

# 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:

$$\begin{split} K_n &= E_{oed,i} / t_v \\ Here, \\ K_t &= G_i / t_v \\ G_i &= R \times C_{soil} \\ \end{bmatrix} \\ \begin{aligned} E_{oed,i} &= 2 \times G_i \times (1 - v_i) / (1 - 2 \times v_i) \\ G_i &= R^2 \times G_{soil} \\ G_{soil} &= E / (2(1 + v_{soil})) \\ \end{aligned}$$

Create 🛱 🛄 🕅 // --> III III 👬 🔳 🚽 C III III 👬 📕 🚽 Element

Where,

K<sub>n</sub>: Normal Stiffness Modulus

K<sub>t</sub>: Shear Stiffness Modulus

 $t_v$ : Virtual Thickness Factor

R: Strength Reduction Factor

C<sub>i</sub>: 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 <u>slip behavior</u> in the normal direction to the interface element

		Interface Wizard Data	×
Strengt	th Reduction factor (R)	Structural Parameters	
- Sandy	soil/ Steel material: R= 0.6 ~ 0.7	Strength Reduction Factor(R)	1
- Clay/S	teel material: R= 0.5	Virtual Thickness Factor(tv)	0.1 m
- Sandy	soil/ Concrete: R= 1.0 ~ 0.8	Consider Element Size	
$-$ Clay/Concrete: $R = 1.0 \approx 0.7$		Line Interface Thickness	1 m
		Conduction for Seepage flow	0 m/sec/m
	The general Virtual Thickness Fac	ctor range is 0.01 ~ 0.1	OK Cancel
	(If the stiffness is high, use a smal	ller value)	

### **Open model**

🗞 Open					×
Look in:	📒 2- MidasPrac	tice ~	G 🌶 📂 🖽 -		
$\wedge$	Name	^	Date modified	Туре	Read Result File
Home	🍖 02 3D Excav	ation_Start	6/7/2024 9:15 AM	GTS	
Desktop	Oper	n Midas tutorial – I	esson 2		
Libraries					Analysis Case Solution Type Results
Network					[Model Information] Elem: 0
	File name:	02 3D Excavation_Start			
	Files of type:	GTS NX Files(*.gts)	~		
IDAC					Geometry drawing

# **Geometry modeling – Excavation area**



# **Geometry modeling – Ground**



# **Cutting ground surface**





# **Bedding plane**





Bedding plane for excavation area by 'Divide solid' function





# **Imprint for 'Plug pegs'**







## **Check duplicate – Auto connect**



# Material



Structure material

Name Buried layer		Colluvium	Weathering soil		
Material	Isotropic	Isotropic Isotropic			
Model Type	Hardening Soil	Hardening Soil	Hardening Soil		
Poisson's Ratio	0.333	0.333 0.306			
Unit Weight	16	17	20		
KO	0.5	0.441	0.74		
Unit Weight (Saturated)	20	20 20			
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	30 34			
K0nc	0.5	0.441	0.384		
Dilatancy Angle	0	4	5		
Cohesion	5	10	15		
Name	Structure n	naterial 1	Structure material 2		
Material	Isotro	pic	Isotropic		
Model Type	ype Elastic		Elastic		
Elastic Modulus	210,000	0,000	200,000,000		
Poisson's Ratio	0.3	}	0.3		
Unit Weight	76.9	8	76.98		



# Property

	Name	Interface (Buried layer)	Interface (Colluvium)	Interface (Weathering Soil)	g Buried layer	Colluvium	Weathering Soil
	Туре	Other	Other	Other	3D	3D	3D
Ground material	Model Type	Interface	Interface	Interface	-	-	-
	Interface Type	Face	Face	Face	-	-	-
	Material	Buried layer	Colluvium	Weathering Soil	Buried layer	Colluvium	Weathering Soil
_							
	Nam	e	Sheet Pile	W	alling, Plus peg, Strut	A	nchor
-	Туре	)	2D		1D		1D
Structure material	Model Type		Shell	Beam		Embedded Truss (linear elasticity)	
	Material		Structure materia	al 1	Structure material 1	Structu	re material 2
-	Section		-	H-Section		Solid Round	
-	Section Size		Uniform Thickness	: 0.1 300x300x10/15		0.025	



