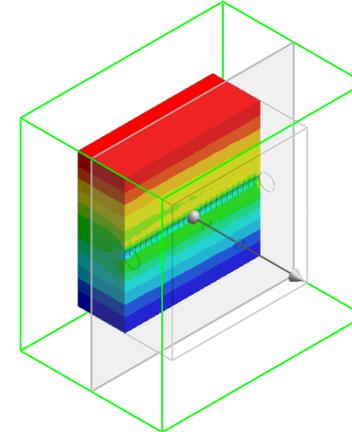


MIDAS *Technical
Material*

Tutorial



3D Tunnel Intersection & Cross Passage

Contents

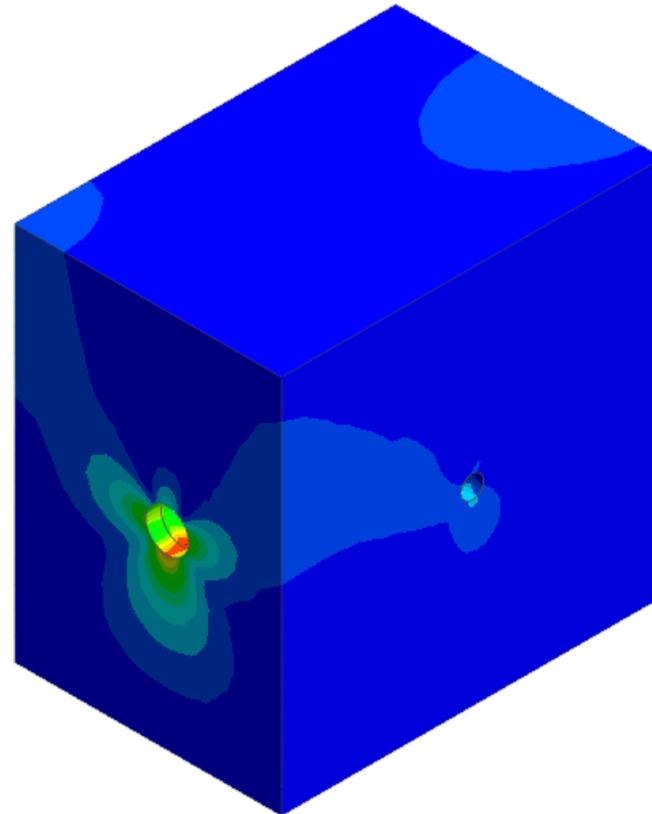
- **Step 1:** Initial Setting
- **Step 2:** Defining Soil material
- **Step 3:** Defining Property
- **Step 4:** Geometric Modeling
- **Step 5:** Meshing
- **Step 6:** Boundary Condition
- **Step 7:** Loads Definition
- **Step 8:** Analysis Case
- **Step 9:** Analysis
- **Step 10:** Results
- **Step 11:** Certification Task

Numerical Model Design

Overview

This model tutorial is intended to show the user the method of creating complex tunnel cross section and analyze the various forces and deformations associated with the design.

Modelling



Contents

- Step 1: Initial Setting
- Step 2: Defining Soil material
- Step 3: Defining Property
- Step 4: Geometric Modeling
- Step 5: Meshing
- Step 6: Boundary Condition
- Step 7: Loads Definition
- Step 8: Analysis Case
- Step 9: Analysis
- Step 10: Results

3D Tunnel Excavation

Material Properties

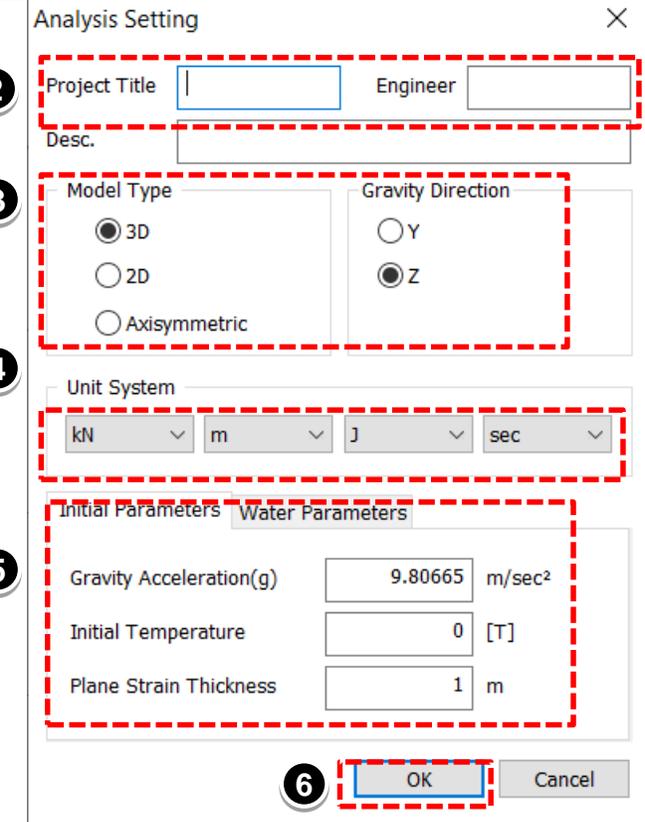
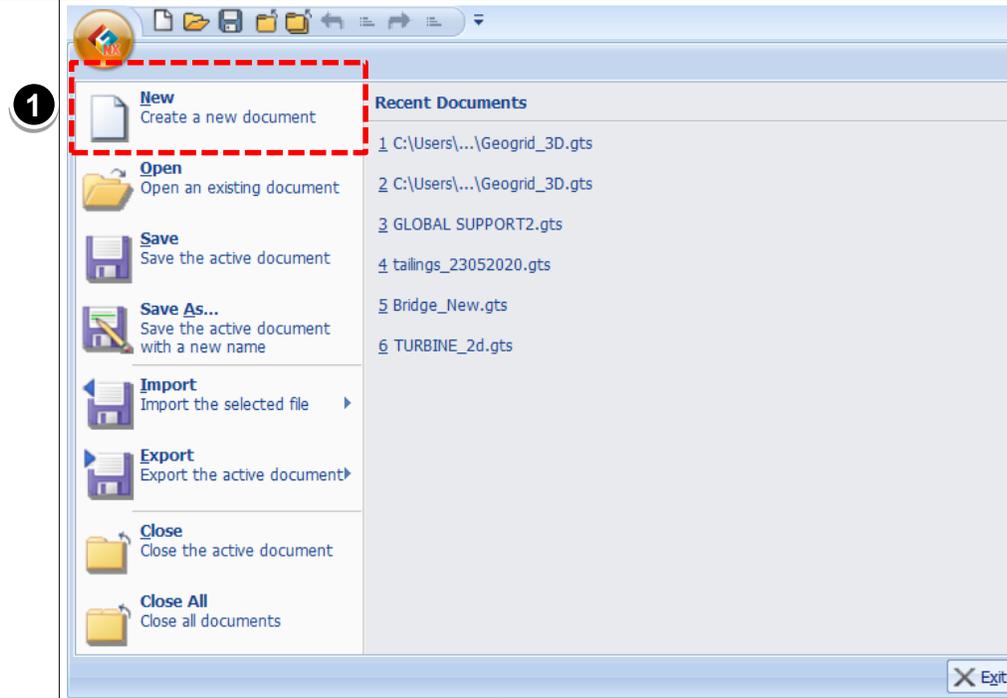
Name	Material Model	Modulus of Elasticity (kN/m ²)	Poisson's ratio	Unit Weight (kN/m ³)	Saturated unit Weight (kN/m ³)	Cohesion (kN/m ²)	Friction angle
SOIL	Mohr-Coulomb	50000	0.3	20	21	30	36

Name	Material Model	Modulus of Elasticity (kN/m ²)	Poisson's ratio	Unit Weight (kN/m ³)
CONCRETE	Elastic	2.73E+07	0.18	24

Procedure

Starting Midas GTS NX

- ① Click on GTS NX icon > **New Project**
- ② Enter the Project name as 3D Tunnel & Engineer XYZ.
- ③ Select Model Type as **3D**.
- ④ Select **kN ,m and sec** in The Unit System.
- ⑤ Use the Default values for Initial parameters.
- ⑥ Click **OK**.



Procedure

Defining Soil Materials

- ① Go to Mesh > Material
- ② Click on Create. Select **Isotropic**
- ③ Select Model type as **Mohr-Coulomb**
- ④ In General tab, Enter the value of **Elastic modulus (E) =50000 kN/m²**
- ⑤ Enter **Poisson's ratio= 0.3, Unit weight = 20 kN/m³**.

The image shows a software interface for defining material properties. It is divided into three main sections:

- Top Section (Software Menu):** Shows the 'Mesh' > 'Material' path. The 'Material Property' button is highlighted with a red dashed box and a circled '1'. The 'Create...' button in the 'Add/Modify Material' dialog is highlighted with a red dashed box and a circled '2'. The 'Mohr-Coulomb' model type is selected in the 'Material' dialog, highlighted with a red dashed box and a circled '3'. The 'General' tab is active, and the 'Elastic Modulus(E)' field is set to 50000 kN/m², highlighted with a red dashed box and a circled '4'. The 'Poisson's Ratio(v)' field is set to 0.3 and the 'Unit Weight(γ)' field is set to 20 kN/m³, both highlighted with a red dashed box and a circled '5'.
- Middle Section (Add/Modify Material Dialog):** A dialog box with a table and several buttons. The table has columns for 'No', 'Name', and 'Type'. The 'Create...' button is highlighted with a red dashed box and a circled '2'. The dropdown menu below it shows 'Isotropic' selected, also highlighted with a red dashed box.
- Right Section (Material Dialog):** A detailed dialog box for defining material properties. The 'ID' is 2 and the 'Name' is 'Soil'. The 'Model Type' is 'Mohr-Coulomb'. The 'General' tab is selected. The 'Elastic Modulus(E)' is 50000 kN/m². The 'Poisson's Ratio(v)' is 0.3. The 'Unit Weight(γ)' is 20 kN/m³. The 'Damping Ratio' is 0.05. The 'Safety Result(Mohr-Coulomb)' section is expanded, showing 'Cohesion(C)' as 30 kN/m² and 'Frictional Angle(Φ)' as 36 [deg].

Procedure

- ➊ Go to Porous Tab > Enter Unit weight (saturated) =21 kN/m³
- ➋ Keep Drainage Parameters as Drained
- ➌ Go to Non-Linear Tab > Enter the value of Cohesion = 30 kN/m²
- ➍ Input the value of Frictional angle =36°
- ➎ Enter the name as SOIL.
- ➏ Click OK

Material

ID 2 Name Soil Color █

Model Type Mohr-Coulomb Structure

➊ **Porous** Non-Linear Thermal Time Dependent

Unit Weight(Saturated) 21 kN/m³

Initial Void Ratio(eo) 0.5

➋ Unsaturated Property

Drainage Parameters

Drained

Unreined Poisson's Ratio 0.405

Skempton's B Coefficient 0.97826087

Seepage & Consolidation Parameters

Permeability Coefficients

kx	ky	kz	
1e-005	1e-005	1e-005	m/sec

Void Ratio Dependency of Permeability(ck) 0.5

Specific Storativity(Ss) 5.230213 1/m Auto

OK Cancel Apply

Material

ID 2 Name Soil Color █

Model Type Mohr-Coulomb Structure

General **Non-Linear** Thermal Time Dependent

➋ Cohesion(C) 30 kN/m²

Inc. of Cohesion 0 kN/m³

Inc. of Cohesion Ref. Height 0 m

➌ Frictional Angle(Φ) 36 [deg]

Dilatancy Angle 36 [deg]

Tension Cut-off

Tensile Strength 0 kN/m²

Cut-off Yield Surface

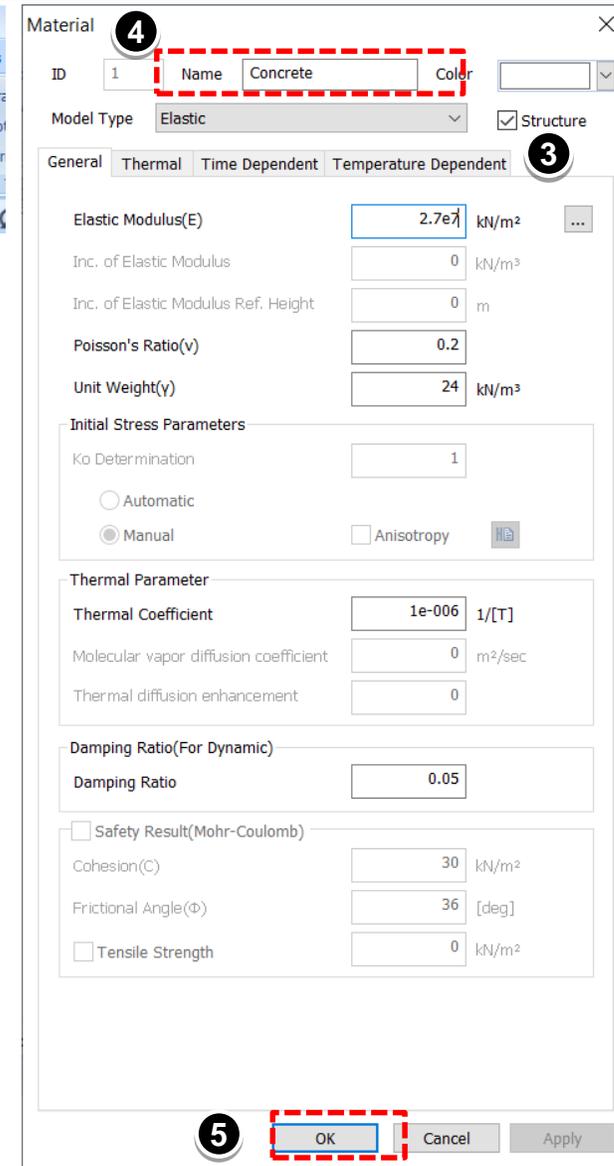
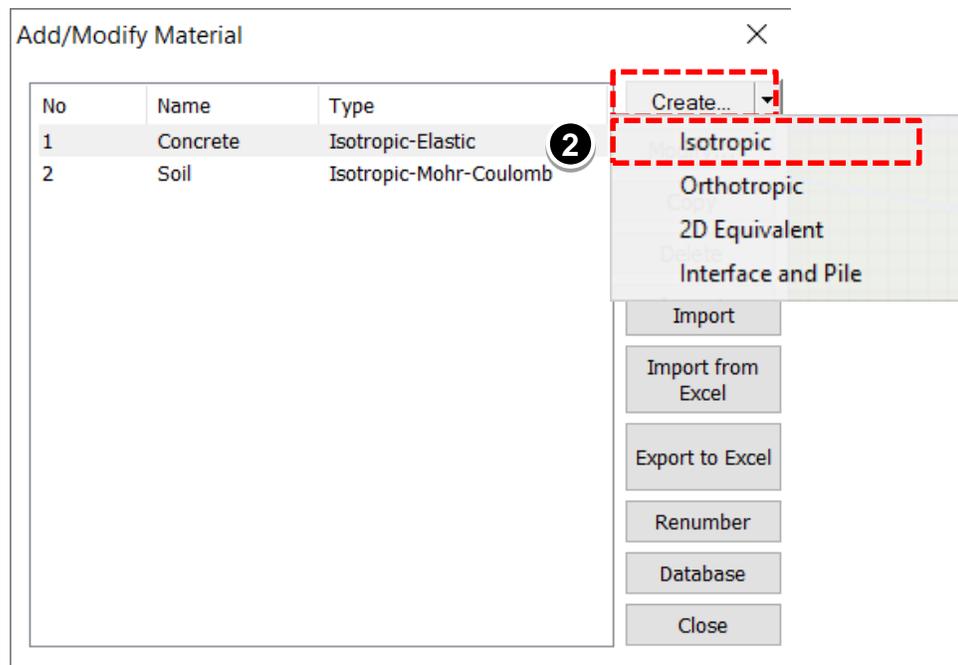
Pressure Rankine

➎ OK Cancel Apply

Procedure

Defining Soil Materials

- ① Go to Mesh > Material
- ② Click on Create. Select **Isotropic**.
- ③ Select Model type as **ELASTIC** & Click on **STRUCTURE** BOX.
- ④ Name it as **CONCRETE**.
- ⑤ Click **OK**.

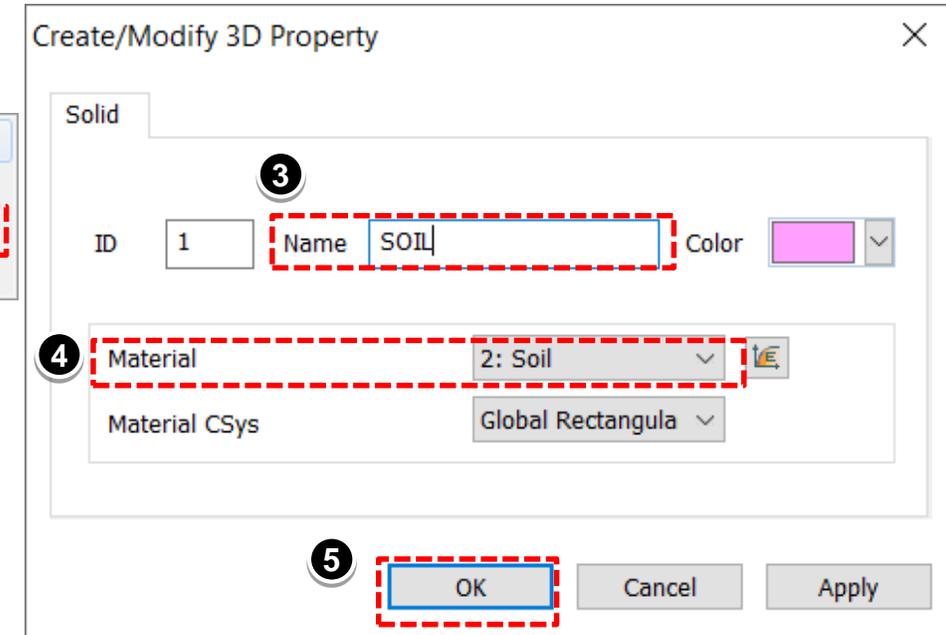
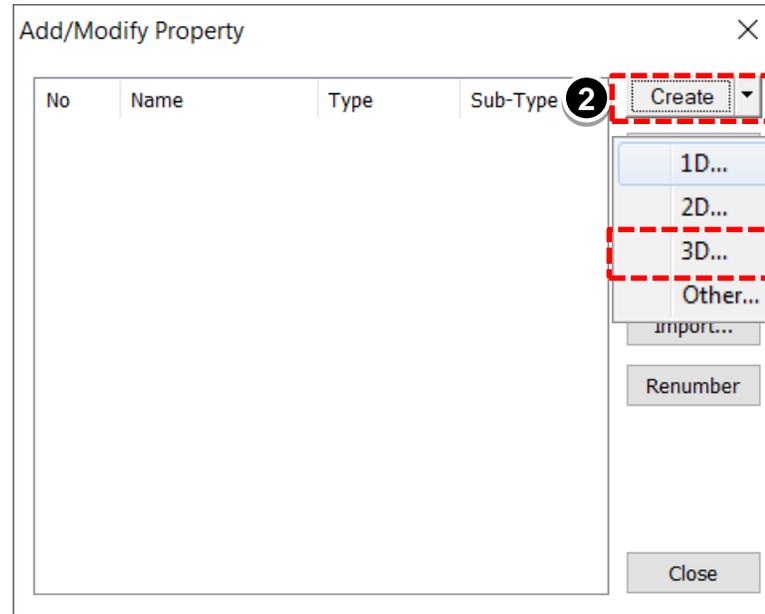


3-1 Defining 3D Property (SOIL)

Procedure

Defining Property

- ① Go to Mesh>Click on Property
- ② Click on Create. Select 3D
- ③ Name it as **SOIL**
- ④ Select **SOIL** from Material drop-down menu.
- ⑤ Click **OK**.



3-2 Defining 2D LINING Property

Procedure

Defining Property

- ① Go to Mesh>Click on Property
- ② Click on Create. Select 2D
- ③ Click on **Shell**.
- ④ Name it as **LINING**.
- ⑤ Select material as **CONCRETE**.
- ⑥ Enter T/T1 as **0.25 m**.
- ⑦ Click **Apply**.

SIMILARLY CREATE SHELL PROPERTY AND NAME IT AS INTERSECTION LINING AND ENTER T/T1 AS 0.5m AND CLICK OK.

