GTS NX
3D Excavation with Retaining System

Lesson 02

Midas Taiwan

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

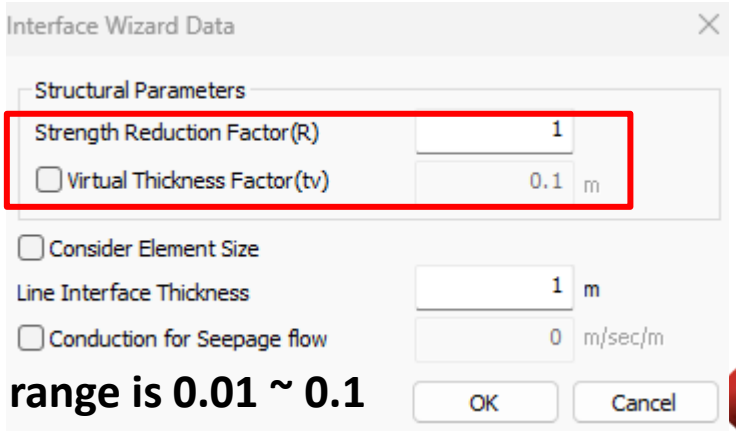
C_i: Interface Cohesion

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

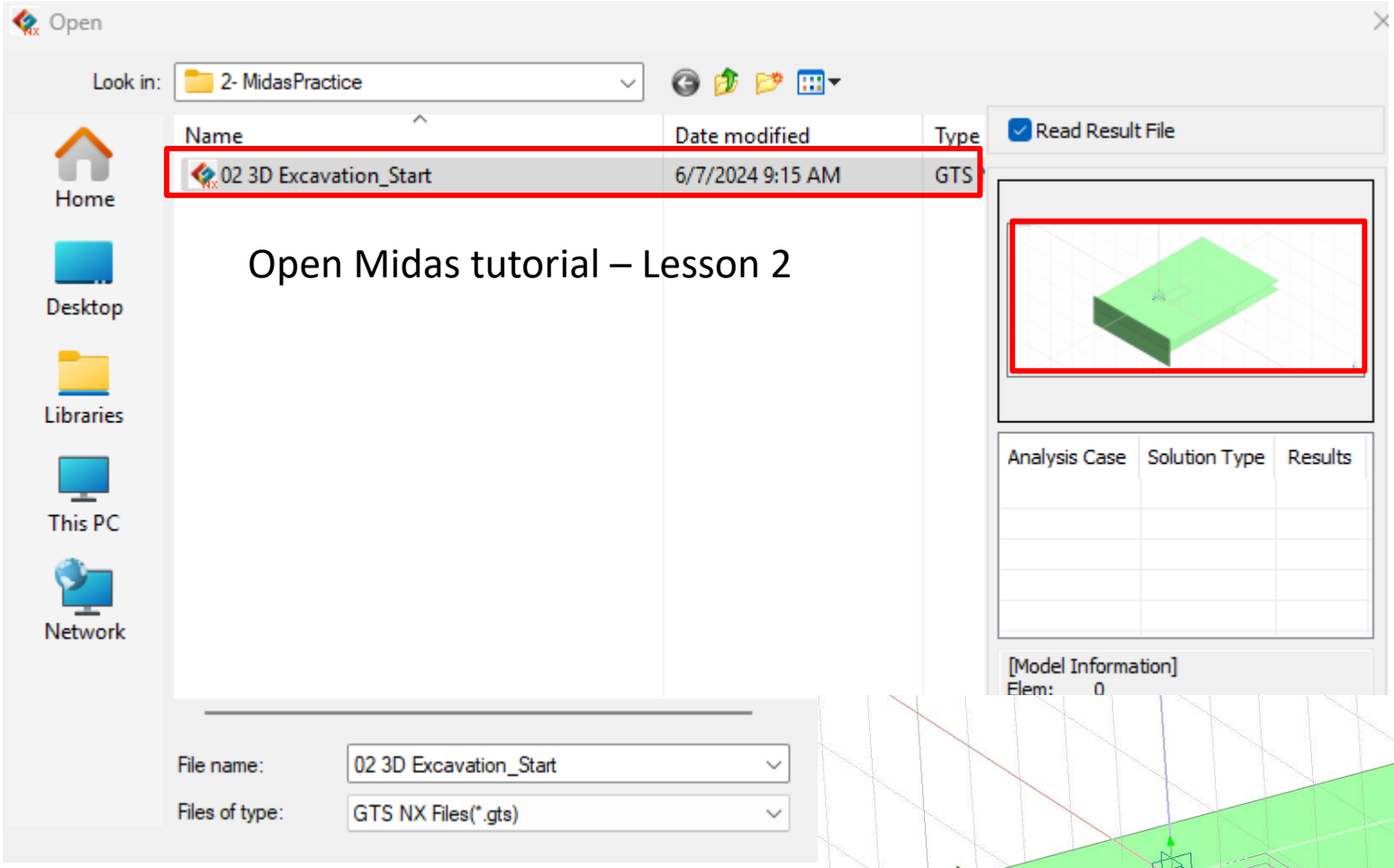
▶ **Strength Reduction factor (R)**

- 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

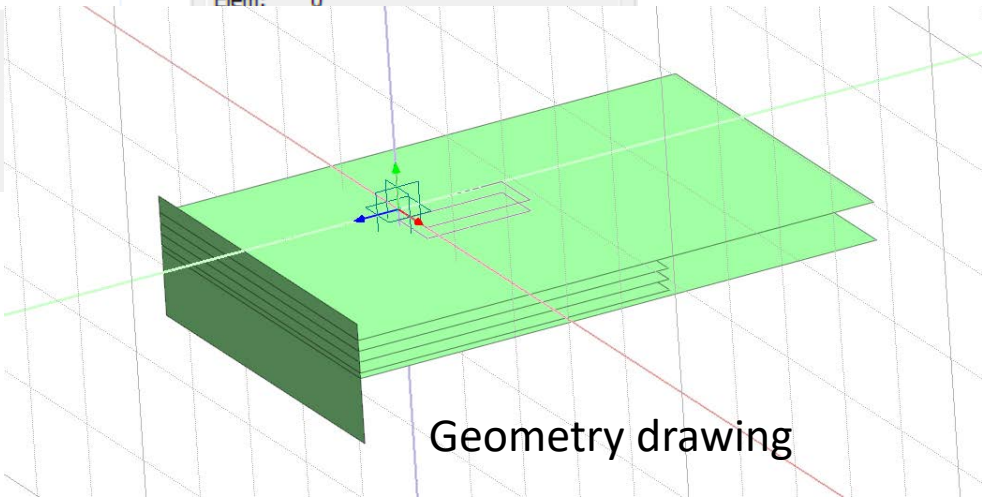


The general **Virtual Thickness Factor range is 0.01 ~ 0.1**
(If the stiffness is high, use a smaller value)

