



GTS NX功能介紹



Contents

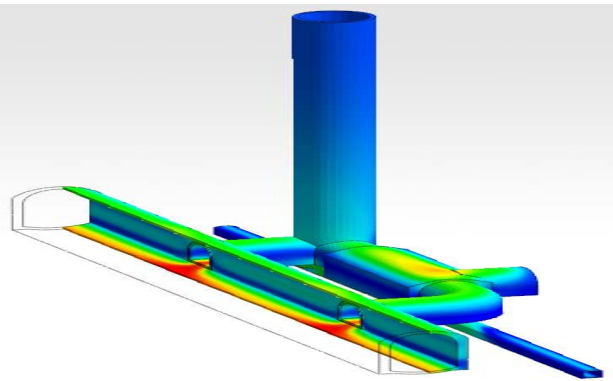
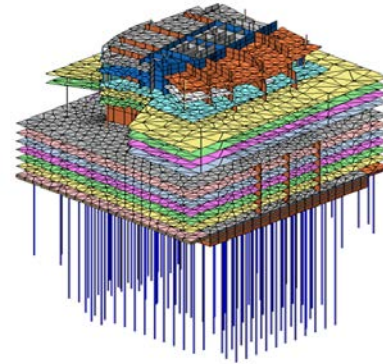
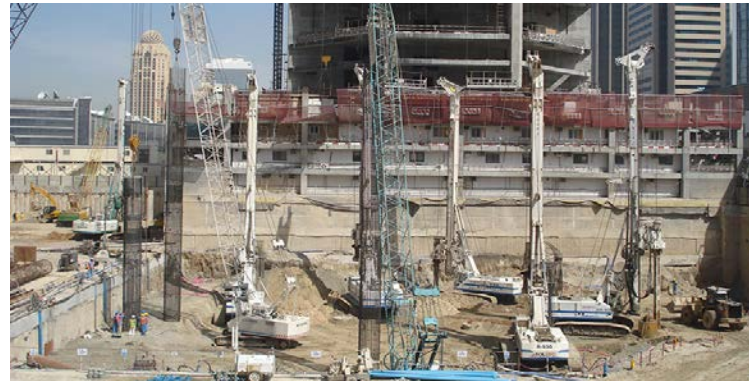
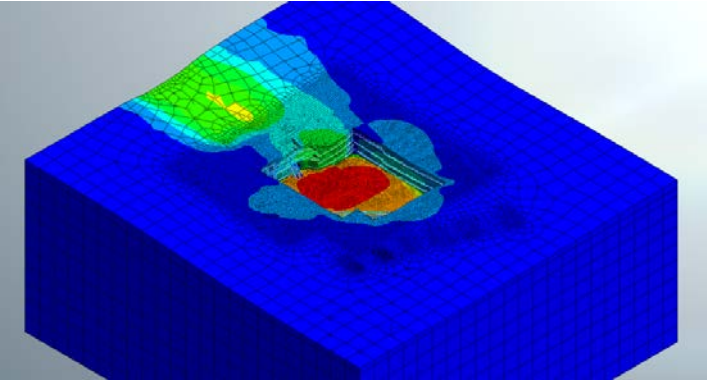
- Why MIDAS Geotech works for engineers
- What to do with GTS NX
- How to enhance the design process
- Case Study
- Fully integrated approach

Why do the engineers suffer?

GTS NX will make your time efficient

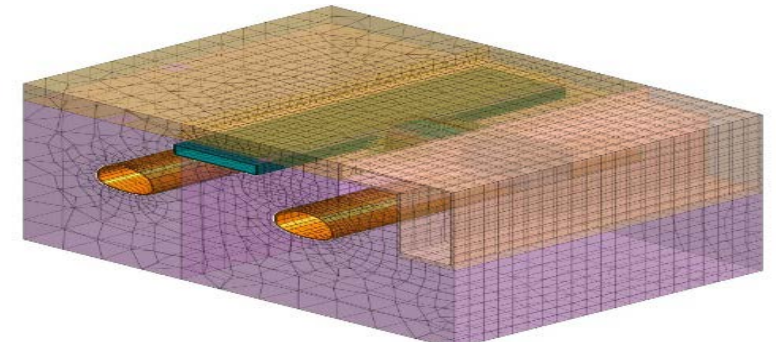
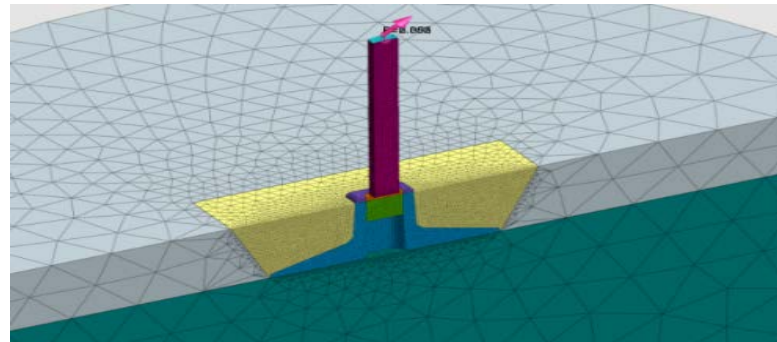
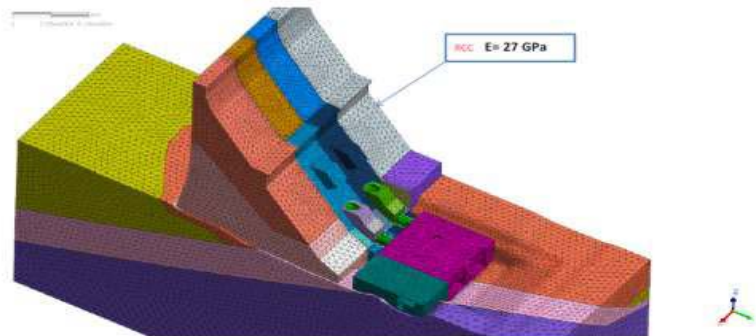
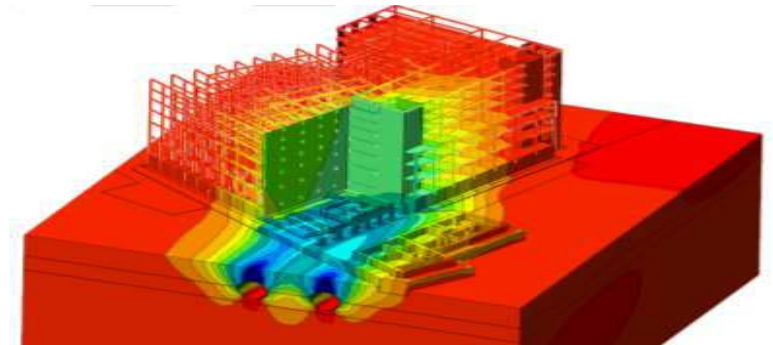
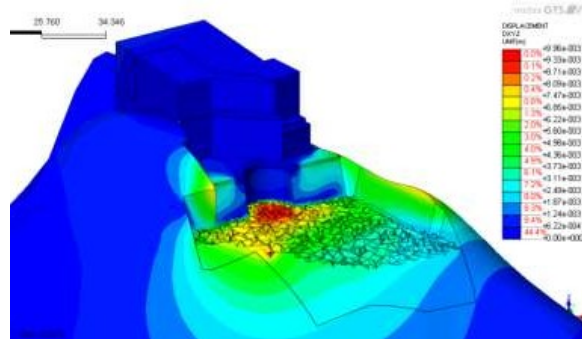
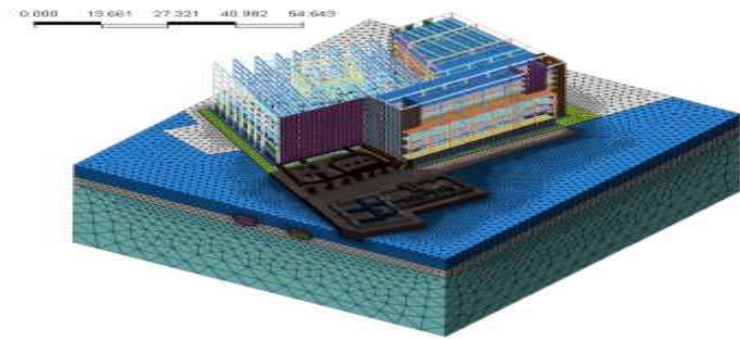


Reasons for 3D



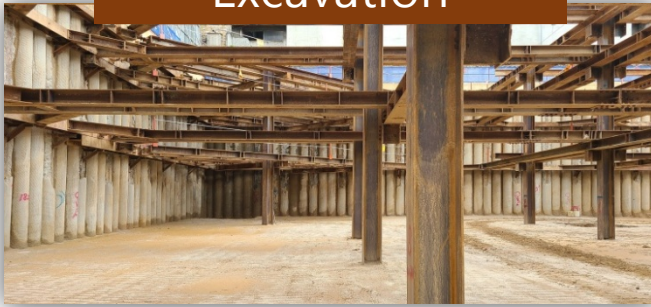
People in MIDAS Geotech

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



What to do w/ GTS NX

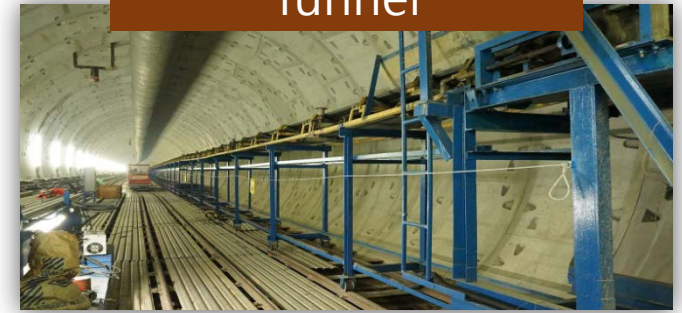
Excavation



Pile



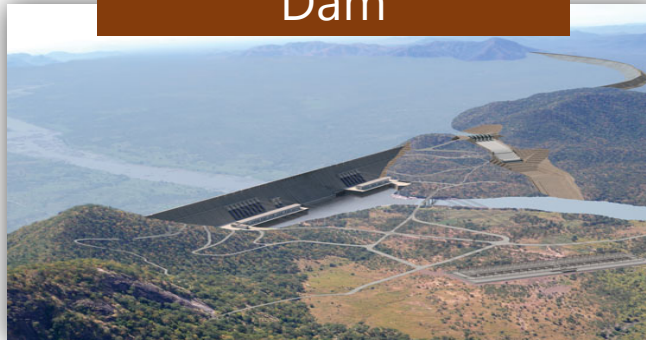
Tunnel



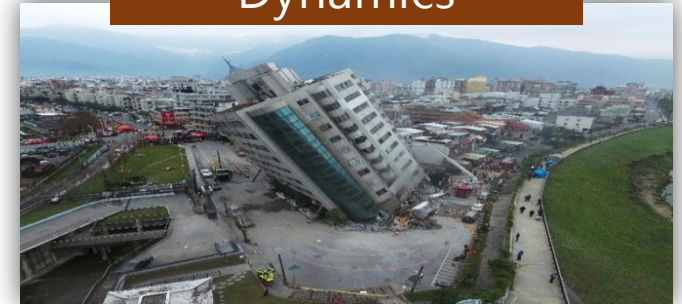
Slope Stability



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

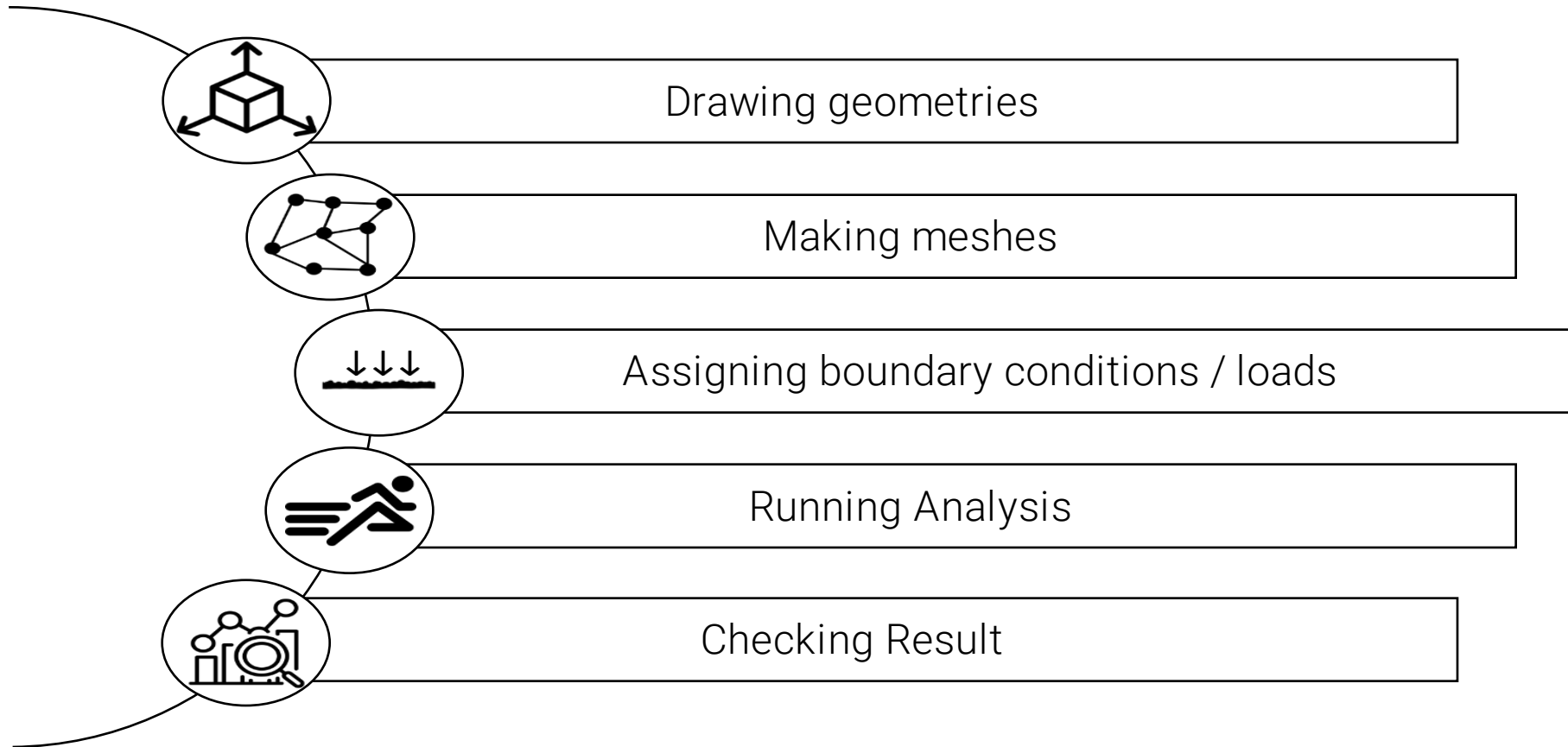
- Eigenvalue / Response Spectrum analysis
- Linear Time History (mode/direct methods)
- Nonlinear Time History analysis
- 1D/2D Equivalency Linear analysis
- Nonlinear time history + SRM Coupled

Slope Stability Analysis

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

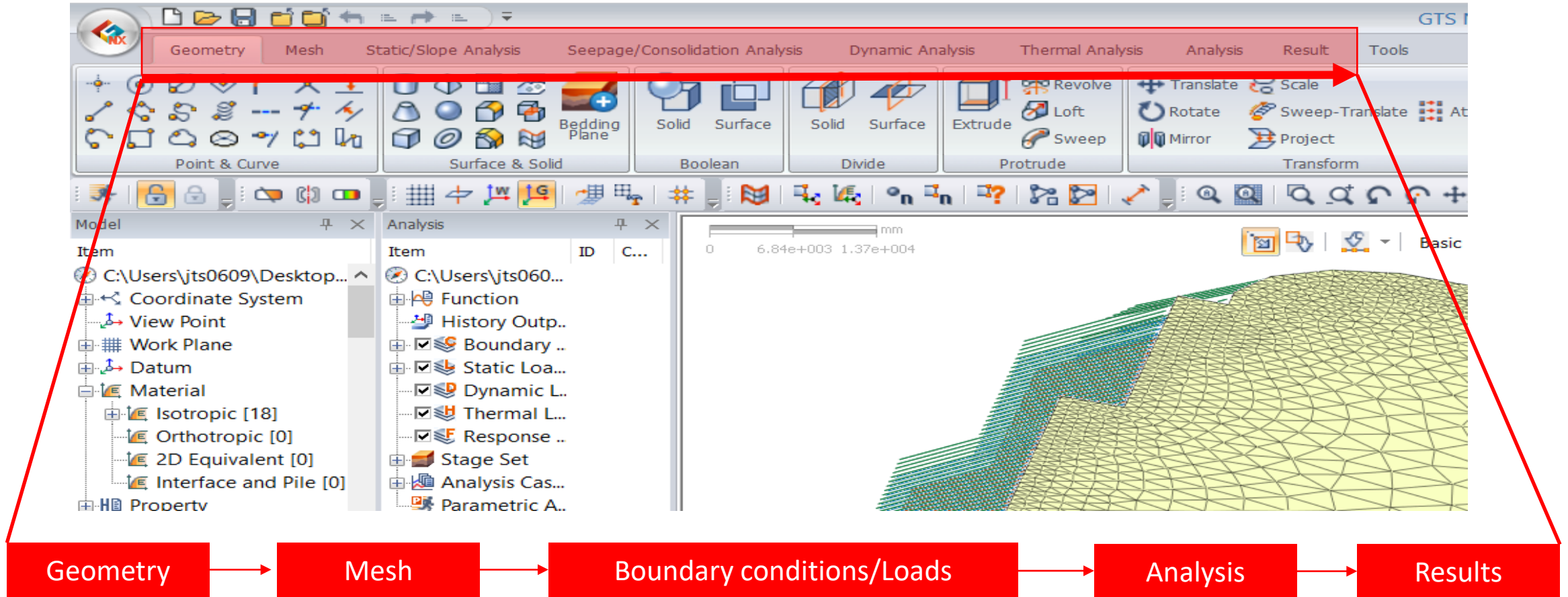
How to enhance your design process

- Simple work-flow



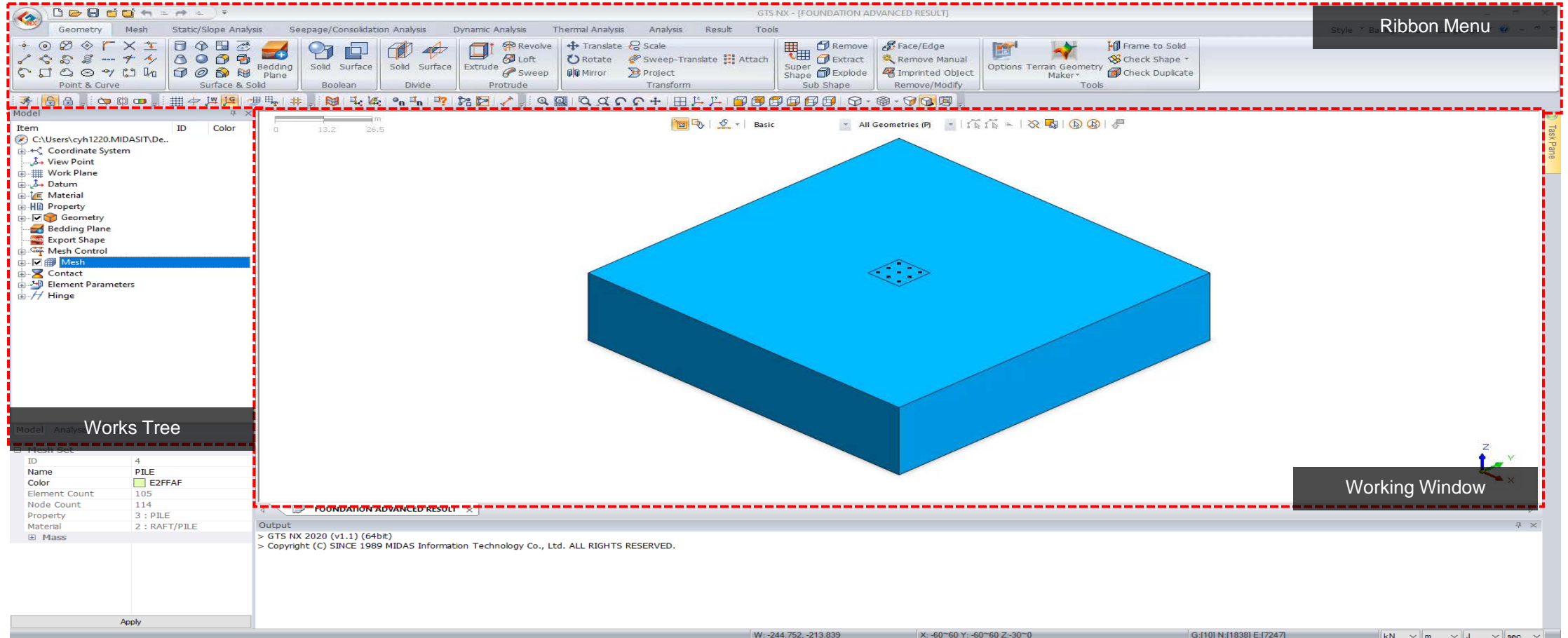
How to enhance your design process

- Simple work-flow



How to enhance your design process

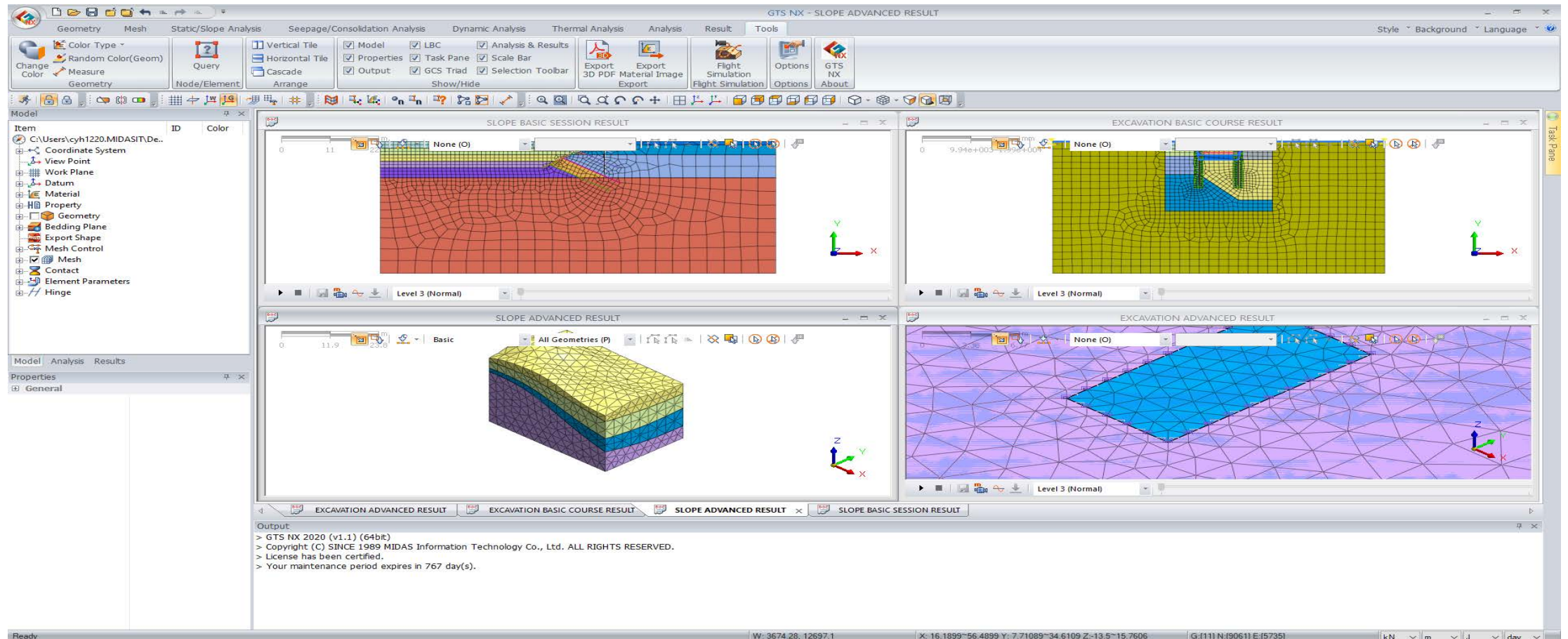
- Graphical User Interface



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)

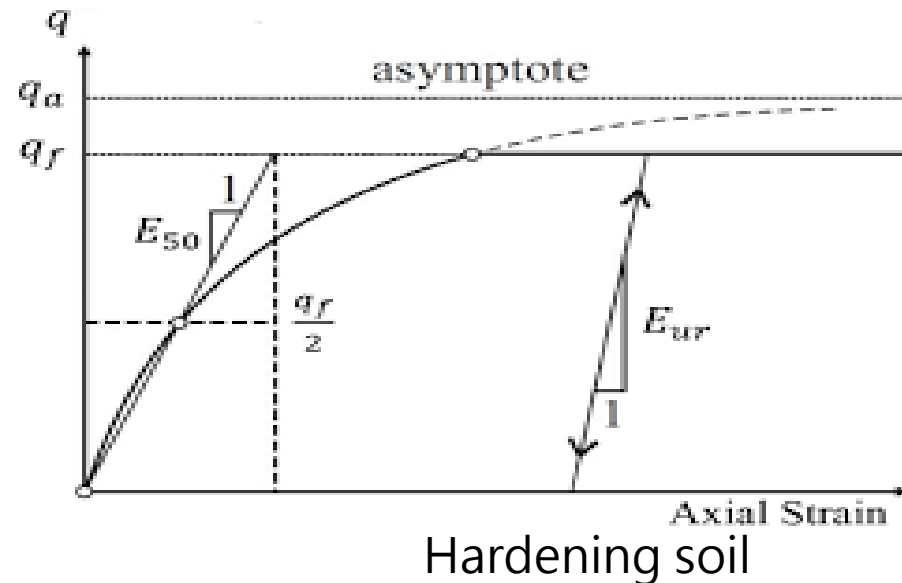
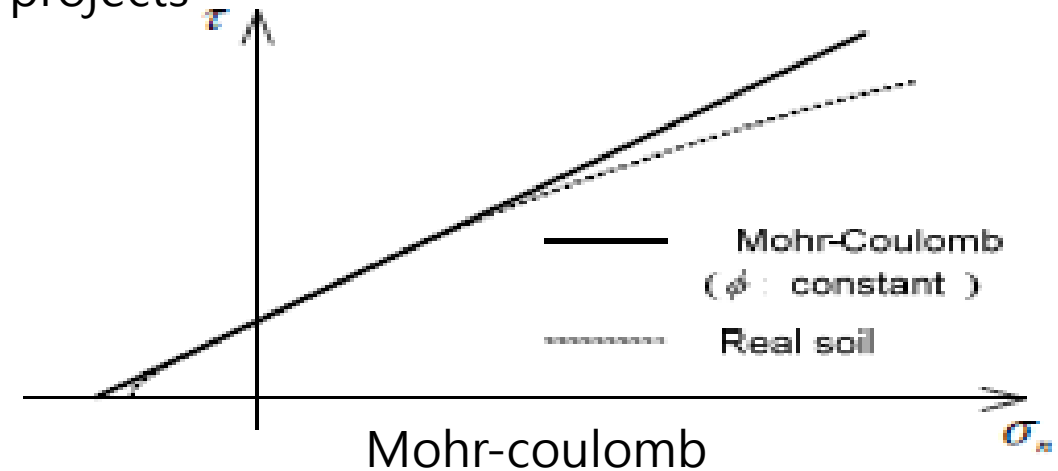
Generalized SCLAY1S

Rock

(Generalized) Hoek Brown

Jointed Rock Mass

CWFS



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

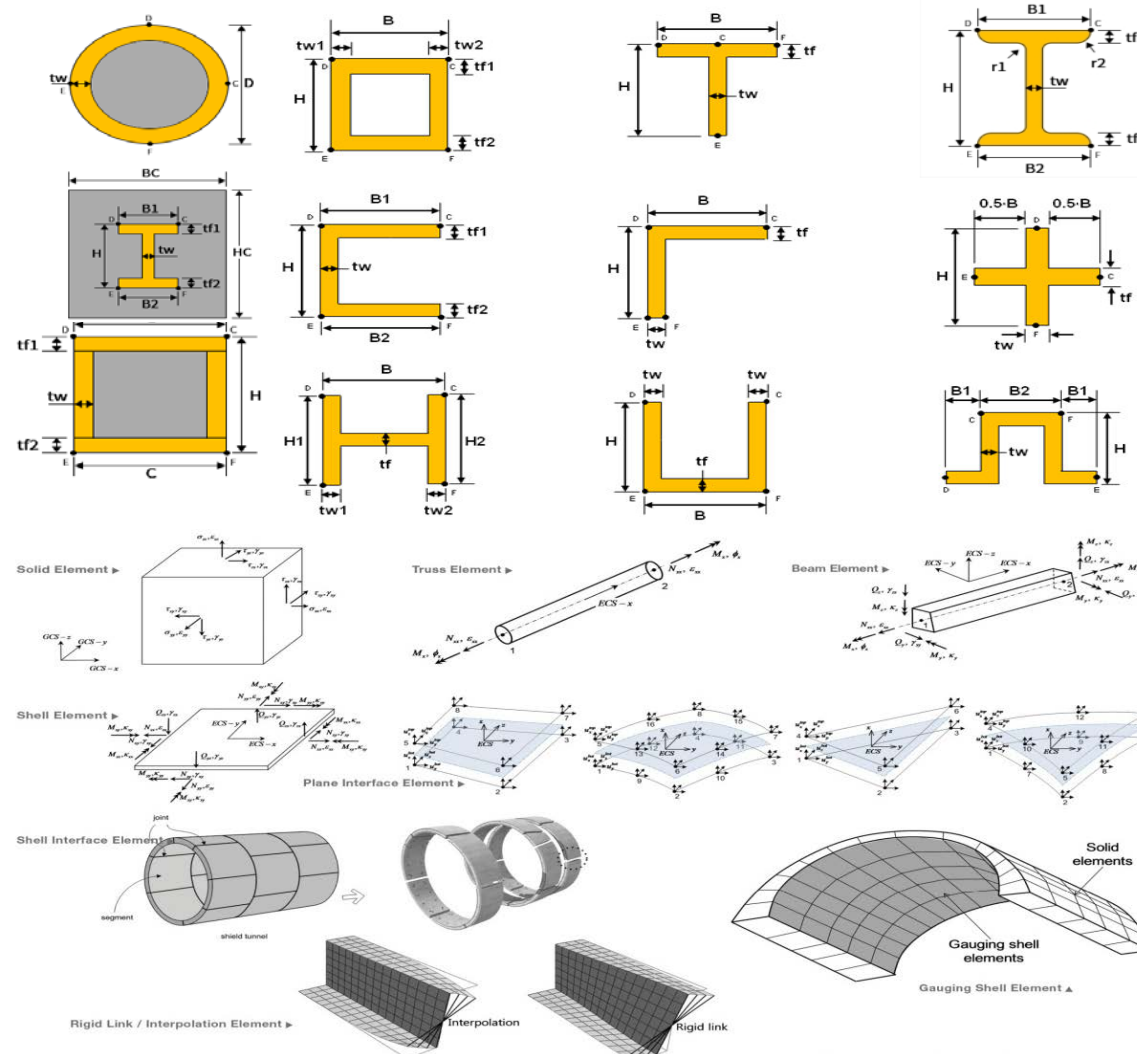
Shell
Gauging shell
Plane stress
Plane strain
Geogrid
Axisymmetric

3D Element

Solid

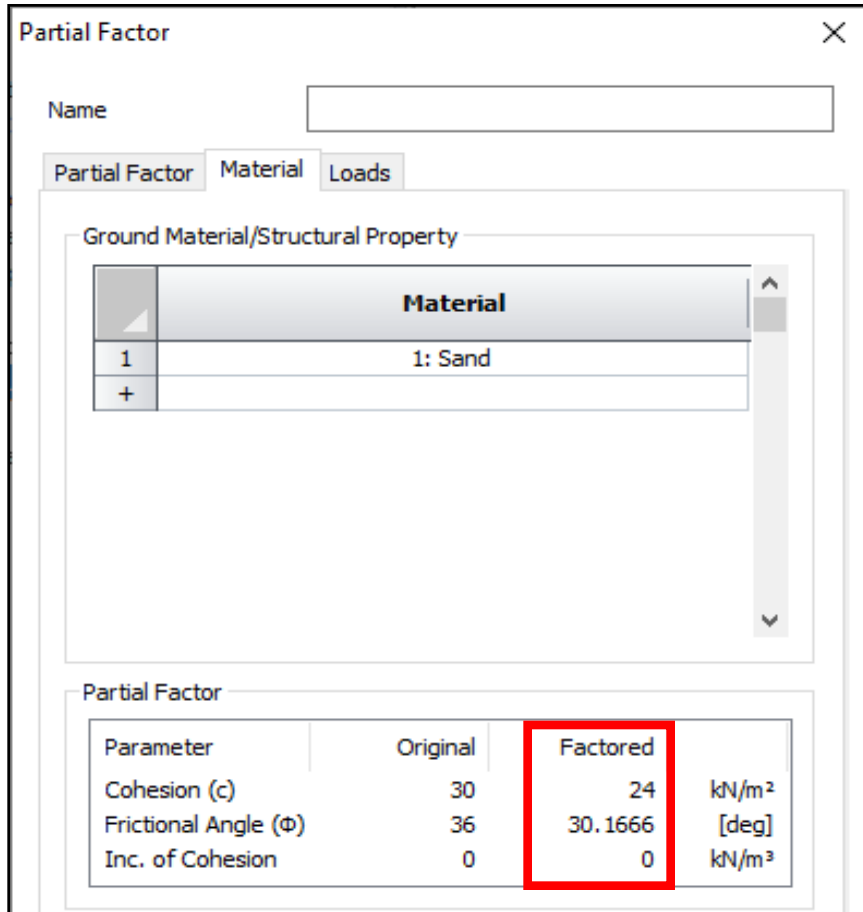
Others

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



How to enhance your design process

- More convenient Partial Factor design function



Partial Factor

Name

Partial Factor Material Loads

Ground Material/Structural Property

	Material
1	1: Sand
+	

Partial Factor

Parameter	Original	Factored	
Cohesion (c)	30	24	kN/m ²
Frictional Angle (Φ)	36	30.1666	[deg]
Inc. of Cohesion	0	0	kN/m ³

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

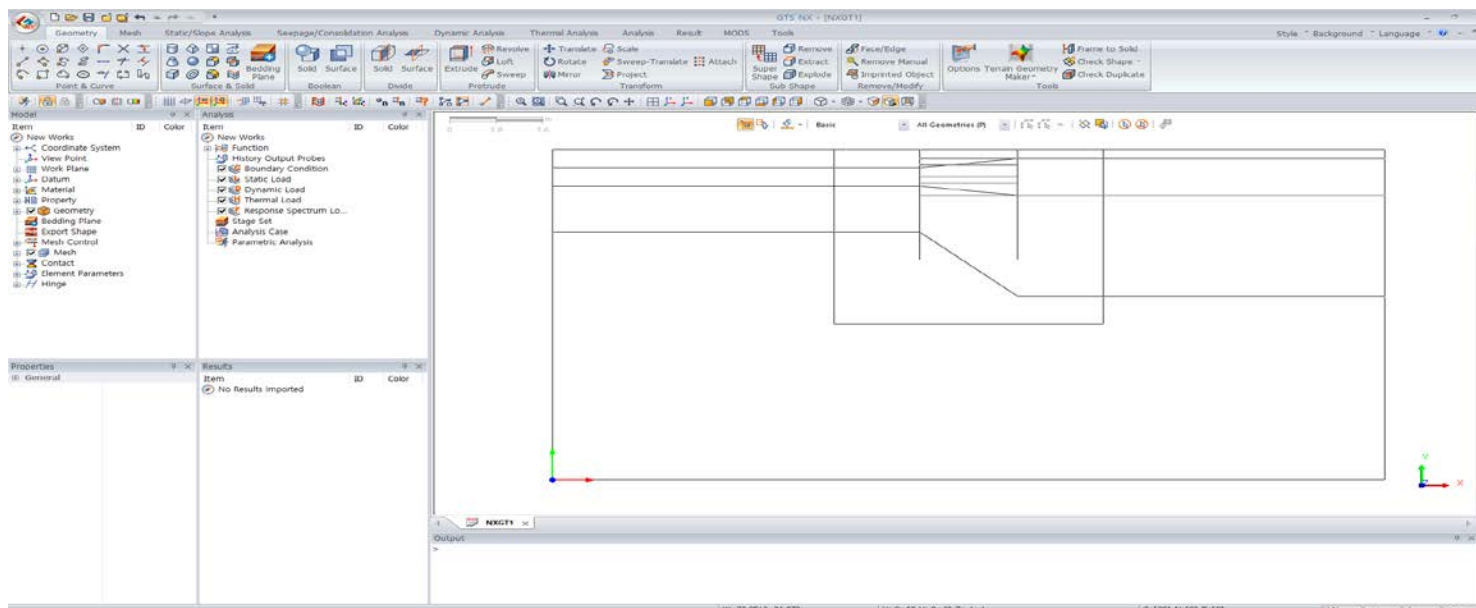
GTS NX is providing the database for this partial factor as below,
Design Approach 1 Combination 1
Design Approach 1 Combination 2
Design Approach 2
Design Approach 3

Directly checking the original and factored parameters

How to enhance your design process

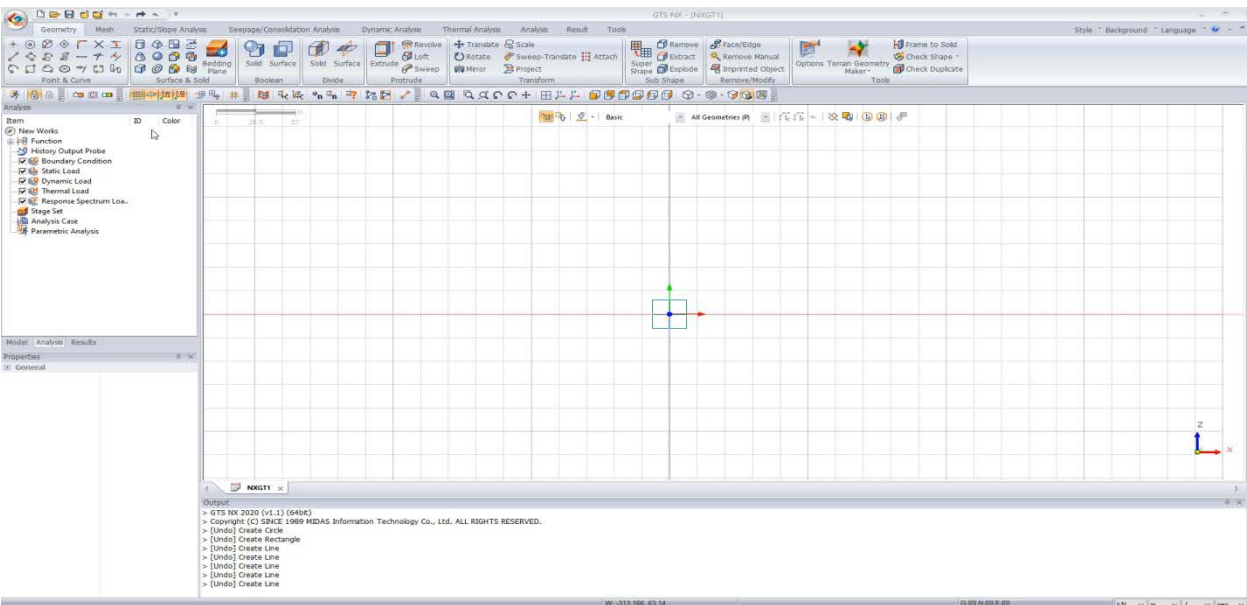
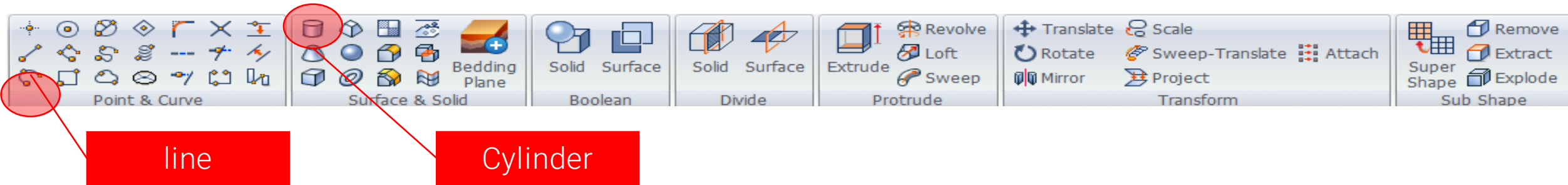
- Perfect compatibility with CAD formats

