GTS NX

Heavy rainfall during deep excavation nearby a river channel

MIDAS Taiwan

Note: The parameters in the example use assumed conditions.

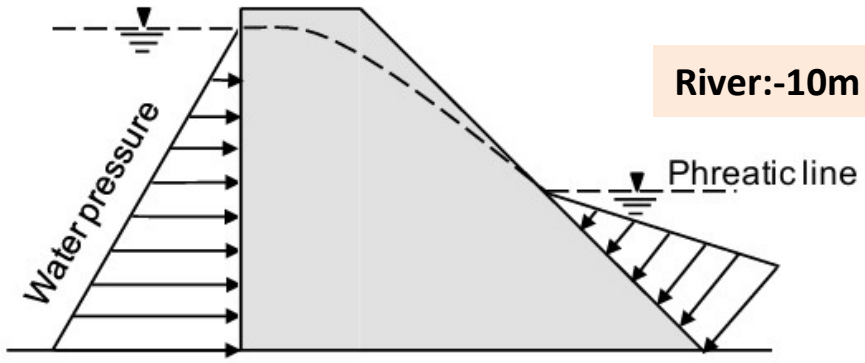
Water Pressure

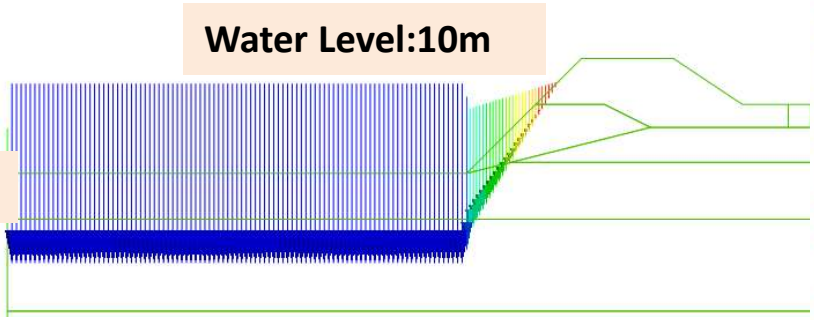
GTS NX can consider water pressure that occurs from the defined water level of a model. Water pressure is added as an edge pressure load for 2D problems and as a surface pressure load for 3D problems.

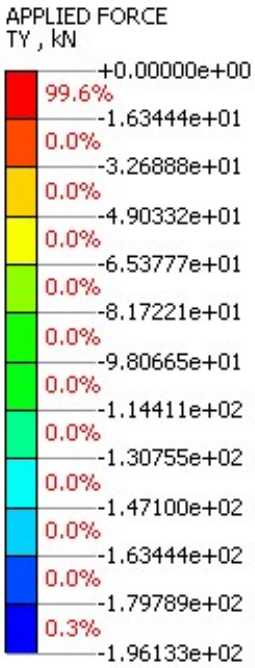
The pressure size needed for calculating the water pressure is determined as follows:

1. Same size as the pore pressure defined on the target edge/surface ($Z_{coordinate}$)
2. Hydrostatic pressure due to user input water level position , ($Z_{water\ Level}$)

$P = \rho \times g \times (Z_{water\ Level} - Z_{coordinate})$ = **196.2(KPa) = 196.2(KN/m²)**







Water=Density 1000 kg/m³

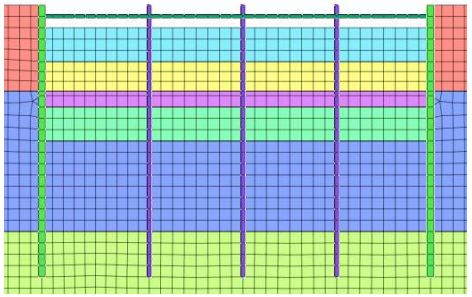
Gravity Acceleration= 9.81 kg/sec2

Reference

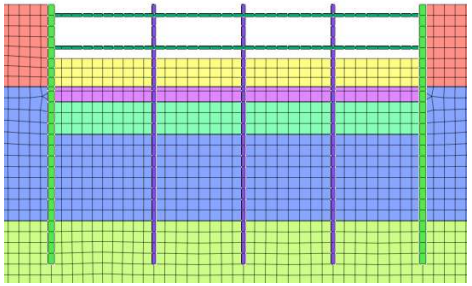
GTS NX_Analysis Reference_Chapter6_LoadConstraint

Explanation-1

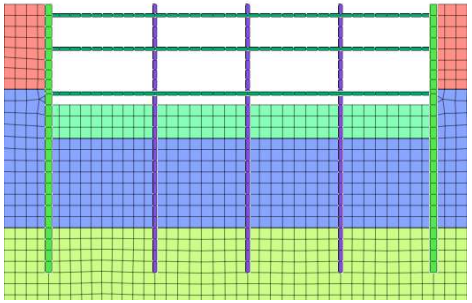
Stage 1



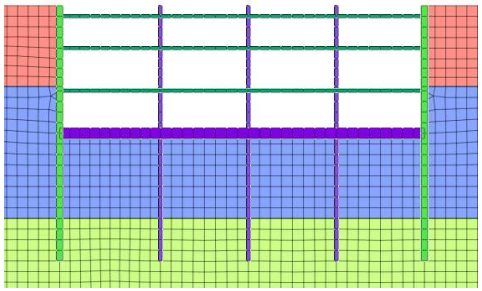
Stage 2



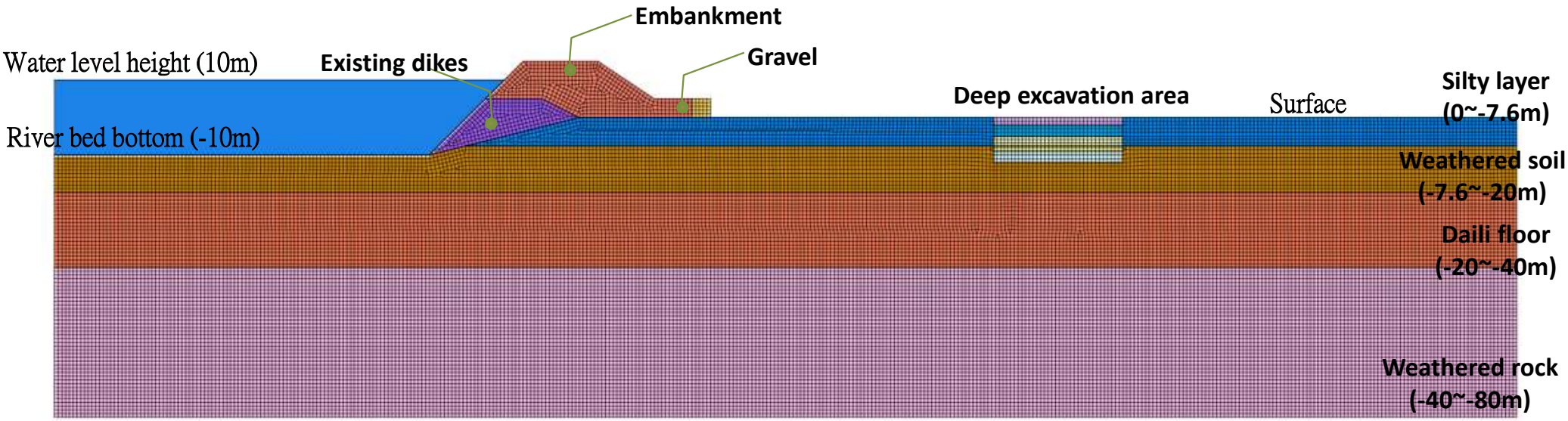
Stage 3



Stage 4



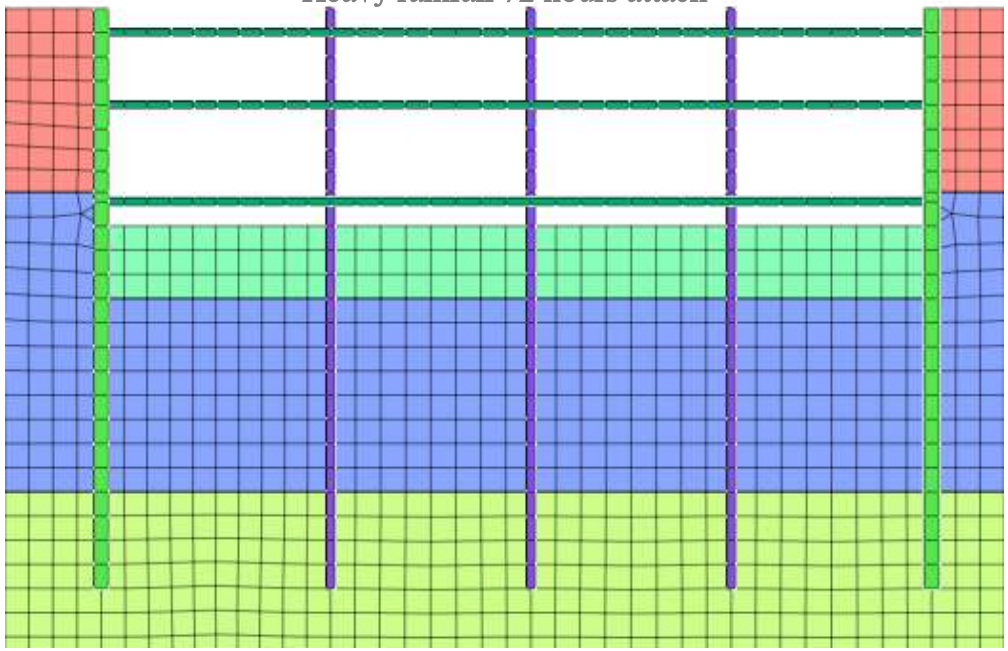
Water Pressure

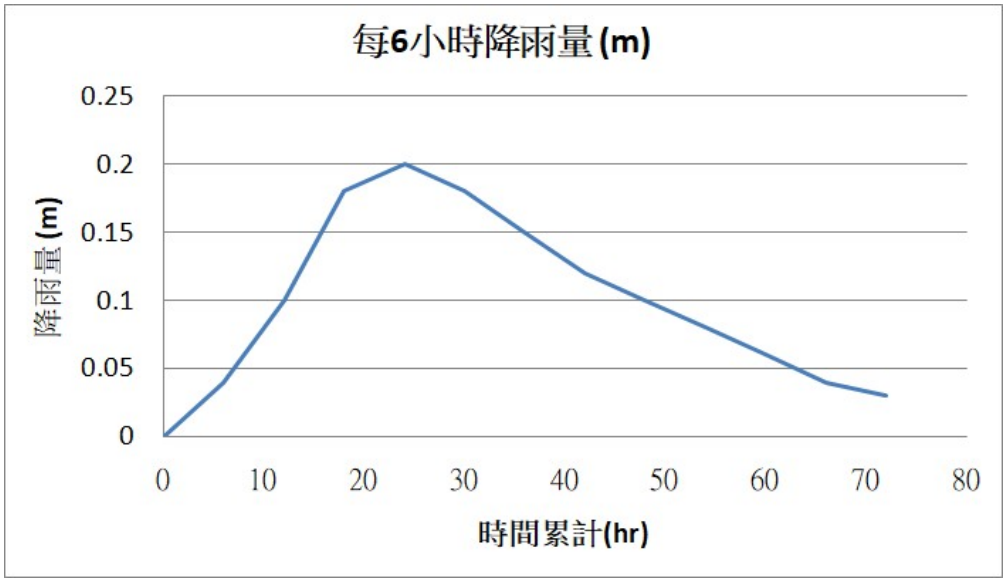


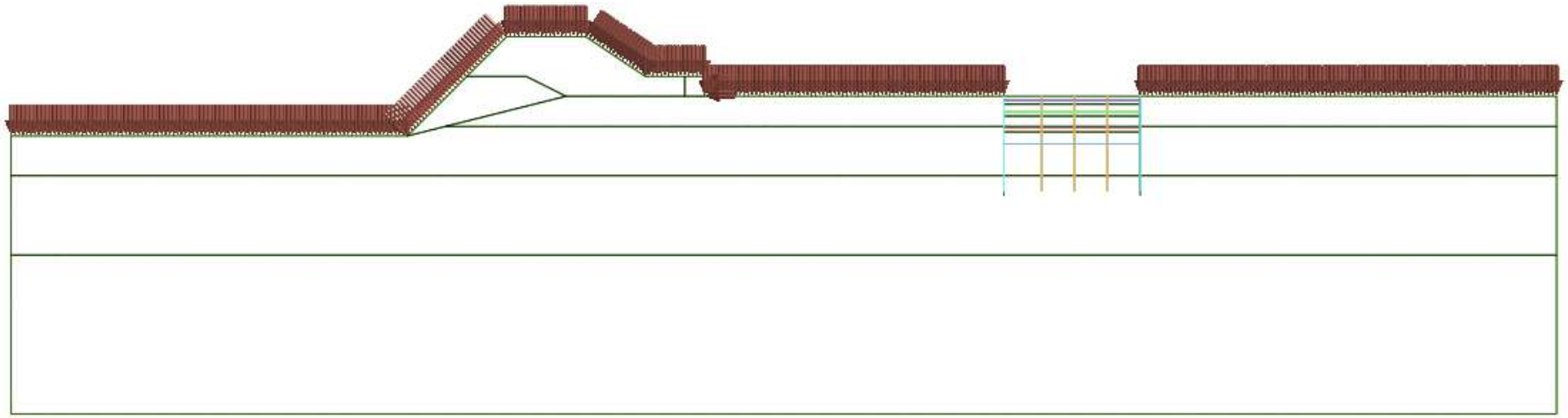
Explanation-2

Before stage 3 of excavation

Heavy rainfall 72 hours attack







Part1. Geometry

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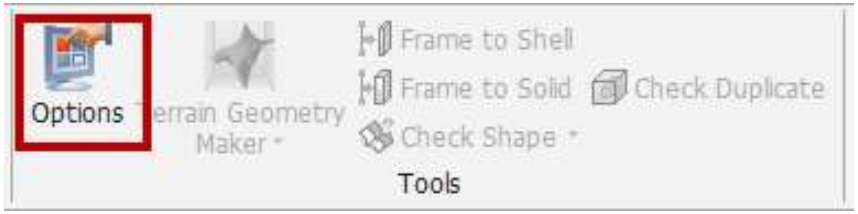
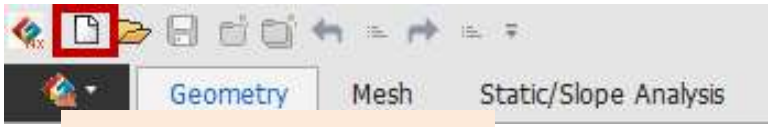
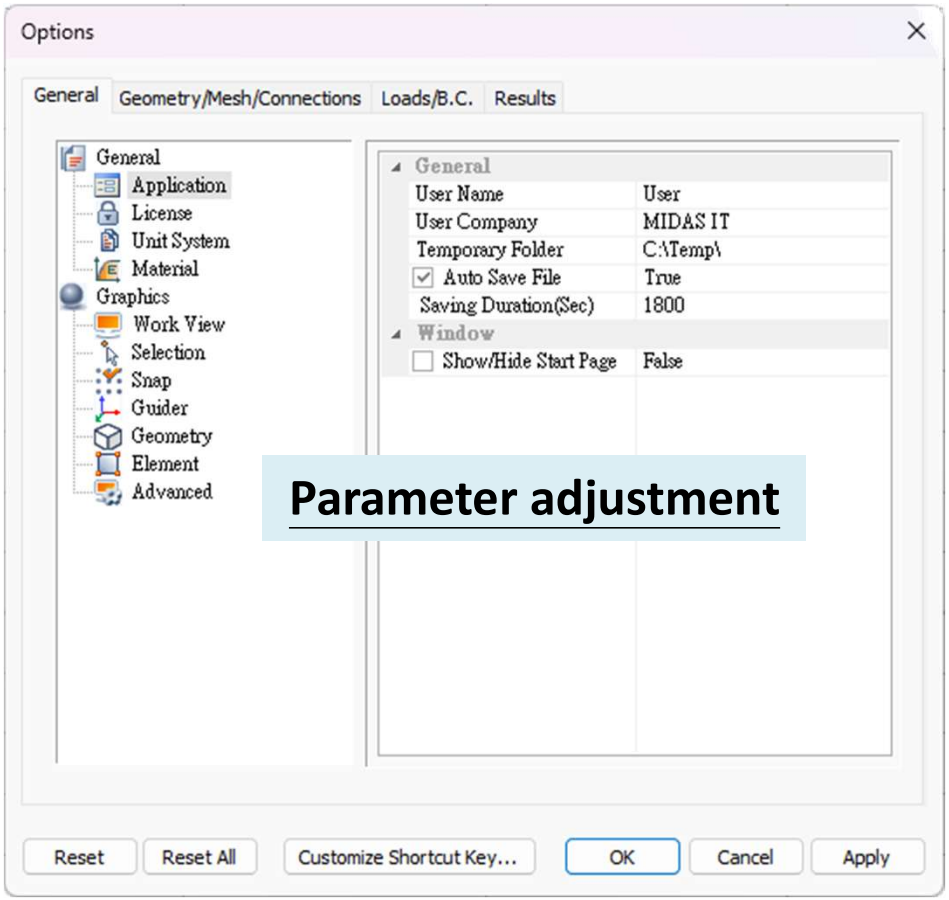
Import

