

# GTS NX 2D Excavation with Retaining System

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Google會議室 <u>https://meet.google.com/sgo-hhbz-qiy</u>

Reference: Midas GTX NX Tutorials

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## **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	high Reduction factor (R)       Structural Parameters         iy soil/ Steel material: R= 0.6 ~ 0.7       Strength Reduction Factor(R)         / Steel material: R= 0.5       Virtual Thickness Factor(tv)         iy soil/ Concrete: R= 1.0 ~ 0.8       Consider Element Size         / Concrete: R= 1.0 ~ 0.7       Conduction for Seepage flow         The general Virtual Thickness Factor       range is 0.01 ~ 0.1         (If the stiffness is high, use a smaller value)	0.1 m	
- Sandy	soil/ Concrete: R= 1.0 ~ 0.8	Consider Element Size	
- Clay/C	$\hat{c}_{n} = 10 \approx 0.7$	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)	

# **2D Element**

### (Beam element/ Truss element)

#### Beam and Truss element comparison:

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	Feature	Truss Elen	nent	Beam Element				
	Resists Axial Force	🗹 Yes		🗹 Yes				
	Resists Bending	🗙 No		🗹 Yes				
	Resists Shear	🗙 No		🗹 Yes				
	Resists Torsion	🗙 No		🗹 Yes				
	Degrees of Freedom (DOF)		e (UX, UY, UZ)	(UX, UY, UZ, RX, RY, RZ)				
	Transfers Moments	🗙 No 🛛 🗹 Yes						
	Typical Application		ables	Beams, frame	mes			
Note:	<b>E.g.,</b> Truss element by library section Input the spacing for	input	Create/Modify 1D Property           Ple         Geogrid(1D)         Plot Only(           Truss         Embedded Truss         Beam           ID         14         Name         1D Property           Constitutive Behavior         From Material         St CONCRETE           Hinge Property         Cross Sectional Area(A)	(1D) Pipe Embedded Beam Color	Section Template	Sold Rectangle		
consid betwe	lering the strength diffe en 2D and 3D	rences	Spacing	1 m	Z L Shape is invalid!			
			OK Ca	Apply	Offset Center-Center 🗸	OK Cance		



## 2D model import



## **Intersect function**





## **Creating geometry area**



## **Soil material**

lo	Name	Туре	Create 🔻		2Г	Model Type Mohr-Coulomb		 □ Stru
L	SOIL1	Isotropic-Mohr-Coulomb	Modify		~ L	General Descus Neg Lingage Thermal	Time Descedard	
2	SOIL2	Isotropic-Mohr-Coulomb				ocherar Porous Non-Linear mermai	Time Dependent	-
3	SOIL3	Isotropic-Mohr-Coulomb	Сору			Elastic Modulus(E)	15000	kN/m²
ł	SOIL4	Isotropic-Mohr-Coulomb	Delete			Inc. of Elastic Modulus	0	kN/m³
	CONCRETE	Isotropic-Elastic	Turnet		2	Inc. of Elastic Modulus Ref. Height	0	m
	STEEL	Isotropic-Elastic	Import		3	Poisson's Ratio(v)	0.25	
, ,	Interface Mat	Interface and Pile-Interface	Import from			Unit Weight(y)	18	kN/m³
	Interface Mat	Interface and Pile-Interface	Excel			- Initial Stress Parameters		
0	Interface Mat	Interface and Pile-Interface	Export to Excel			Ko Determination	0.5	
-						Automatic		
			Renumber			Manual	Anisotropy	HB
			Database			Thermal Parameter		
			Chan			Thermal Coefficient	1e-06	1/[T]
			Close			Molecular vapor diffusion coefficient	0	m²/sec
	Material	×	Material		$\times$	Thermal diffusion enhancement	0	
	ID 1 Name S	OIL1 Color	ID 1 Name SOIL1	Color	$\sim$	Damping Ratio(For Dynamic)		
	General Porous Non-Linea	r Thermal Time Dependent	Model Type Mohr-Coulomb	<ul> <li>✓ □ Structure</li> </ul>		Damping Ratio	0.05	
	Unit Weight(Saturated)	18 kN/m³	General Porous Non-Linear The	rmal Time Dependent				
'	Initial Void Ratio(eo)	0.5	Cohesion(C)	5 kN/m²	6	Safety Result(Monr-Coulomb)	30	kNUm2
	Unsaturated Property	· · · · · · · · · · · · · · · · · · ·	Inc. of Cohesion	0 kN/m³	•	Conesion(C)	26	NN9111-
	Drainage Parameters Drained	~	Inc. of Cohesion Ref. Height	0 m		Frictional Angle(Φ)		[aeg]
	O Undrained Poisso	n's Ratio 0.495	Frictional Angle(Φ)	30 [deg]	7	Tensile Strength	U	kN/m²
	Skempton`s B Co	efficient 0.983277592	Dilatancy Angle	0 [deg]				
	Permeability Coefficient	s		0 L61/m2				
	1e-06	ky kz 1e-06 1e-06 m/sec	Cut-off Yield Surface	• NA111*				
	Void Ratio Dependenc	v of Permeability(ck) 0.5	OPressure	Rankine				
		y of remeability (avy				OK	Cancel	A