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

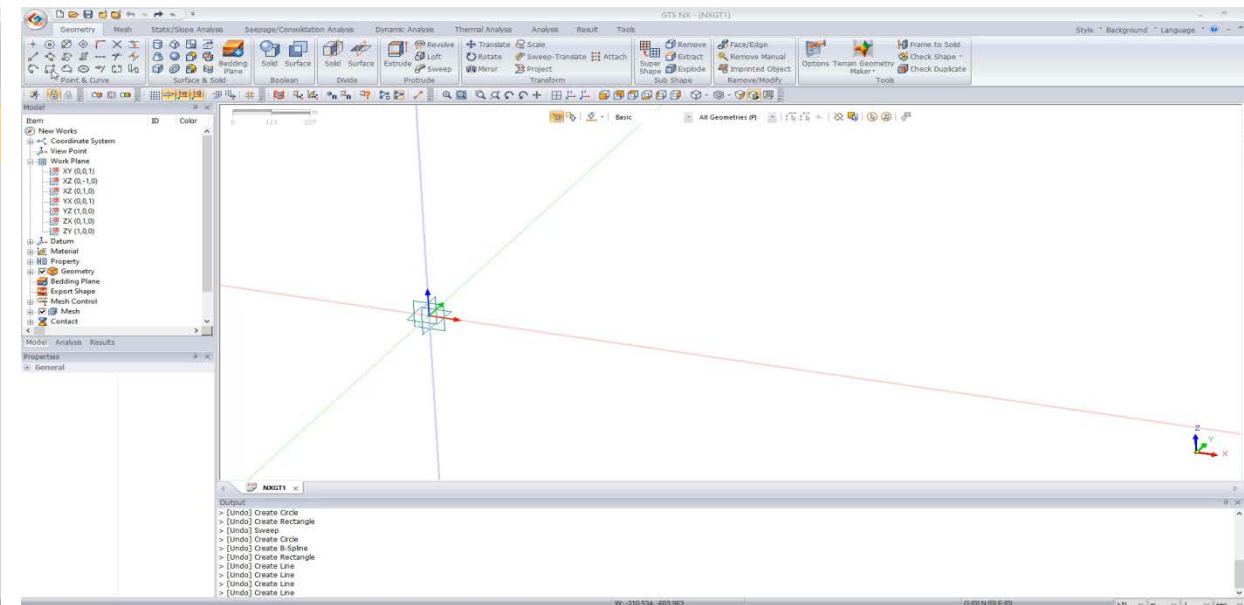


How to enhance your design process

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



Line / Square / Circle

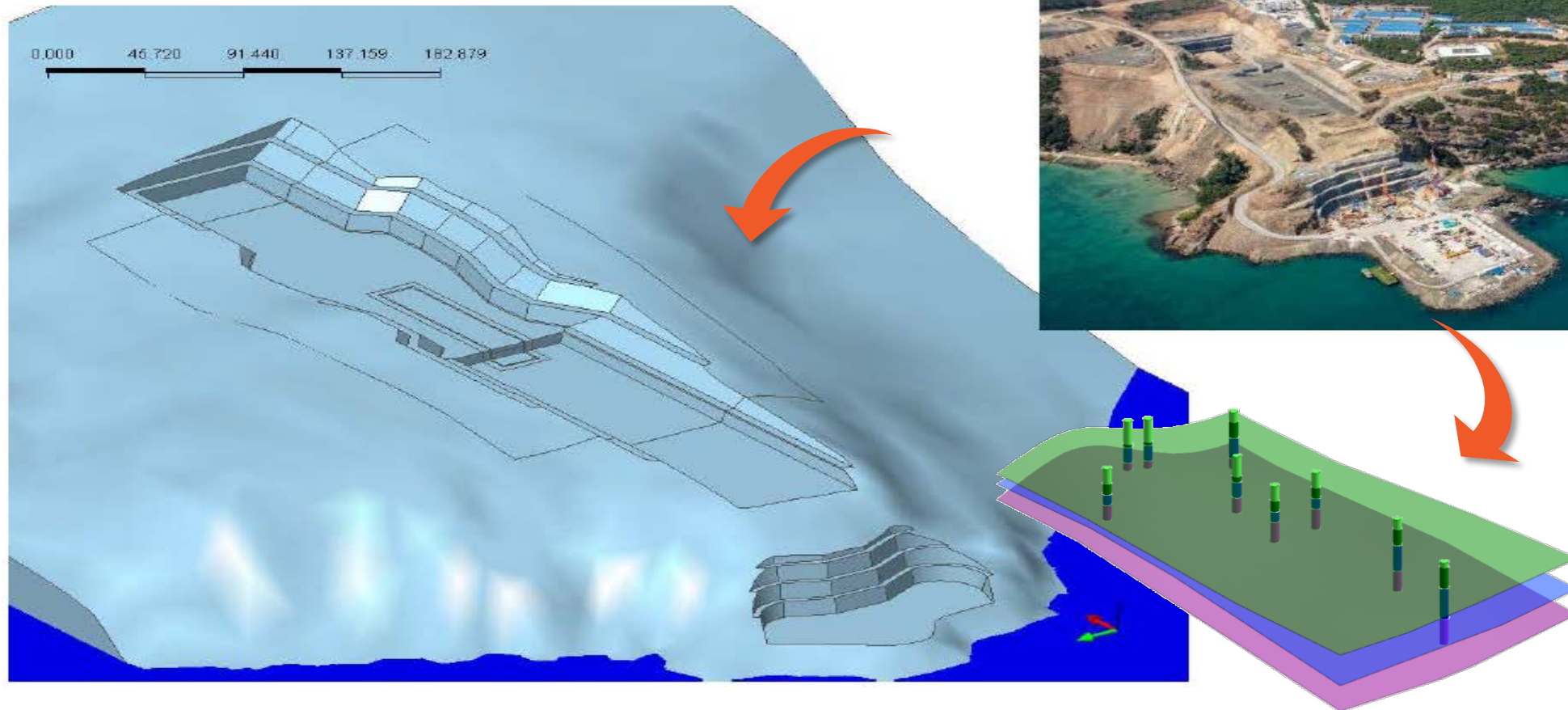


Extrude / Sweep

How to enhance your design process

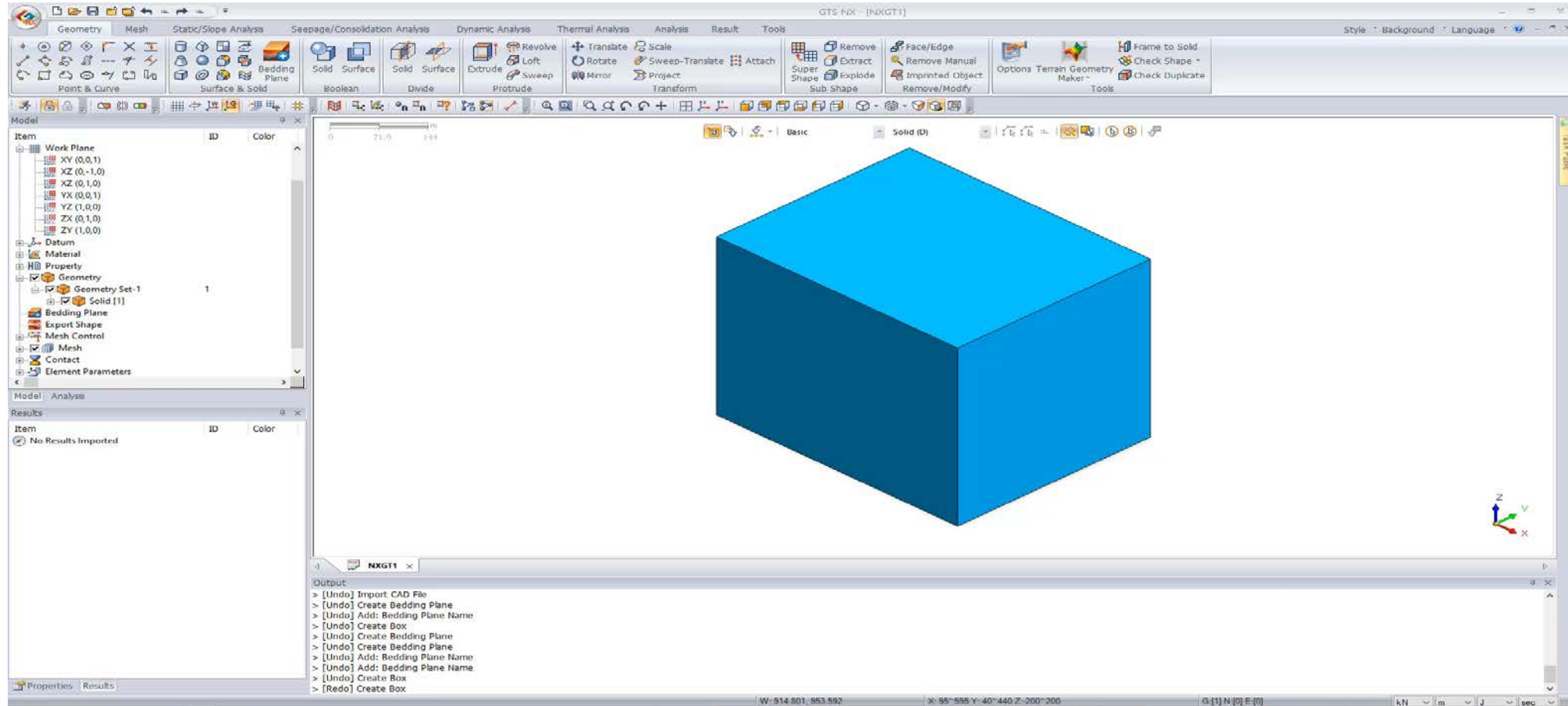
- **TGM & Bedding plane wizard**

Easily create the surface of the site by simple topography import



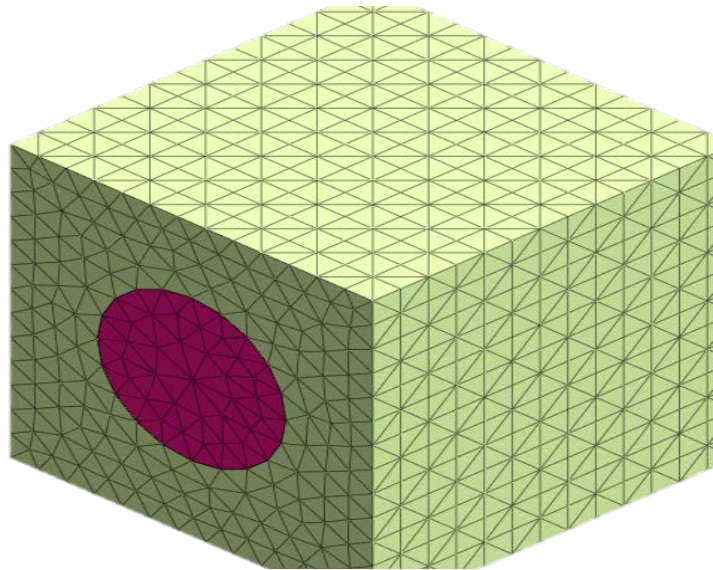
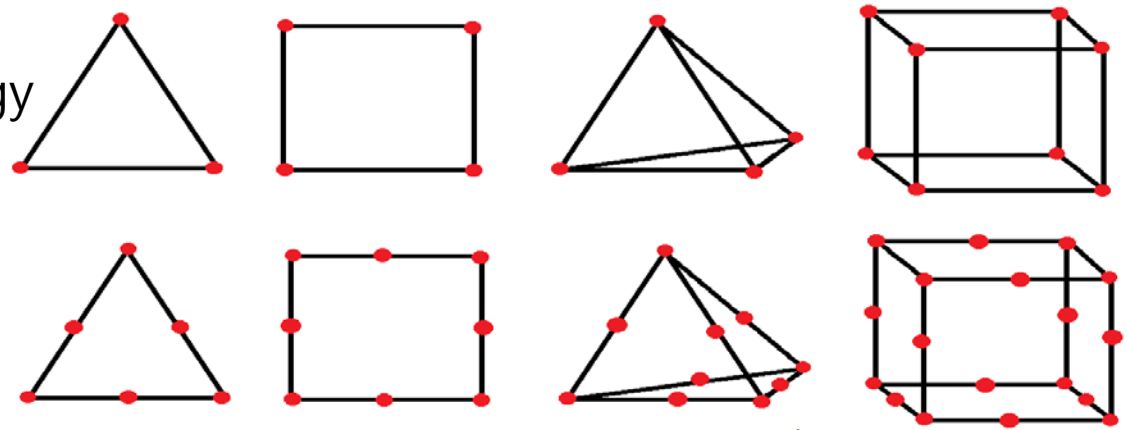
How to enhance your design process

- **TGM & Bedding plane wizard**
Easily create the surface of the site by simple topography import

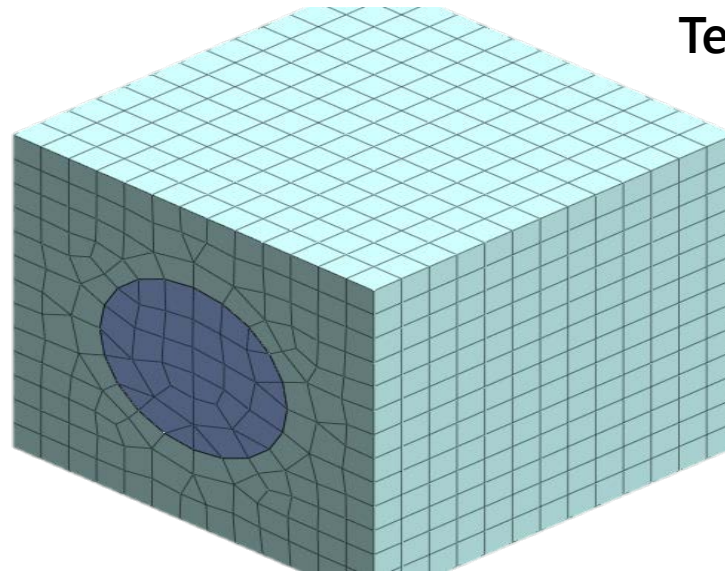


How to enhance your design process

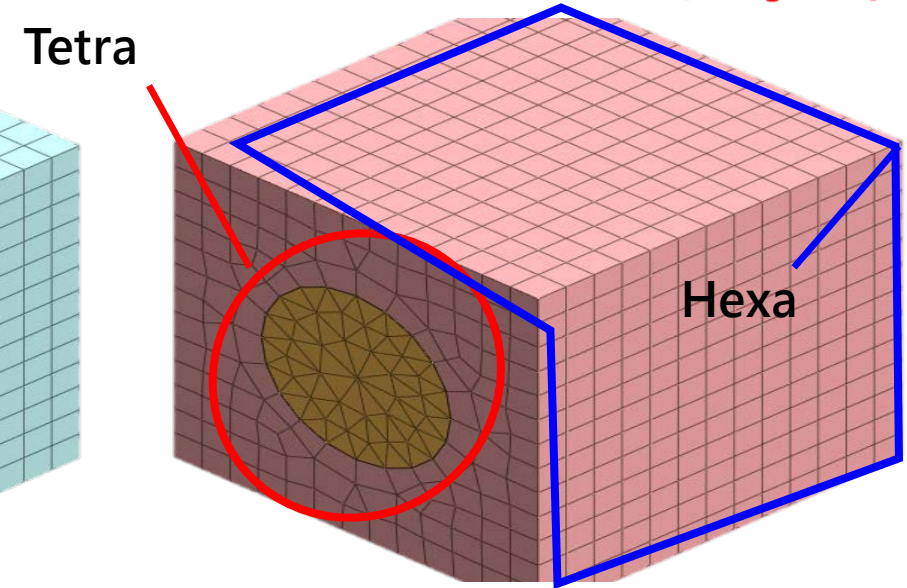
- **TGM & Bedding plane wizard**
Powerful meshing algorithm with Hybrid technology



Tetrahedral



Hexahedral



Tetra + Hexa(hybrid)

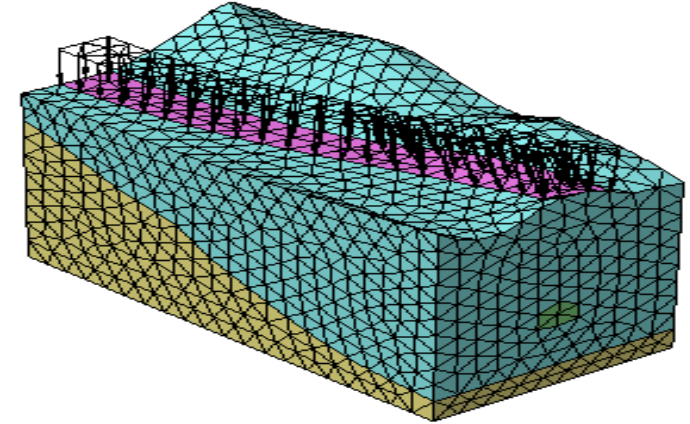
How to enhance your design process

- Boundary conditions & Loads

Boundary

Constraint
Change Properties
Review
Water level
Nodal Head
Surface Flux

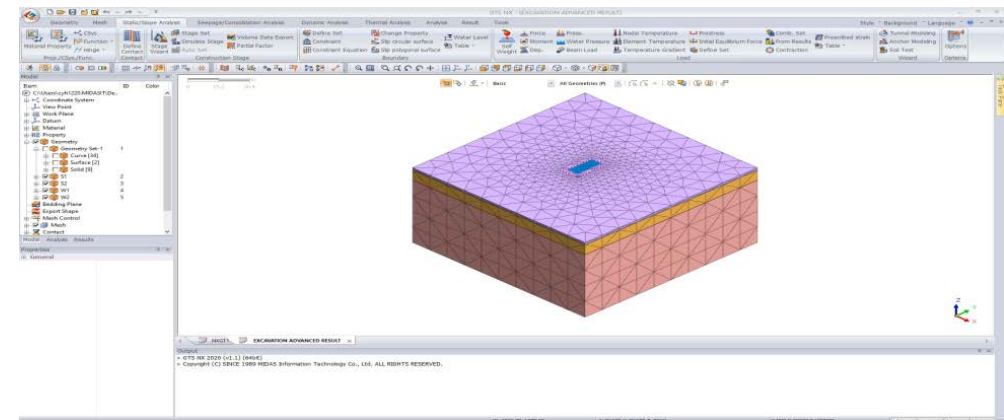
Slip Circle/Polygonal Surface
Draining Condition
Non Consolidation
Transmitting



Loads

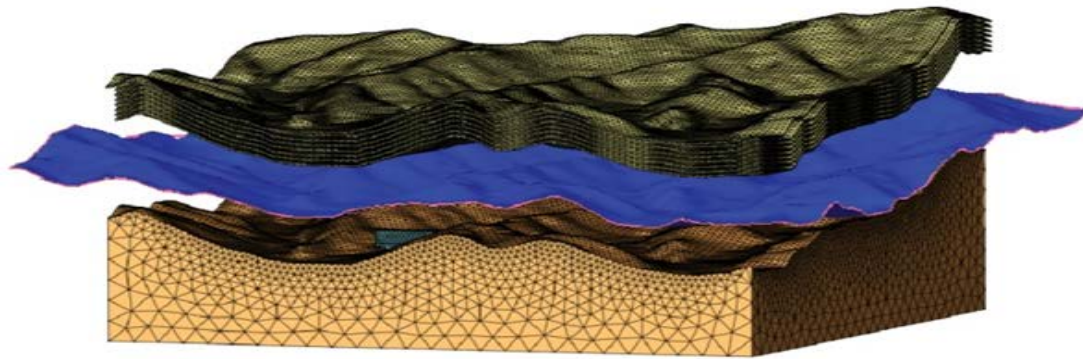
Self Weight
Force
Moment
Displacement
Pressure(Surge / Water)
Line Beam Load
Element Beam Load
Temperature
Pre-stress

Contraction
Initial Equilibrium Force
Combined Load
Response Spectrum
Ground Acceleration
Time Varying Static
Dynamic Nodal / Surface
Load to Mass
Train Dynamic Load Table

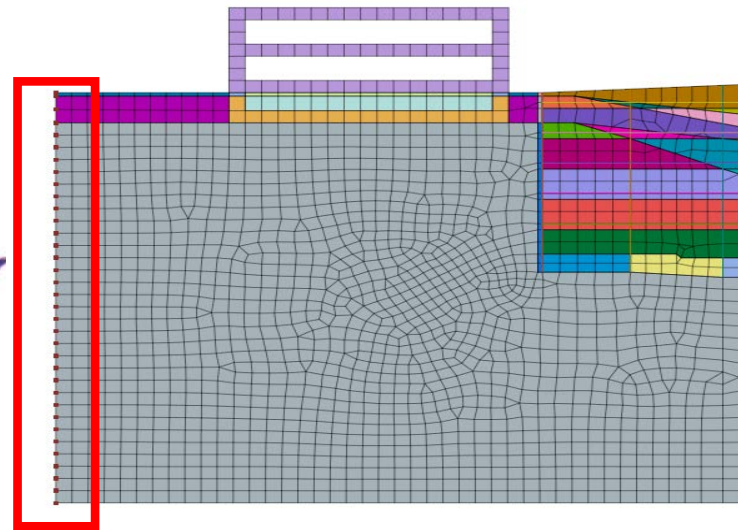


How to enhance your design process

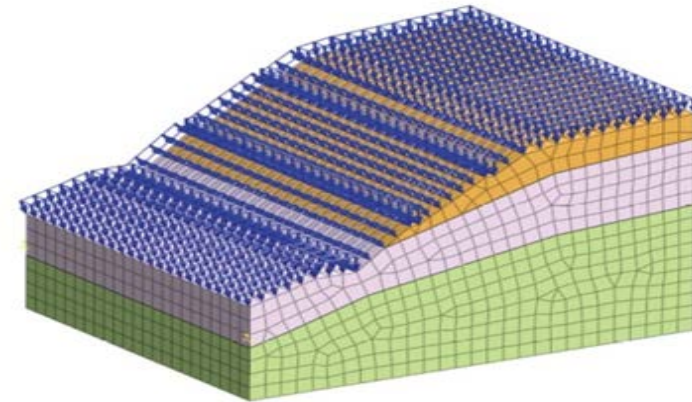
- Water condition control – nodal head, line & surface flux, water level



3D water level automatic generation



Nodal head for water level

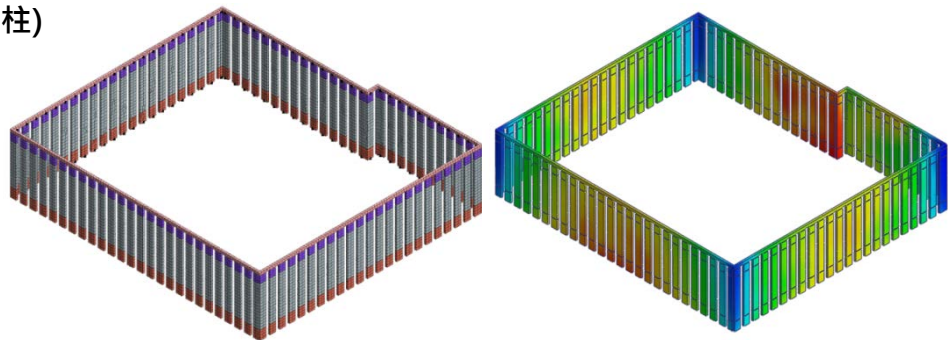


Rainfall intensity input

How to enhance your design process

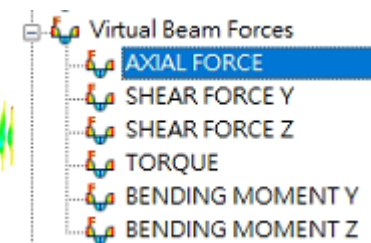
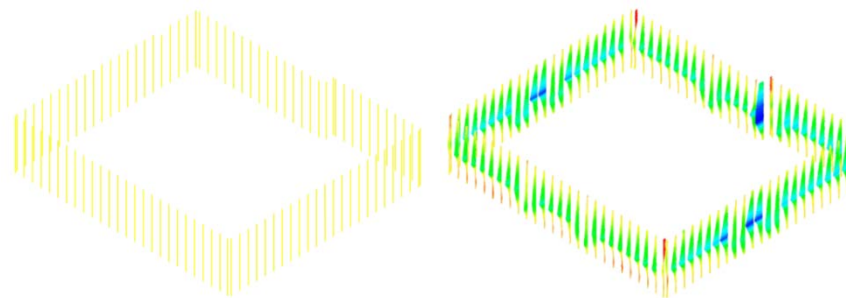
- Easy check result – 1D/2D Equivalent Elements

實體元素
(擋土柱)

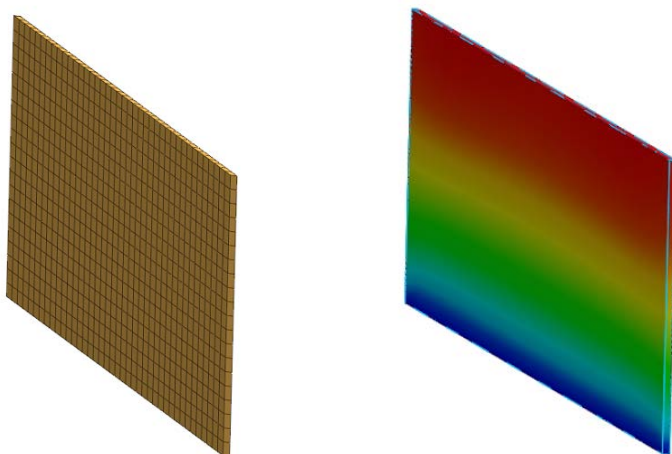


如何計算等效軸力?

虛擬梁(Virtual Beam)

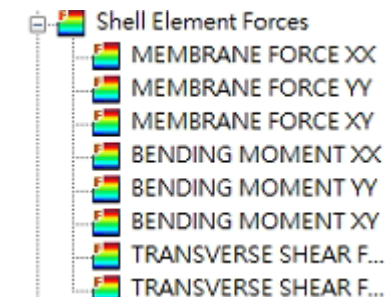
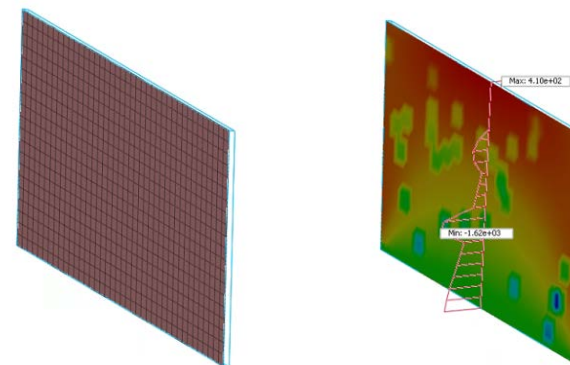


實體元素



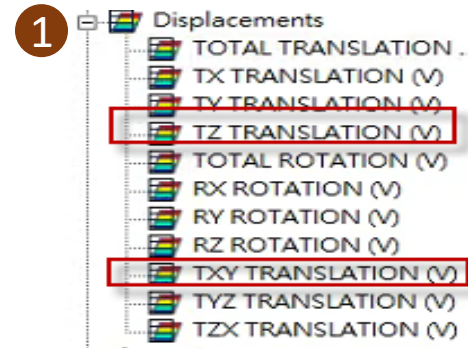
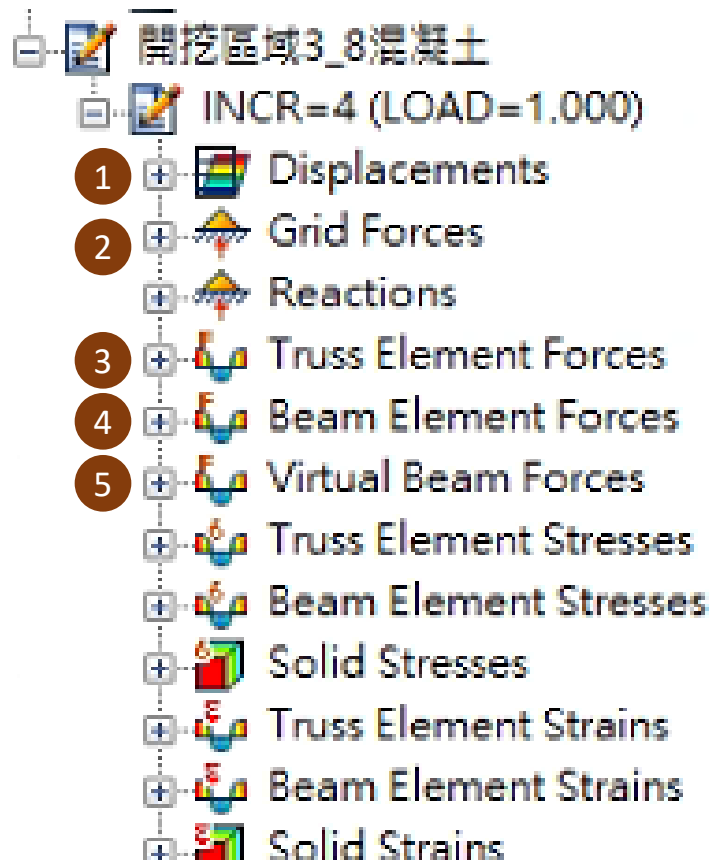
如何得到受力方向大小?

測量板(Gauging Shell)

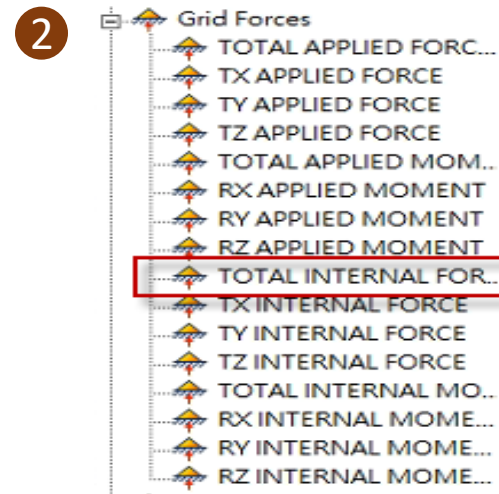


How to enhance your design process

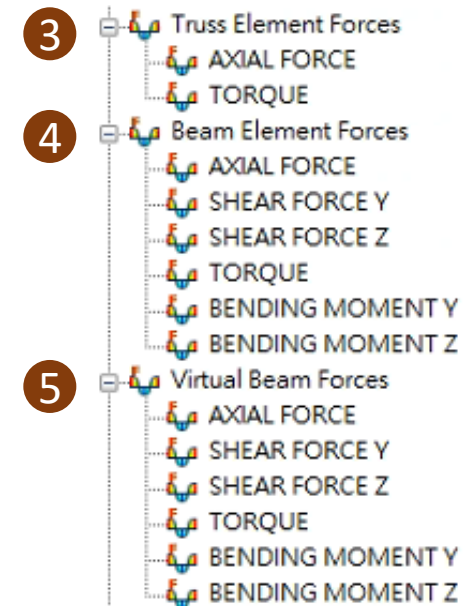
- Easy check result - various types of results



水平變位TXY
垂直變位TZ



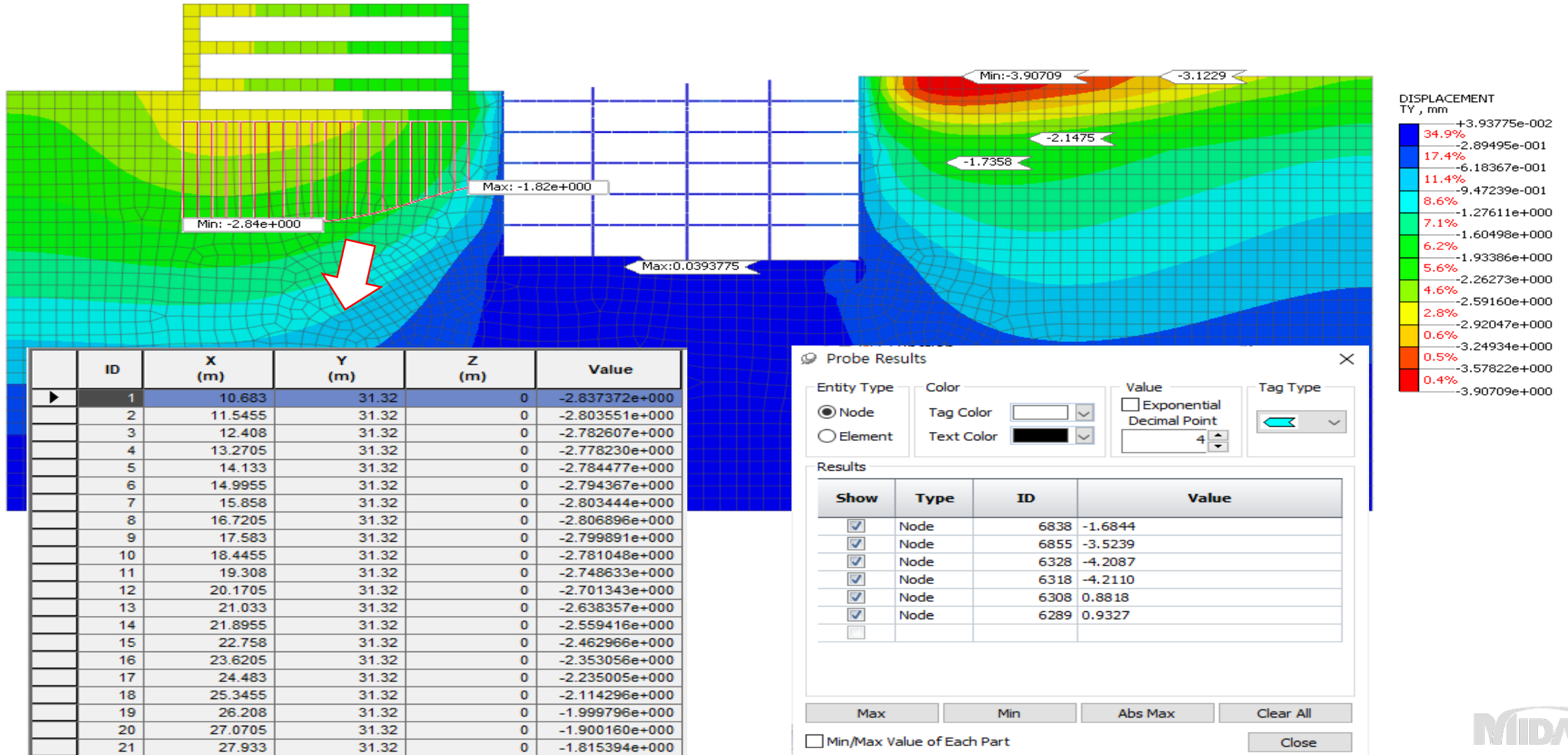
內力
Grid Force



軸力
Axial Force

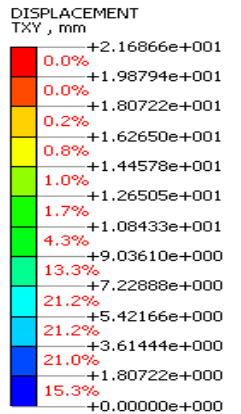
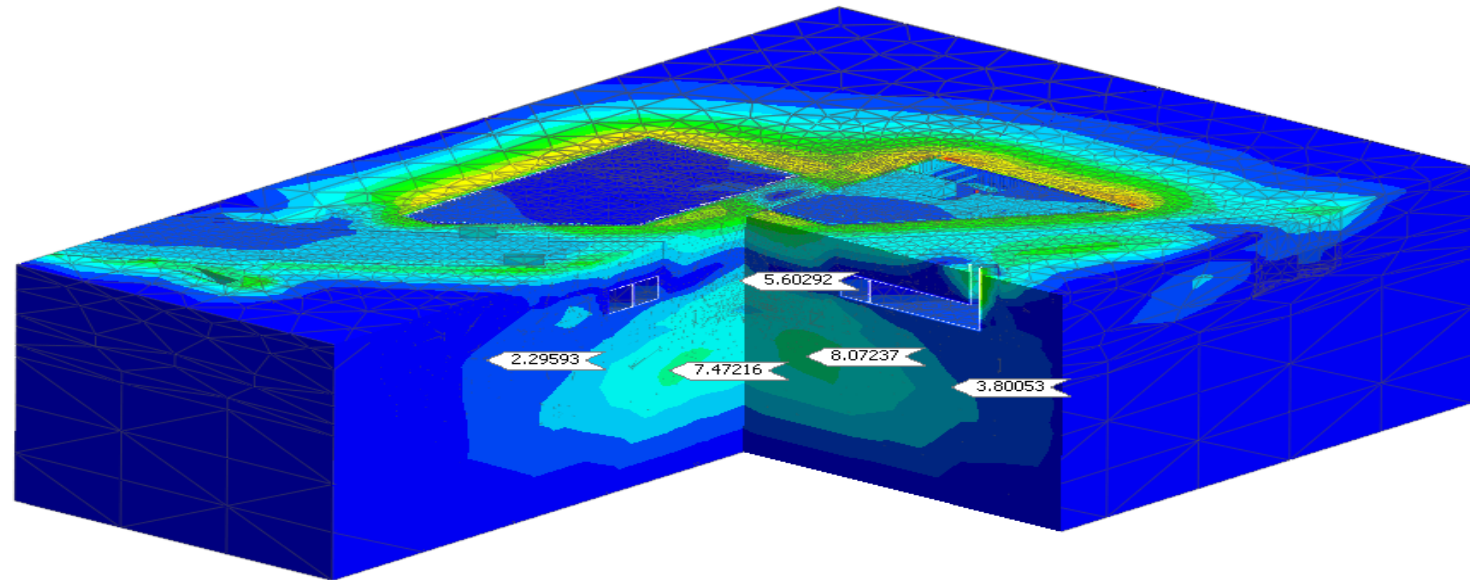
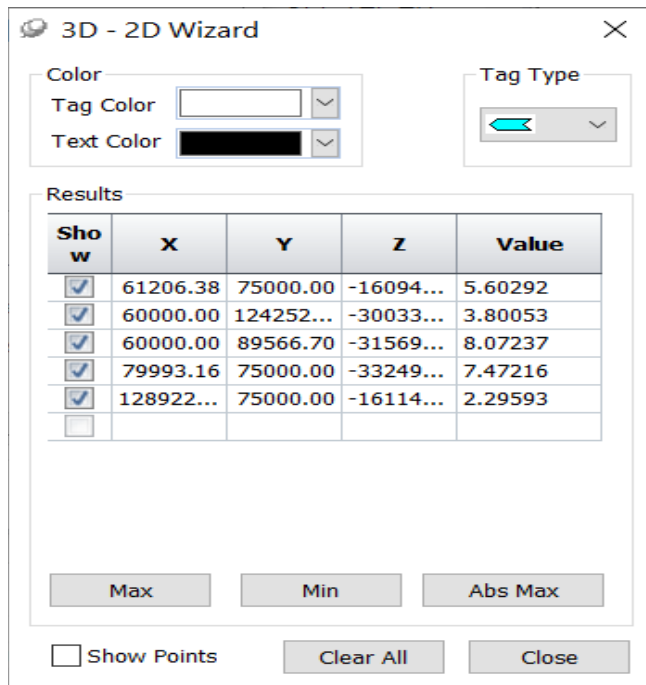
How to enhance your design process

- Easy check result - Probe



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

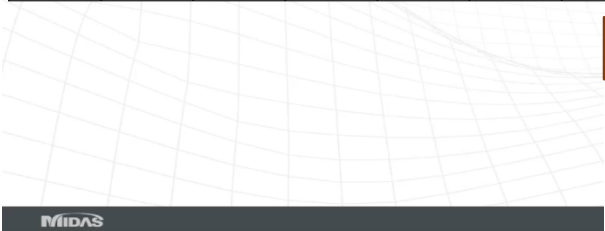
materials and properties with "PDF" format

Material

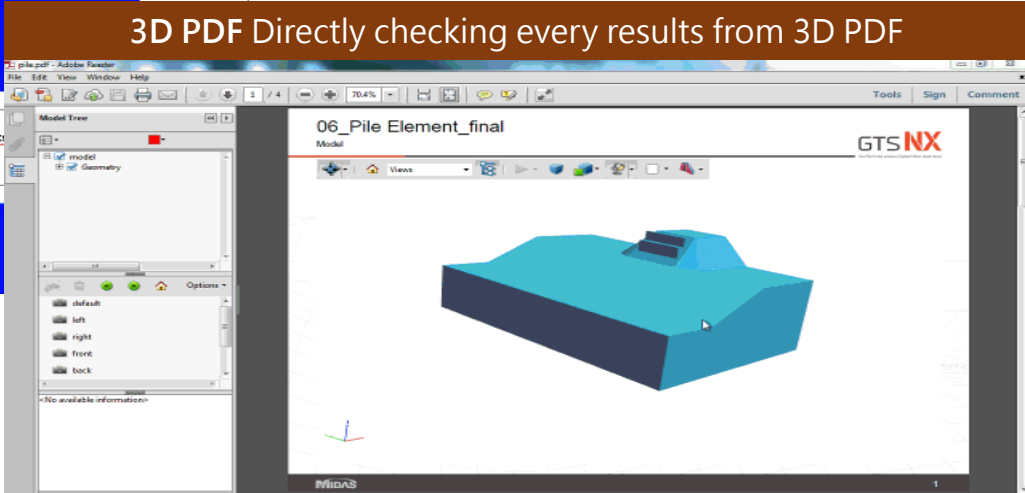
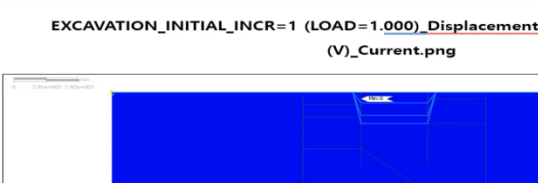
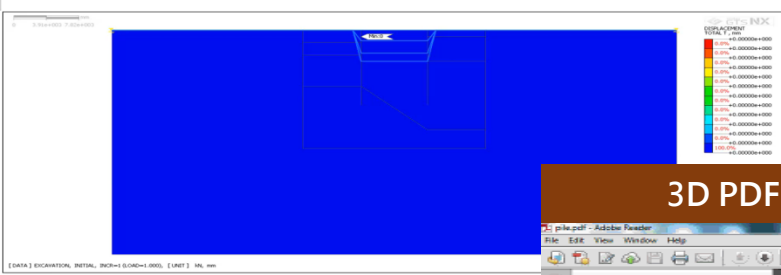
GTSNX

Elastic

Name	E (kN/mm ²)	Inc. of Elastic (kN/mm ²)	Inc. of E Ref. Height (mm)	v	γ (kN/mm ³)	K ₀	Thermal Coeff. (1/T)	Molecular Vapor Diffusion Coeff. (mm/sec ²)	Thermal Diffusion Enhancement	Damping Ratio
	y_sat (kN/mm ²)	e_o	kx (mm/sec)	ky (mm/sec)	kz (mm/sec)	S ₆ (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	

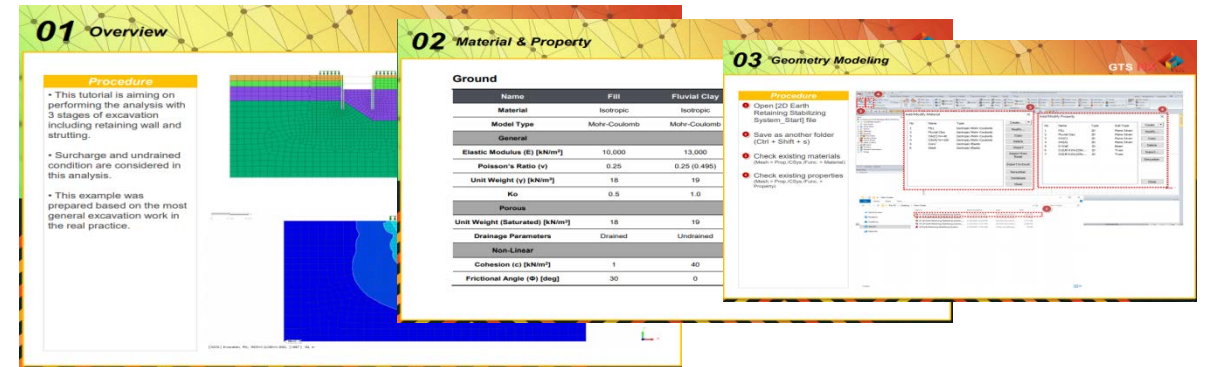
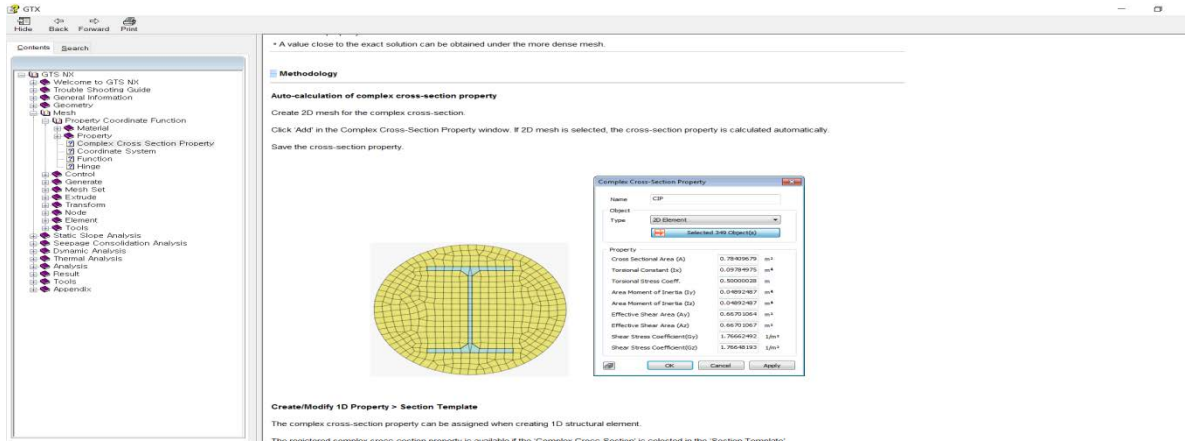


Results export with "WORD" format

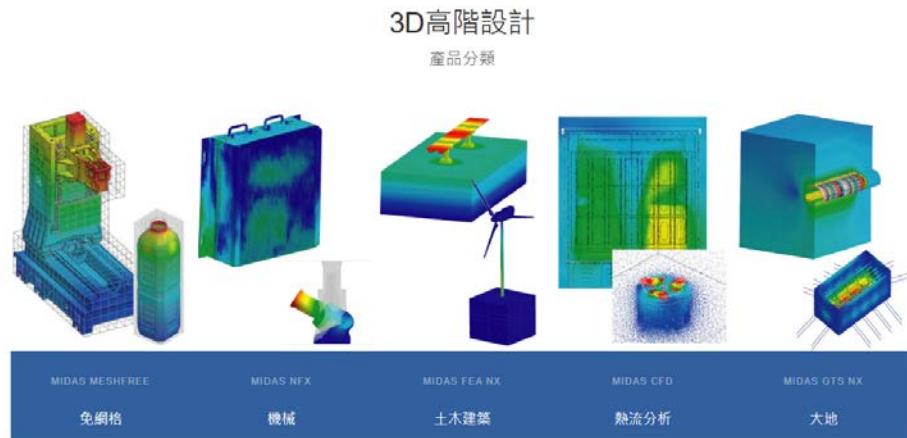


Technical support system

- Help manuals / Tutorials with various topics



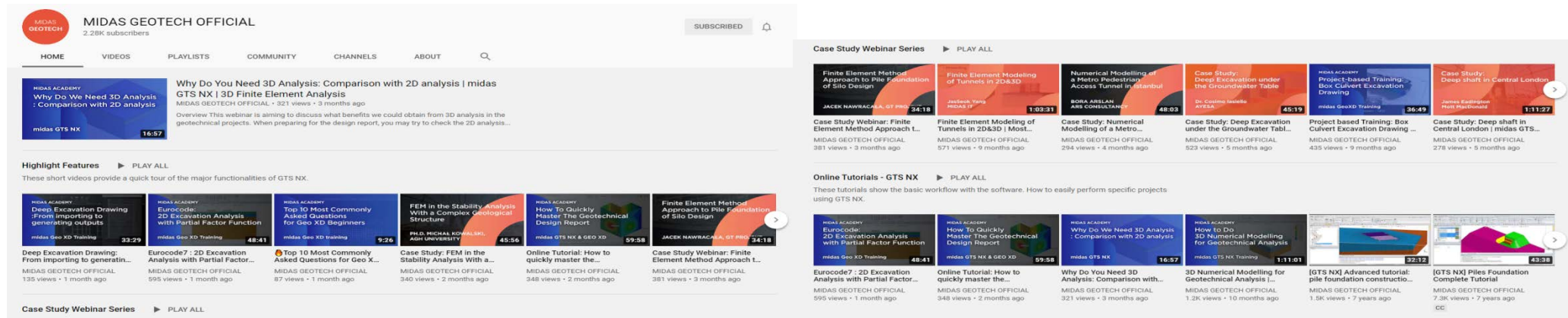
- Taiwan MIDAS Solid-Simulation website



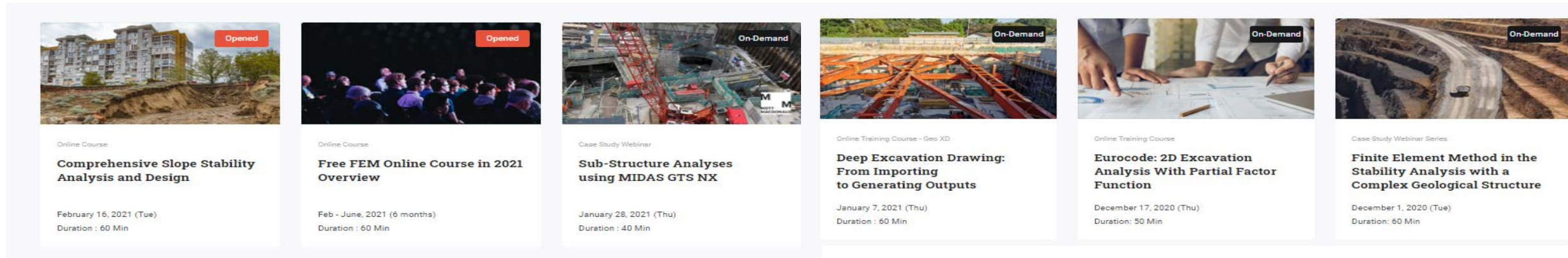
<https://www.midasuser.com.tw/SolidSimulation/>