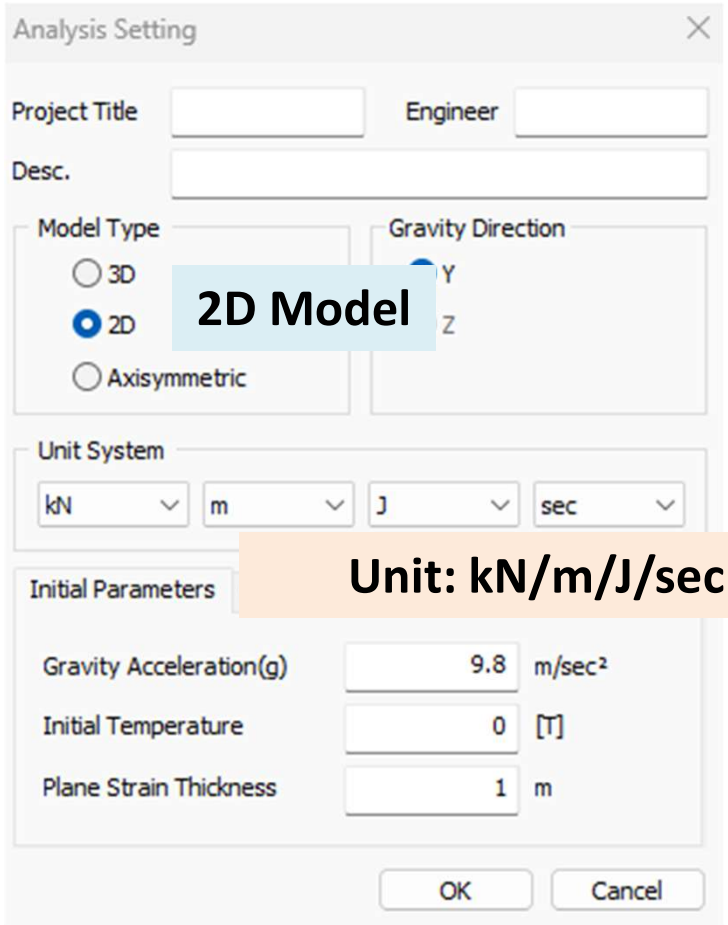




New document



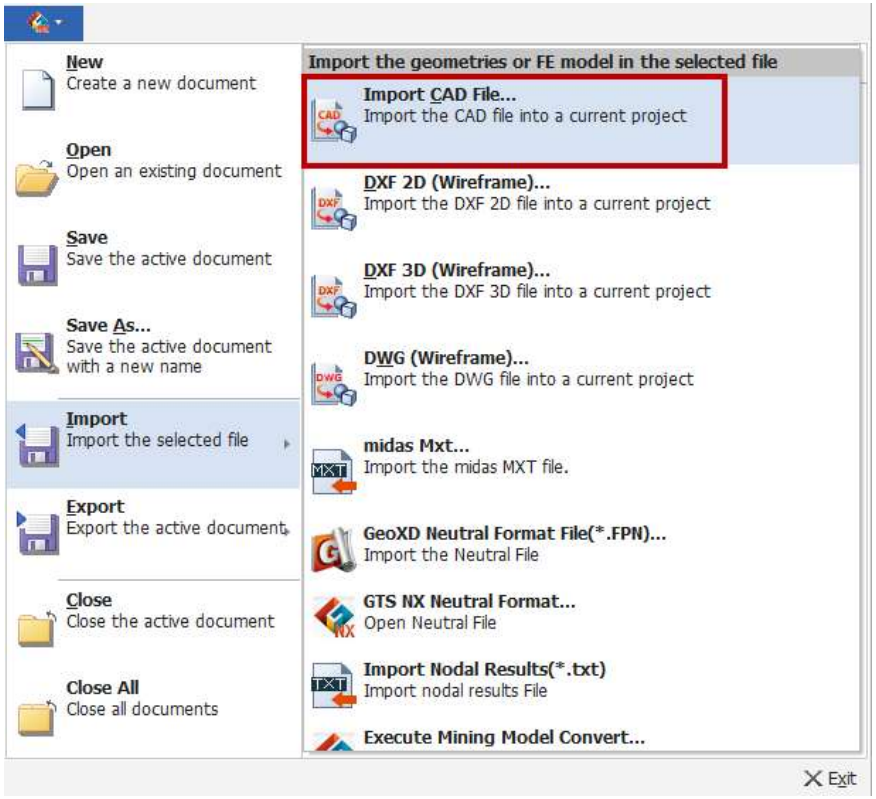
Parameter adjustment

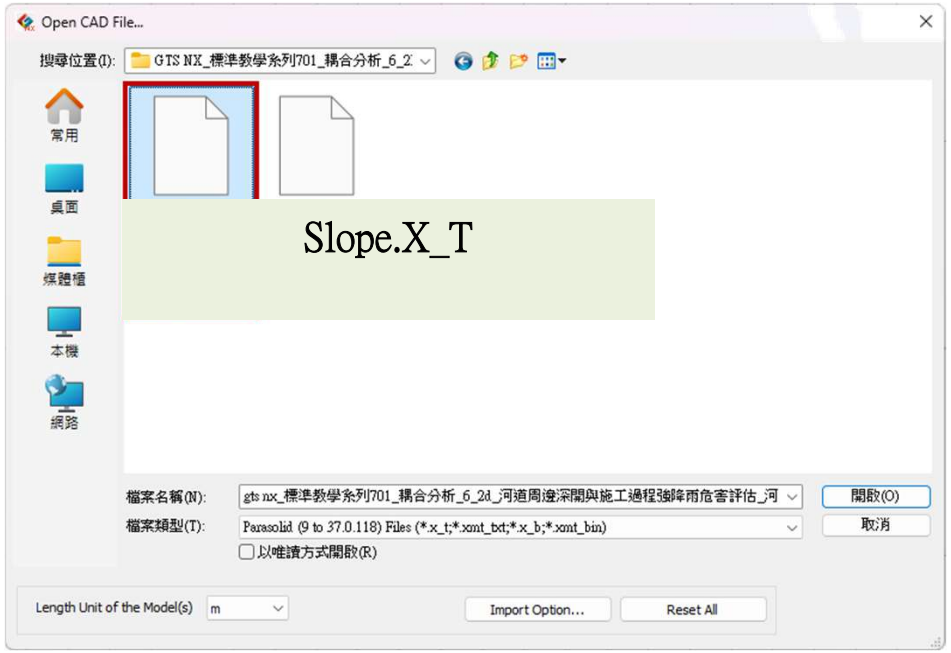


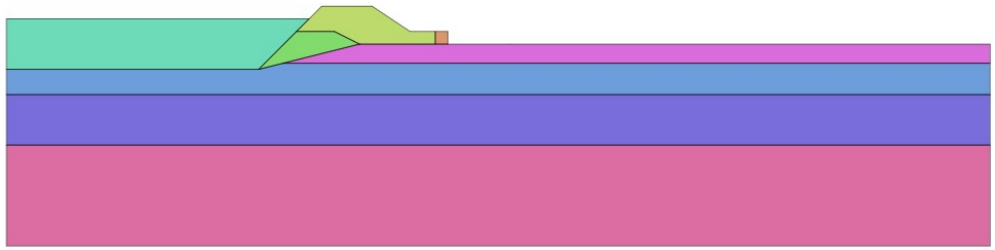
2D Model

Unit: kN/m/J/sec

Import

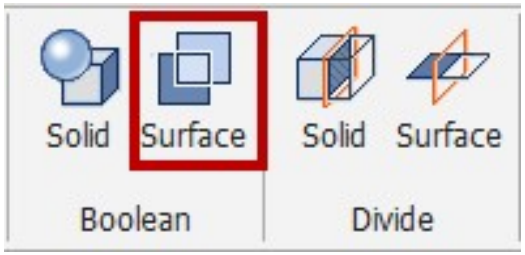




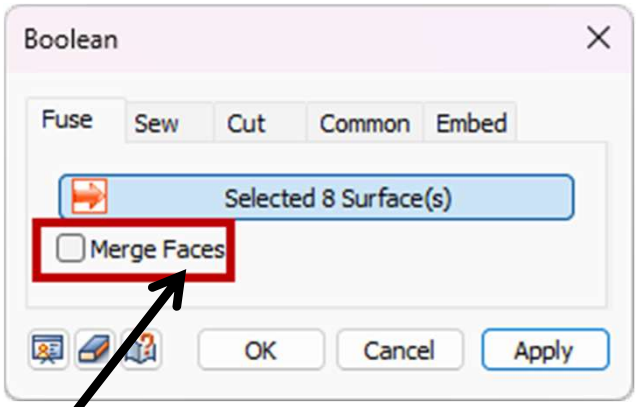


註:支援匯入DWG/DXF線模型

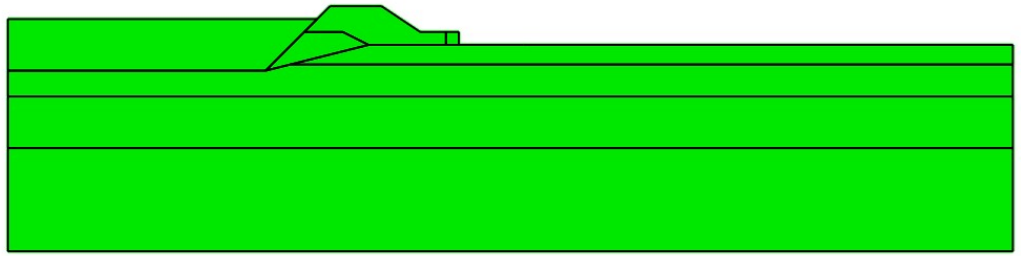
Surface merging

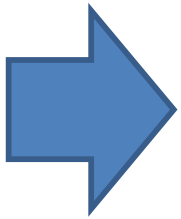


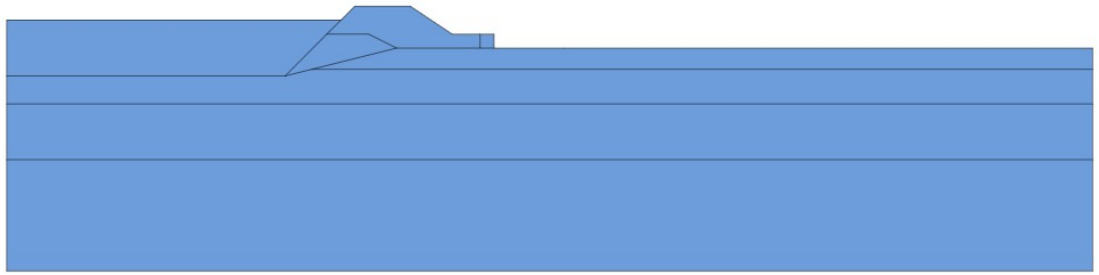
Selecting all



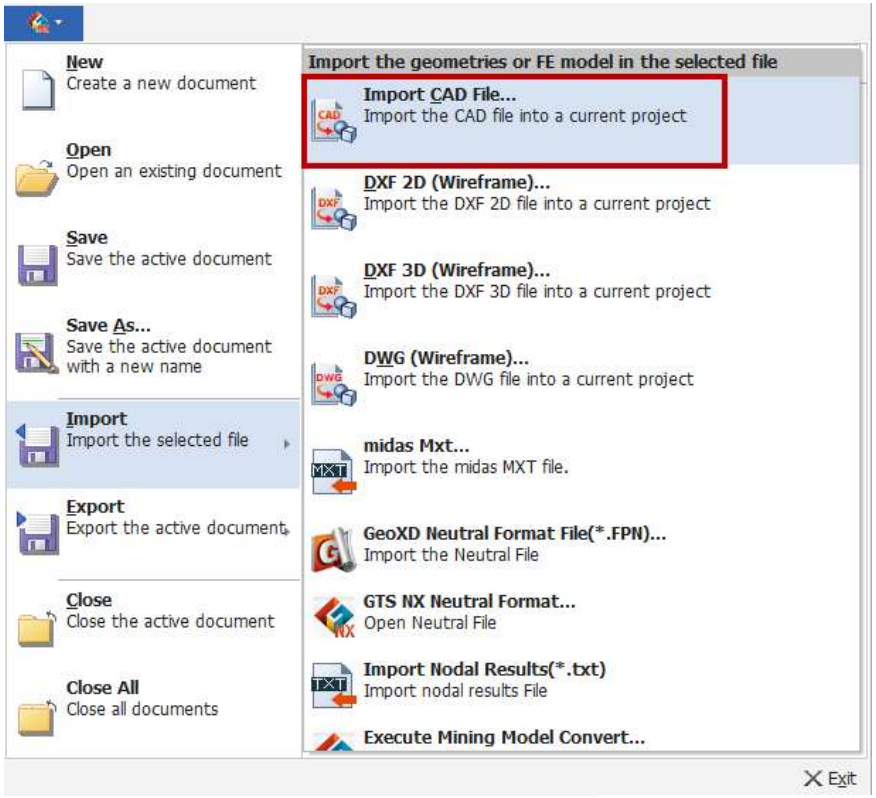
Do not tick

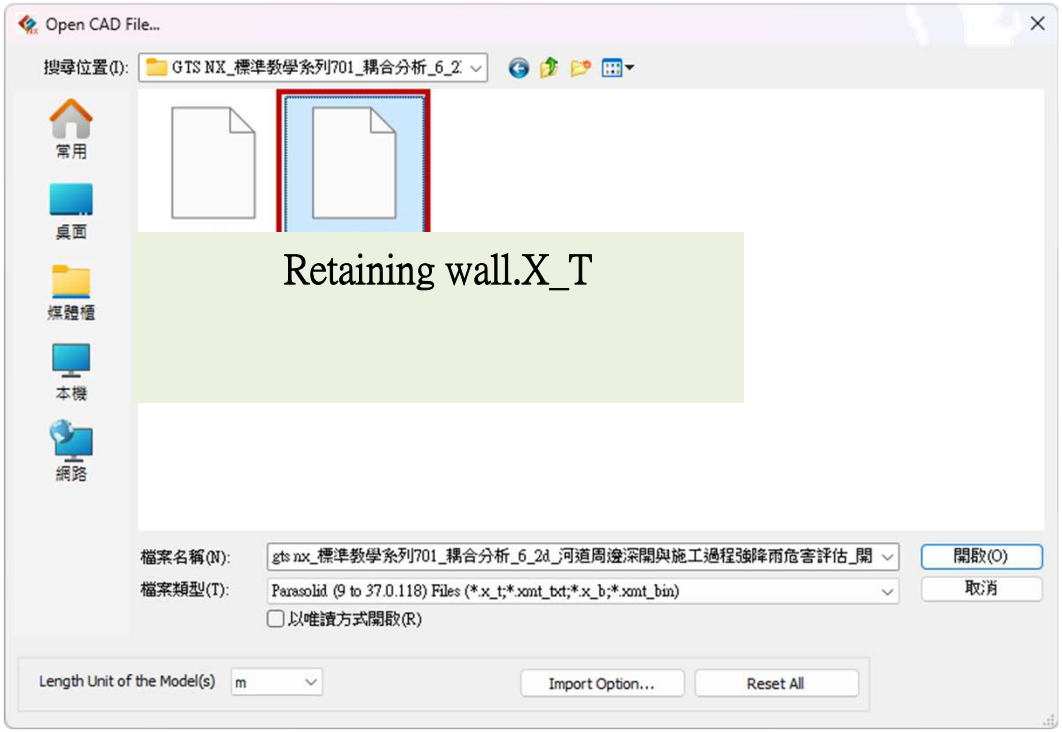


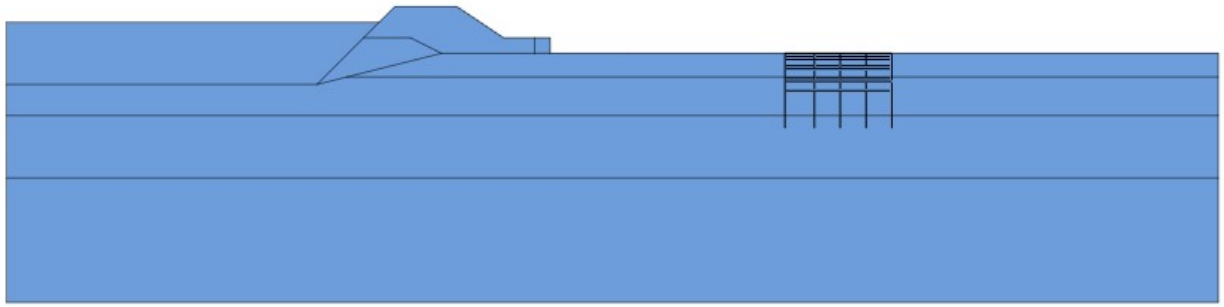




Import excavation area







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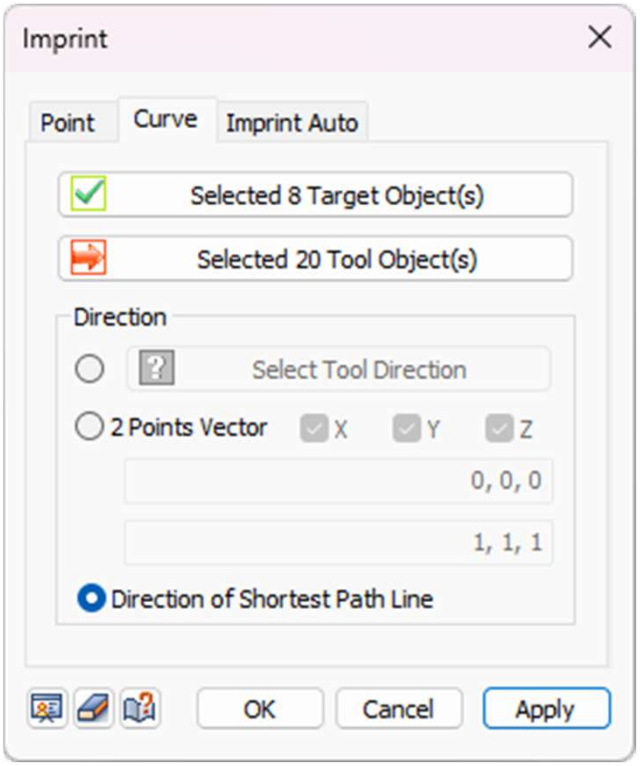
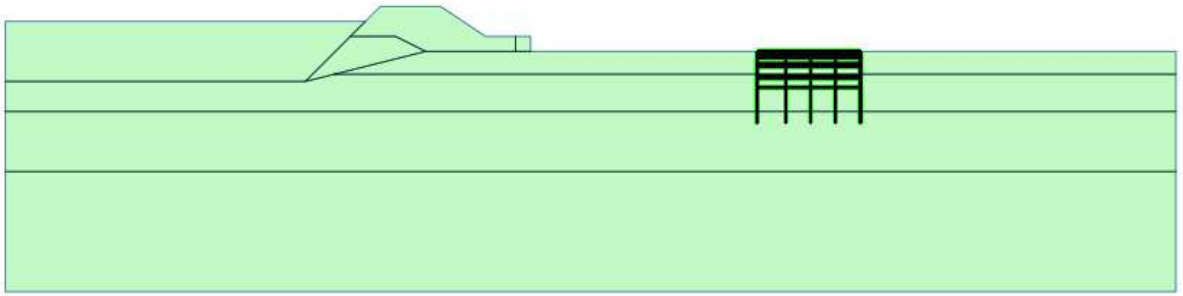


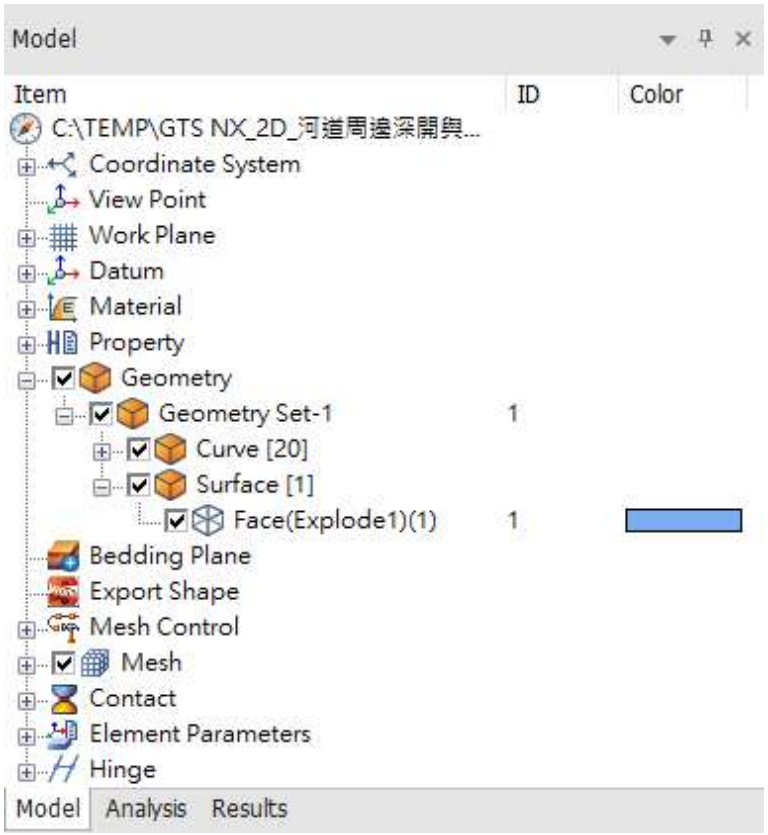
Shortest path line selected

Target Object: All surfaces

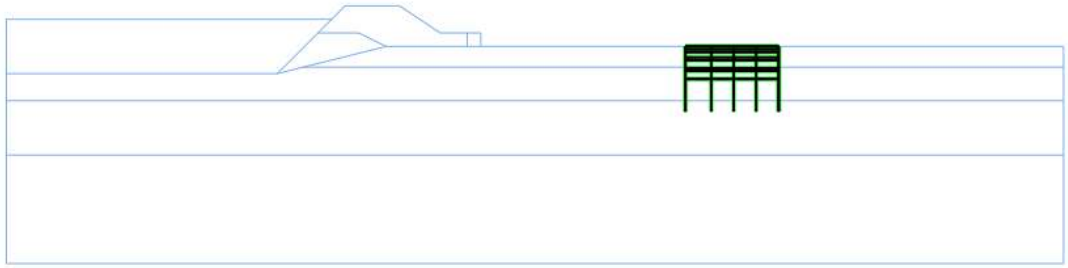


Tool Object: Excavation zone

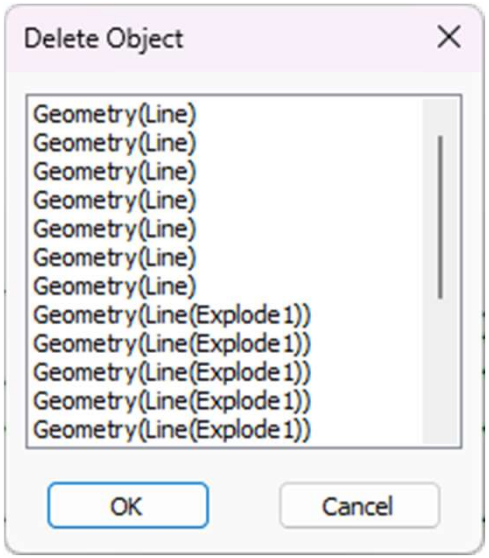
Delete curves



Step1.Excavation curves



Step2. DELETE



Part2. Soil Property

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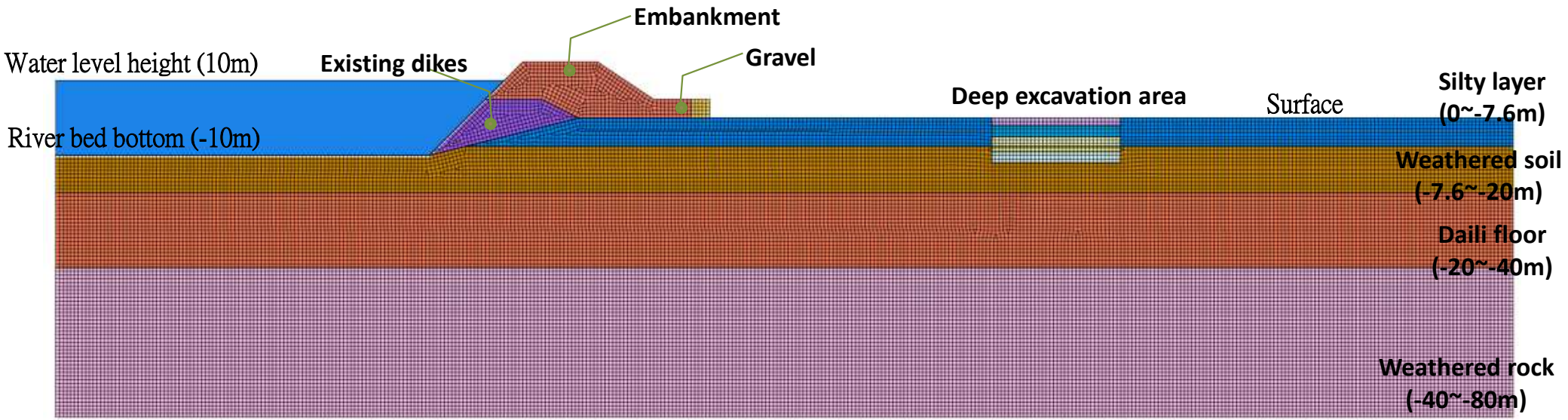
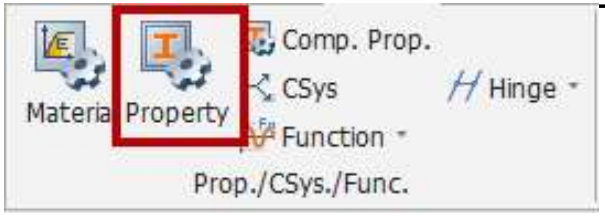
Soil Layer Distribution

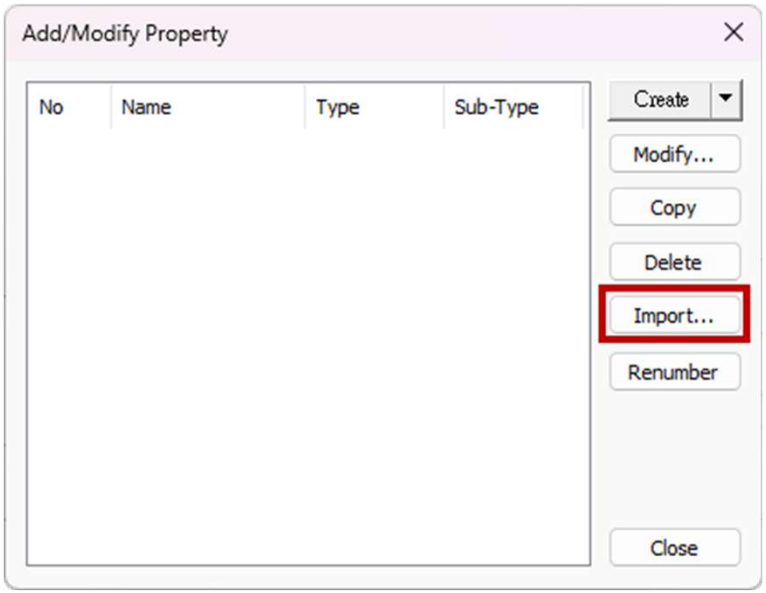
Water Pressure



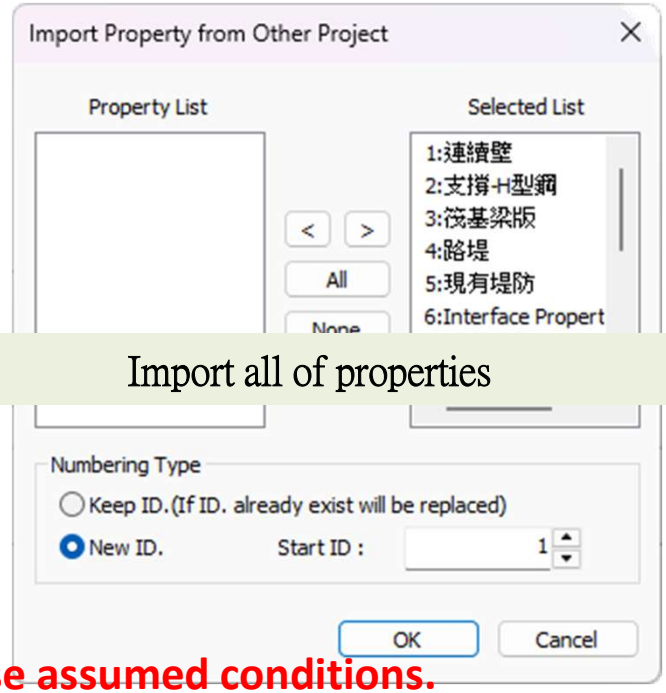
Note: The parameters in the example use assumed conditions.

Property Import





Import: 選擇_河道周邊深開與施工過程強降雨危害評估_MAT&PROP.gts



Import all of properties

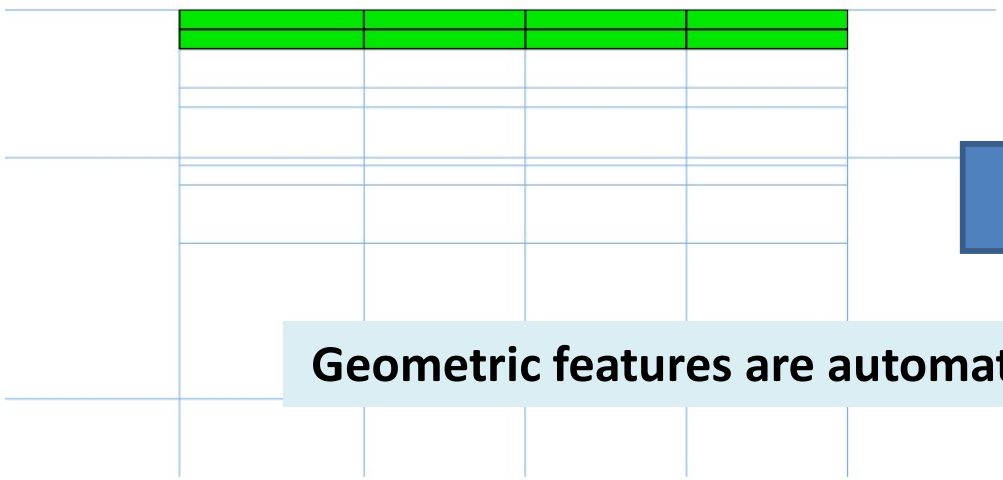
Note: The parameters in the example use assumed conditions.

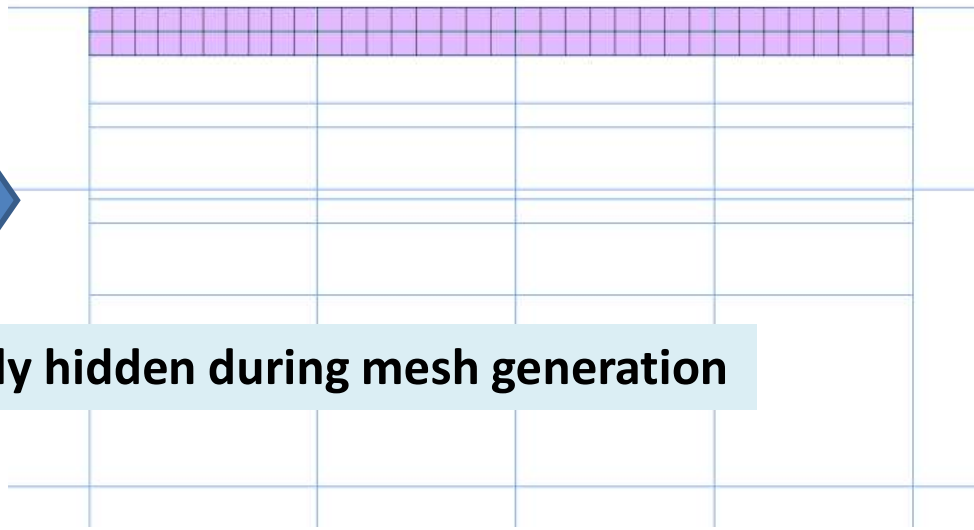
Excavation area – Stage 1 -1

Mesh size: 1/ Prop: Silty layer

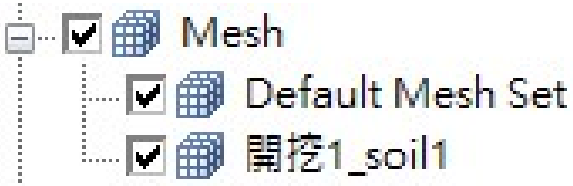
Geometry set: Excav 1_Soil1

Mesh set: Excav1_Soil1





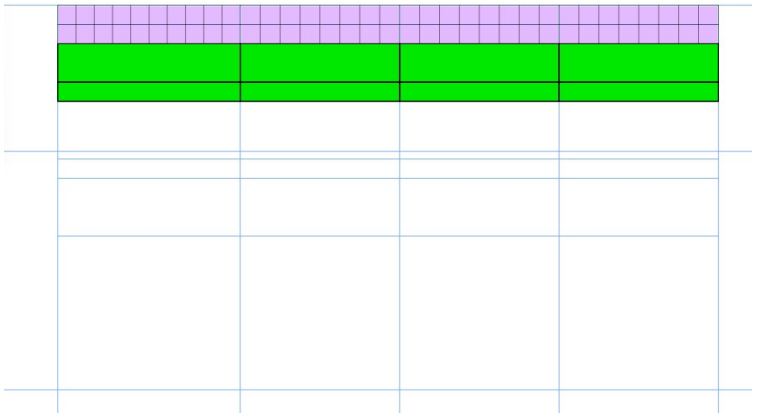
Geometric features are automatically hidden during mesh generation