## Soil property

Multicity Property         Name         No         No <td< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>create/moully 2D Property</th><th>y</th></td<>								create/moully 2D Property	y
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1       0       Stell         2       501.2       20       Plene Stein         3       501.3       20       Plene Stein         0       Use Stein       Delete         1       Interface Proper       Other	No	Name	Туре	Sub-Type	Create			ID 2 Name	SOIL1 Color
2       SOL1       20       Piere Strint         3       SOL2       20       Piere Strint         0       Conv       Conv       Material       1::::::::::::::::::::::::::::::::::::	1		2D	Shell	Modify				
3       SOL2       20       Plane Strain       Copy         SOL3       20       Plane Strain       Copy       Plane Strain       Copy         SOL3       20       Plane Strain       Copy       Plane Strain       Copy         D-Wall       10       Beam       Plane Strain       Copy       Adde       0 (dod)         SOL3       20.0228x.       10       True       Plane Strain       Property       Plane Strain       Property         Sola Interface Proper       Other       Interface Proper       Other       Interface Proper       Other       Name       Viail       Correct Maching 10 Property         Beam       Interface Proper       Other       Rigd Link       Other       Rigd Link       Correct Maching 10 Property       Rigd Link       Name       Sola Strain Jacobia       Plain Strain property         Itel face Proper       Other       Rigd Link       Other       Rigd Link       Other       Rigd Link       Sola Strain Jacobia       Interface Proper       Other       Rigd Link       Correct Plane State Strain Jacobia       Plane State Strain Jacobia       Plane State State Strain Jacobia       Plane State State State Strain Jacobia       Plane State State State State State Strain Jacobia       Plane State State State State Strain Jacobia	2	SOIL1	2D	Plane Strain					
Control Viral 20     Photo Strang     Control Viral 20     Photo Strang     Control Viral 20     Photo Strang Viral 2	3	SOIL2	2D	Plane Strain	Сору			Material	1: SOIL1 🗸 🔟
Control to the control of the c	4	SOIL3	2D	Plane Strain	Delete			Material CSys	
Coverant       D       Tutes         Still & filts/220x       D       Tutes         Interface Proper       Other       Interface         10       Interface Proper       Other         11       Interface Proper       Other         12       Interface Proper       Other         13       Interface Proper       Other         14       Interface Proper       Other         15       Interface Proper       Other         16       Name       D-Vial         17       Toport       Tutes         10       Interface Proper       Other         11       Interface Cover       Other         12       Interface Cover       Other         13       Other       Rigd Ink         14       Interface Cover       Section-I         13       Section-I       Section-I         14       Section-I       Section-I         15       Interial       Section-I         16       Name       D-Vial         17       Name       Si(L8 Gib/L229k:101 @ 4         16       Name       Section-I         17       Name       Si(L8 Gib/L22		D W-II	10	Plane Strain	beete			CSys	Global Rectangular 🗸
Sizula Sizulo 28		D-Wall	10	Beam	Import			() Anda	
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Interface Proper Other Interface     Rigid Link     Other Rig	11	Interface Proper	Other	Interface	Beam				
3       Rigid Link       Other       Rigid Link         10       6       Name       D-Val       Color         Image Property       Image Property       Image Property       Image Property	12	Interface Proper	Other	Interface	Jean				OK Cancel App
Material       S: CONCRETE       Image         Image       Section i       Section i         Image       Section i       Section i       Section i         Image       Section i       Section i       Section i         Image:       Section i       Section i       Section i         Image:       Section i       Section i       Section i         Image:       Section i       Section i       Section i	13	Rigid Link	Other	Rigid Link	ID 6 Name D-W	/all Color	Truss		