Technical support system

- Various training video contents



- Training Program (Online Course / Case study)

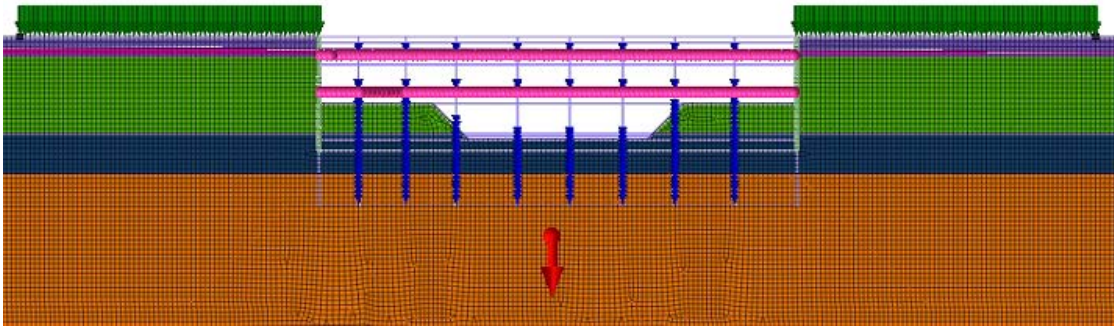


MIDAS Geotech has rich experience and know-how to grow the practical engineers

MIDAS Case Study

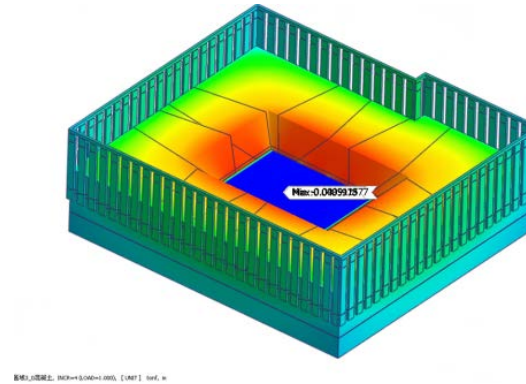
3D島式開挖

2D分析

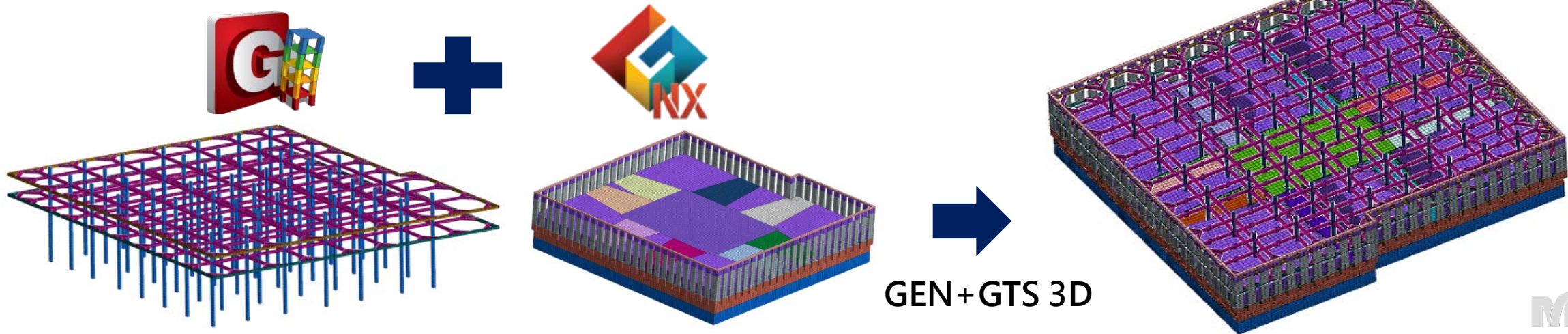
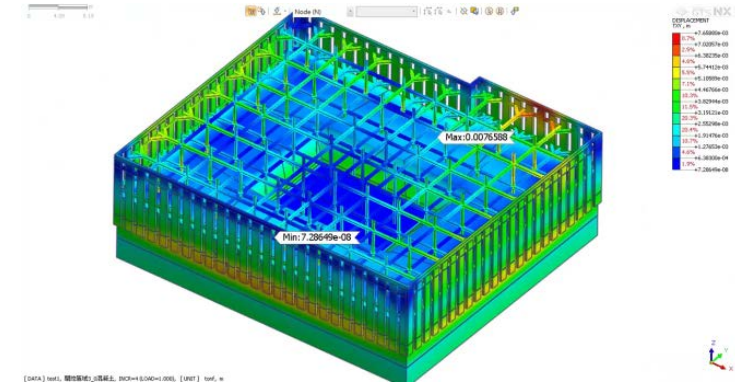


2D 建模只考慮模型的一個平面，縱向支撐、水平支撐和傾斜梁無法建模。

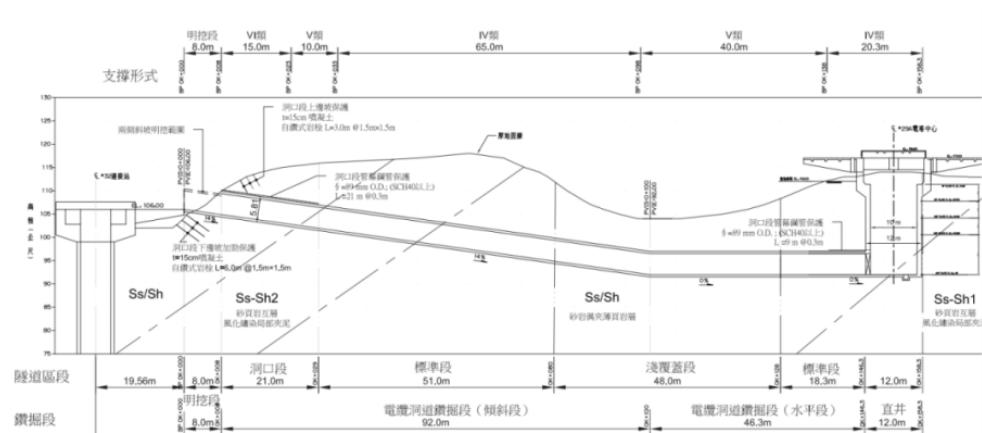
開挖面最大垂直位移 (m)



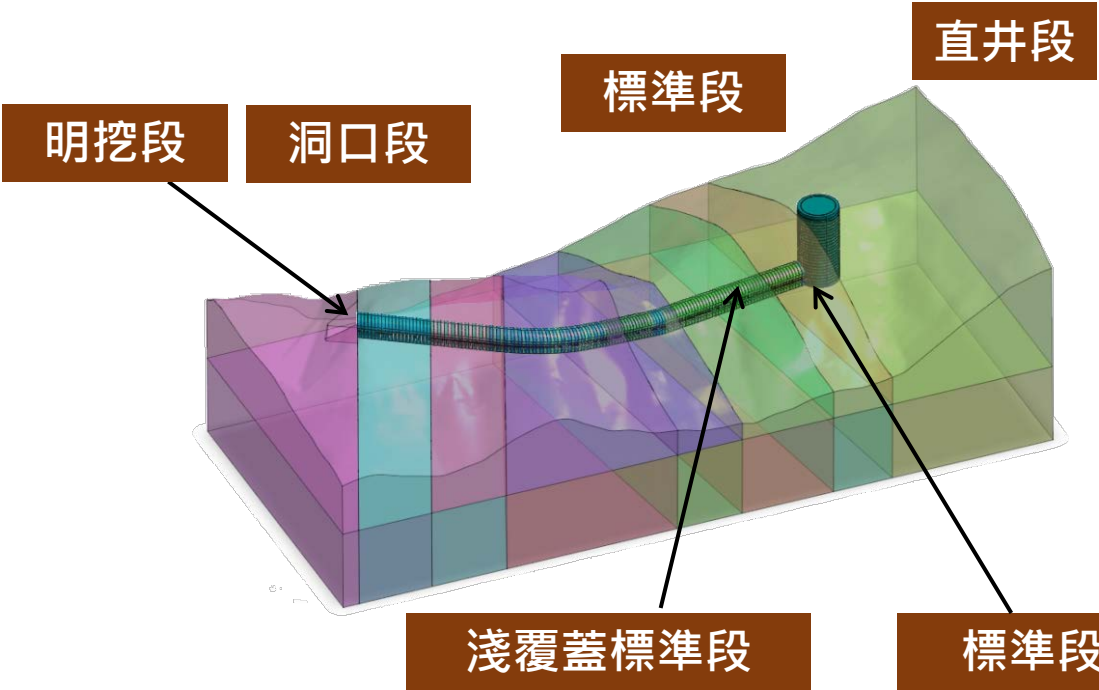
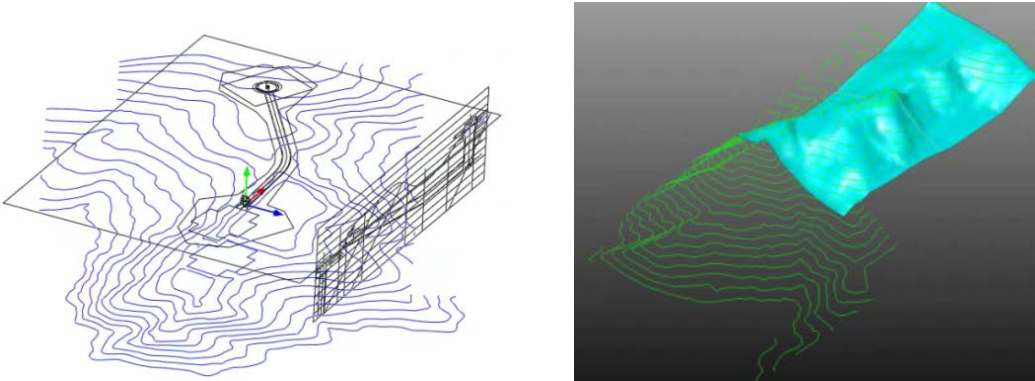
開挖面最大水平位移 (m)



GTS NX NATM實例

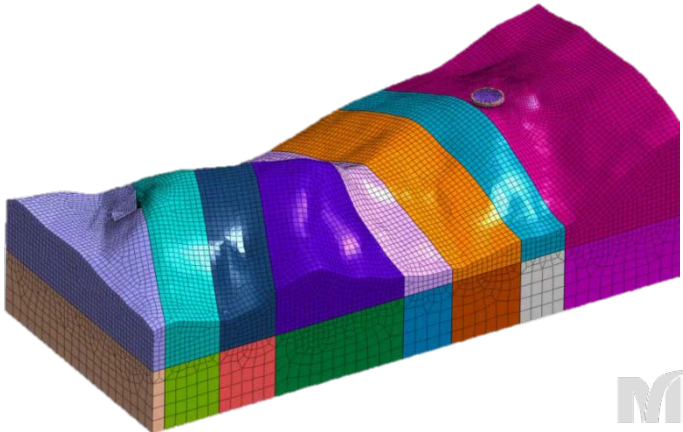


MIDAS/TGM



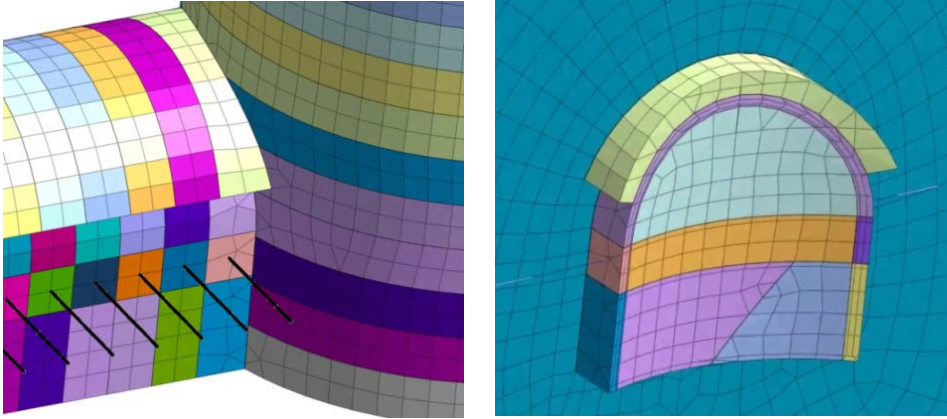
Hybird Mesher

(六面體 + 五面體 + 四面體)

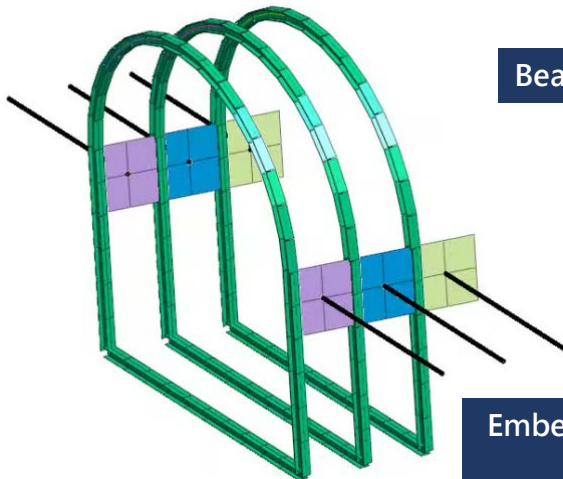


GTS NX NATM實例

GTS NX 混合網格/全共點建模



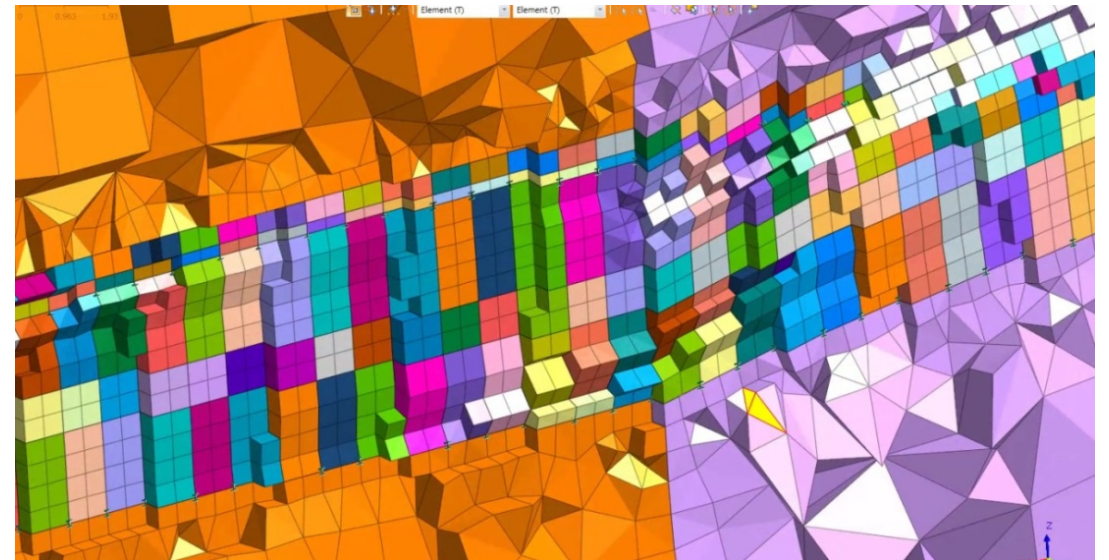
Shell Element(傳力裝置)



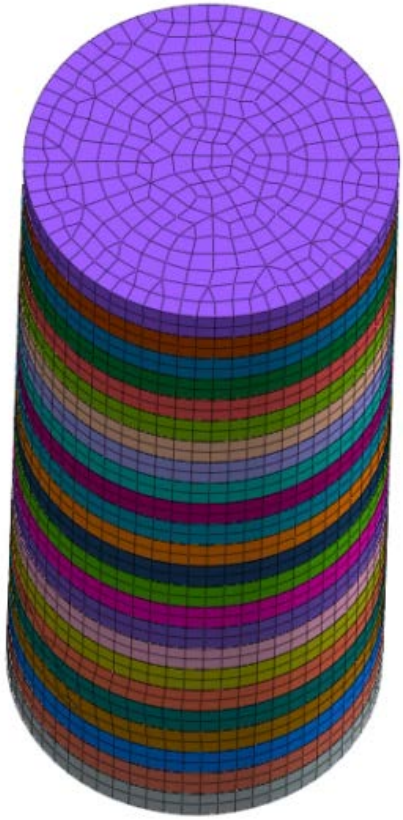
Beam Element(H型鋼)

Embedded Truss Element
(Rock Bolt)

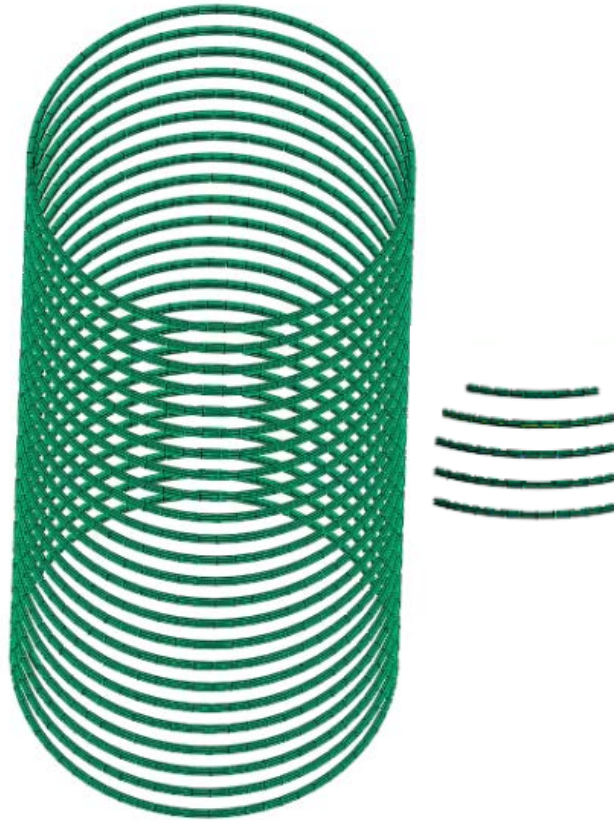
GTS NX 混合網格/全共點建模



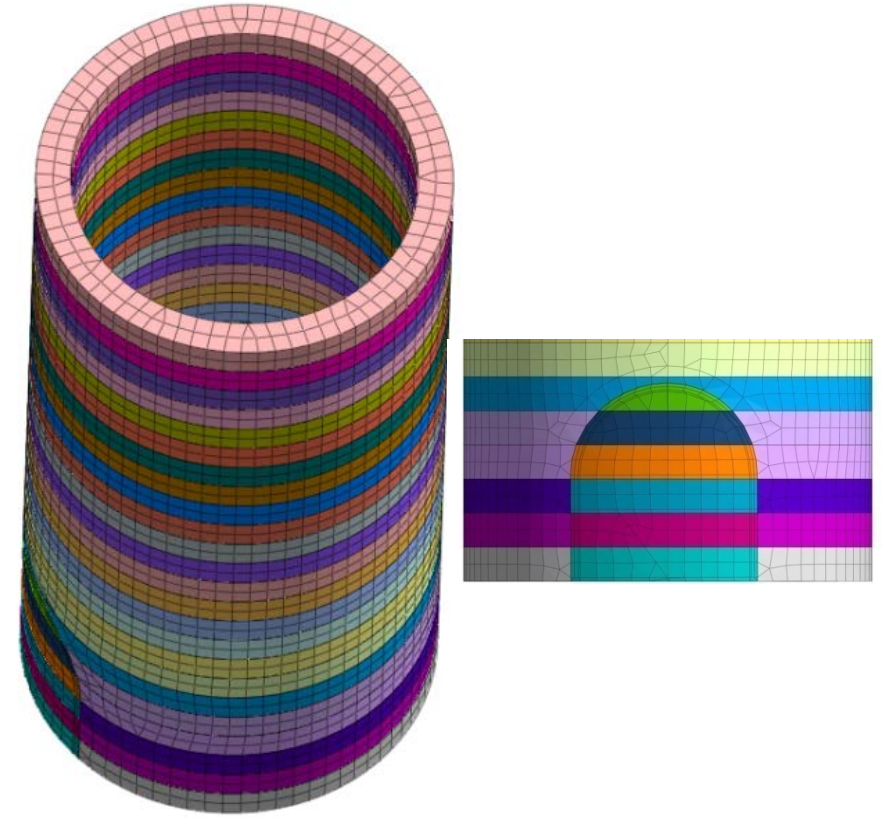
直井段



直井主開挖區



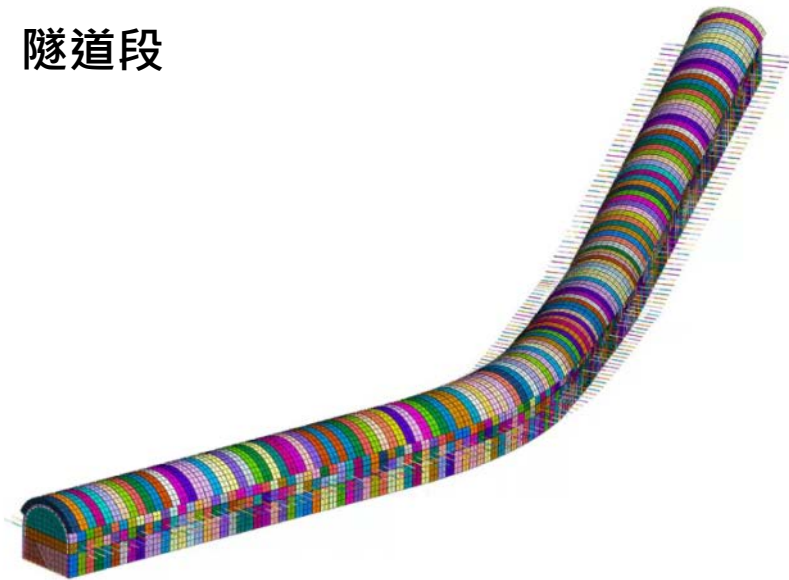
直井鋼支保



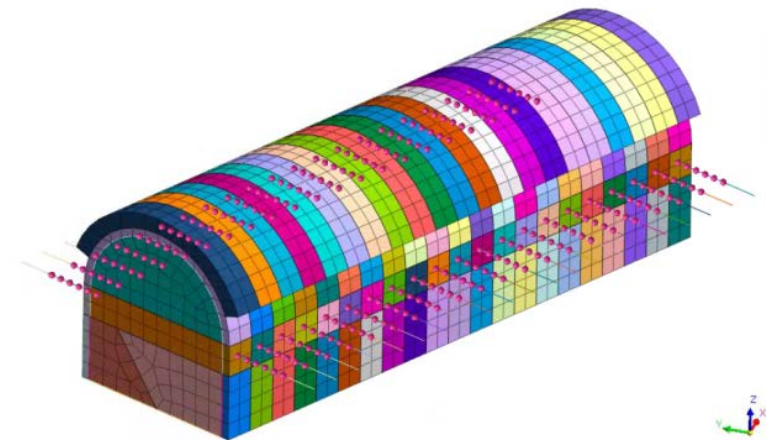
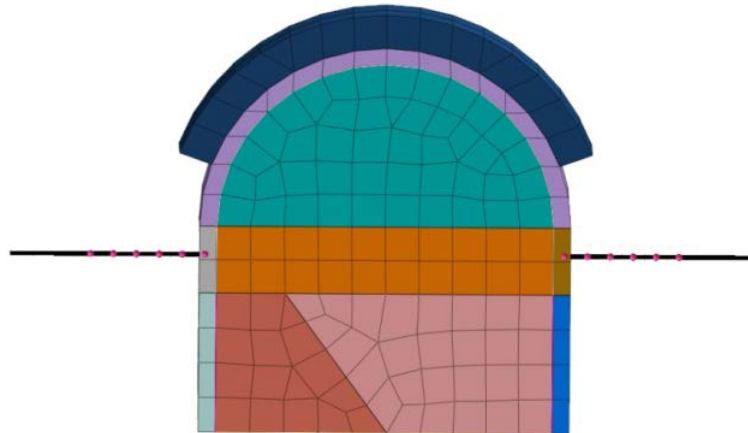
直井背填區

GTS NX NATM實例

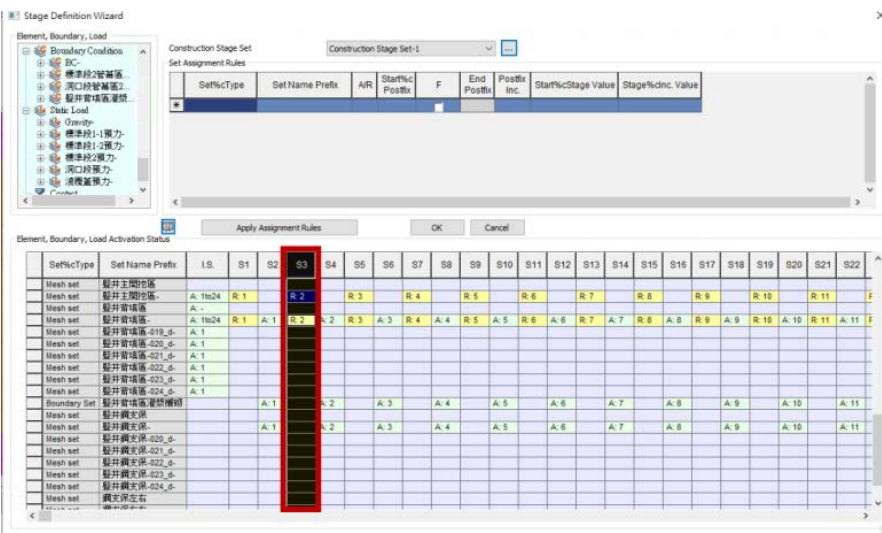
隧道段



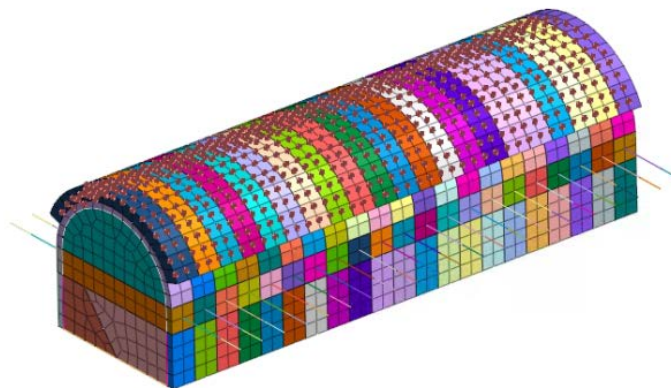
Anchors地錨 (預力施加)



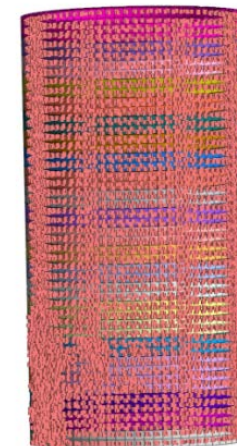
施工階段模組



管幕區變更材質



豎井背填灌漿和襯砌



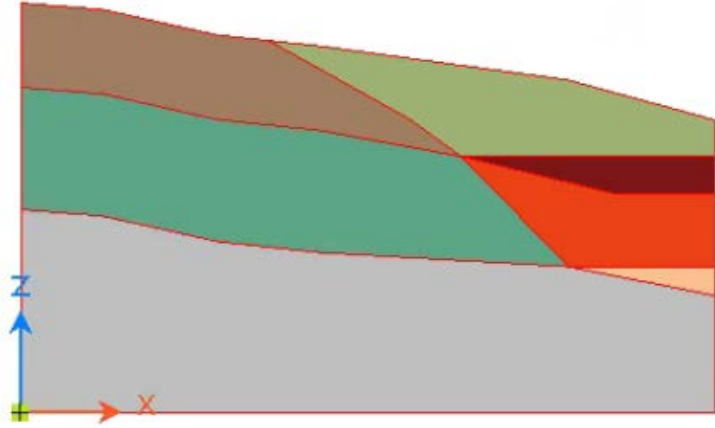


GTS NX 邊坡穩定分析

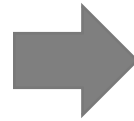
- 2D分析 - 方法 1
Limit Equilibrium Method(LEM)-極限平衡法 2D
- 2D分析 - 方法 2
Stress Analysis Method (SAM)-應力分析法 2D
- 2D分析 - 方法 3
Strength Reduction Method (SRM)-強度折減法 2D
- 3D分析
Strength Reduction Method (SRM)-強度折減法 3D

GTS NX 2D邊坡穩定分析

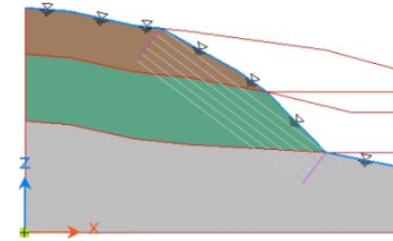
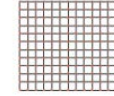
開挖後邊坡穩定性計算



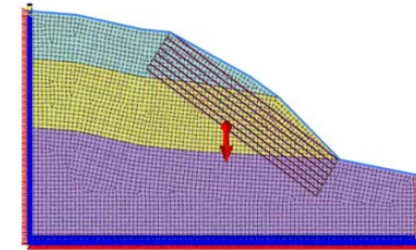
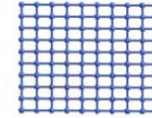
Weathered Soil
Weathered Rock
Soft Rock



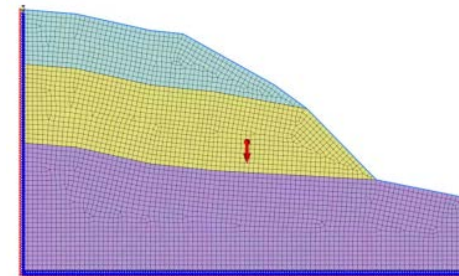
2D分析-方式1.LEM



2D分析-方式2.SAM



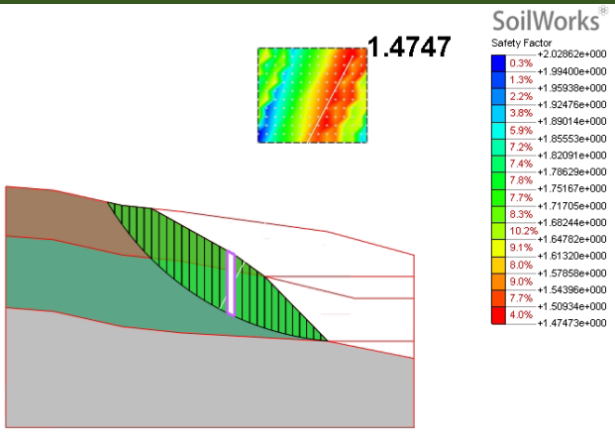
2D分析-方式3.SRM



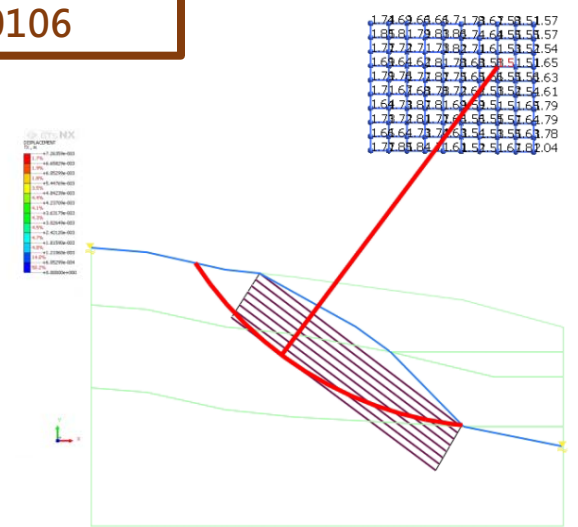
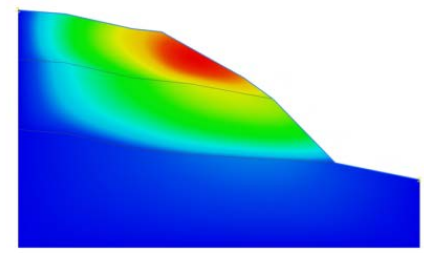
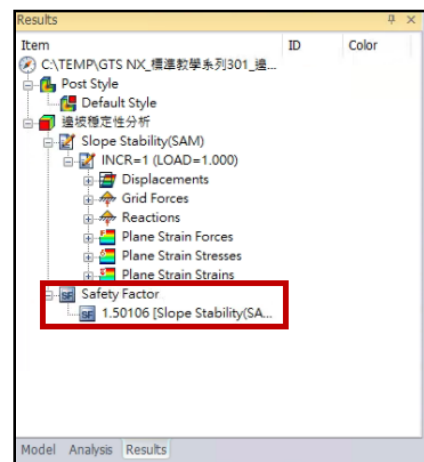
SRM：將邊坡地基材料的抗剪強度 (c , ϕ) 逐漸減小，直到計算過程中的發散點，此時假定發生了邊坡破壞，該點的最大強度折減率被認為是最小安全係數。

GTS NX 2D邊坡穩定分析

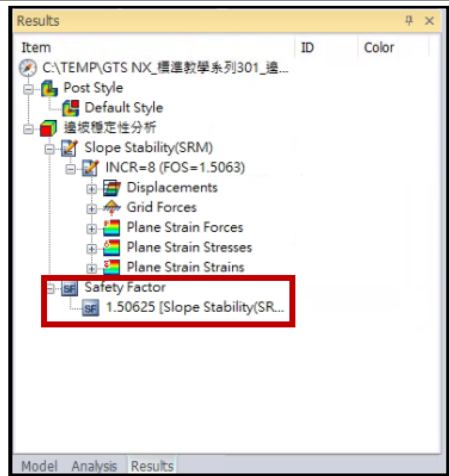
2D分析-方式1
LEM計算之安全係數1.4747



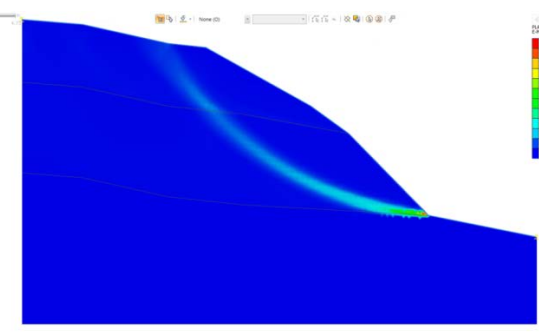
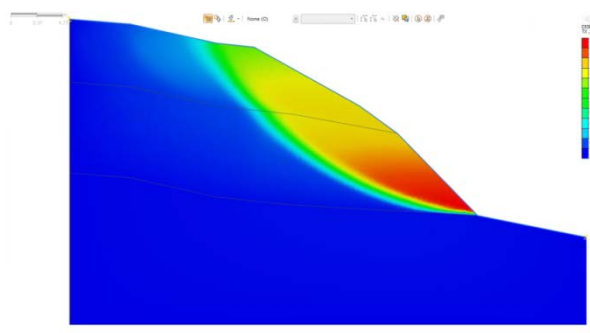
2D分析-方式2
SAM計算之安全係數1.50106



2D分析-方式3
SRM計算之安全係數1.50625



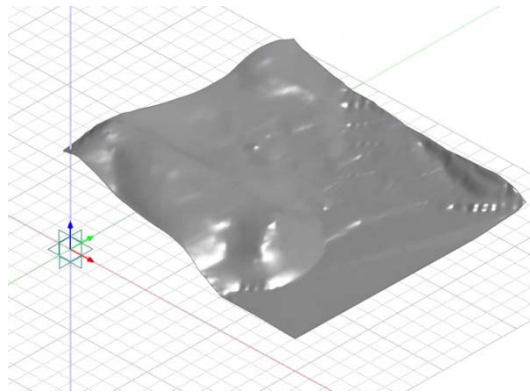
2D分析-方式3
SRM透過水平變形和最大剪切應變判斷破壞面



GTS NX 3D邊坡穩定分析

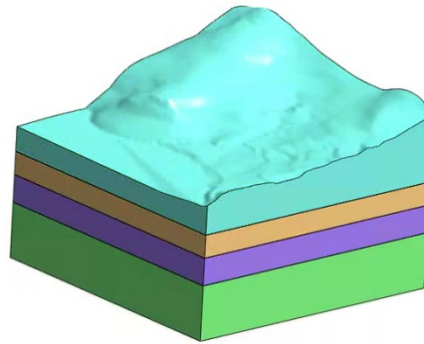
Strength Reduction Method (SRM)

3D地形面特徵

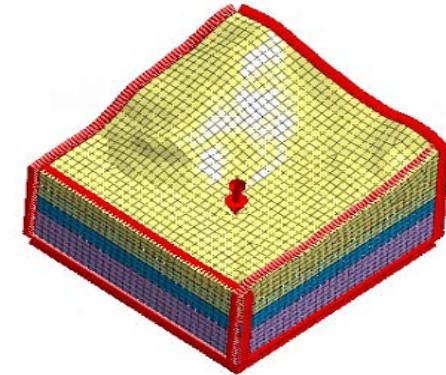


300m × 300m

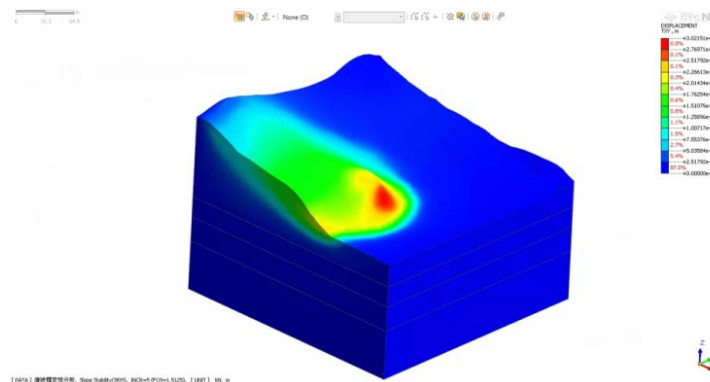
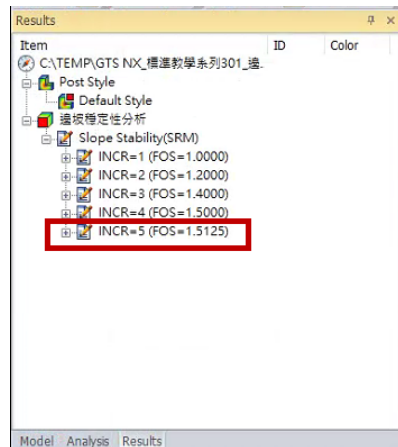
3D地形實體特徵



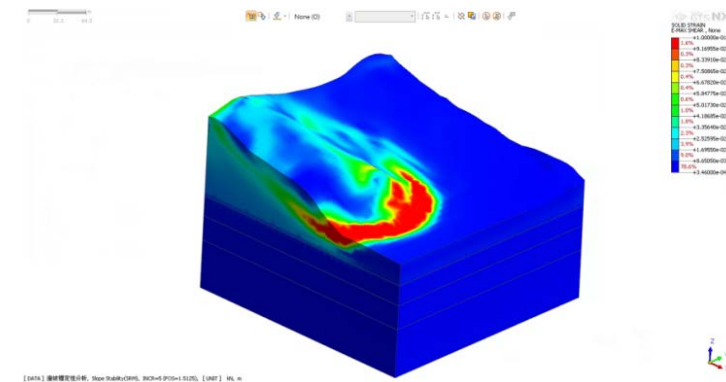
自重



3D分析
SRM計算之安全係數1.5125

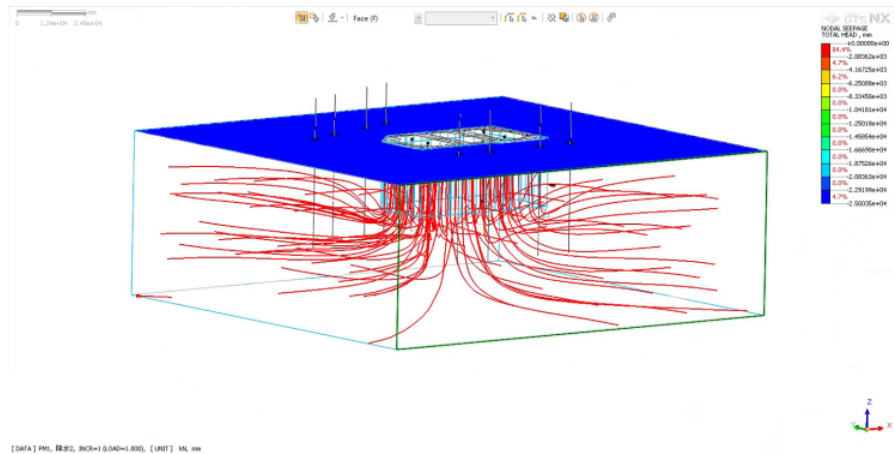
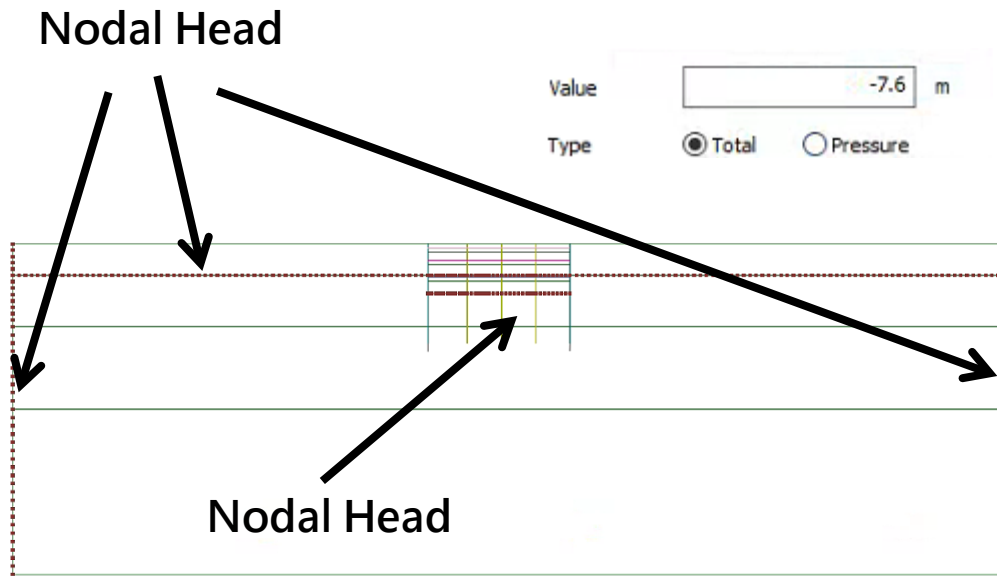


Tx Translation(m)