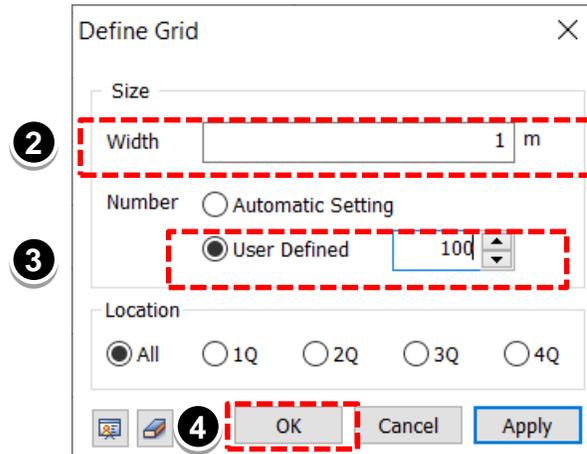
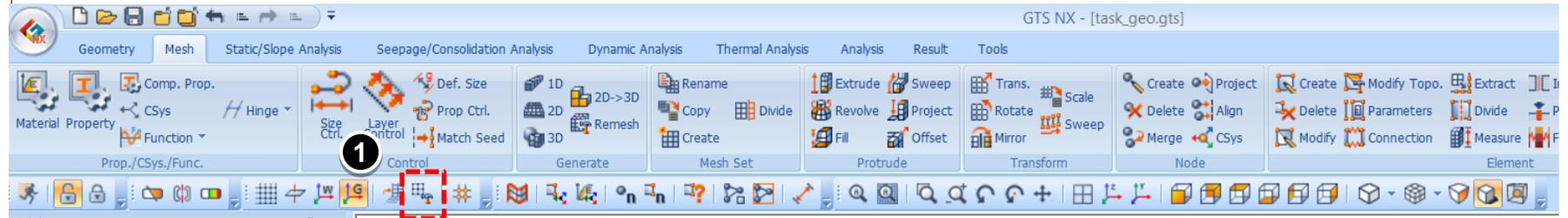
The screenshot shows the software interface with the following elements:

- Menu Bar:** Geometry, Mesh, Static/Slope Analysis, Seepage/Consolidation Analysis, Dynamic Analysis, Thermal Analysis, Analysis, Result, Tools.
- Toolbar:** Material, Property, CSys, Hinge, Def. Size, Prop. Ctrl., Match Seed, 1D, 2D, 3D, Remesh, Rename, Copy, Divide, Create, Mesh Set, Extrude, Sweep, Revolve, Project, Fill, Offset, Protrude.
- Add/Modify Property Dialog (Step 2):** A table with columns No, Name, Type, Sub-Type. A 'Create' dropdown menu is open, showing options: 1D..., 2D..., 3D..., Other..., Import..., Renumber, Close.
- Create/Modify 2D Property Dialog (Steps 3-7):**
 - Plot Only(2D):** Shell (selected), Plane Stress, Plane Strain, Geogrid(2D).
 - Gauging Shell:** (Empty)
 - Axisymmetric:** (Empty)
 - ID:** 7, **Name:** LINING, **Color:** Yellow.
 - Material:** 1: Concrete.
 - Material CSys:** CSys (selected), Element CSys (dropdown), Angle (radio button), 0 [deg].
 - Thickness:**
 - Uniform Thickness
 - Base Function:** None (dropdown)
 - T/T1:** 0.25 m
 - T2:** 1 m
 - T3:** 1 m
 - T4:** 1 m
 - Buttons:** OK, Cancel, Apply.

4-1 Geometric Modelling- Redefining Grid Size

Procedure

- 1 Go to Geometry > Point
- 2 Enter width as 1m.
- 3 Click **user defined** and enter 100.
- 4 Click OK.



4-2 Geometric modelling-Creation of Circle

Procedure

- ① Go to Geometry > Circle
- ② Select Method as **Input Center Location and Radius**.
- ③ Enter the Location as **0,0**.
- ④ Click **Apply**.
- ⑤ Enter the Radius as **2.8**.
- ⑥ Click on **Make Face**.
- ⑦ Click **OK**.

The image illustrates the software interface for creating a circle. The top toolbar shows the 'Geometry' tab selected, with the 'Circle' icon highlighted. Below the toolbar are two dialog boxes for creating a circle.

Dialog 1 (Left): Shows the 'Input Center Location' method. The 'Location' field is set to '0,0'. The 'Apply' button is highlighted.

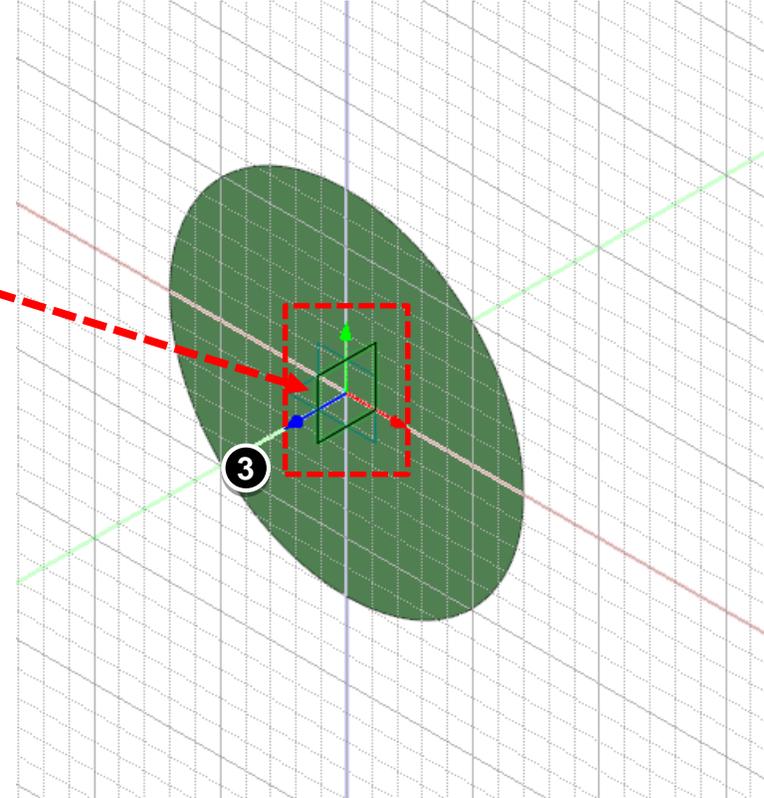
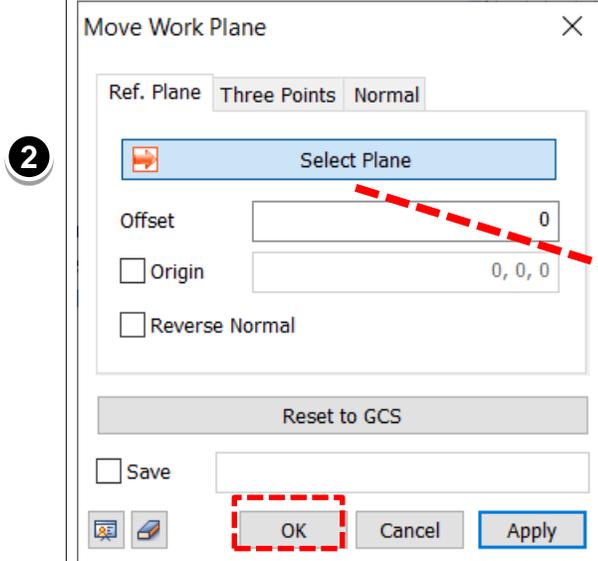
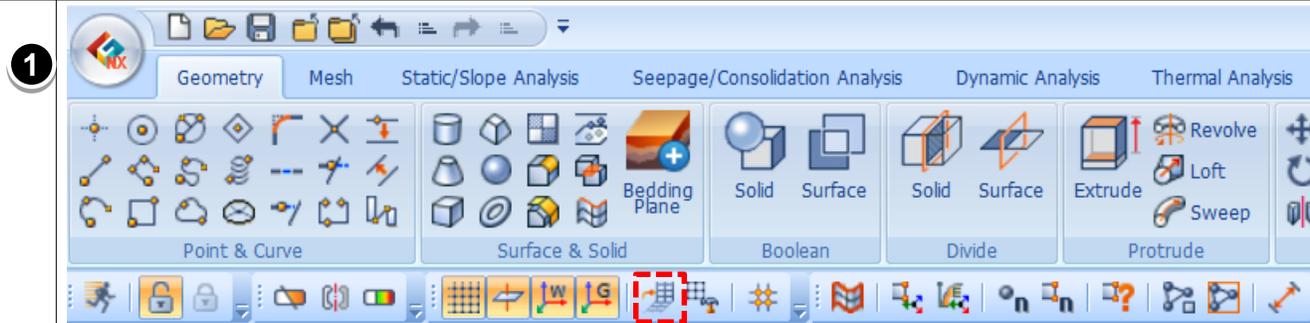
Dialog 2 (Right): Shows the 'Input Radius' method. The 'Radius' field is set to '2.8'. The 'Make Face' checkbox is checked. The 'OK' button is highlighted.

A red dashed arrow points from the 'OK' button in the second dialog to a 3D view of a green circle on a grid.

4-3 Geometric modelling-Changing the Work Plane

Procedure

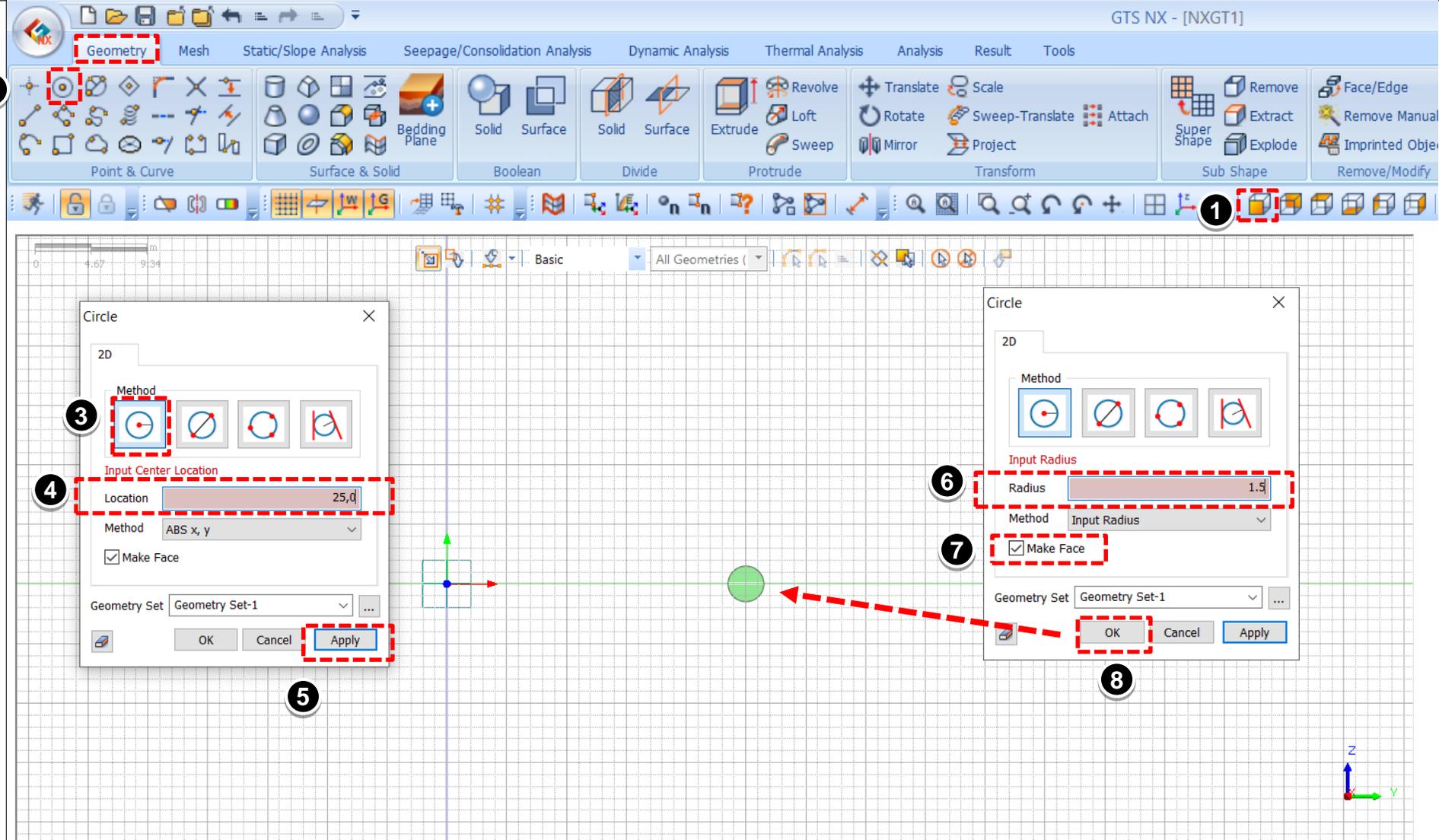
- 1 Go to **Move Work Plane**.
- 2 Click on **Select Plane**.
- 3 Select the plane as shown.
- 4 Click **OK**.



4-4 Geometric modelling- Creation of Cross Passage Section Circle

Procedure

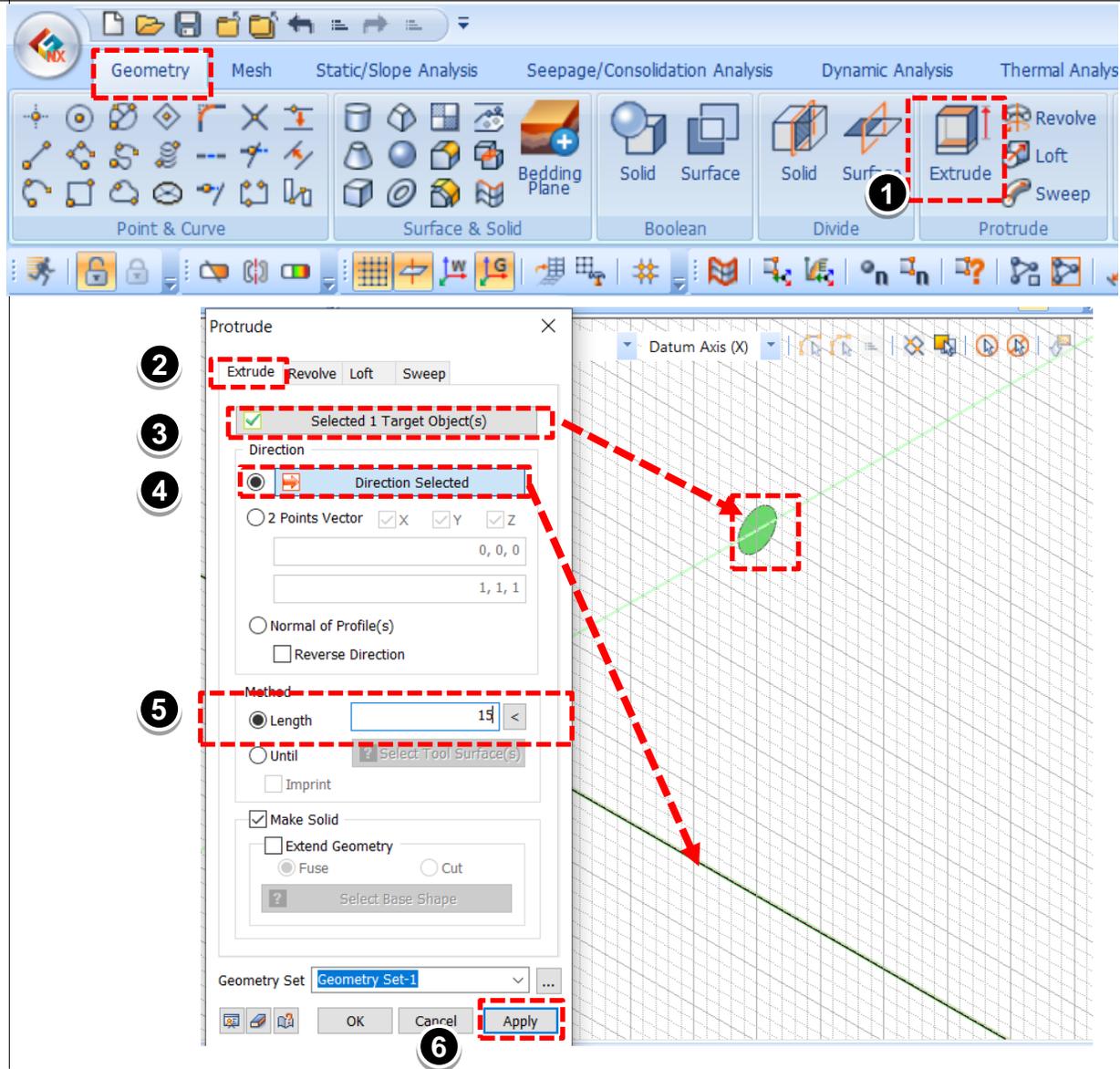
- ① Click on Front View.
- ② Go to Geometry > Circle
- ③ Select Method as **Input Center Location and Radius**.
- ④ Enter the Location as **25,0**.
- ⑤ Click **Apply**.
- ⑥ Enter the Radius as **1.5**.
- ⑦ Click on **Make Face**.
- ⑧ Click **OK**.



4-5 EXTRUSION – 2D TO 3D SOLIDS CREATION

Procedure

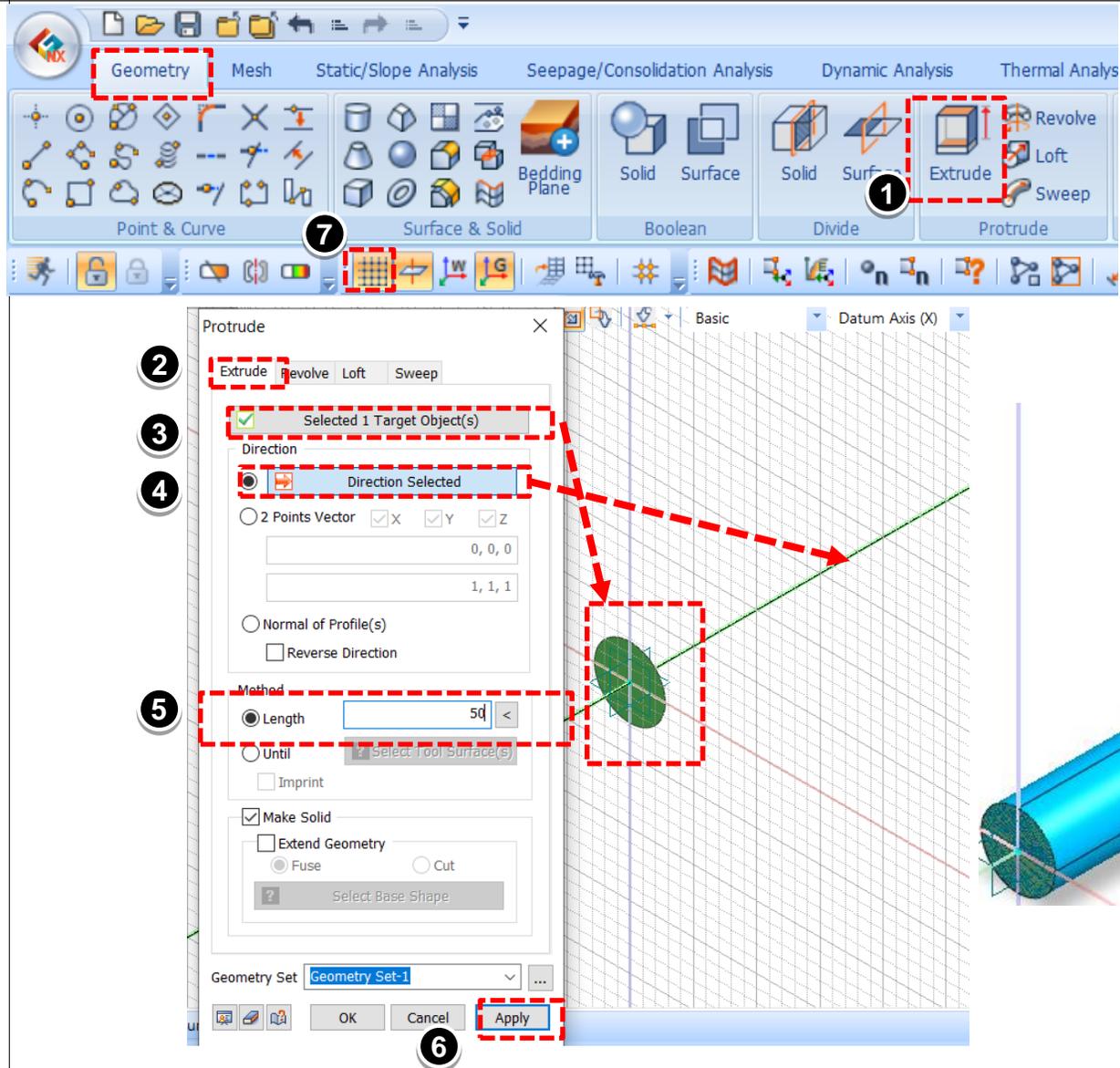
- ❶ Go to Geometry>Protrude>Extrude
- ❷ Select Extrude.
- ❸ Select the **cross passage 2D circle** as target object.
- ❹ Click on the **X-axis** as selected direction.
- ❺ Enter length as **15m**.
- ❻ Click **Apply**.



4-6 EXTRUSION – 2D TO 3D SOLIDS CREATION

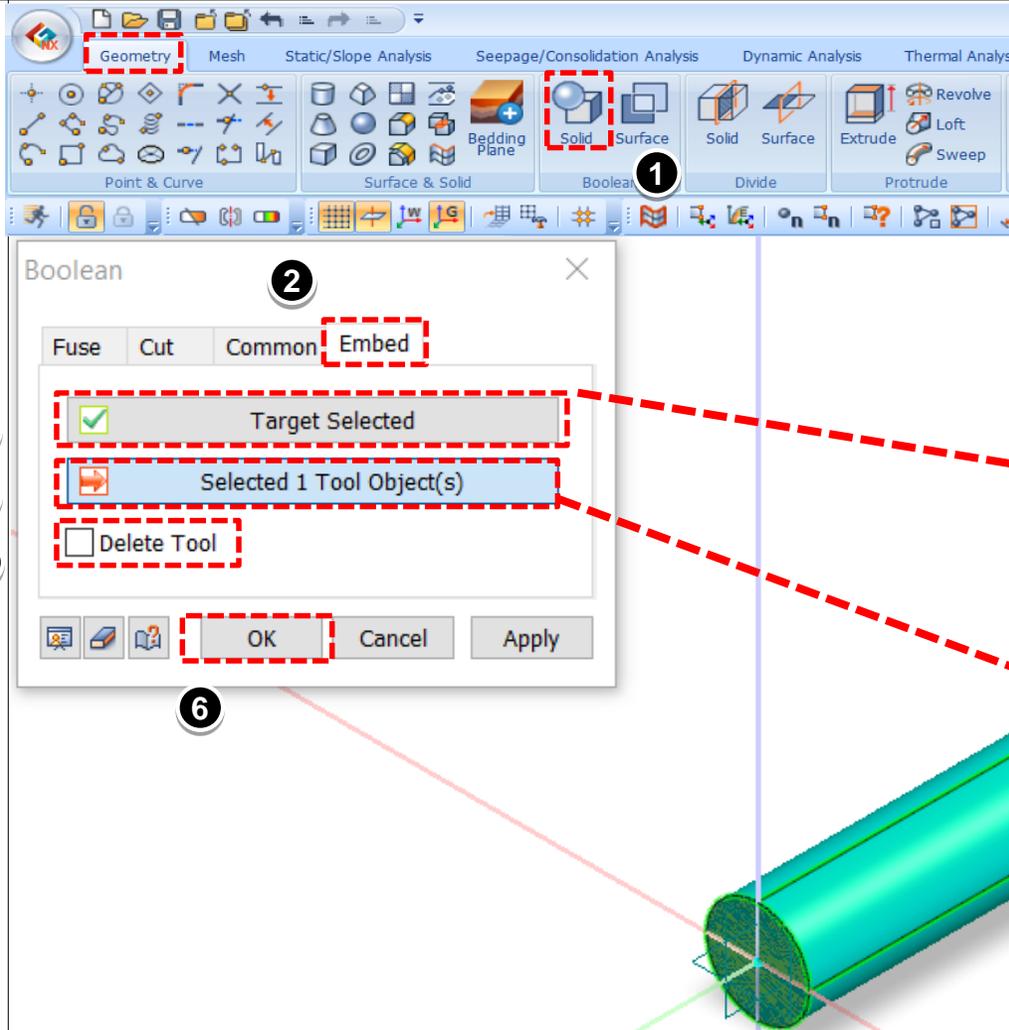
Procedure

- ➊ Go to Geometry>Protrude>Extrude
- ➋ Select Extrude.
- ➌ Select the **Main Tunnel 2D Circle** as target object.
- ➍ Click on the **Y-axis** as selected direction.
- ➎ Enter length as **50m**.
- ➏ **Click Apply.**
- ➐ Click to activate/deactivate the grid.