I Hrage Property       I         I Taper       Section I         Cross Sectional Area(A)       1         I Torsional Constant(I)       0.40595950         OK       Constitutive Behavior         Torsional Stress Coefficent(Gry)       0.683333333         Material       I: STEEL         I Hrage Property       Image: Stress Coefficent(Gry)         I Shear Stress Coefficent(Gry)       I.5         I Spacing       1         I m       Stress.         Stress Coefficent(Gry)       I.5         I Spacing       1         I m       Stress.         Stress.       Stress.         Stress.       Stress.         I m       Stress.         I					Material	5: CONCRETE V			
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Cross Sectional Area(A) 1 1 m <sup>2</sup> Torsional Constant(Ix) 0.140596345 m <sup>4</sup> Torsional Stress Coeff. 0.662395303 0.662395303 m <sup>4</sup> Area Moment of Inertia(Iy) 0.083333333 m <sup>4</sup> Effective Shear Area(A) 0.833441841 m <sup>2</sup> Effective Shear Area(A) 0.833441841 m <sup>2</sup> Shear Stress Coefficient(Gry) 1.5 1.5 1/m <sup>2</sup> Stress Stress Stress Stress Stress Stress Cort Cancel Apply					Taper	Section-i Section-j			
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Area Moment of Inertia(Iz)       0.0833333333       0.0833333333       m <sup>4</sup> Effective Shear Area(Ay)       0.833441841       m <sup>2</sup> Effective Shear Area(Az)       0.833441841       m <sup>2</sup> Shear Stress Coefficient(Gz)       1.5       1.5       1/m <sup>2</sup> Stress       Stress       Stress       Stress         Y Axis Variable       Constant       V       V         Spacing       1       m       Section       H-Section         Solid Rectangle       M       Section       K       Cancel       Apply         OK       Cancel       Apply       OK       Cancel       Apply					Area Moment of Inertia(Iy)	0.083333333 0.0833333333 m <sup>4</sup>	0	ngerroperty	× 83
Effective Shear Area(Ay)       0.833441841       0.833441841       m²         Effective Shear Area(Az)       0.833441841       m²         Shear Stress Coefficient(Gy)       1.5       1.5       1/m²         Shear Stress Coefficient(Gz)       1.5       1.5       1/m²         Y Axis Variable       Constant       0       m4         Y Axis Variable       Constant       0       m         Y Axis Variable       Constant       0       m         Spacing       1       m       Image: Solid Rectangle       Image: Section       Solid Rectangle         OK       Cancel       Apply       OK       Cancel       Apply	_				Area Moment of Inertia(Iz)	0.083333333 0.083333333 m <sup>4</sup>	Cross	Sectional Area(A)	0.0129 m²
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Shear Stress Coefficient(Gz) 1.5 1.5 1/m <sup>2</sup> Stress Stress Stress y Axis Variable Constant z Axis Variable Constant constant Constant Spacing 1 m Solid Rectangle Beam property OK Cancel Apply					Shear Stress Coefficient(Gy)	1.5 1.5 1/m²			
Stress Stress   y Axis Variable Constant   z Axis Variable Constant   Spacing 1   Spacing 1   Solid Rectangle H-Section     Beam property   OK   Cancel        OK     Cancel        Stress     Iruss property     Section     OK        OK        OK        Stress           Stress        Stress           Stress                                                 Solid Rectangle <b>OK</b> Cancel Apply					Shear Stress Coefficient(Gz)	1.5 1.5 1/m²		_	
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Beam property OK Cancel Apply OK Cancel Apply					Section	Solid Rectangle			
OK Cancel Apply OK Cancel Apply					Beam	property			
	(III)					OK Cancel Apply		ОК	Cancel Apply

## **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
Туре	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

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Name	D-Wall	S1	S2
Туре	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