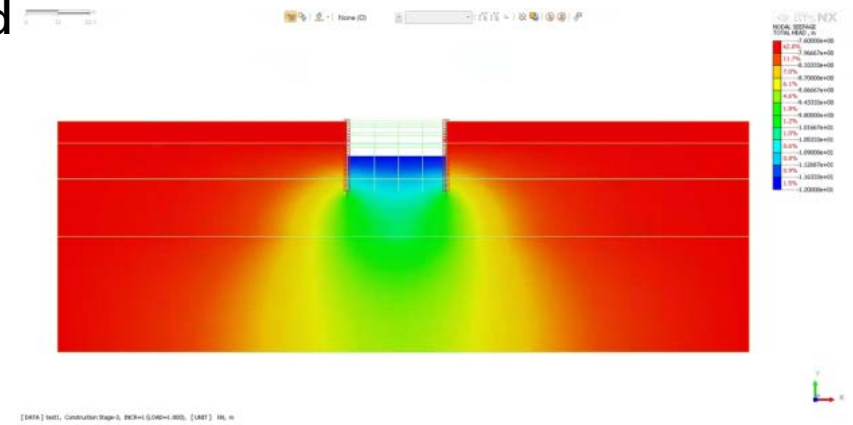


Maximum Shear Strain

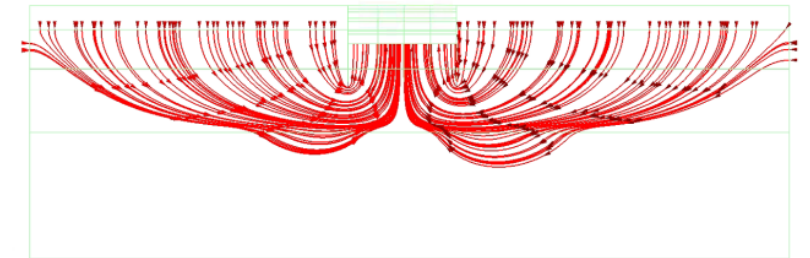
GTS NX-降水井模擬



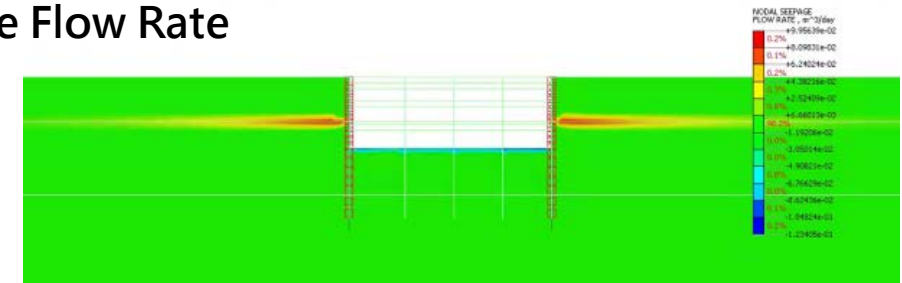
Total Head



Flow Path



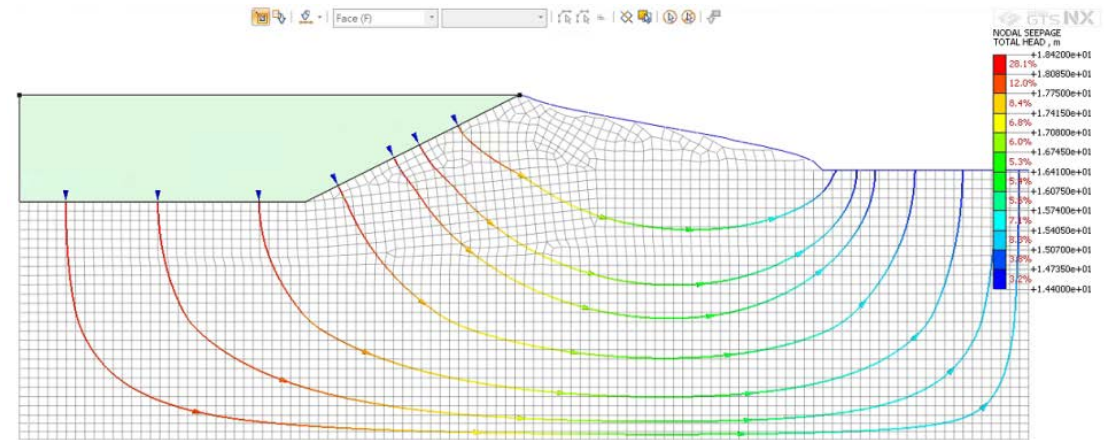
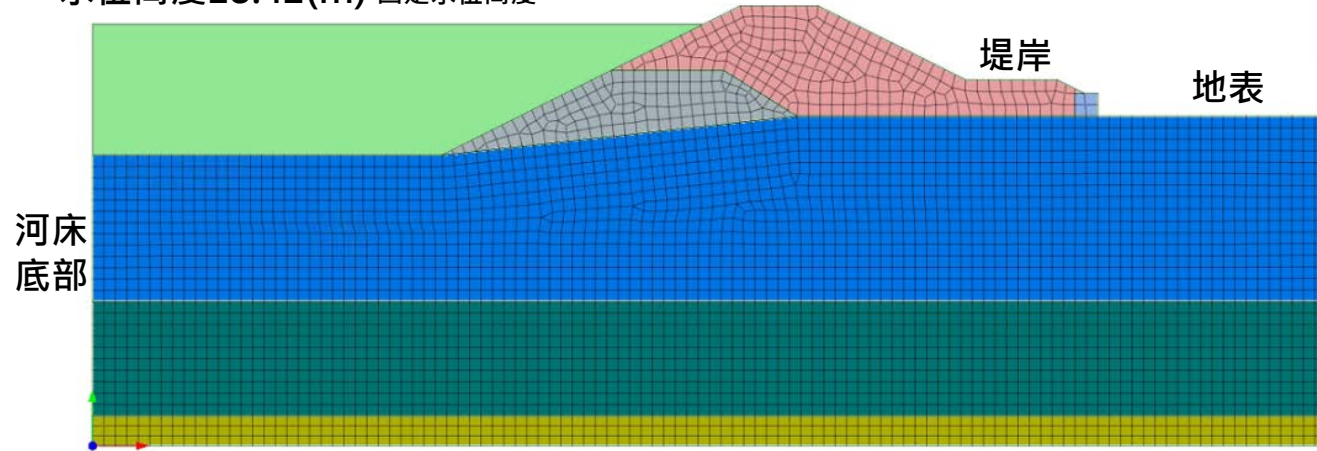
Seepage Flow Rate



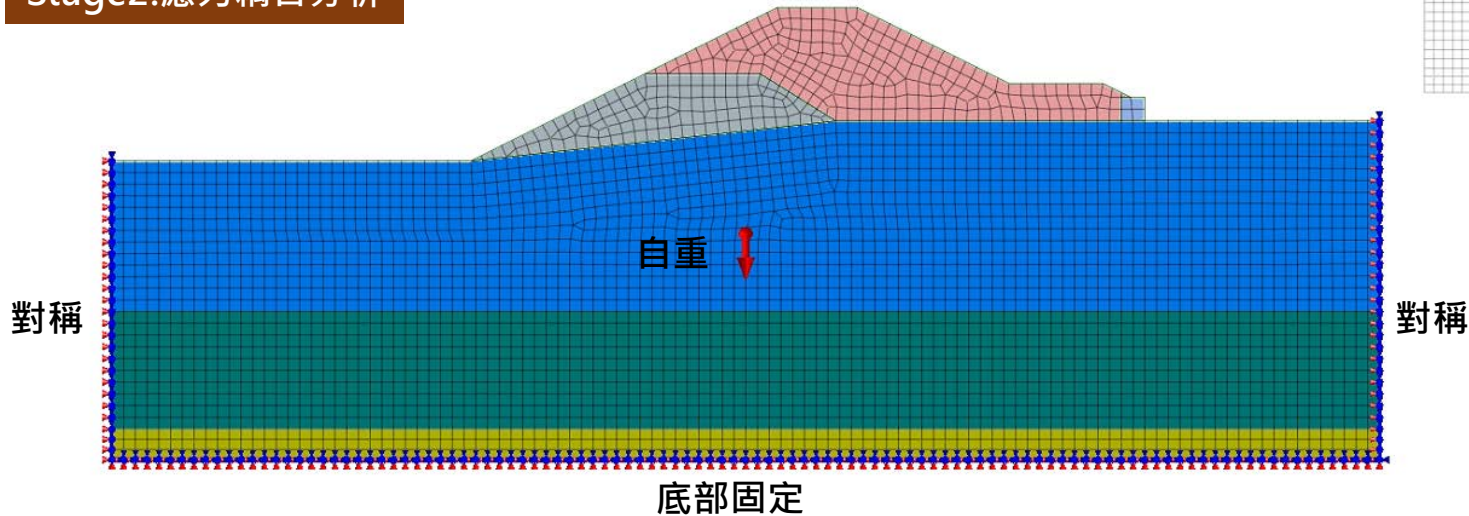
GTS NX-滲流應力耦合分析

Stage1.滲流分析

水位高度18.42(m) 固定水位高度



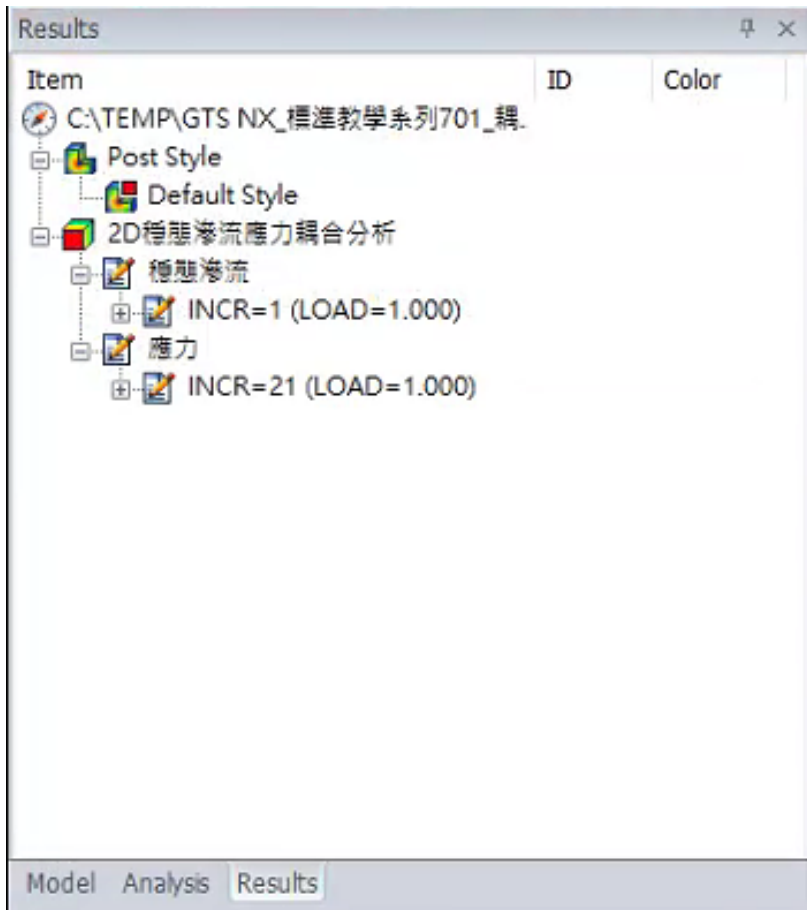
Stage2.應力耦合分析



GTS NX-滲流應力耦合分析

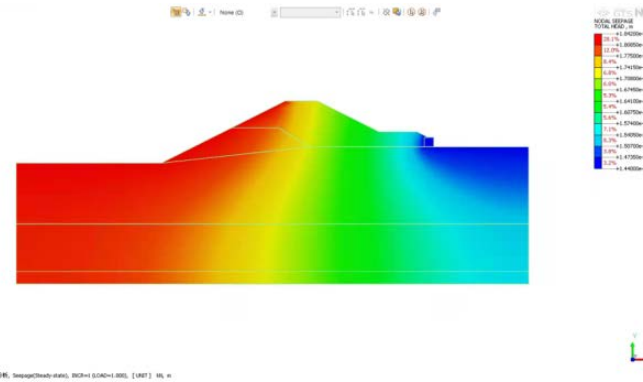
Results

穩態滲流 INCR=1：滲流結果
應力 INCR=21：應力結果

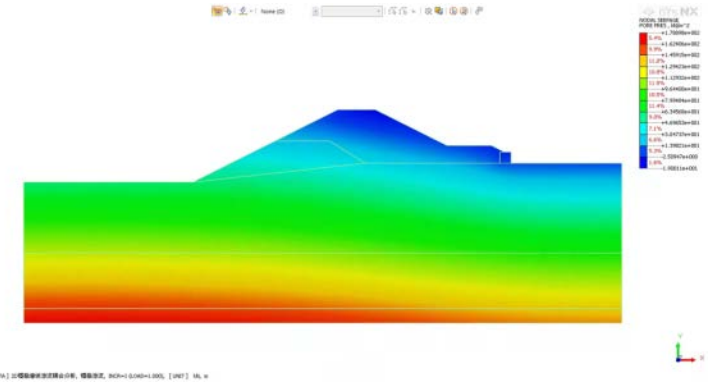


滲流結果

Total Head(m)

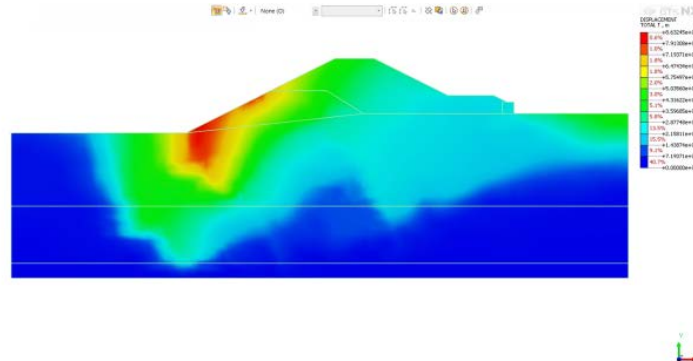


Pore Pressure(KN/m²)

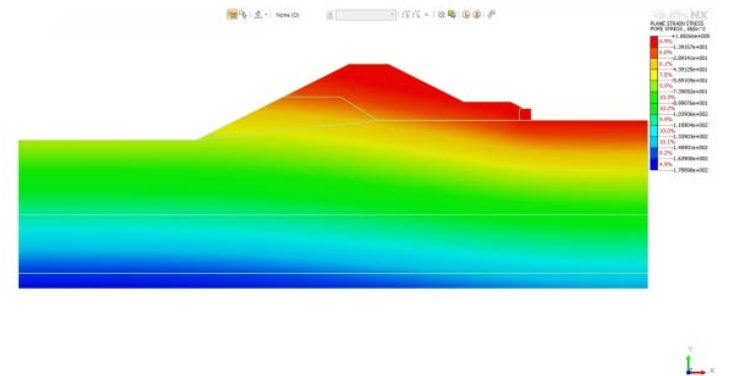


應力結果

Displacement Total(m)



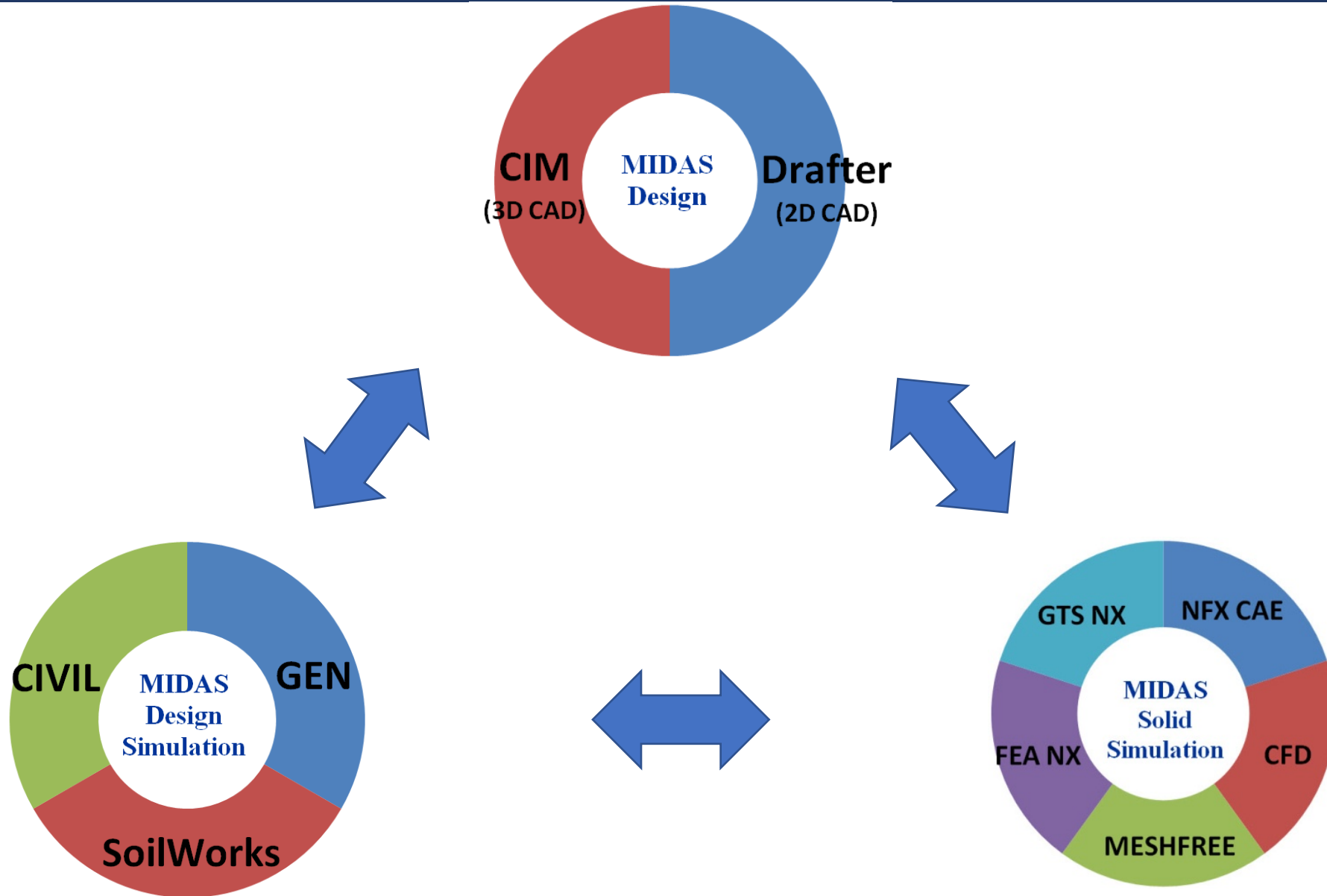
Pore Stress(KN/m²)



MIDAS

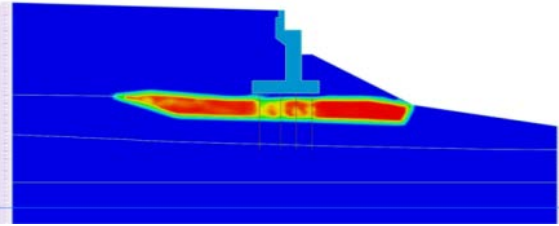
整合性介紹

MIDAS 整合性

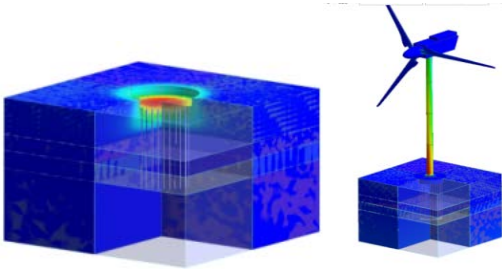


Solid Total Solution

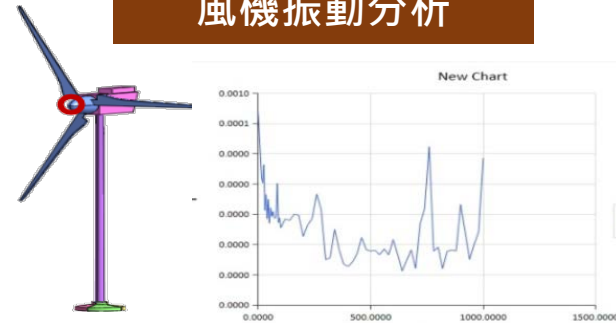
土壤液化分析



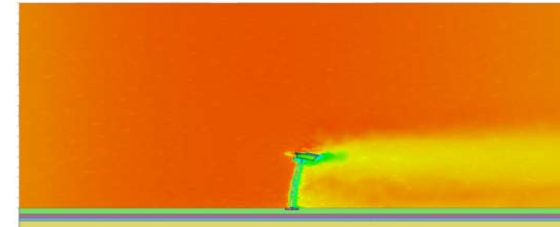
風機安裝施工階段分析



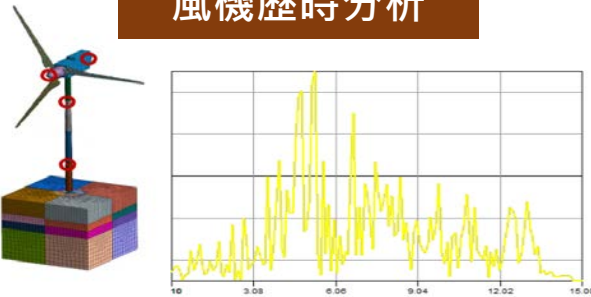
風機振動分析



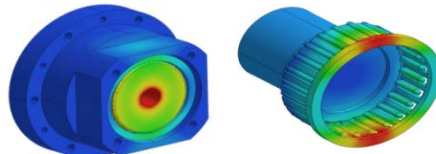
風機流固耦合分析



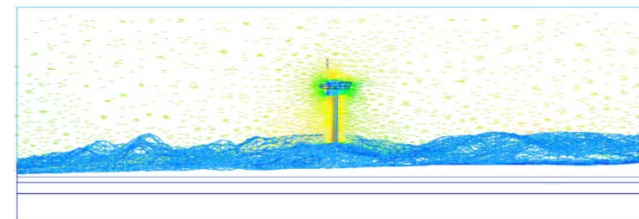
風機歷時分析



齒輪組分析

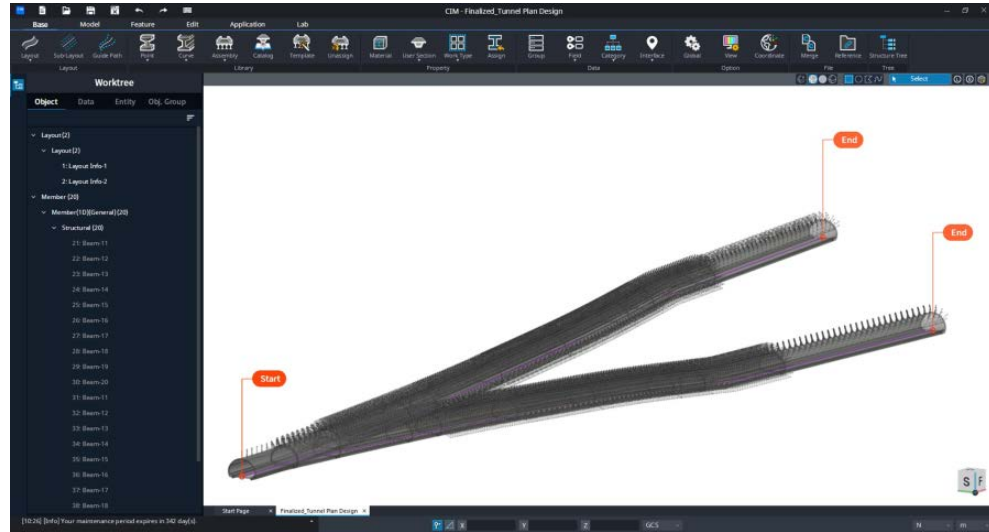


風機地形風場分析

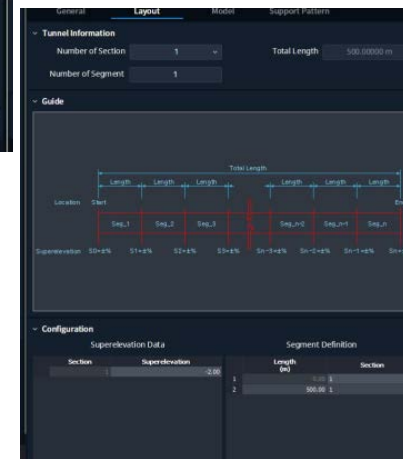
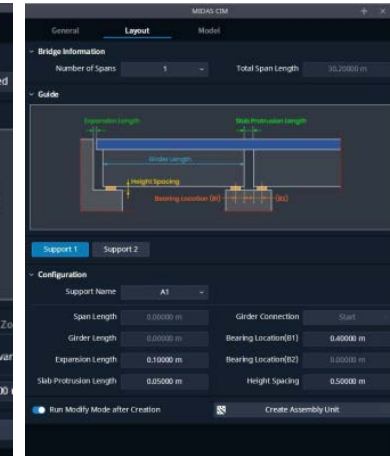
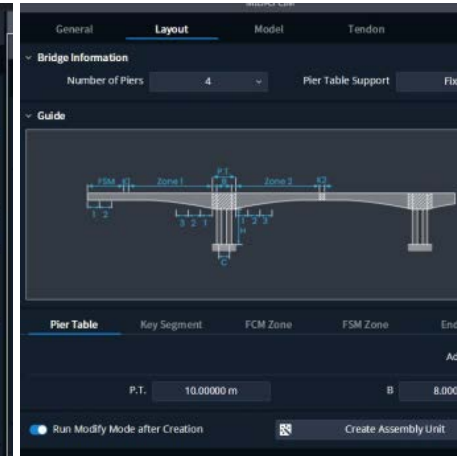
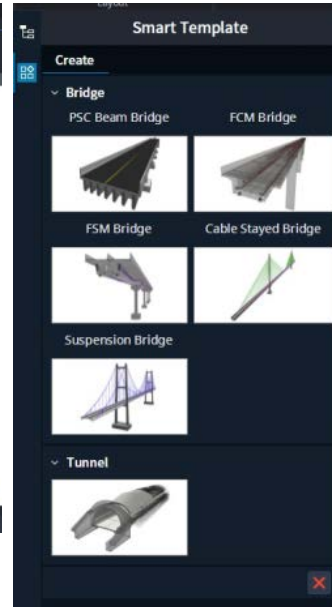


CIM+GTS 3D 模型整合

CIM-3D模型隨路線線形自動變更

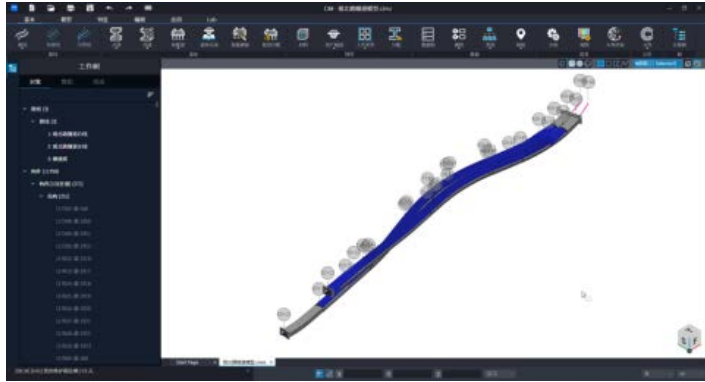


Bridge & Tunnel Wizard

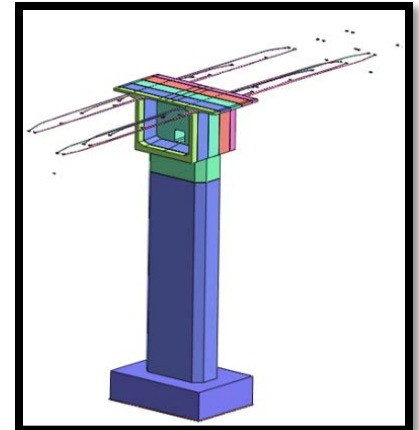
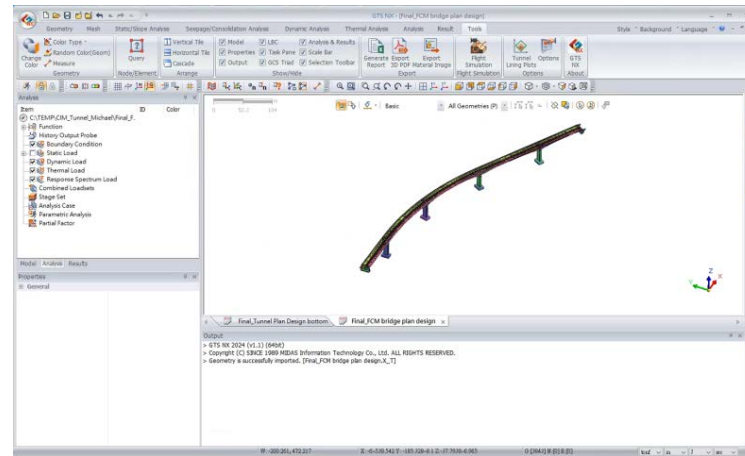
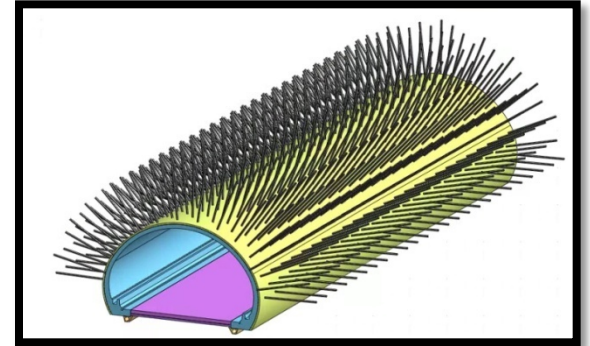
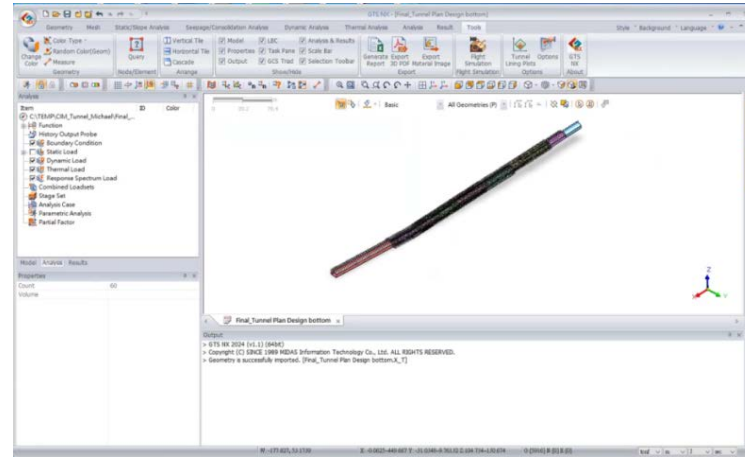
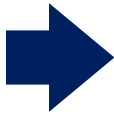
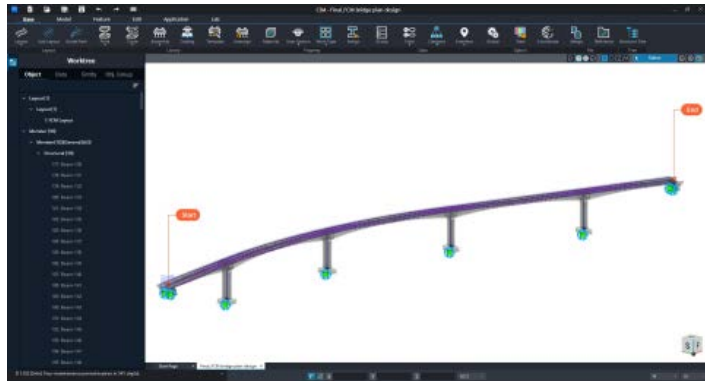


CIM+GTS 3D 模型整合

Tunnel

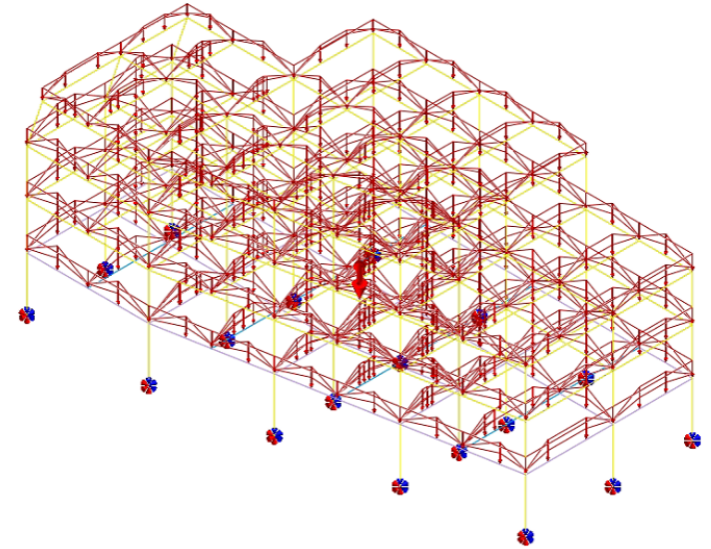
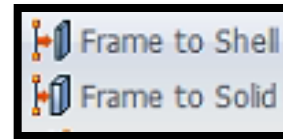
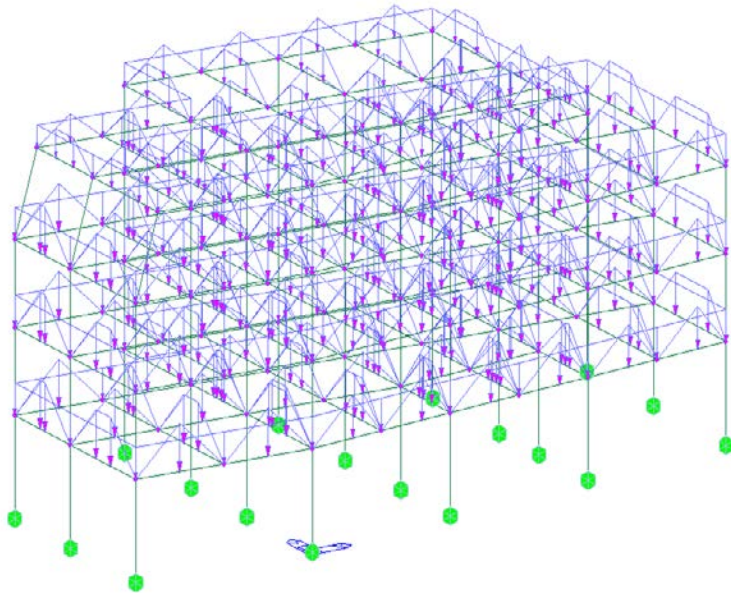
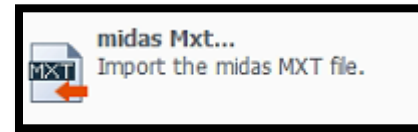
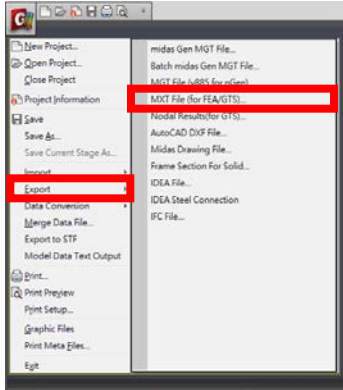


Bridge

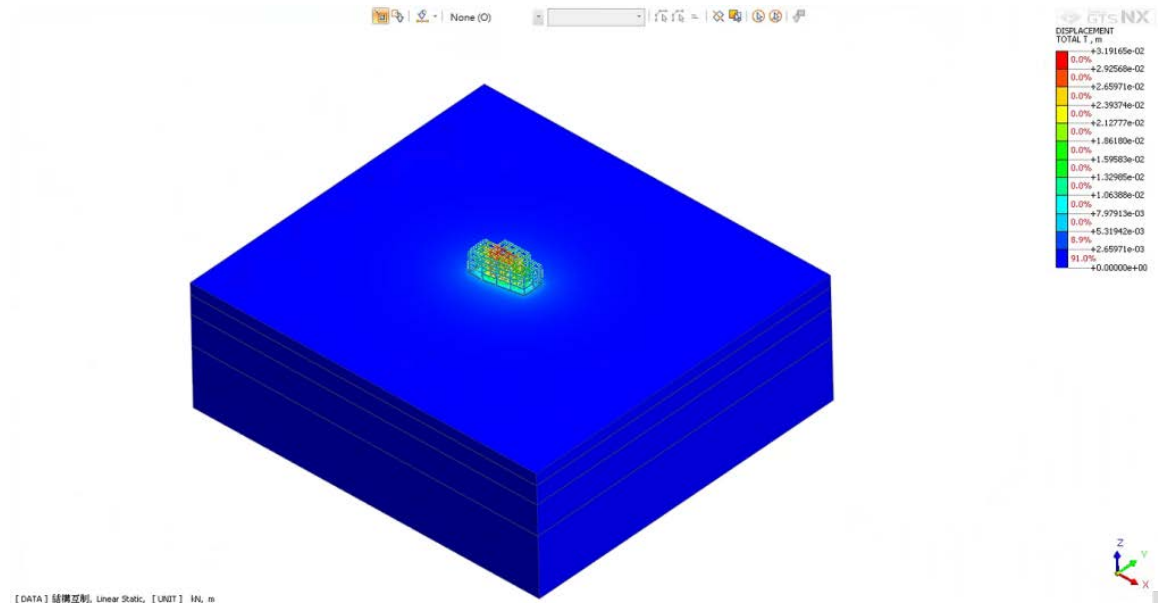
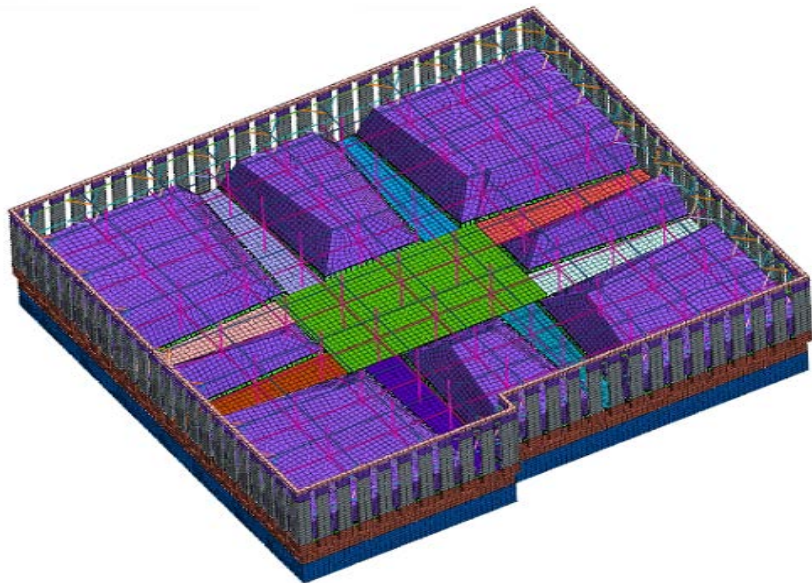
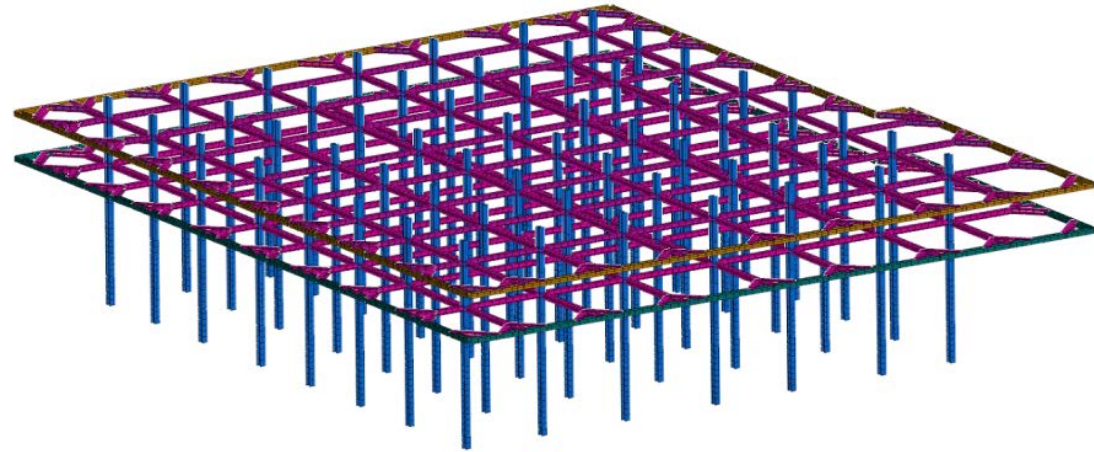
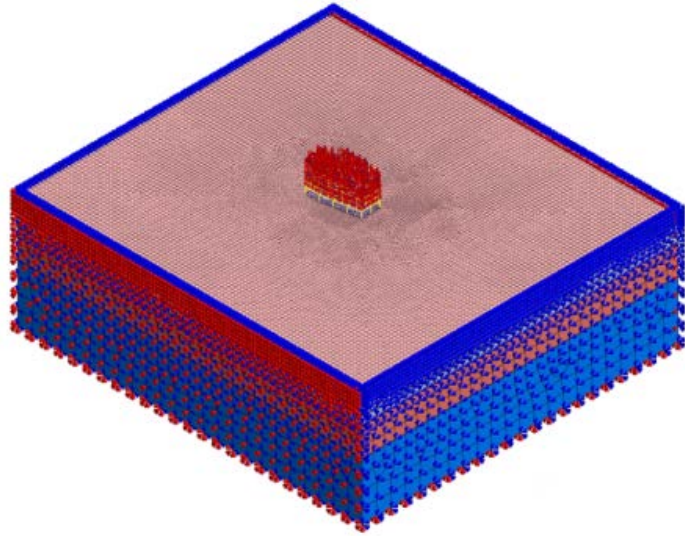


CIM>S NX
實體特徵直接轉換

GTS NX & Gen 結構互制分析



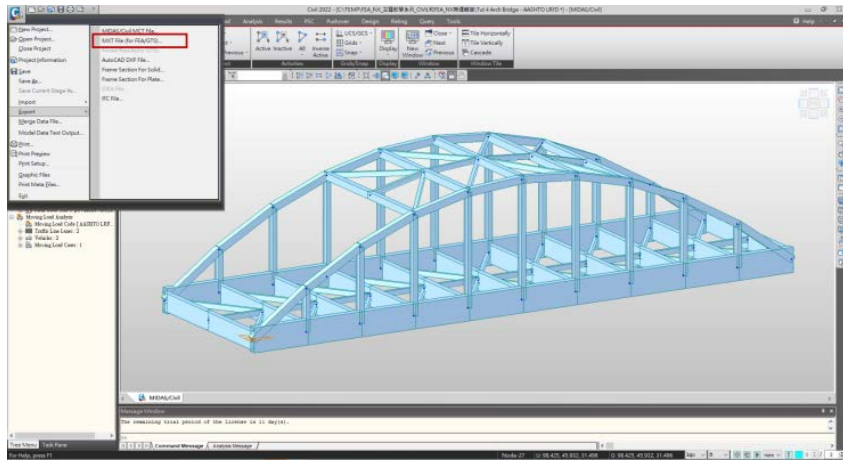
GTS NX & Gen 結構互制分析



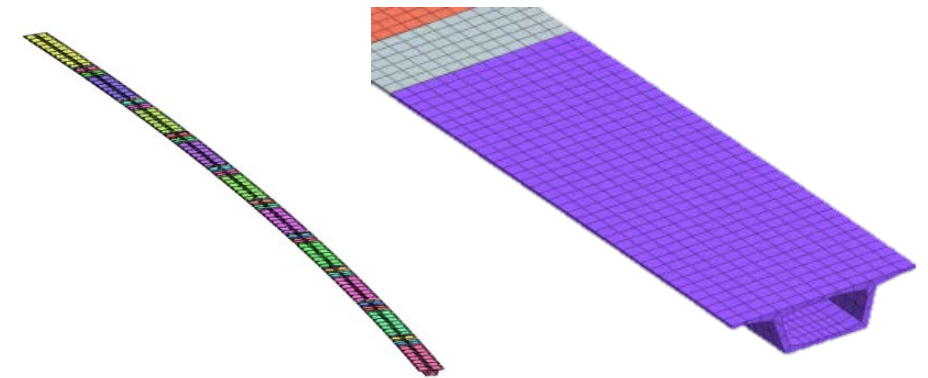
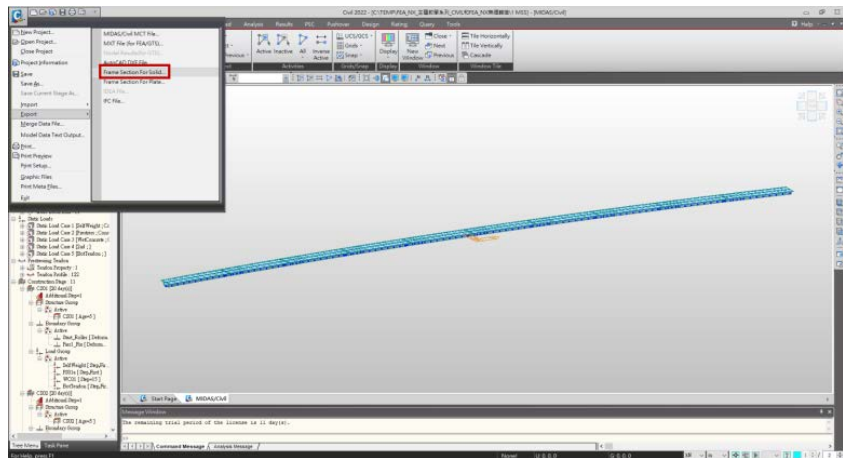
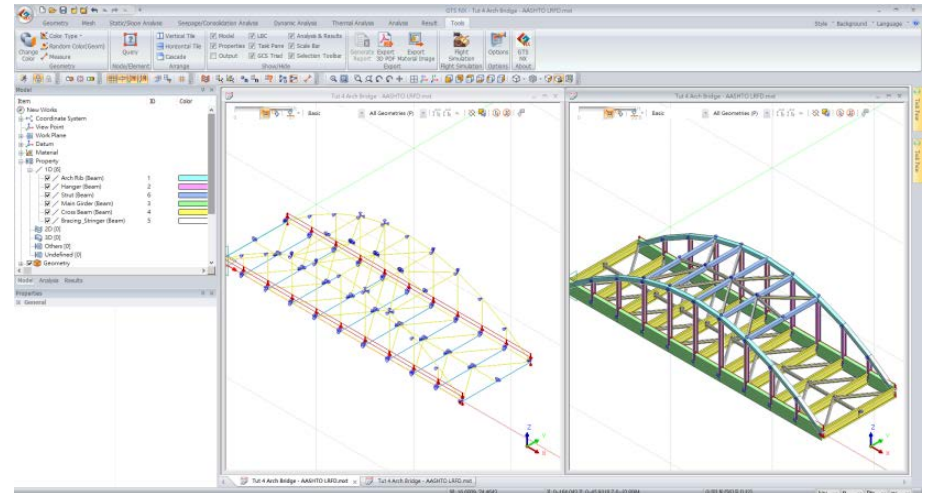
GTS NX+CIVIL無縫轉換