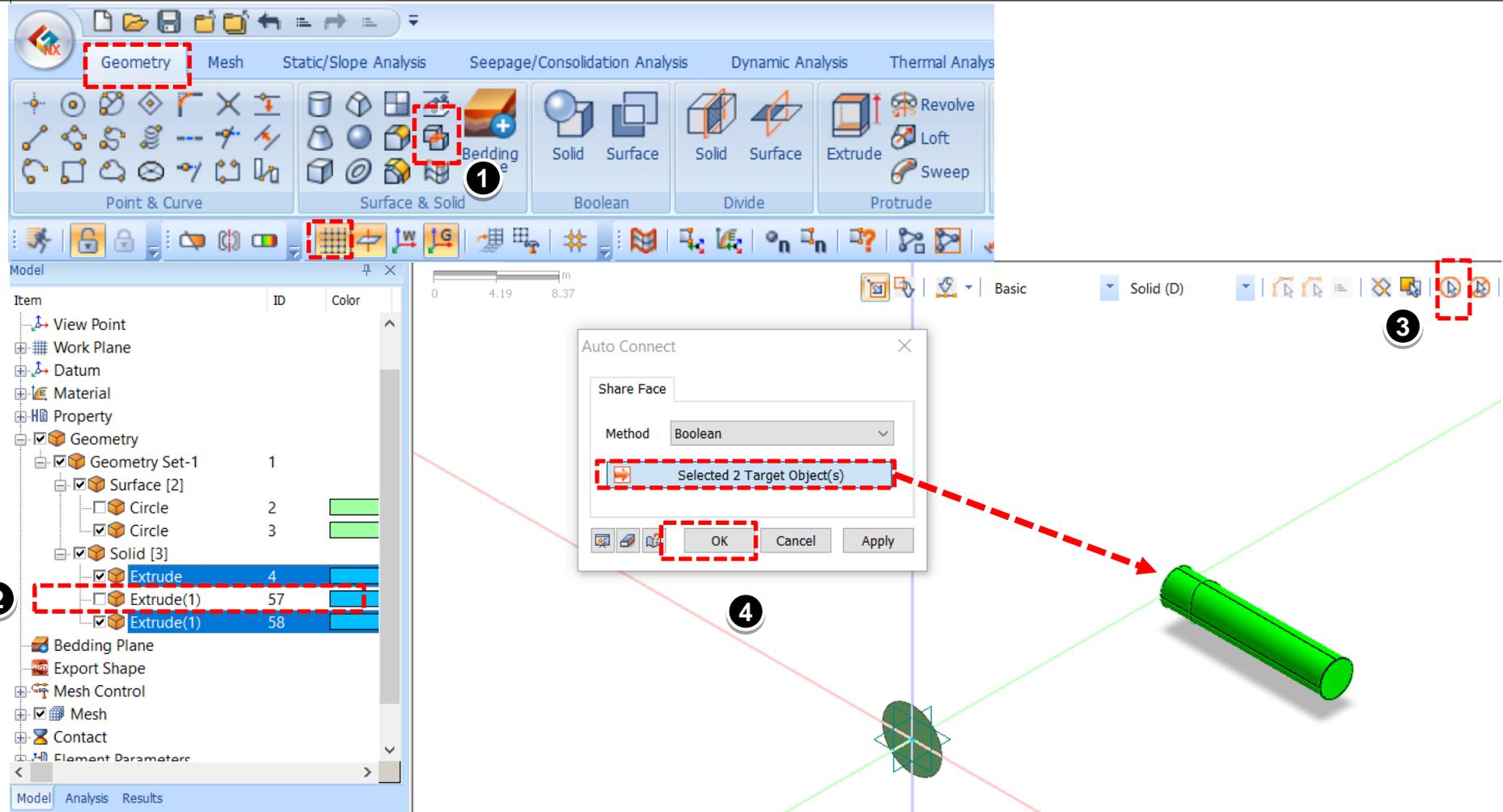
Procedure

- ① Go to Geometry>Boolean>Solid
- ② Select Embed.
- ③ Select the **Main Tunnel** as target object.
- ④ Select the **Cross Passage** as target object.
- ⑤ Deactivate Delete Tool.
- ⑥ Click OK.



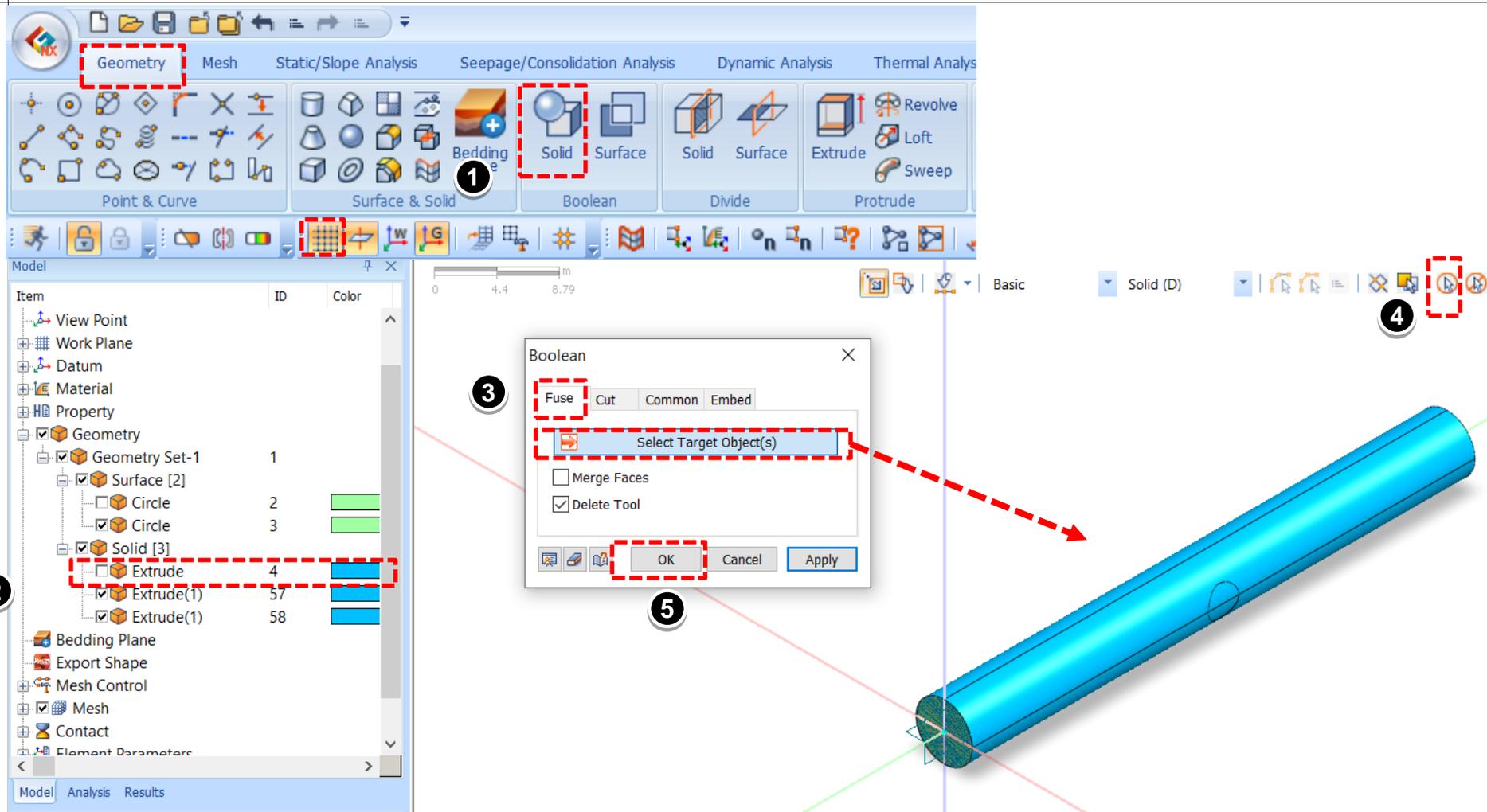
Procedure

- ❶ Go to Geometry>AutoConnect.
- ❷ In the model tab, deactivate the main tunnel solid.
- ❸ Click on Select All and the two solids are selected.
- ❹ Click OK.



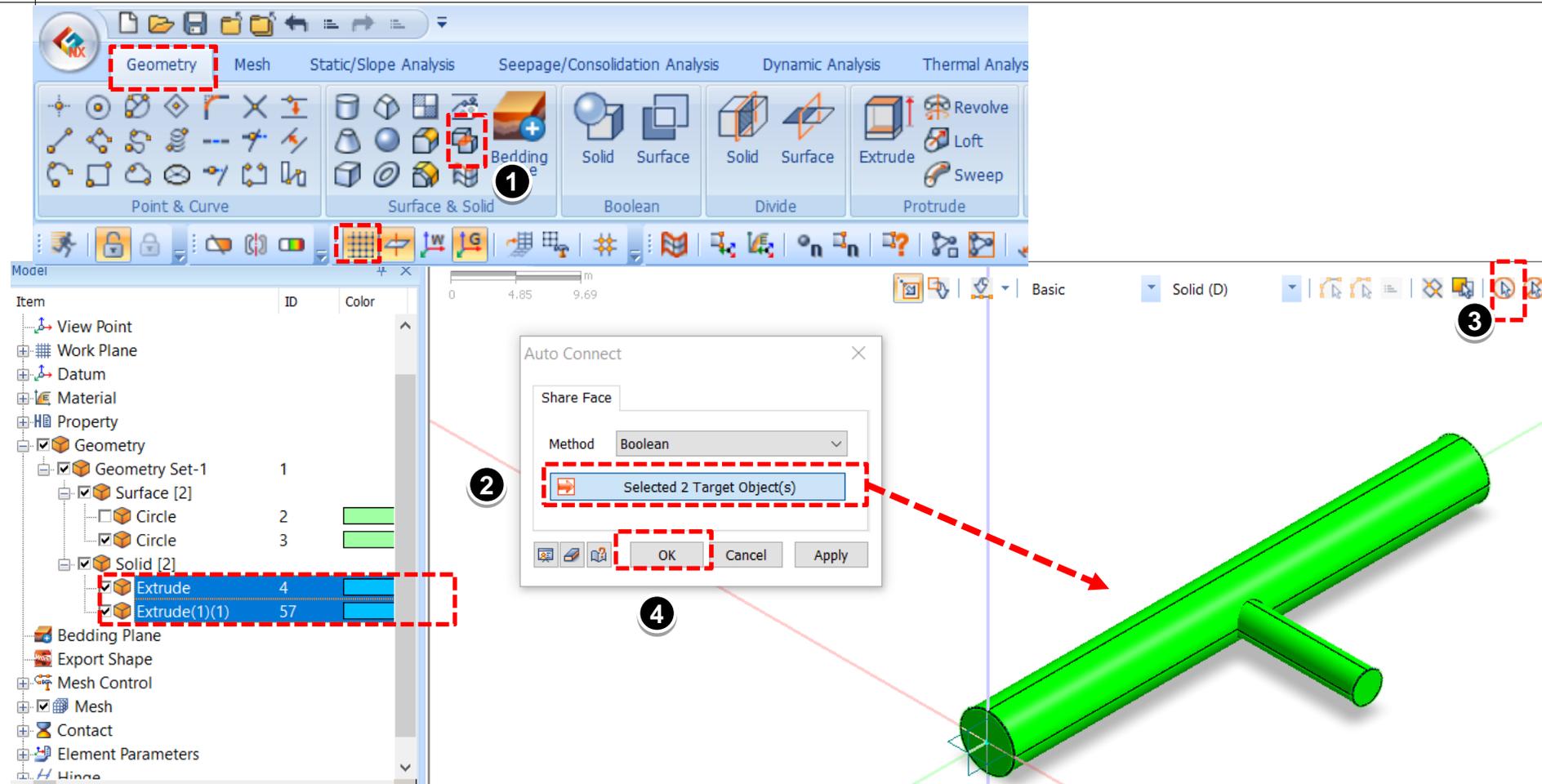
Procedure

- ❶ Go to Geometry>Solid. .
- ❷ In the model tab, deactivate the external cross passage solid.
- ❸ Select Fuse.
- ❹ Click on Select All and the two solids are selected.
- ❺ Click OK.



Procedure

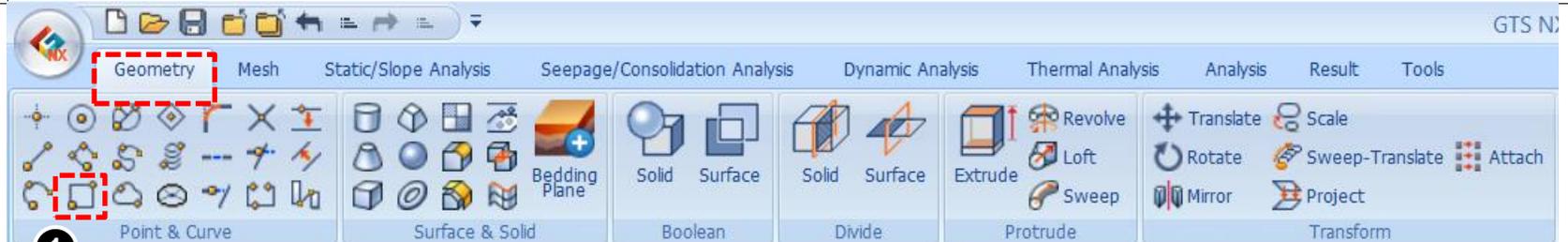
- ❶ Go to Geometry>Autoconnect.
- ❷ Select the two left solids, main tunnel & cross passage.
- ❸ Click Select All.
- ❹ Click OK.



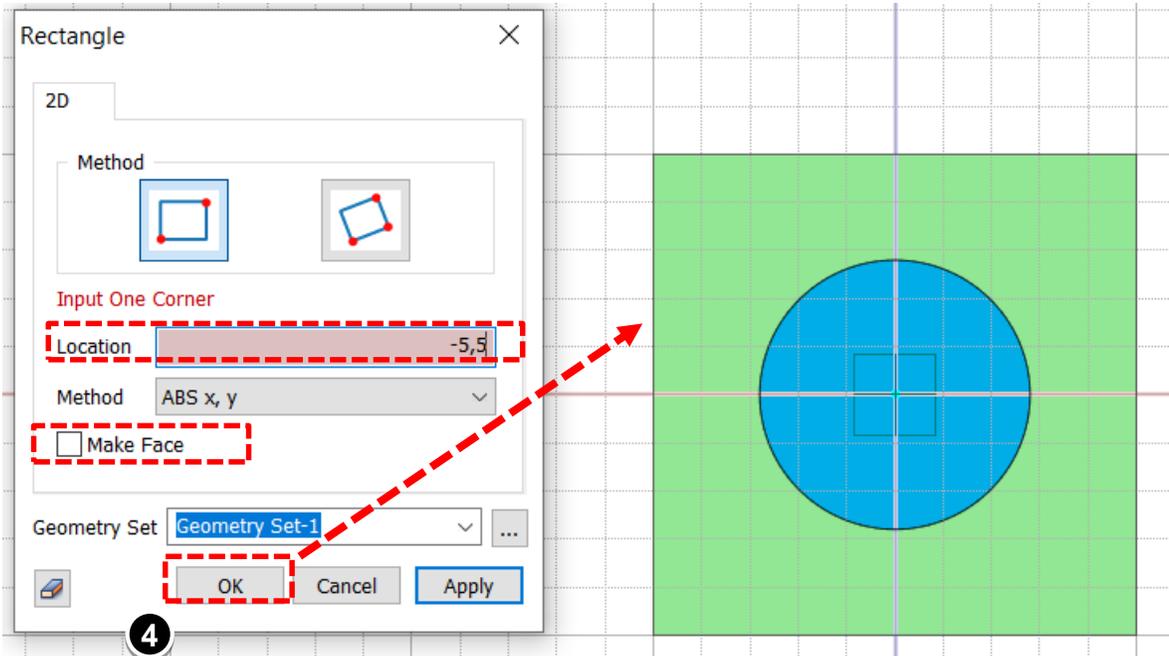
4-11 CUTTING PLANES CREATION

Procedure

- 1 Go to Geometry>Rectangle.
- 2 Input the corners as (-5,5), (5,-5) and Method as ABS x,y.
- 3 Click on **Make Face**.
- 4 Click OK.

