

midas Civil Training

DESIGN THE FUTURE WITH MIDAS

Super-T Bridge

Hands on Training



midas Civil Training

DESIGN THE FUTURE WITH MIDAS

Super-T Bridge

Hands on Training



Table of Contents

1 Prestressed Composite Girder Bridge Analysis & Design

Step 1. Properties

Step 2. Prestressed Composite Bridge Wizard

Step 3. Load - TDM / Moving Load / Response Spectrum

Step 4. Analysis

Step 5. Results

Step 6. Design

Step 7. Tips

2 Appendix. Load Combinations

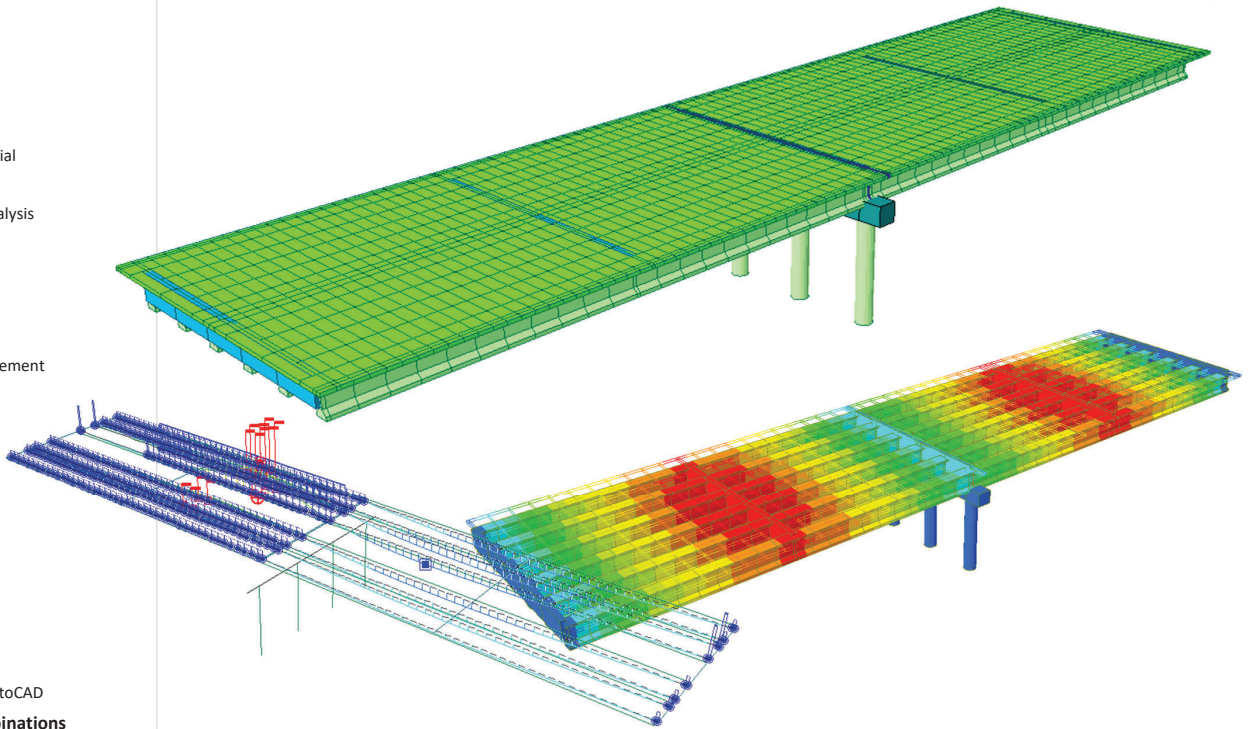
Prestressed Composite Girder Bridge Analysis & Design