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

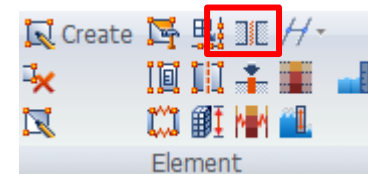
Midas Taiwan

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:

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

$$K_t = G_i / t_v$$

$$C_i = R \times C_{\text{soil}}$$

Here,

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

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

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

Where,

K_n : Normal Stiffness Modulus

K_t : Shear Stiffness Modulus

t_v : Virtual Thickness Factor

R : Strength Reduction Factor

C_i : Interface Cohesion

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

K_t (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: $R = 0.6 \sim 0.7$
- Clay/ Steel material: $R = 0.5$
- Sandy soil/ Concrete: $R = 1.0 \sim 0.8$
- Clay/ Concrete: $R = 1.0 \sim 0.7$

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

Interface Wizard Data

☐ Structural Parameters

☒ Strength Reduction Factor(R) 1

☐ Virtual Thickness Factor(tv) 0.1 m

☐ Consider Element Size

Line Interface Thickness 1 m

☐ Conduction for Seepage flow 0 m/sec/m

OK Cancel



2D Element

(Beam element/ Truss element)

► Beam and Truss element comparison:

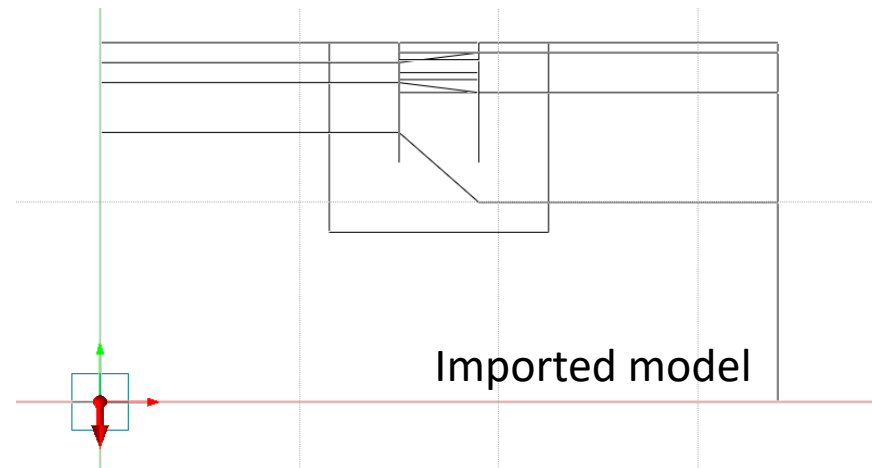
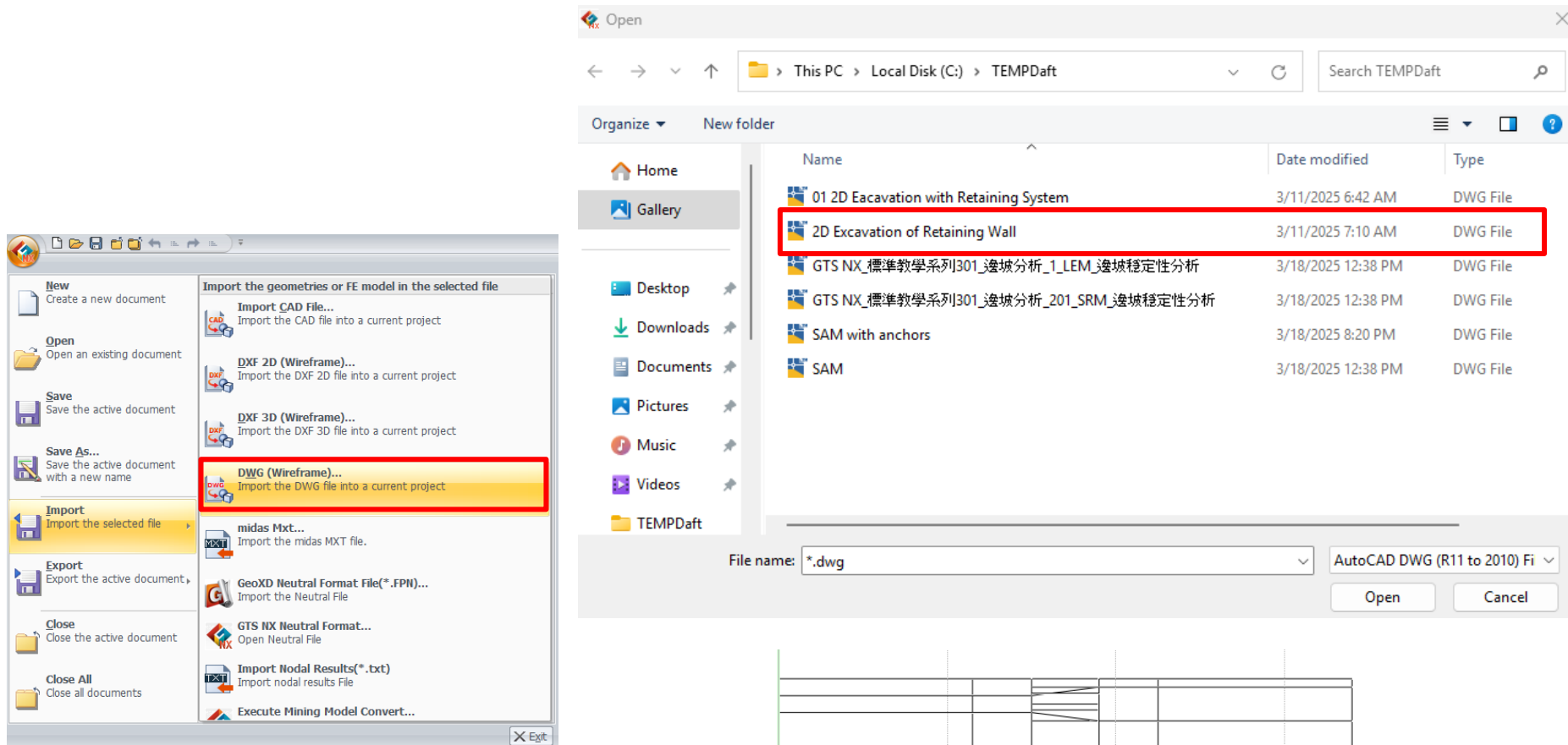
Feature	Truss Element	Beam Element
Resists Axial Force	✓ Yes	✓ Yes
Resists Bending	✗ No	✓ Yes
Resists Shear	✗ No	✓ Yes
Resists Torsion	✗ No	✓ Yes
Degrees of Freedom (DOF)	3 per node (UX, UY, UZ)	6 per node (UX, UY, UZ, RX, RY, RZ)
Transfers Moments	✗ No	✓ Yes
Typical Application	Trusses, cables	Beams,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

E.g., Truss element input by library section

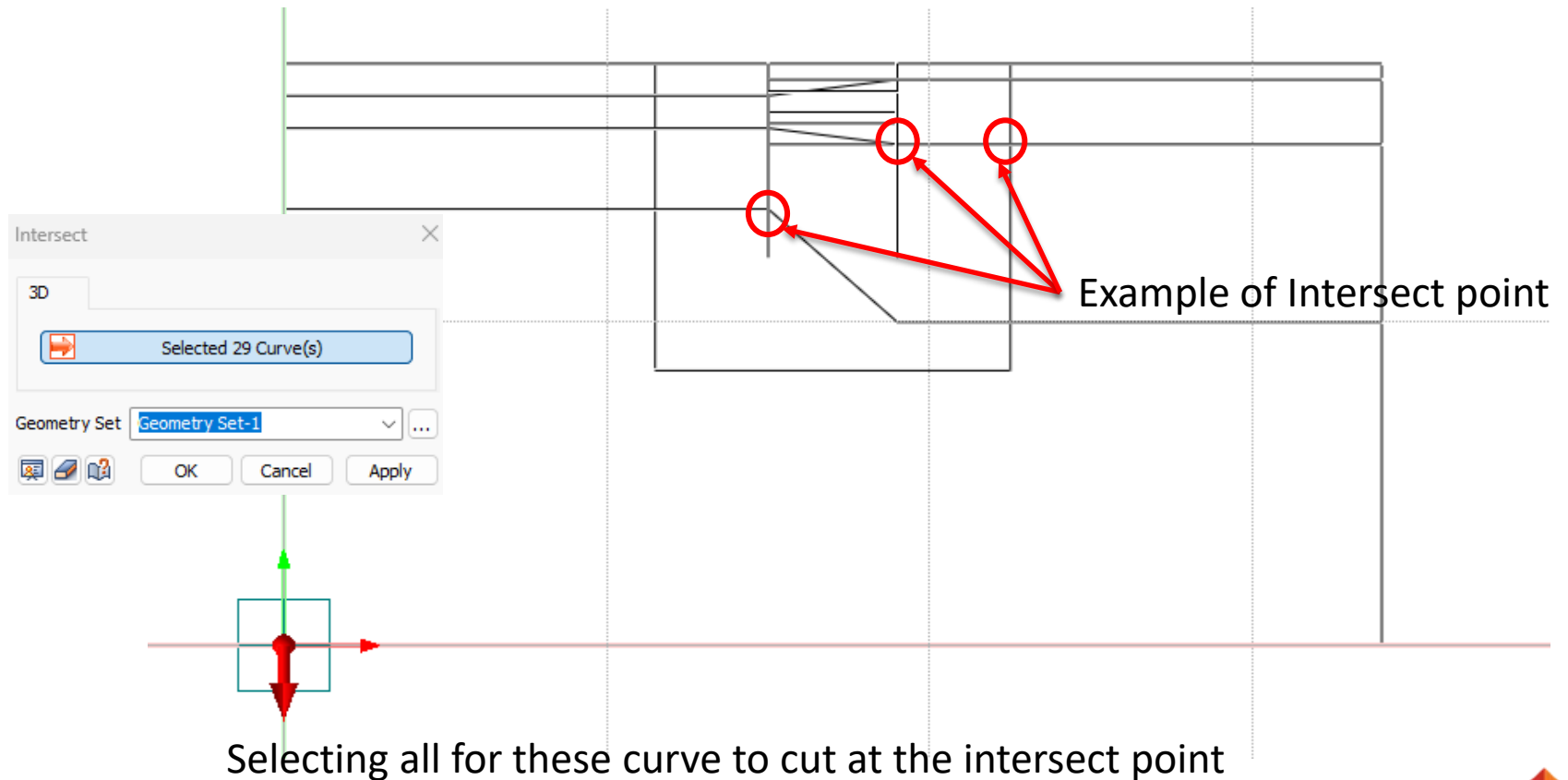
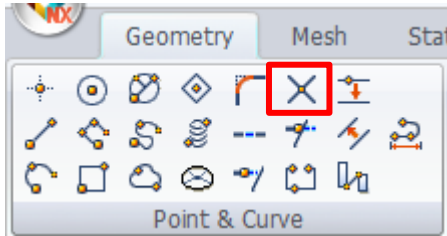
Note: Input the spacing for considering the strength differences between 2D and 3D



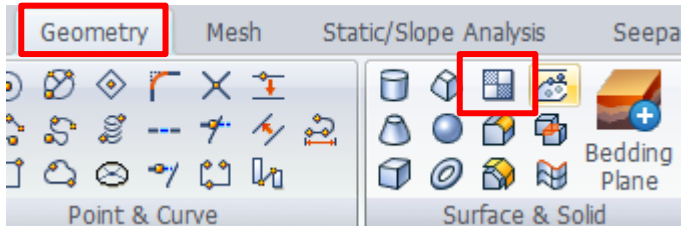
2D model import



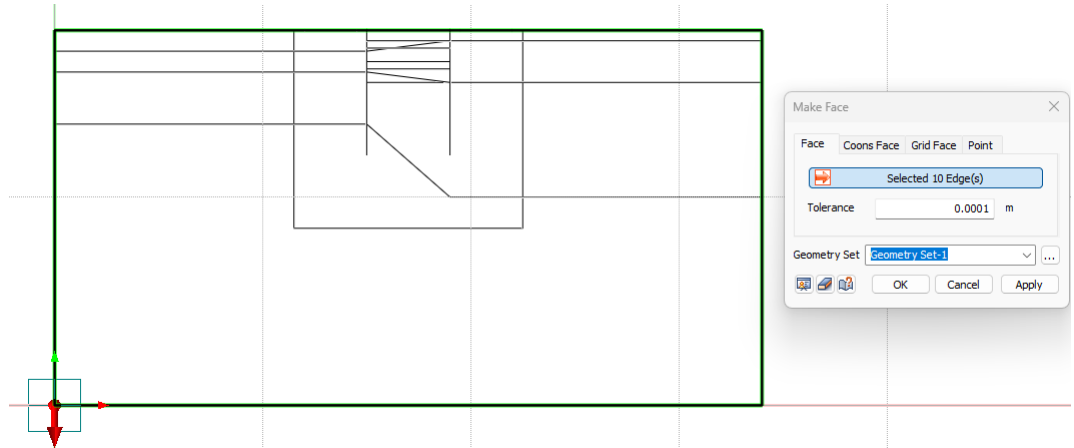
Intersect function



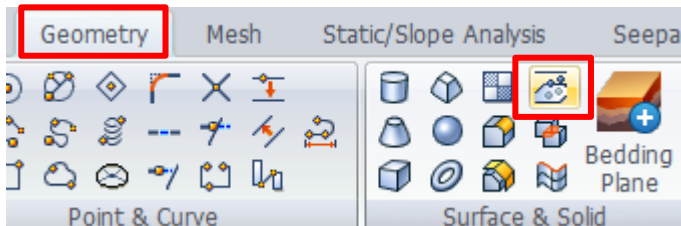
Creating geometry area



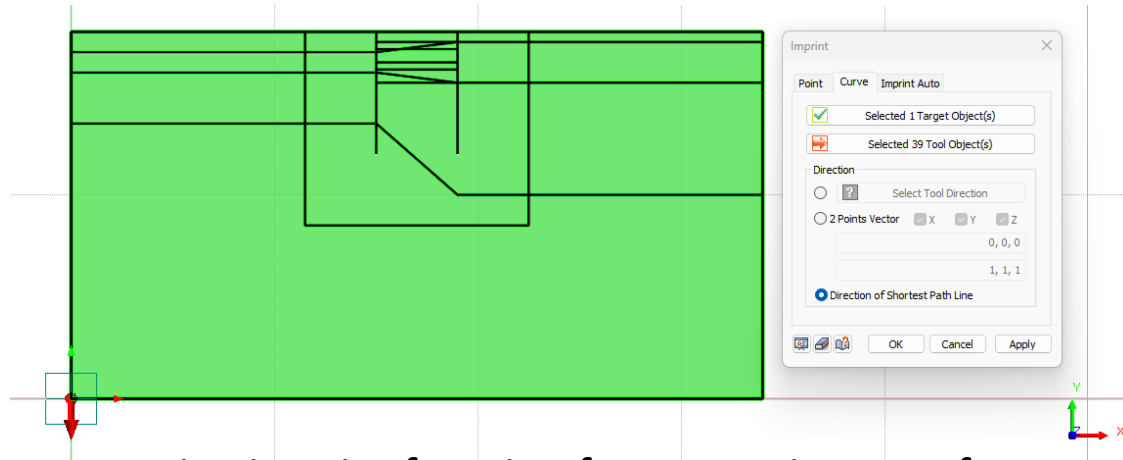
Make face function



Selecting the outside line for 'Target object'



Imprint function



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

Soil material

Add/Modify Material

No	Name	Type
1	SOIL 1	Isotropic-Mohr-Coulomb
2	SOIL 2	Isotropic-Mohr-Coulomb
3	SOIL 3	Isotropic-Mohr-Coulomb
4	SOIL 4	Isotropic-Mohr-Coulomb
5	CONCRETE	Isotropic-Elastic
6	STEEL	Isotropic-Elastic
7	Interface Mat...	Interface and Pile-Interface
8	Interface Mat...	Interface and Pile-Interface
9	Interface Mat...	Interface and Pile-Interface
10	Interface Mat...	Interface and Pile-Interface

1

Create...
Modify...
Copy
Delete
Import
Import from Excel
Export to Excel
Renumber
Database
Close

Material

ID 1 Name SOIL 1 Color []

2 Model Type Mohr-Coulomb [] Structure []

General Porous Non-Linear Thermal Time Dependent

3

Elastic Modulus(E) 15000 kN/m²
Inc. of Elastic Modulus 0 kN/m³
Inc. of Elastic Modulus Ref. Height 0 m
Poisson's Ratio(ν) 0.25
Unit Weight(γ) 18 kN/m³

Initial Stress Parameters
Ko Determination 0.5
☒ Automatic
☐ Manual ☐ Anisotropy []

Thermal Parameter
Thermal Coefficient 1e-06 1/[T]
Molecular vapor diffusion coefficient 0 m²/sec
Thermal diffusion enhancement 0

Damping Ratio(For Dynamic)
Damping Ratio 0.05

☐ Safety Result(Mohr-Coulomb)
Cohesion(C) 30 kN/m²
Frictional Angle(ϕ) 36 [deg]
☐ Tensile Strength 0 kN/m²

DB

OK Cancel Apply

Material

ID 1 Name SOIL 1 Color []

Model Type Mohr-Coulomb [] Structure []

General Porous Non-Linear Thermal Time Dependent

4

Unit Weight(Saturated) 18 kN/m³
Initial Void Ratio(e_0) 0.5

☐ Unsaturated Property []

Drainage Parameters
Drained []
☒ Undrained Poisson's Ratio 0.495
☐ Skempton's B Coefficient 0.983277592

5

Seepage & Consolidation Parameters
Permeability Coefficients
kx 1e-06 ky 1e-06 kz 1e-06 m/sec
☐ Void Ratio Dependency of Permeability(k) 0.5
Specific Storage(S_s) 5.23021 1/m Auto

Material

ID 1 Name SOIL 1 Color []

Model Type Mohr-Coulomb [] Structure []

General Porous Non-Linear Thermal Time Dependent

6

Cohesion(C) 5 kN/m²
Inc. of Cohesion 0 kN/m³
Inc. of Cohesion Ref. Height 0 m

7

Frictional Angle(ϕ) 30 [deg]
☐ Dilatancy Angle 0 [deg]
☐ Tension Cut-off
Tensile Strength 0 kN/m²
Cut-off Yield Surface
☐ Pressure ☒ Rankine

General step for defining a specific soil material



Soil property

Add/Modify Property

No	Name	Type	Sub-Type
1		2D	Shell
2	SOIL1	2D	Plane Strain
3	SOIL2	2D	Plane Strain
4	SOIL3	2D	Plane Strain
5	SOIL4	2D	Plane Strain
6	D-Wall	1D	Beam
7	S1(UB 610x229x...	1D	Truss
8	S2(UB 610x229x...	1D	Truss
9	Interface Proper...	Other	Interface
10	Interface Proper...	Other	Interface
11	Interface Proper...	Other	Interface
12	Interface Proper...	Other	Interface
13	Rigid Link	Other	Rigid Link

Create Modify... Copy Delete Import... Renum

Create/Modify 1D Property

Beam

ID 6 Name D-Wall Color

Material 5: CONCRETE

☐ Hinge Property

☐ Taper

	Section-i	Section-j
Cross Sectional Area(A)	1	1 m ²
Torsional Constant(Ix)	0.140596345	0.140596345 m ⁴
Torsional Stress Coeff.	0.682395003	0.682395003 m
Area Moment of Inertia(Iy)	0.083333333	0.083333333 m ⁴
Area Moment of Inertia(Iz)	0.083333333	0.083333333 m ⁴
Effective Shear Area(Ay)	0.833441841	0.833441841 m ²
Effective Shear Area(Az)	0.833441841	0.833441841 m ²
Shear Stress Coefficient(Gy)	1.5	1.5 1/m ²
Shear Stress Coefficient(Gz)	1.5	1.5 1/m ²

Stress... Stress...

y Axis Variable Constant

z Axis Variable Constant

☐ Spacing 1 m

☒ Section... Solid Rectangle

OK Cancel Apply

Beam property

Create/Modify 2D Property

Plane Strain

ID 2 Name SOIL1 Color

Material 1: SOIL1

Material CSys

☒ CSys Global Rectangular

☐ Angle 0 [deg]

OK Cancel Apply

Plain strain property

Truss

ID 7 Name S1(UB 610x229x101 @ 4 Color

Constitutive Behavior From Material

Material 6: STEEL

☐ Hinge Property

Cross Sectional Area(A) 0.0129 m²

Torsional Constant 0 m⁴

Torsional Stress Coeff. 0 m

☒ Spacing 4 m

☒ Section... H-Section

OK Cancel Apply

Truss property

Soil property

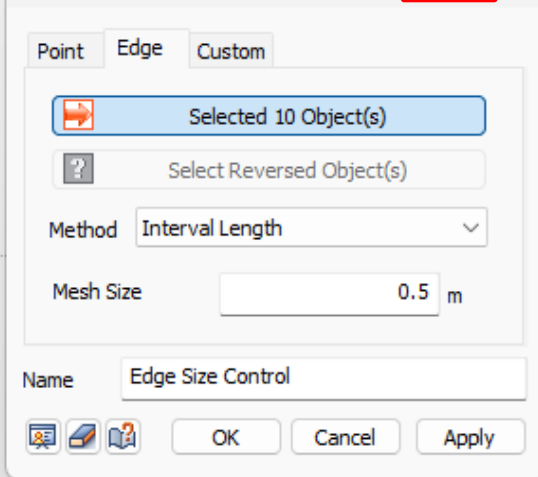
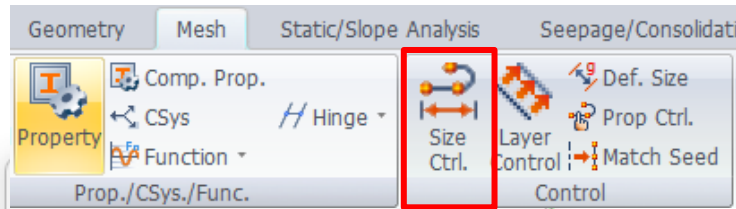
► Ground property

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

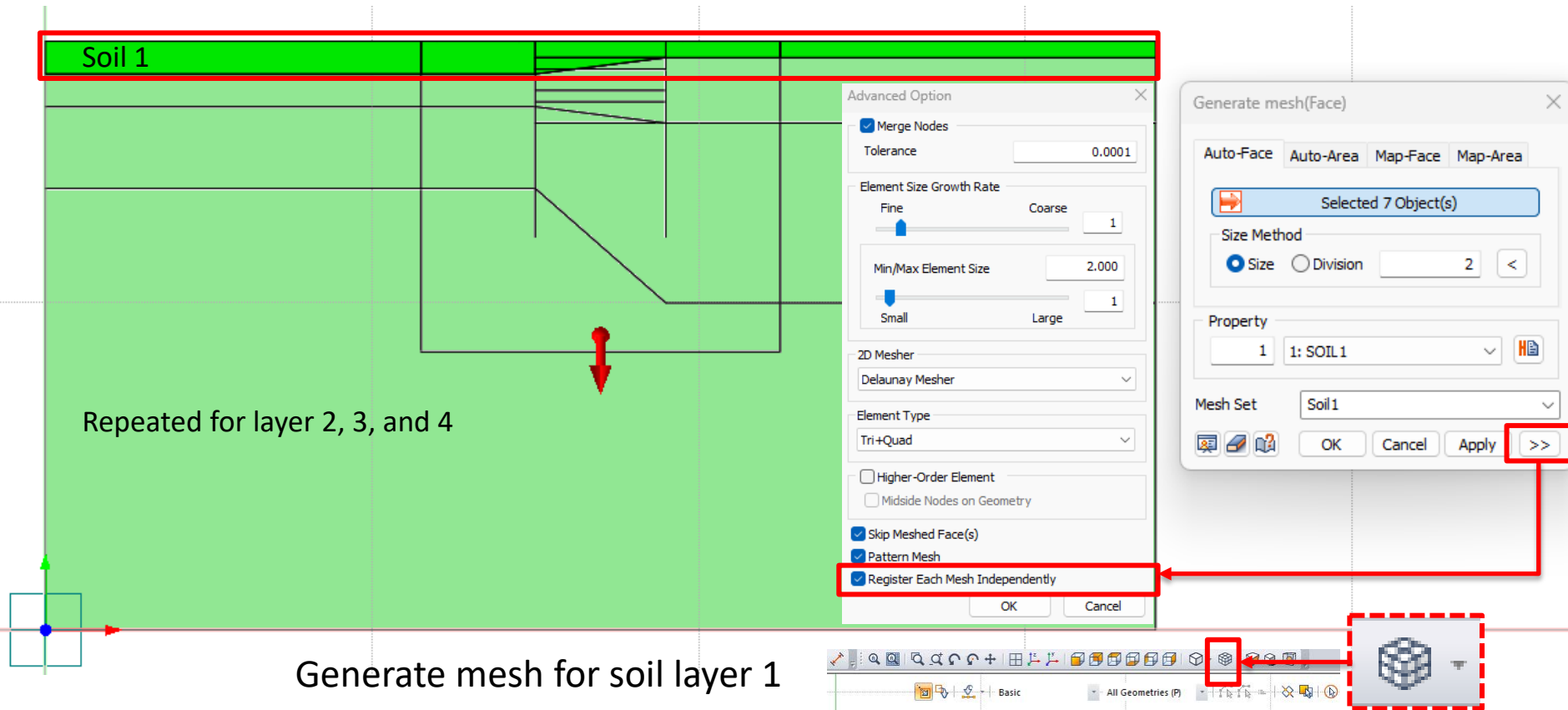
Name	D-Wall	S1	S2
Type	1D	1D	1D
Model Type	Beam	Truss	Truss
Material	CONCRETE	STEEL	STEEL
Section	Solid Rectangle	H-Section	H-Section
Section Size	1x1m @ 1m c/c	UB 610x229x101 @ 4m c/c	UB 610x229x101 @ 4m c/c

Mesh size control

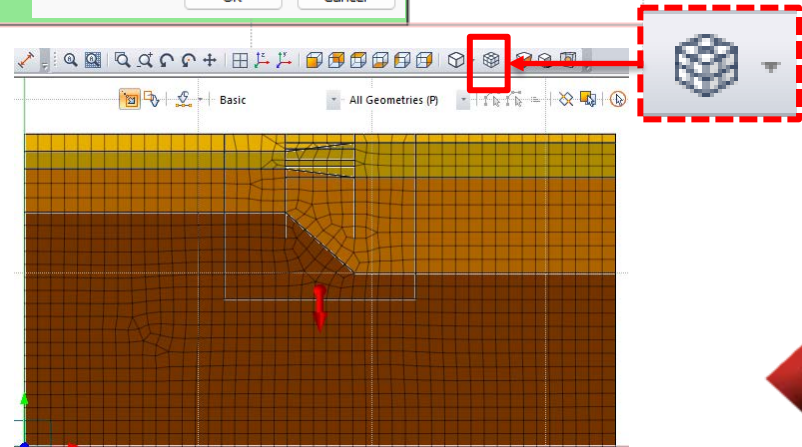


Mesh size control to increase the accuracy in plastic area

Generate mesh

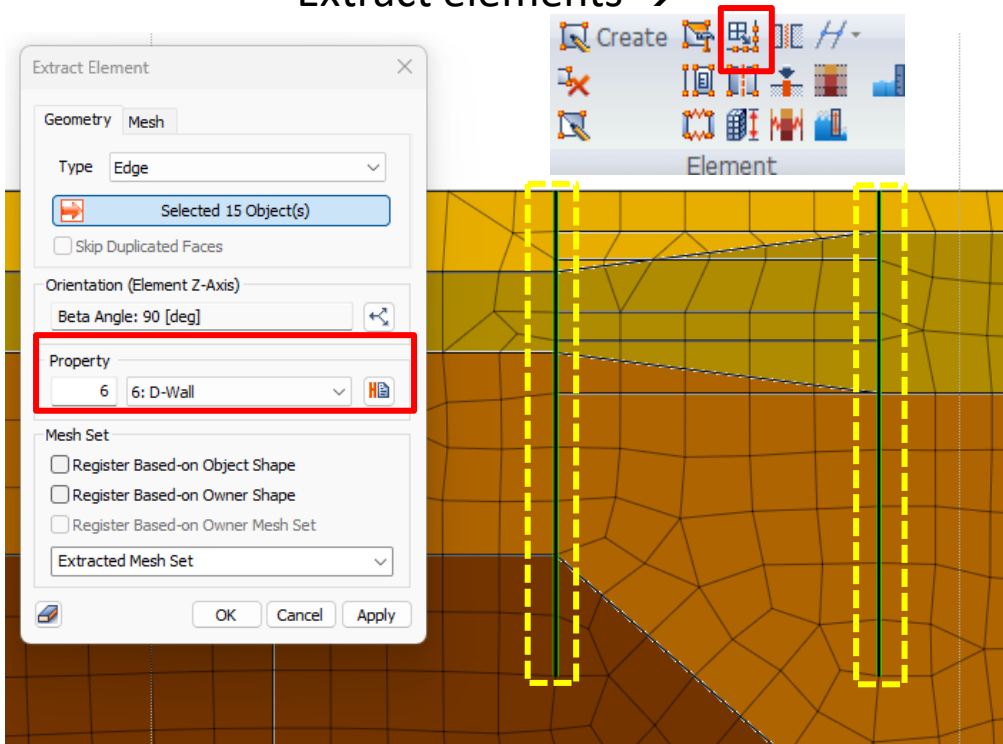


To show 'Property color'
Display Mode (Mesh) → Property color

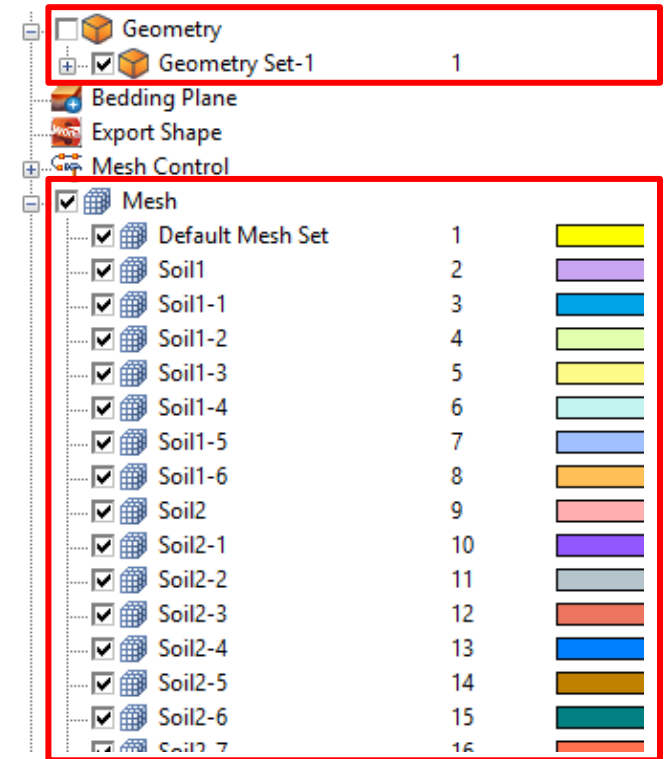


Create & Extract elements

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)

Create Interface

Line Shell Plane

Element ID 1194

Method

Type From Truss/Beam

Parameters

☒ Selected 22 Object(s)

☒ Merge Nodes

Property Parameters

☐ Manual Input ☒ Wizard

☐ Register Interface Mesh Set Separately

☒ Create Other Element Rigid Link

Property

9 9: Interface Property(Wizar

Mesh Set Line Interface

OK Cancel Apply

Type From Element Boundary

Param Manual Node ID Input

Property From Truss/Beam(T/X-cross type)

☒ From Mesh-Set (T/X-cross type)

☐ From Node

Create Interface

Line Shell Plane

Element ID 1128

Method

Type From Truss/Beam

Parameters

☒ Merge Nodes ☒ Selected 2 Obj...

Property Parameters

☒ Manual Input ☐ Wizard

☐ Register Interface Mesh Set Separately

☒ Create Other Element Rigid Link

Property 9

Mesh Set Line Interface

OK Cancel Apply

Create Interface

Line Shell Plane

Element ID 1128

Method

Type From Truss/Beam

Parameters

☒ Merge Nodes

Property Parameters

☒ Manual Input ☐ Wizard

☐ Register Interface Mesh Set Separately

☒ Create Other Element Rigid Link

Property 9

Mesh Set Line Interface

OK Cancel Apply

Interface Wizard Data

Structural Parameters

Strength Reduction Factor(R) 0.67

☐ Virtual Thickness Factor(tv) 0.1 m

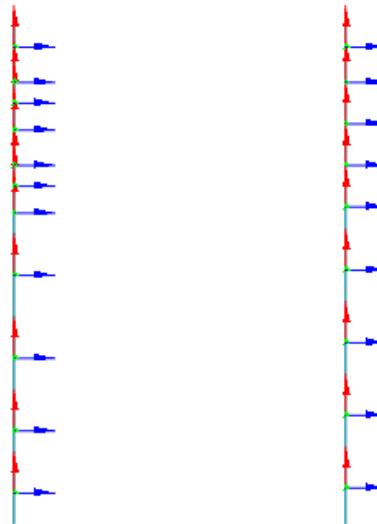
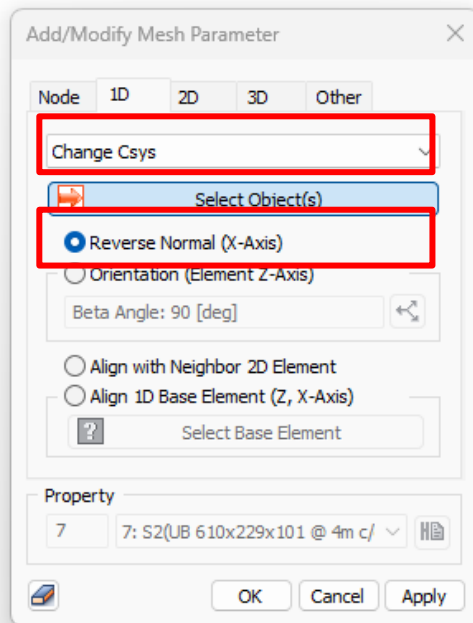
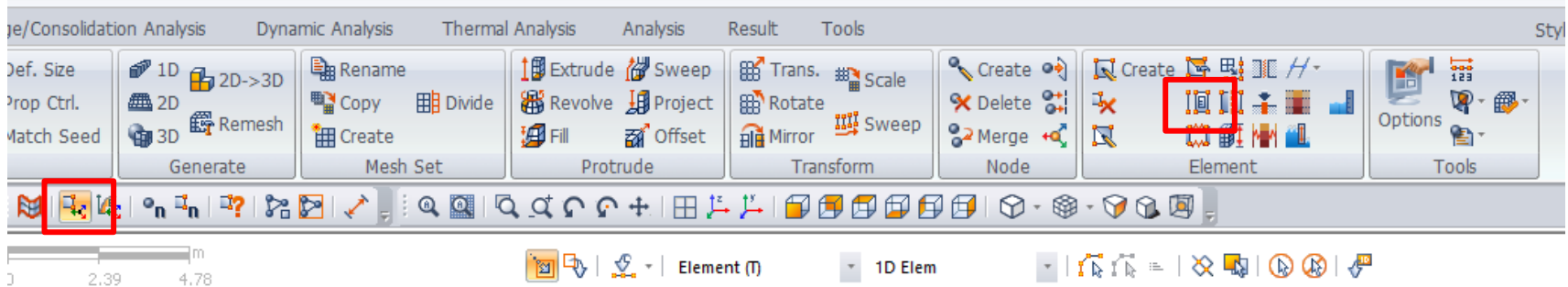
☐ Consider Element Size

Line Interface Thickness 1 m

☐ Conduction for Seepage flow 0 m/sec/m

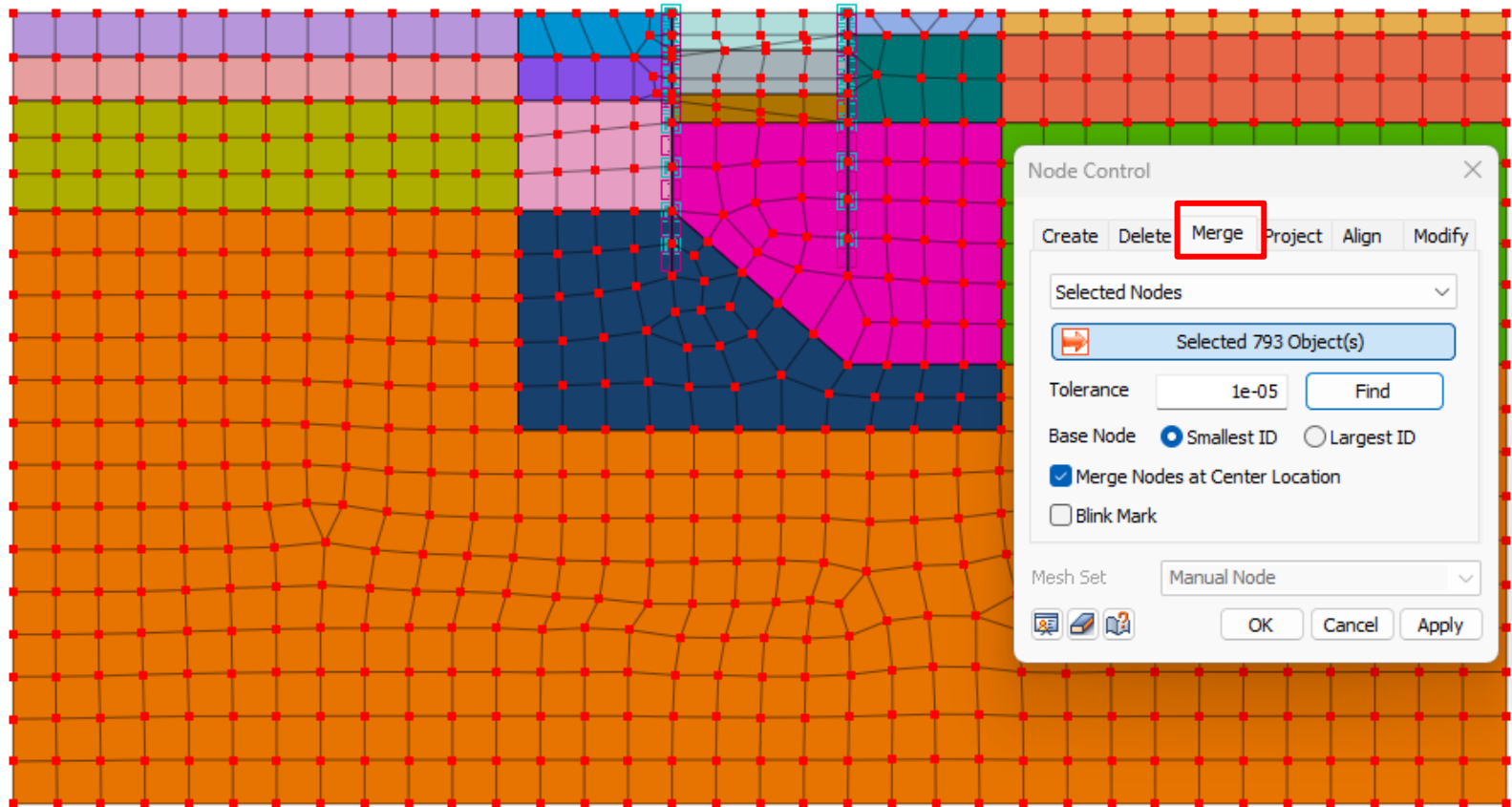
OK Cancel

Adjusting the RW local axis



Changing the axis of the local retaining wall axis

Merge node

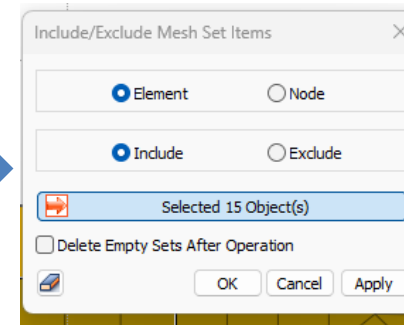
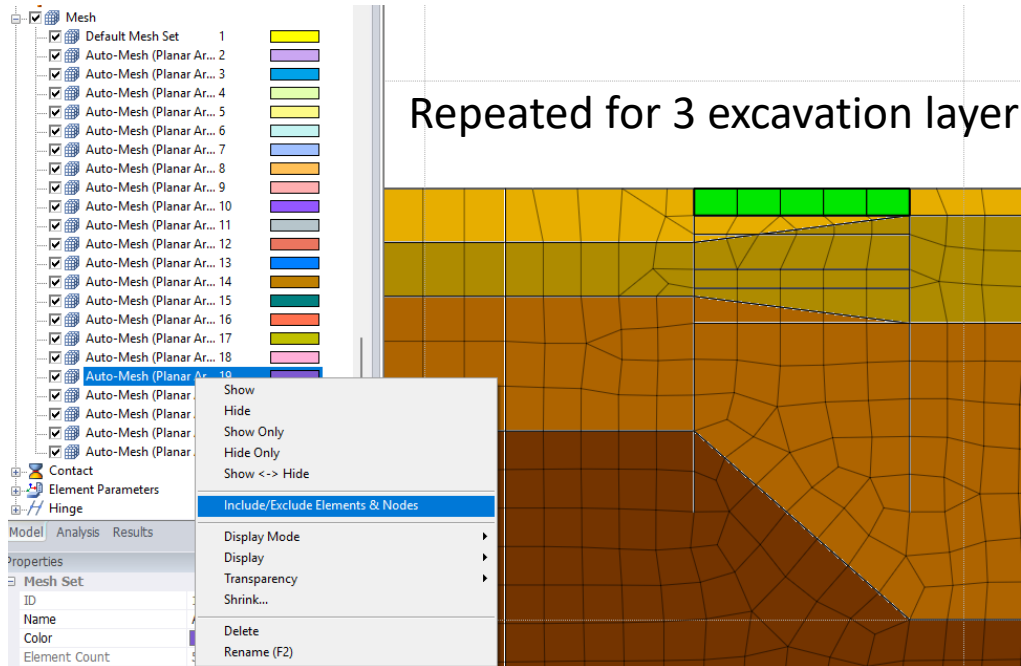


Checking the merge node function for interface

Selecting all nodes → Mesh → Node → Merge → Find

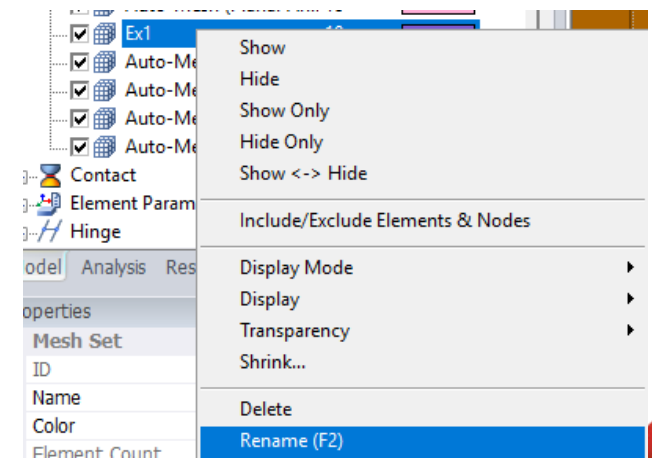
Group mesh set

Model tree

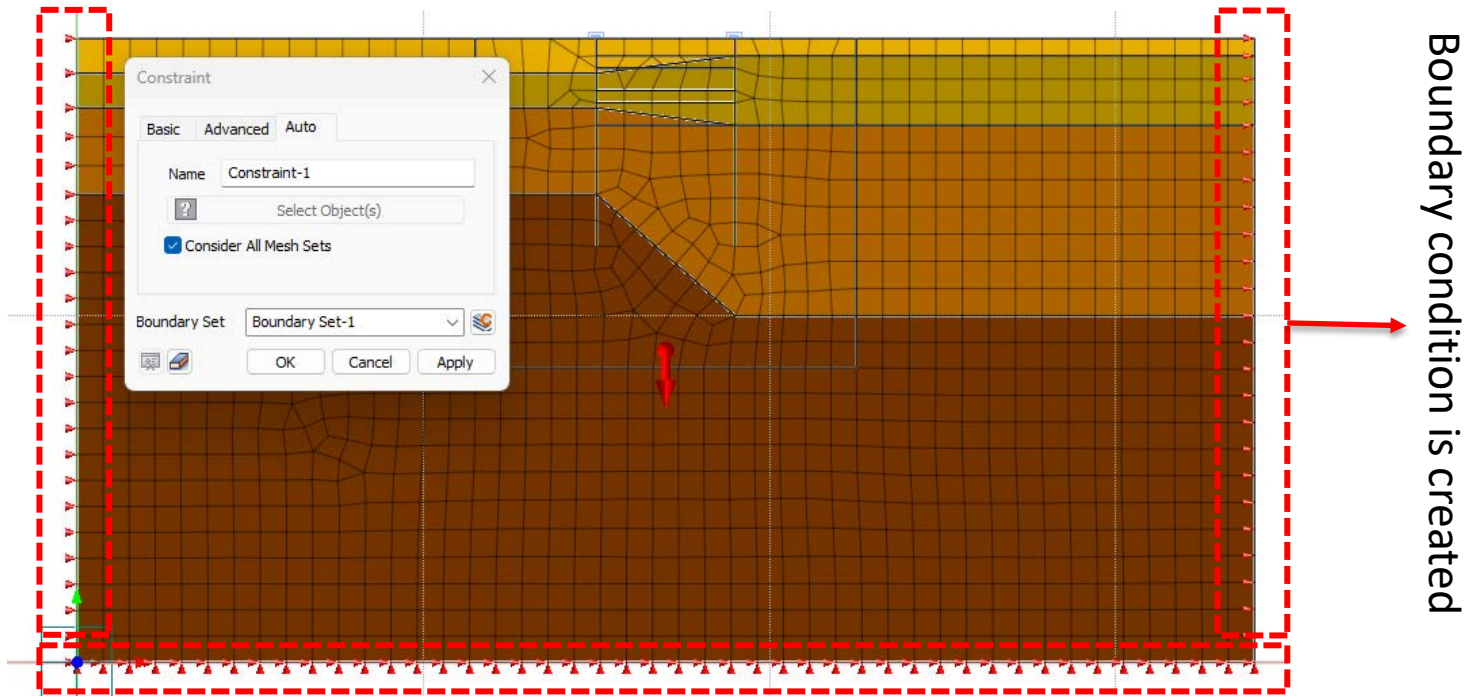
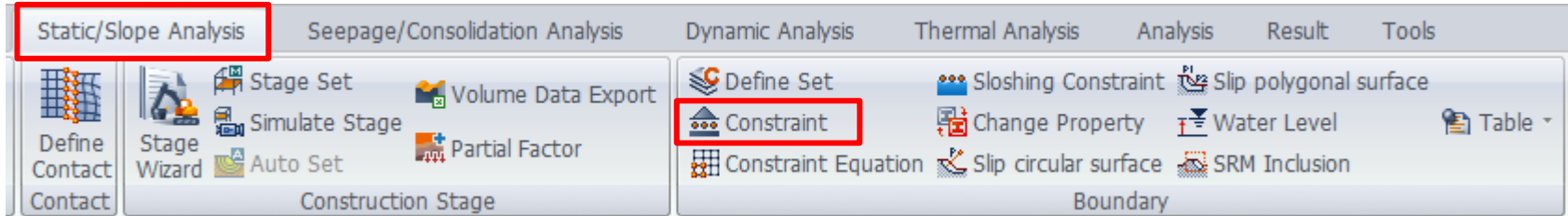


Selecting 'Include/Exclude Elements & Nodes'

Rename the group mesh set to control the excavation layer



Boundary condition



Creating a 2D boundary condition

Construction stage set

Construction Stage Set

Name: Excav

Stage Type: Stress

No	Name	Type
1	Excav	Stress

Buttons: Add, Modify, Copy, Delete, Define CS...