Excavation area –Stage 2 -2

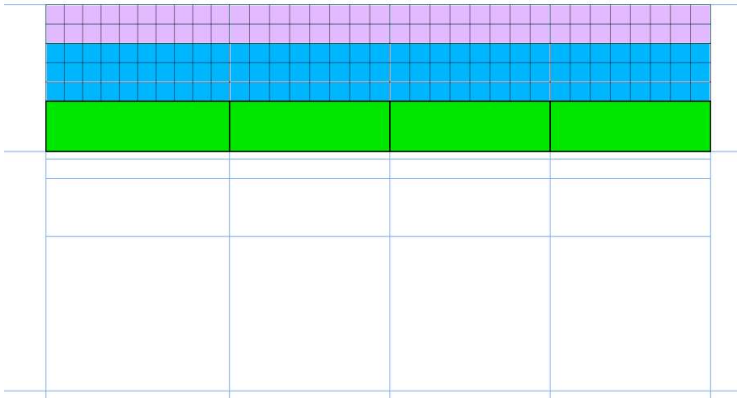
Mesh size: 1/ Prop: Silty sand layer

Geometry set: Excav2_Soil2

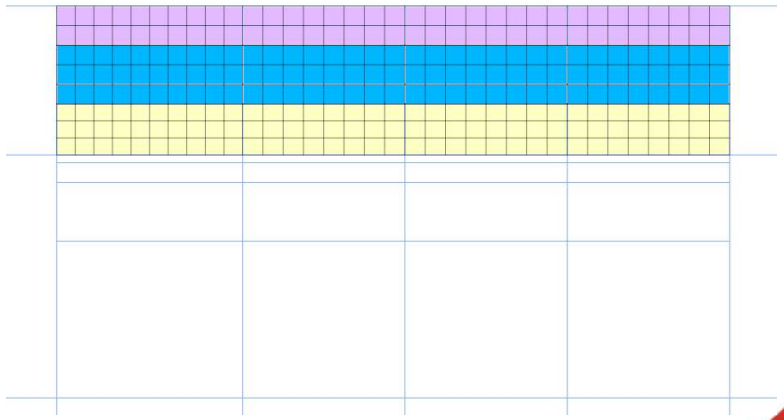


Mesh set: Excav2_Soil2

Geometry set: Excav3_soil3



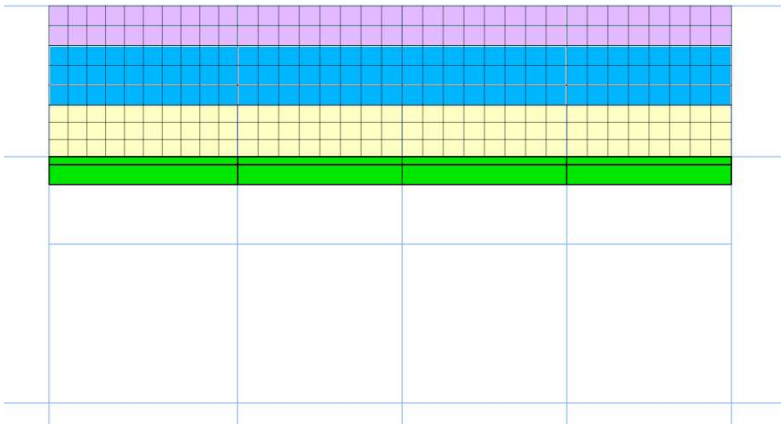
Mesh set: Excav3_Soil3



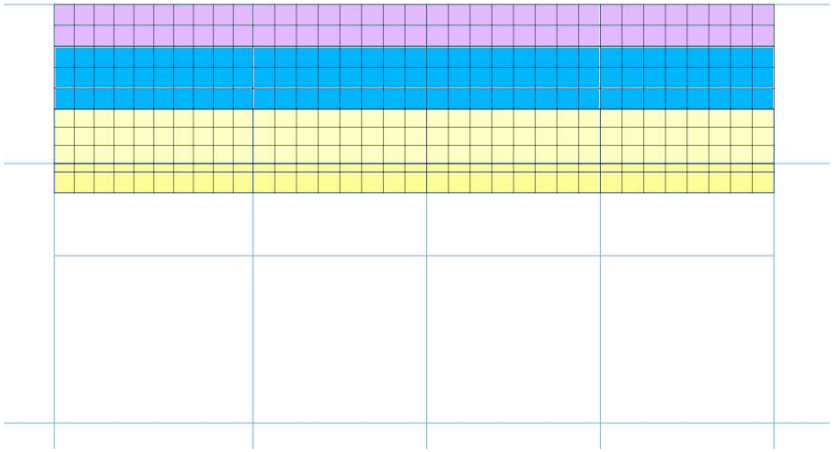
Excav area – Stage 3 -3

Mesh size: 1/ Prop: Weathered soil

Geometry set: Excav3_Soil2



Mesh set: Excav3_Soil2

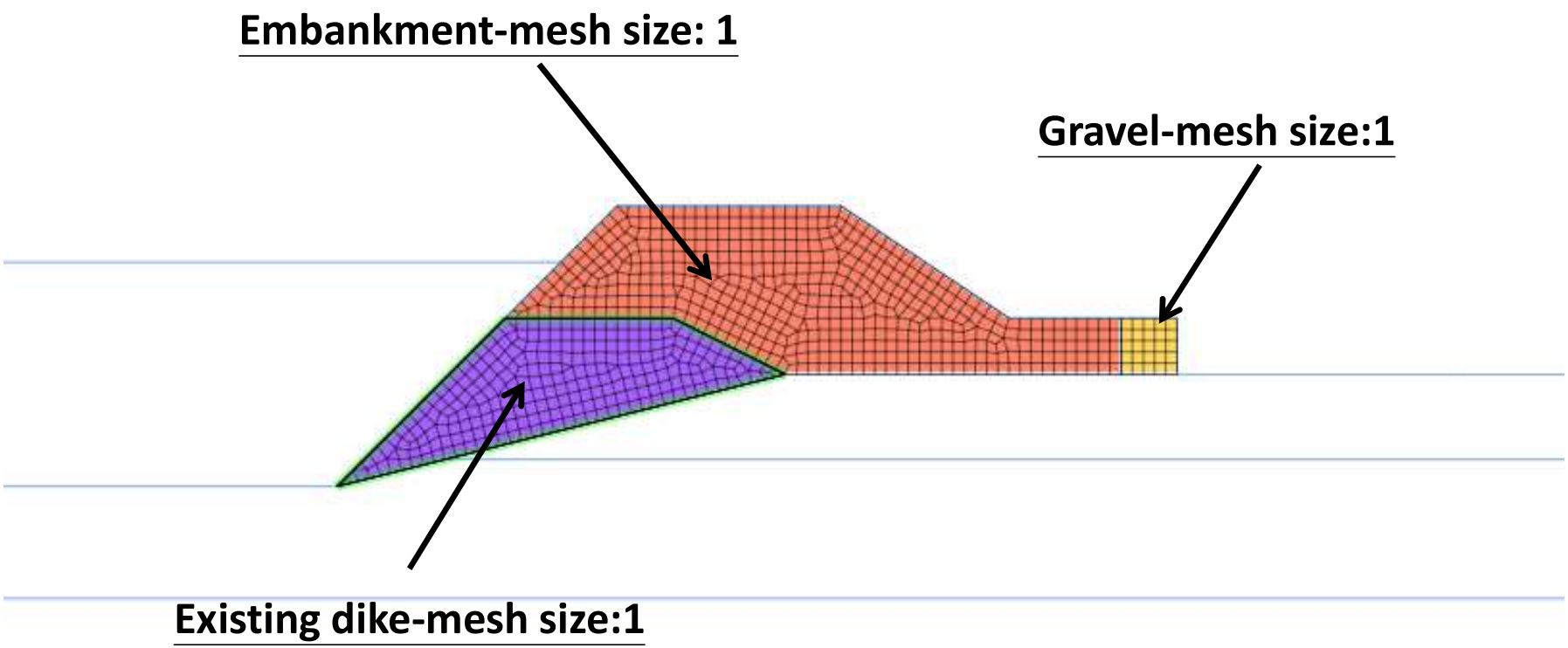


Geometry set: Excav4_Soil2

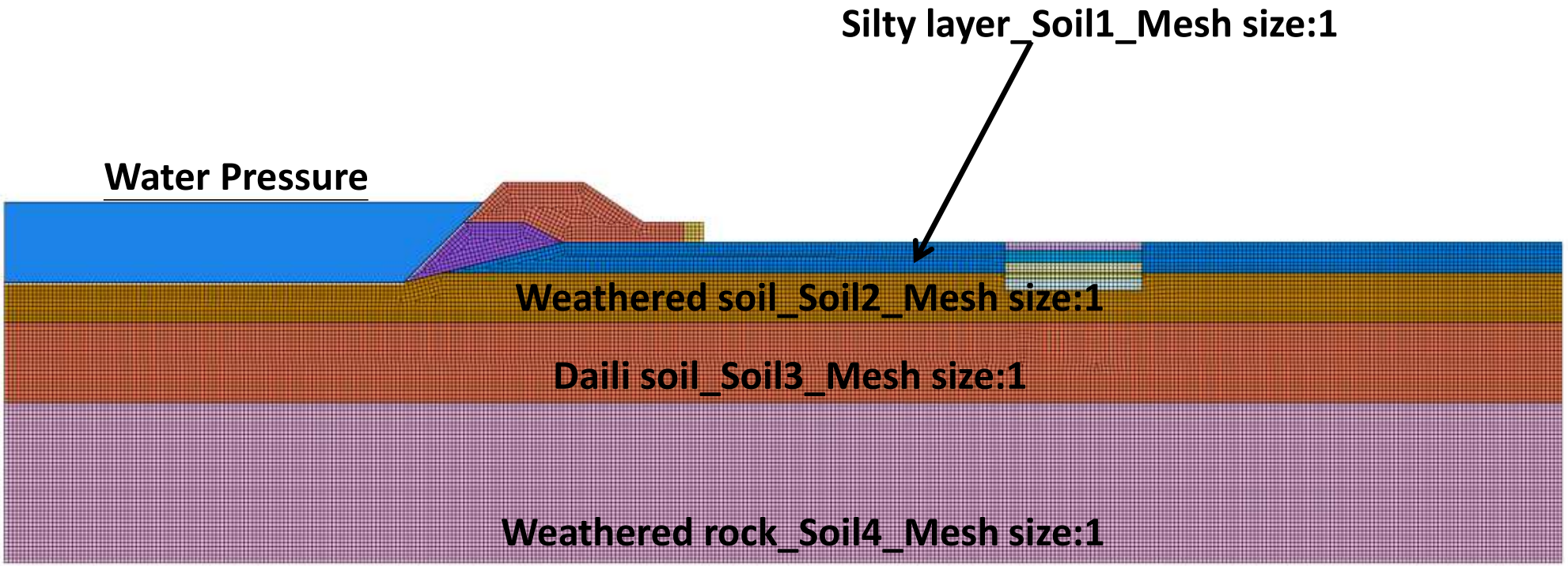
Mesh set: Excav 4_Soil2

Riverbank area

Separated mesh set



Soil Layer


Silty layer_Soil1_Mesh size:1
Water Pressure
Weathered soil_Soil2_Mesh size:1
Daili soil_Soil3_Mesh size:1
Weathered rock_Soil4_Mesh size:1

Part3. Mesh

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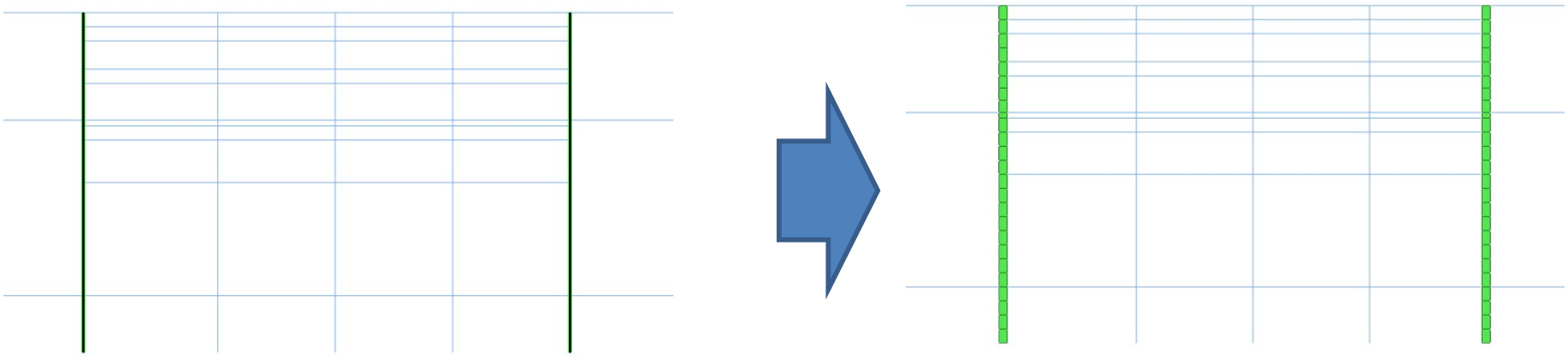
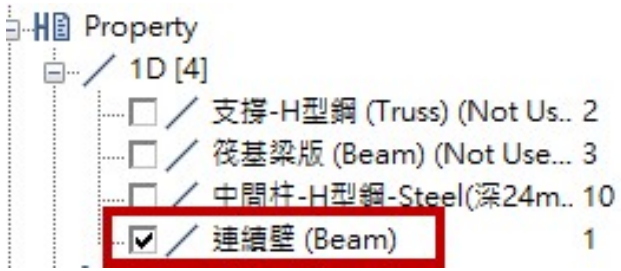
Retaining Wall-1D Beam

Extracting 1D element to retaining wall

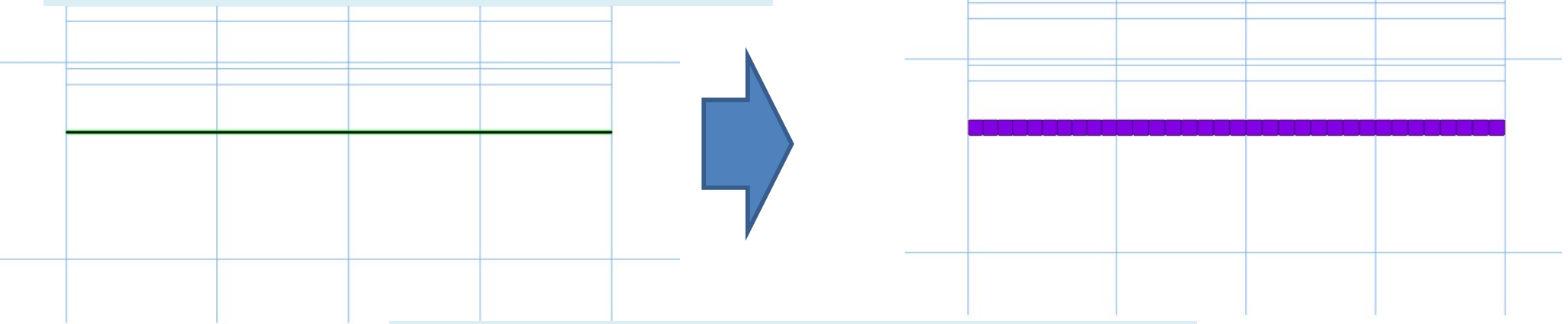


Tick on to view the property shape of BEAM



Raft foundation-1D Beam

Extracting 1D element to raft foundation

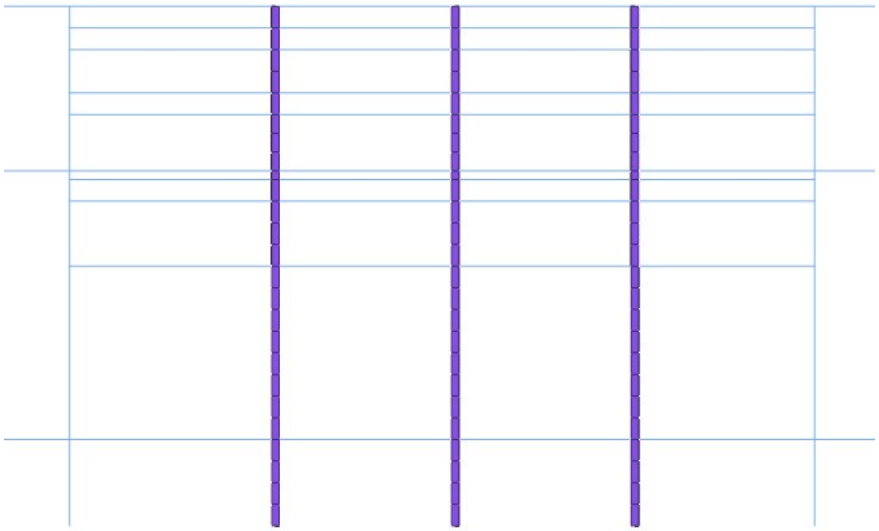


Tick on to view the property shape of BEAM

Center Column-1D Beam

Center column(depth 24m)
(H350 ×250 ×12 ×19)-Beam

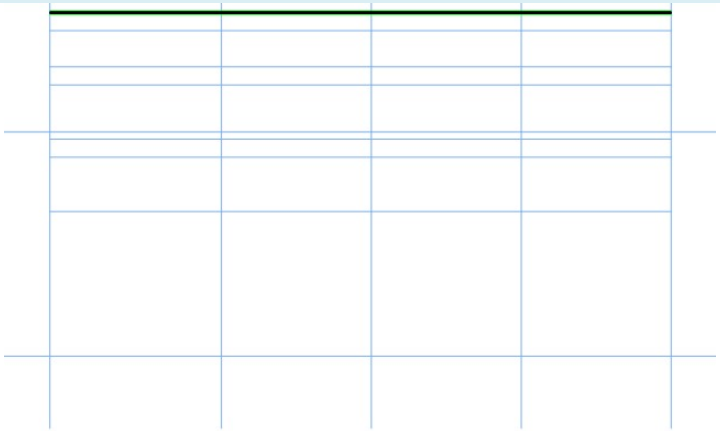
Extracting 1D element to center column



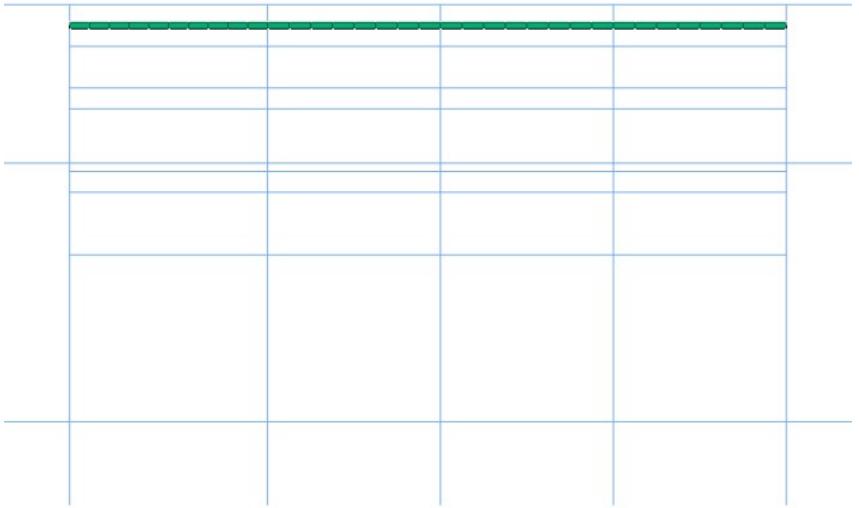
Tick on to view the property shape of BEAM

Strut Layer1-1D Truss

Extracting 1D element to strut_Layer1

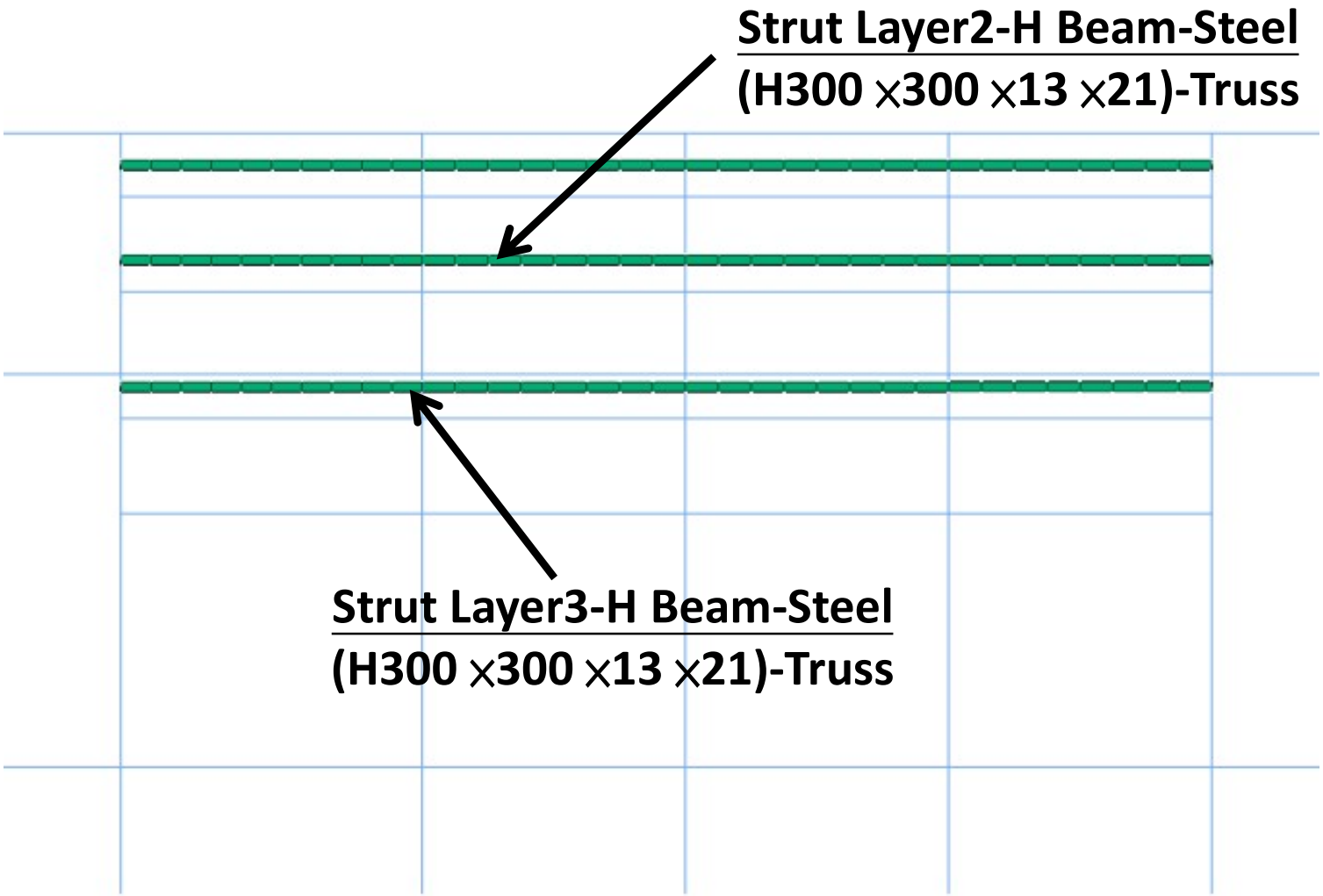


Strut Layer1-H Beam-Steel
(H300 ×300 ×13 ×21)-Truss

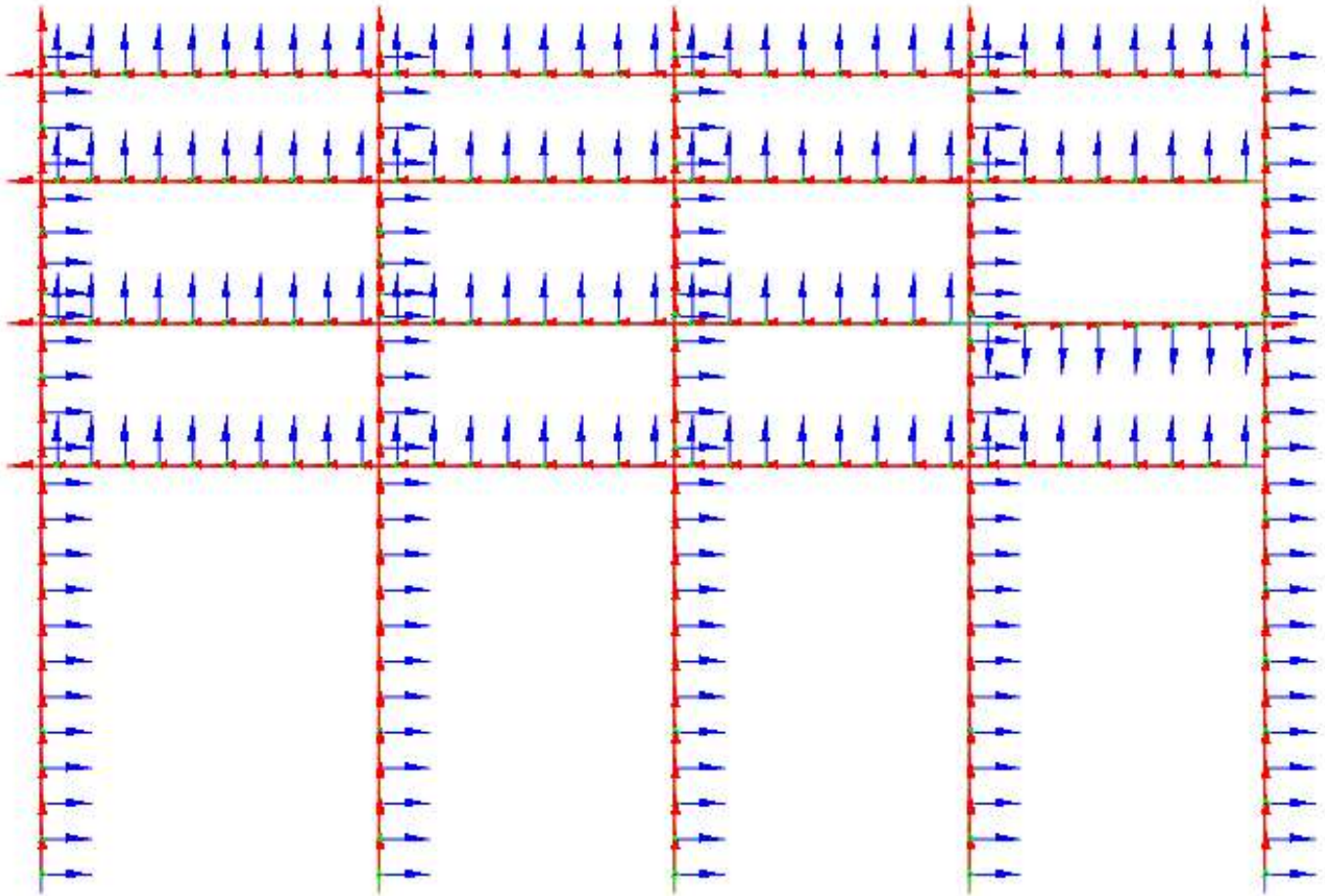


Tick on to view the property shape of STRUSS

Strut Layer2&3-1D Truss



Element Local Orientation

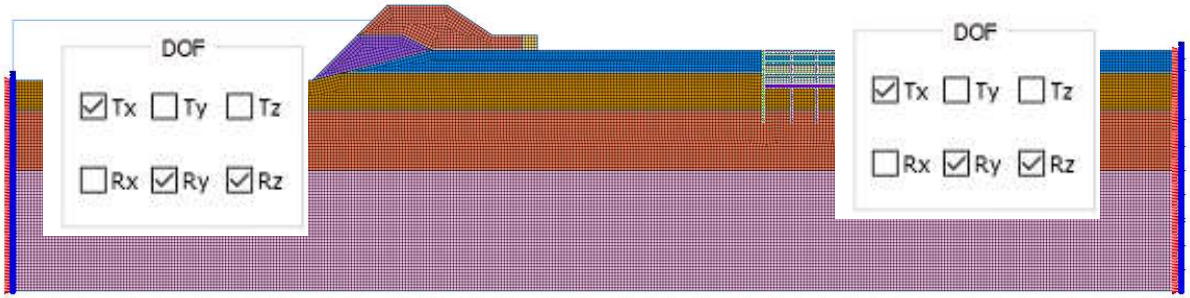


Part4.Boundary Conditions

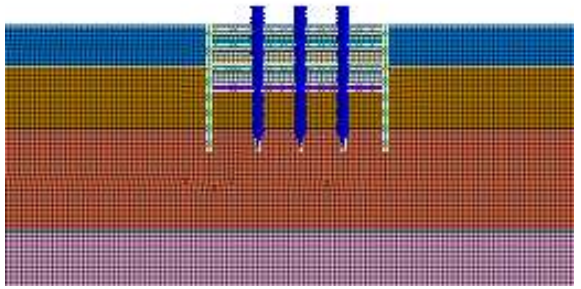
MIDAS Taiwan

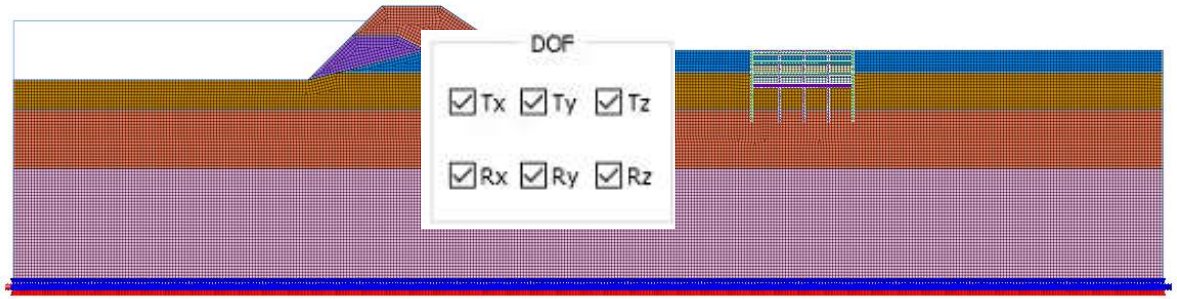
Boundary Conditions

BC for 2-sided edges



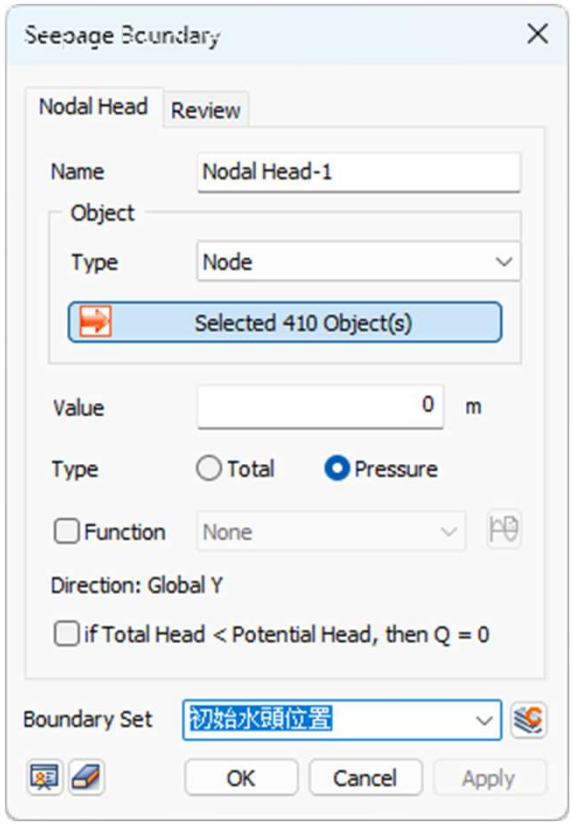
Constraint Ry for center column





Initial Water Head Level

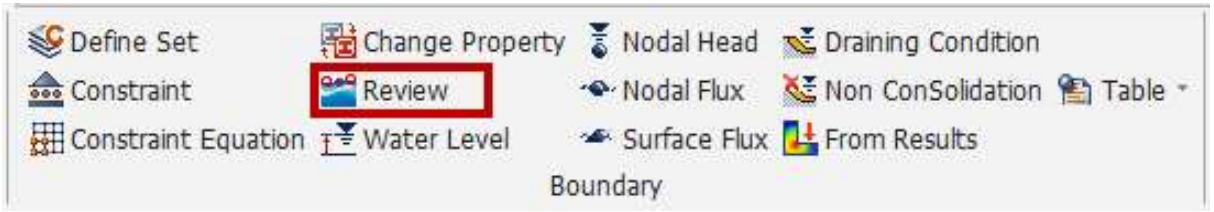
(Nodal Head ,Pressure=0 m)