Open model

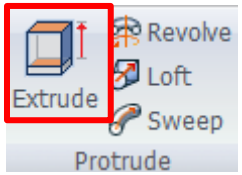


Open Midas tutorial – Lesson 2

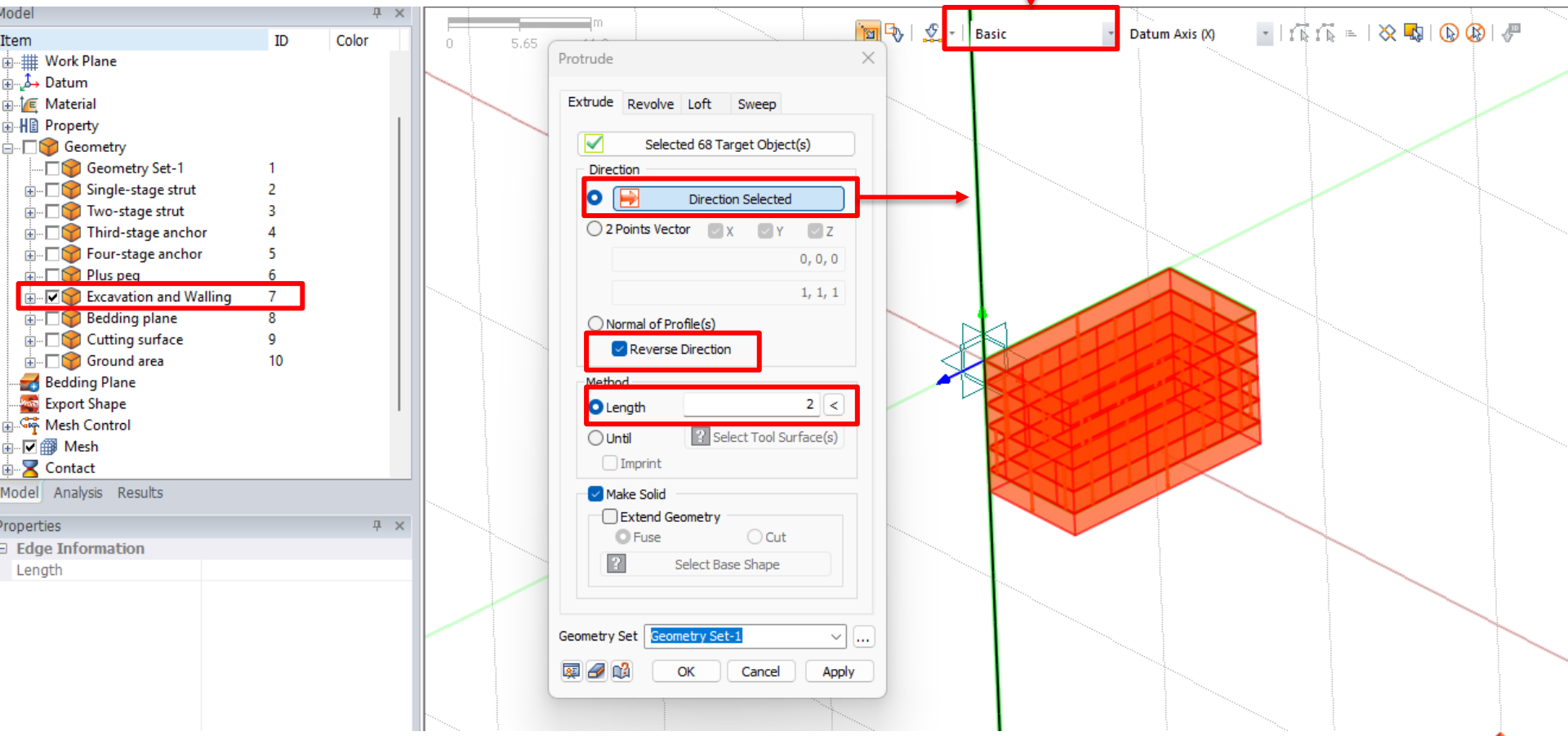


Geometry drawing

Geometry modeling – Excavation area

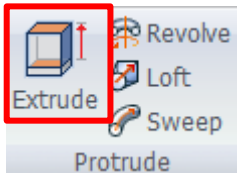


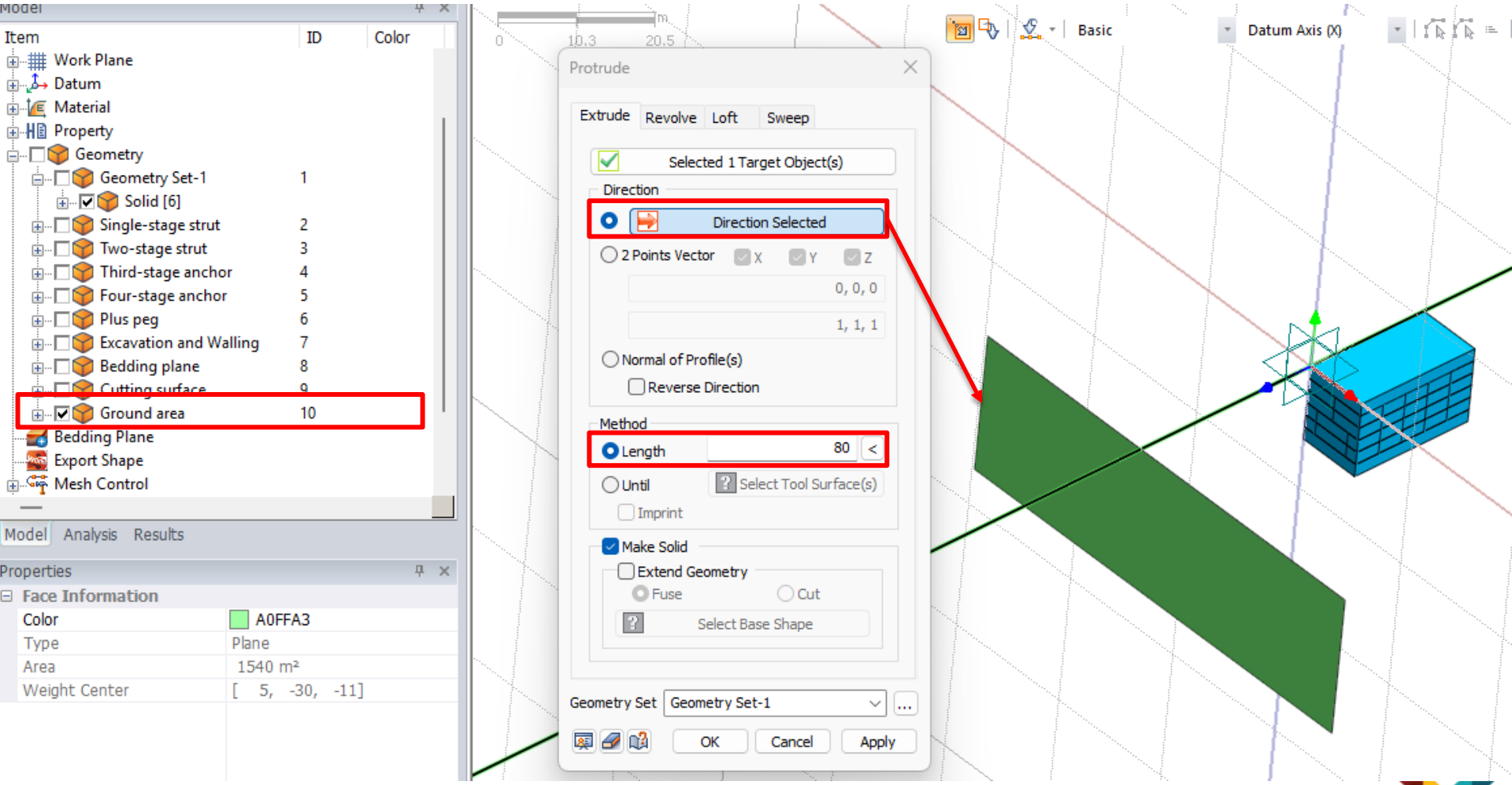
Change into ‘Edge’, then ‘Select All’



Extruding excavation area

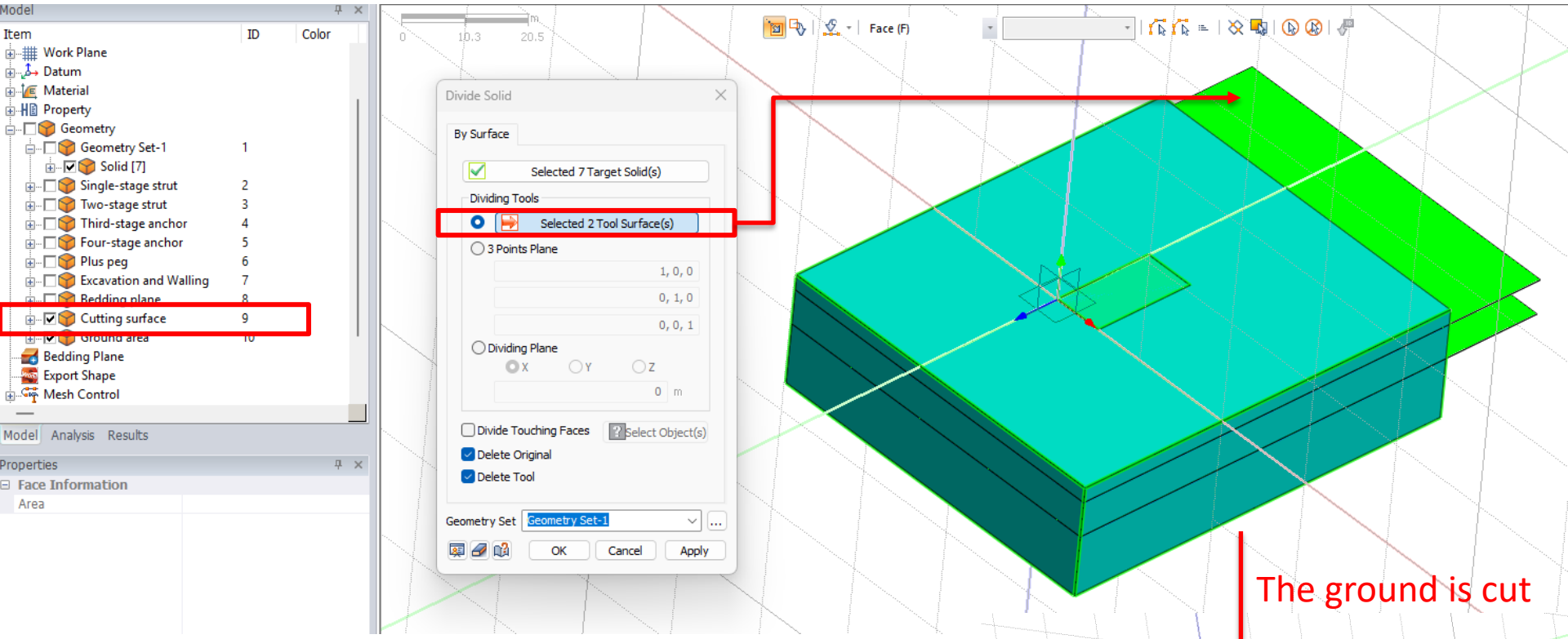
Geometry modeling – Ground





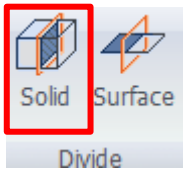
Ground area

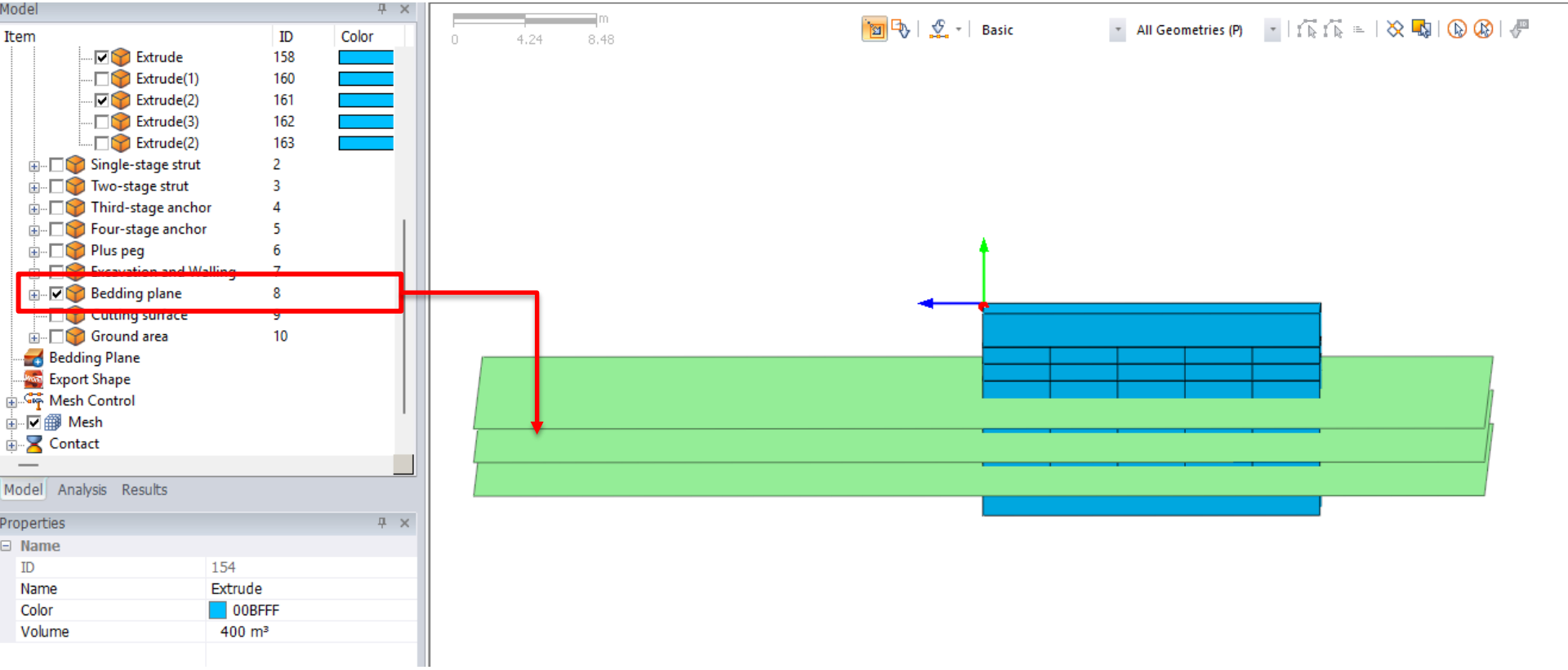
Cutting ground surface



Cutting surface for ground by ‘Divide solid’ function

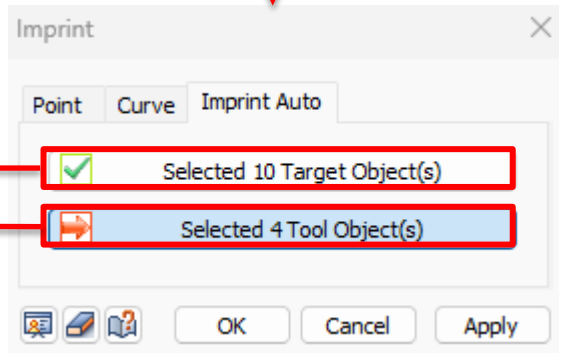
Bedding plane





Bedding plane for excavation area by ‘Divide solid’ function

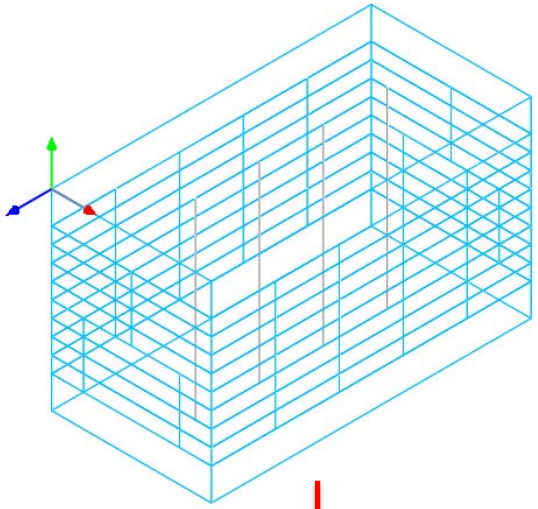
Imprint for ‘Plug pegs’



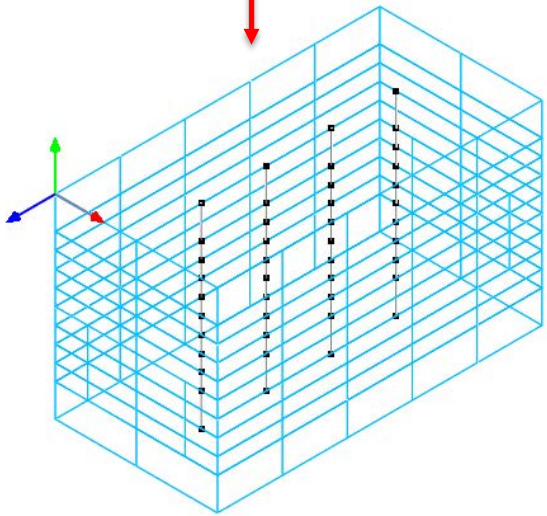
Excavation area

Plug pegs

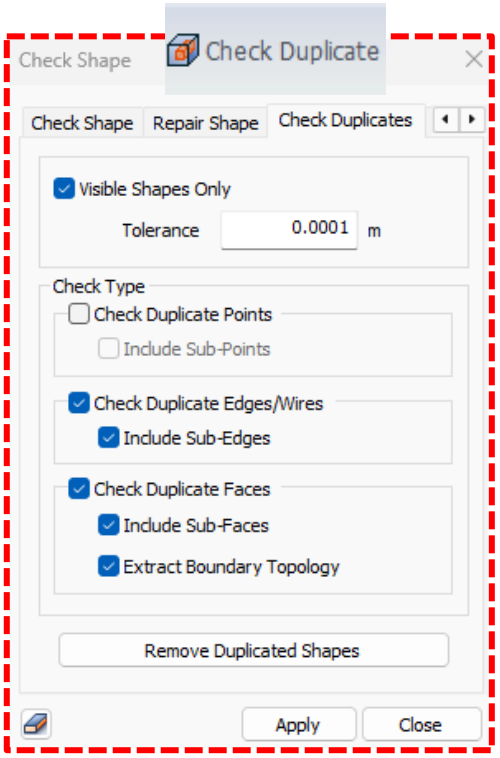
‘Imprint’ for creating node at different surface in excavation area



