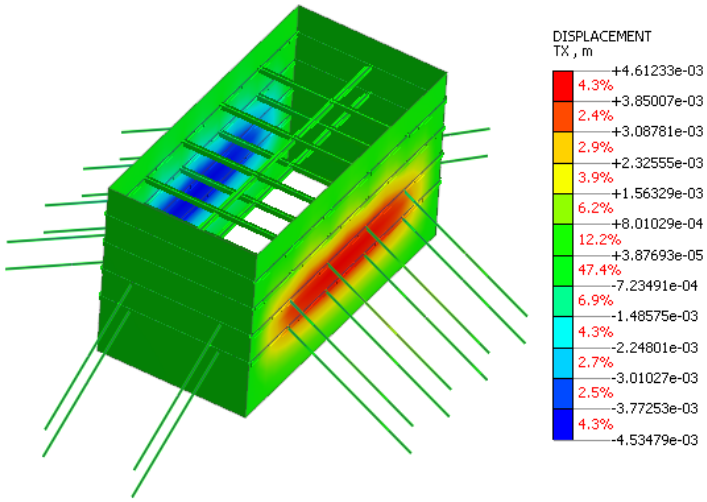
Stage 6. Excavation layer 4 and Installation strut layer 4

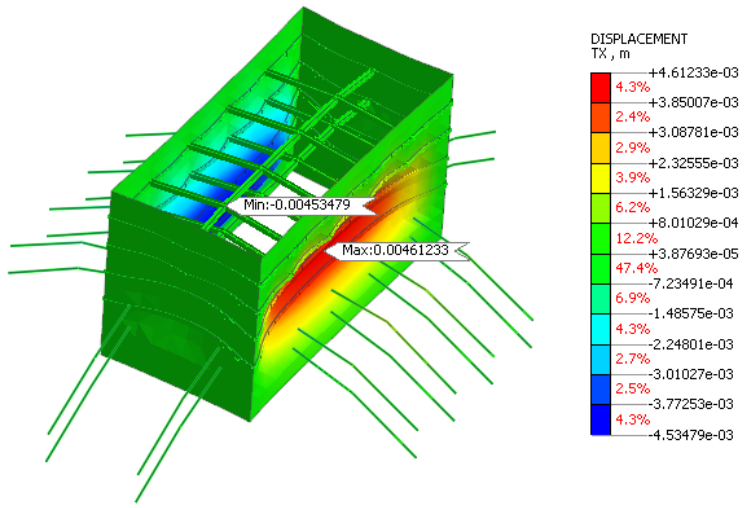
Define CS – Stage 7



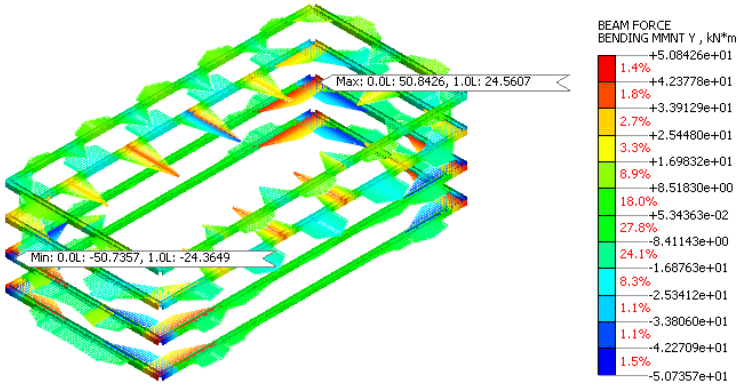
Stage 7. Excavation layer 5

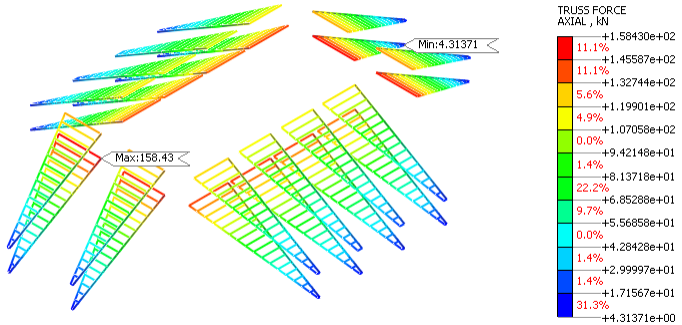