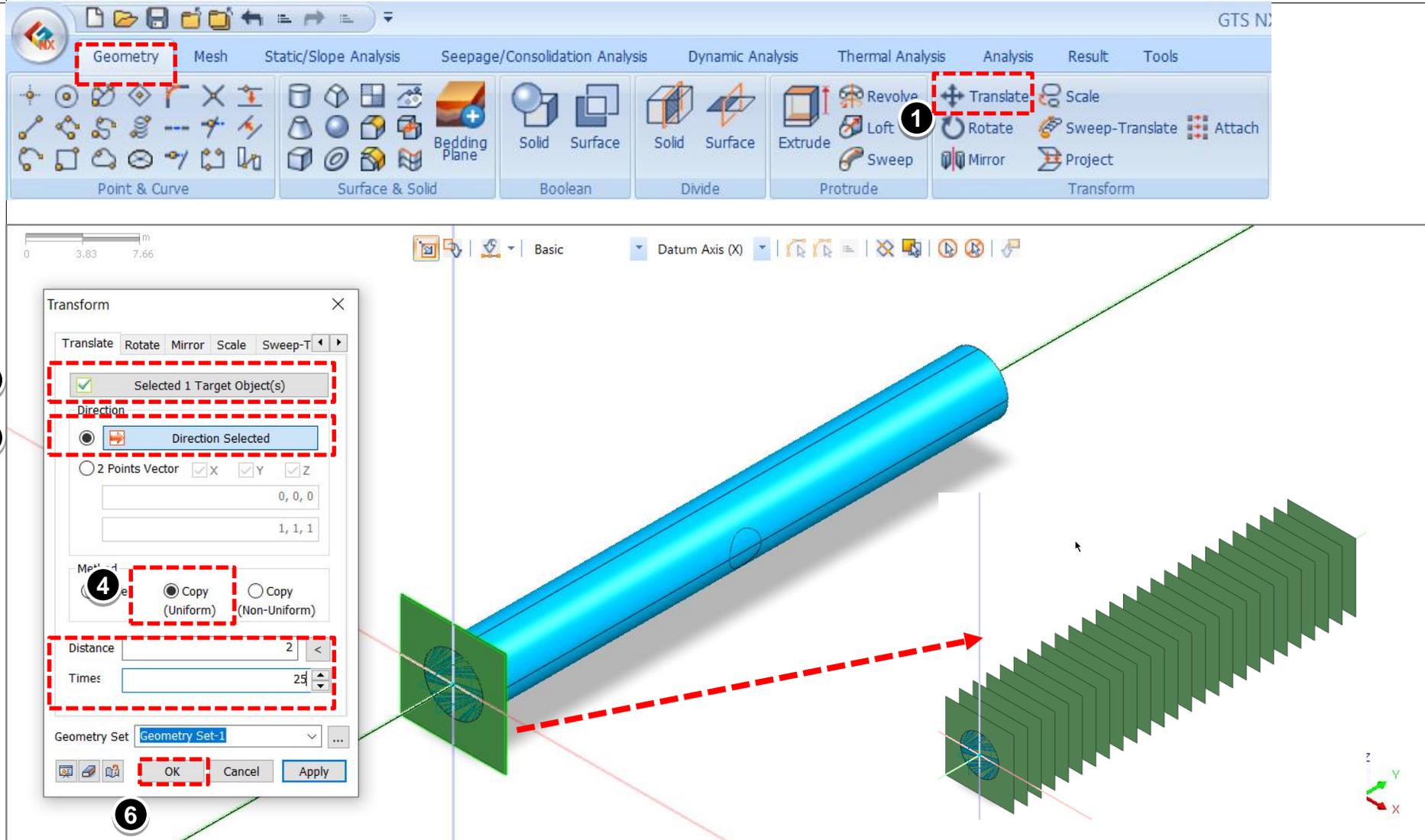


1



Procedure

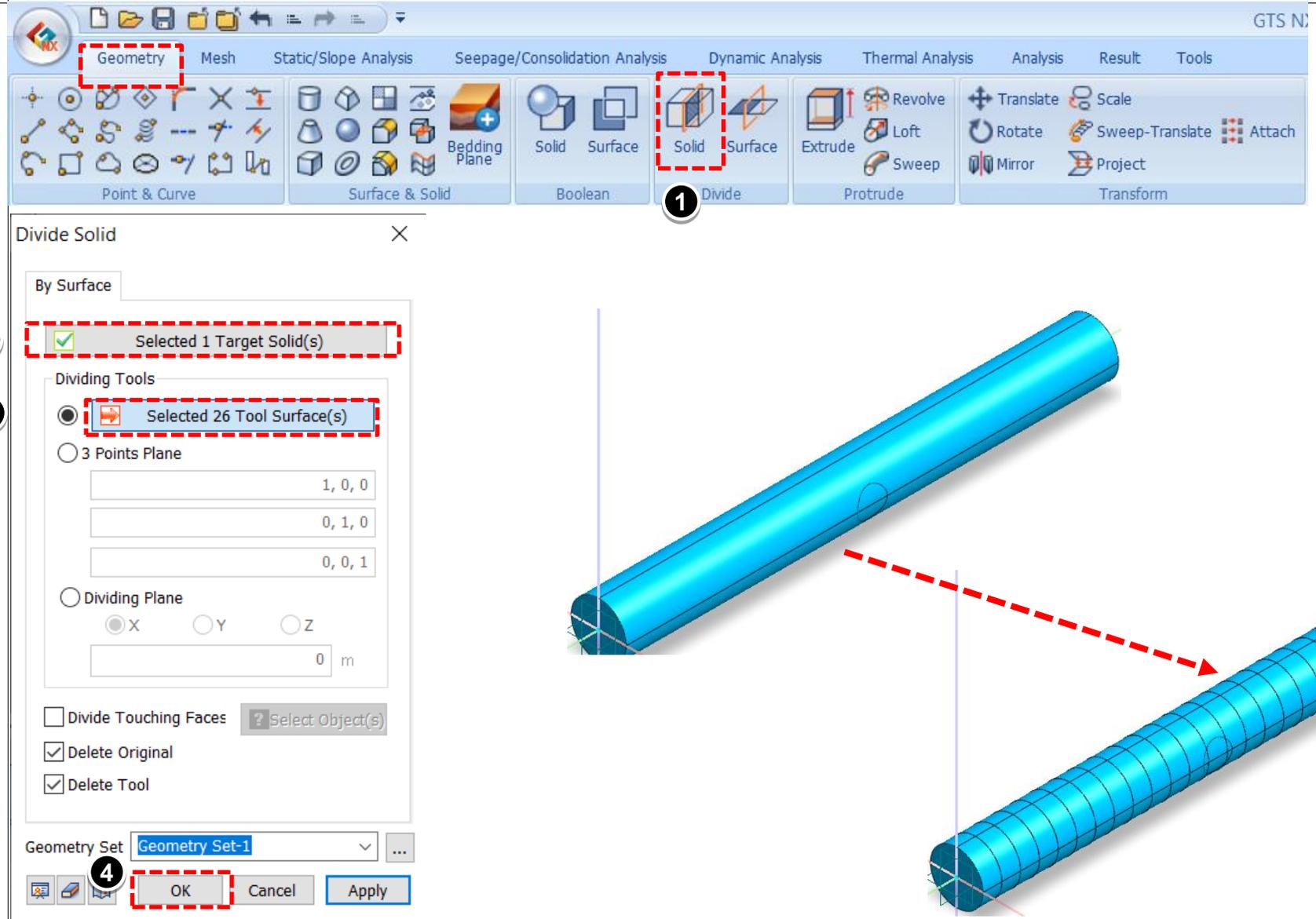
- ① Go to Geometry>Translate.
- ② Select the rectangle as target object..
- ③ Select the **Y-axis** as direction.
- ④ In the method tab, select **Copy**.
- ⑤ In distance, enter **2** and in Times enter **25**.
- ⑥ Click **OK**.



4-13 CUTTING SOLID INTO ADVANCEMENT SEGMENTS

Procedure

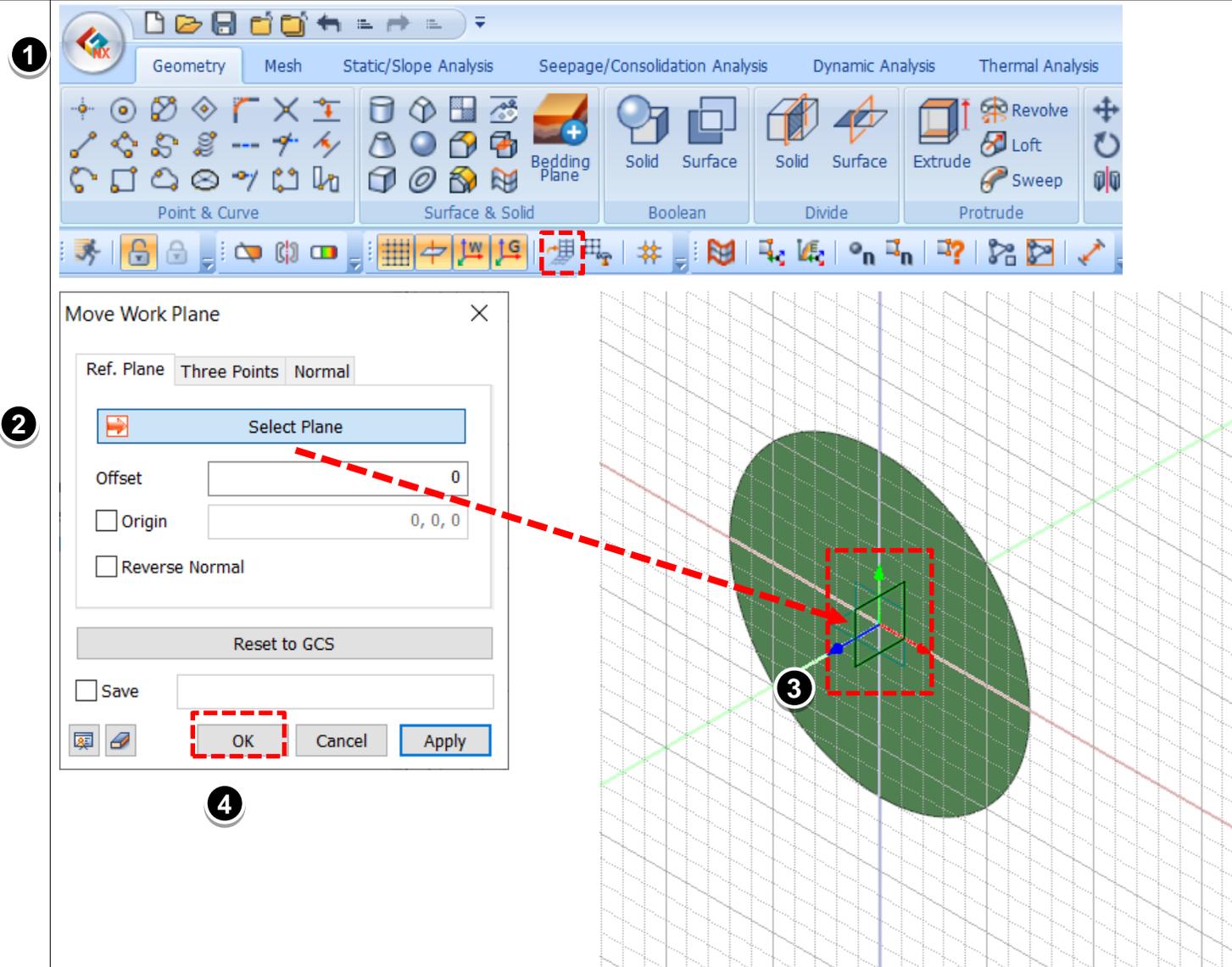
- ❶ Go to Geometry>Divide.
- ❷ Select the Main Tunnel Solid.
- ❸ Select all the cutting plane faces created in the previous step (4-12).
- ❹ Click OK.



4-14 Geometric modelling-Changing the Work Plane

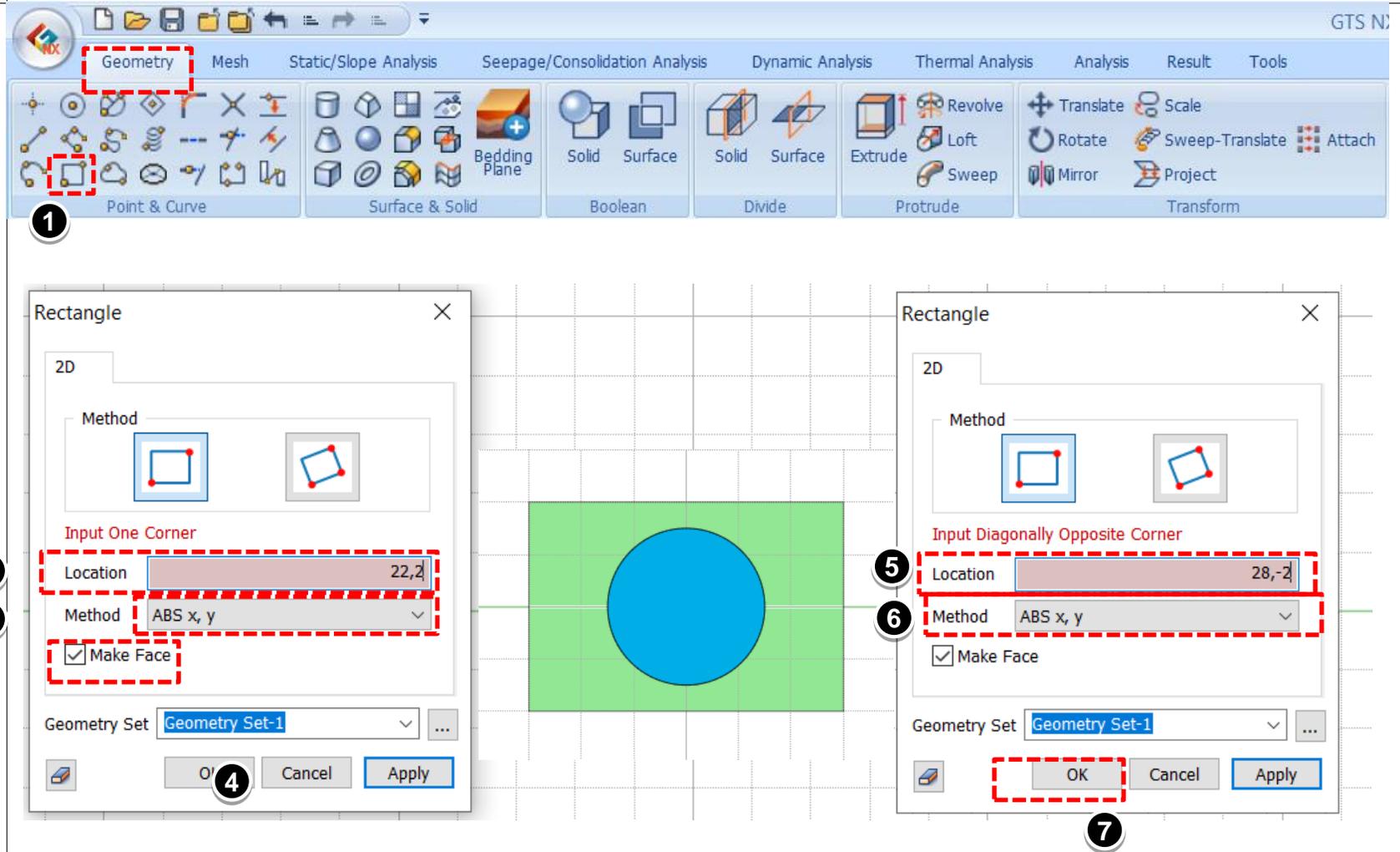
Procedure

- 1 Go to **Move Work Plane**.
- 2 Click on **Select Plane**.
- 3 Select the plane as shown.
- 4 Click **OK**.



Procedure

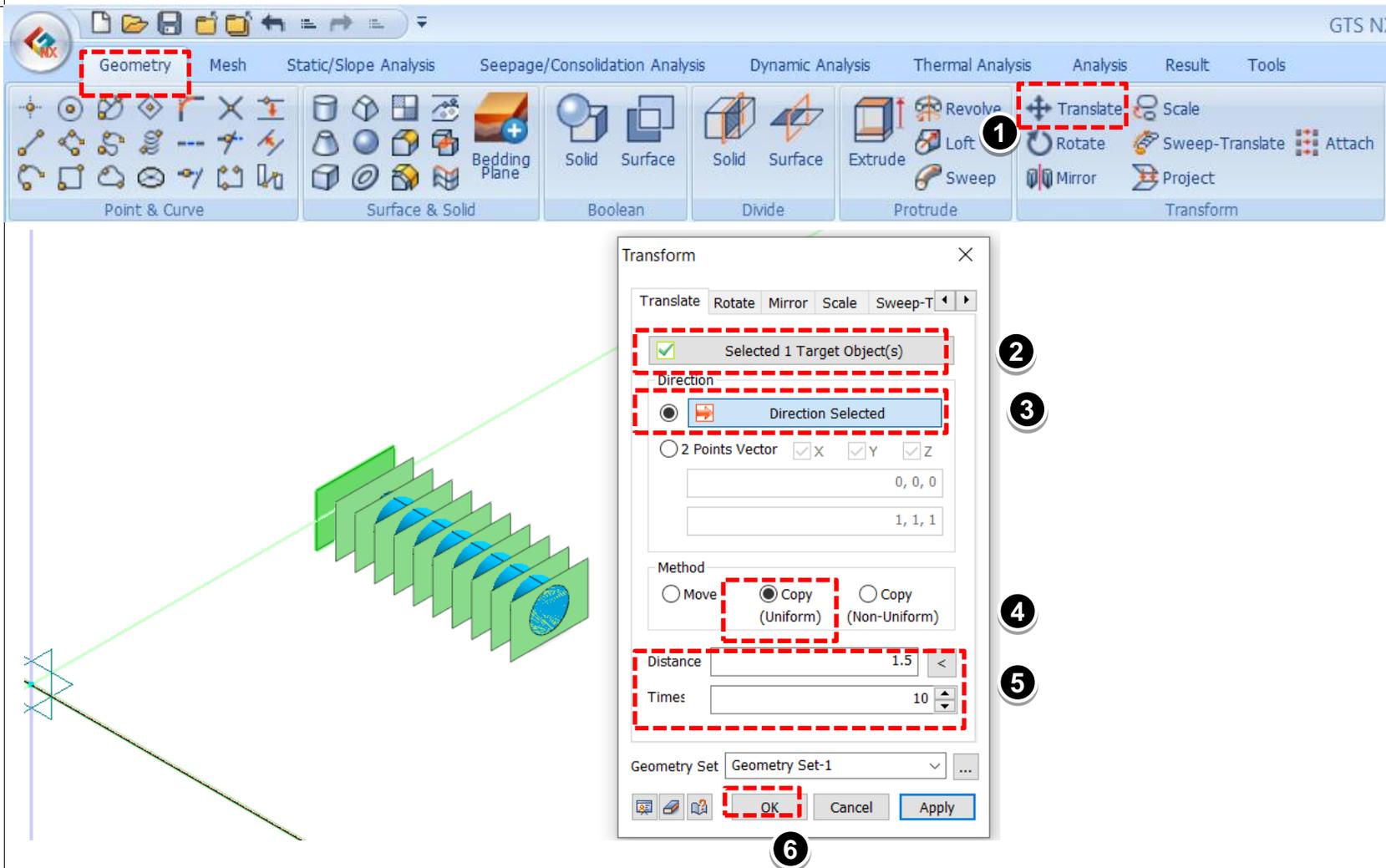
- ❶ Go to Geometry>Rectangle.
- ❷ Input the start corner as (22,2).
- ❸ Select the method as ABS x,y.
- ❹ Click on **Make Face**.
- ❺ Input the diagonally opposite corner as (28,-2).
- ❻ Select the method as ABS x,y.
- ❼ Click OK.



Procedure

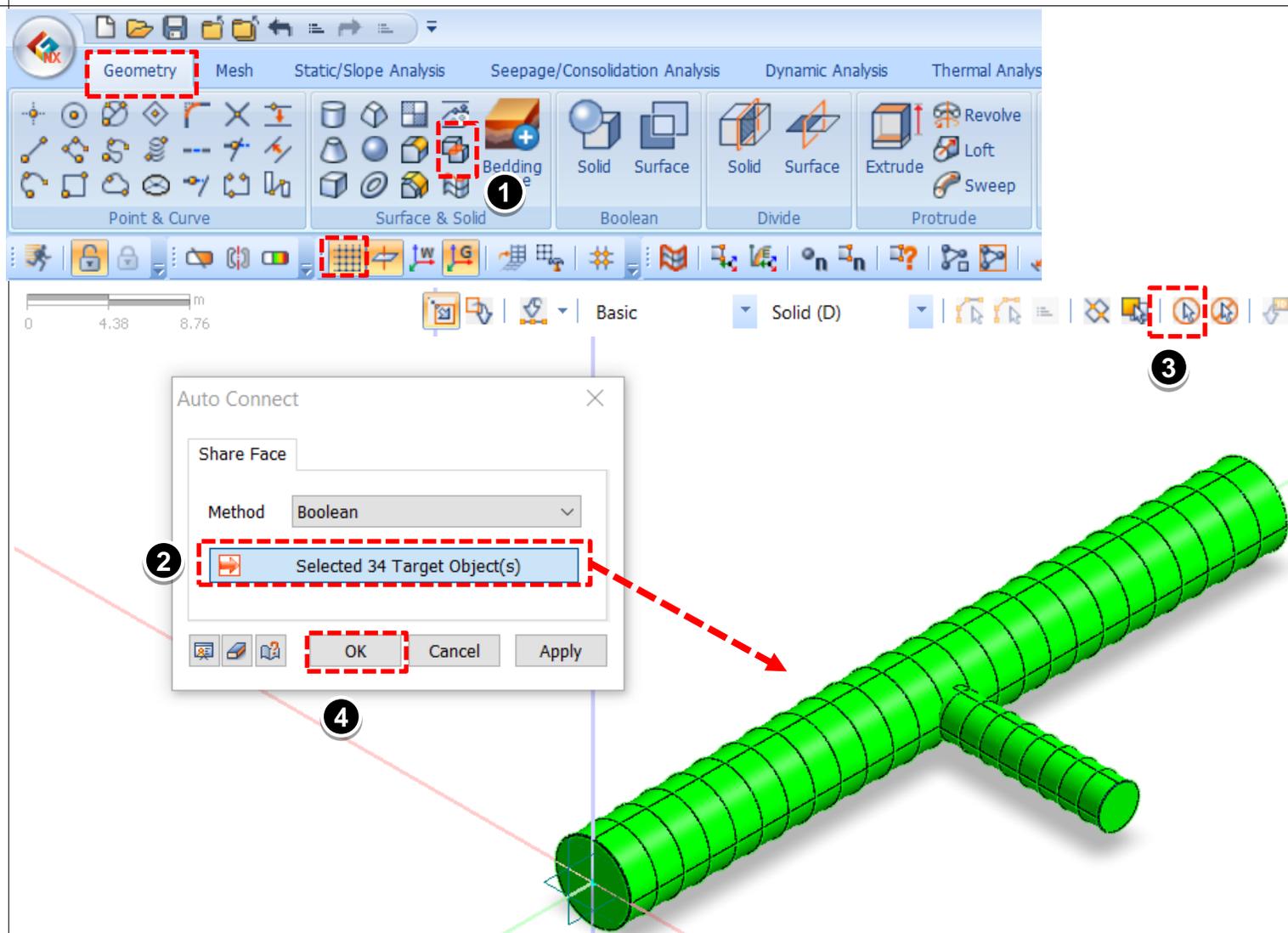
- ① Go to Geometry>Translate.
- ② Select the rectangle s target object..
- ③ Select the X-axis as direction.
- ④ In the method tab, select Copy.
- ⑤ In distance, enter 1.5 and in Times enter 10.
- ⑥ Click OK.

FOLLOW STEPS IN SLIDE 4-13 AND CUT THE CROSS PASSAGE INTO SEGMENTS.



Procedure

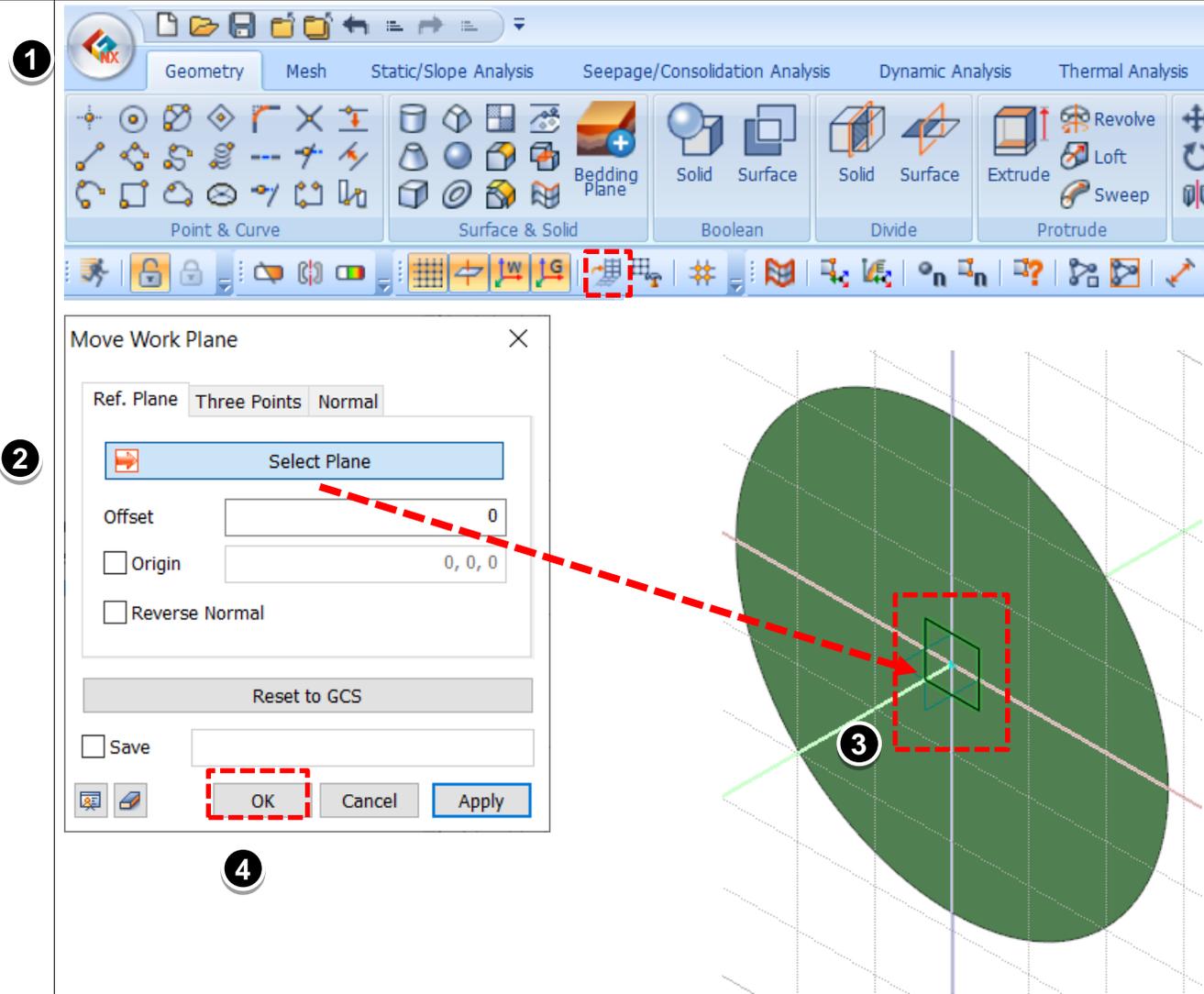
- 1 Go to Geometry>Autoconnect.
- 2 Select the two left solids, main tunnel & cross passage.
- 3 Click Select All.
- 4 Click OK.