1

Prestressed Composite Girder Bridge Analysis & Design

Overview

- **Properties**
 - Material / Section
- **Prestressed Composite Bridge Wizard**
 - Layout
 - Section
 - Tendon
 - Load
 - Construction Stage
- **Load**
 - Time Dependent Material
 - Moving load
 - Response Spectrum Analysis
- **Analysis**
 - Moving Load
- **Results**
 - Load Combination
 - Reaction/Force/Displacement
 - Moving Tracer
 - Concurrent Force
 - Tendon Losses
 - Mode Shape
- **Design**
 - PSC Design
- **Tips**
 - Smart Report
 - MCT Command Shell
 - Tendon Template
 - Import tendon from AutoCAD
- **Appendix. Load Combinations**



MIDASIT

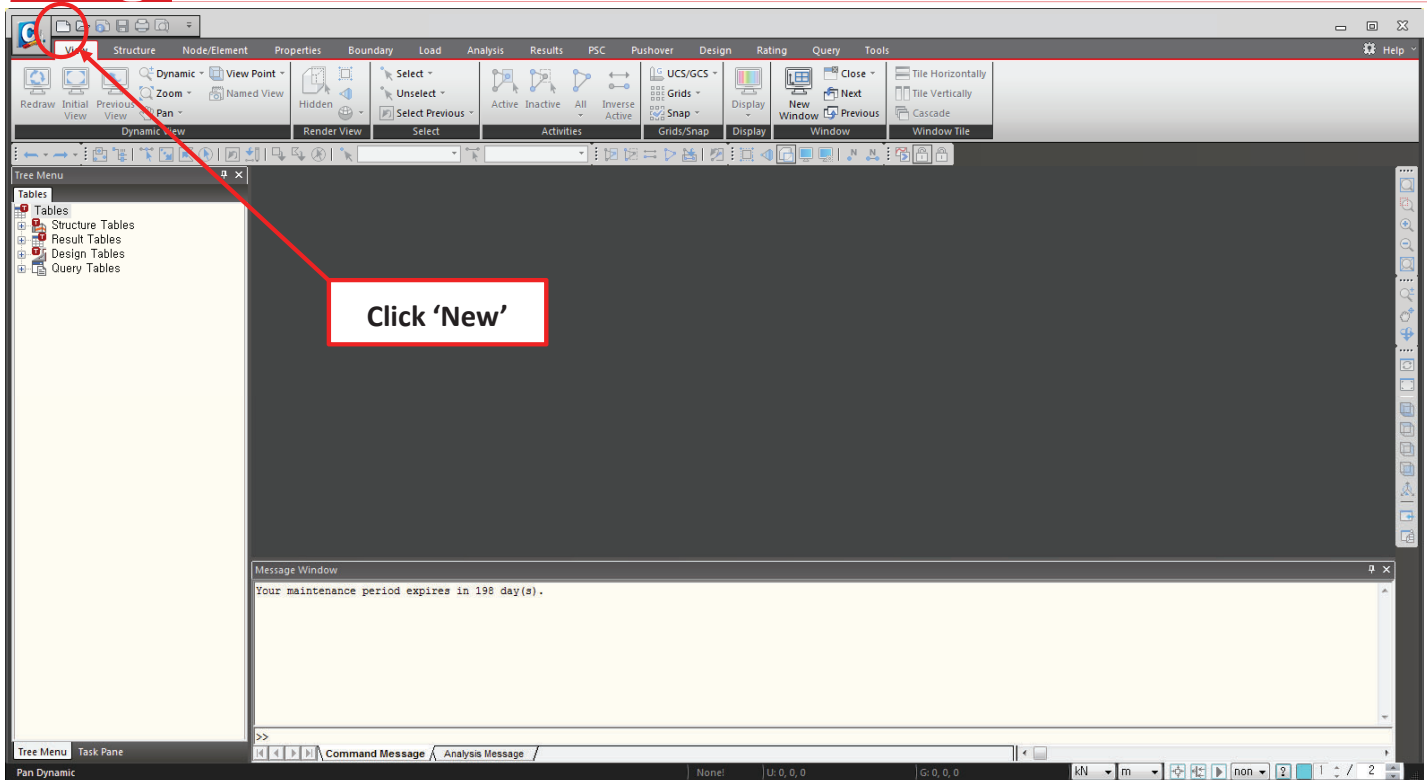