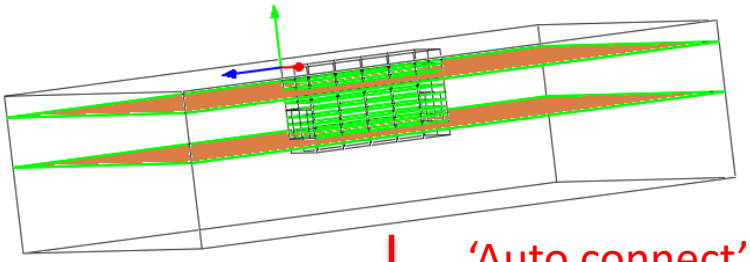
Before and After using ‘Imprint’



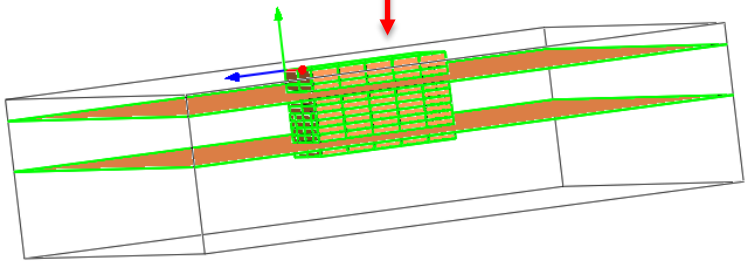
Check duplicate – Auto connect

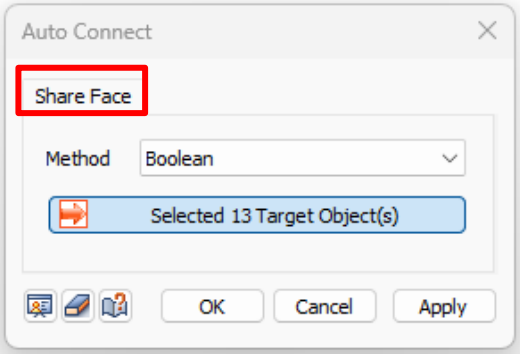


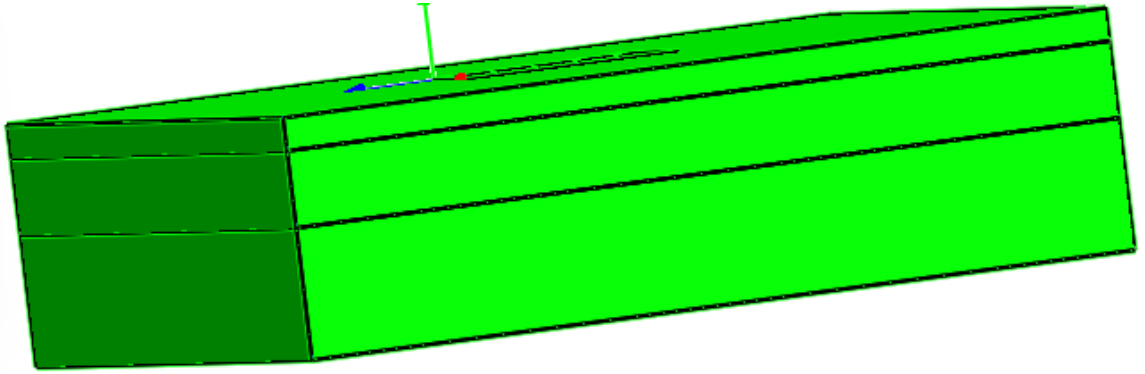
Auto connect



'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

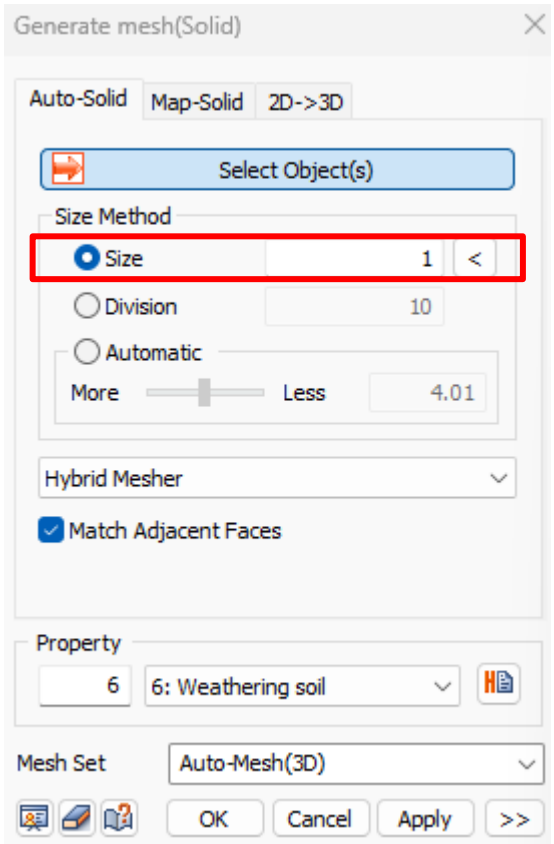
▶ Ground material

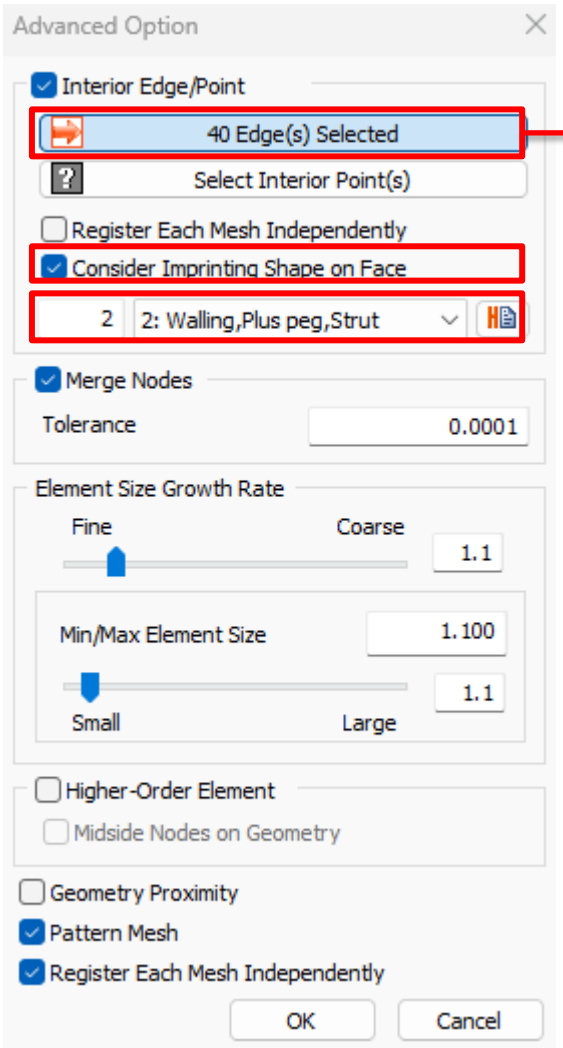
Name	Interface (Buried layer)	Interface (Colluvium)	Interface (Weathering Soil)	Buried layer	Colluvium	Weathering Soil
Type	Other	Other	Other	3D	3D	3D
Model Type	Interface	Interface	Interface	-	-	-
Interface Type	Face	Face	Face	-	-	-
Material	Buried layer	Colluvium	Weathering Soil	Buried layer	Colluvium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

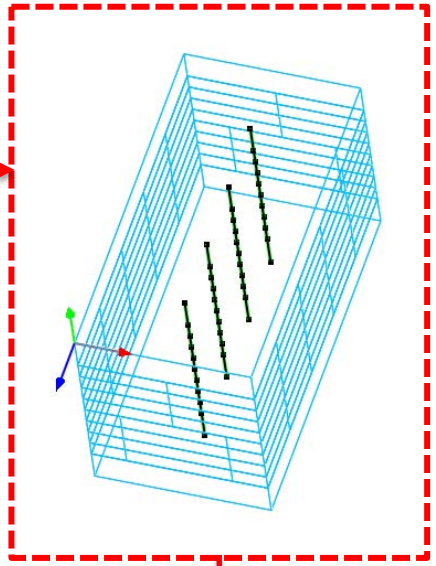
▶ Structure material

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

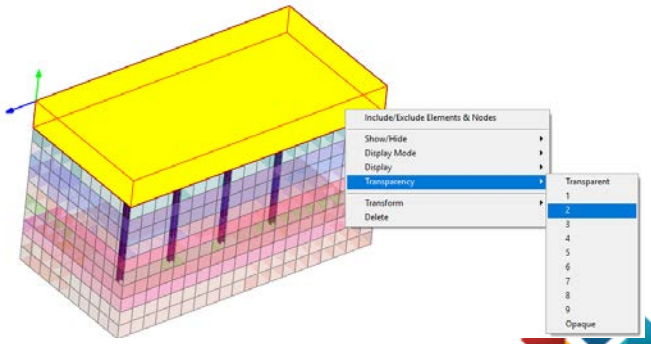
3D mesh – Excavation area





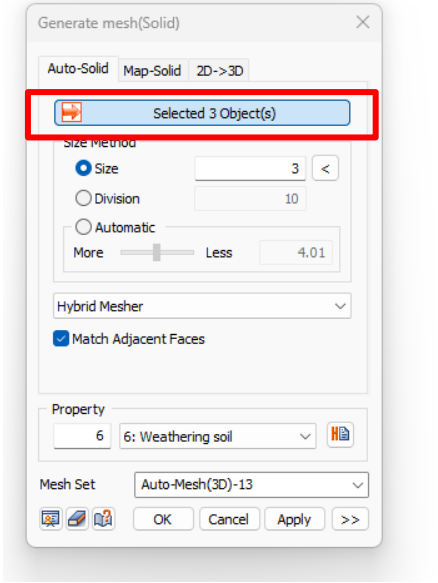


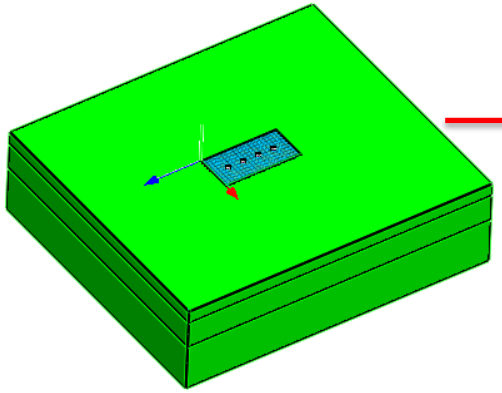
''Transparency' display mode



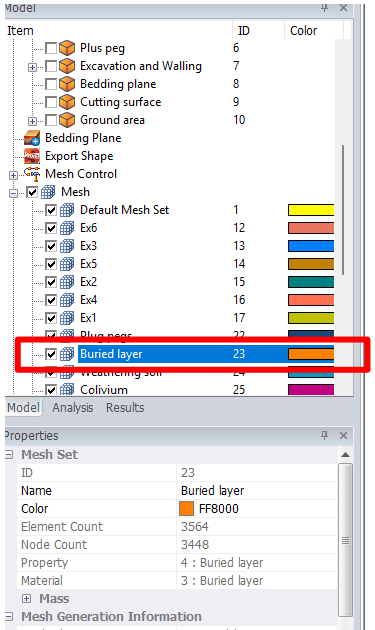
- Generate meshes with nodes connected to interior edges