Define construction stage:

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

Define Construction Stage

Construction Stage Set Name: Excav-RW

Stage ID: 1: Initial

Stage Name: Initial

Stage Type: Stress

Buttons: Move to Previous, Move to Next, New, Insert, Delete

Set Data

- Mesh
- Default Mesh Set
- Ex1
- Ex2
- Ex3
- Line Interface
- RW
- Rigid Link Mesh
- Soil1
- Soil1-1
- Soil1-2
- Soil1-3
- Soil1-5
- Soil1-6
- Soil2
- Soil2-1
- Soil2-10
- Soil2-11
- Soil2-12
- Soil2-13
- Soil2-14
- Soil2-3
- Soil2-4
- Soil2-6
- Soil2-7
- Soil2-8

Activated Data

- Mesh
- Default Mesh Set
- Ex1
- Ex2
- Ex3
- Rigid Link Mesh
- Soil1
- Soil1-1
- Soil1-2
- Soil1-3
- Soil1-5
- Soil1-6
- Soil2
- Soil2-1
- Soil2-10
- Soil2-11
- Soil2-12
- Soil2-13
- Soil2-14
- Soil2-3
- Soil2-4
- Soil2-6
- Soil2-7
- Soil2-8
- Soil2-9
- Boundary Condition

Deactivated Data

- Mesh
- Boundary Condition
- Static Load
- Combined Load Sets
- Contact

Sort By: Name

Show Data: Activate

Buttons: Save, Close

Analysis Control...

Output Control...

Initial Condition

☐ Define Water Level For Global

0 m None

☐ Define Water Level For Mesh Set

Input Water Level...

☐ Sub Stage...

☐ LDF... Copy To Specific Stage...

☒ Clear Displacement

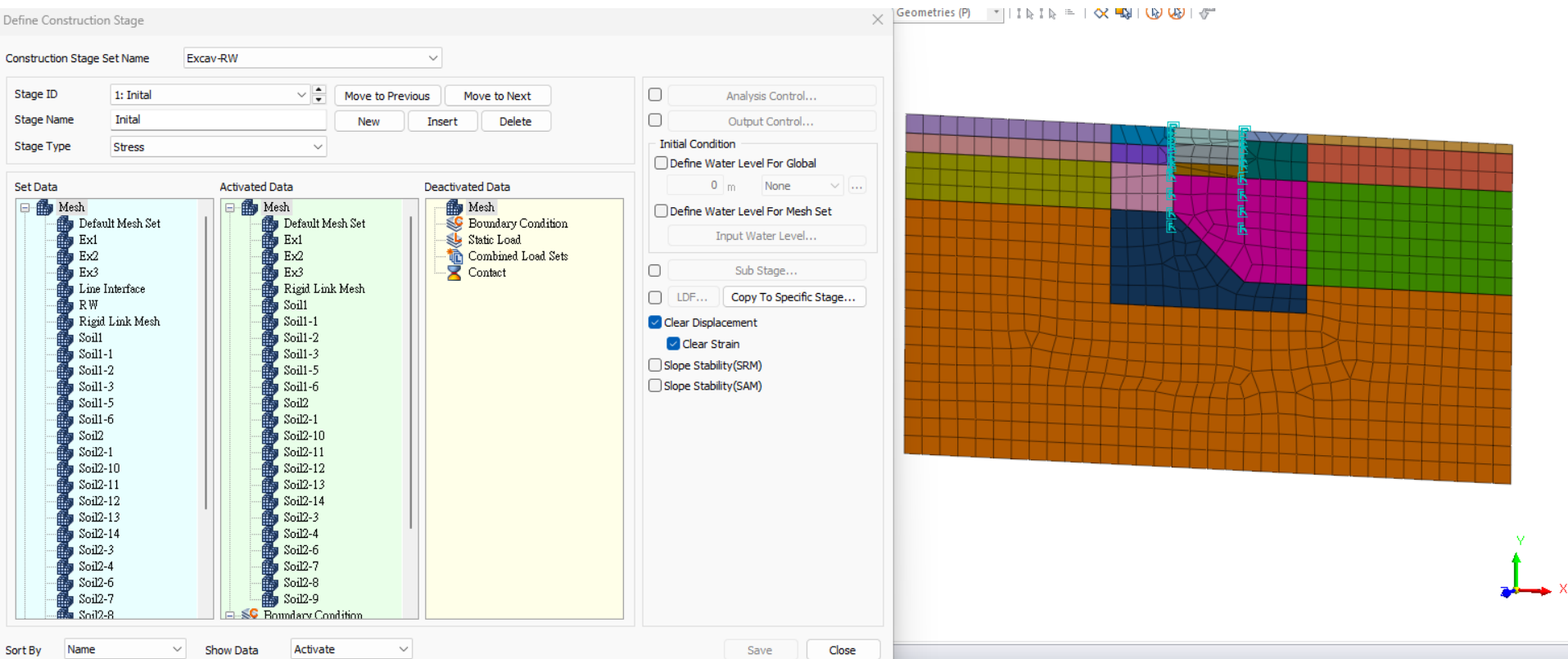
☒ Clear Strain

☐ Slope Stability(SRM)

☐ Slope Stability(SAM)

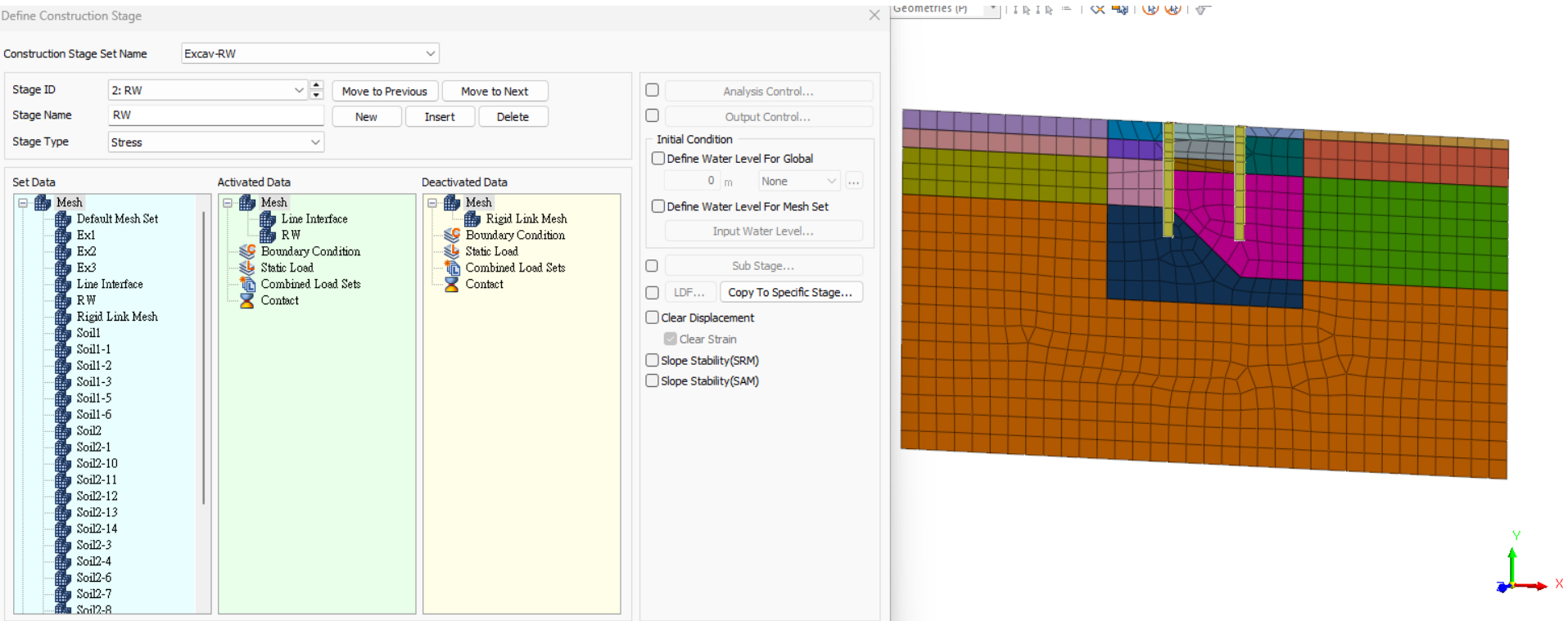


Stage 1. Initial



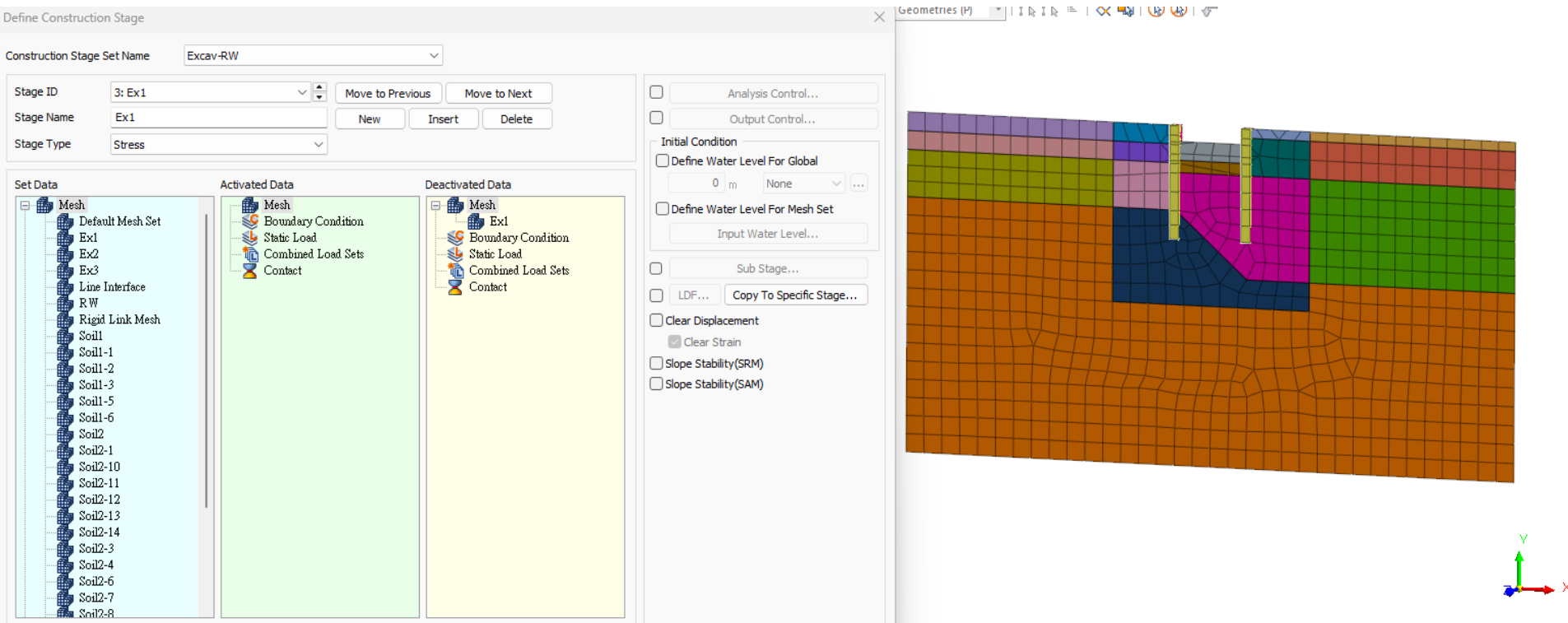
Stage 1. Input the initial condition

Stage 2. Install RW



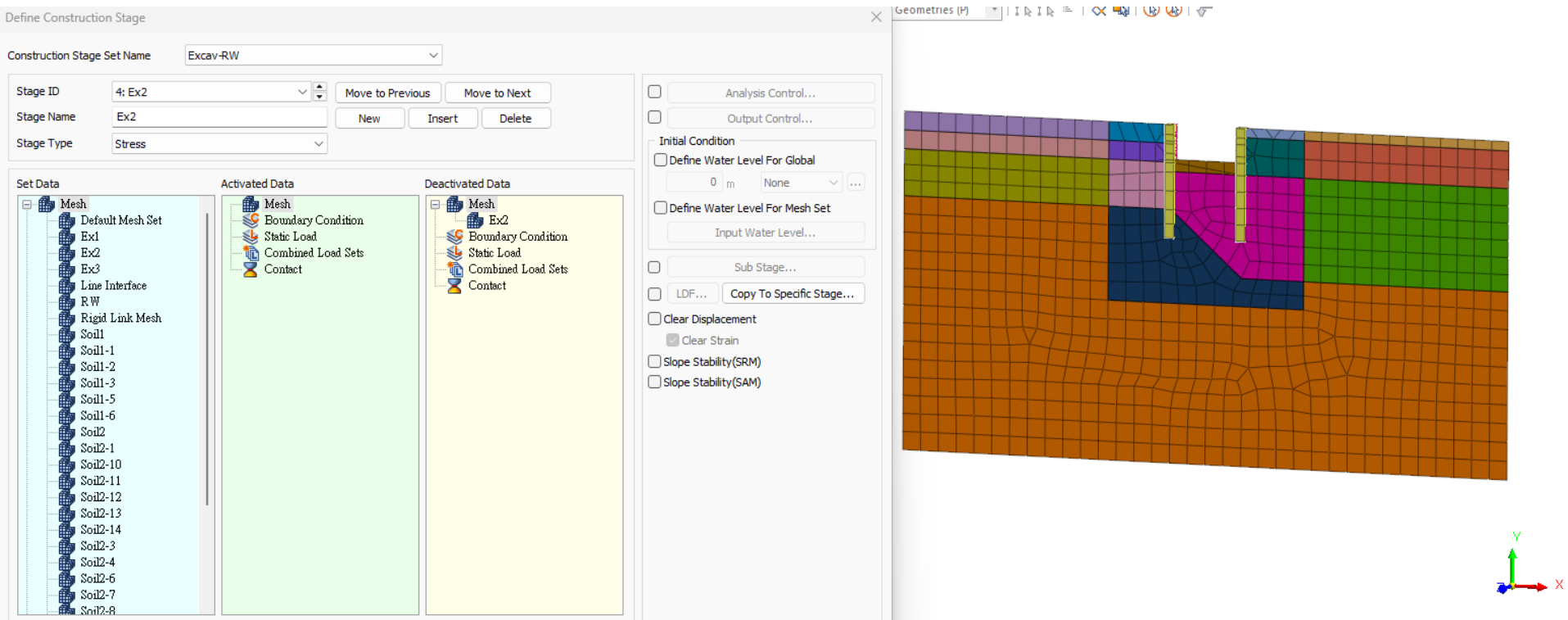
Stage 2. Install the retaining wall

Stage 3. Excavation for layer 1



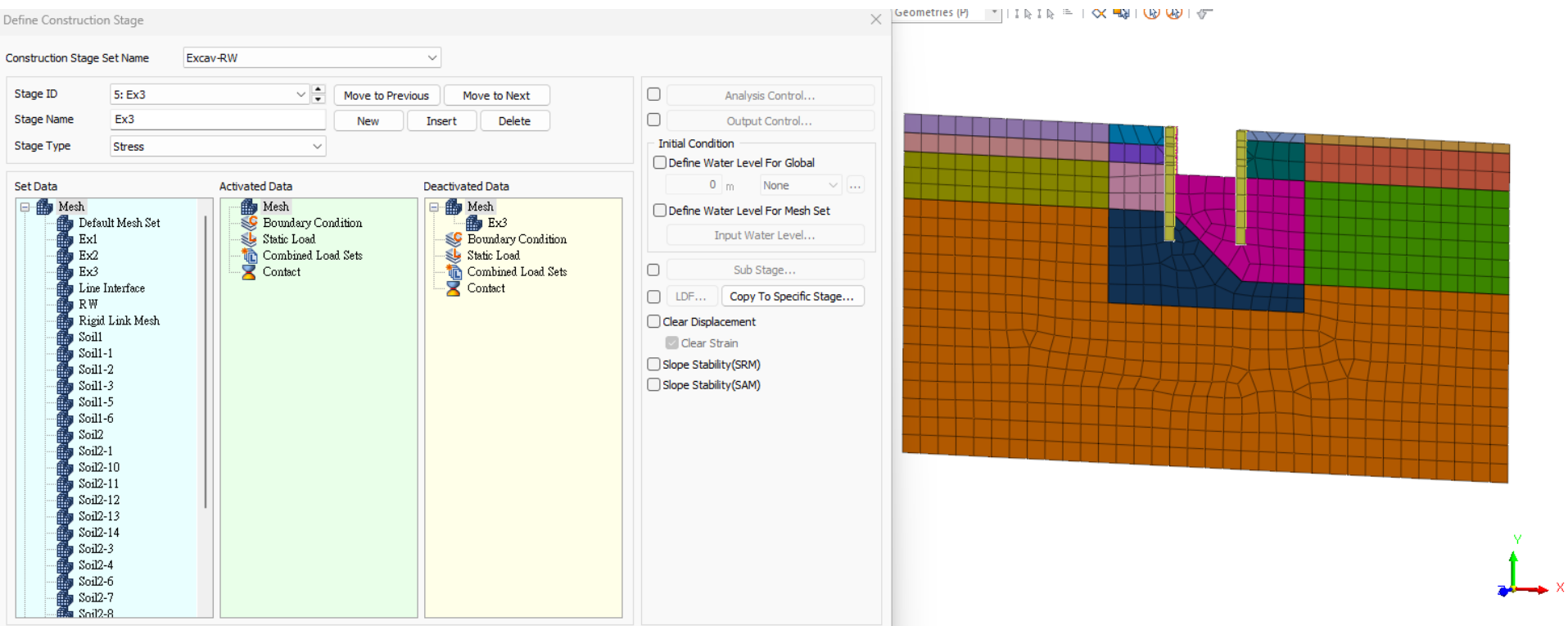
Stage 3. Excavation for layer 1

Stage 4. Excavation for layer 2



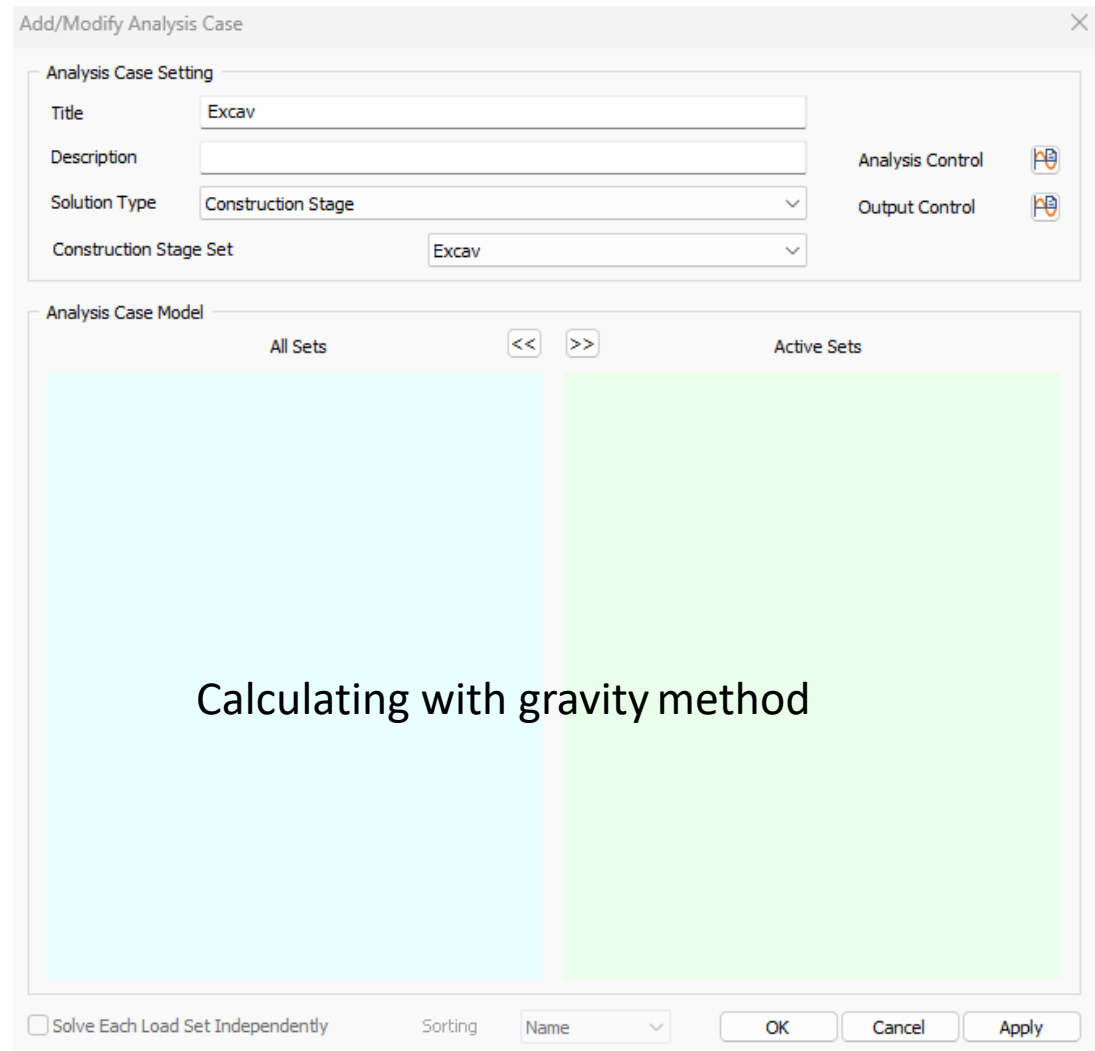
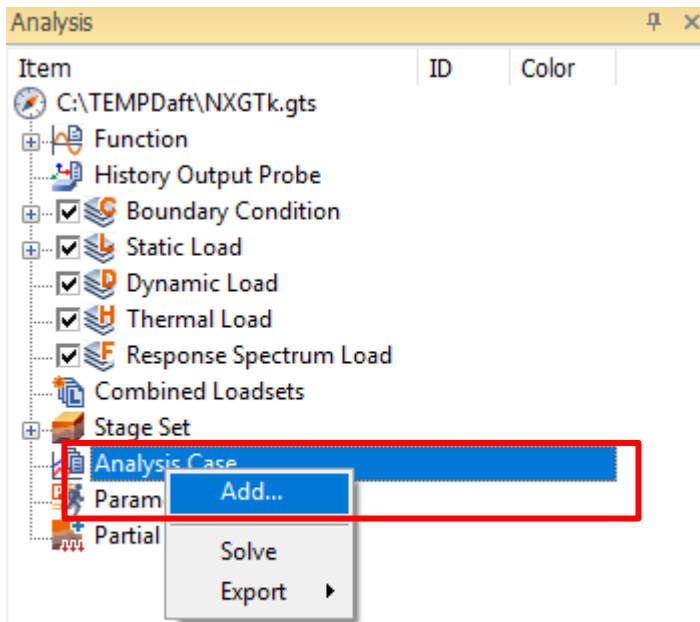
Stage 4. Excavation for layer 2

Stage 5. Excavation for layer 3

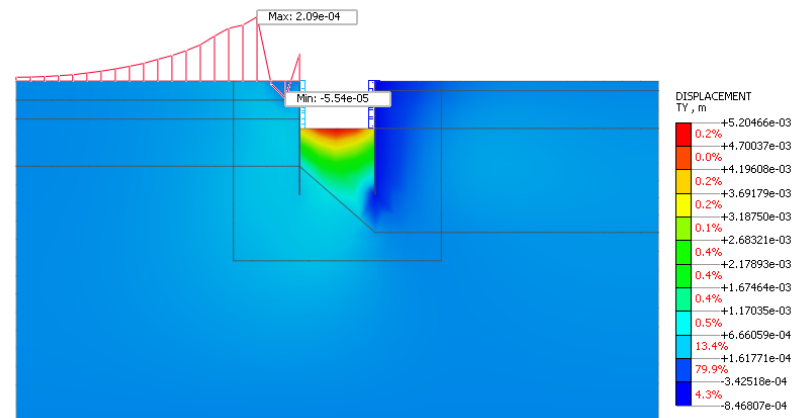
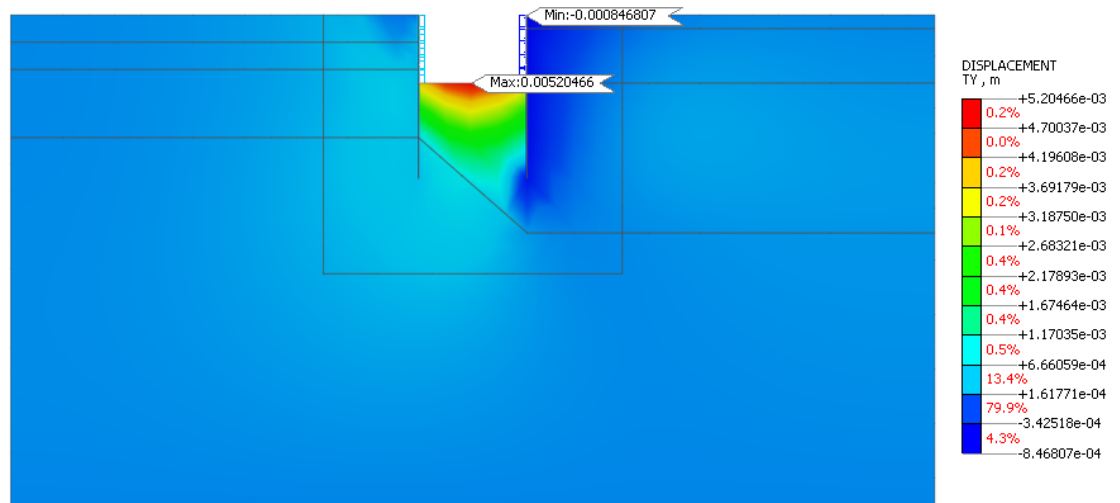
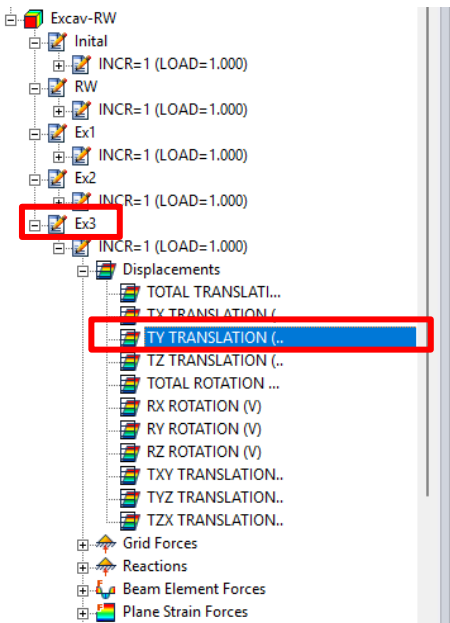


Stage 5. Excavation for layer 3

Analysis control

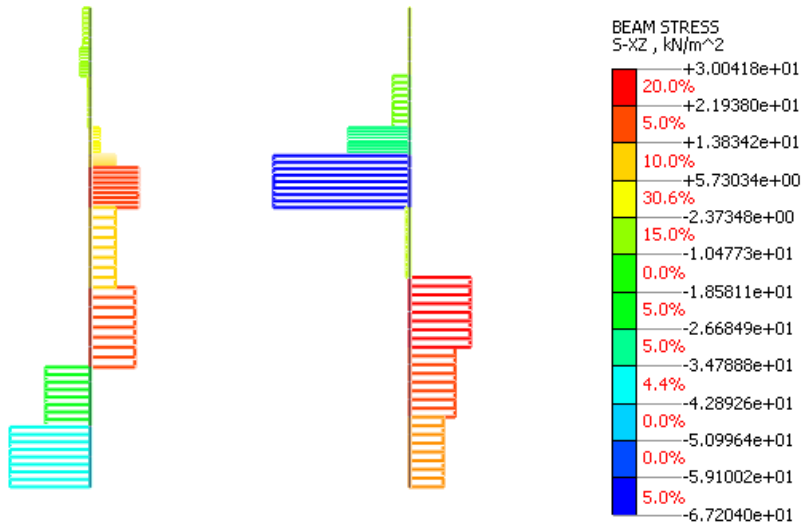


Result – Vertical displacement

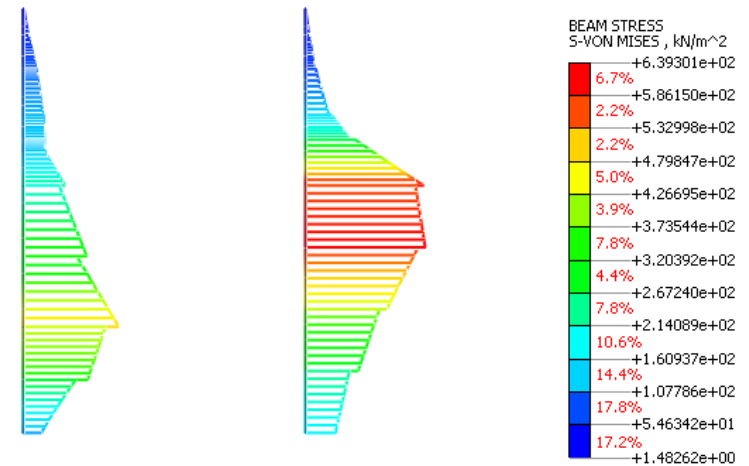


Result → Advanced → Cutting Diagram

Result – Forces in RW



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

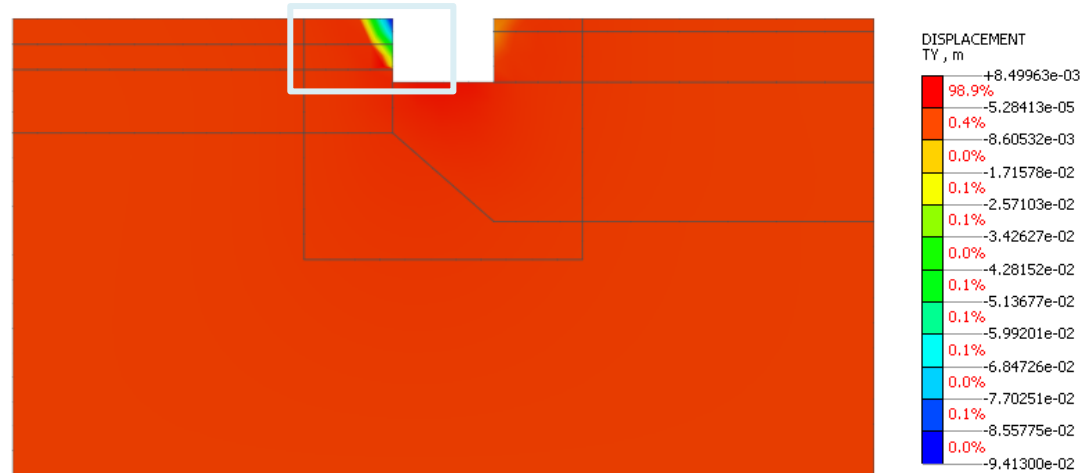


Bending moment in RW
(Beam stresses → S-VON MISES)

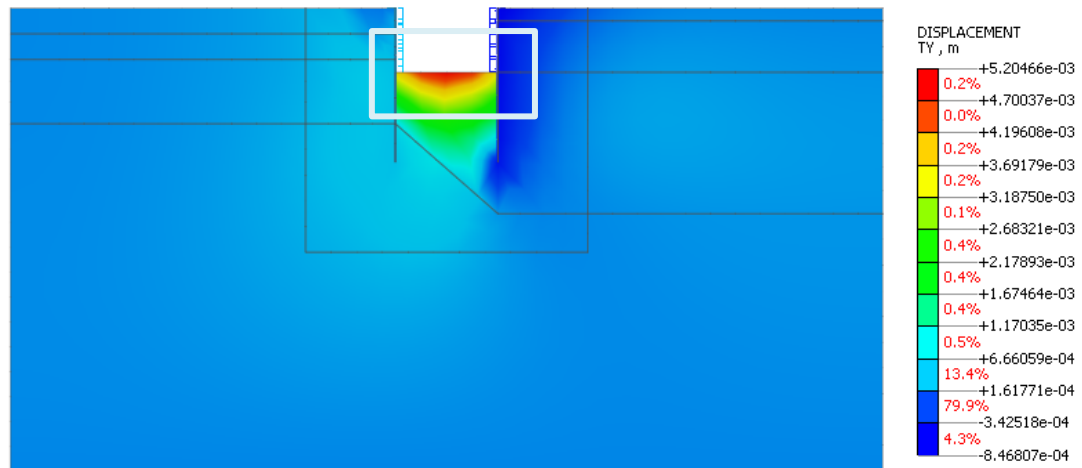
Result – Comparison

(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

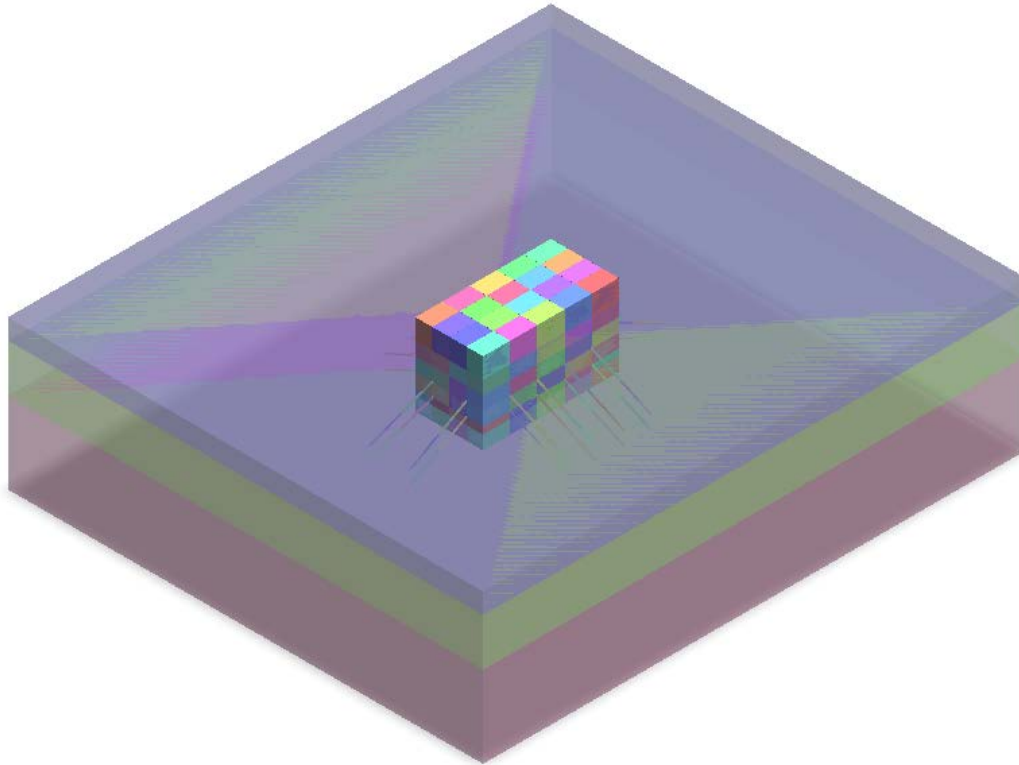
3D Excavation with Retaining System

Lesson 02

Midas Taiwan

Reference: Midas GTX NX Tutorials

Project case overview



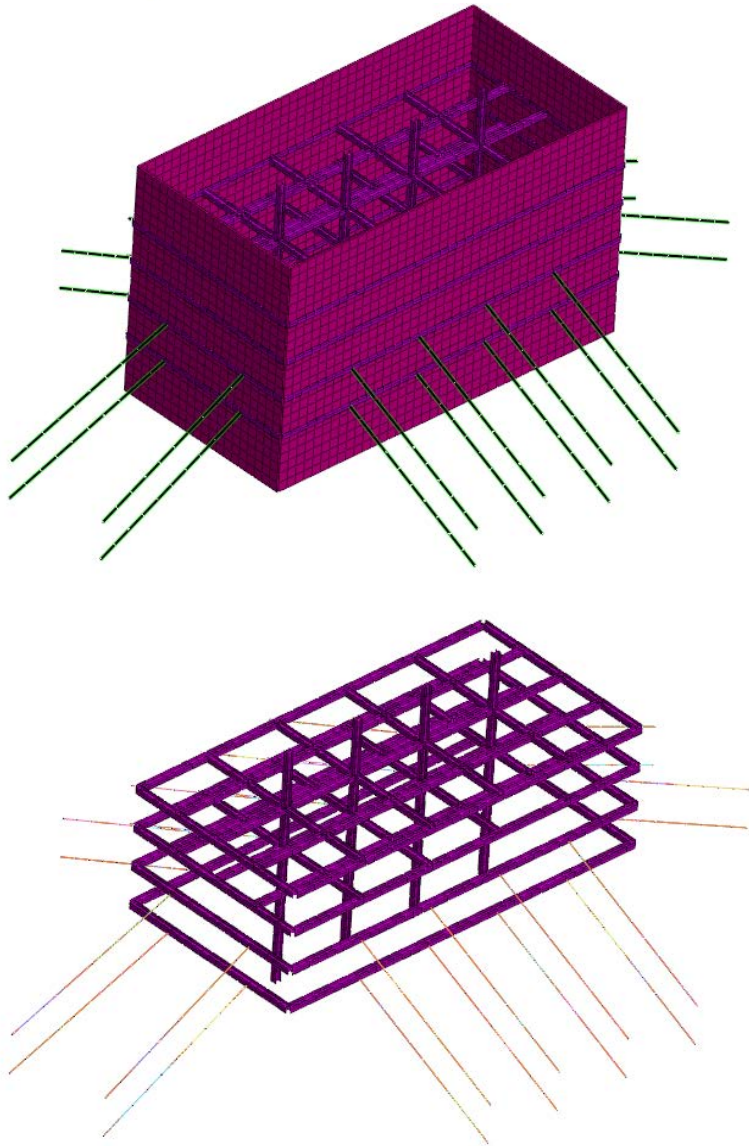
Project overview:

Rectangular Excavation : 10 x 20m
Depth: 12m

Soil Property Overview:

3m of Buried Layer
7m of Colluvium
12m of Weathering soil

Project case overview



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

Pre-processing

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

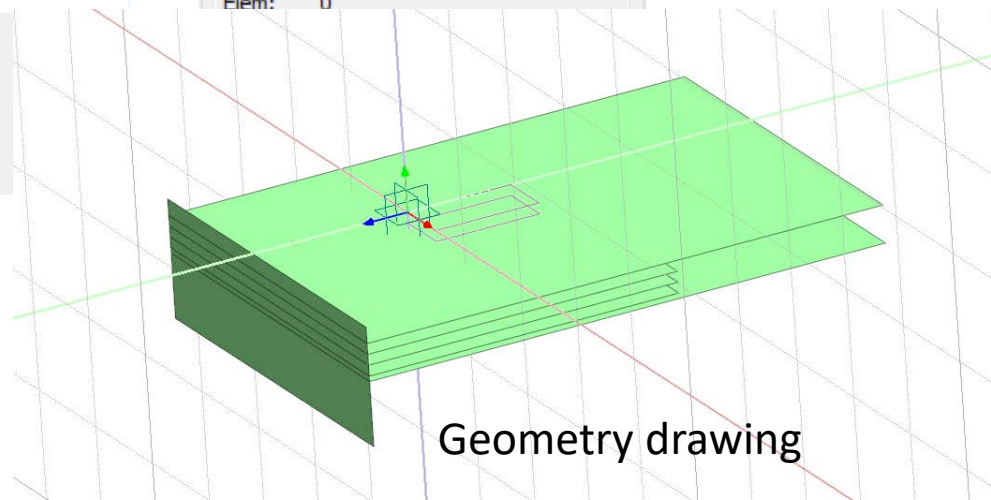
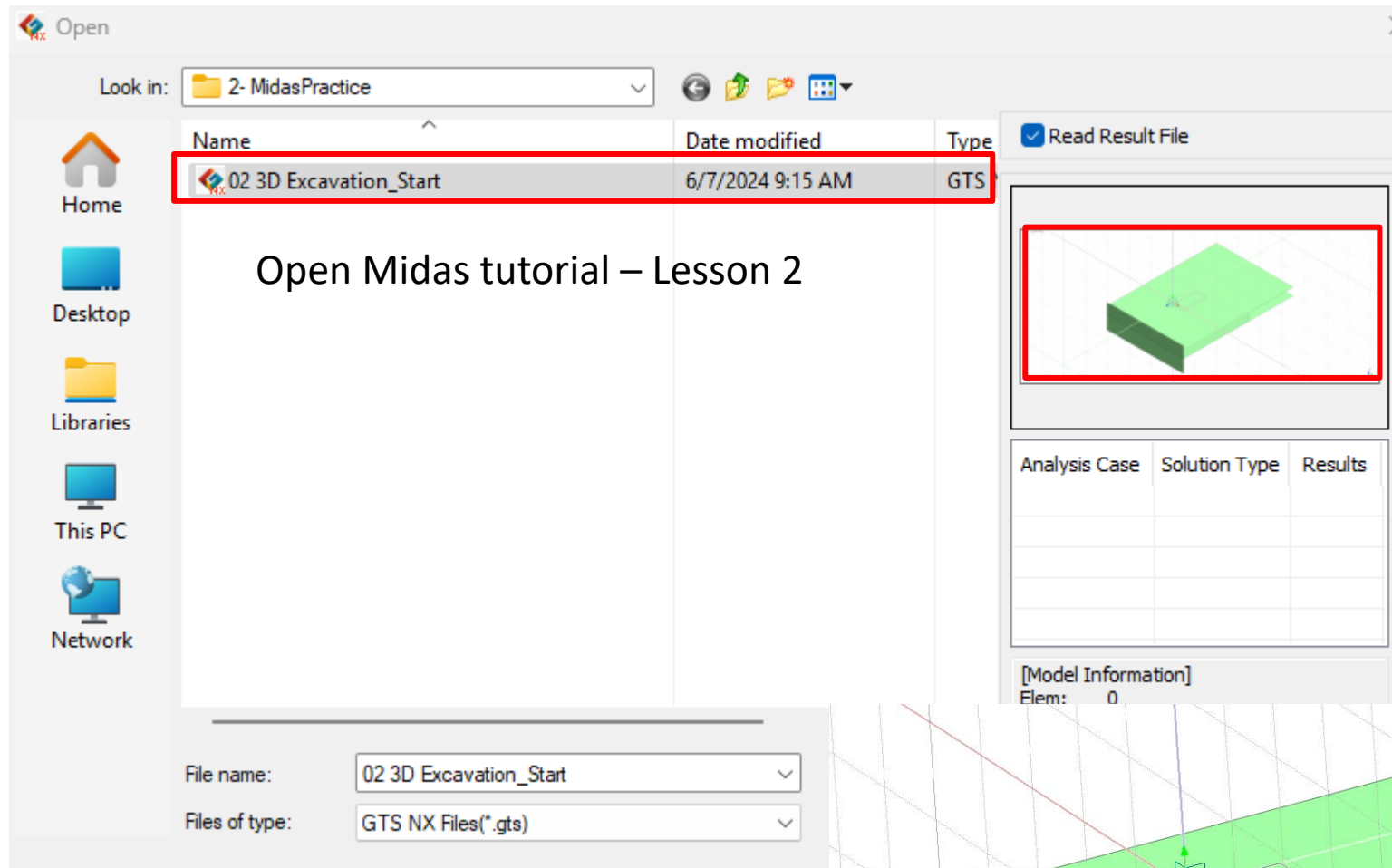
Solving

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.