Overview

- **Properties**
 - Material / Section
- **Prestressed Composite Bridge Wizard**
 - Layout
 - Section
 - Tendon
 - Load
 - Construction Stage
- **Load**
 - Time Dependent Material
 - Moving load
 - Response Spectrum Analysis
- **Analysis**
 - Moving Load
- **Results**
 - Load Combination
 - Reaction/Force/Displacement
 - Moving Tracer
 - Concurrent Force
 - Tendon Losses
 - Mode Shape
- **Design**
 - PSC Design
- **Tips**
 - Smart Report
 - MCT Command Shell
 - Tendon Template
 - Import tendon from AutoCAD
- **Appendix. Load Combinations**

Step 1. Properties

3

Start



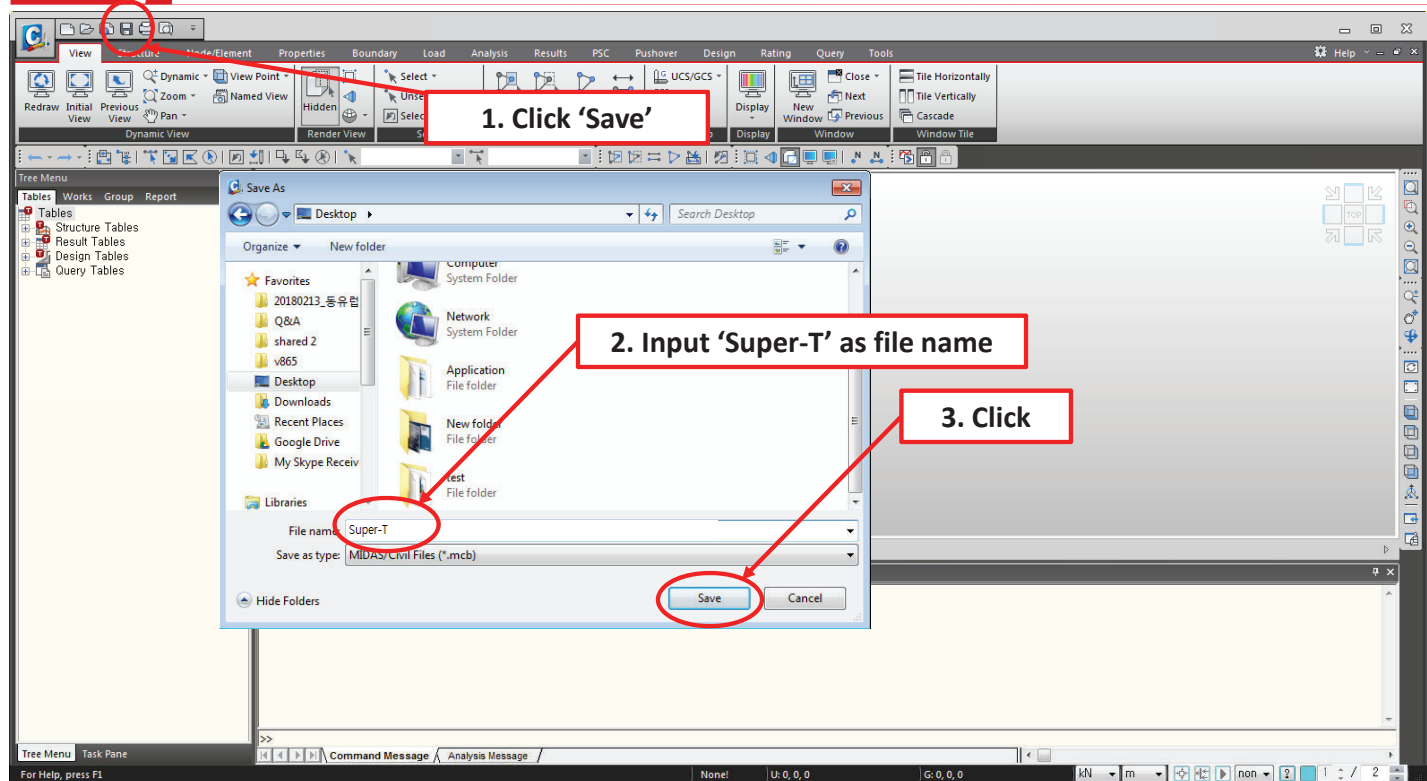
Procedure

Create a new project file.