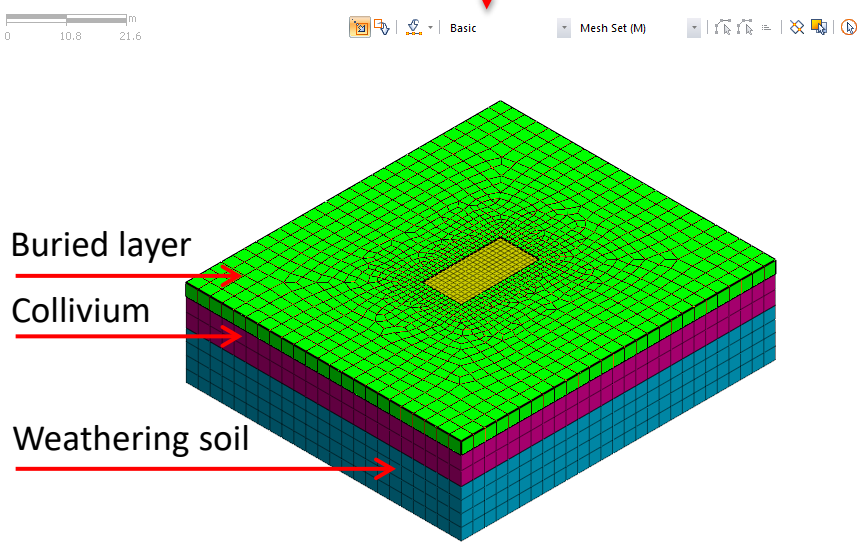
3D mesh - Ground



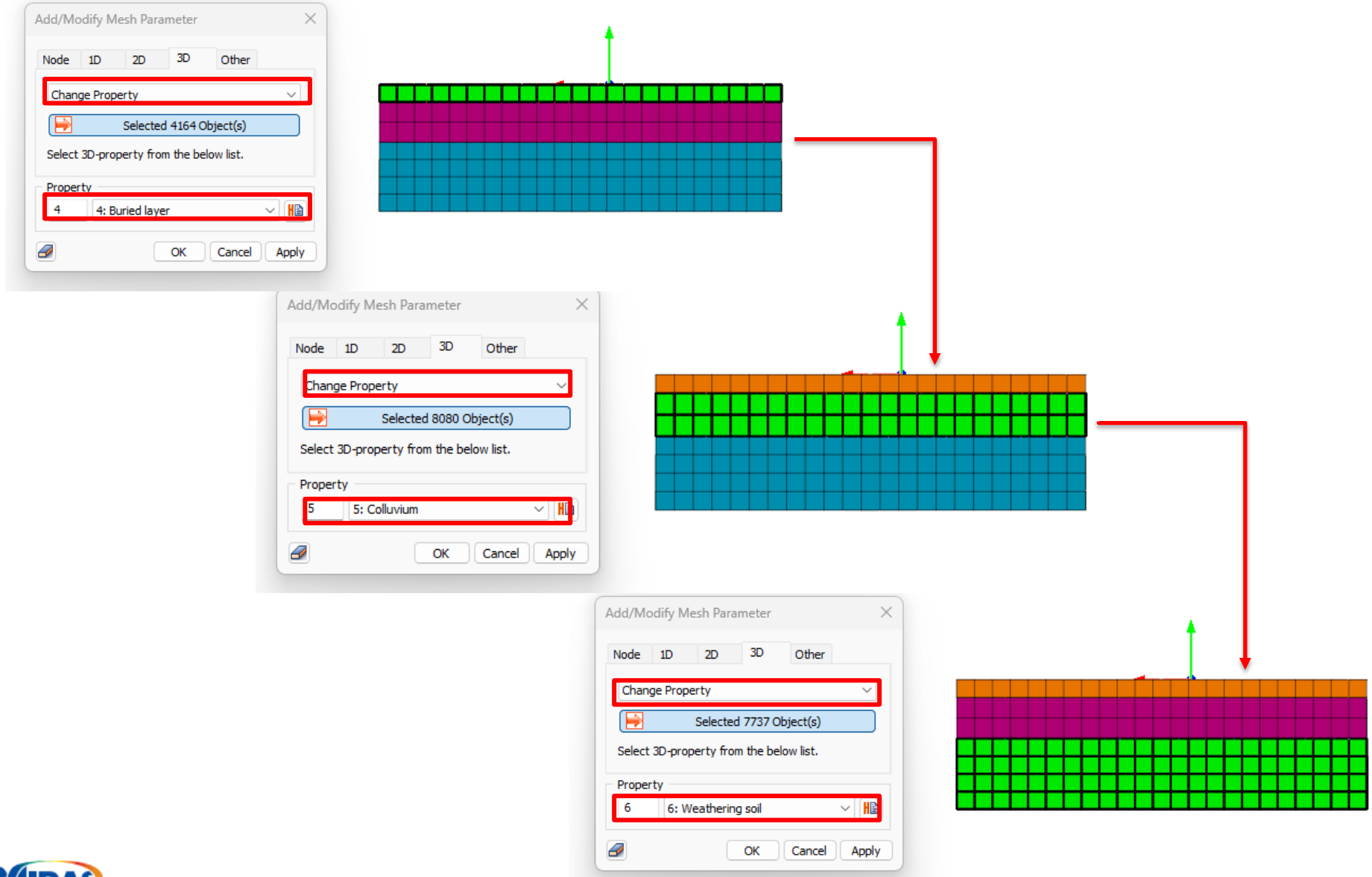


Need to Change property

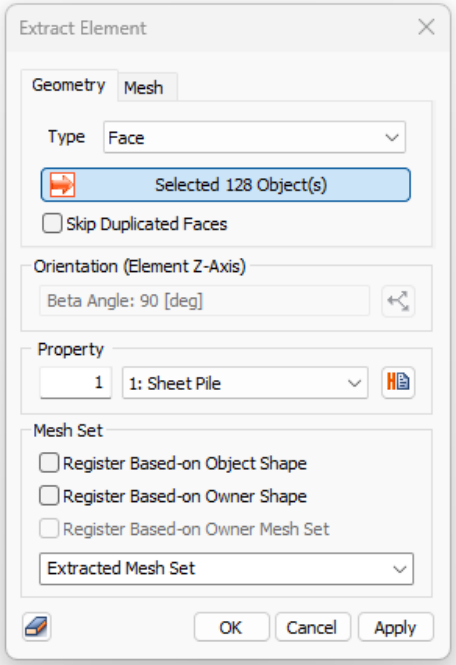


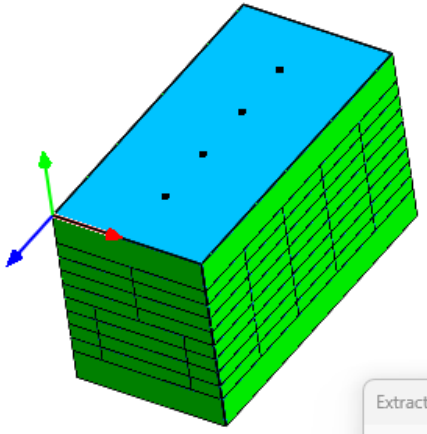


Change property – Ground

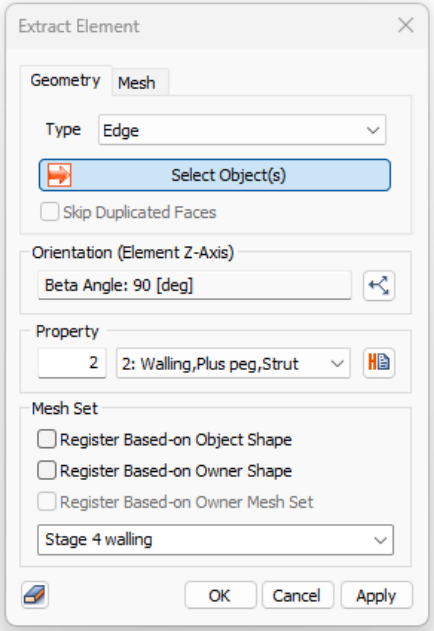


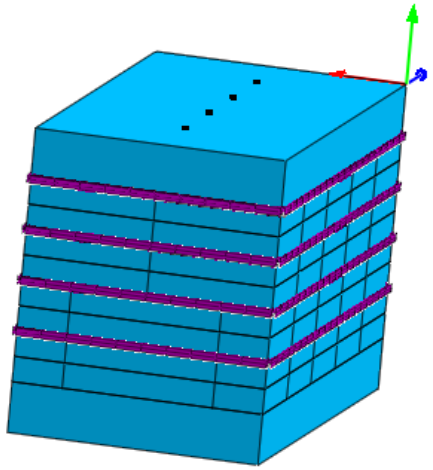
Extract elements for RW, Walling





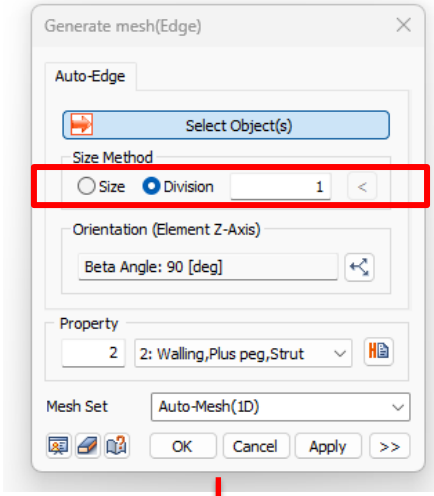
▼ Extracting walling from ‘Edge’ geometry

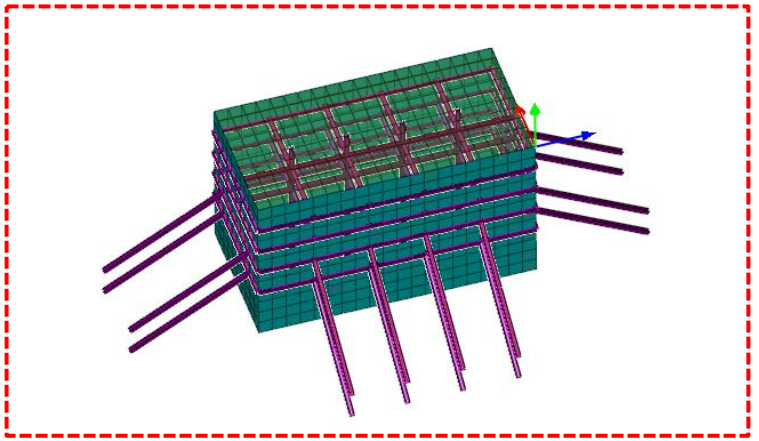




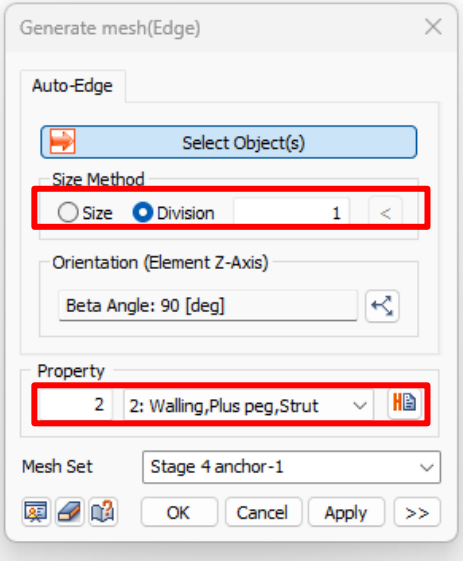
▲ Extracting sheet pile from ‘Face’ geometry