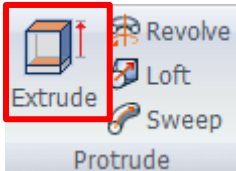
Post Processing

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

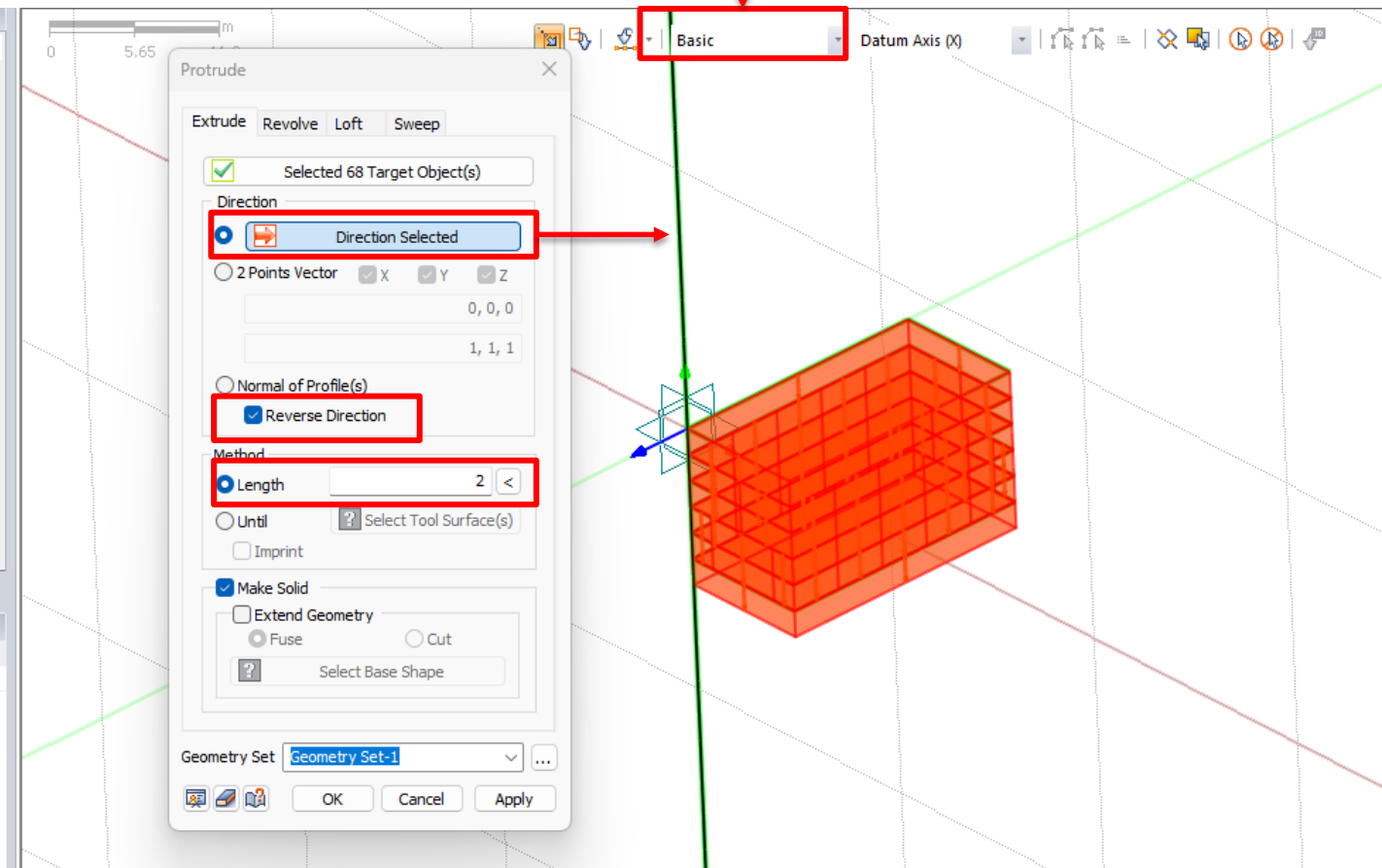
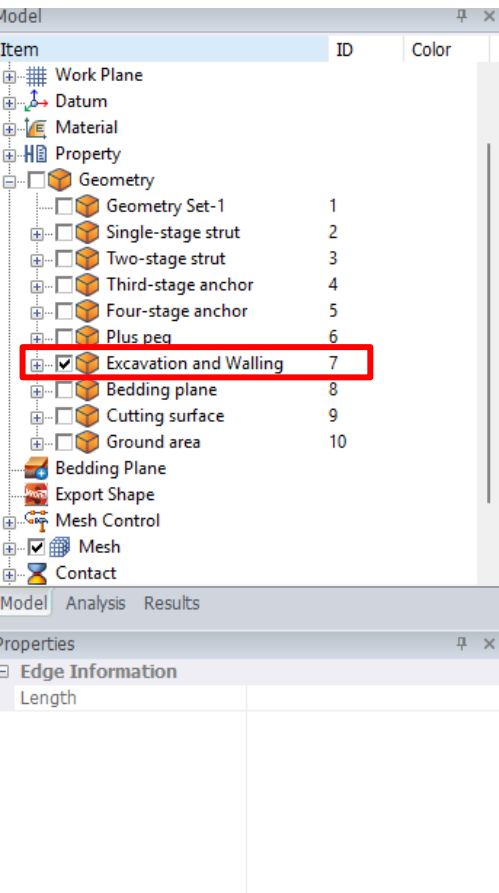
Open model



Geometry modeling – Excavation area

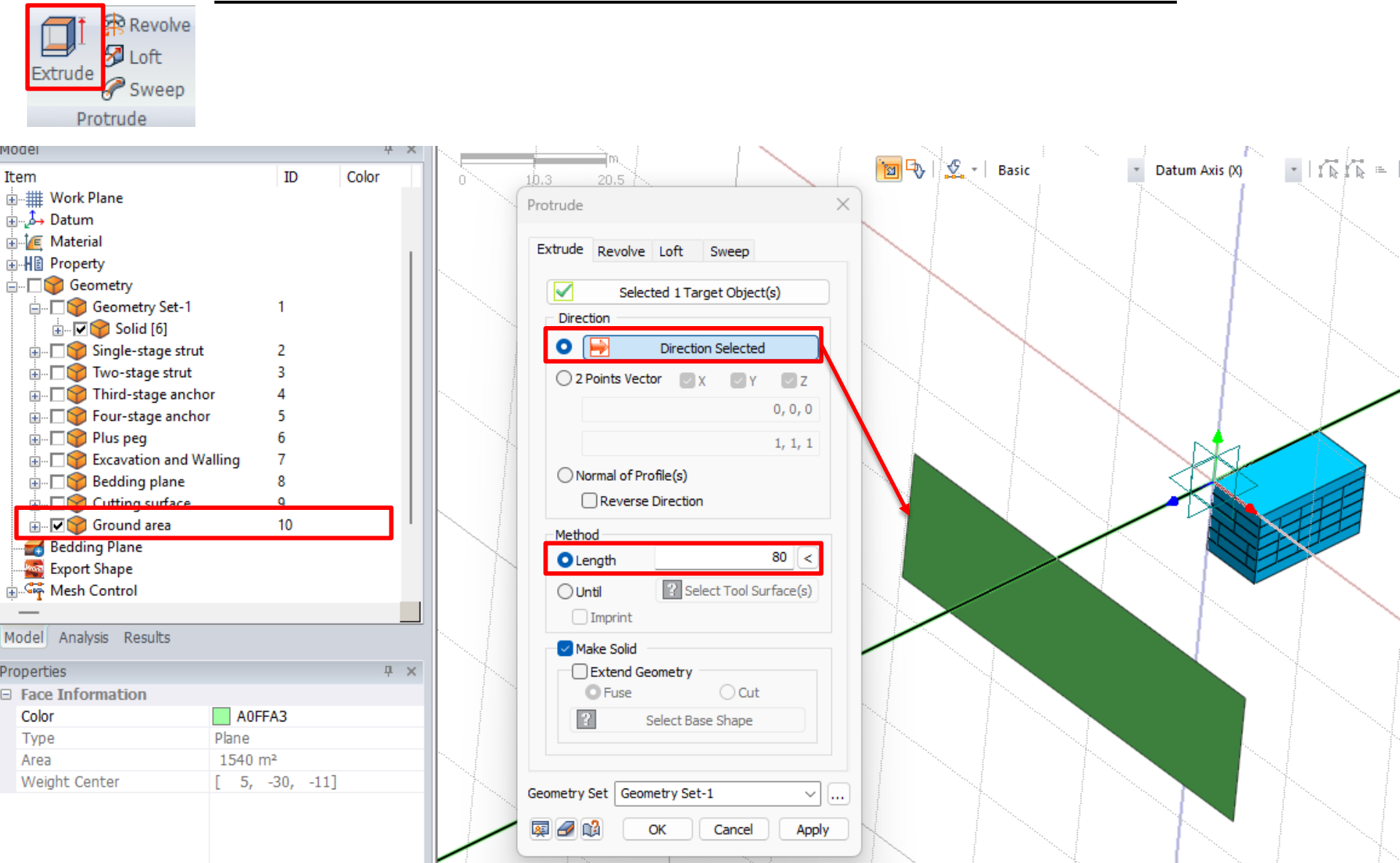


Change into 'Edge', then 'Select All'



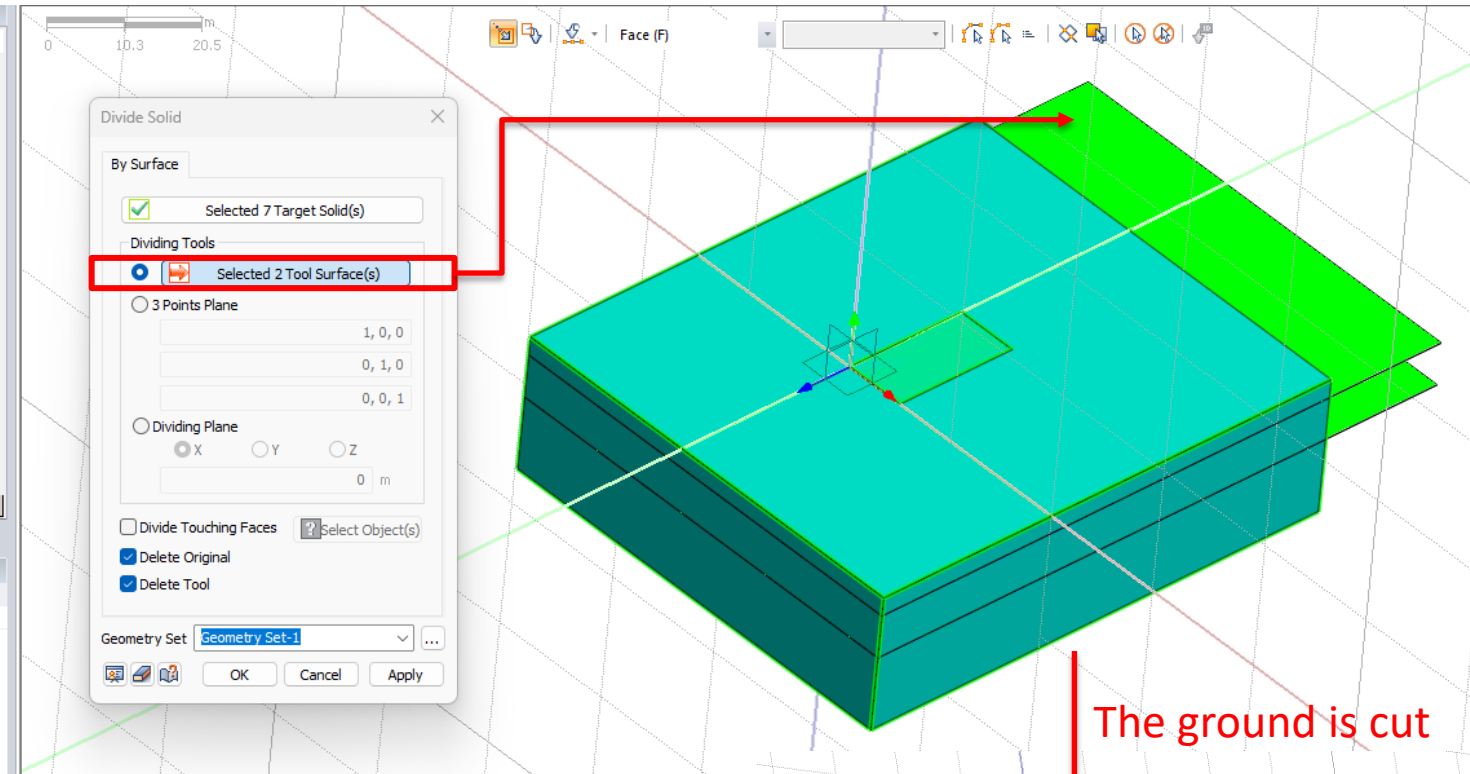
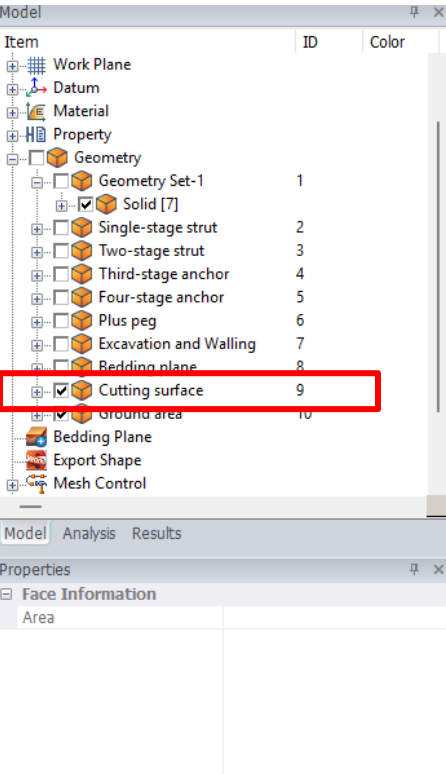
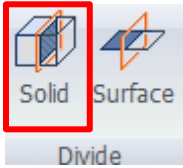
Extruding excavation area

Geometry modeling – Ground

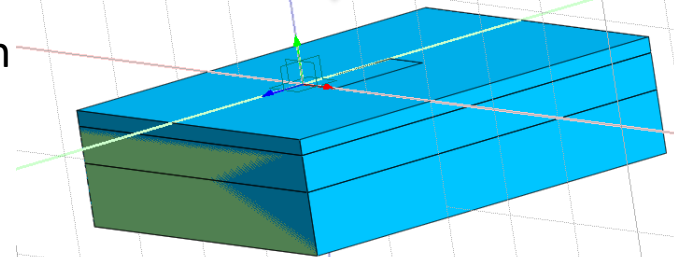


Ground area

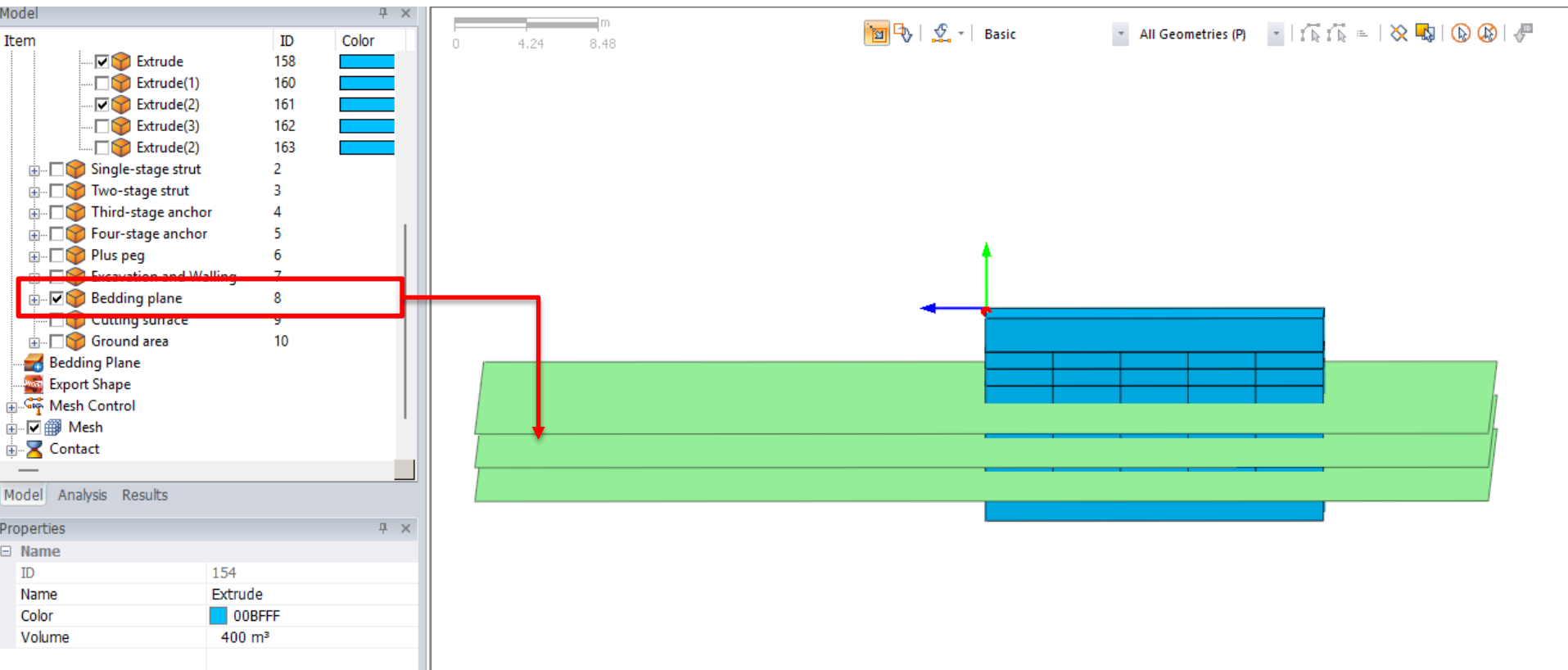
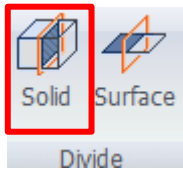
Cutting ground surface



Cutting surface for ground by 'Divide solid' function



Bedding plane



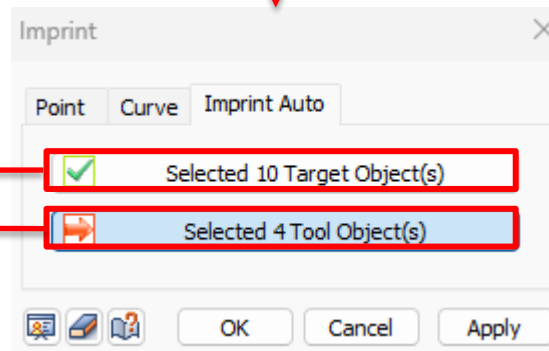
Bedding plane for excavation area by 'Divide solid' function

Imprint for 'Plug pegs'

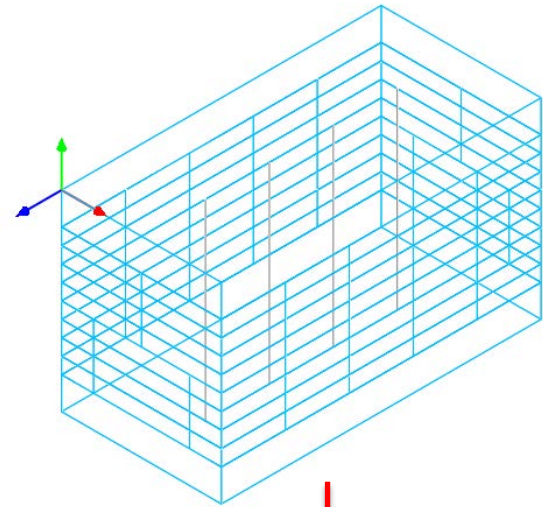


Excavation area

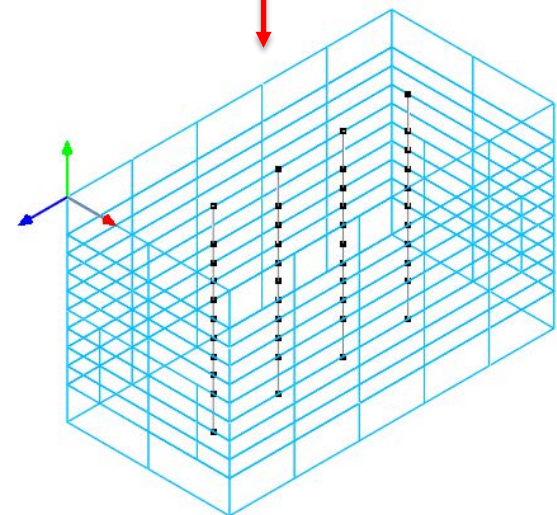
Plug pegs



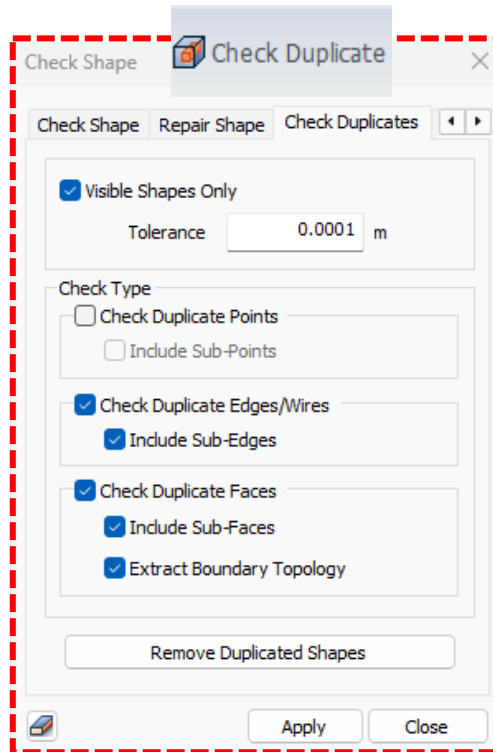
'Imprint' for creating node at different surface
in excavation area



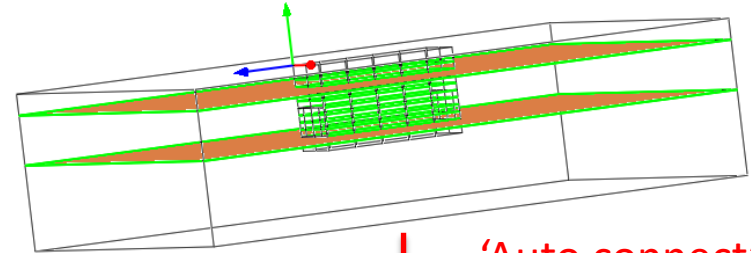
Before and After
using 'Imprint'



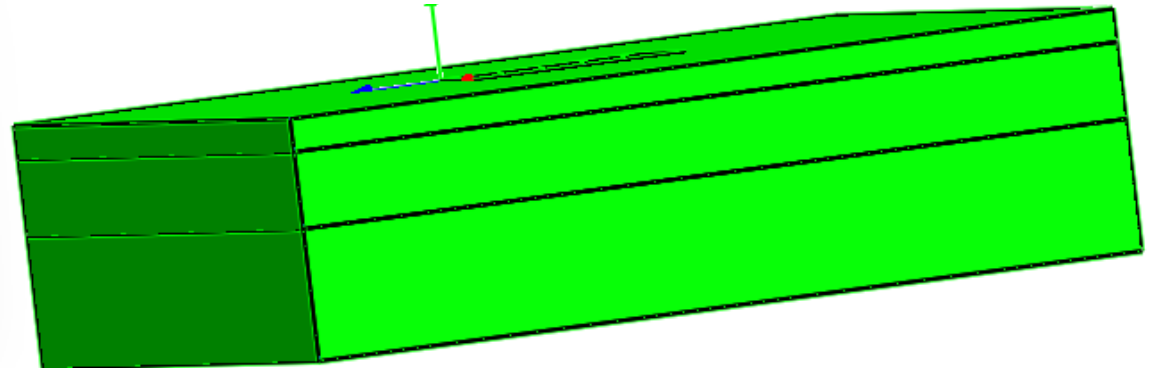
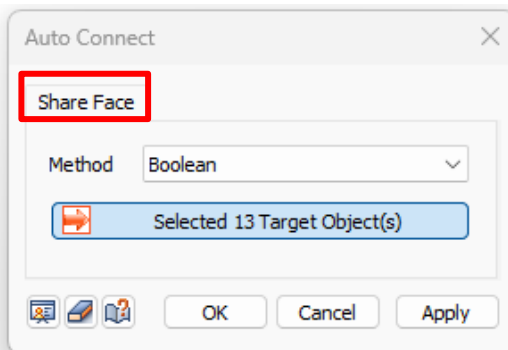
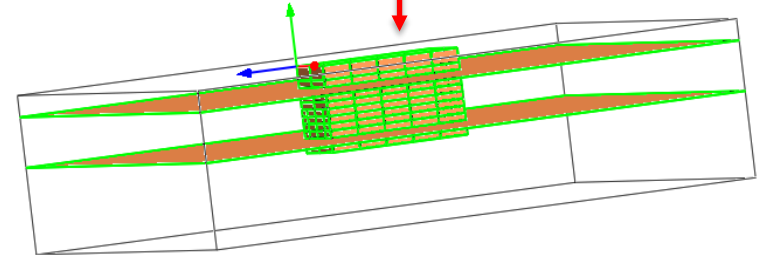
Check duplicate – Auto connect



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
Euref	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

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

Generate mesh(Solid)

Auto-Solid | Map-Solid | 2D->3D

Select Object(s)

Size Method

☒ Size 1

☐ Division 10

☐ Automatic 4.01

Hybrid Mesher

☒ Match Adjacent Faces

Property

6 6: Weathering soil

Mesh Set Auto-Mesh(3D)

OK Cancel Apply >>

Advanced Option

☒ Interior Edge/Point

40 Edge(s) Selected

Select Interior Point(s)

☐ Register Each Mesh Independently

☒ Consider Imprinting Shape on Face

2 2: Walling, Plus peg, Strut

☒ Merge Nodes

Tolerance 0.0001

Element Size Growth Rate

Fine Coarse 1.1

Min/Max Element Size 1.100

Small Large 1.1

☐ Higher-Order Element

☐ Midside Nodes on Geometry

☐ Geometry Proximity

☒ Pattern Mesh

☒ Register Each Mesh Independently

OK Cancel

“Transparency” display mode

Include/Exclude Elements & Nodes

Show/Hide

Display Mode

Display

Transparency

Transform

Delete

1

2

3

4

5

6

7

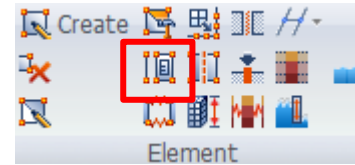
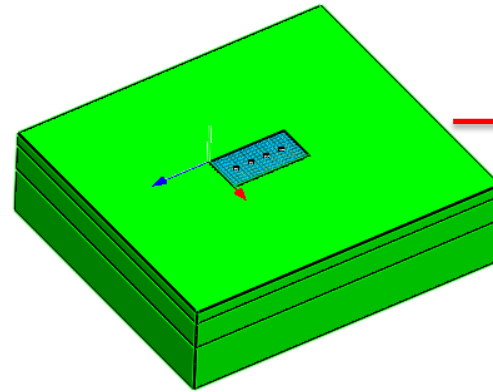
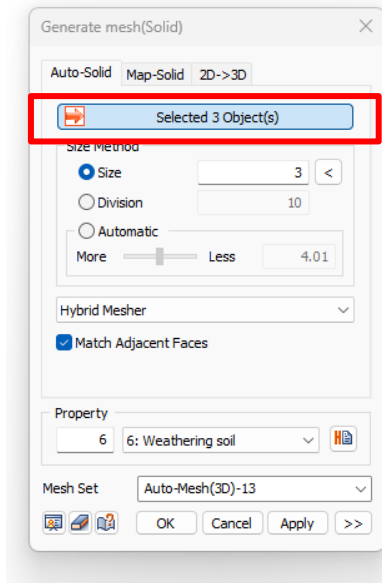
8

9

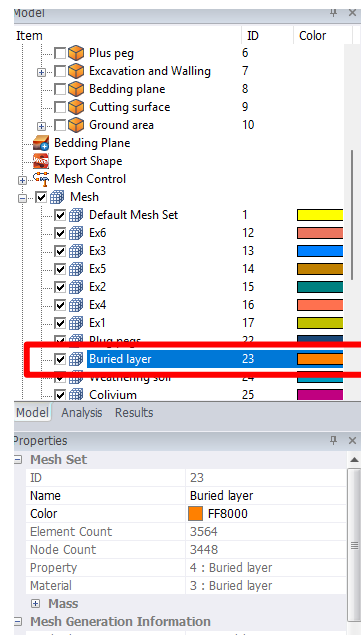
Opaque

► Generate meshes with nodes connected to interior edges

3D mesh - Ground



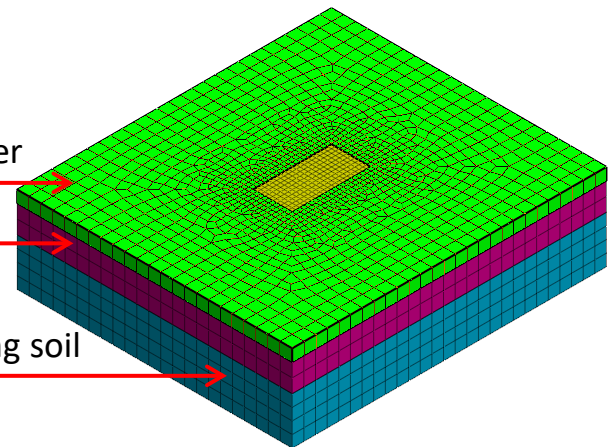
Need to Change property



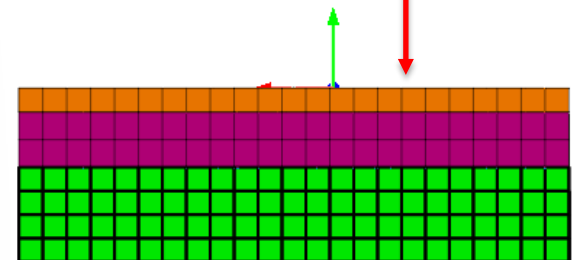
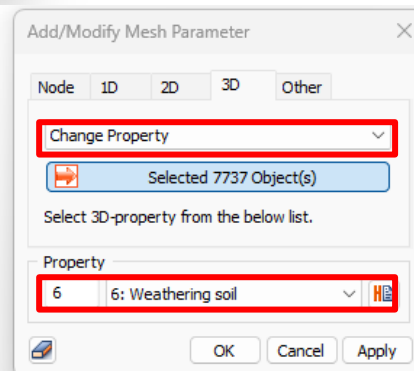
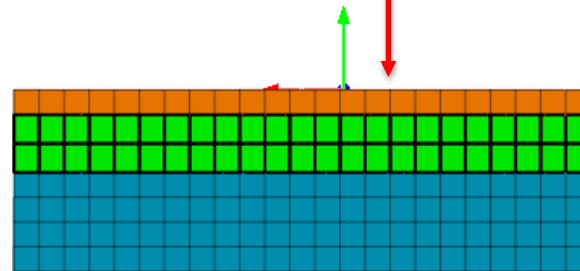
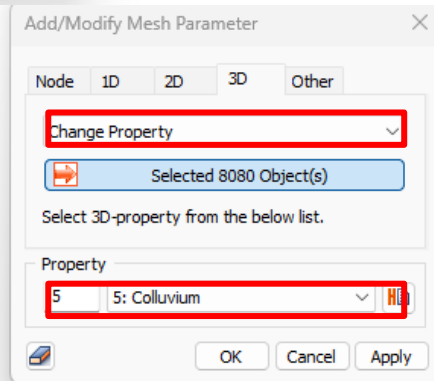
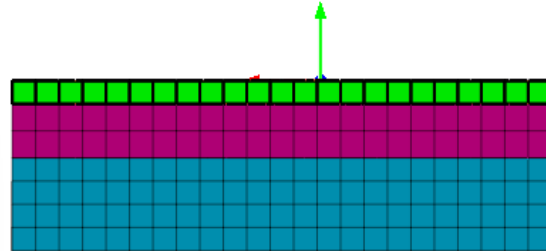
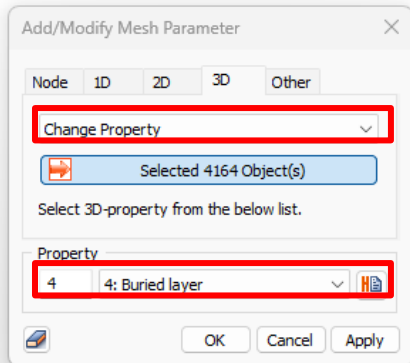
Buried layer

Collivium

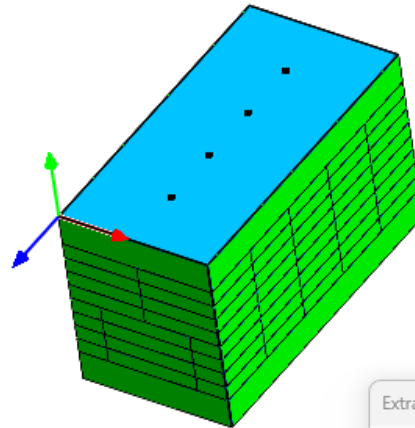
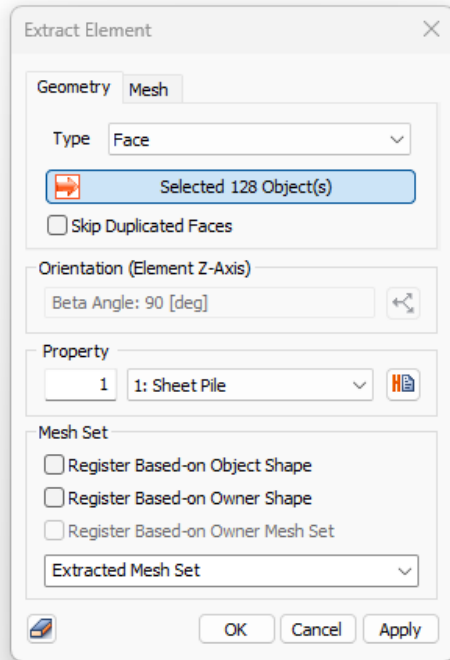
Weathering soil



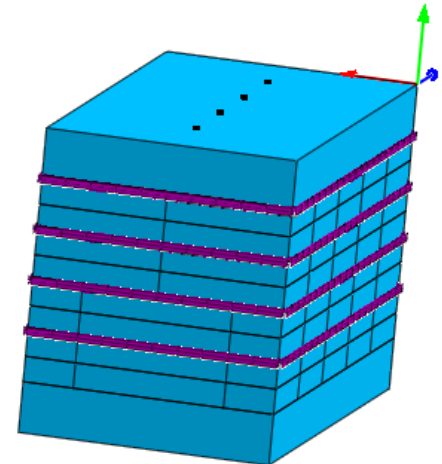
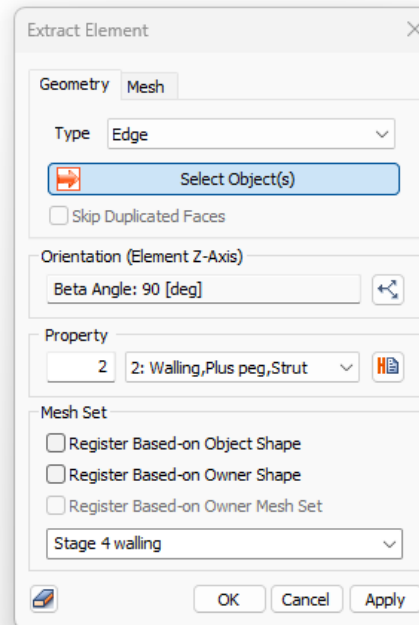
Change property – Ground



Extract elements for RW, Walling

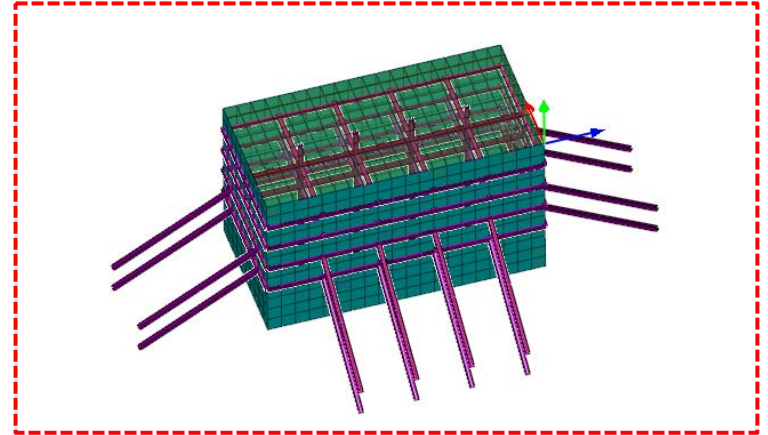
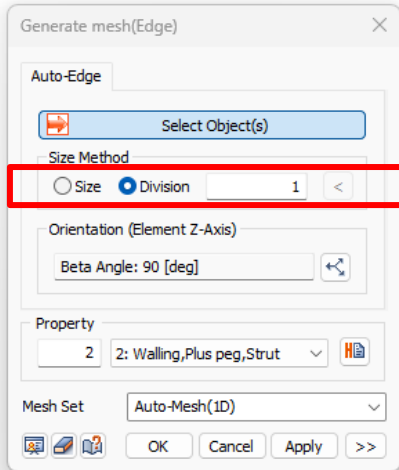


▼ Extracting walling from 'Edge' geometry

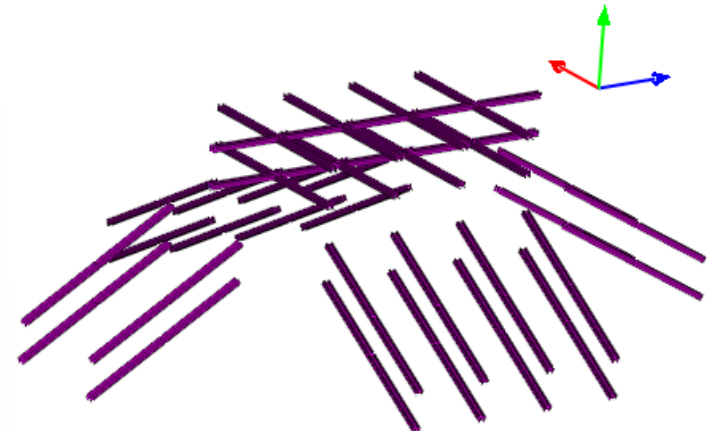
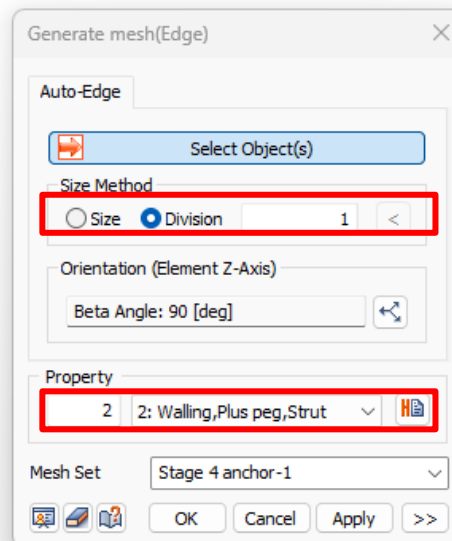


▲ Extracting sheet pile from 'Face' geometry

1D mesh – Struts & Anchors



▲ Image of supporting and RW after meshing

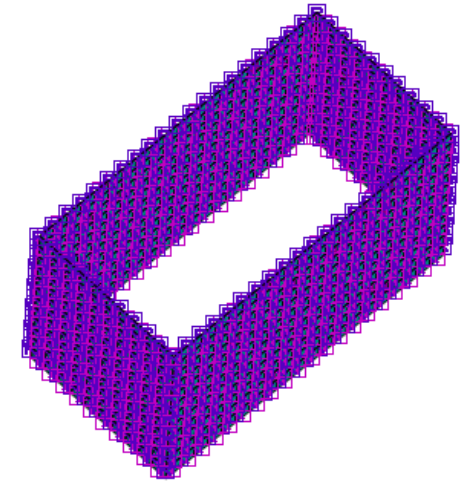
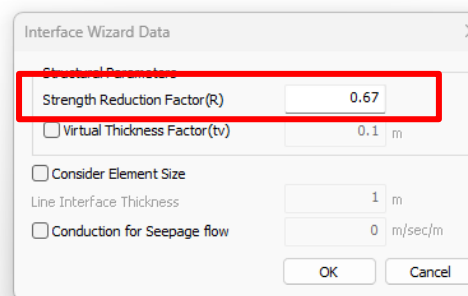
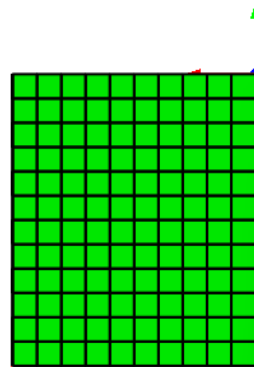
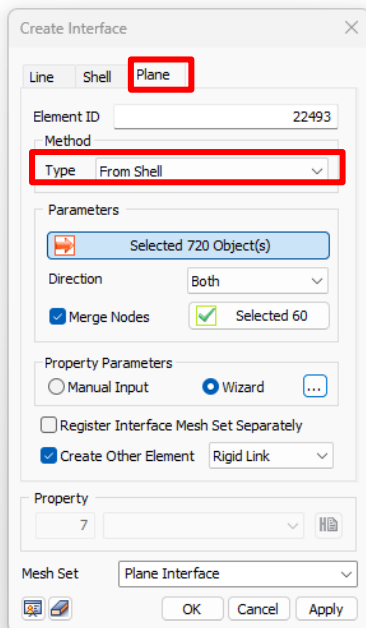