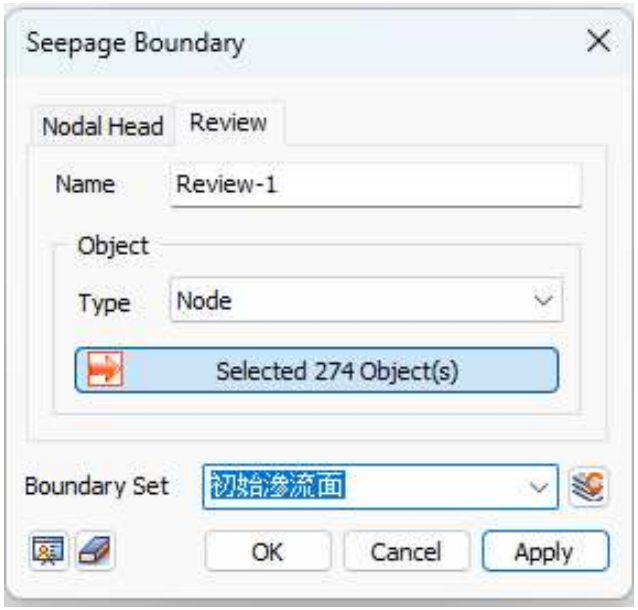


Selecting line features

Edge features selected

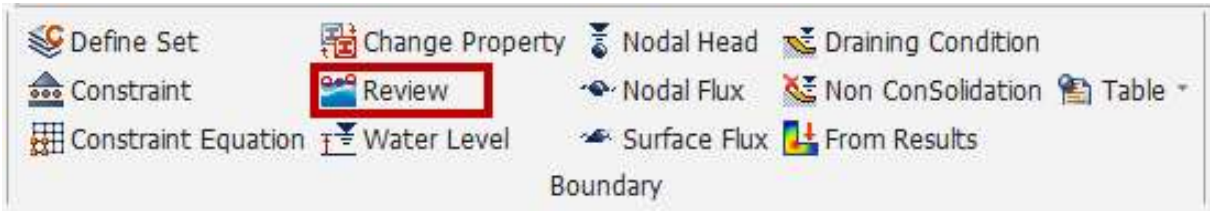
Initial Seepage Surface

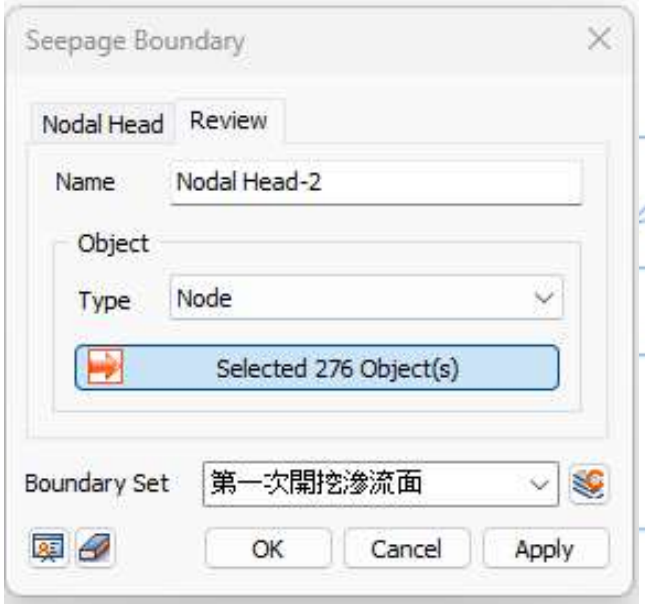


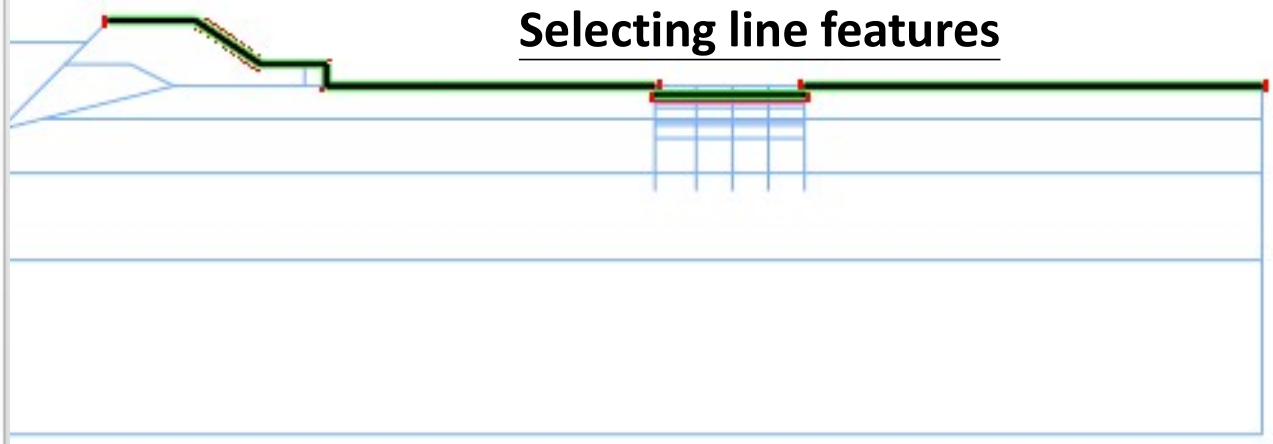


Selecting line features

Excav Stage1_Seepage Surface

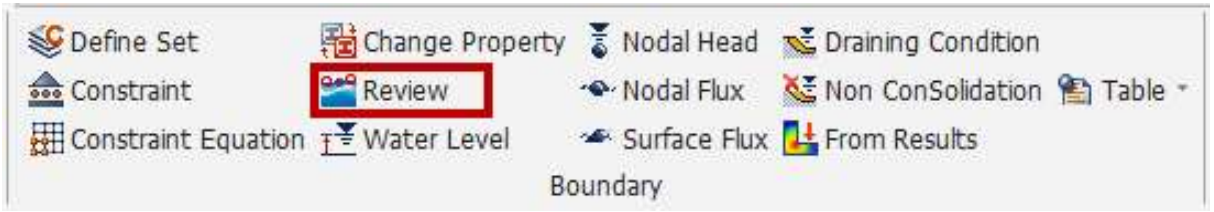


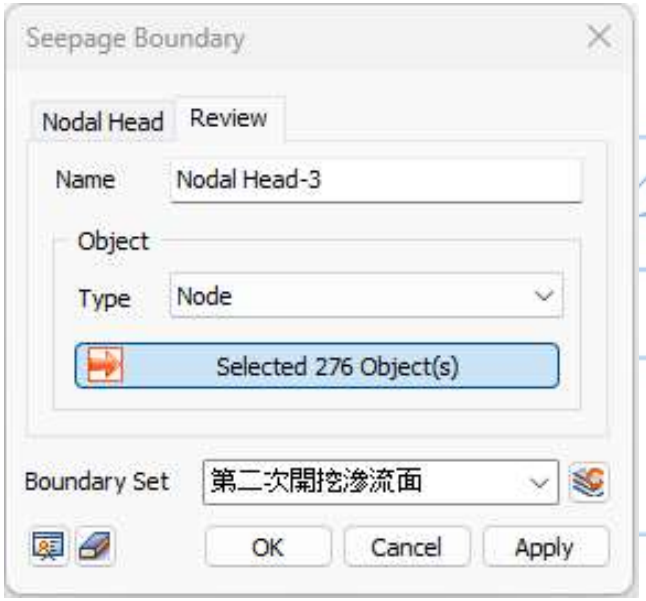




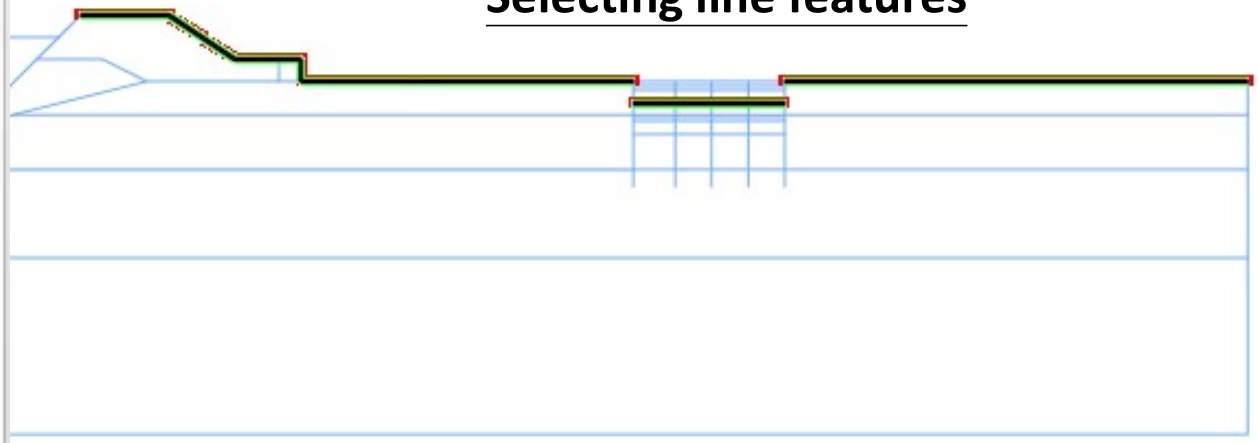
Selecting line features

Excav Stage2_Seepage Surface

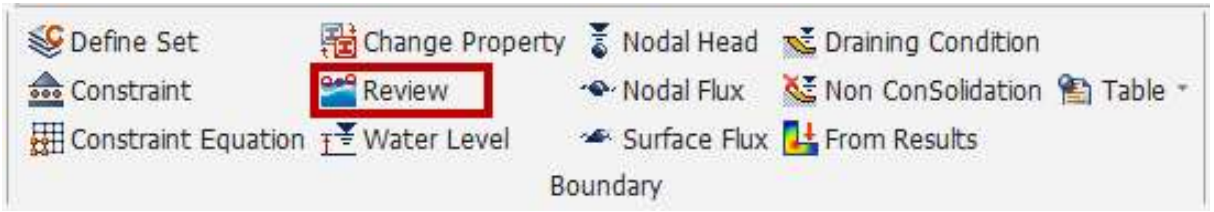


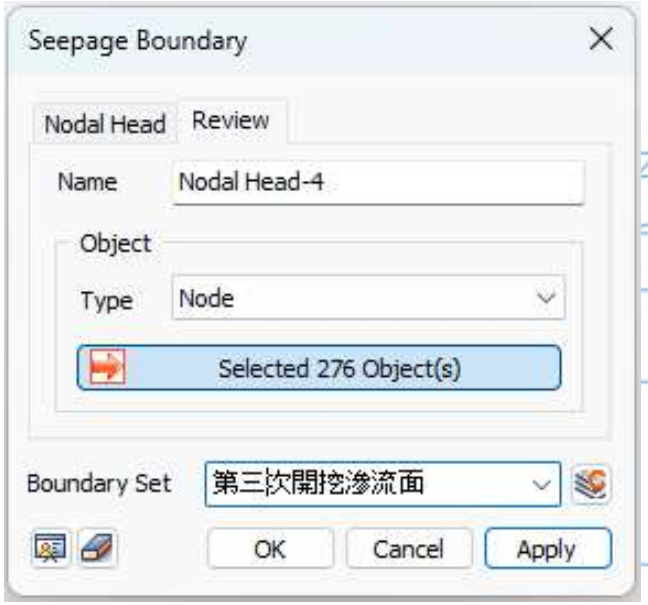


Selecting line features

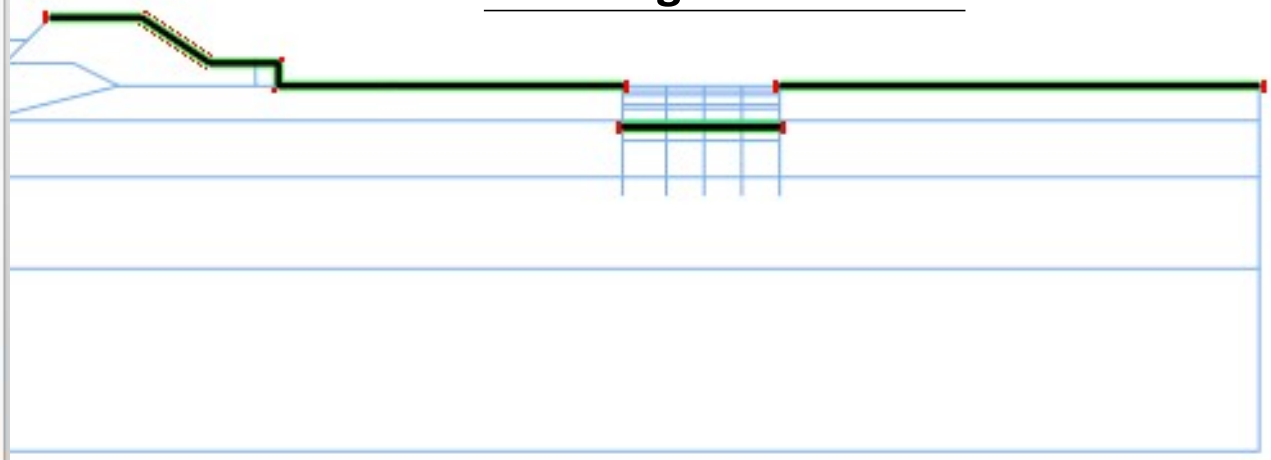


Excav Stage 3_Seepage Surface

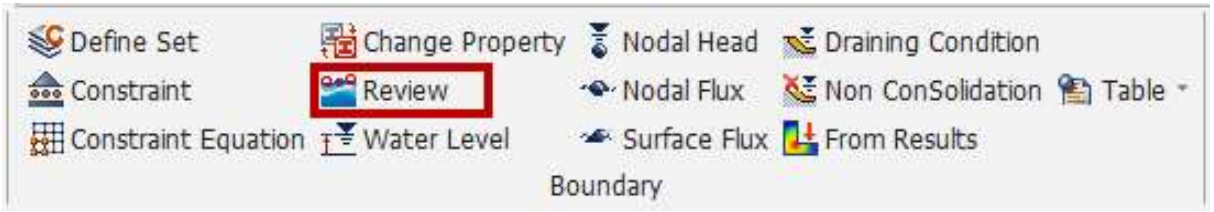


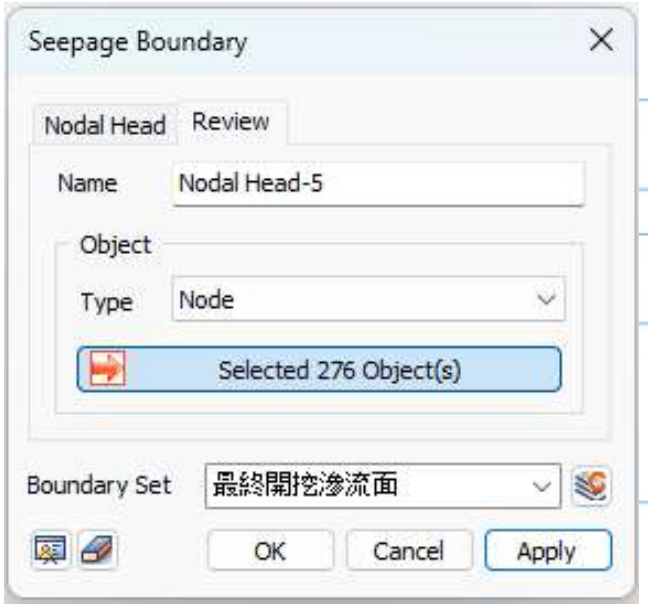


Selecting line features

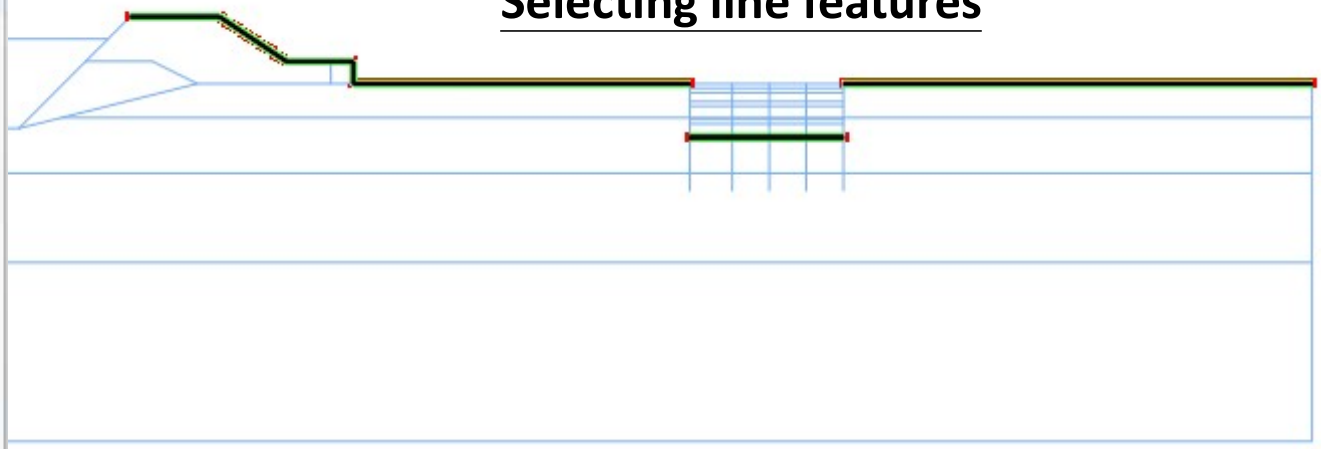


Excav Stage4_Seepage surface



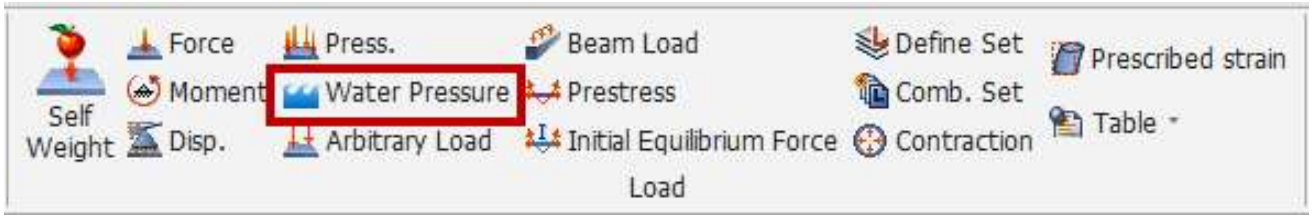


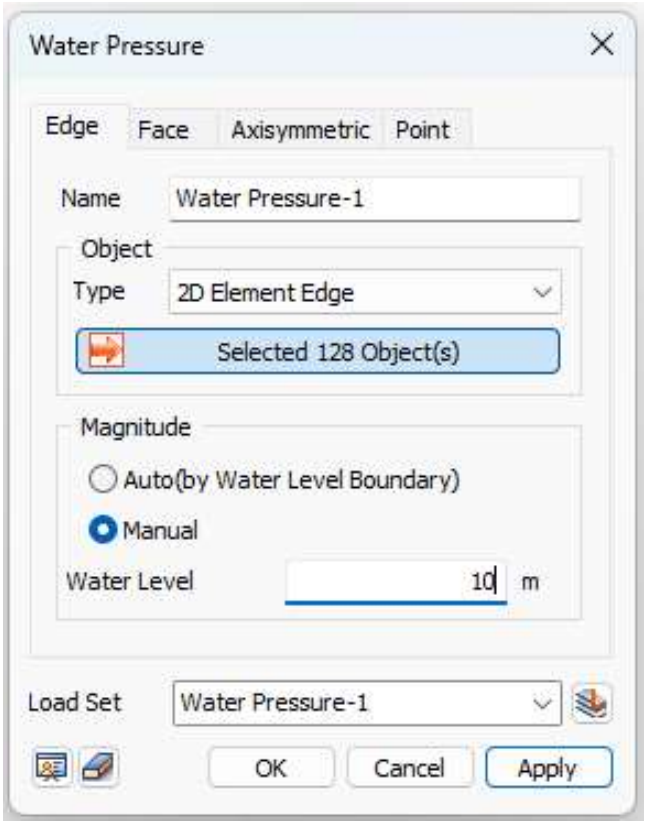
Selecting line features

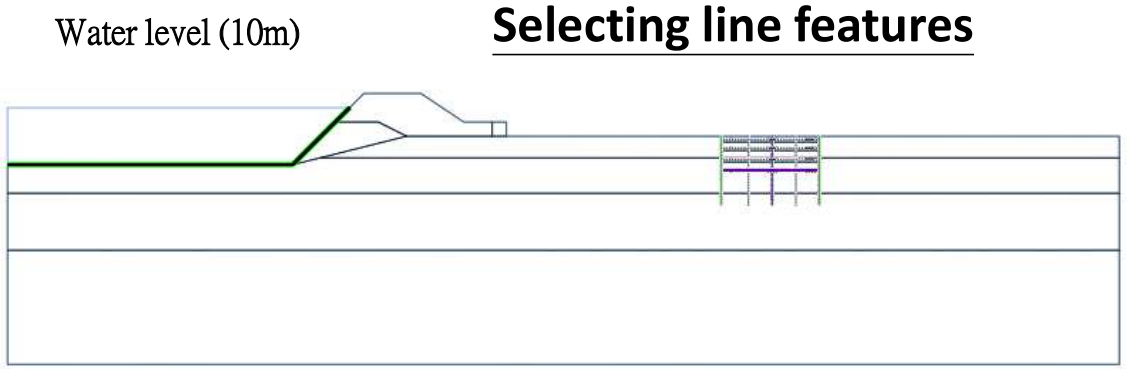


Water Pressure

(Pressure to represent for river reservoir pressure)







Selecting line features

Part5.Interface Elements

MIDAS Taiwan

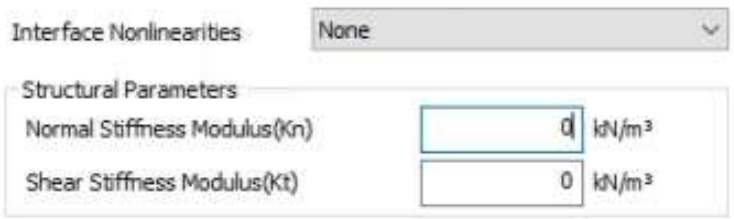
Interface Element-1

GTS NX Interface Element Wizard

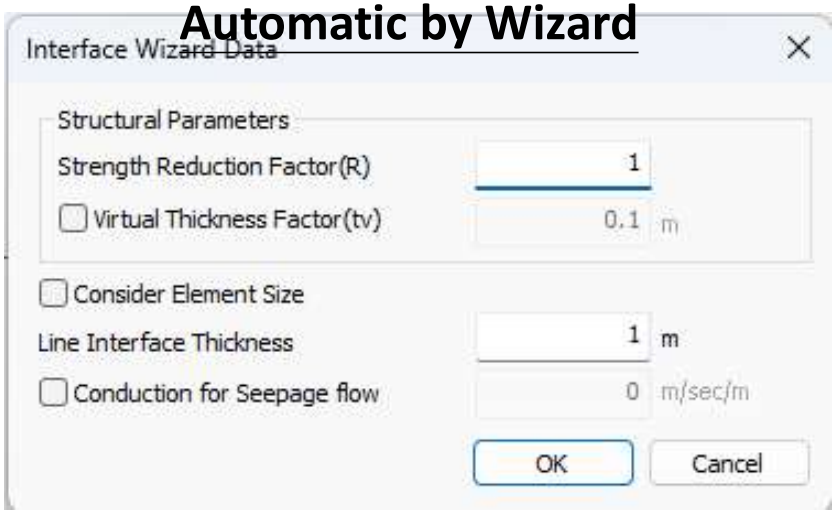
- Automatic calculation of normal stiffness (Kn) & tangential stiffness (Kt)