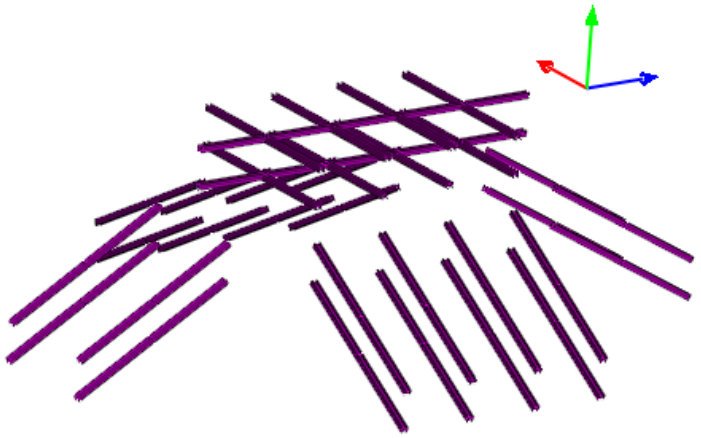
1D mesh – Struts & Anchors





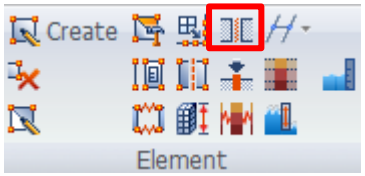
▲ Image of supporting and RW after meshing



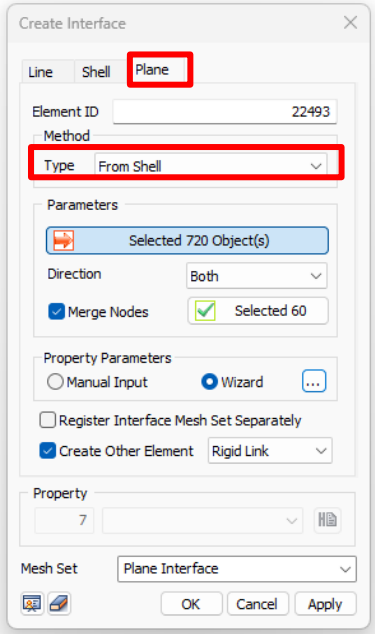


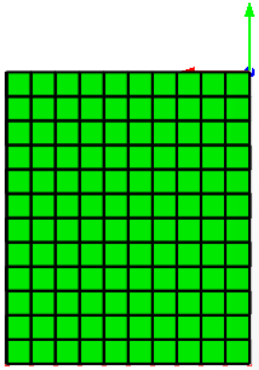
▲ Meshing Struts and Anchors

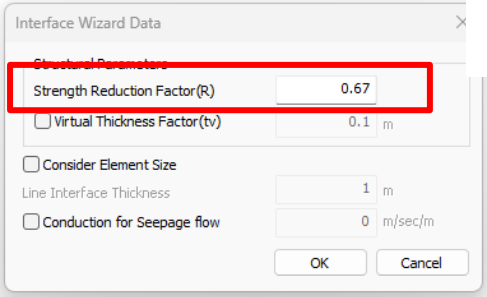
Plane interface

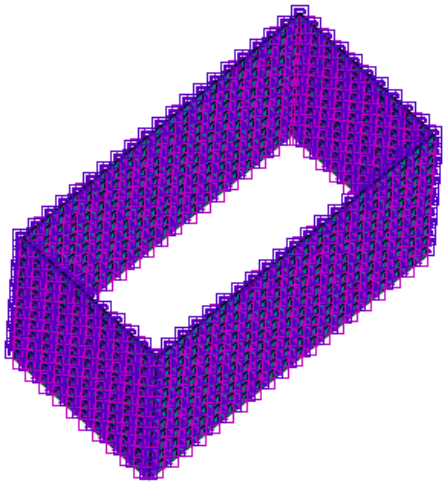


Selecting ‘Interface’

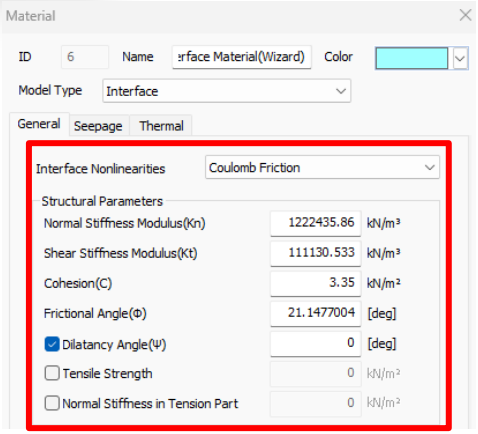






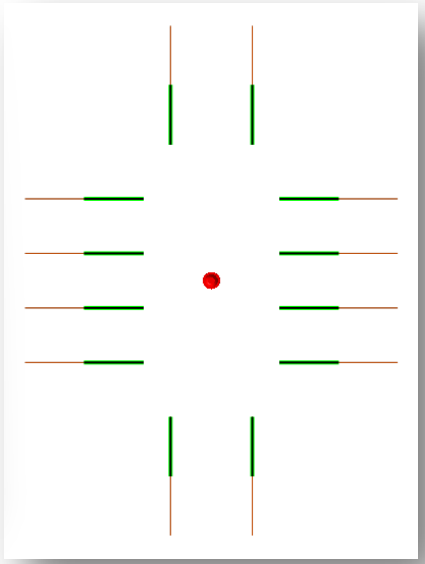


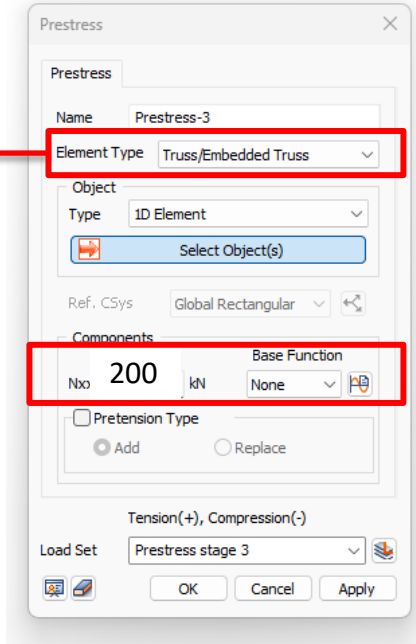
Interface is created

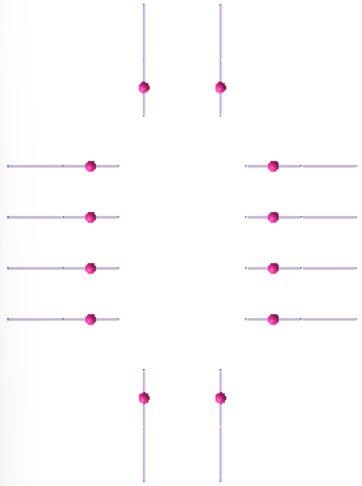


→ ‘Interface’ is created for each soil material by GTX Wizard

Prestressed - Anchors





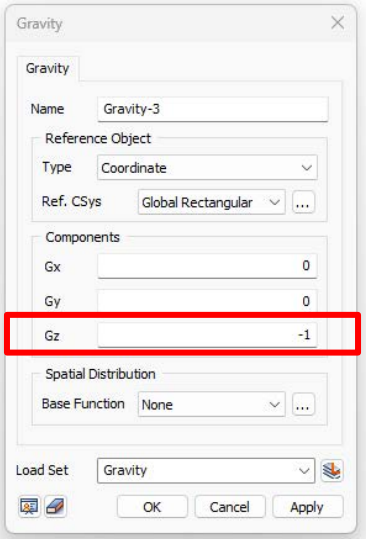


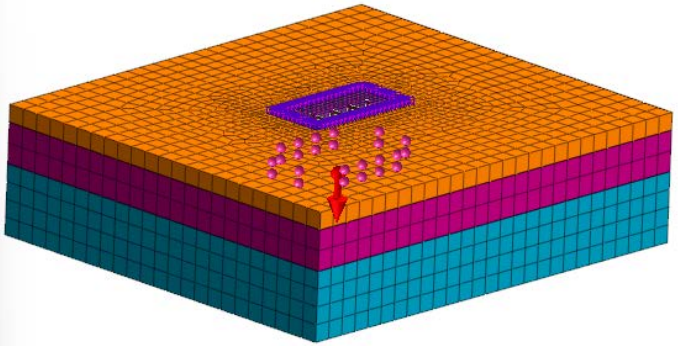
Selecting the length of anchors should add a prestressed load