4-18 Geometric modelling-Changing the Work Plane

Procedure

- 1 Go to **Move Work Plane**.
- 2 Click on **Select Plane**.
- 3 Select the plane as shown.
- 4 Click **OK**.



Procedure

- ❶ Go to Geometry>Rectangle.
- ❷ Input start corner as (-20,25).
- ❸ Select the method as ABS x,y.
- ❹ Click on **Make Face**.
- ❺ Input the diagonally opposite corner as (15,-25).
- ❻ Select the method as ABS x,y.
- ❼ Click OK.

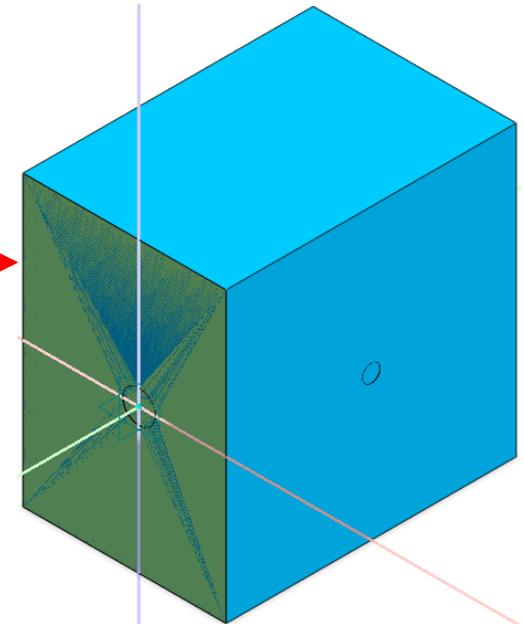
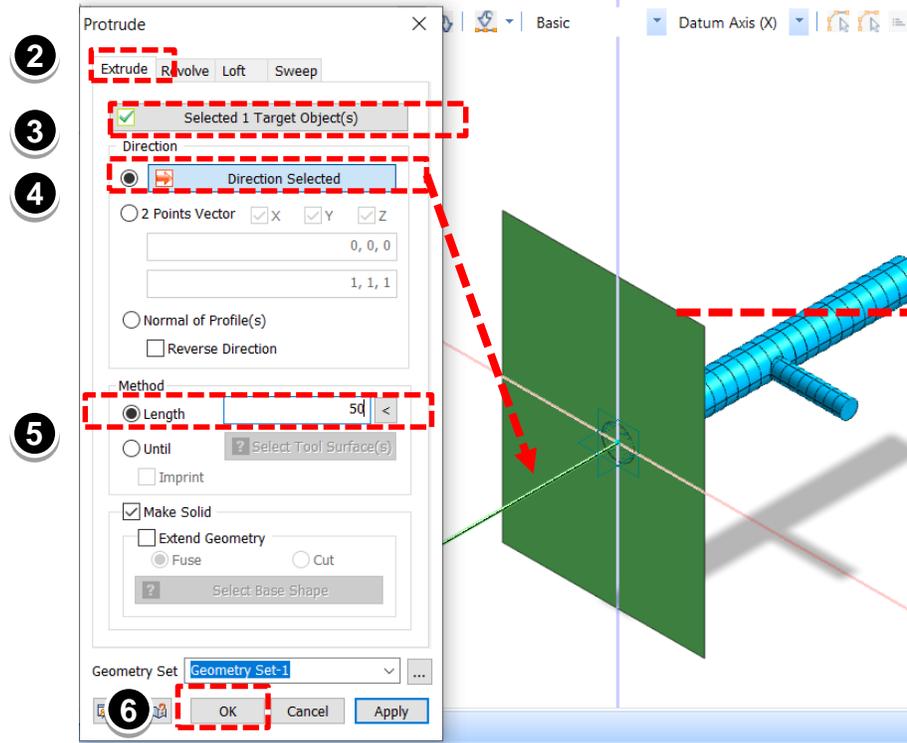
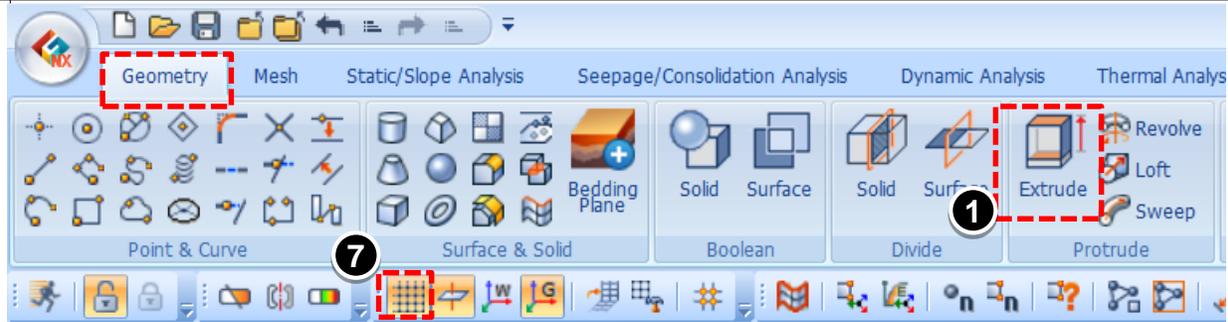
The screenshot displays the software interface for creating a main soil body. The 'Geometry' toolbar is visible at the top, with the 'Rectangle' icon highlighted by a red dashed box and a circled '1'. The 'Rectangle' dialog box is open, showing the 'Method' dropdown set to 'ABS x, y' and the 'Make Face' checkbox checked. The 'Location' field contains '-20,25'. The 'Geometry Set' dropdown is set to 'Geometry Set-1'. The 'OK' button is highlighted with a red dashed box and a circled '4'. The background shows a 3D model of a soil body with a blue cylinder and a red circle.

The 'Rectangle' dialog box is shown in two states:

- State 1 (Left):** The 'Location' field contains '-20,25'. The 'Method' dropdown is set to 'ABS x, y'. The 'Make Face' checkbox is checked. The 'OK' button is highlighted with a red dashed box and a circled '4'.
- State 2 (Right):** The 'Location' field contains '15,-25'. The 'Method' dropdown is set to 'ABS x, y'. The 'Make Face' checkbox is checked. The 'OK' button is highlighted with a red dashed box and a circled '7'.

Procedure

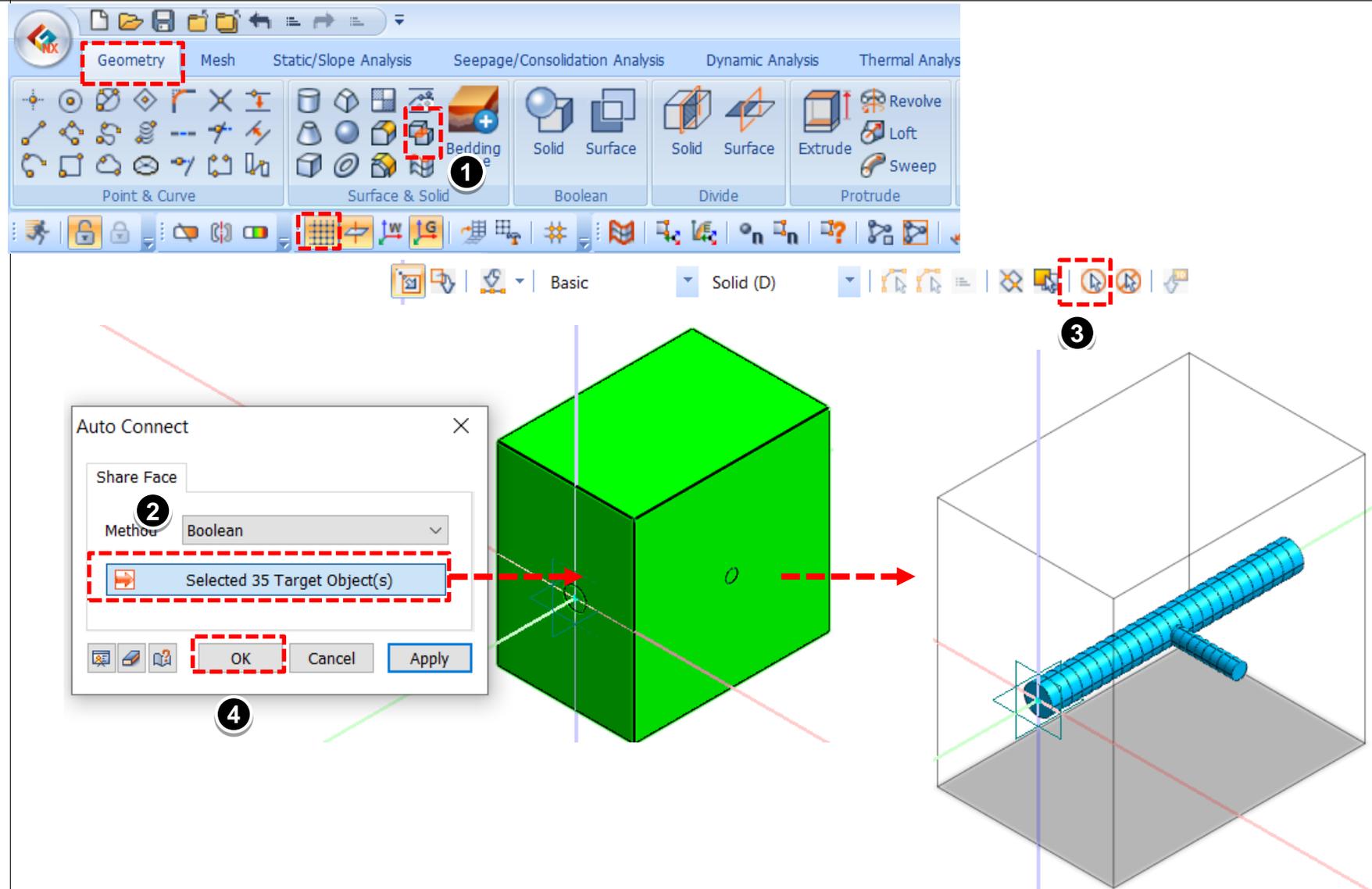
- ➊ Go to Geometry>Protrude>Extrude
- ➋ Select Extrude.
- ➌ Select the **Main Tunnel 2D Circle** as target object.
- ➍ Click on the **Y-axis** as selected direction.
- ➎ Enter length as **50m**.
- ➏ **Click Apply**.
- ➐ Click to activate/deactivate the grid.



4-21 CONNECTING ALL SOLIDS SEGMENTS

Procedure

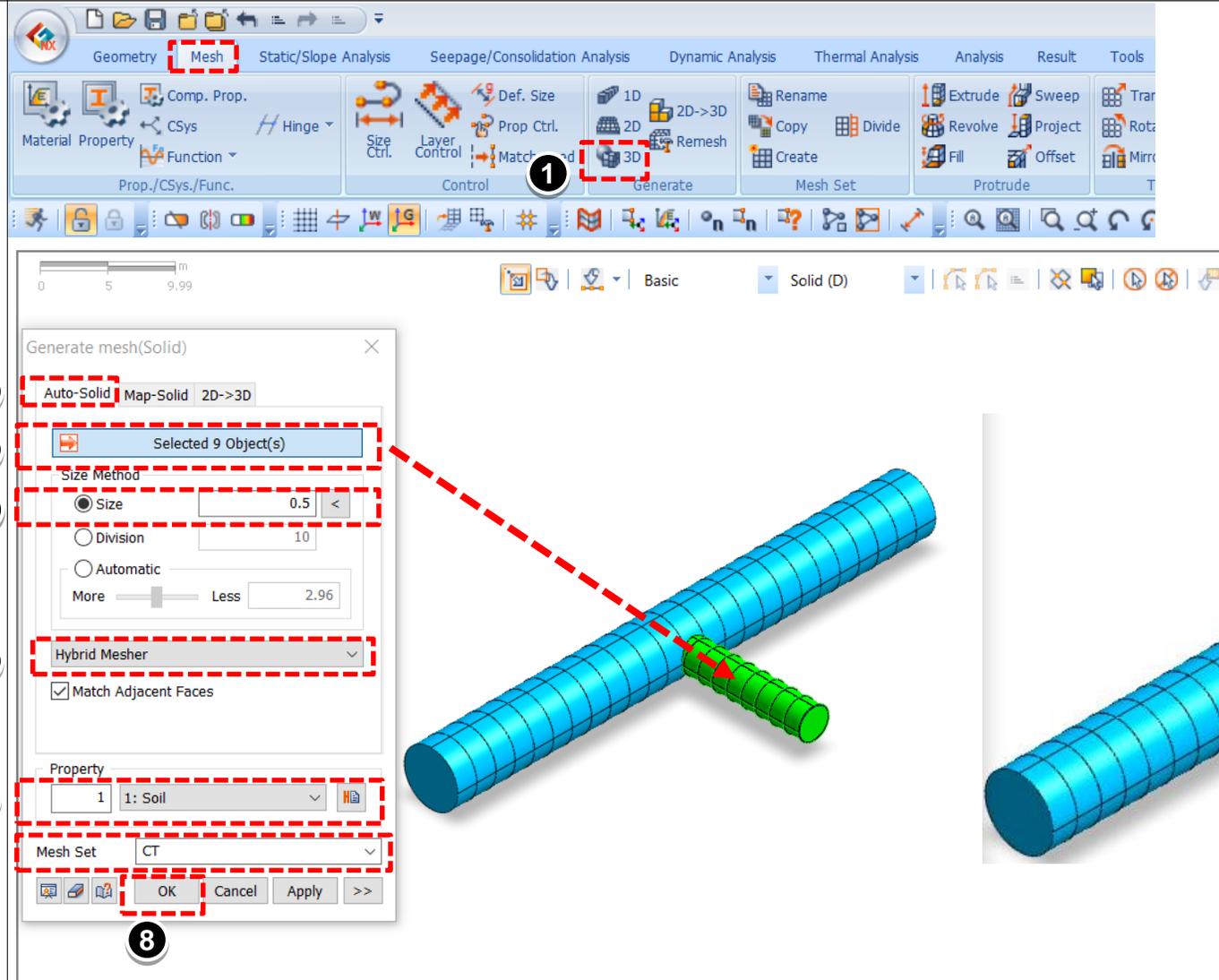
- 1 Go to Geometry>Autoconnect.
- 2 Select the solids in the model.
- 3 Click Select All.
- 4 Click OK.



5-1 Meshing Cross Passage Segments

Procedure

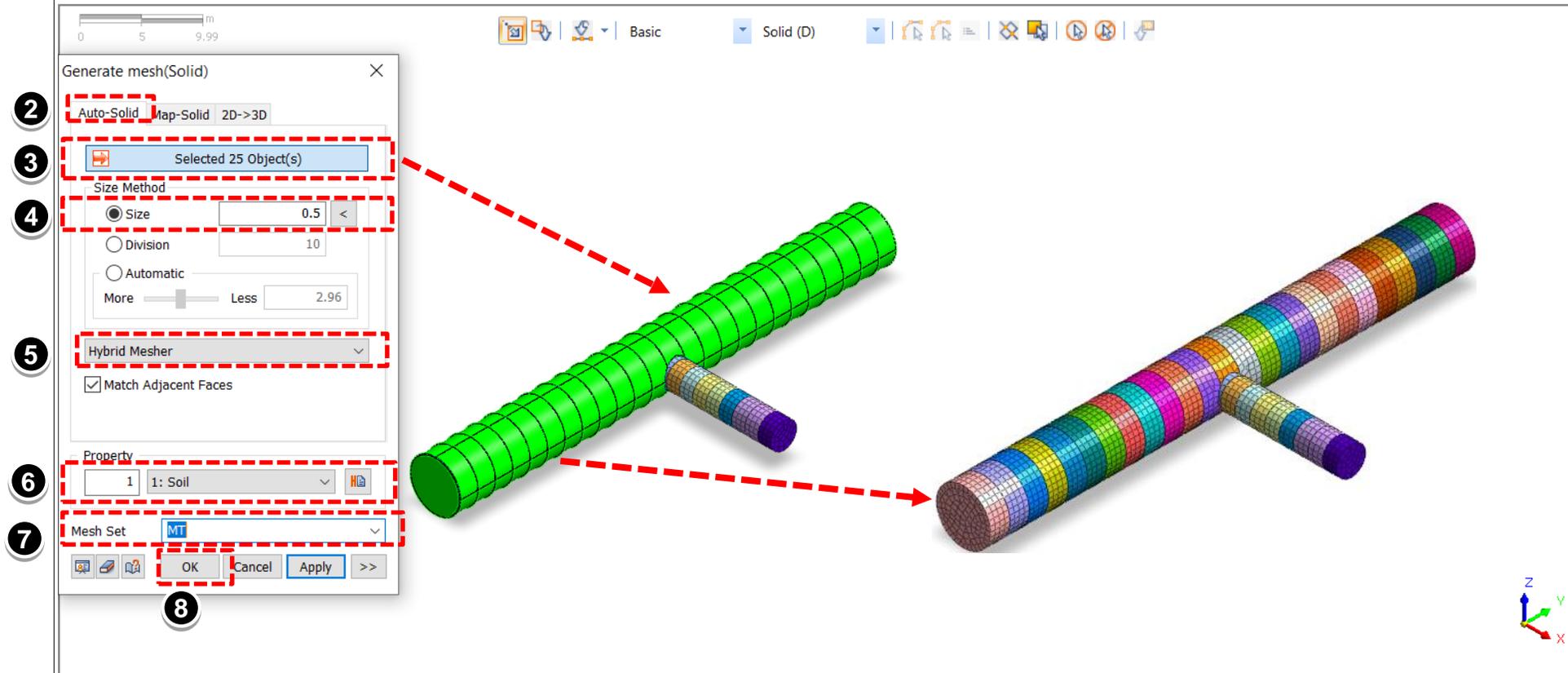
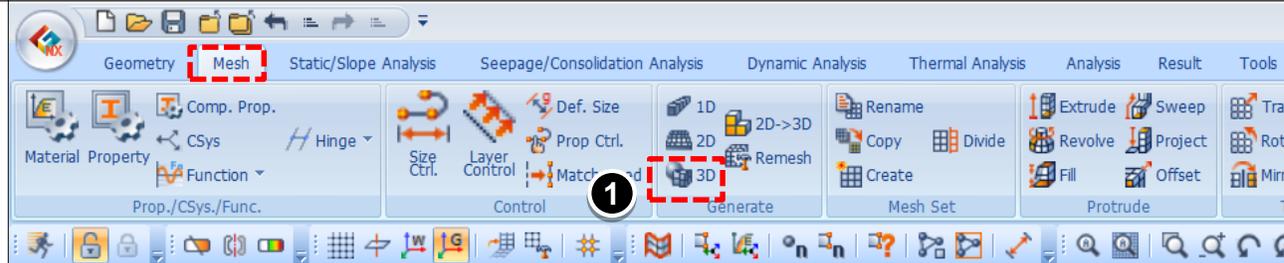
- 1 Go to Mesh > Generate > 3D
- 2 Select Auto-Solid.
- 3 Select the 9 segments of cross passage.
- 4 In the Size method give size 0.5 m.
- 5 Select Hybrid Mesher as the mesher type.
- 6 In the property drop-down menu, select **Soil**.
- 7 Give the Mesh set name "CT." GTS NX will automatically assign the names to the solid sections selected.
- 8 Click OK.



5-2 Meshing Main Tunnel Segments

Procedure

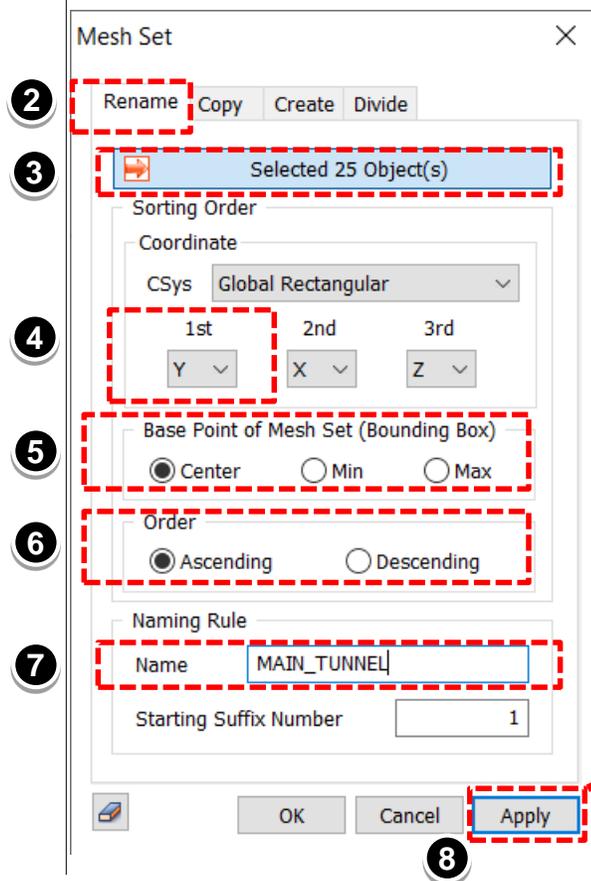
- 1 Go to Mesh > Generate > 3D
- 2 Select Auto-Solid.
- 3 Select the 25 segments of main tunnel.
- 4 In the Size method give size 0.5 m.
- 5 Select Hybrid Mesher as the mesher type.
- 6 In the property drop-down menu, select **Soil**.
- 7 Give the Mesh set name "MT." GTS NX will automatically assign the names to the solid sections selected.
- 8 Click OK.