- **Virtual Thickness Factor (tv)**
  - Range from 0.01 ~ 0.1 ◦
  - Use smaller values for higher stiffness ◦
- **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

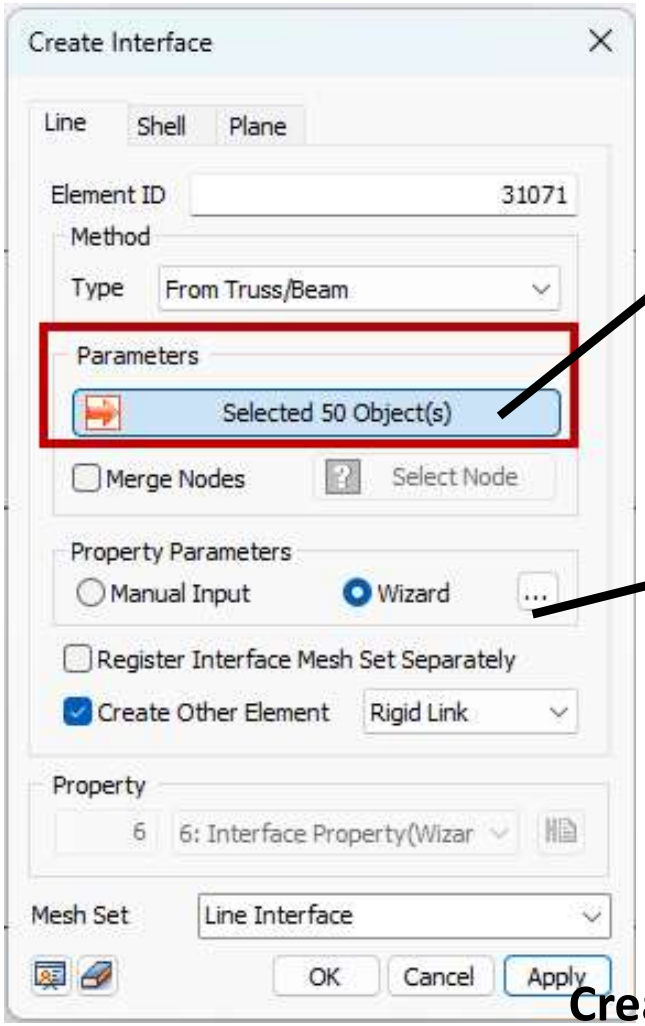
Manual definition

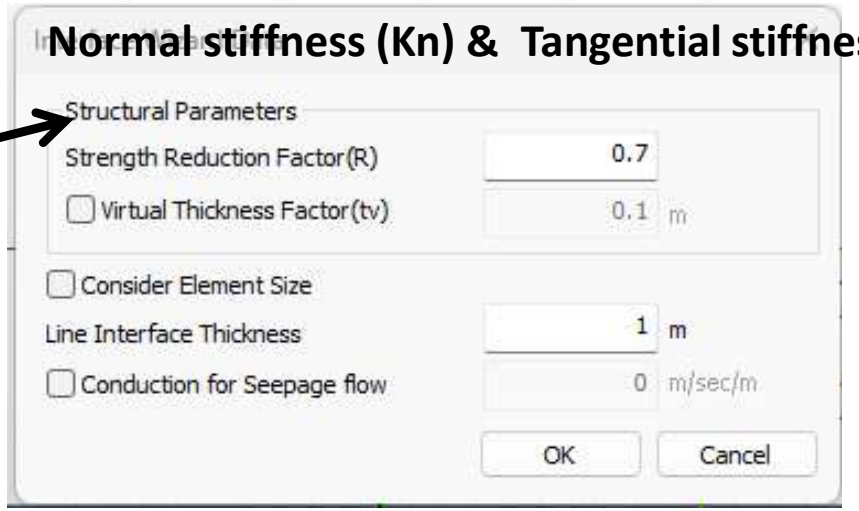


Automatic by Wizard



Interface Element-2

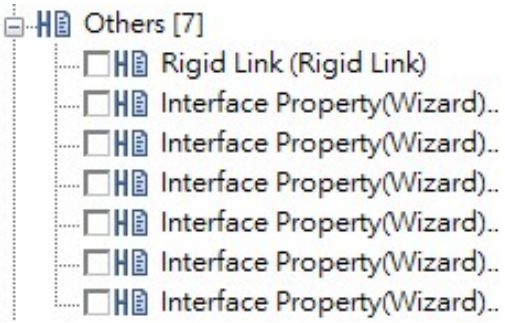




Creating Rigid link for soil and retaining wall before RW is constructed

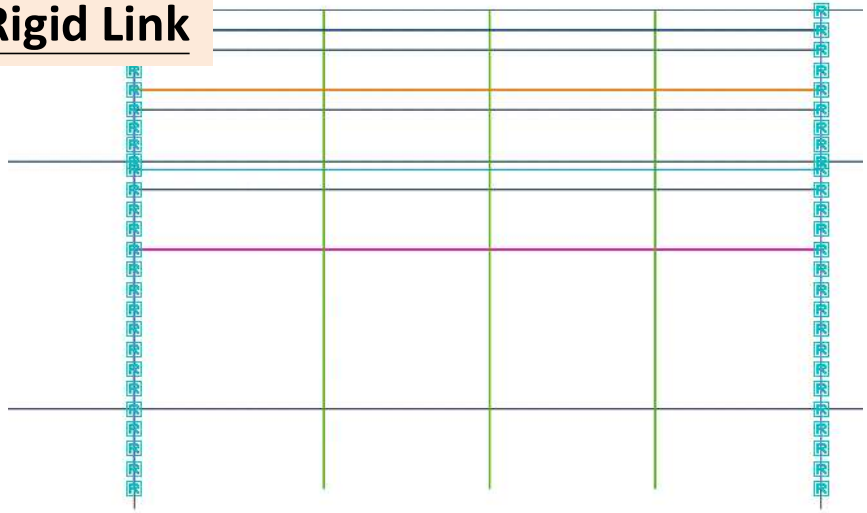
Interface Element-3

Normal stiffness (Kn) & Tangential stiffness (Kt)



Line Interface

Rigid Link



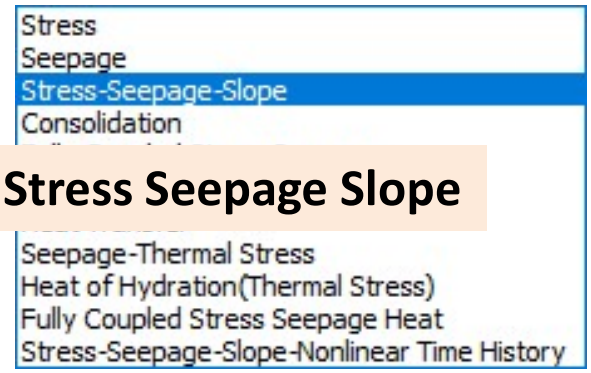
Part6.Construction Stage

MIDAS Taiwan

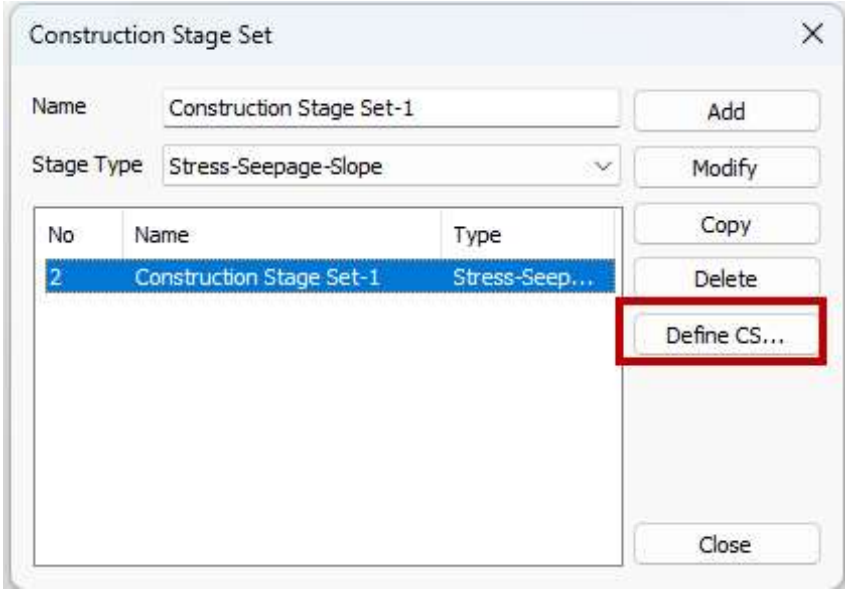
Construction Stage-1

(Selecting type of simulation)

GTS NX Type of simulation

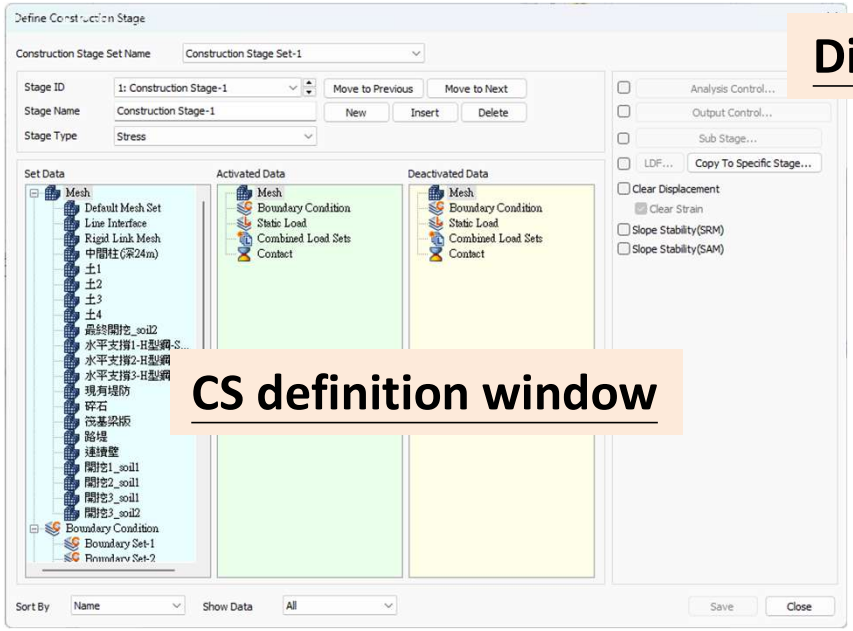


Stress Seepage Slope



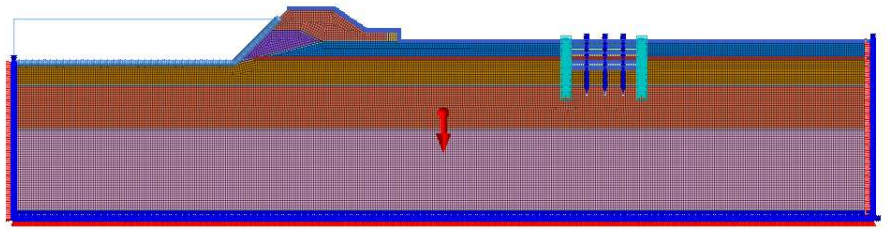
Step1.New

Step2.Define CS



CS definition window

Displaying all mesh sets/ BCs/ Geometry sets



Construction Stage-2

Stage0.Intial condition

Stage1.RW (24m) & center column

Stage2.Ex1_-2m

Stage3.Strut1_-1m

Stage4.Ex2_-5m

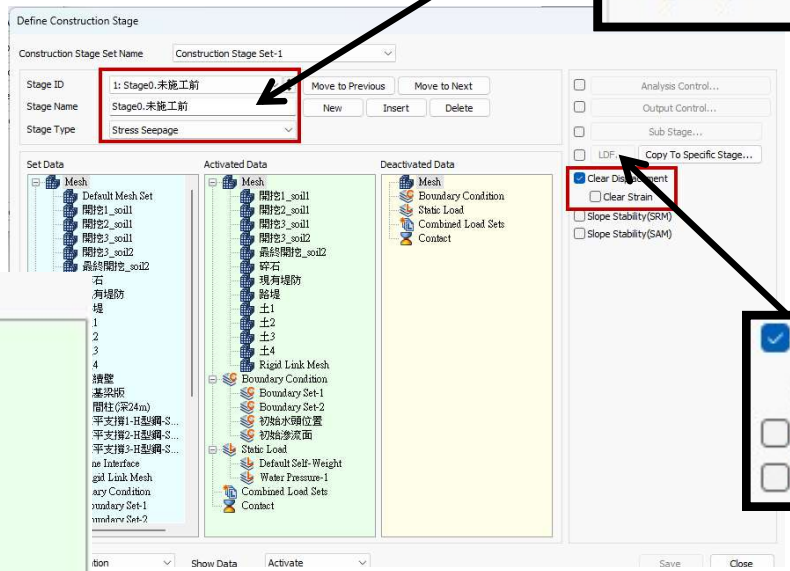
Stage5.Strut2_-4m

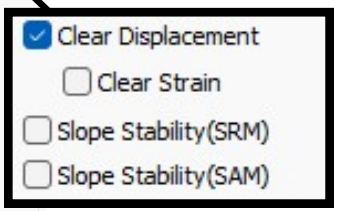
Stage6.Ex3_-9m

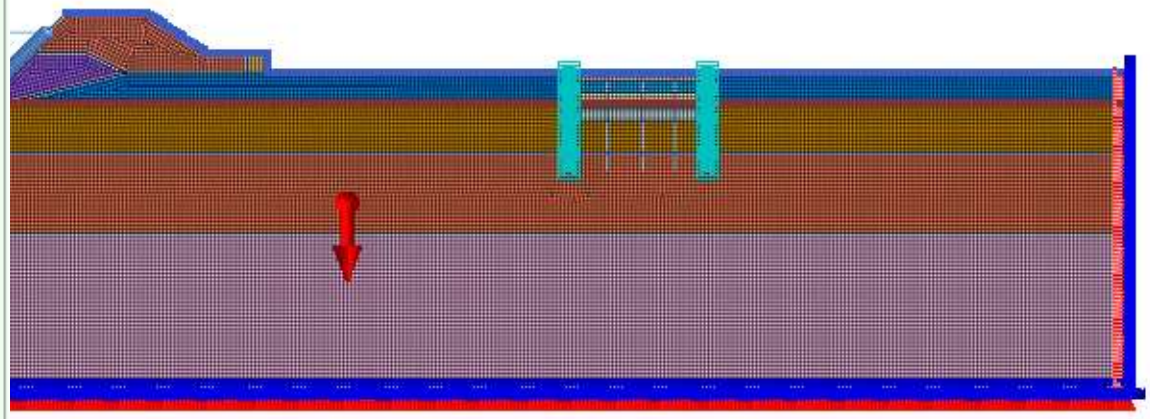
Stage7.Strut3_-8m

Stage8.Ex4_-12m

Stage9.Raft foundation (t= 1m)







Construction Stage-3

Stage0.Intial condition

Stage1.RW (24m) & center column

Stage2.Ex1_-2m

Stage3.Strut1_-1m

Stage4.Ex2_-5m

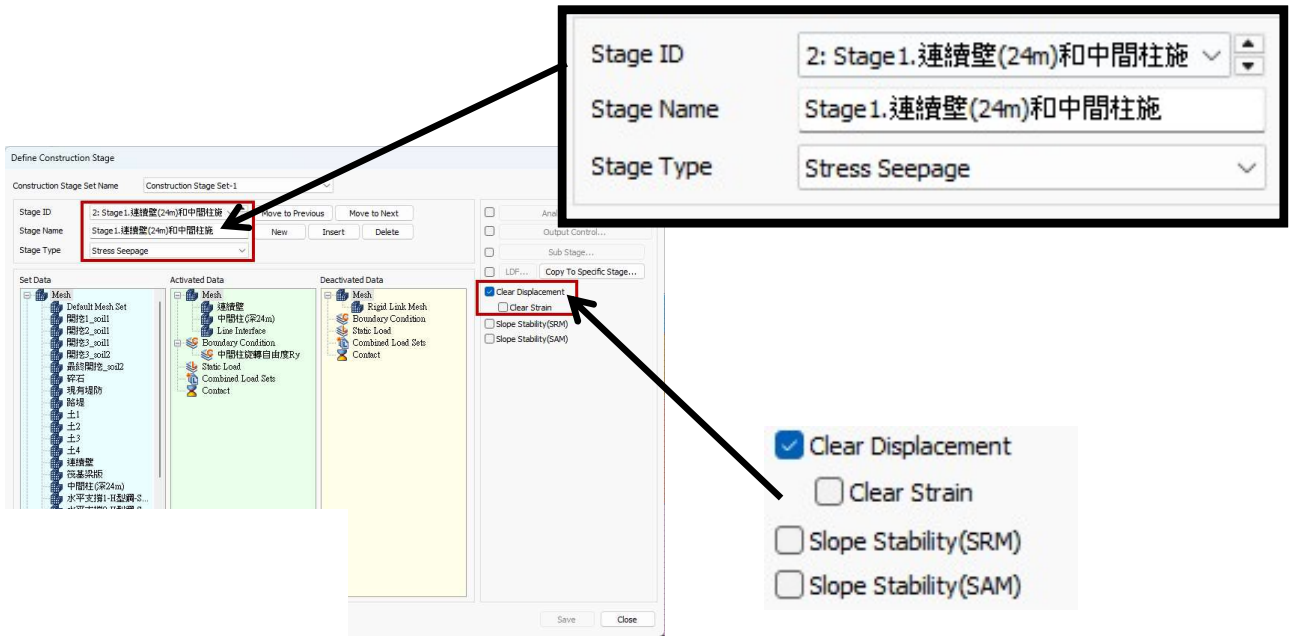
Stage5.Strut2_-4m

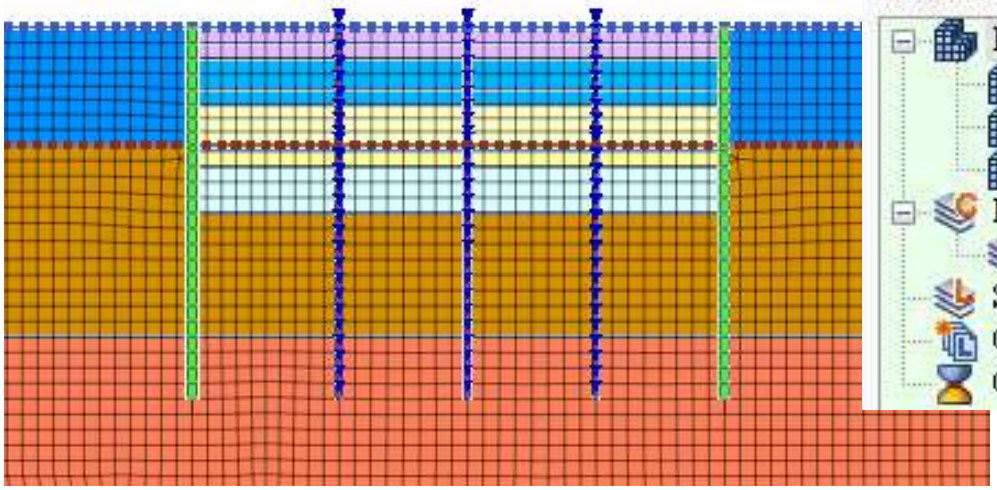
Stage6.Ex3_-9m

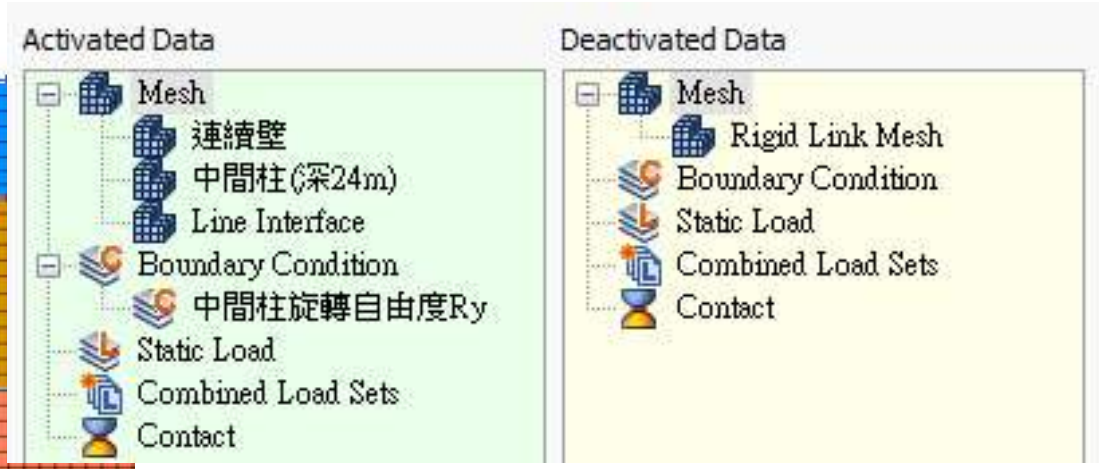
Stage7.Strut3_-8m

Stage8.Ex4_-12m

Stage9.Raft foundation (t= 1m)