MIDAS IT

4

Start



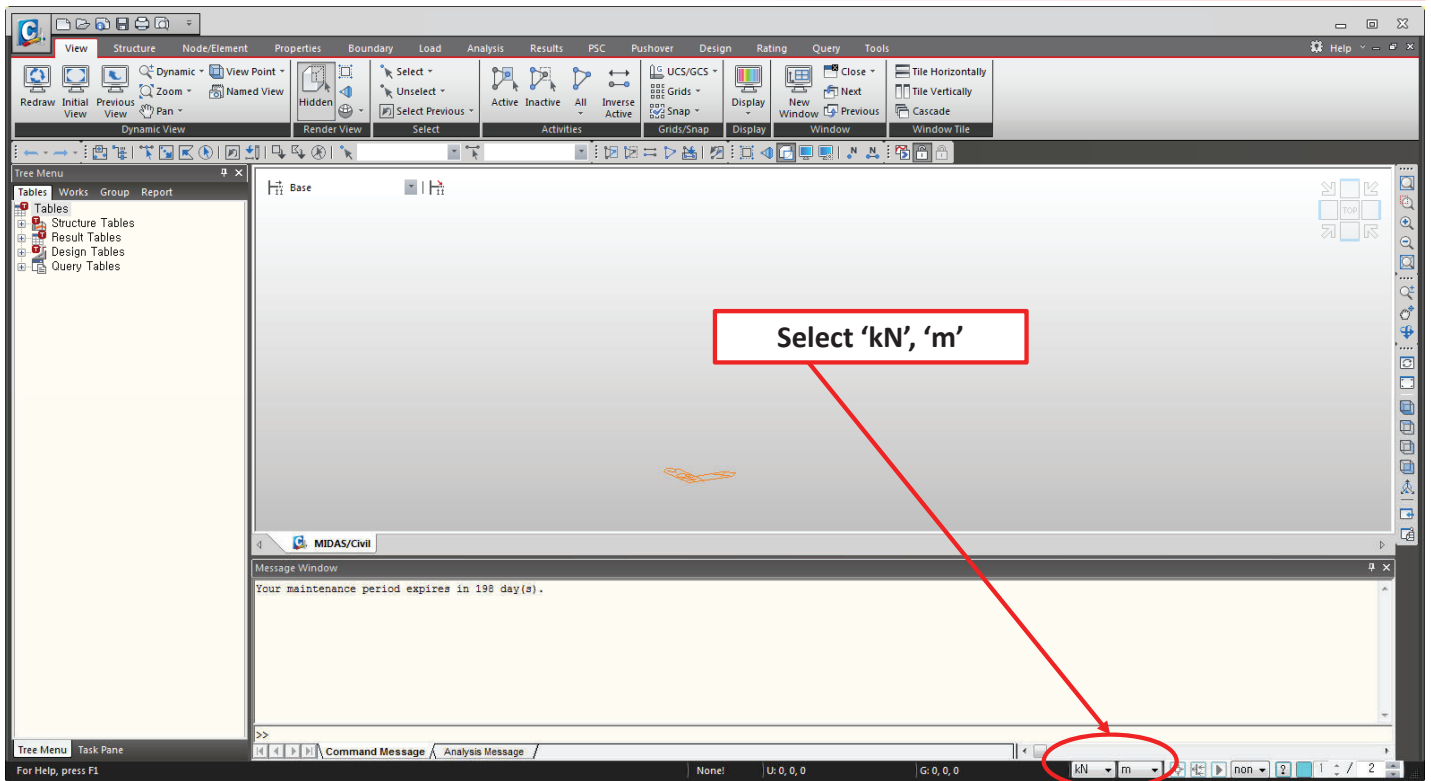
Procedure

Save the current work in a project file. Save As dialog will prompt if a project file has not been assigned previously.