5-3 Renaming Main Tunnel Segments

Procedure

- ❶ Go to Mesh > Rename
- ❷ Click on Rename.
- ❸ Select the 25 mesh sets for the **main tunnel segments**.
- ❹ In sorting order, start with **Y axis** as the 1st priority.
- ❺ Leave the base point as Center.
- ❻ Set the order as **Ascending**.
- ❼ Enter the name as **Main Tunnel**.
- ❽ Click **Apply**.



Item	ID	Color	
<input checked="" type="checkbox"/>	MAIN_TUNNEL-001	45	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-002	63	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-003	49	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-004	53	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-005	68	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-006	51	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-007	57	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-008	66	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-009	62	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-010	56	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-011	52	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-012	46	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-013	59	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-014	47	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-015	65	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-016	60	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-017	55	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-018	64	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-019	48	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-020	54	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-021	69	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-022	50	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-023	58	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-024	67	[Color]
<input checked="" type="checkbox"/>	MAIN_TUNNEL-025	61	[Color]

5-4 Renaming Cross Passage Segments

Procedure

- 1 Go to Mesh > Rename
- 2 Click on Rename.
- 3 Select the 9 mesh sets for the **cross passage segments**.
- 4 In sorting order, start with **X axis** as the 1st priority.
- 5 Leave the base point as Center.
- 6 Set the order as **Ascending**.
- 7 Enter the name as **Cross Tunnel**.
- 8 Click **OK**.

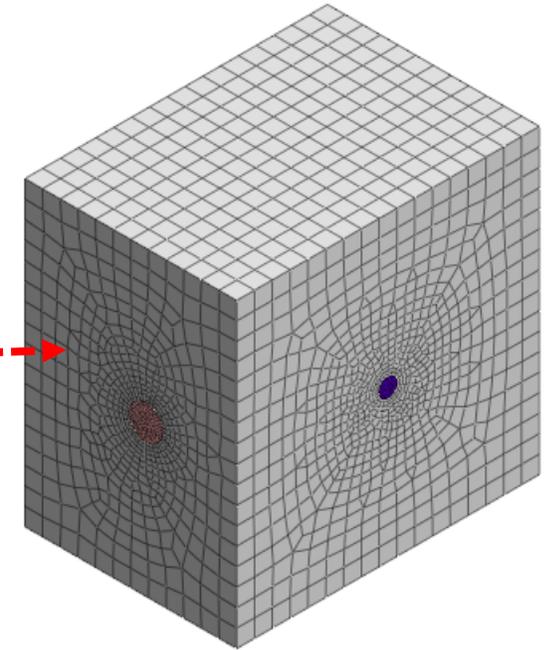
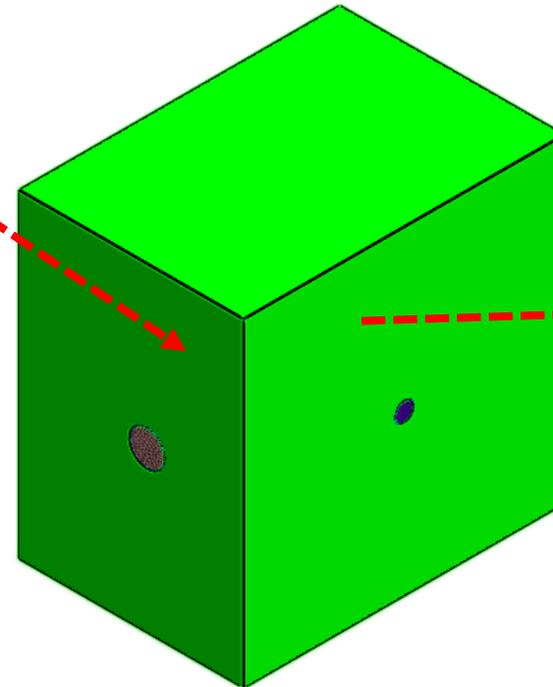
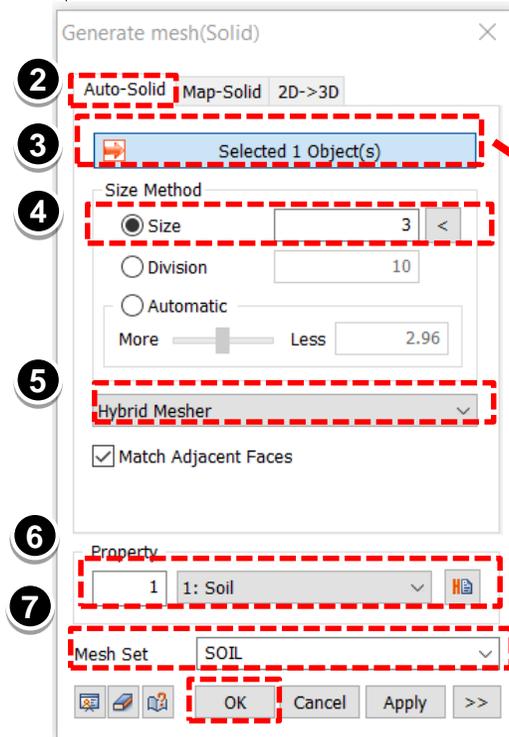
The screenshot shows the software interface with the 'Mesh Set' dialog box open. The 'Rename' button is highlighted with a red dashed box and a circled '2'. The 'Selected 9 Object(s)' list is highlighted with a red dashed box and a circled '3'. The 'Sorting Order' section is highlighted with a red dashed box and a circled '4', showing 'Coordinate' set to 'Global Rectangular', '1st' priority set to 'X', '2nd' to 'Y', and '3rd' to 'Z'. The 'Base Point of Mesh Set (Bounding Box)' section is highlighted with a red dashed box and a circled '5', showing 'Center' selected. The 'Order' section is highlighted with a red dashed box and a circled '6', showing 'Ascending' selected. The 'Naming Rule' section is highlighted with a red dashed box and a circled '7', showing 'Name' set to 'Cross_Tunnel' and 'Starting Suffix Number' set to 1. The 'OK' button is highlighted with a red dashed box and a circled '8'. A red dashed arrow points from the 'OK' button to the 'Item' list on the right, which shows the selected mesh sets: Cross_Tunnel-001 to Cross_Tunnel-009.

Item	ID	Color
<input checked="" type="checkbox"/> Cross_Tunnel-001	43	
<input checked="" type="checkbox"/> Cross_Tunnel-002	44	
<input checked="" type="checkbox"/> Cross_Tunnel-003	42	
<input checked="" type="checkbox"/> Cross_Tunnel-004	41	
<input checked="" type="checkbox"/> Cross_Tunnel-005	40	
<input checked="" type="checkbox"/> Cross_Tunnel-006	39	
<input checked="" type="checkbox"/> Cross_Tunnel-007	38	
<input checked="" type="checkbox"/> Cross_Tunnel-008	37	
<input checked="" type="checkbox"/> Cross_Tunnel-009	36	
<input checked="" type="checkbox"/> Default Mesh Set	1	
<input checked="" type="checkbox"/> MAIN_TUNNEL-001	45	
<input checked="" type="checkbox"/> MAIN_TUNNEL-002	63	
<input checked="" type="checkbox"/> MAIN_TUNNEL-003	49	
<input checked="" type="checkbox"/> MAIN_TUNNEL-004	53	
<input checked="" type="checkbox"/> MAIN_TUNNEL-005	68	
<input checked="" type="checkbox"/> MAIN_TUNNEL-006	51	
<input checked="" type="checkbox"/> MAIN_TUNNEL-007	57	
<input checked="" type="checkbox"/> MAIN_TUNNEL-008	66	
<input checked="" type="checkbox"/> MAIN_TUNNEL-009	62	
<input checked="" type="checkbox"/> MAIN_TUNNEL-010	56	
<input checked="" type="checkbox"/> MAIN_TUNNEL-011	52	
<input checked="" type="checkbox"/> MAIN_TUNNEL-012	46	
<input checked="" type="checkbox"/> MAIN_TUNNEL-013	59	
<input checked="" type="checkbox"/> MAIN_TUNNEL-014	47	
<input checked="" type="checkbox"/> MAIN_TUNNEL-015	65	
<input checked="" type="checkbox"/> MAIN_TUNNEL-016	60	
<input checked="" type="checkbox"/> MAIN_TUNNEL-017	55	
<input checked="" type="checkbox"/> MAIN_TUNNEL-018	64	
<input checked="" type="checkbox"/> MAIN_TUNNEL-019	48	
<input checked="" type="checkbox"/> MAIN_TUNNEL-020	54	
<input checked="" type="checkbox"/> MAIN_TUNNEL-021	69	
<input checked="" type="checkbox"/> MAIN_TUNNEL-022	50	

5-5 Meshing Soil Body

Procedure

- ❶ Go to Mesh > Generate > 3D
- ❷ Select Auto-Solid.
- ❸ Select the 9 segments of cross passage.
- ❹ In the Size method give size 3 m.
- ❺ Select Hybrid Mesher as the mesher type.
- ❻ In the property drop-down menu, select **Soil**.
- ❼ Give the Mesh set name **SOIL**.
- ❽ Click **Apply**.



5-6 Meshing-Extraction of SHELL Elements (MAIN TUNNEL LINING)

Procedure

- ① Go to Mesh>Element>Extract
- ② Change the type to **FACE**.
- ③ Select the four faces as shown in the enclosed box.
- ④ The property is **LINING**.
- ⑤ Name retaining wall mesh set as **MAIN_TUNNEL_LINING_1**.
- ⑥ Click **OK**.

REPEAT THE SAME STEPS FOR ALL THE MAIN TUNNEL SECTIONS TO CREATE SHELL ELEMENTS FOR THEM.

NOTE: WHILE CREATING THE INTERSECTION LINING, ENSURE THAT FOR THE MAIN TUNNEL SEGMENTS IN THAT PARTICULAR SECTION ARE SEPARATELY CREATED LEAVING THESE SEGMENTS, IN ORDER TO HAVE THE UNIFORMITY OF LINING.

1 Go to Mesh>Element>Extract

2 Change the type to **FACE**.

3 Select the four faces as shown in the enclosed box.

4 The property is **LINING**.

5 Name retaining wall mesh set as **MAIN_TUNNEL_LINING_1**.

6 Click **OK**.

7 Click **Apply**.

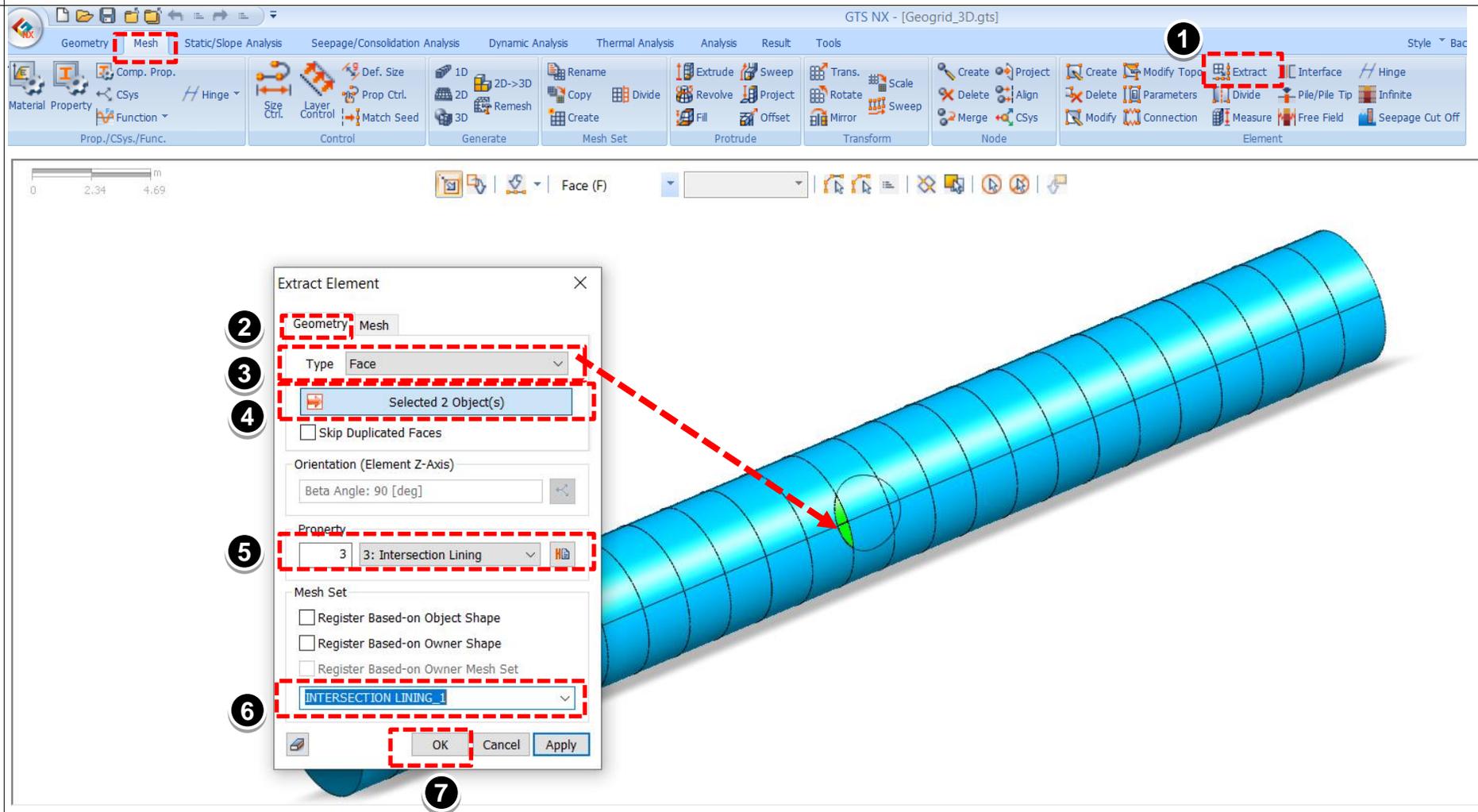
MAIN TUNNEL SEGMENTS CONTAINING PARTS OF INTERSECTION LINING.

5-7 Meshing-Extraction of SHELL Elements (INTERSECTION LINING)

Procedure

- ① Go to Mesh>Element>Extract.
- ② Select Geometry.
- ③ Change the type to **FACE**.
- ④ Select the two faces as shown in the enclosed box.
- ⑤ The property is **INTERSECTION LINING**.
- ⑥ Name retaining wall mesh set as **INTERSECTION_LINING_1**.
- ⑦ Click **OK**.

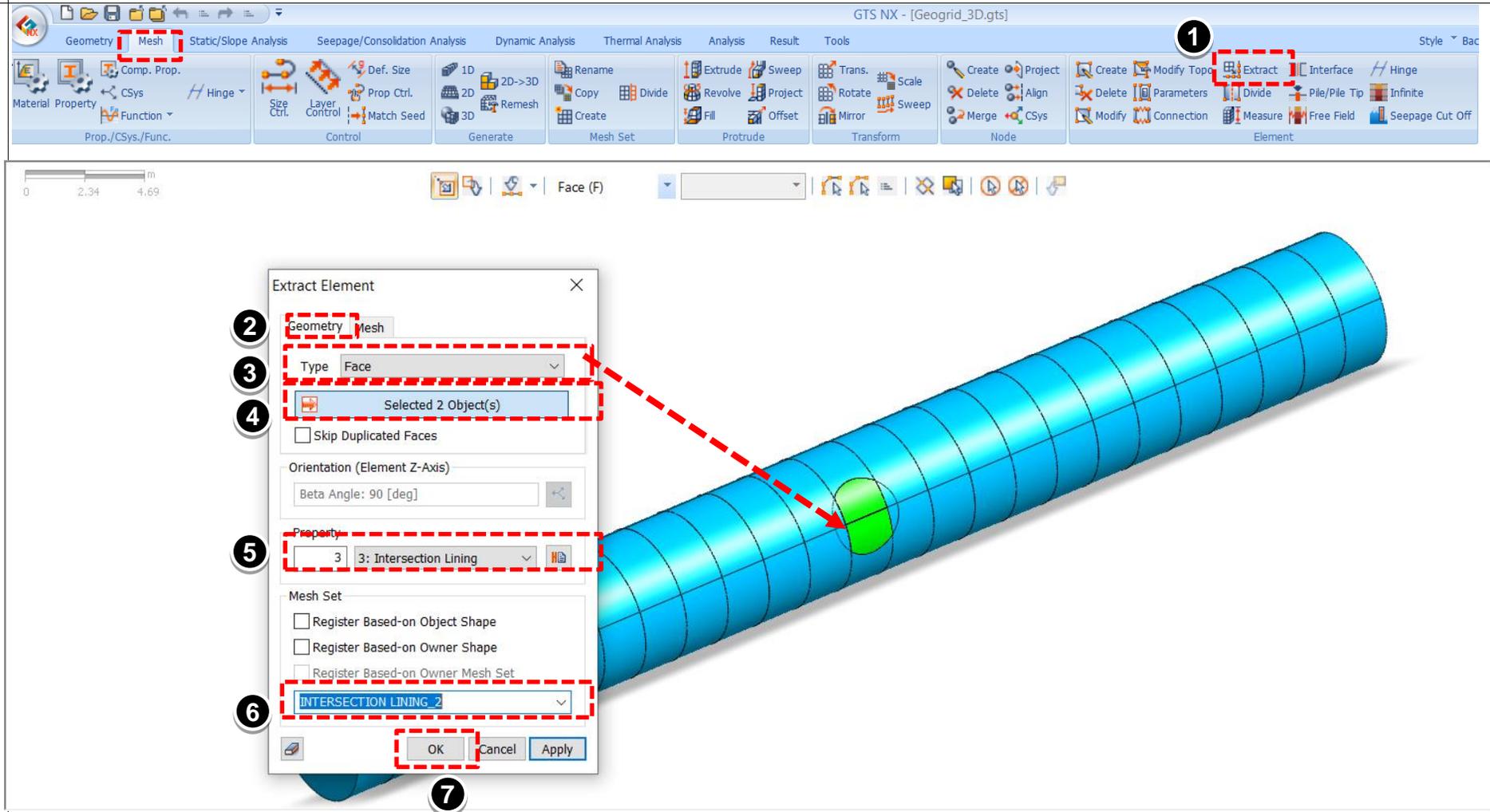
NOTE: WHILE CREATING THE INTERSECTION LINING, ENSURE THAT FOR THE MAIN TUNNEL SEGMENTS IN THAT PARTICULAR SECTION ARE SEPARATELY CREATED LEAVING THESE SEGMENTS, IN ORDER TO HAVE THE UNIFORMITY OF LINING.



5-8 Meshing-Extraction of SHELL Elements (INTERSECTION LINING)

Procedure

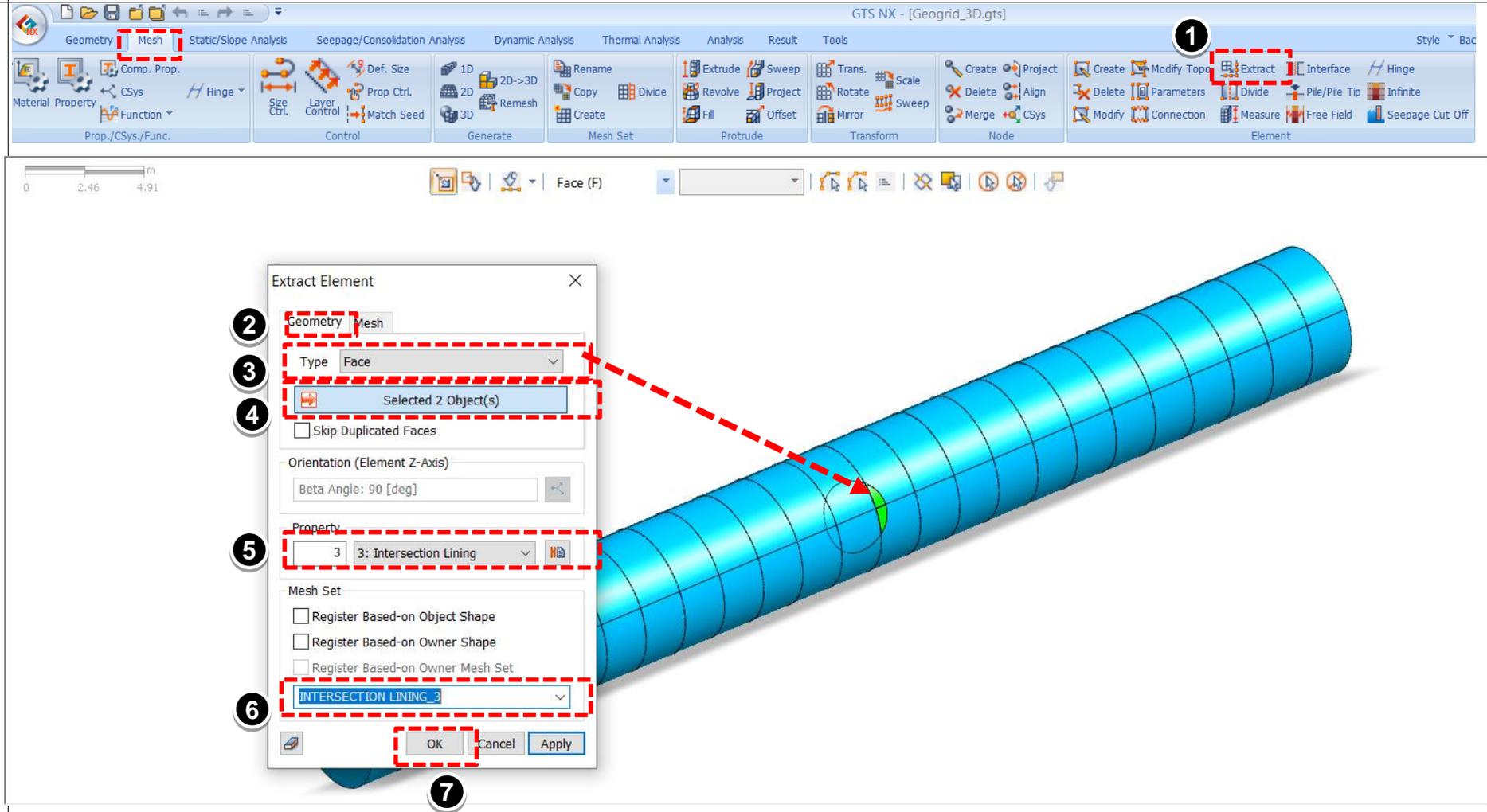
- ① Go to Mesh>Element>Extract.
- ② Select Geometry.
- ③ Change the type to **FACE**.
- ④ Select the two faces as shown in the enclosed box.
- ⑤ The property is **INTERSECTION LINING**.
- ⑥ Name retaining wall mesh set as **INTERSECTION_LINING_2**.
- ⑦ Click **OK**.