## **Generate mesh**



## **Create & Extract elements**



'Extract elements' for retaining wall

**MIDAS** 

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



### **Create interface element**

### (Wizard interface)



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  $\rightarrow$  Mesh  $\rightarrow$  Node  $\rightarrow$  Merge  $\rightarrow$  Find





## Group mesh set

#### Model tree



Selecting 'Include/Exclude Elements & Nodes'

Rename the group mesh set to control the excavation layer

Include/Exclude Mesh Set I	tems X					
O Element	○ Node					
O Include	CExclude					
Selected 15	5 Object(s)					
Delete Empty Sets After O	peration					
ОК	Cancel Apply					
V III Ex1 V III Auto-Me V III Auto-Me V III Auto-Me V III Auto-Me	Show Hide Show Only Hide Only Show <-> Hide					
Element Param	Include/Exclude Elements & Nodes					
odel Analysis Res operties Mesh Set ID	Display Mode  Display  Transparency  Shrink					
Name	Delete					
1.0101						



## **Boundary condition**



Creating a 2D boundary condition





## **Construction stage set**

Construction Stage Set       Name     Excav       Stage Type     Stress       No     Name       1     Excav	Add Add Modify Type Copy Stress Delete Define CS Define CS	Define construction stage Stage Name → Set Data -	e: → Initial condition → Save → New
	Construction Stage Set Name Exc Stage ID 1: Initial Stage Name Initial Stage Type Stress Set Data Set Data Set Data Set Data Set Data Set Data Set Data Set Data Solid Soli	Activated Data          Activated Data       Deactivated Data         Activated Data       Default Mesh Set         Ex1       Mesh         Default Mesh Set       Static Load         Ex2       Soill -1         Soill -2       Soill -2         Soill -6       Soill -3         Soill -1       Soill -2         Soill -2       Soill -1         Soill -2       Soill -1         Soill -1       Soill -2         Soill -2       Soill -1         Soill -2       Soill -1         Soill -2       Soill -2         Soill -1       Soill -2         Soill -2       Soill -1         Soill -2       Soill -2         Soill -3       Soill -2         Soill -1       Soill -1         Soill -2       Soill -1         Soill -2       Soill -1         Soill -1       Soill -1         Soill -1       Soill -1         Soill -2       Soill -1         Soill -3       Soill -2         Soill -4       Soill -2         Soill -3       Soill -2         Soill -4       Soill -2         Soill -3       Soill -2         Soill -4       Soill -2	Analysis Control   Output Control   Initial Condition   Define Water Level For Global   Imput Water Level   Sub Stage   Clear Displacement   Clear Strain   Slope Stability(SRM)   Slope Stability(SAM)







Stage 1. Input the initial condition









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**

Add/Modify Analysis Case

Analysis Item

MIDAS

				Analysis Case Set	ting					
				Title	Excav			Applycic Coptrol	b	
				Solution Type Construction Stage			Analysis Control			
				Solution Type	Solution Type Construction Stage			Output Control	P	
				Construction Sta	ge Set	Excav		~		
Analysis			<del>т</del> ×	Analysis Case Mo	del					
Item	ID	Color			All Sets	<<	>>	Active	Sets	
<ul> <li>C:\TEMPDaft\NXGTk.gts</li> <li>Function</li> <li>History Output Probe</li> <li>Secondary Condition</li> <li>Static Load</li> <li>Static Load</li> <li>Static Load</li> <li>Thermal Load</li> <li>Response Spectrum Load</li> <li>Combined Loadsets</li> <li>Stage Set</li> <li>Analysis Case</li> <li>Partial</li> <li>Solve</li> <li>Export</li> </ul>				Solve Each Load	Calculatin	g with gra	avity me	ethod	Cancel	Apply



 $\times$ 

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## **Result – Vertical displacement**







. --8.46807e-04

## **Result – Forces in RW**





Shear force in RW (Beam stresses  $\rightarrow$  S-XZ)

Bending moment in RW (Beam stresses  $\rightarrow$  S-VON MISES)



BEAM STRESS

6.7%

S-VON MISES , kN/m^2

+6.39301e+02



### **Result – Comparison** (Displacement with & without RW)



 $\rightarrow$  There is a change in maximum displacement due to the installation of the retaining wall



without RW

with RW