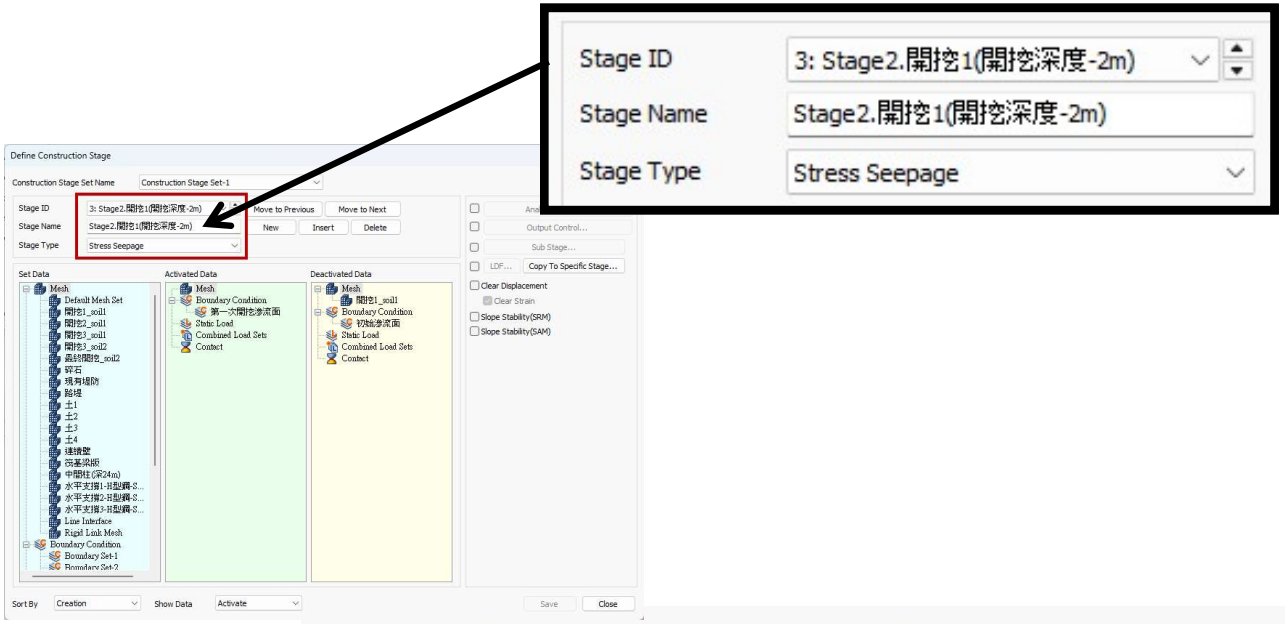


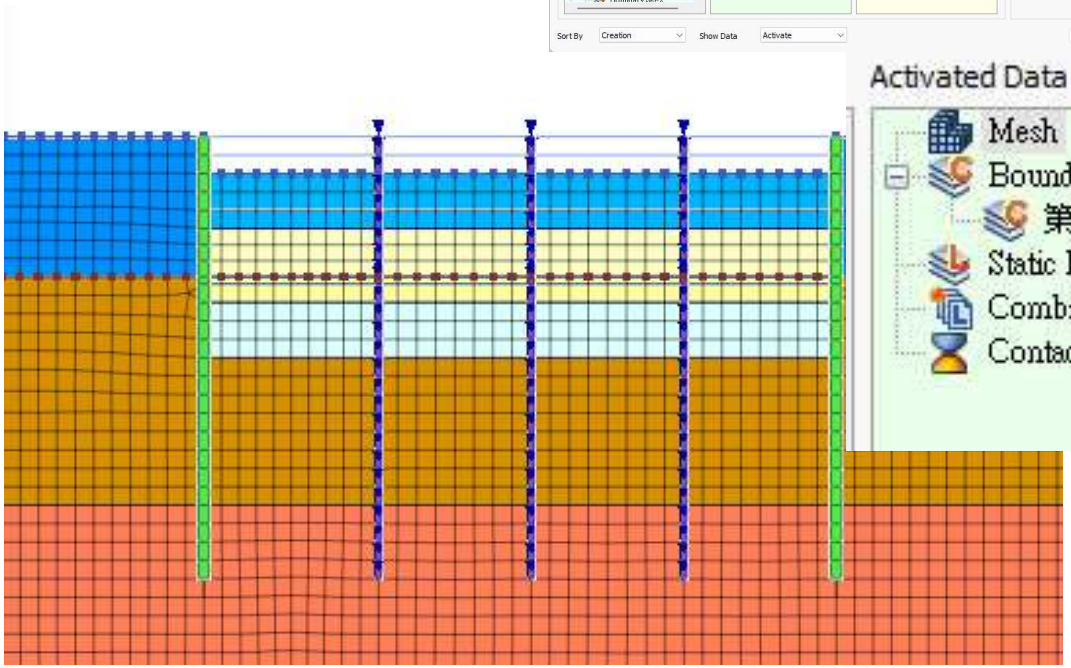


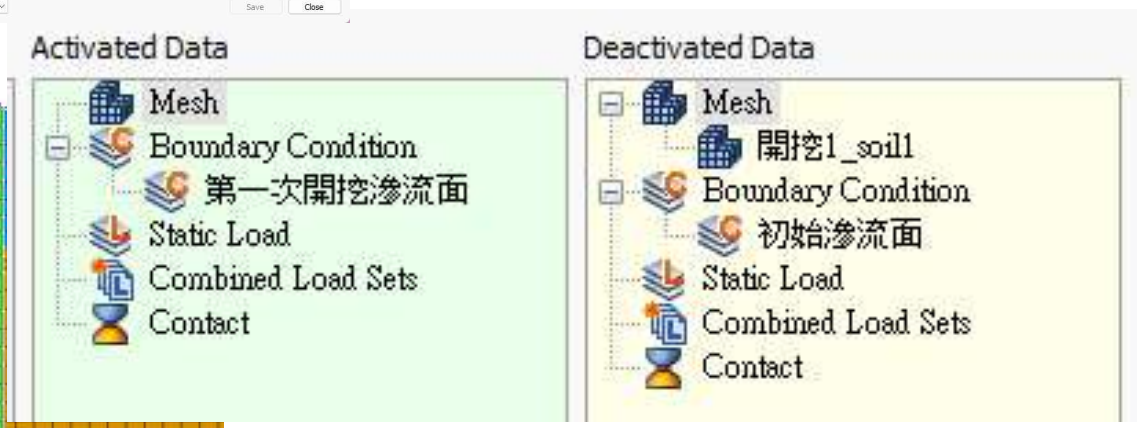


Construction Stage-4

Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

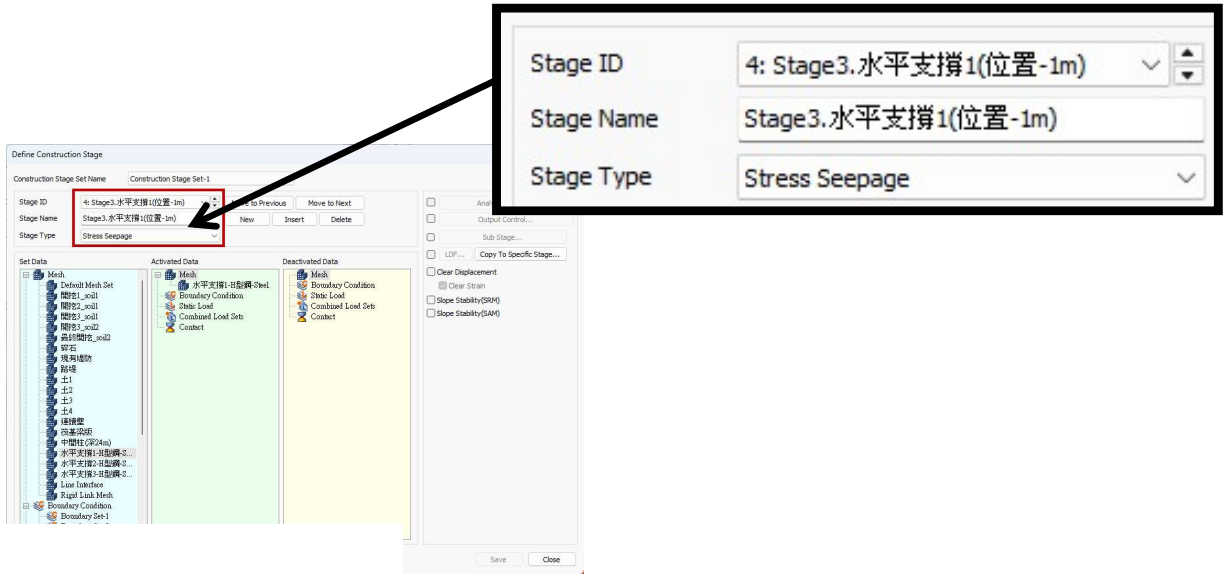


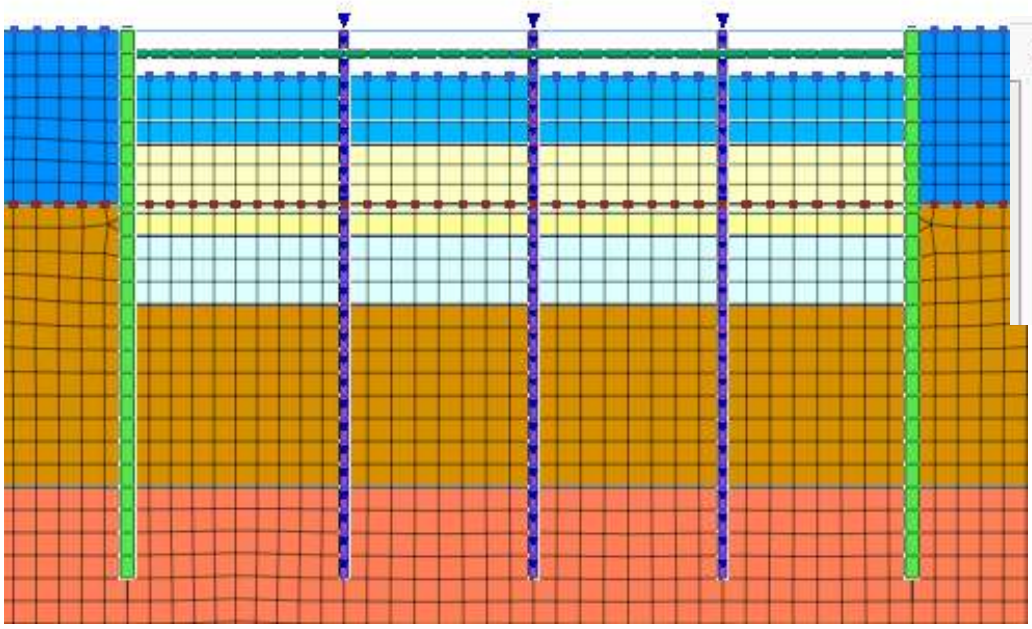




Construction Stage-5

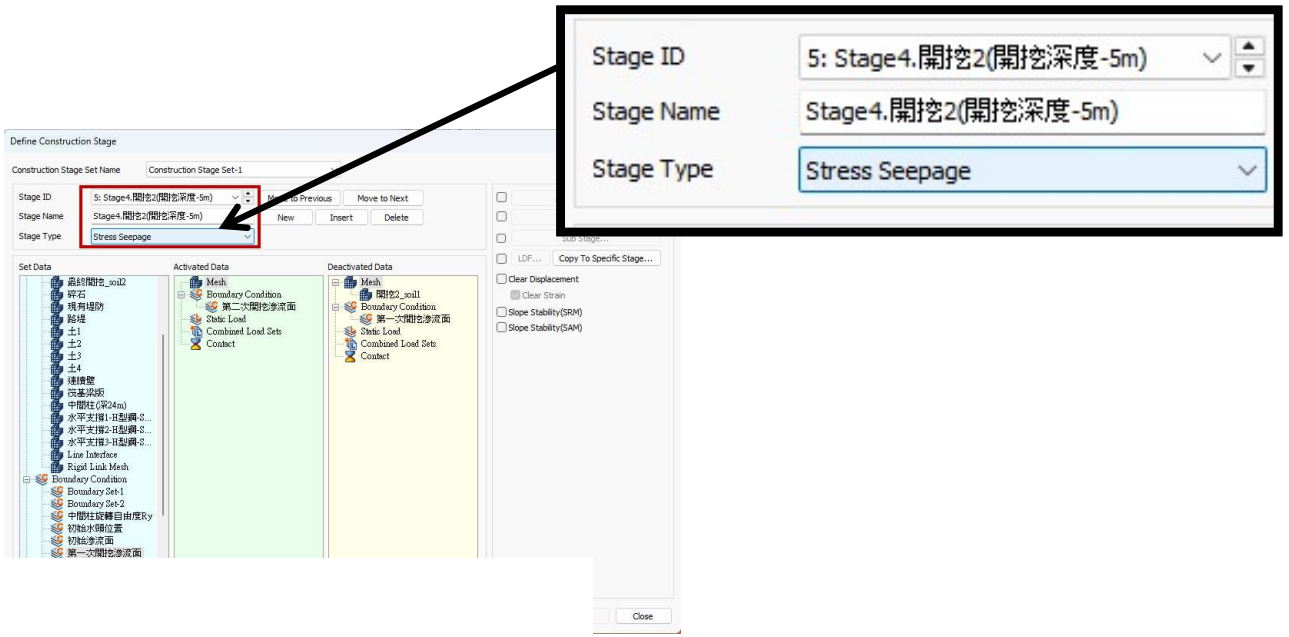
Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

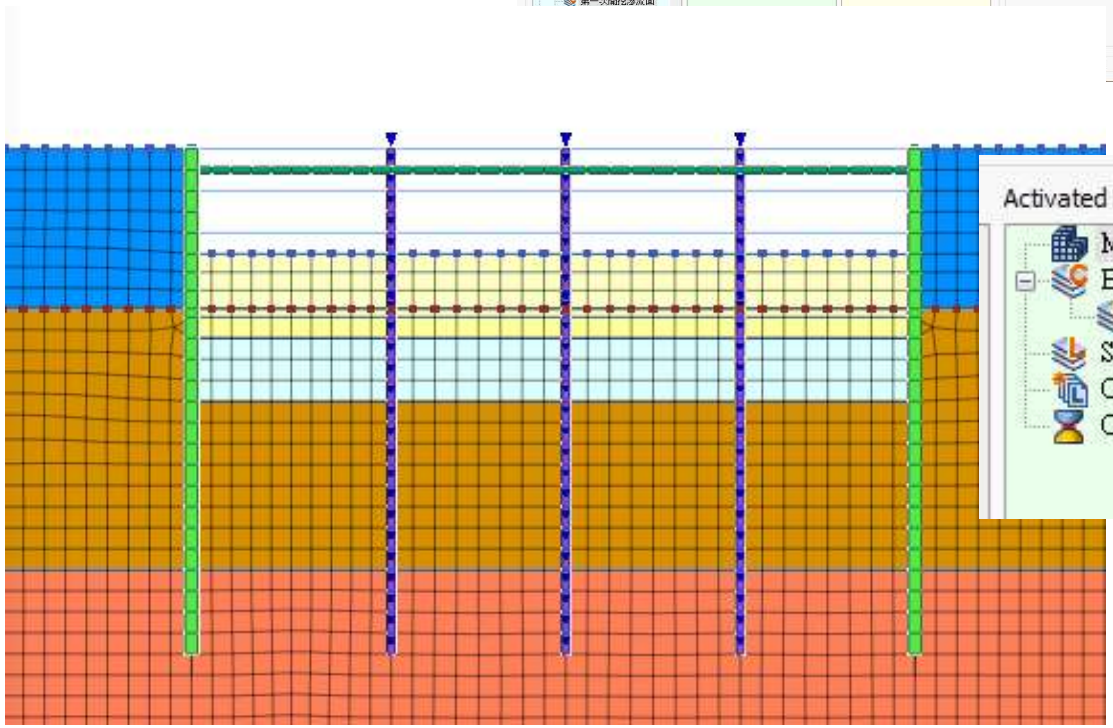


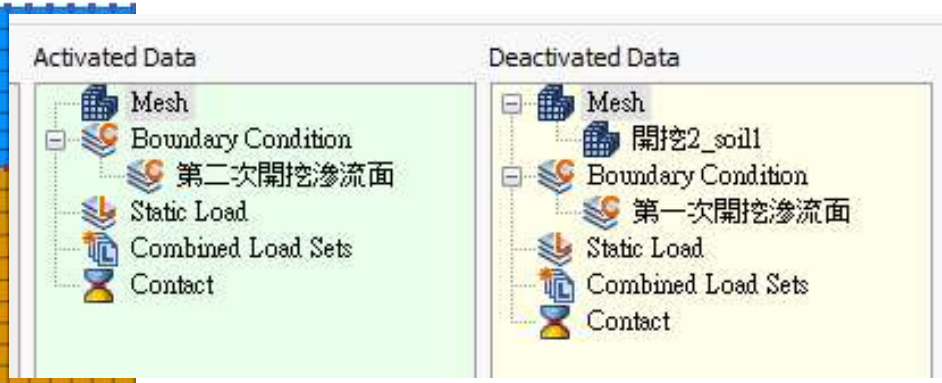


Construction Stage-6

Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

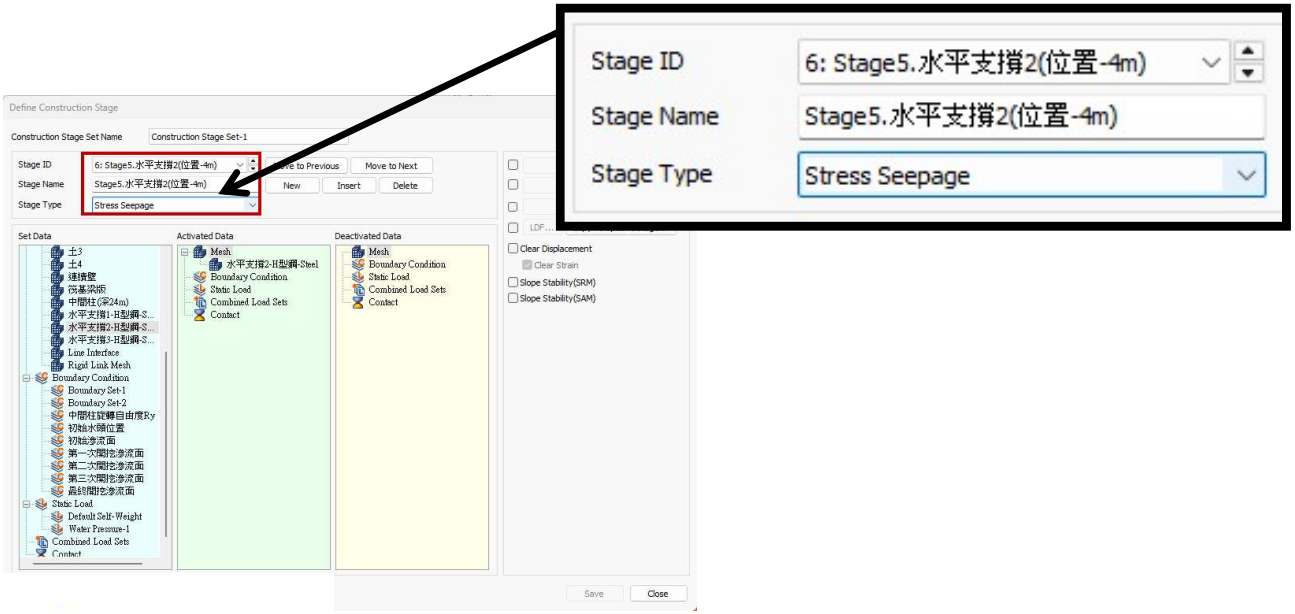


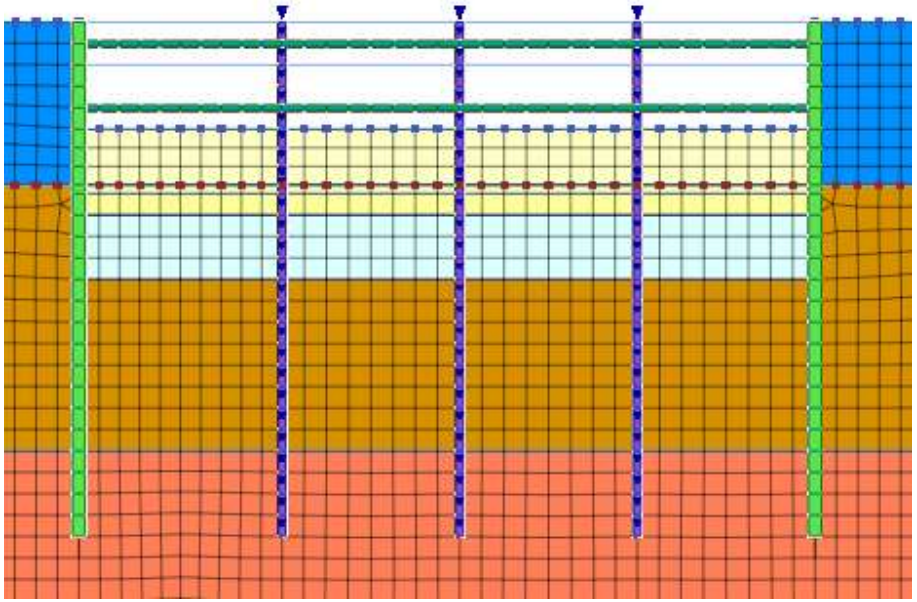




Construction Stage-7

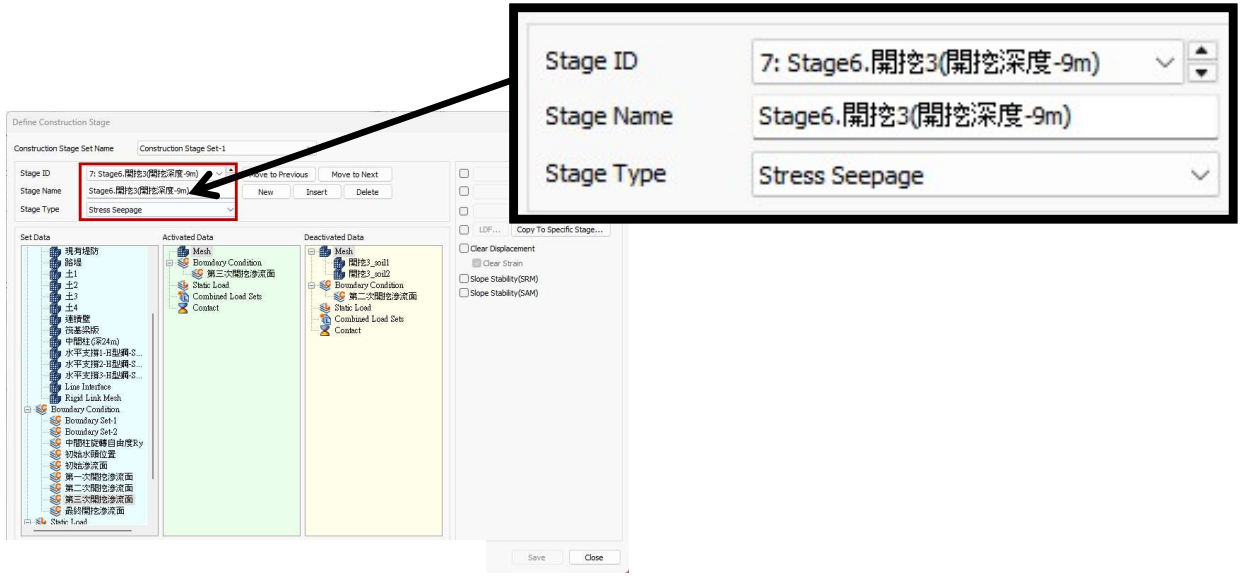
Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

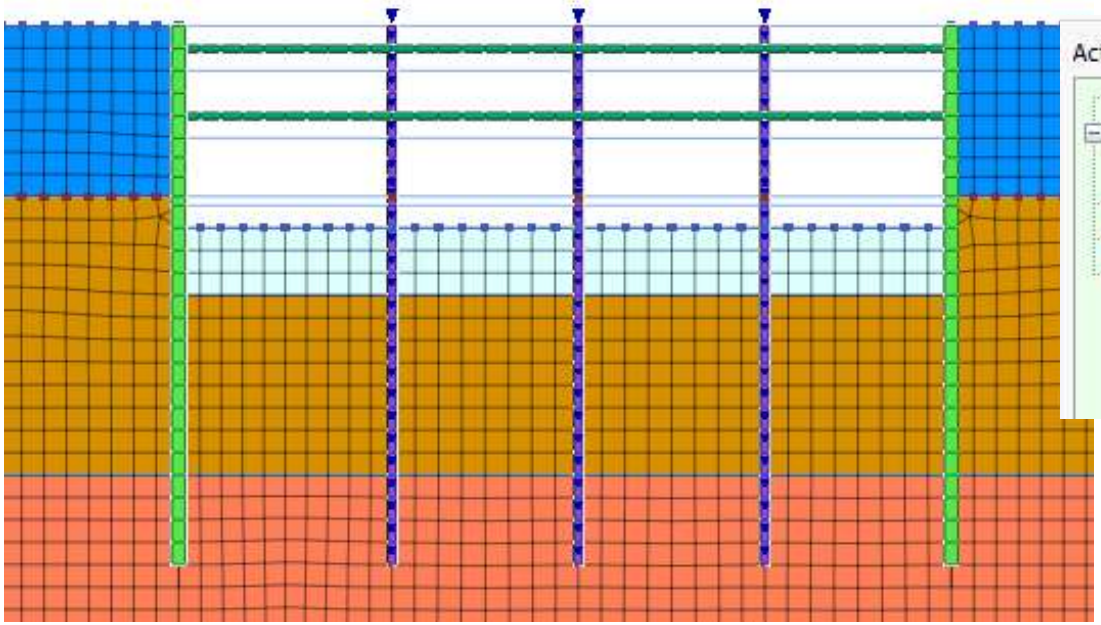


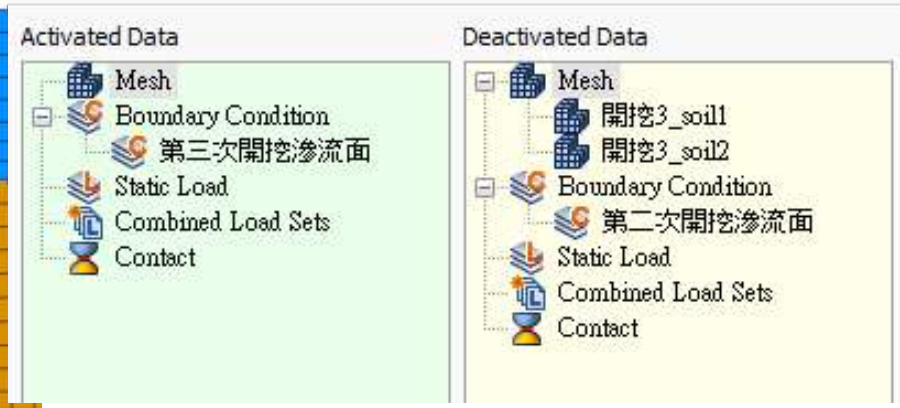


Construction Stage-8

Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

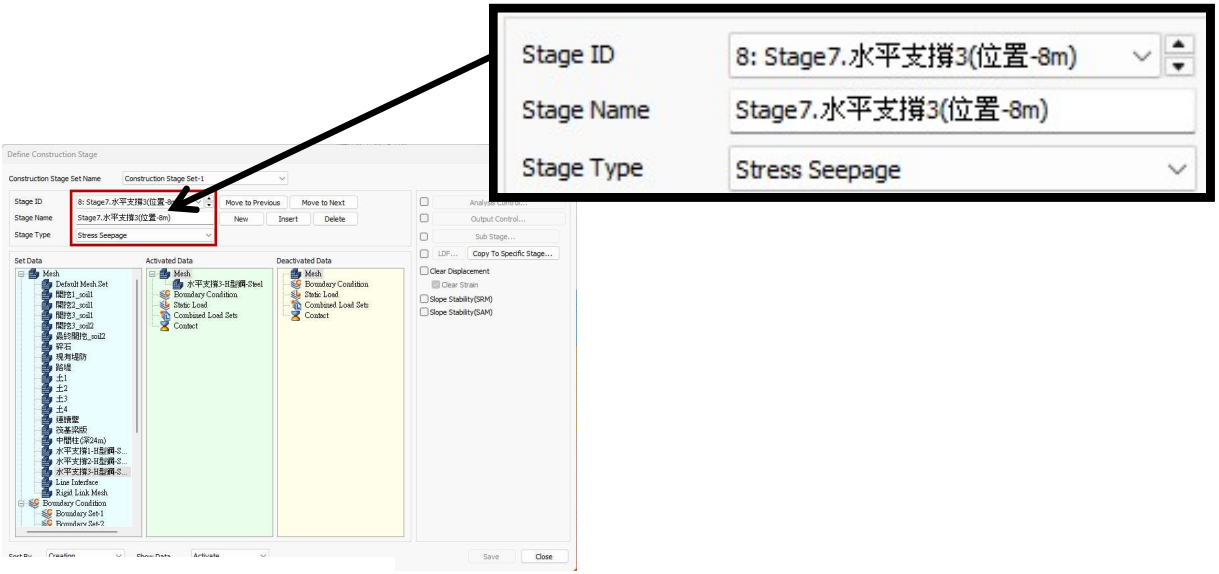


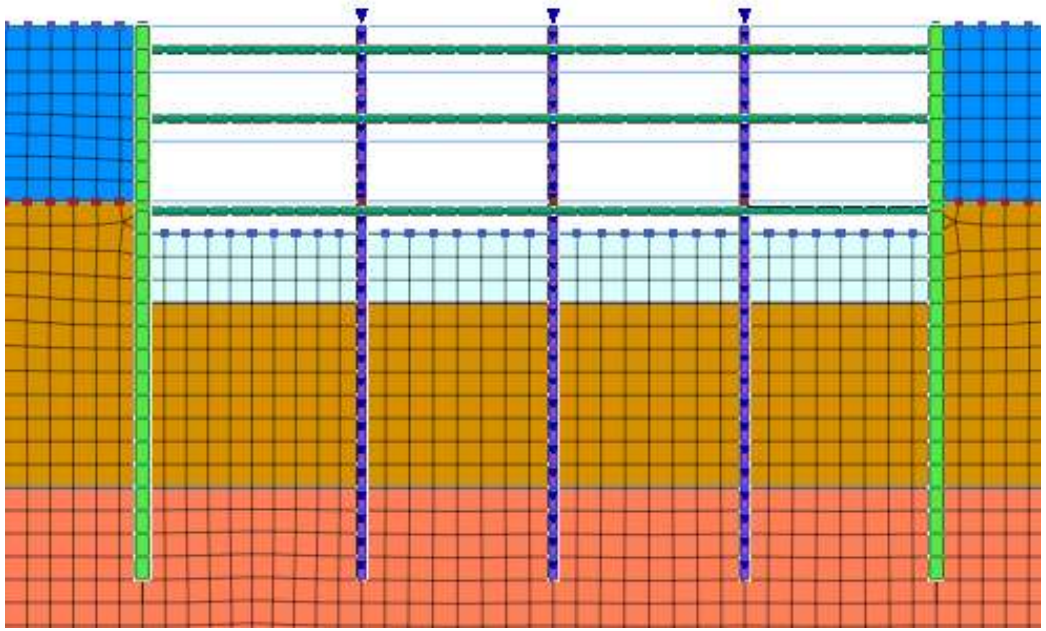




Construction Stage-9

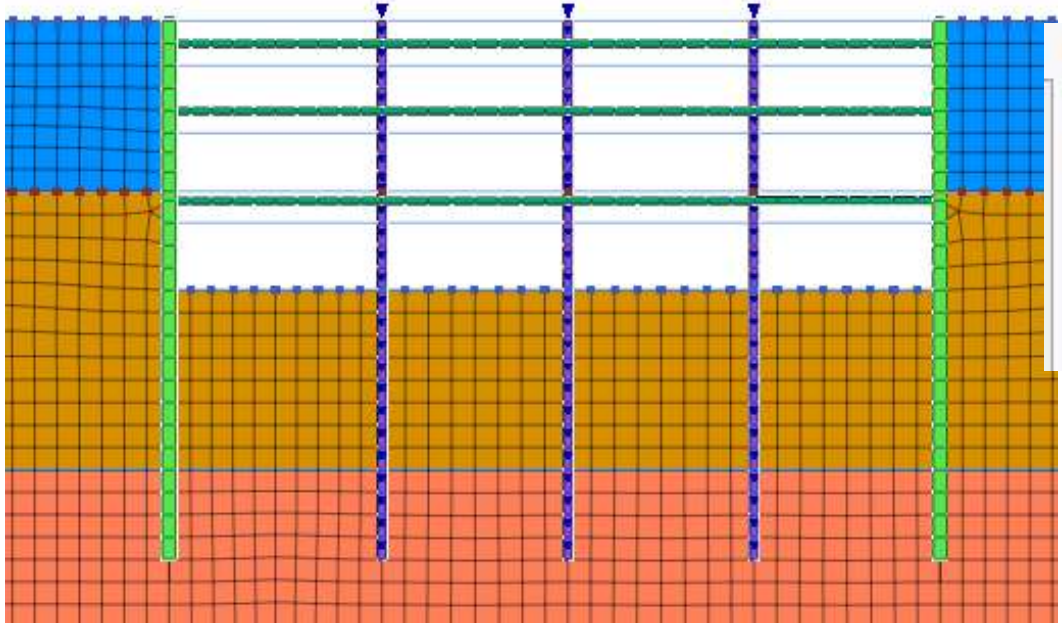
Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