5-9 Meshing-Extraction of SHELL Elements (INTERSECTION LINING)

Procedure

- ① Go to Mesh>Element>Extract.
- ② Select Geometry.
- ③ Change the type to **FACE**.
- ④ Select the two faces as shown in the enclosed box.
- ⑤ The property is **INTERSECTION LINING**.
- ⑥ Name retaining wall mesh set as **INTERSECTION_LINING_3**.
- ⑦ Click **OK**.

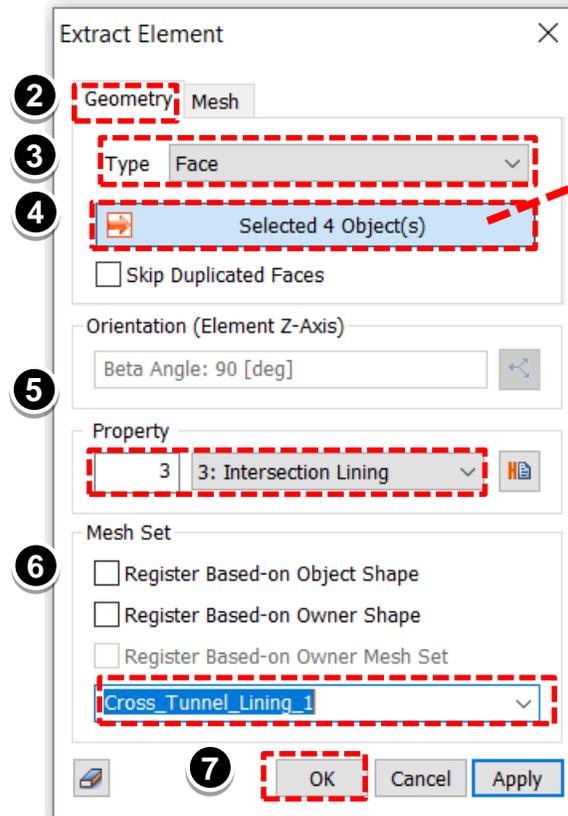
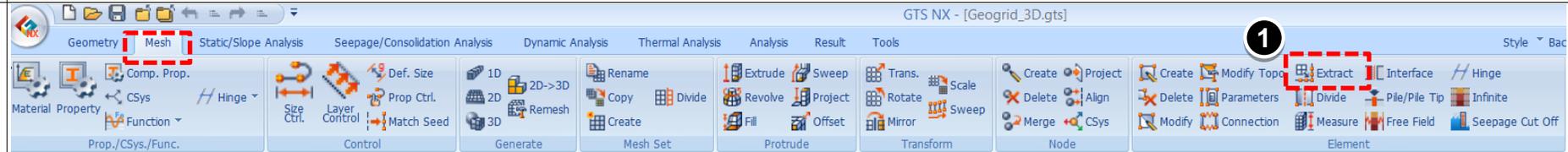


5-10 Meshing-Extraction of SHELL Elements (CROSS PASSAGE LINING)

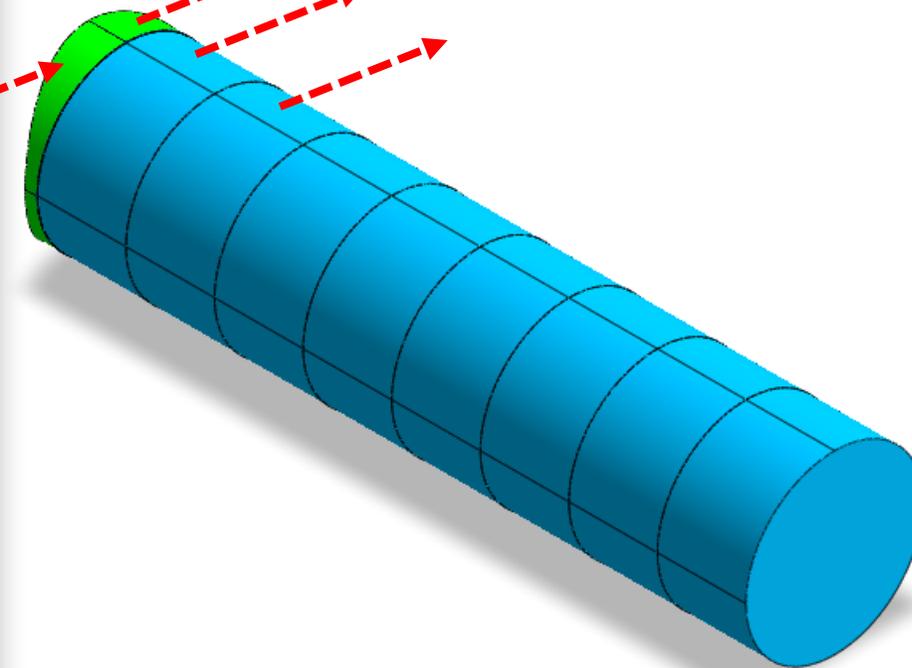
Procedure

- ① Go to Mesh>Element>Extract
- ② Select Geometry
- ③ Change the type to **FACE**.
- ④ Select the four faces as shown in the enclosed box.
- ⑤ The property is **LINING**.
- ⑥ Name mesh set as **CROSS_TUNNEL_LINING_1**.
- ⑦ Click **OK**.

NOTE : SHELL/LINING FOR MESH SETS CROSS_TUNNEL_1, CROSS_TUNNEL_2 AND CROSS_TUNNEL_3 WILL HAVE THE PROPERTY OF INTERSECTION LINING. ALL THE OTHER SECTIONS OF CROSS PASSAGE WITH HAVE THE SHELL ELEMENT PROPERTY OF LINING.



**SHELL ELEMENT PROPERTY
- INTERSECTION LINING**

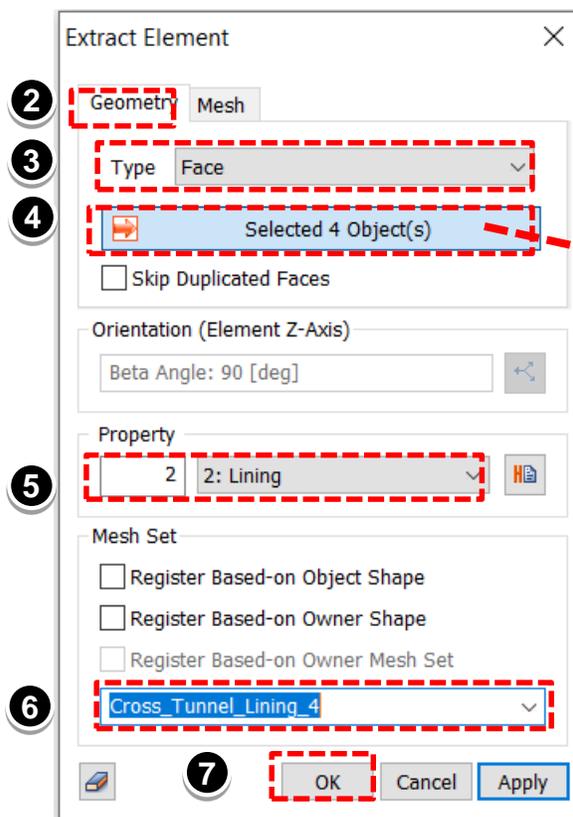
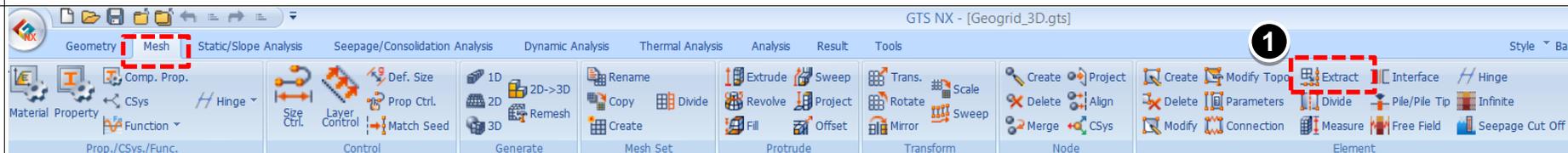


5-11 Meshing-Extraction of SHELL Elements (CROSS PASSAGE LINING)

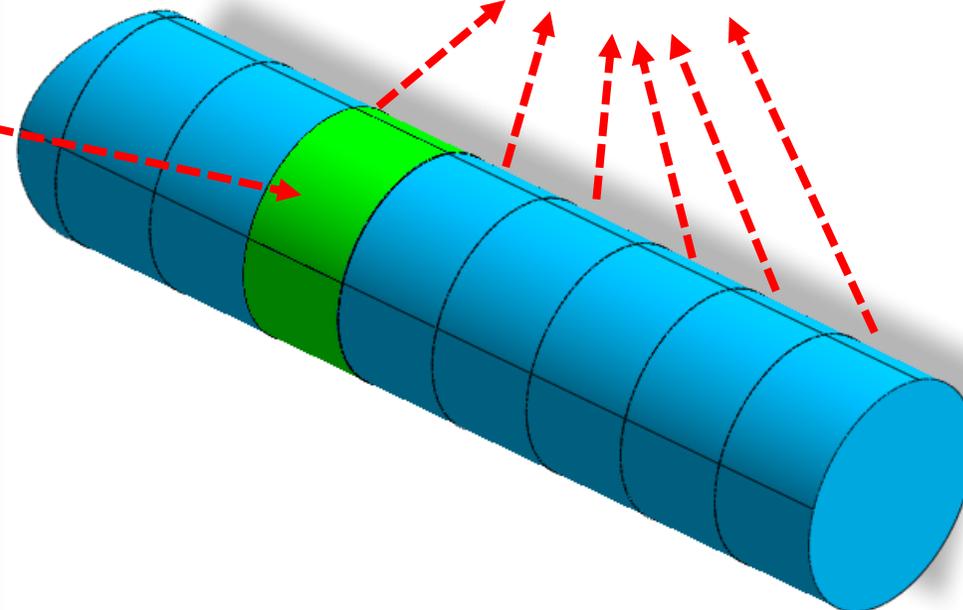
Procedure

- ① Go to Mesh>Element>Extract
- ② Select Geometry.
- ③ Change the type to **FACE**.
- ④ Select the four faces as shown in the enclosed box.
- ⑤ The property is **LINING**.
- ⑥ Name mesh set as **CROSS_TUNNEL_LINING_4**.
- ⑦ Click **OK**.

NOTE : SHELL/LINING FOR MESH SETS CROSS_TUNNEL_1, CROSS_TUNNEL_2 AND CROSS_TUNNEL_3 WILL HAVE THE PROPERTY OF INTERSECTION LINING. ALL THE OTHER SECTIONS OF CROSS PASSAGE (Cross_Passage_4 to 9) WILL HAVE THE SHELL ELEMENT PROPERTY OF LINING.

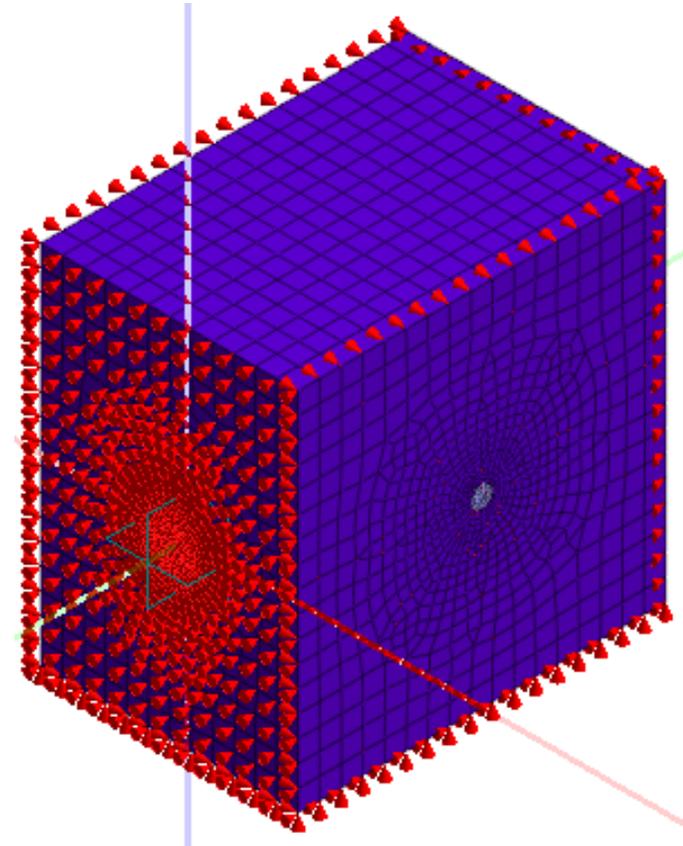
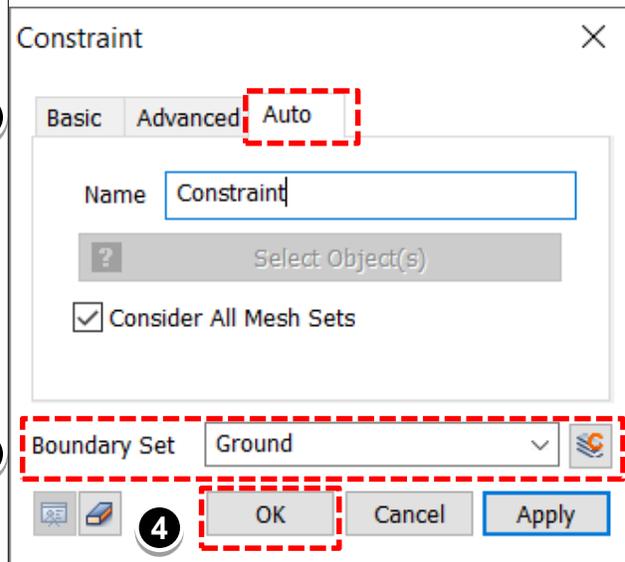
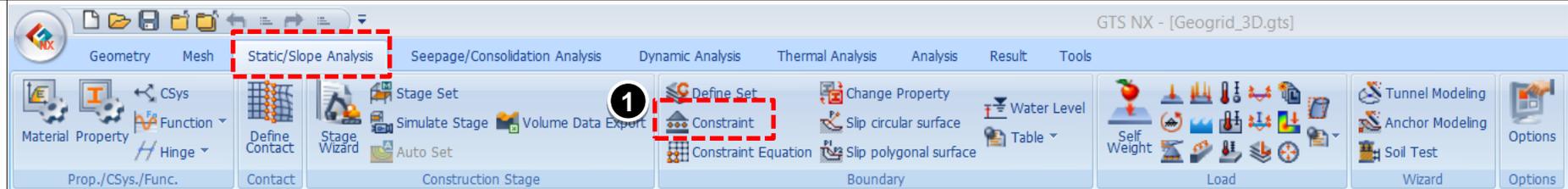


SHELL ELEMENT PROPERTY – LINING



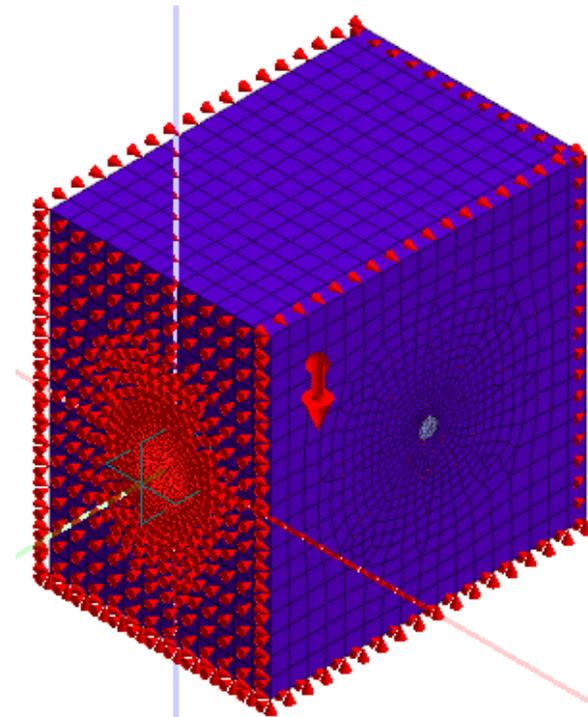
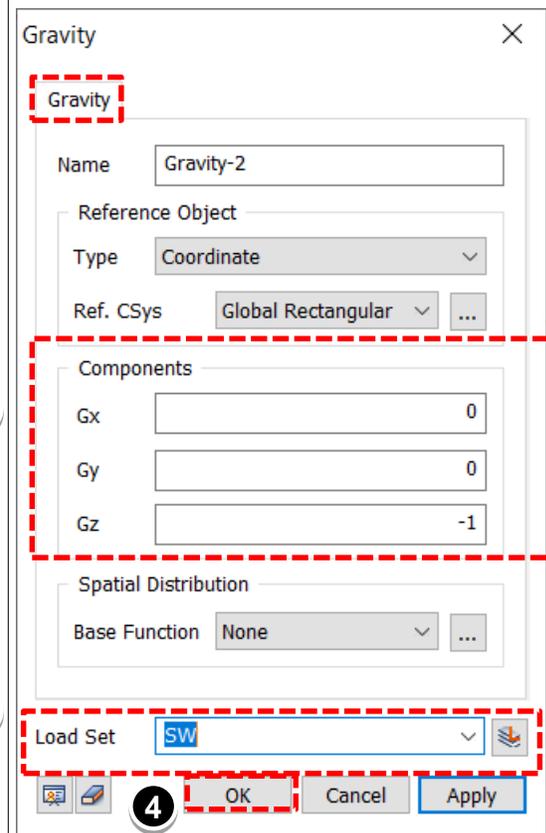
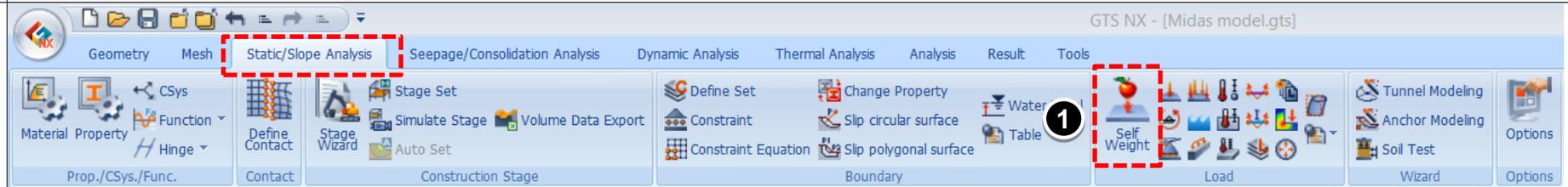
Procedure

- ① Go to Static/Slope Analysis > Constraint
- ② Select Auto, check on “**Consider All mesh Sets**”
- ③ Name the boundary Set as “**Ground**”
- ④ Click OK



Procedure

- ① Go to Static/Slope Analysis > Load > Self Weight
- ② Check for gravity Direction, G_z should be -1
- ③ Name the Load Set as "SW"
- ④ Click OK



8-1 Construction Stage Analysis

Procedure

- 1 Go to Static/Slope Analysis/Stage Set.
- 2 Enter the desired name for the stage set.
- 3 Click **Add**.
- 4 Click on **Define CS Stage Set**.
The next steps are defined in the subsequent steps.

Construction Stage Set

No	Name	Type
1	Cross Tunnel	Stress

Close

8-2 Construction Stages Planning

Procedure

ACTIVATE AND DEACTIVATE THE MESH SETS AS GIVEN IN THE TABLE FOR EACH STAGE AND NAME THE STAGES AS GIVEN THE TABLE FROM S1 TO S33.

Stage name	ACTIVATION MESH	DEACTIVATION MESH
S1	Main Tunnel Lining 1	Main Tunnel 1
S2	Main Tunnel Lining 2	Main Tunnel 2
S3	Main Tunnel Lining 3	Main Tunnel 3
S4	Main Tunnel Lining 4	Main Tunnel 4
S5	Main Tunnel Lining 5	Main Tunnel 5
S6	Main Tunnel Lining 6	Main Tunnel 6
S7	Main Tunnel Lining 7	Main Tunnel 7
S8	Main Tunnel Lining 8	Main Tunnel 8
S9	Main Tunnel Lining 9	Main Tunnel 9
S10	Main Tunnel Lining 10	Main Tunnel 10
S11	Main Tunnel Lining 11	Main Tunnel 11
S12	Main Tunnel Lining 12, Intersection Lining 1	Main Tunnel 12

8-3 Construction Stage Analysis

Procedure

ACTIVATE AND DEACTIVATE THE MESH SETS AS GIVEN IN THE TABLE FOR EACH STAGE AND NAME THE STAGES AS GIVEN THE TABLE FROM S1 TO S33.