Results – RW system





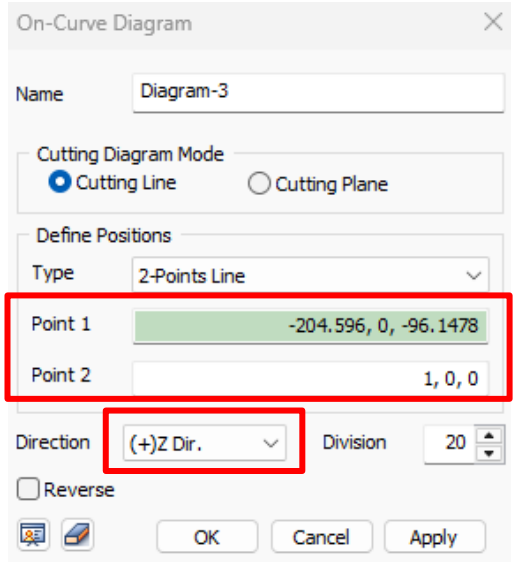
- Deformed and undeformed in horizontal displacement

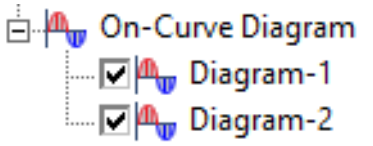




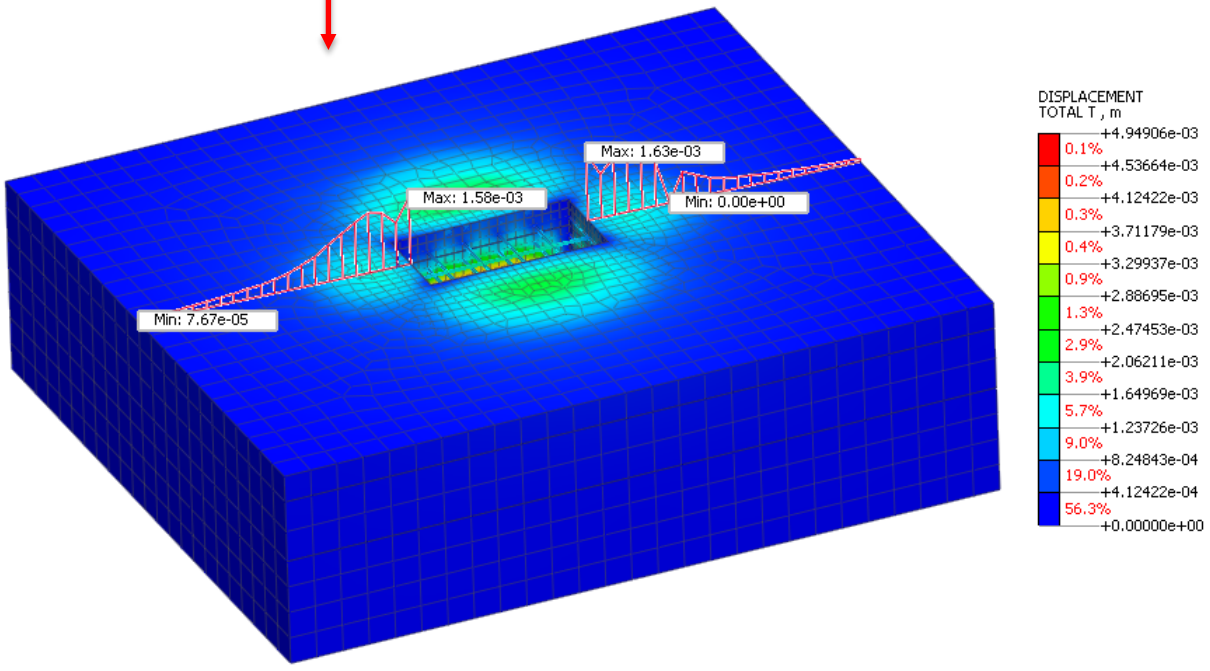
- Beam force, bending moment in walling & Truss force, axial force in anchors