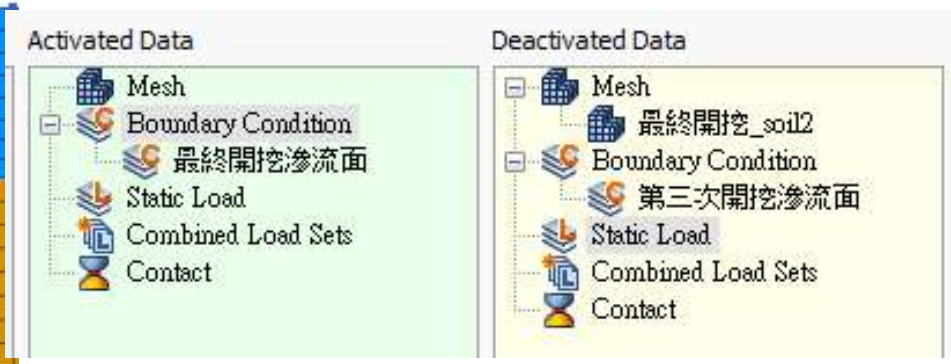




Construction Stage-10

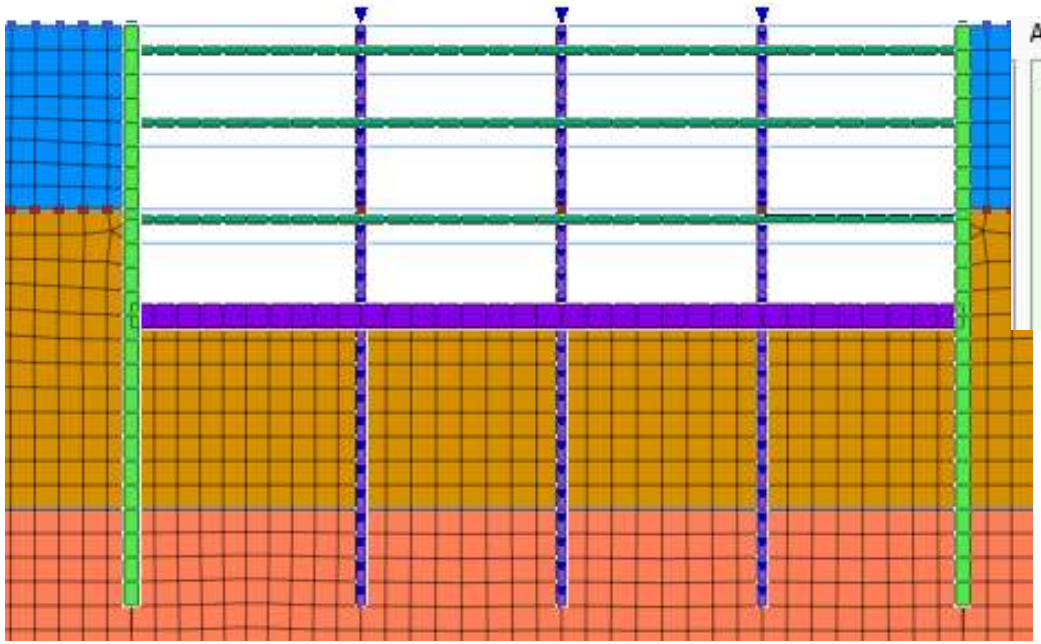
Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

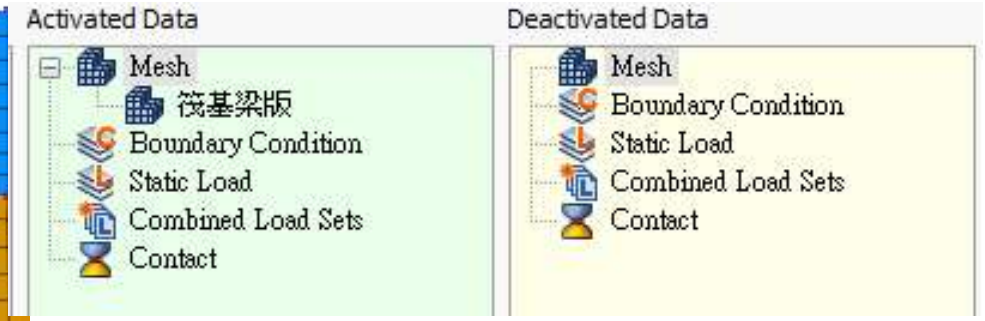




Construction Stage-11

Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)





Part7.Analysis & Calculation

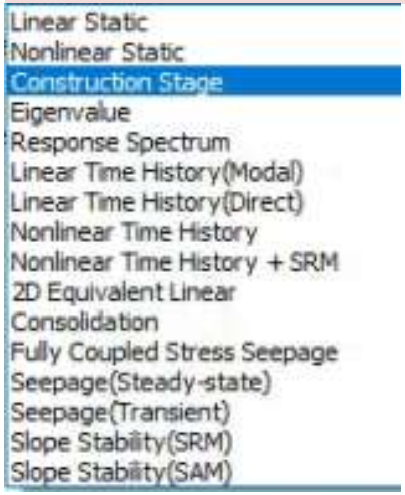
MIDAS Taiwan

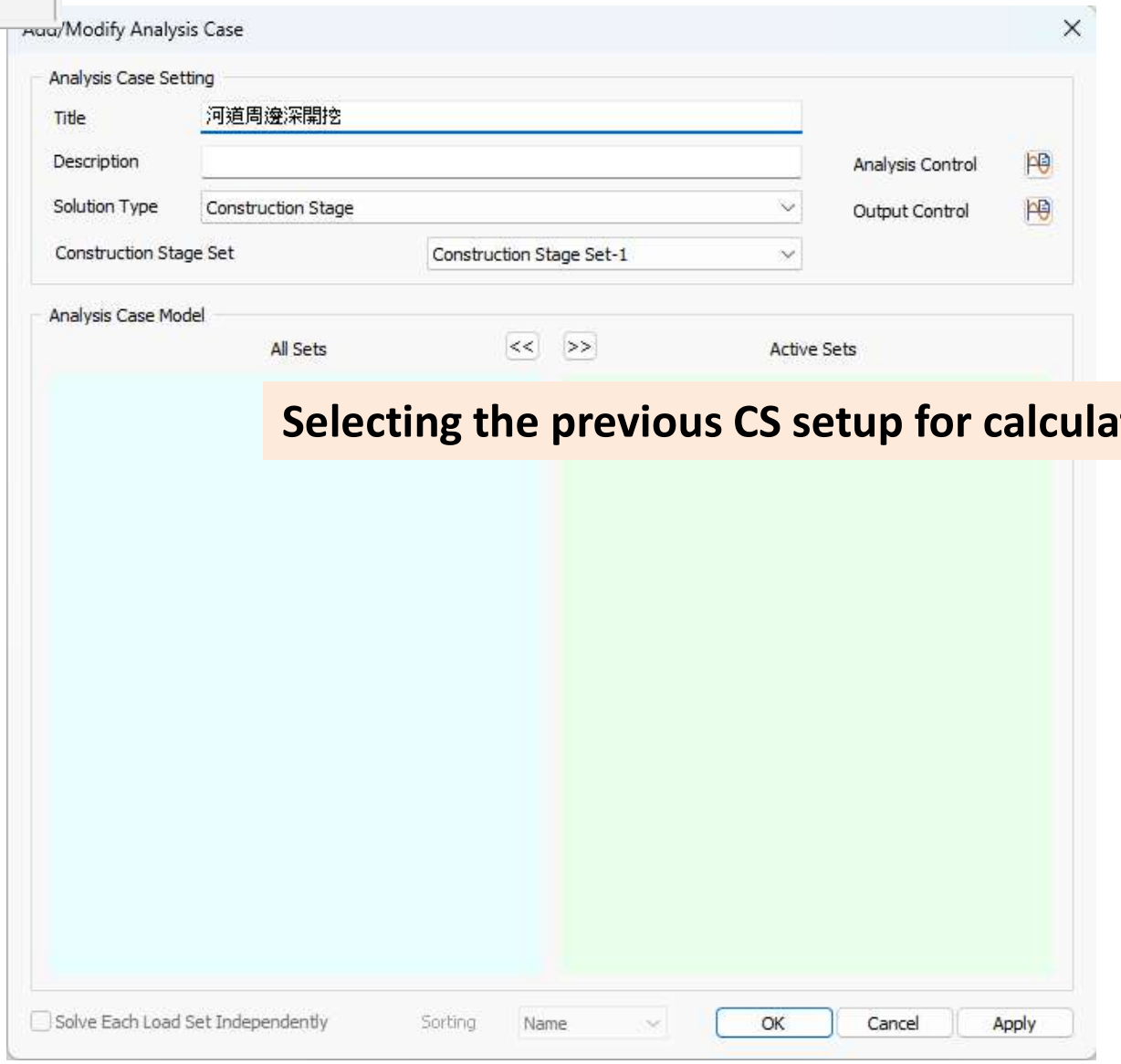
Analysis

(Deep excavation nearby river channel)

Analysis type: Construction Stage

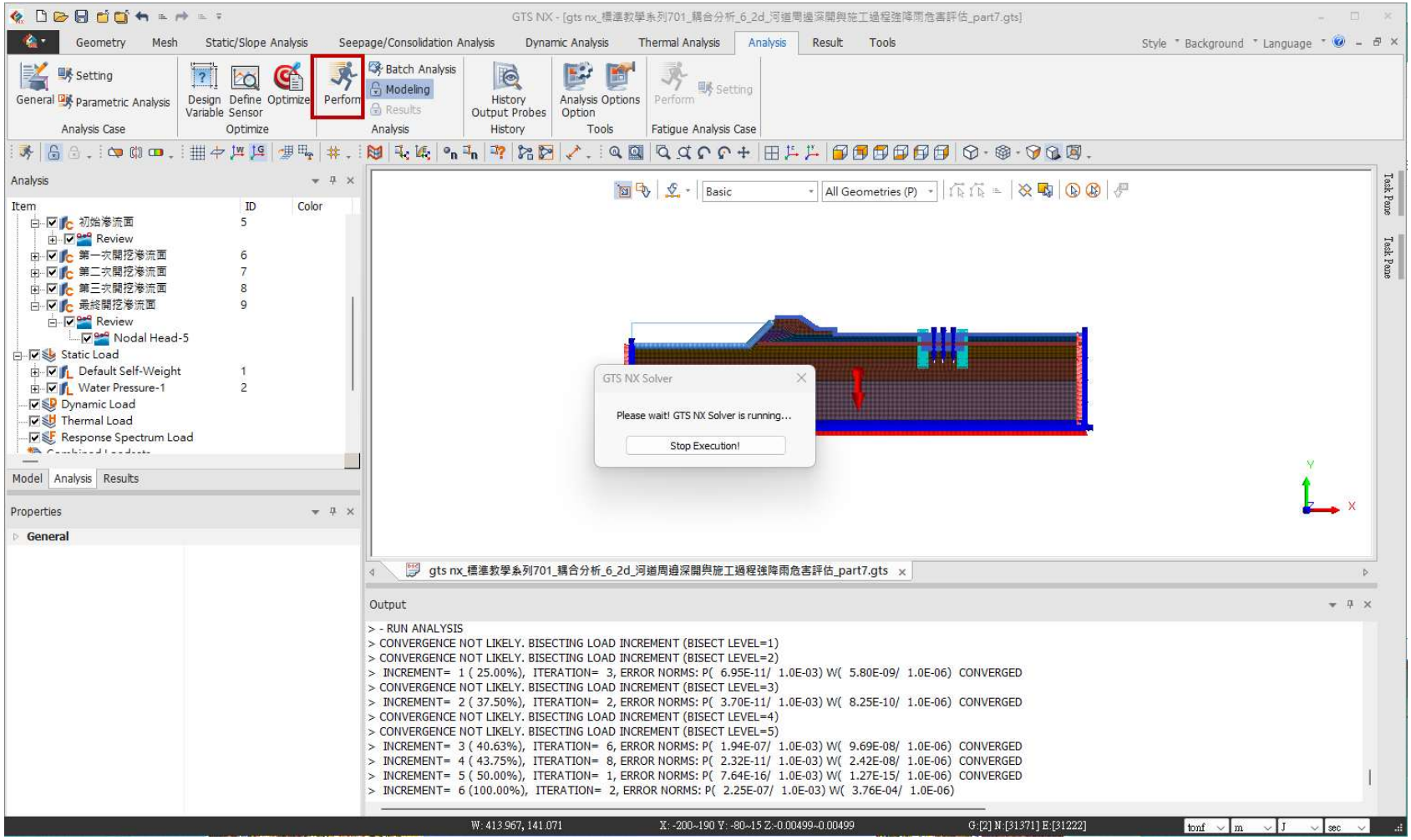
Construction Stage





Selecting the previous CS setup for calculation

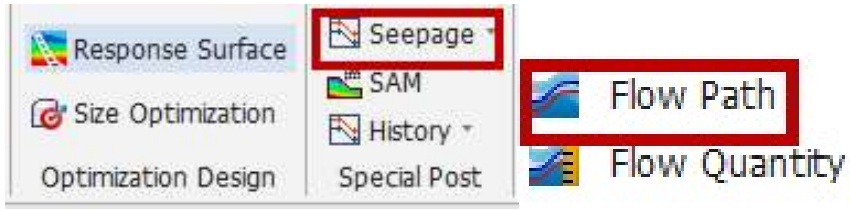
Calculation



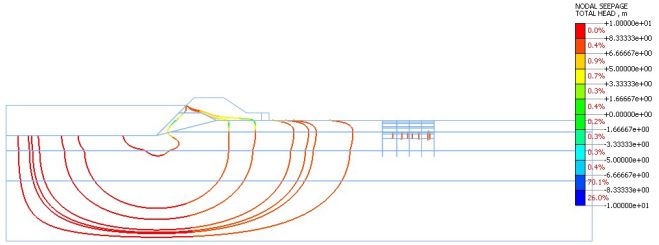
Results-1

Sequence of analysis in CS

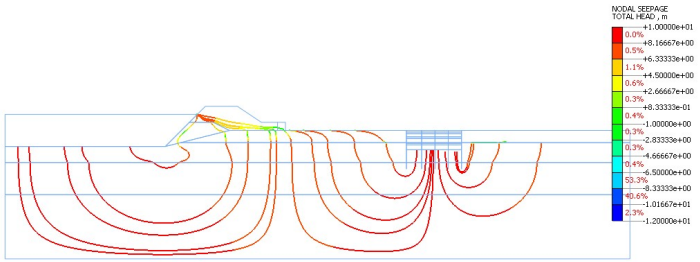
- 河道周邊深開挖
  - Stage0.未施工前-Seepage
  - Stage0.未施工前-Stress
  - Stage1.連續壁(24m)和中間柱施-Seepage
  - Stage1.連續壁(24m)和中間柱施-Stress
  - Stage2.開挖1(開挖深度-2m)-Seepage
  - Stage2.開挖1(開挖深度-2m)-Stress
  - Stage3.水平支撐1(位置-1m)-Seepage
  - Stage3.水平支撐1(位置-1m)-Stress
  - Stage4.開挖2(開挖深度-5m)-Seepage
  - Stage4.開挖2(開挖深度-5m)-Stress
  - Stage5.水平支撐2(位置-4m)-Seepage
  - Stage5.水平支撐2(位置-4m)-Stress
  - Stage6.開挖3(開挖深度-9m)-Seepage
  - Stage6.開挖3(開挖深度-9m)-Stress
  - Stage7.水平支撐3(位置-8m)-Seepage
  - Stage7.水平支撐3(位置-8m)-Stress
  - Stage8.最終開挖 (-12m)-Seepage
  - Stage8.最終開挖 (-12m)-Stress
  - Stage9.筏基梁版(t=1m)-Seepage
  - Stage9.筏基梁版(t=1m)-Stress



施工階段0_Flow Path



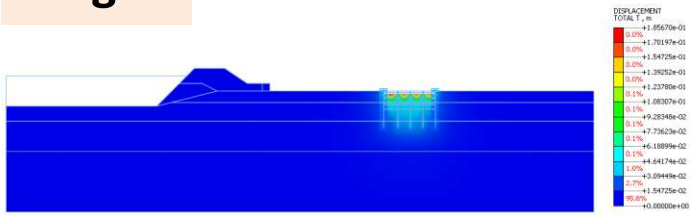
施工階段9_Flow Path



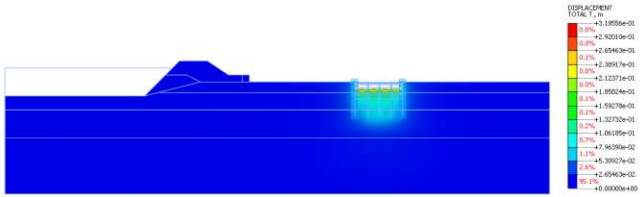
Results-2
(Total Translation(m))

Stage0.Intial condition
Stage1.RW (24m) & center column
Stage2.Ex1_-2m
Stage3.Strut1_-1m
Stage4.Ex2_-5m
Stage5.Strut2_-4m
Stage6.Ex3_-9m
Stage7.Strut3_-8m
Stage8.Ex4_-12m
Stage9.Raft foundation (t= 1m)

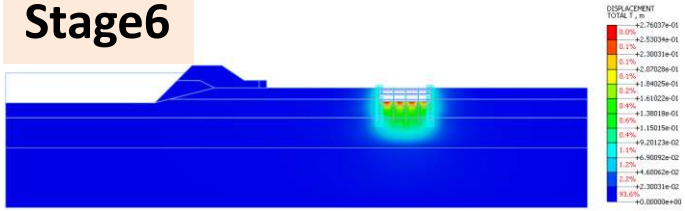
Stage2



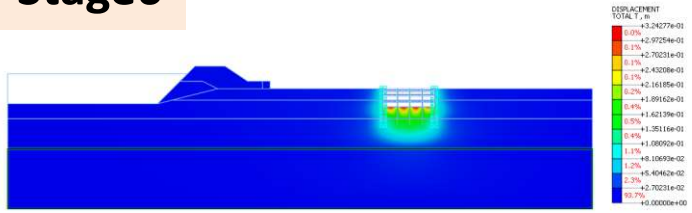
Stage4



Stage6



Stage6



Part8. Heavy rainfall assessment

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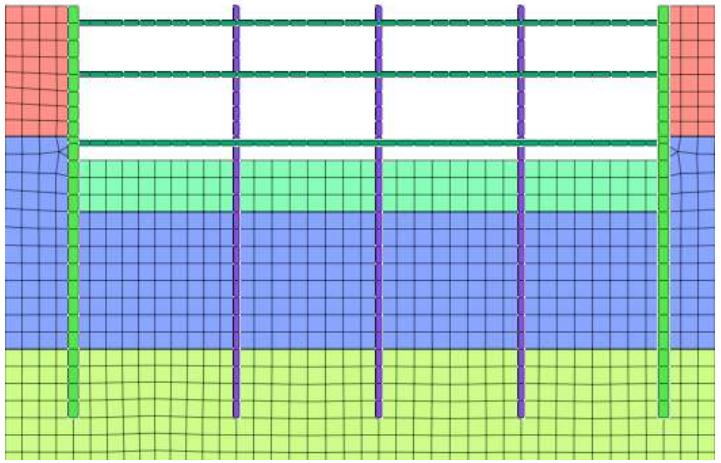
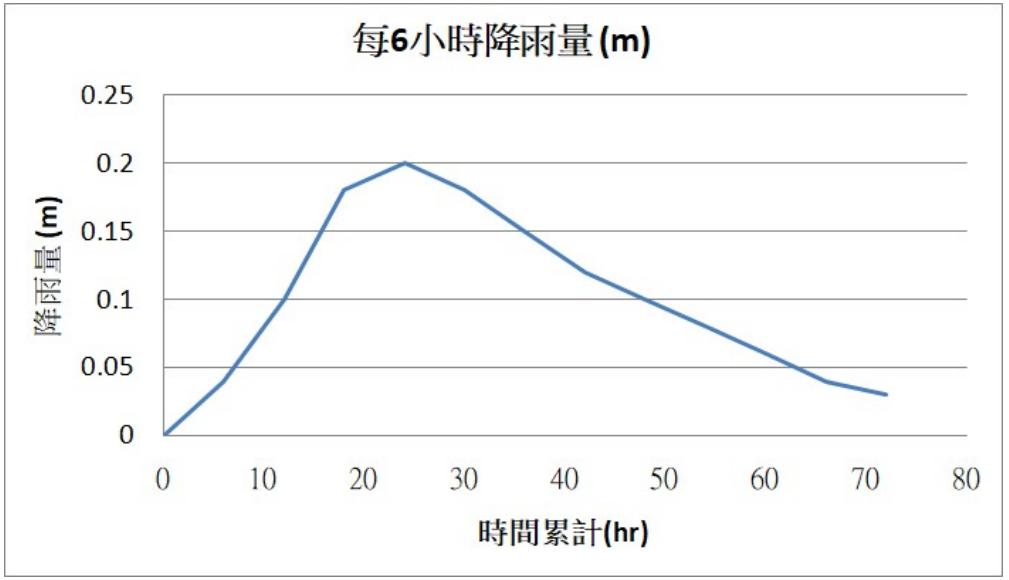
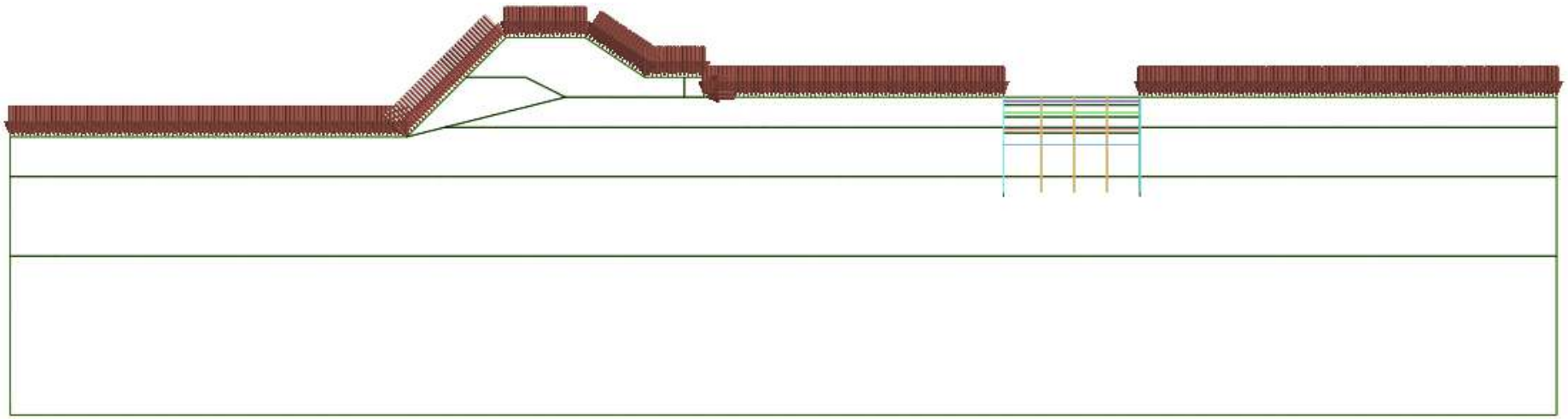
Bofore Excav Stage 3

Heavy rainfall struck 72 hours continuously



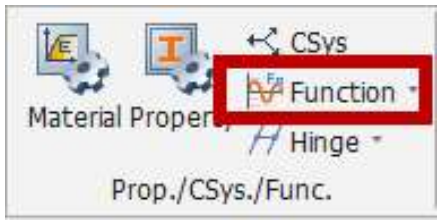




Rainfall Recording

(Hours)

Unit (kn/m/J/hr)



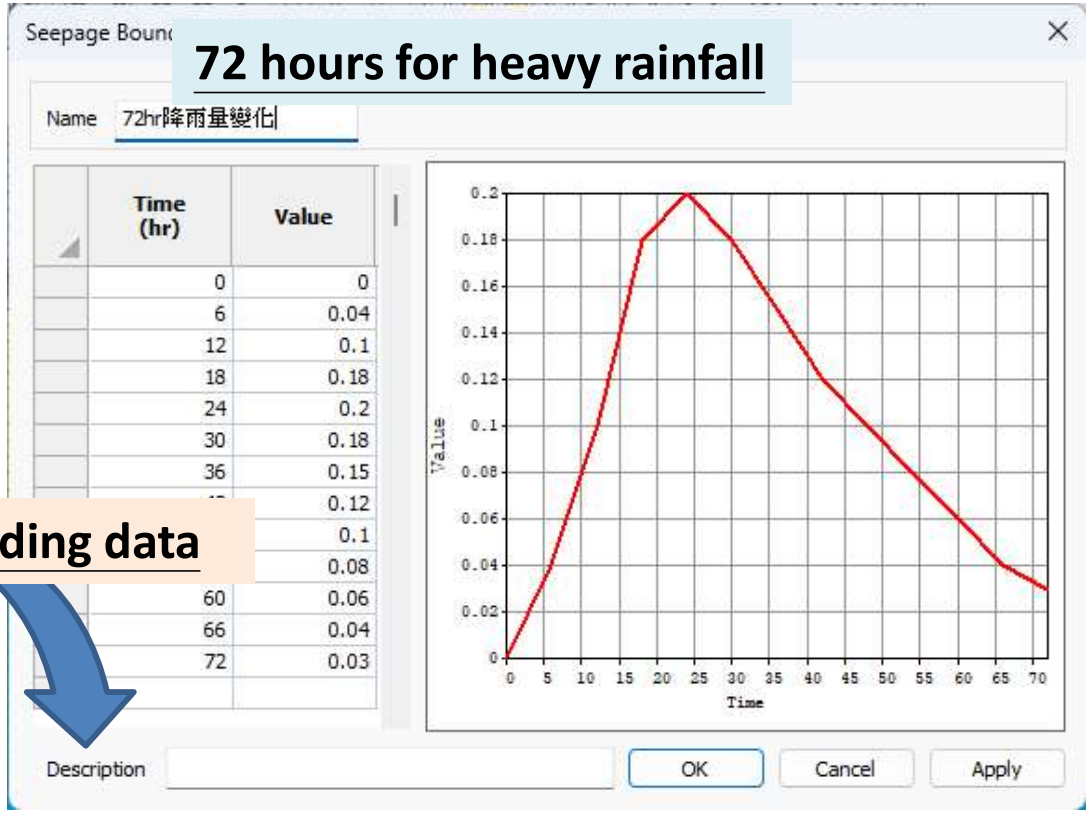
Seepage Boundary

開啓Excel

時間累計(hr)	每6小時降雨量 (m)
0	
6	
12	0.1
18	0.18
24	0.2
30	0.18
36	0.15
42	0.12
48	0.1
54	0.08
60	0.06
66	0.04
72	0.03