## **3D mesh – Excavation area**

	Advanced Option $\qquad \qquad \qquad$	
	Interior Edge/Point	
Generate mesh(Solid) ×	40 Edge(s) Selected	
Auto Calid up a tit an un	Select Interior Point(s)	
Auto-solid Map-Solid 2D->3D	Register Each Mesh Independently	
Select Object(s)	Consider Imprinting Shape on Face	
Size Method	2 2: Walling,Plus peg,Strut 🗸 🔢	
O Size 1 <	Merge Nodes	
O Division 10	Tolerance 0.0001	
Automatic		
More Less 4.01	Element Size Growth Rate	
	Fine Coarse	
Hybrid Mesher 🗸 🗸		
Match Adjacent Faces	Min/Max Element Size 1.100	"Iransparency
	1.1	display mode
Preparty	Small Large	↓ · · ·
6 6: Weathering soil	Higher-Order Element	
Mesh Set Auto-Mesh(3D) ~		
	Geometry Proximity	Include Exclude Lements & Nodes Show/Hide ,
	Pattern Mesh     Pagister Each Mech Independently	Diglay Mode Diglay Diglay Tanapa Tongravery 3 Tanapa
		Trendom 9 Detee 3
	OK Cancel	

• Generate meshes with nodes connected to interior edges



### **3D mesh - Ground**



## **Change property – Ground**



## **Extract elements for RW, Walling**



## 1D mesh – Struts & Anchors

Generate mesh(Edge)       ×         Auto-Edge       •         Select Object(s)       •         Size Method       •         Size ODivision       1 <         Orientation (Element Z-Axis)       •         Beta Angle: 90 [deg]       •		
2     2: Walling,Plus peg,Strut     Hill       Mesh Set     Auto-Mesh(1D)     V       Image: Control of the structure     OK     Cancel     Apply	▲ Ir	mage of supporting and RW after meshing
	Generate mesh(Edge)	
MIDAS	Property       2     2: Walling, Plus peg, Strut       Mesh Set     Stage 4 anchor -1       Image: Construction of the stage	Meshing Struts and Anchors

## **Plane interface**





#### **Prestressed - Anchors**



Selecting the length of anchors should add a prestressed load

#### Prestressed: 200 kN





# **Gravity – Boundary conditions**

Assigning gravity

iravity		×				
Gravity						
Name	Gravity-3					
Referer	nce Object					
Type	Coordinate $\lor$					
Ref. CS	/s Global Rectangular 🗸			- annihite		
Compor	ents				1,	
Gx	0			Store.	23 <sup>77</sup>	
Gy	0					1-1-1-
Gz	-1			HAN-	110	
Spatial I	Distribution		H			
Base Fu	nction None V		- un			
					Jul Martin	
ad Set	Gravity					
	OK Cancel Apply					

Assigning boundary condition

Basic Ad	vanced Auto						
Name	Constraint-1						
?	? Select Object(s)						
🔽 Consi	Consider All Mesh Sets						
Boundary Se	t BC 🗸 😪						







### **Rotation constraint**

Basic Advanced Auto	Preventing 'Rz' rotation
Name Constraint-6 Object Type Node ~	$\varphi_{  }$
DOF Symmetric Plane Tx Ty Tz XY YZ Rx Ry Rz ZX Anti-Symmetric	<b>↓</b>
Boundary Set Control rotation Second	

 $\rightarrow$  The deformation or rotation is constrained to prevent the degree of freedom errors







#### Stage 1. Initial conditions







Stage 2. Install sheet pile and plug pegs







Stage 3. Excavation layer 1 and Installation strut layer 1





Construction Stage Set Name Construction Stage Set-1	~		
Stage ID 4: Ex2 and Strut2 Move to Pre	vious Move to Next	Analysis Control	
Stage Name Ex2 and Strut2 New	Insert Delete	Output Control	
Stage Type Stress V		Initial Condition     Define Water Level For Global	
Set Data Activated Data	Deactivated Data	0 m None $\sim$	
Mesh Default Mesh Set Colivium Default Mesh Set Ex1 Ex2 Ex2 Ex3 Ex4 Ex5 Rigid Link Mesh Sheet pile Stage 1 walling Stage 2 strut Combined Load Sets Contact Combined Load Sets Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact Contact	Mesh Boundary Condition Static Load Combined Load Sets Contact	<ul> <li>Define Water Level For Mesh Set</li> <li>Input Water Level</li> <li>Sub Stage</li> <li>LDF Copy To Specific Stage</li> <li>Clear Displacement</li> <li>Clear Strain</li> <li>Slope Stability(SRM)</li> </ul>	

Stage 4. Excavation layer 2 and Installation strut layer 2







Stage 1. Excavation layer 3 and Installation strut layer 3







Stage 6. Excavation layer 4 and Installation strut layer 4







Stage 7. Excavation layer 5





## Results – RW system



#### Deformed and undeformed in horizontal displacement

MIDAS



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



## **Results - Displacement**





# **Geometry modeling – Ground**



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