Stage name	ACTIVATION MESH	DEACTIVATION MESH
S13	Main Tunnel Lining 13, Intersection Lining 2	Main Tunnel 13
S14	Main Tunnel Lining 14, Intersection Lining 3	Main Tunnel 14
S15	Main Tunnel Lining 15	Main Tunnel 15
S16	Main Tunnel Lining 16	Main Tunnel 16
S17	Main Tunnel Lining 17	Main Tunnel 17
S18	Main Tunnel Lining 18	Main Tunnel 18
S19	Main Tunnel Lining 19	Main Tunnel 19
S20	Main Tunnel Lining 20	Main Tunnel 20
S21	Main Tunnel Lining 21	Main Tunnel 21
S22	Main Tunnel Lining 22	Main Tunnel 22

8-4 Construction Stage Analysis

Procedure

ACTIVATE AND DEACTIVATE THE MESH SETS AS GIVEN IN THE TABLE FOR EACH STAGE AND NAME THE STAGES AS GIVEN THE TABLE FROM S1 TO S33.

Stage name	ACTIVATION MESH	DEACTIVATION MESH
S23	Main Tunnel Lining 23	Main Tunnel 23
S24	Main Tunnel Lining 24	Main Tunnel 24
S25	Main Tunnel Lining 25, Cross Tunnel Lining 1	Main Tunnel 25, Cross Tunnel 1, Intersection Lining 1,2 &3.
S26	Cross Tunnel Lining 2	Cross Tunnel 2
S27	Cross Tunnel Lining 3	Cross Tunnel 3
S28	Cross Tunnel Lining 4	Cross Tunnel 4
S29	Cross Tunnel Lining 5	Cross Tunnel 5
S30	Cross Tunnel Lining 6	Cross Tunnel 6
S31	Cross Tunnel Lining 7	Cross Tunnel 7
S32	Cross Tunnel Lining 8	Cross Tunnel 8
S33	Cross Tunnel Lining 9	Cross Tunnel 9

Procedure

- ❶ Go to Static/Slope Analysis> Stage Wizard.
- ❷ In the Set Type Drop Down Menu, **select Mesh Set**.
- ❸ In the Set name Prefix select **Cross Tunnel Lining**.
- ❹ **A/R** stands for **ADD/REMOVE**. Addition will be displayed as **green** in color and Removal will be shown in **Yellow**.
- ❺ **Start Stage** stands for stage in which the particular mesh will be added to the construction stage wizard, if left at 1, then the mesh set will be activated from the initial stage itself.

Repeat the same process for all mesh sets. The sequence is described in the next slide.

After all the mesh sets are activated and the necessary commands entered, activate the **Boundary Condition & Load Set**.

The screenshot shows the software interface for the 'Static/Slope Analysis' stage. The 'Stage Wizard' dialog box is open, showing the 'Construction Stage Set' as 'CROSS TUNNEL'. The 'Set Assignment Rules' table is as follows:

Set Type	Set Name Prefix	A/R	Start Postfix	F	End Postfix	Postfix Inc.	Start Stage	Stage Inc.
Mesh set	CROSS_TUNNEL LINING	A					1	
Boundary Set	Cross Tunnel-							
Load Set	Default Mesh Set							
	INTERSECTION LINING							
	MAIN_TUNNEL-							
	MAIN_TUNNEL LINING							
	SOIL							
	BOUNDARY CONDITION							
	GROUND							
	STATIC LOAD							
	SW							
	CONTACT							

The 'Element, Boundary, Load Activation Status' table is also visible, showing the activation status for various sets across stages S1 to S16. The 'Mesh set' row for 'CROSS_TUNNEL LINING' is highlighted in green, indicating it is added.

Procedure

After all the mesh sets are activated and the necessary commands entered, activate the Boundary Condition & Load Set.

- 1 Enter the data for each mesh set as shown.

For boundary condition & load set, no data entry is required, assign A to both as they both will be active from initial stage till S33.

- 2 Click Apply Assignment Rules.
- 3 Click OK.

The data should match correctly with the table in the bottom as shown.

Stage Definition Wizard

Element, Boundary, Load

Construction Stage Set: CROSS TUNNEL

Set Assignment Rules

Set Type	Set Name Prefix	A/R	Start Postfix	F	End Postfix	Postfix Inc.	Start Stage	Stage Inc.
Mesh set	Cross_Tunnel-	R	1	<input type="checkbox"/>		1	25	1
Mesh set	CROSS_TUNNEL_LINING_	A	1	<input type="checkbox"/>		1	25	1
Mesh set	INTERSECTION_LINING_	A	1	<input type="checkbox"/>		1	13	1
Mesh set	MAIN_TUNNEL-	R	1	<input type="checkbox"/>		1	1	1
Mesh set	MAIN_TUNNEL_LINING_	A	1	<input type="checkbox"/>		1	1	1
Mesh set	INTERSECTION_LINING_	R	1	<input type="checkbox"/>		1	25	0

Apply Assignment Rules OK Cancel

Element, Boundary, Load Activation Status

Set Type	Set Name Prefix	I.S.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30	S31	S32	S33
Mesh set	Cross_Tunnel-	A: 1to9																									R: 1	R: 2	R: 3	R: 4	R: 5	R: 6	R: 7	R: 8	R: 9
Mesh set	CROSS_TUNNEL_LINING_	A: 1	A: 2	A: 3	A: 4	A: 5	A: 6	A: 7	A: 8	A: 9																A: 1	A: 2	A: 3	A: 4	A: 5	A: 6	A: 7	A: 8	A: 9	
Mesh set	Default Mesh Set																																		
Boundary Set	GROUND	A: -																																	
Mesh set	INTERSECTION_LINING_														A: 1	A: 2	A: 3																		
Mesh set	MAIN_TUNNEL-	A: 1to25	R: 1	R: 2	R: 3	R: 4	R: 5	R: 6	R: 7	R: 8	R: 9	R: 10	R: 11	R: 12	R: 13	R: 14	R: 15	R: 16	R: 17	R: 18	R: 19	R: 20	R: 21	R: 22	R: 23	R: 24	R: 25								
Mesh set	MAIN_TUNNEL_LINING_		A: 1	A: 2	A: 3	A: 4	A: 5	A: 6	A: 7	A: 8	A: 9	A: 10	A: 11	A: 12	A: 13	A: 14	A: 15	A: 16	A: 17	A: 18	A: 19	A: 20	A: 21	A: 22	A: 23	A: 24	A: 25								
Mesh set	SOIL	A: -																																	
Load Set	SW	A: -																																	

Procedure

- 1 In the Analysis Tab, Click on General
- 2 Name the case as **Tunnel Analysis**.
- 3 In the Solution Type Drop-Down Menu, **Construction Stage**.
- 4 Click on **Analysis Control**.
- 5 Click in **Initial Stage**, and select **both** the options.
- 6 Click **OK**.
- 7 Click **OK**.
- 8 Click **Perform**.

The screenshot displays the software interface for defining an analysis case. The top menu bar includes 'Geometry', 'Mesh', 'Static/Slope Analysis', 'Seepage/Consolidation Analysis', 'Dynamic Analysis', 'Thermal Analysis', 'Analysis', 'Result', and 'Tools'. The 'Analysis' tab is active, showing sub-tabs for 'General', 'Parametric Analysis', 'Perform', 'Batch Analysis', 'Modeling', 'History Output Probes', and 'Options'. The 'Perform' sub-tab is selected, leading to the 'Add/Modify Analysis Case' dialog box.

The 'Add/Modify Analysis Case' dialog box contains the following fields and options:

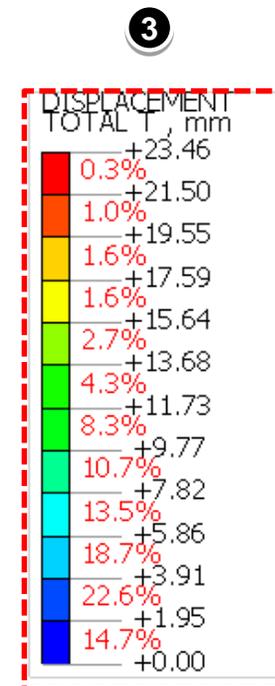
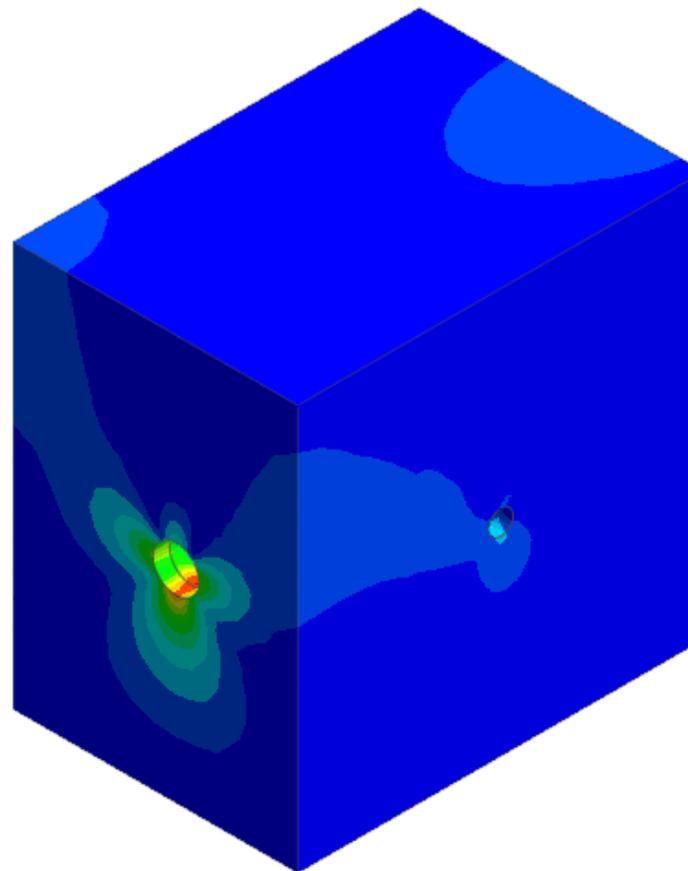
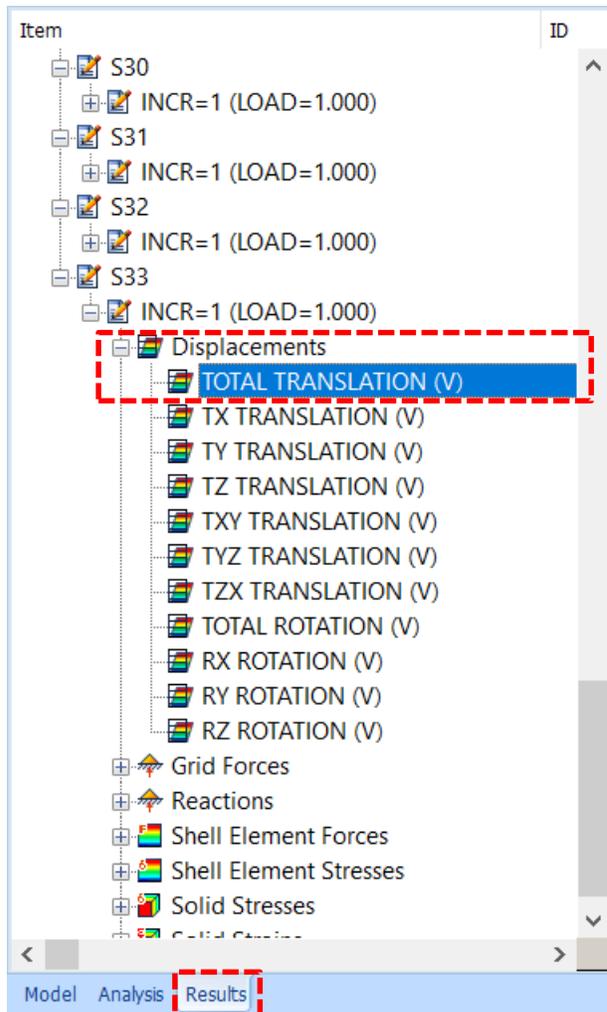
- Analysis Case Setting:**
 - Title: Tunnel Analysis
 - Description: (empty)
 - Solution Type: Construction Stage
 - Construction Stage Set: Cross Tunnel
- Analysis Case Model:**
 - All Sets: (empty)
 - Active Sets: (empty)
- Buttons:** Solve Each Load Set Independently, Sorting, Name, OK, Cancel, Apply.

The 'Analysis Control' dialog box is open, showing the following settings:

- General:**
 - Water Pressure:
 - Automatically Consider Water Pressure:
 - Initial Stage:
 - Initial Stage for Stress Analysis: 1:I.S.
 - Apply K0 Condition:
 - Cut-Off Negative Effective Pressure:
 - Initial Stress:
 - Estimate Initial Stress of Activated Elements:
 - Final Calculation Stage:
 - End Stage: Middle Stage: 1:I.S.
 - Specify Restart Stage: (empty)
 - Restart Option:
 - Save only User Specified Stages: Save All Stages:
 - Initial Temperature:
 - Initial Temperature By Value: 0 [T]
 - Initial Temperature By Load Set: None
 - Saturation Effects:
 - Consider Partially Saturated Effects for Stress Analysis:
 - Max. Negative Pore Pressure:
 - Max. Negative Pore Pressure Limit: 0 kN/m²
 - Initial Configuration:
 - Estimate Initial Configuration of Activated Nodes:
- Buttons:** OK, Cancel.

Procedure

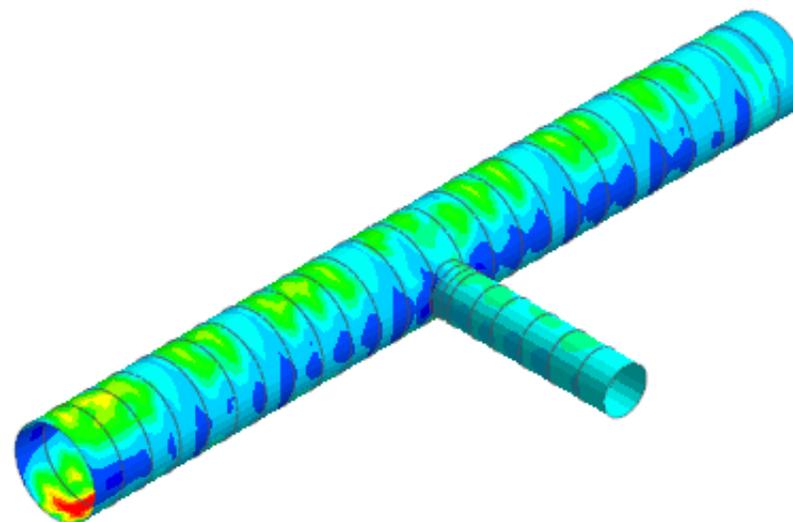
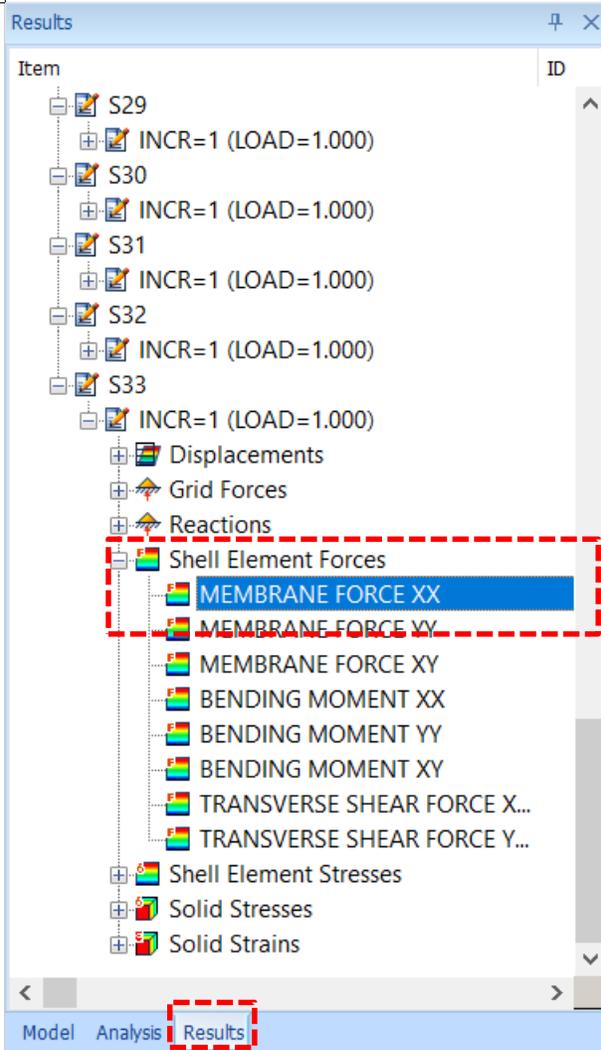
- ① Go to Results>S33
- ② Click on Total Displacements.
- ③ Legend shows the displacement around the model.



10-3 Result (SHELL ELEMENT FORCES)

Procedure

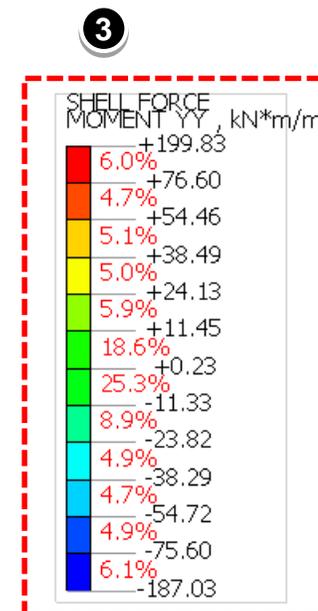
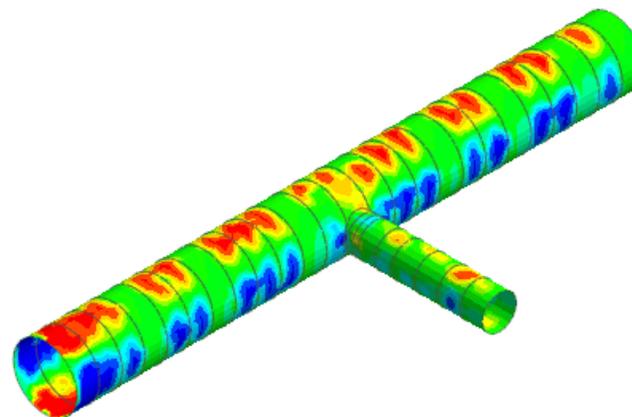
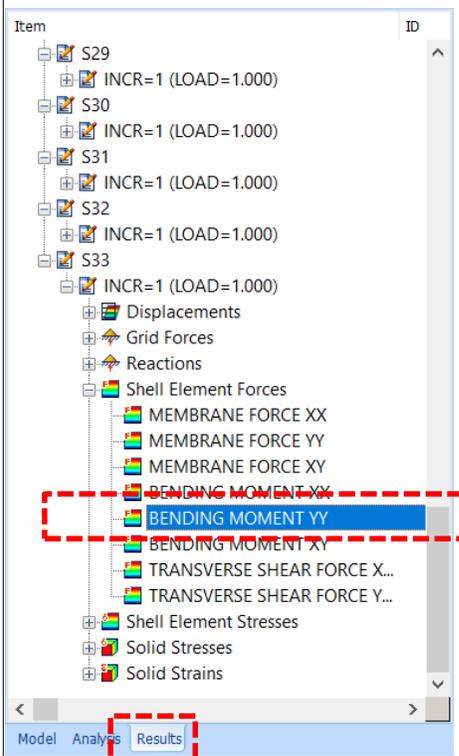
- ① Go to Results> S33
- ② Click on SHELL ELEMENT FORCES.
- ③ Legend shows the forces acting on the shell.



10-3 Result (BENDING MOMENTS ON SHELL)

Procedure

- ① Go to Results>S33
- ② Click on BEAM ELEMENT FORCES & select **Bending Moment YY**.
- ③ Legend shows the bending moments acting on the LINING.



- GTS NX Certification task for participants involves submission of file (.docx or .pdf) with :
 - Generating the model as shown in tutorial.
 - Images/3D PDF report in the output.
 - Short summary of model creation, and results.

KINDLY SUBMIT YOUR FINAL RESULTS IN THE PROVIDED WORD FILE FORMAT.

CERTIFICATION TASK GUIDELINES

Online Course Assignment

You can download the model files and a report template for your assignment mission. Please click the download button below.

In addition, please be noted that the assignment submission policy has been changed. Click the 'Go To Submit' button to hand in your assignment. Submission through email is not accepted.

Upon completion of your submission, you will receive a confirmation of completion and the uploaded assignment will be automatically counted.

- **Deadline:**
- **Submission:** Click **[Go To Submit]**
- **Format:** Only the provided report in docx or pdf file format.

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ONLINE COURSE ASSIGNMENT

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<small>Organization*</small>	<small>Country*</small>
<input type="text" value="TEST"/>	<input type="text" value="Albania"/>
<small>Email*</small>	
<input type="text" value="01b0218@midasot.com"/>	
<small>Select the title of the online course*</small>	
<input type="text" value="[Session 3]Deep Excavation Analysis according to Eurocode 7"/>	
<small>Files*</small>	
<small>Please attach your assignment report here. pdf or docx format only. (see details below)</small>	
<input type="text" value="파일첨부 선택된 파일 없음"/>	
<input checked="" type="checkbox"/> I agree to submit the file and personal information to MIDAS ENG SOLUTION.*	
<small>By clicking submit below, you consent to allow MIDAS ENG SOLUTION to store and process the personal information submitted above to provide you the content requested.</small>	

MODEL DATA & TASK FILES INSTALLATION DATE – 12TH MAY

SUBMISSION ONLY VIA LINK, MAIL SUBMISSIONS NOT ACCEPTED

SUBMISSION DATE : 21st MAY