MIDAS IT

5

Start



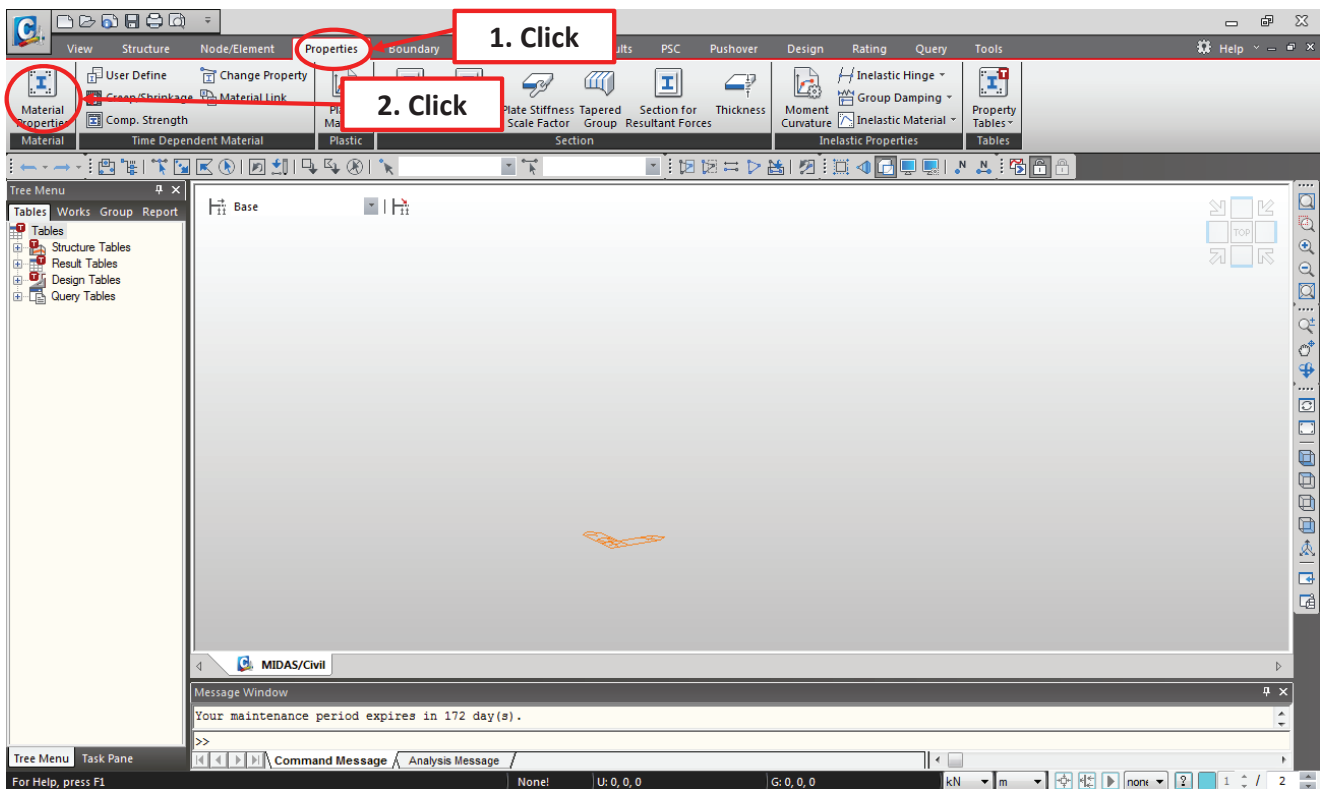
Procedure

At any point of pre- and post-processing, the unit can be changed at the Status Bar without opening the Unit System dialog box. Also, every input and output values are converted accordingly at every change.