Prestressed: 200 kN

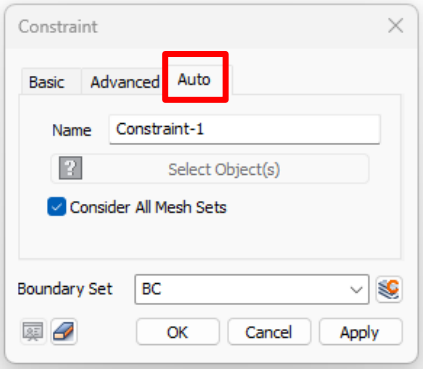
Gravity – Boundary conditions

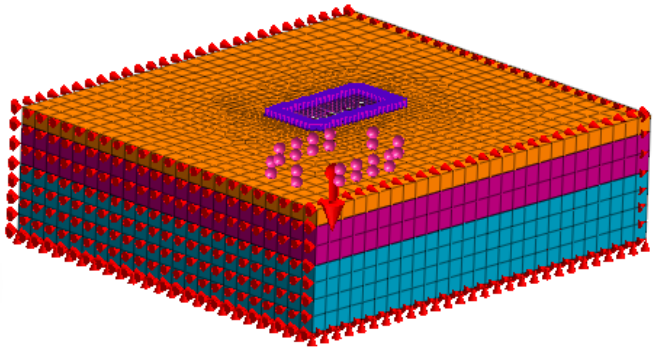
▶ Assigning gravity



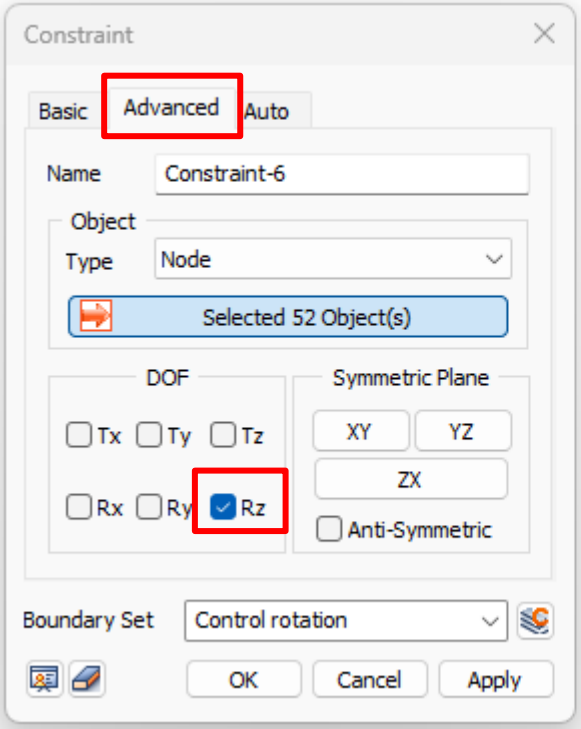


▶ Assigning boundary condition

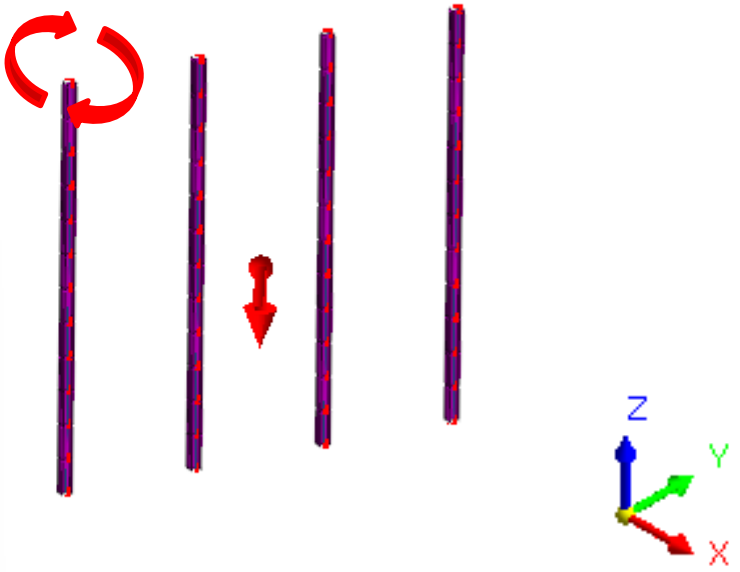




Rotation constraint

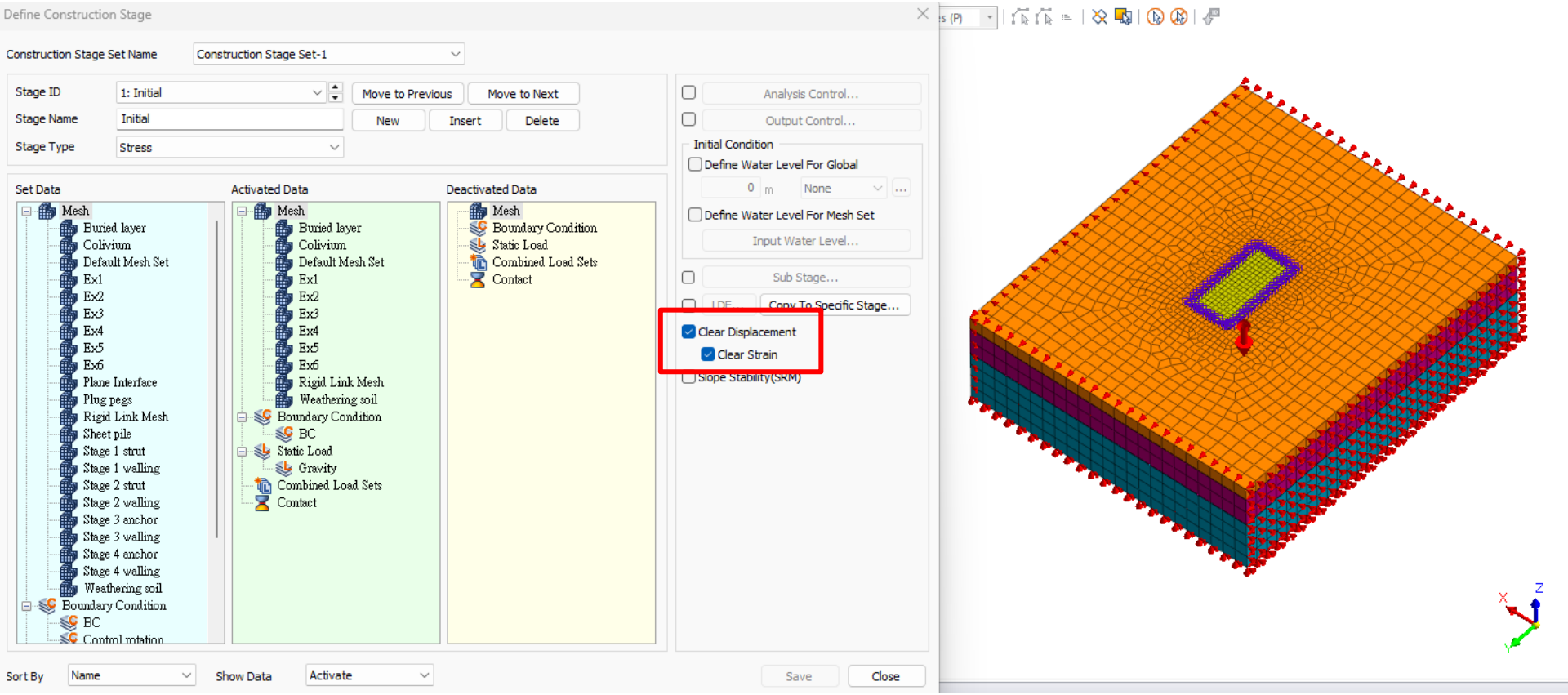


▼ Preventing ‘Rz’ rotation



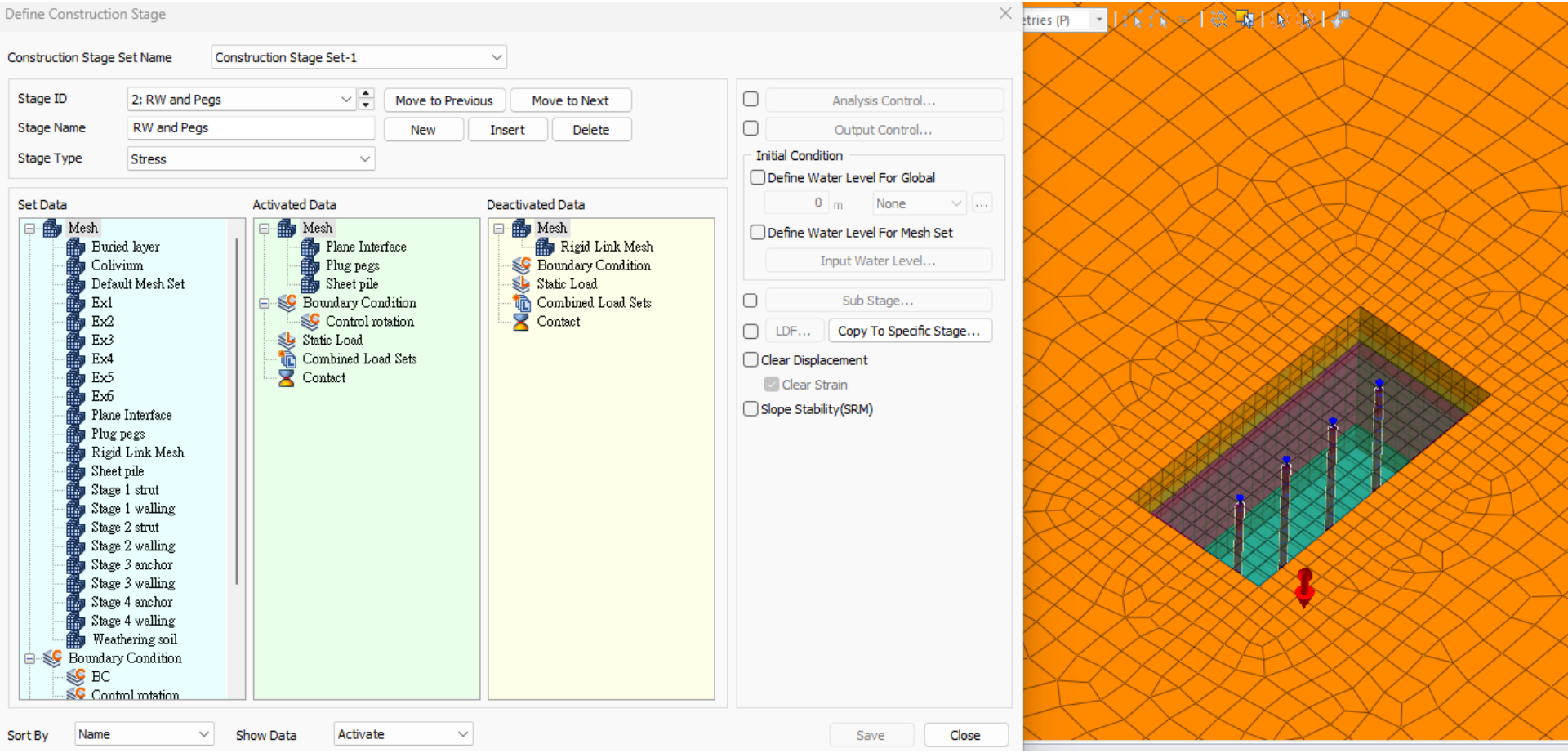
→ The deformation or rotation is constrained to prevent the degree of freedom errors