Copy & paste recording data

72 hours for heavy rainfall



註:GTS NX不支援Y軸單位切換。

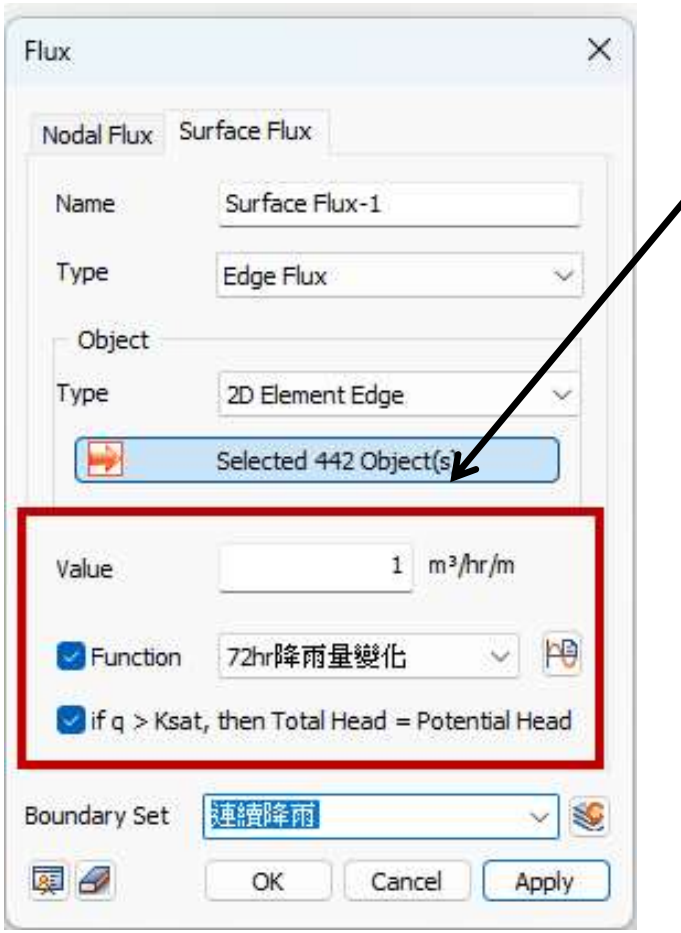
Surface Flux

Unit (KN/m/J/hr)

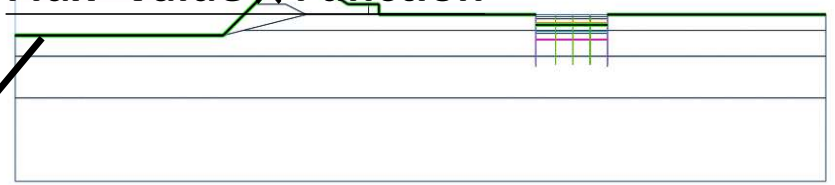
kN | m | J | hr

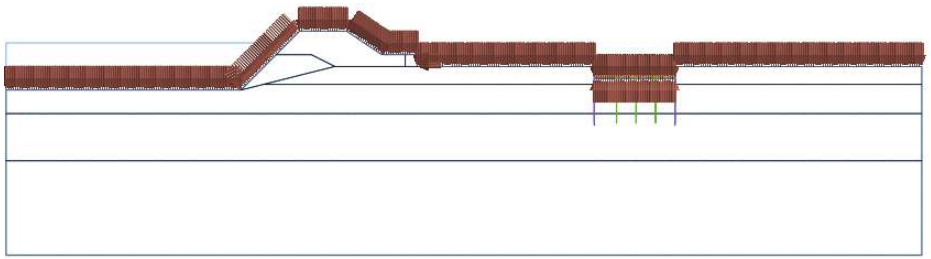
Seepage/Consolidation Analysis

Selecting line features



Flux=Value × Function



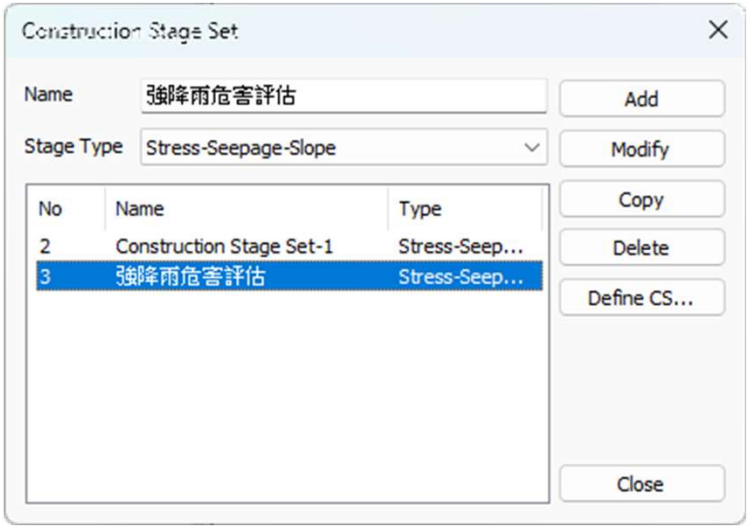


Note:
if surface flux > coefficient of permeability
total head = potential head

Continuous rainfall curve

Heavy Rainfall Assessment-1

New CS type: Stress-Seepage-slope

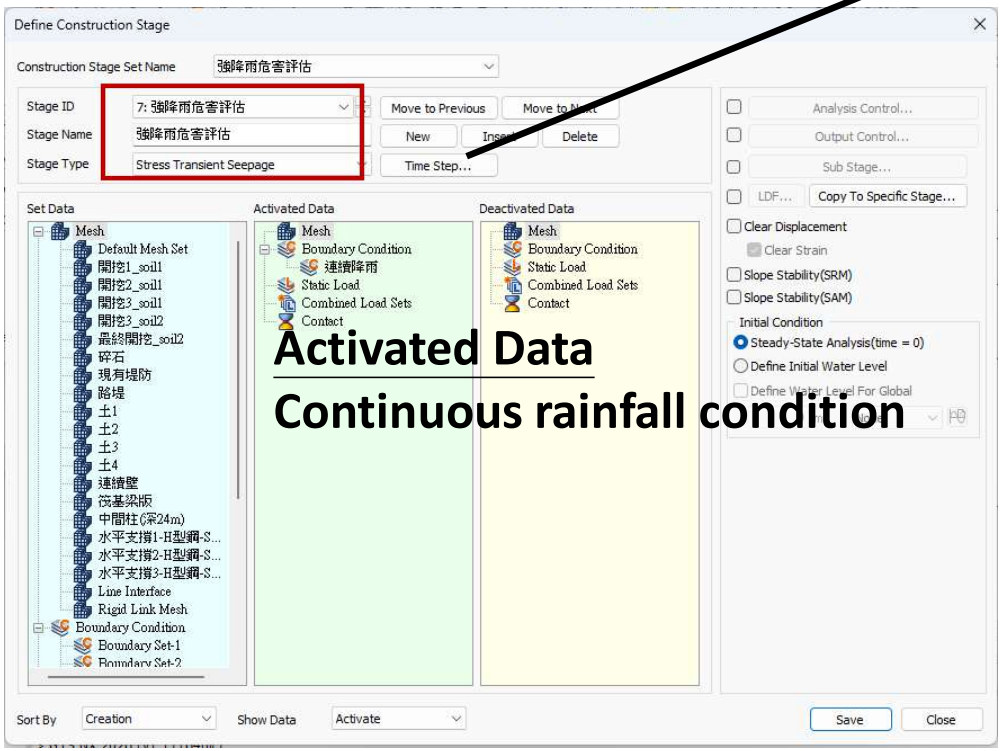


Step1.Select stage6

Step2. Insert

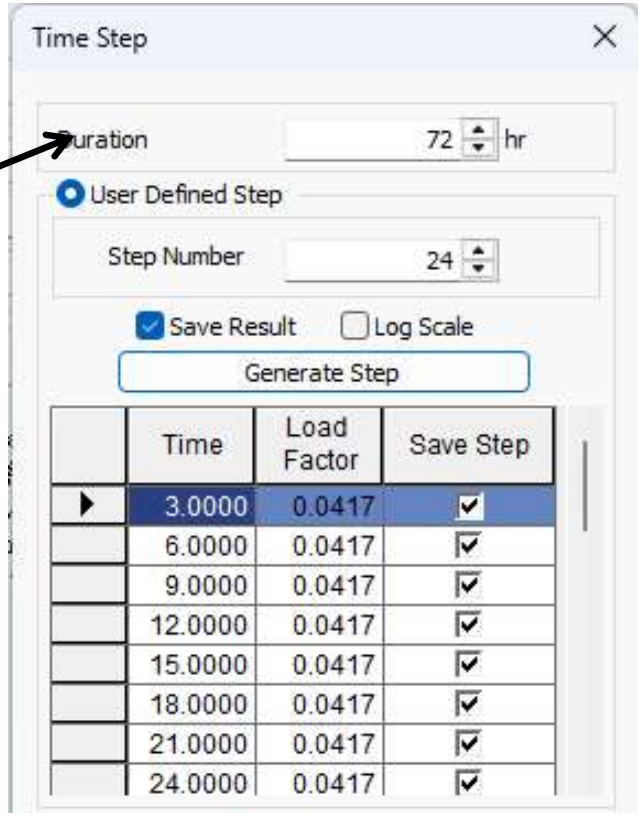
Step3. Select the previous construction stage

Heavy Rainfall Assessment-2

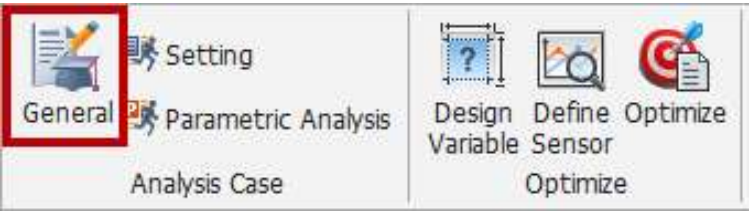


Activated Data

Continuous rainfall condition

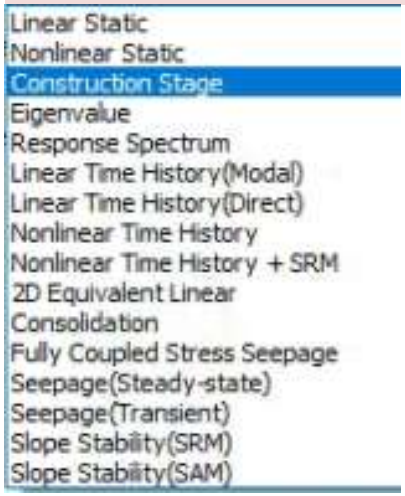


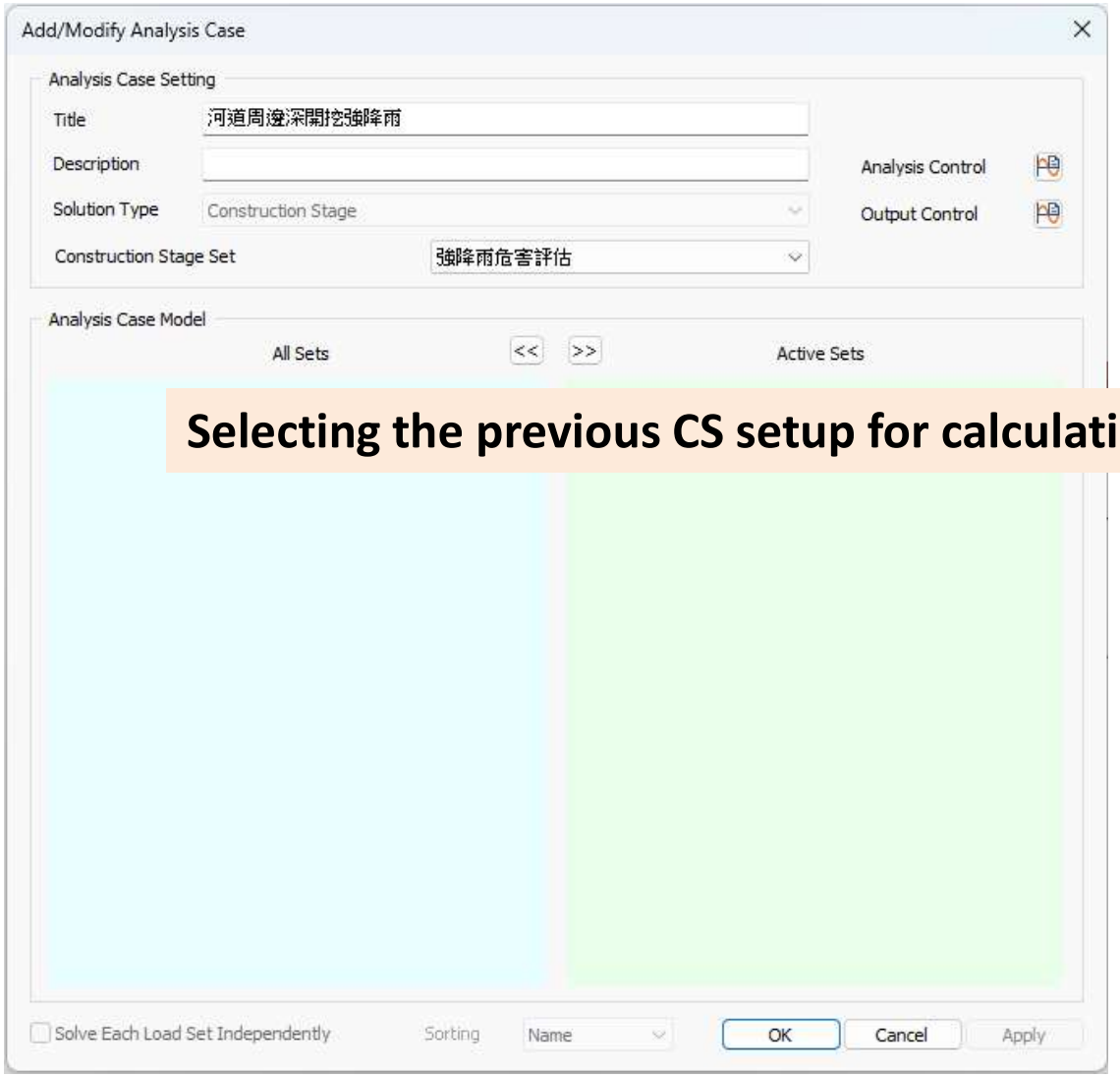
Analysis-1



Analysis type: Construction Stage

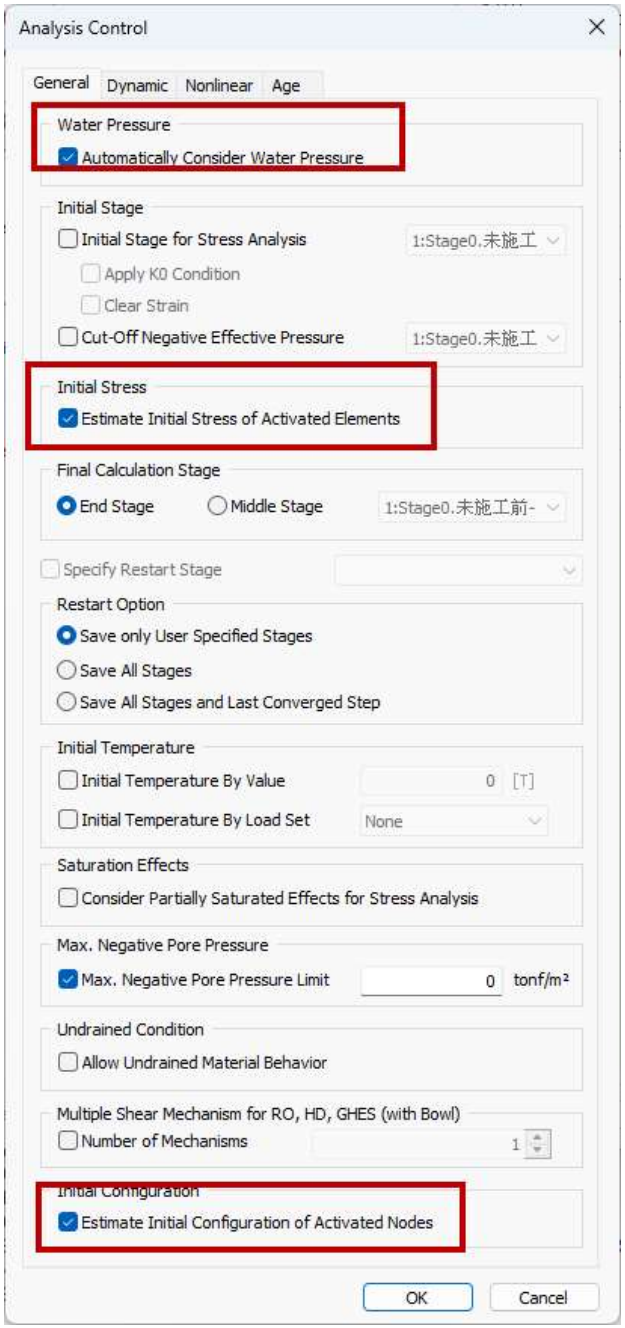
Construction Stage





Selecting the previous CS setup for calculation

Analysis-2

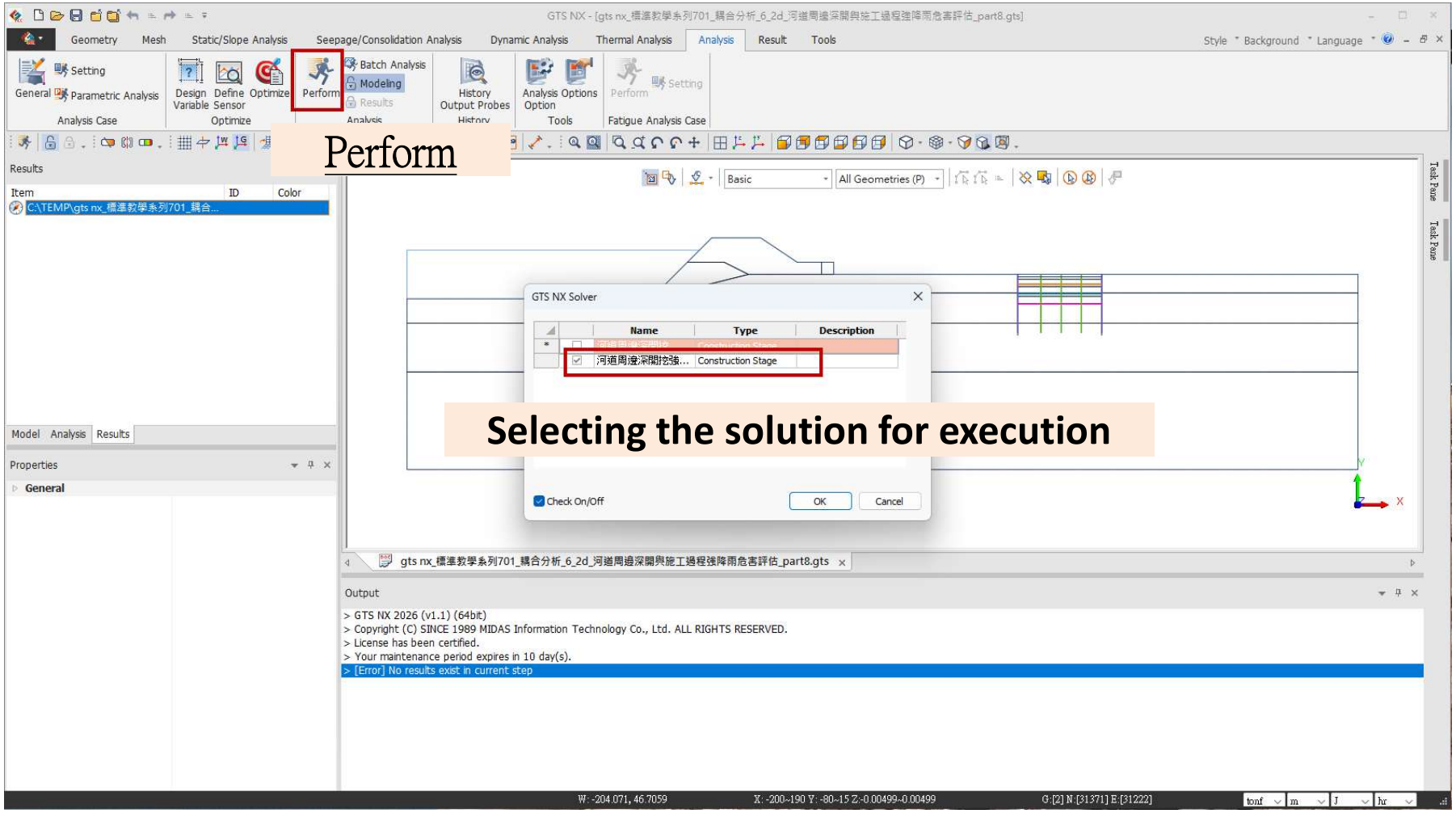


Tick on
Automatically Consider Water Pressure

Tick on
Estimate initial stress of activated elements

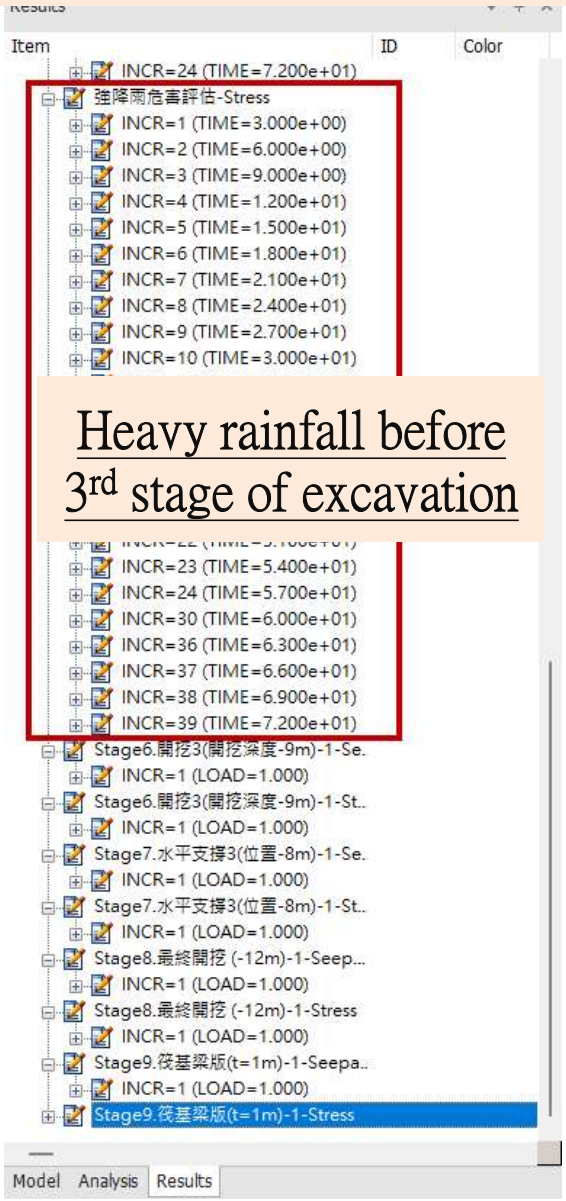
Tick on
Estimate initial Configuration of activated nodes

Calculation



Results

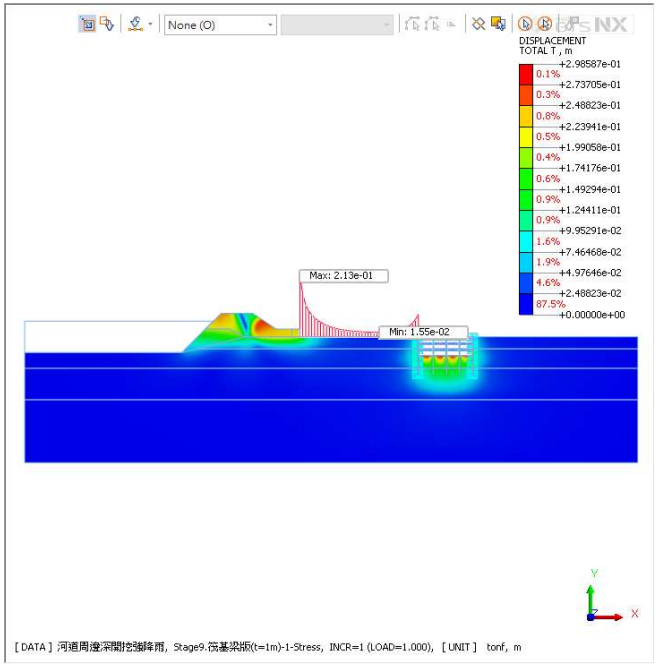
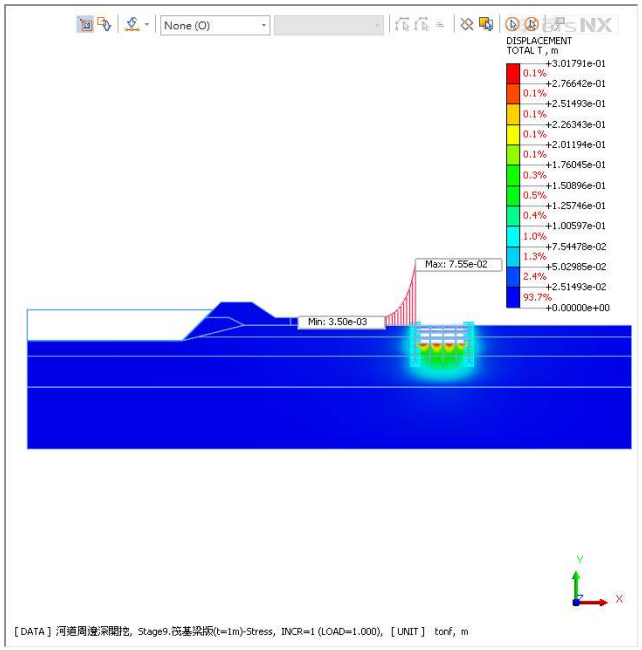
Sequence of analysis in CS



Heavy rainfall before 3rd stage of excavation

Stage6.Ex3_-9m

Heavy rainfall consideration



No rainfall consideration