Results - Displacement

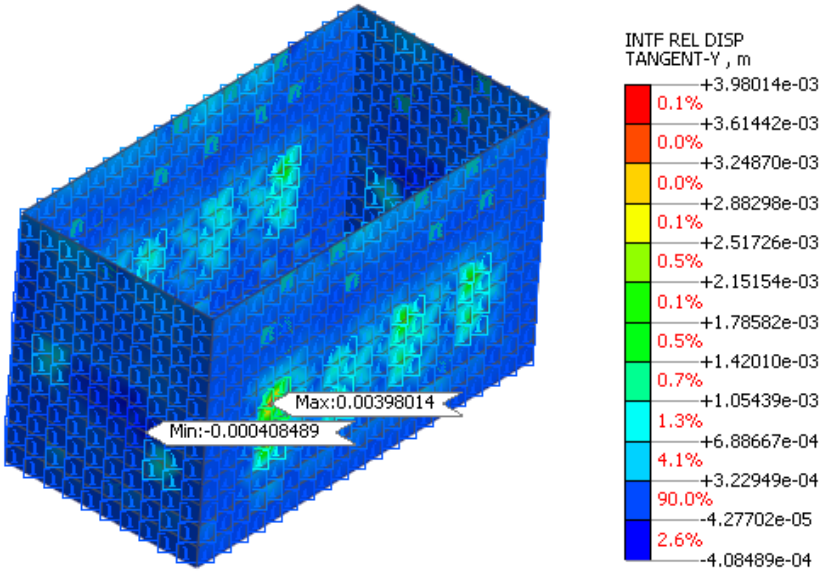


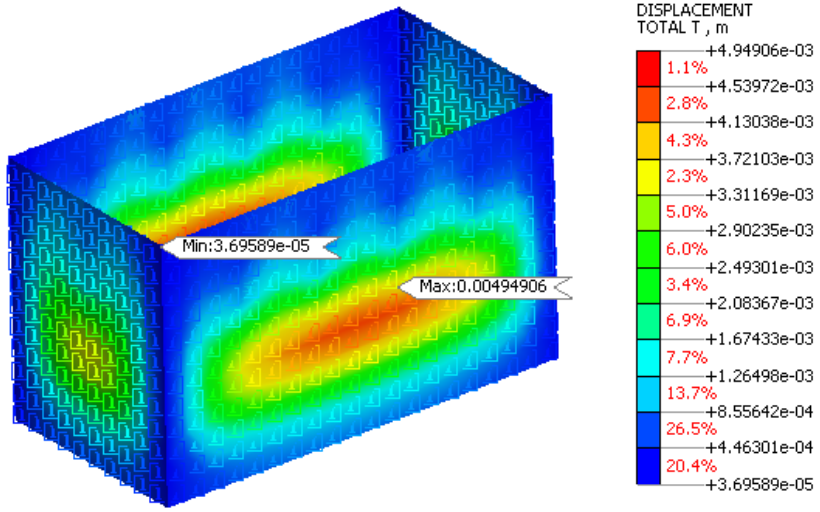


Creating a diagram and showing the displacement



Geometry modeling – Ground





▶ The comparison between interface force and total translation:
(a) Interface force _ Tangent-Y displacement; (b) Total translation


Thank you!