Define CS – Stage 1



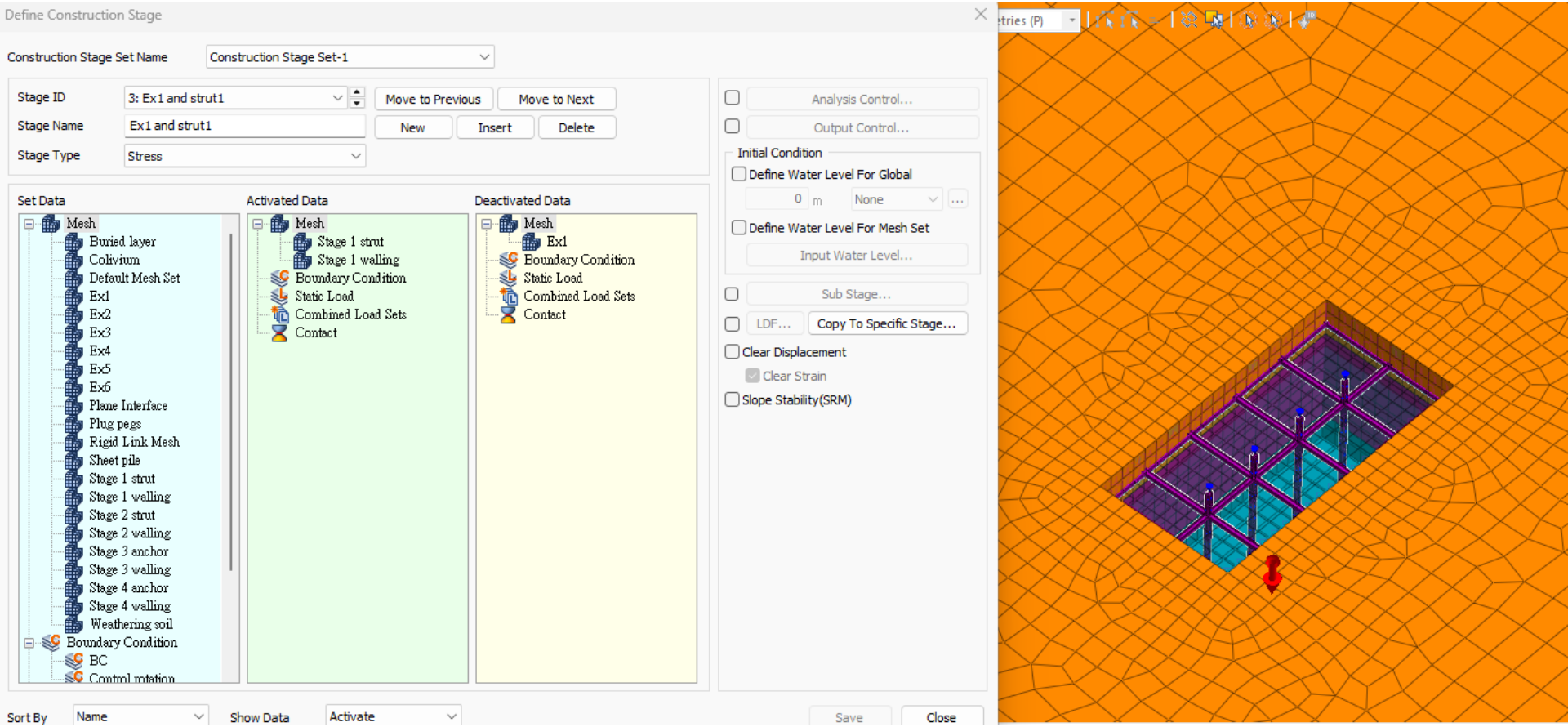
Stage 1. Initial conditions

Define CS – Stage 2



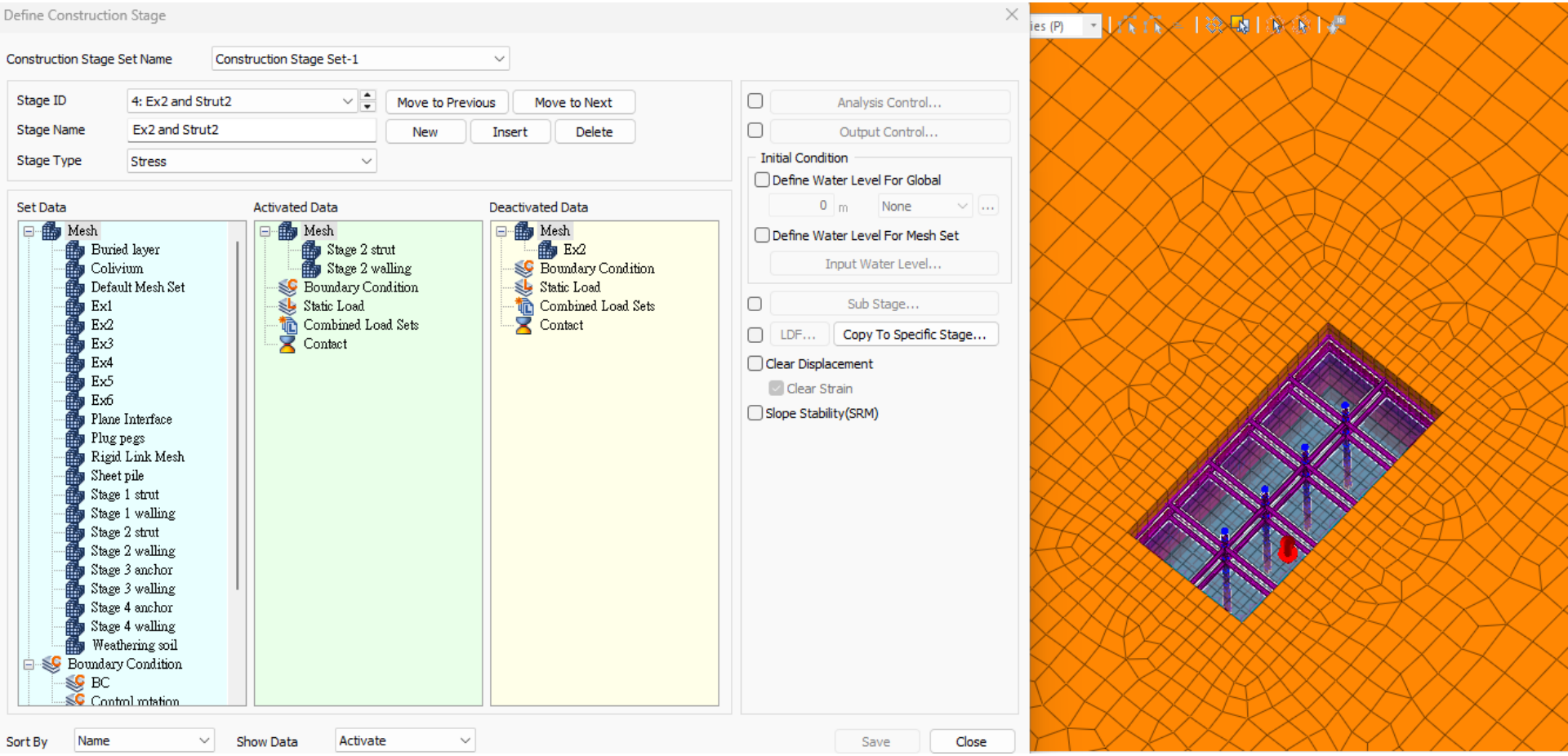
Stage 2. Install sheet pile and plug pegs

Define CS – Stage 3



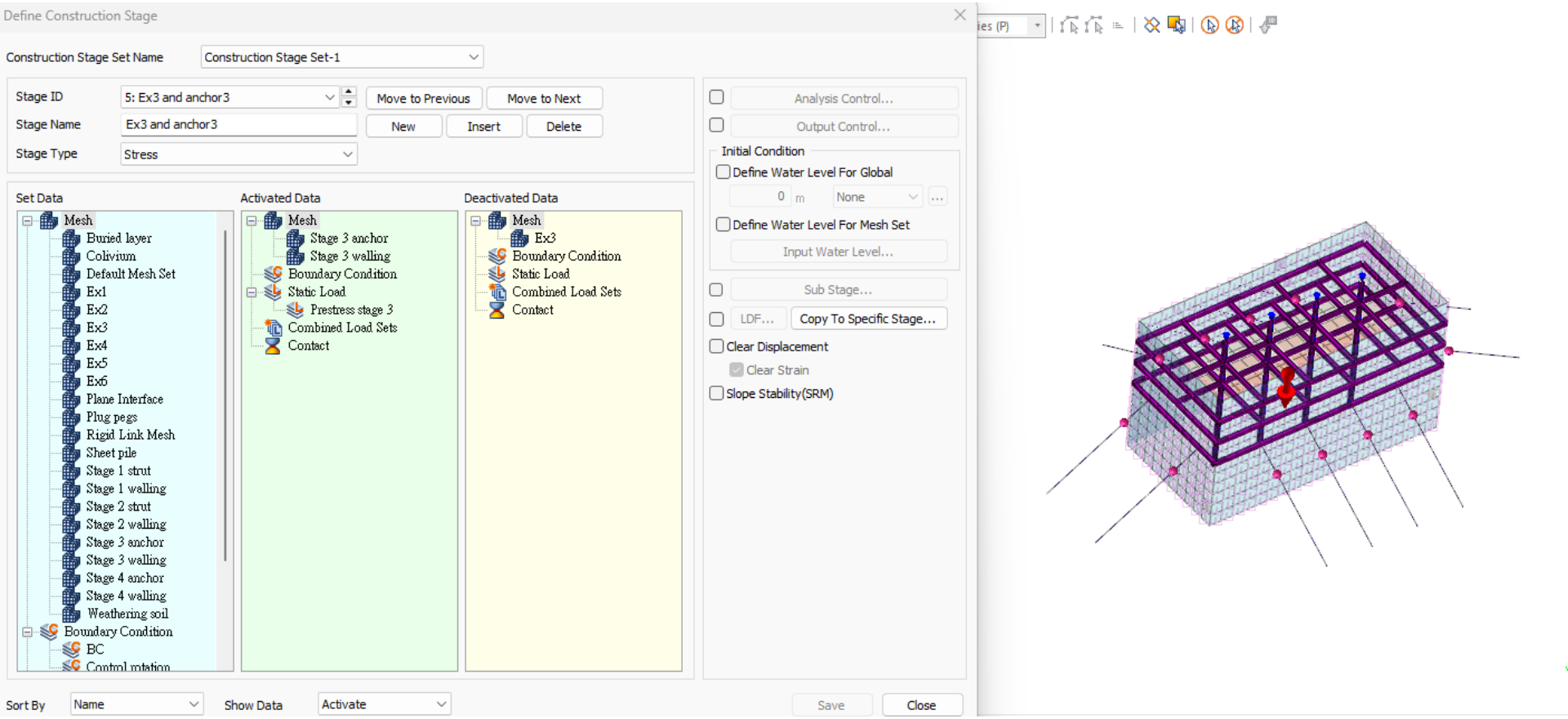
Stage 3. Excavation layer 1 and Installation strut layer 1

Define CS – Stage 4



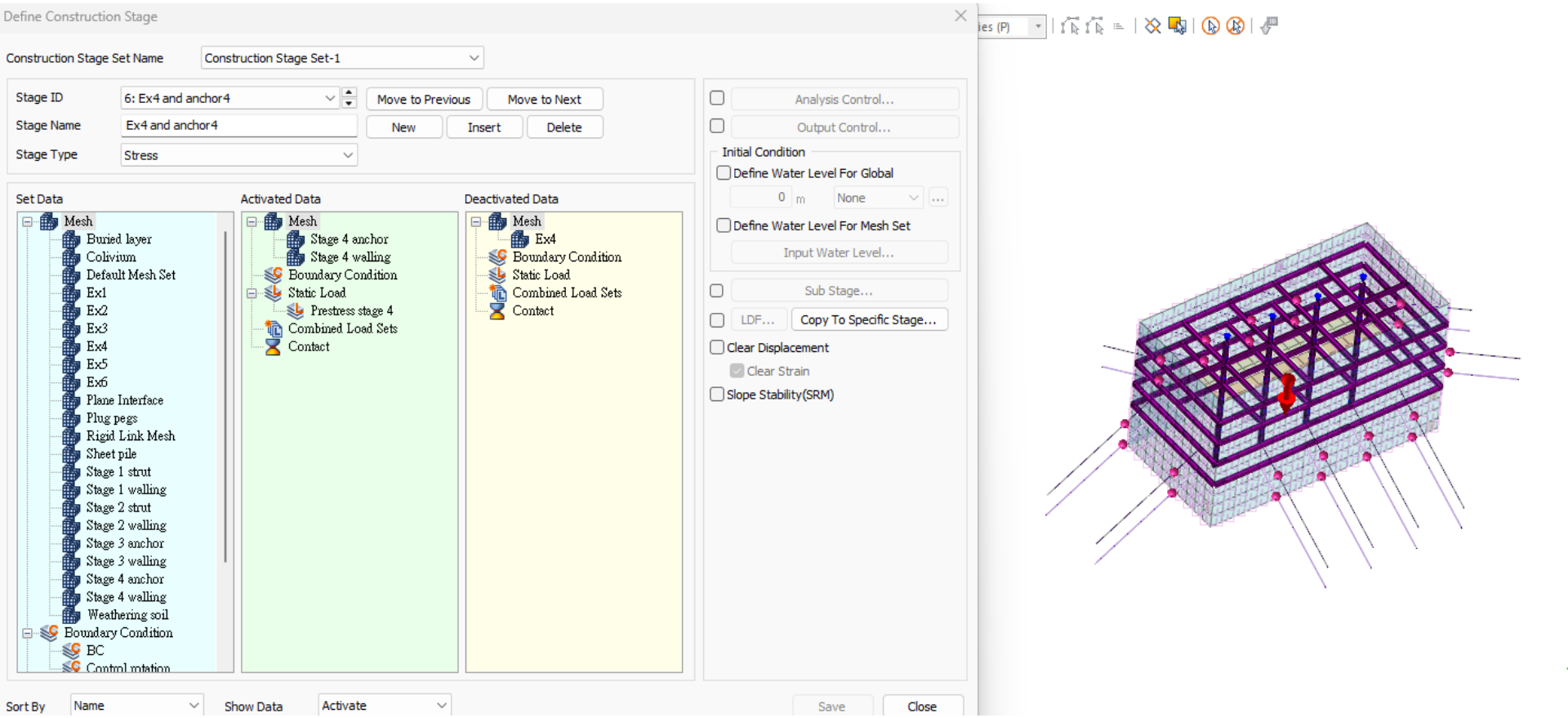
Stage 4. Excavation layer 2 and Installation strut layer 2

Define CS – Stage 5



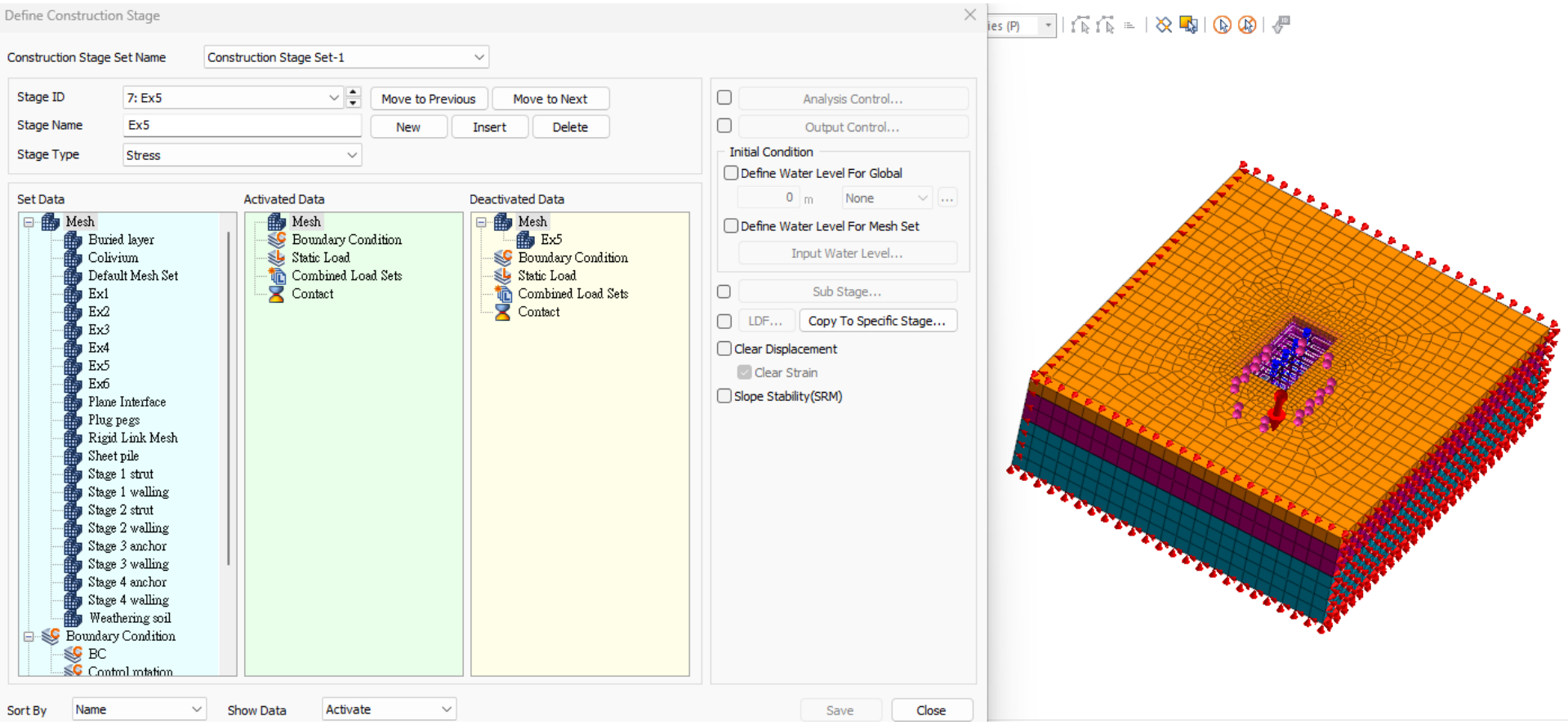
Stage 1. Excavation layer 3 and Installation strut layer 3