▲ Meshing Struts and Anchors

Plane interface

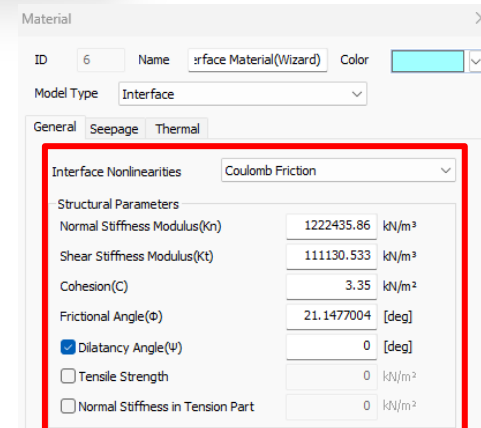


Selecting 'Interface'

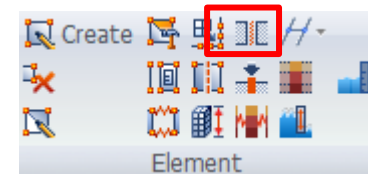


Interface is created

→ 'Interface' is created for each soil material by GTX Wizard



Interface Wizard



► Interface Wizard equation from Midas GTX NX manual:

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

$$K_t = G_i / t_v$$

$$C_i = R \times C_{\text{soil}}$$

Here,

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

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

$$G_{\text{soil}} = E / (2(1 + \nu_{\text{soil}}))$$

Where,

K_n : Normal Stiffness Modulus

K_t : Shear Stiffness Modulus

t_v : Virtual Thickness Factor

R : Strength Reduction Factor

C_i : Interface Cohesion

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

K_t (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: $R = 0.6 \sim 0.7$
- Clay/ Steel material: $R = 0.5$
- Sandy soil/ Concrete: $R = 1.0 \sim 0.8$
- Clay/ Concrete: $R = 1.0 \sim 0.7$

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

Interface Wizard Data

☐ Structural Parameters

☒ Strength Reduction Factor(R) 1

☐ Virtual Thickness Factor(tv) 0.1 m

☐ Consider Element Size

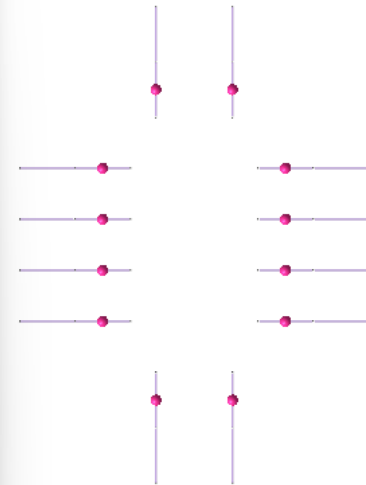
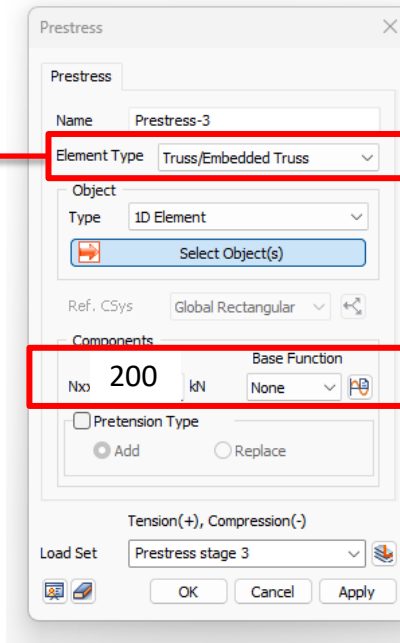
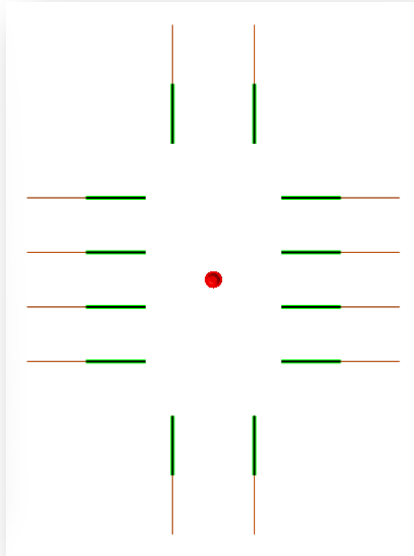
Line Interface Thickness 1 m

☐ Conduction for Seepage flow 0 m/sec/m

OK Cancel



Prestressed - Anchors

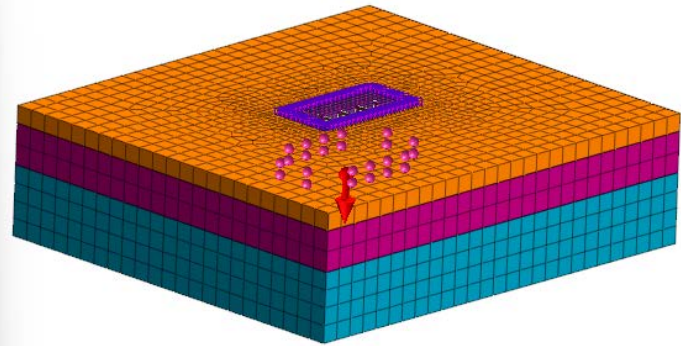
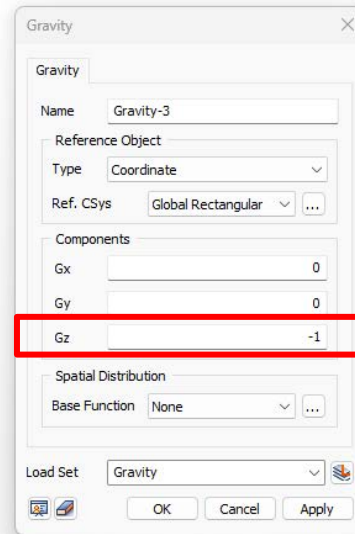


Selecting the length of anchors should add a prestressed load

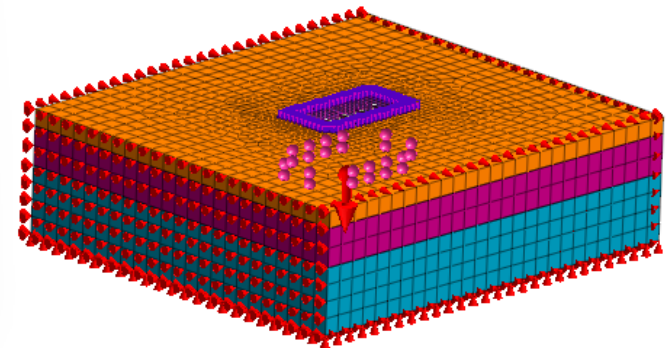
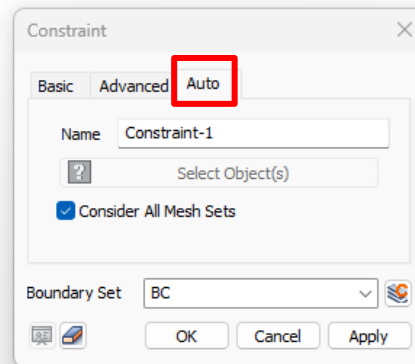
Prestressed: 200 kN

Gravity – Boundary conditions

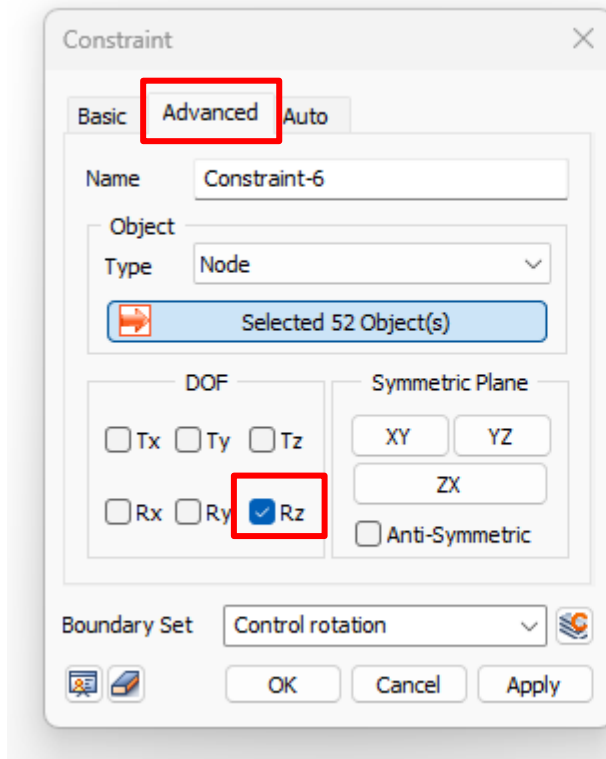
► Assigning gravity



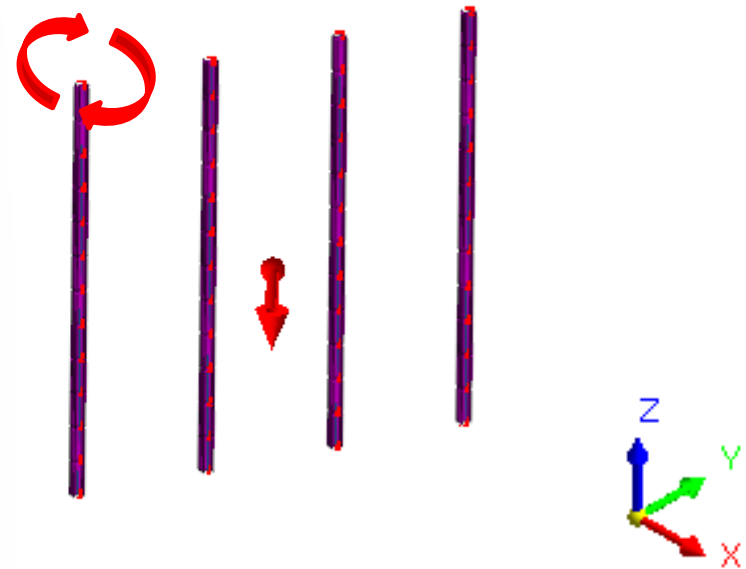
► Assigning boundary condition



Rotation constraint

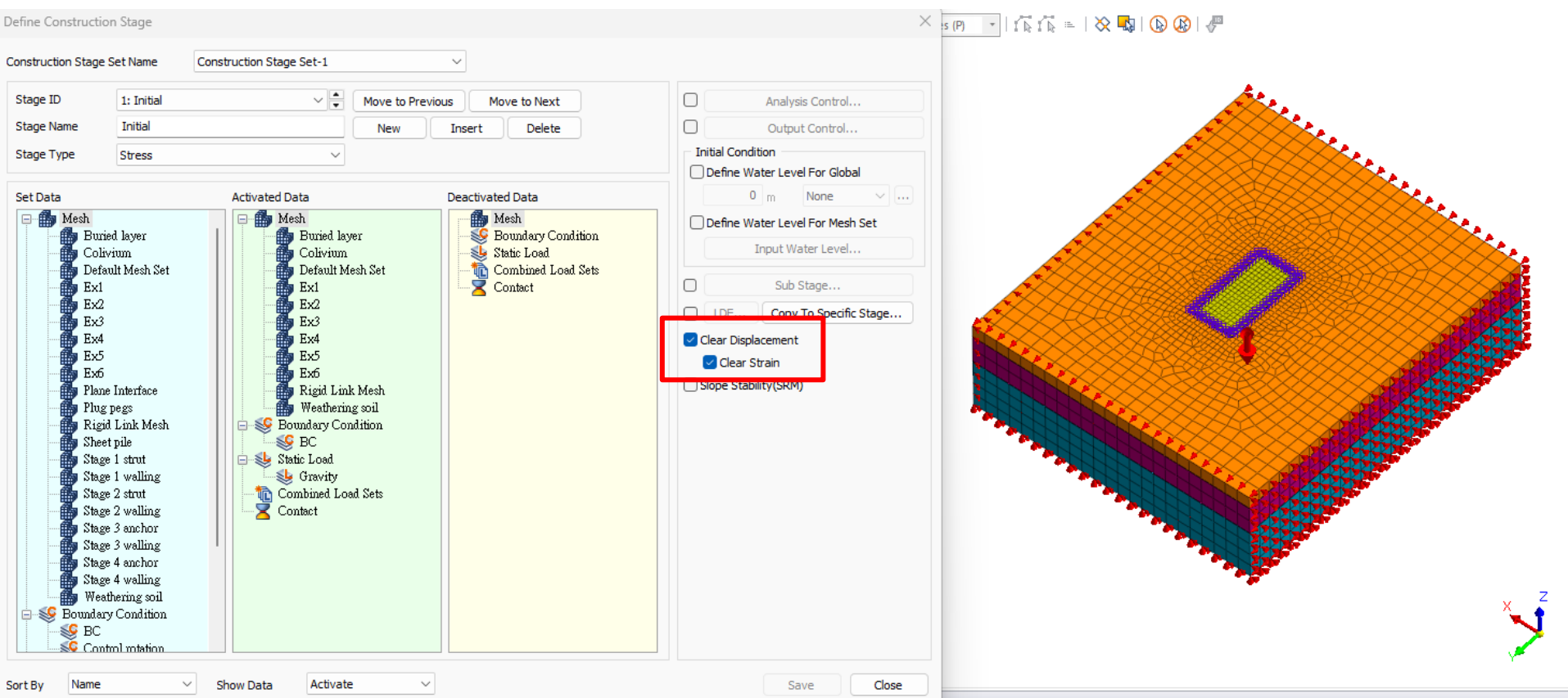


▼ Preventing 'Rz' rotation



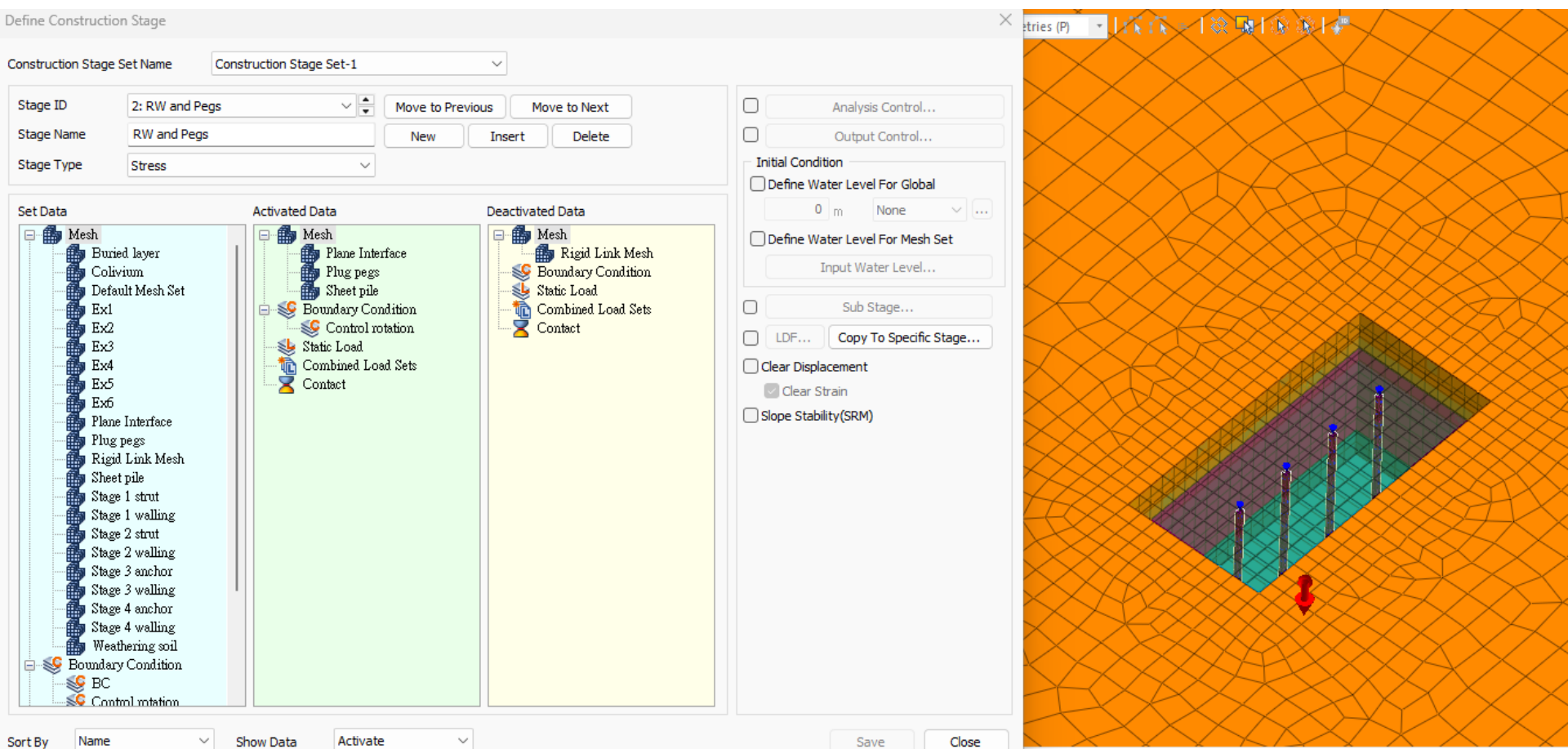
→ The deformation or rotation is constrained to prevent the degree of freedom errors

Define CS – Stage 1



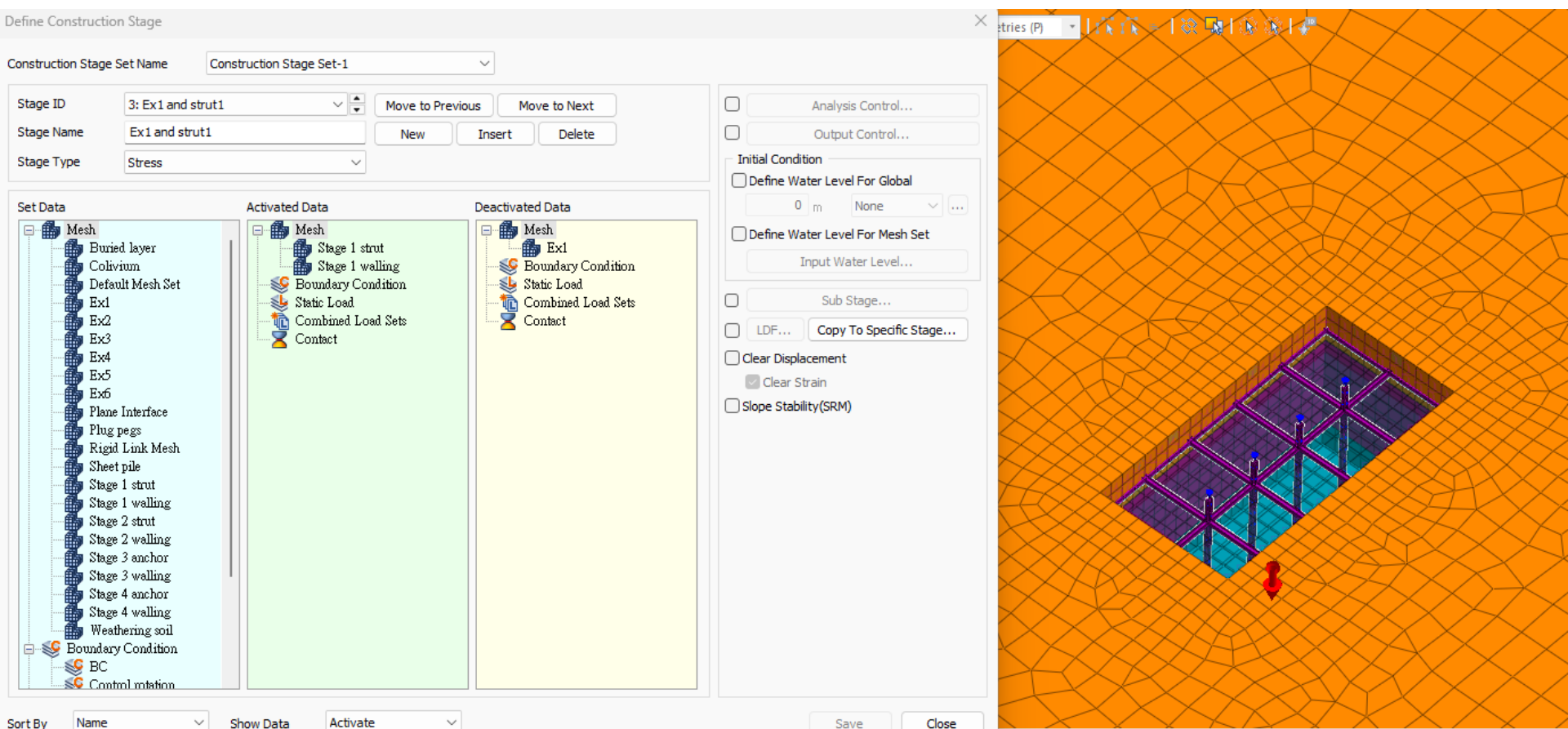
Stage 1. Initial conditions

Define CS – Stage 2



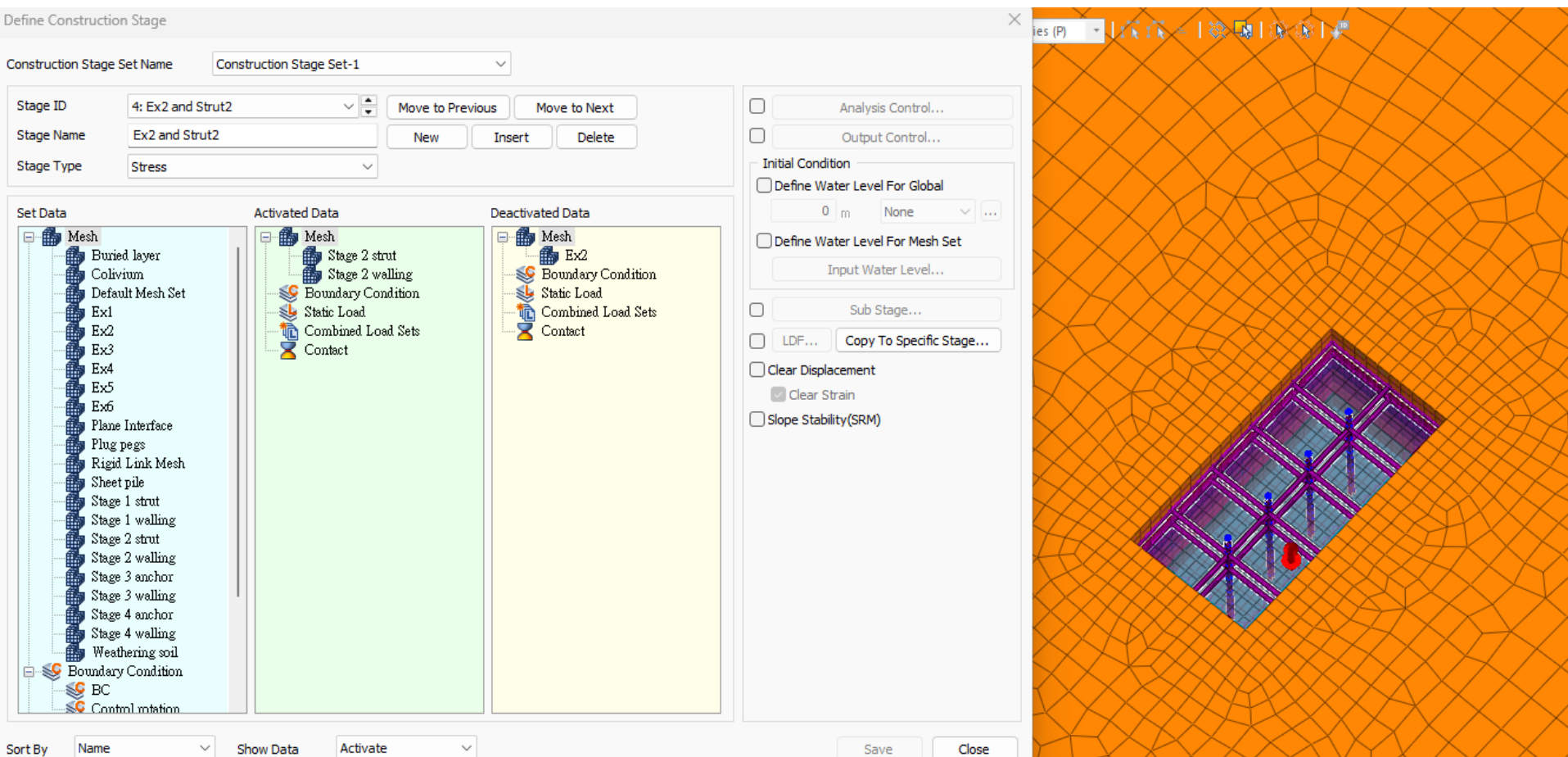
Stage 2. Install sheet pile and plug pegs

Define CS – Stage 3



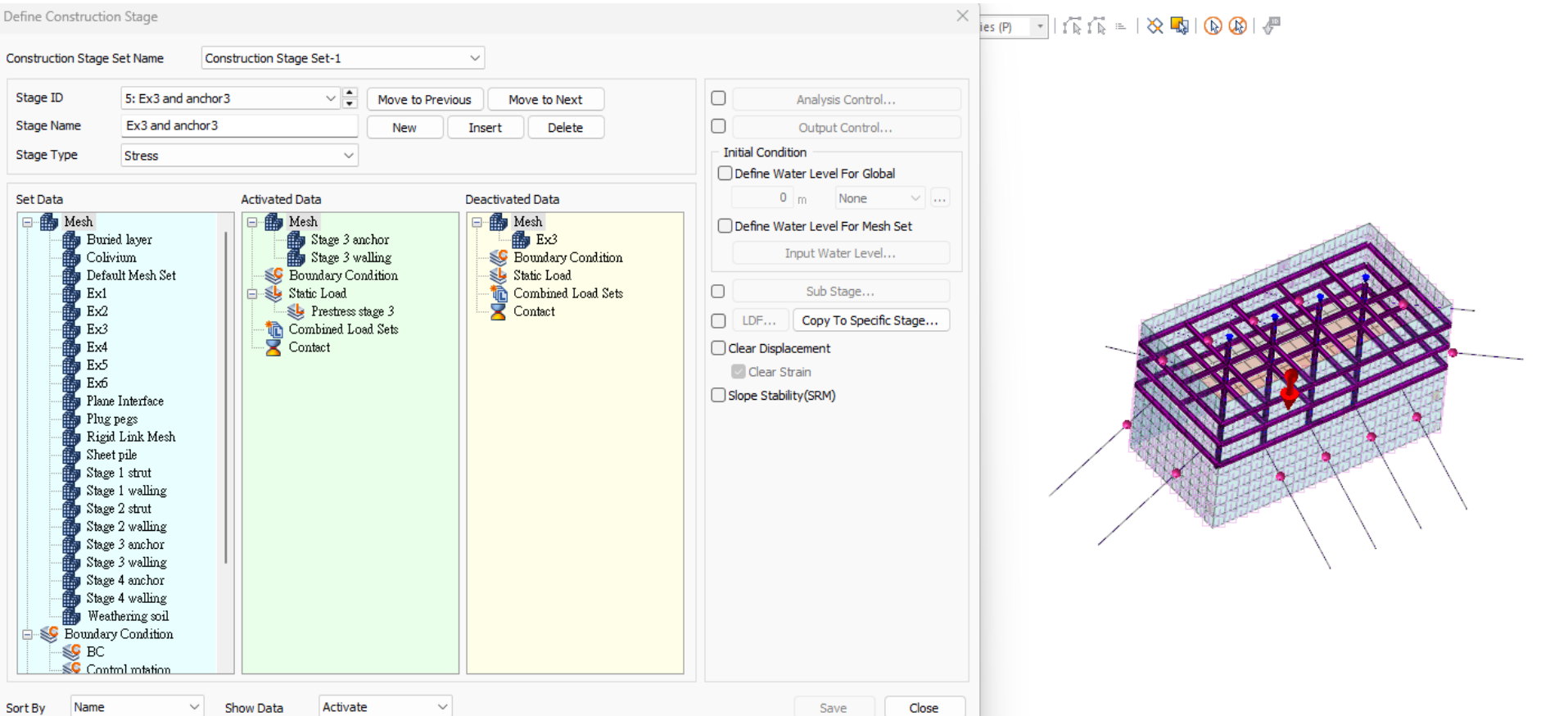
Stage 3. Excavation layer 1 and Installation strut layer 1

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

Define Construction Stage

Construction Stage Set Name: Construction Stage Set-1

Stage ID: 6: Ex4 and anchor4 | Move to Previous | Move to Next

Stage Name: Ex4 and anchor4 | New | Insert | Delete

Stage Type: Stress

Set Data

- Mesh
 - Buried layer
 - Colivium
 - Default Mesh Set
 - Ex1
 - Ex2
 - Ex3
 - Ex4
 - Ex5
 - Ex6
 - Plane Interface
 - Plug pegs
 - Rigid Link Mesh
 - Sheet pile
 - Stage 1 strut
 - Stage 1 walling
 - Stage 2 strut
 - Stage 2 walling
 - Stage 3 anchor
 - Stage 3 walling
 - Stage 4 anchor
 - Stage 4 walling
 - Weathering soil
 - Boundary Condition
 - BC
 - Control rotation

Activated Data

- Mesh
 - Stage 4 anchor
 - Stage 4 walling
 - Boundary Condition
 - Static Load
 - Prestress stage 4
 - Combined Load Sets
 - Contact

Deactivated Data

- Mesh
 - Ex4
 - Boundary Condition
 - Static Load
 - Combined Load Sets
 - Contact

Analysis Control...

Output Control...

Initial Condition

- ☐ Define Water Level For Global
 - 0 m | None | ...
- ☐ Define Water Level For Mesh Set
 - Input Water Level...

Sub Stage...

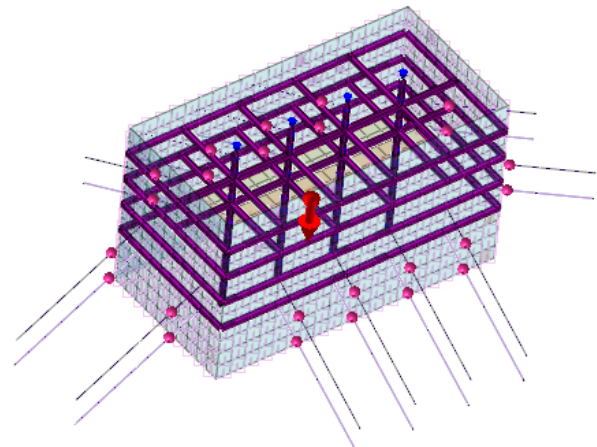
LDF... | Copy To Specific Stage...

☐ Clear Displacement

☒ Clear Strain

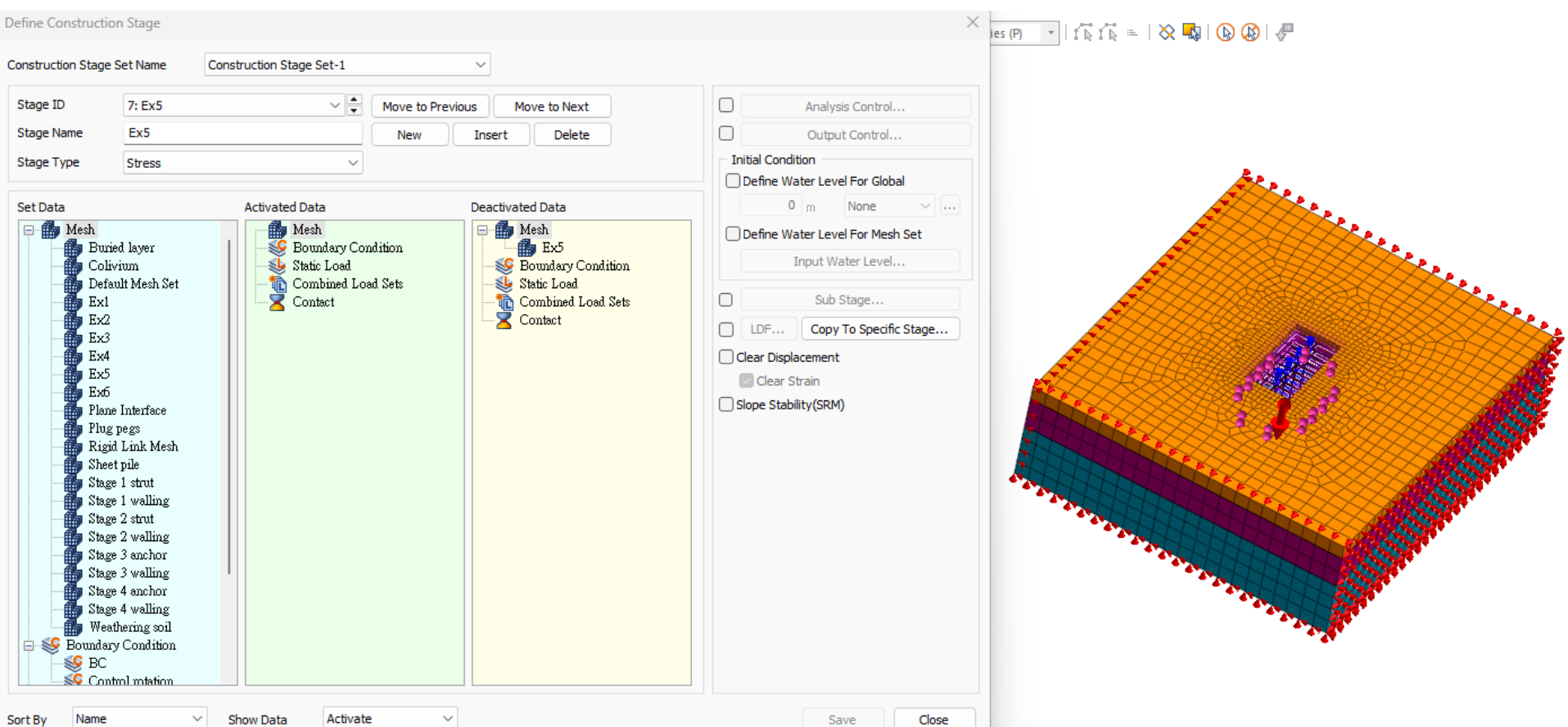
☐ Slope Stability(SRM)

Sort By: Name | Show Data: Activate | Save | Close



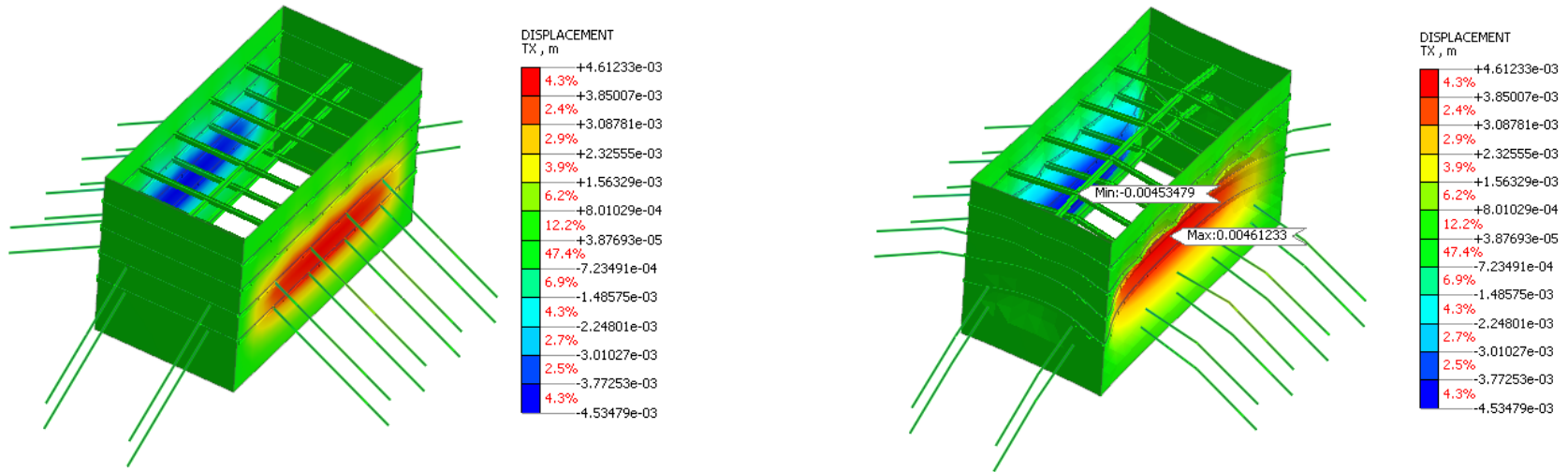
Stage 6. Excavation layer 4 and Installation strut layer 4

Define CS – Stage 7

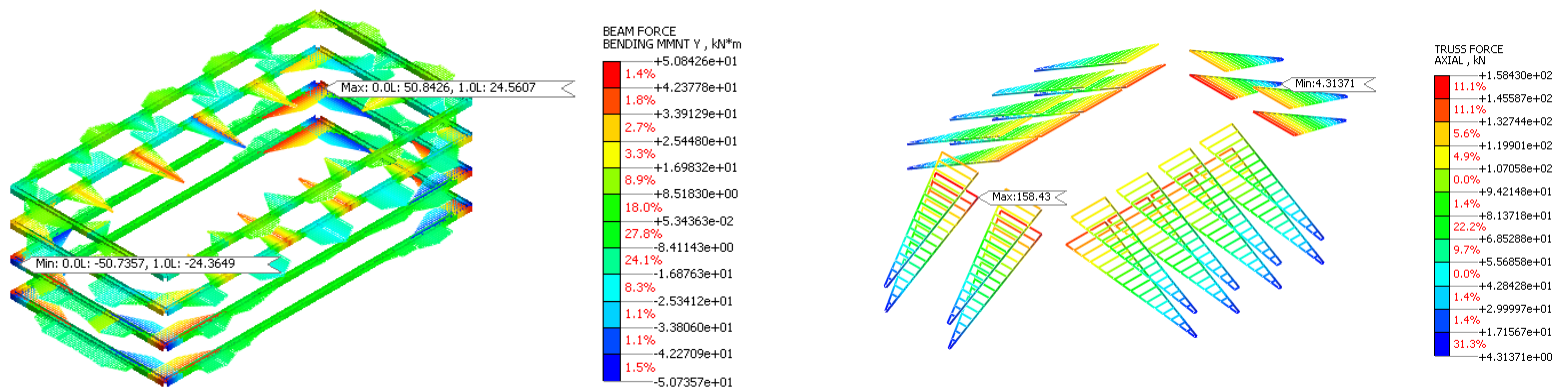


Stage 7. Excavation layer 5

Results – RW system



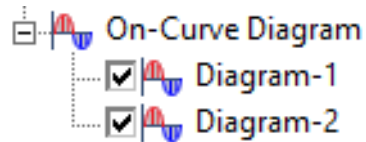
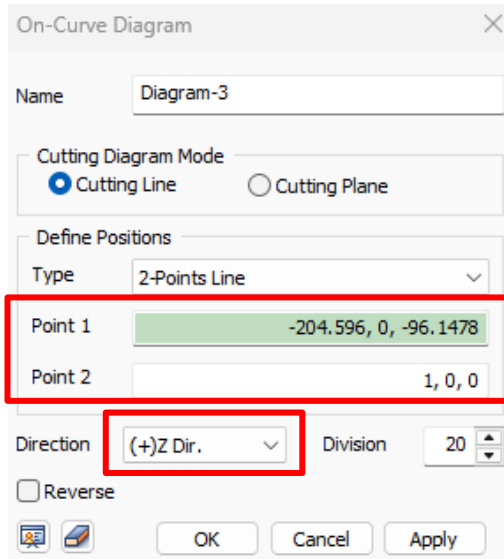
► Deformed and undeformed in horizontal displacement



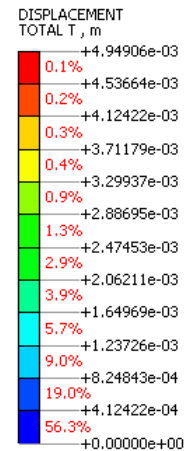
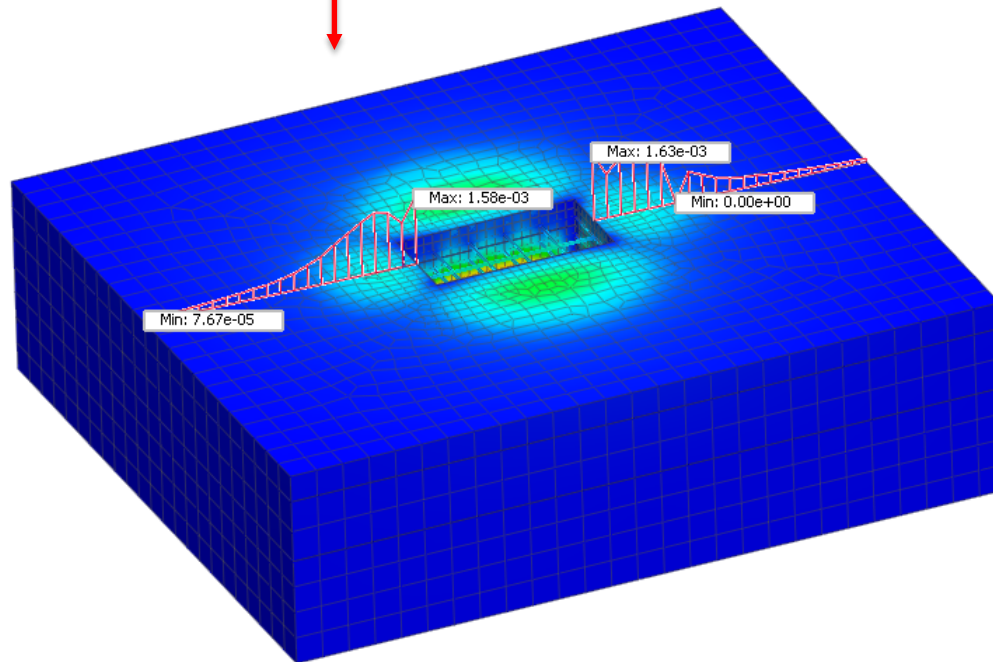
► Beam force, bending moment in walling & Truss force, axial force in anchors



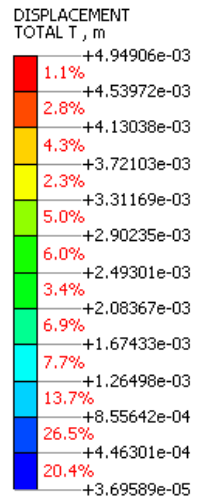
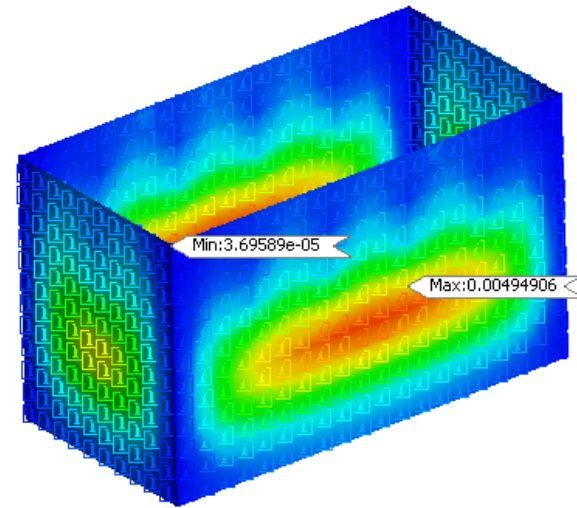
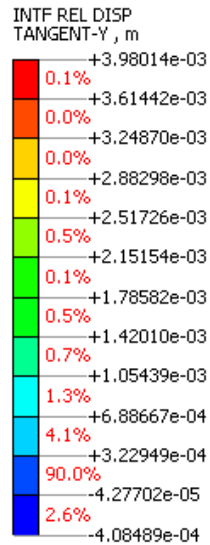
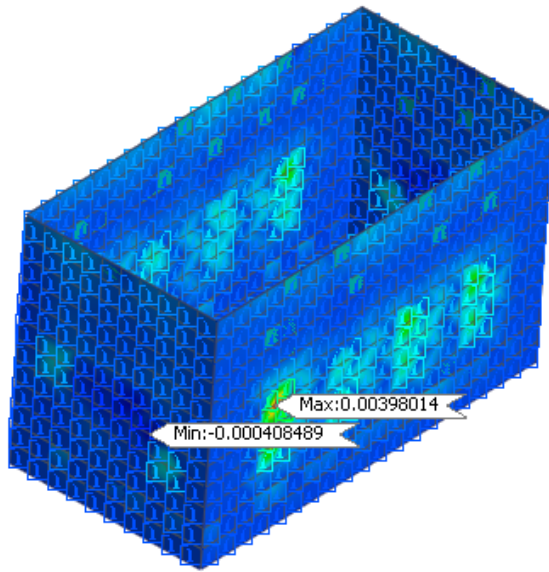
Results - Displacement



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! 