Define CS – Stage 6



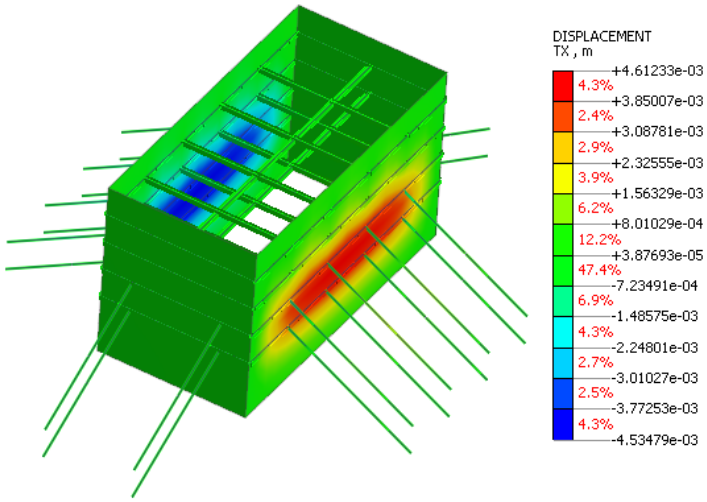
Stage 6. Excavation layer 4 and Installation strut layer 4

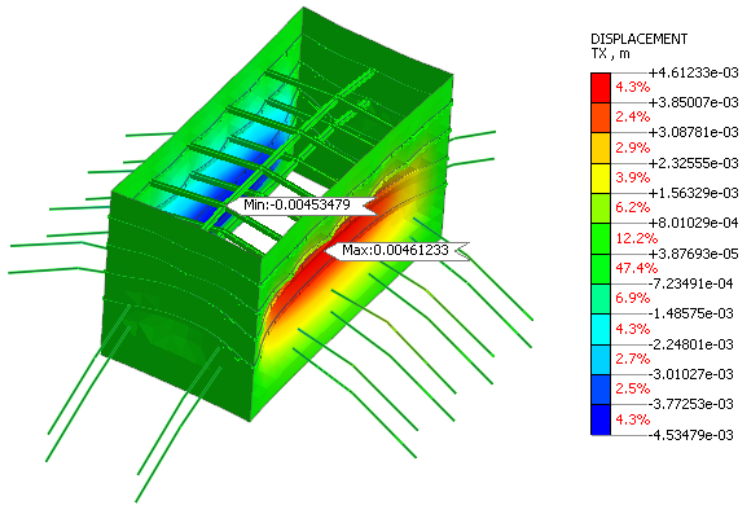
Define CS – Stage 7



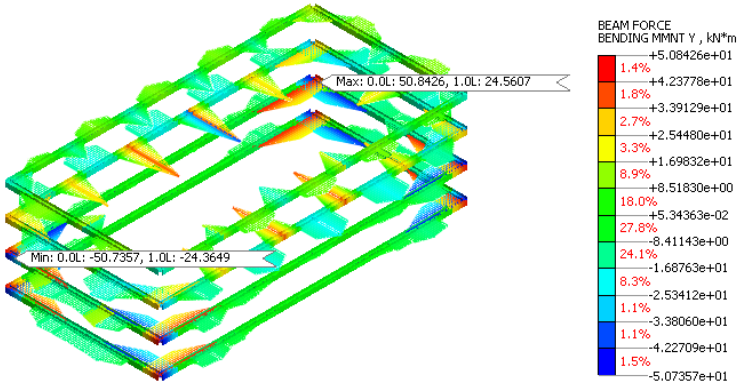
Stage 7. Excavation layer 5

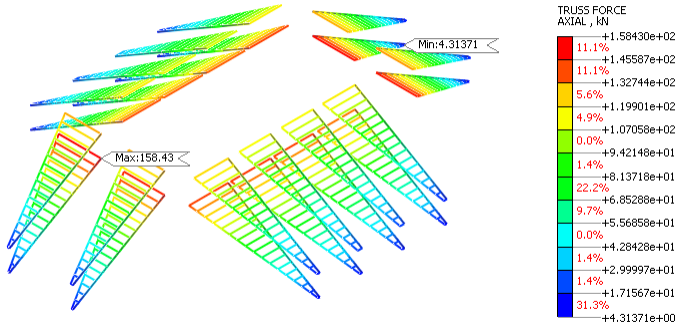
Results – RW system





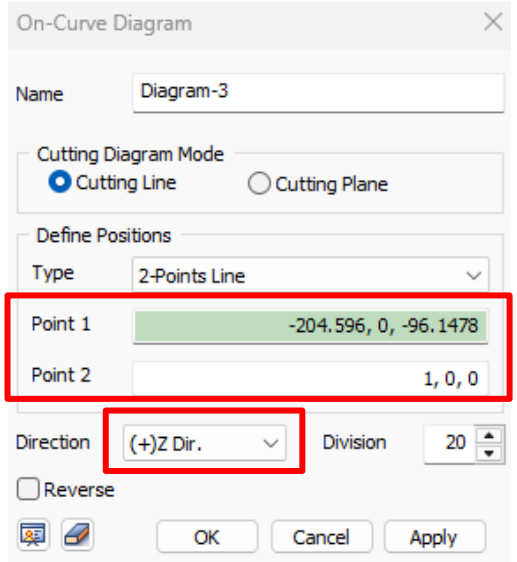
- Deformed and undeformed in horizontal displacement

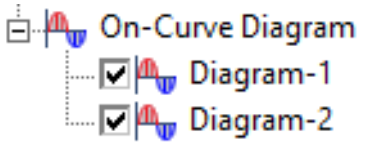




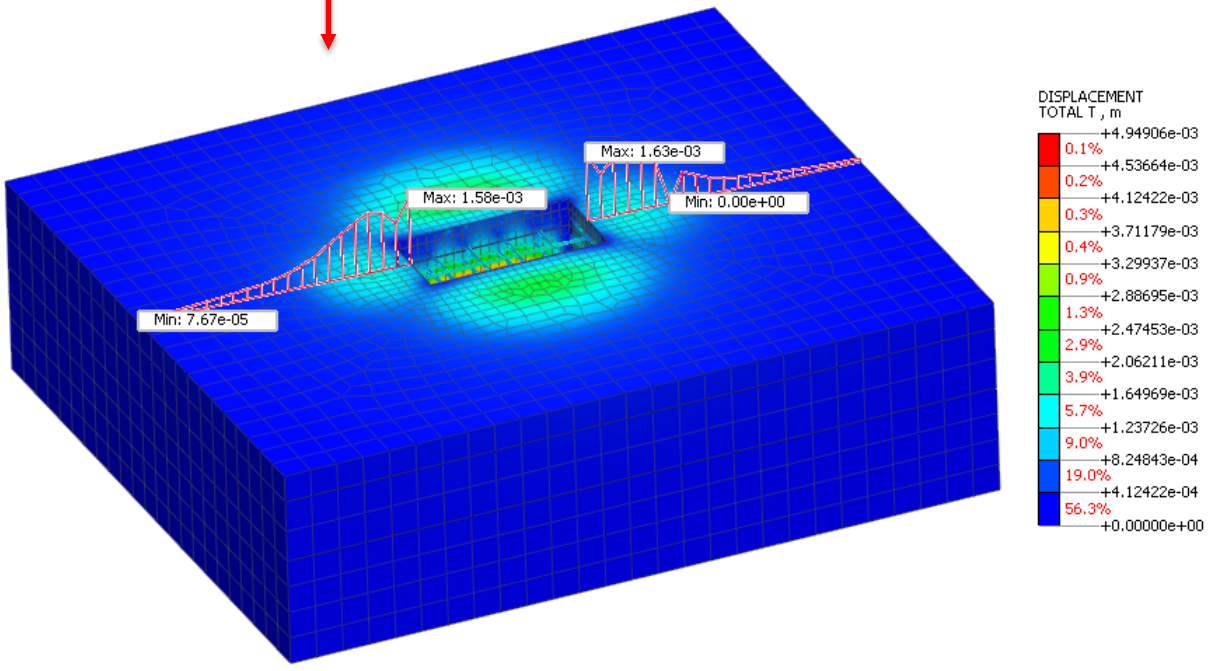
- Beam force, bending moment in walling & Truss force, axial force in anchors

Results - Displacement

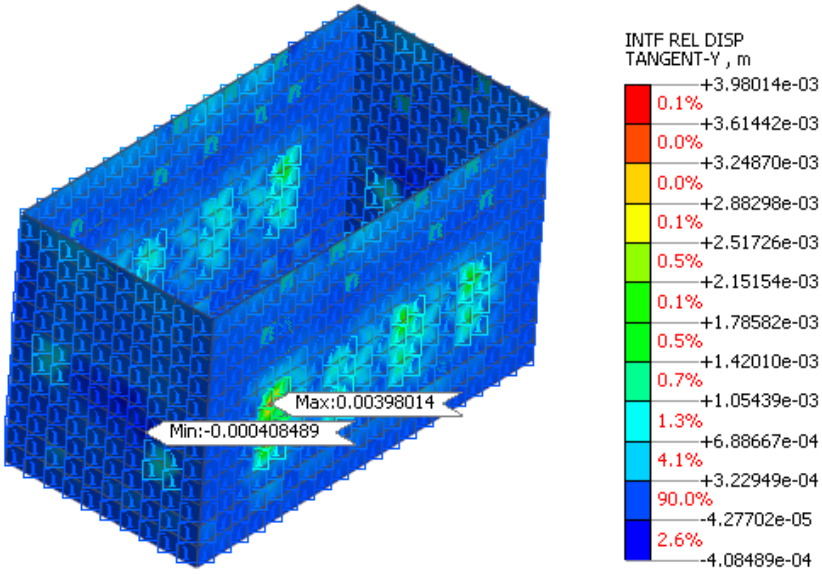


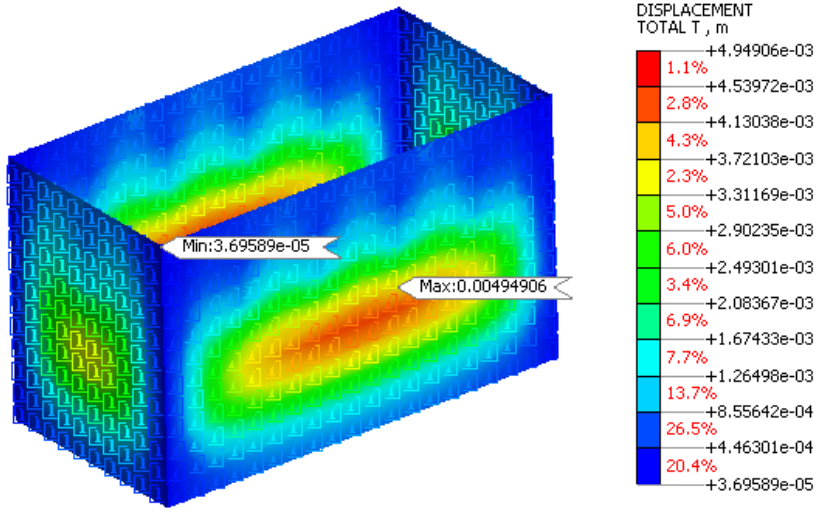


Creating a diagram and showing the displacement



Geometry modeling – Ground





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


Thank you!