MIDASIT

6

Material / Section



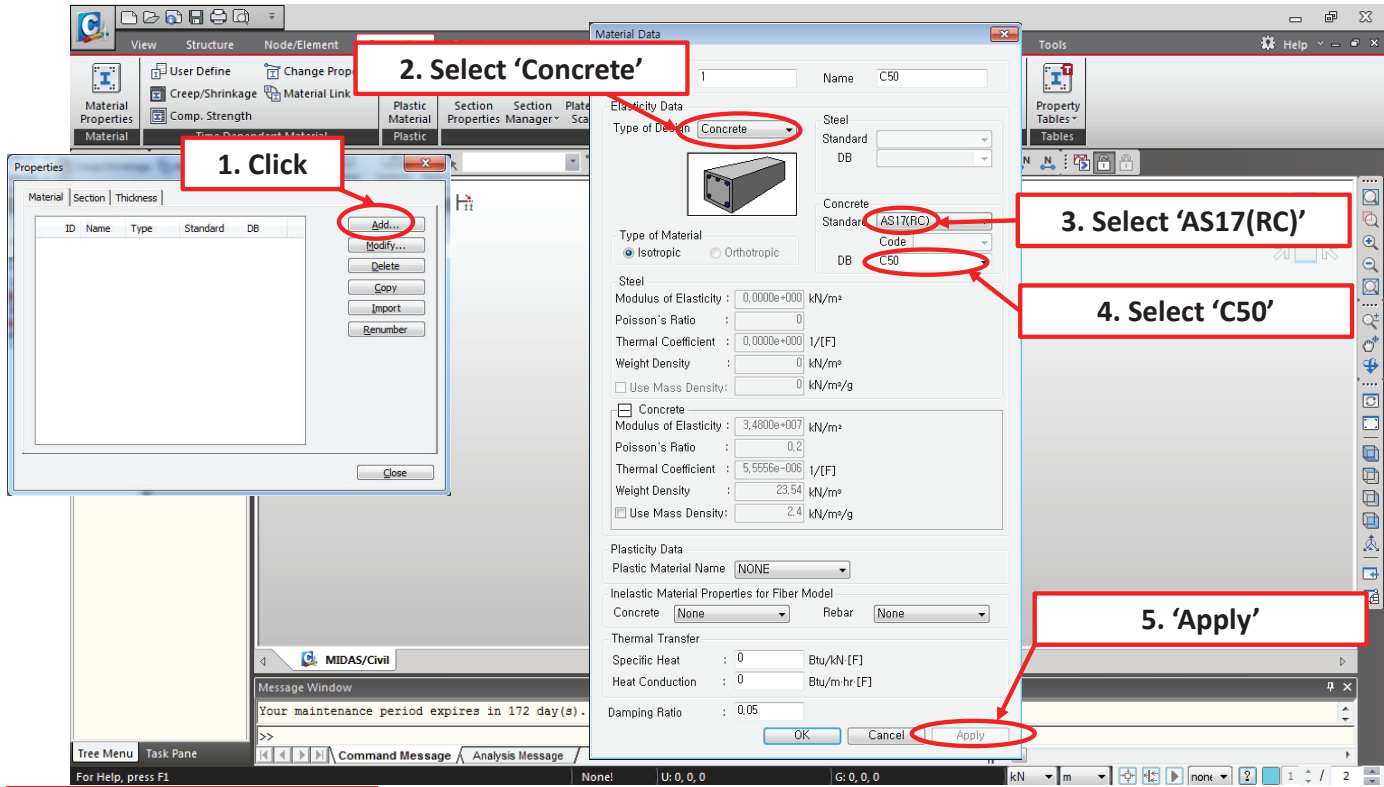
Procedure

Define material

MIDASIT

7

Material / Section



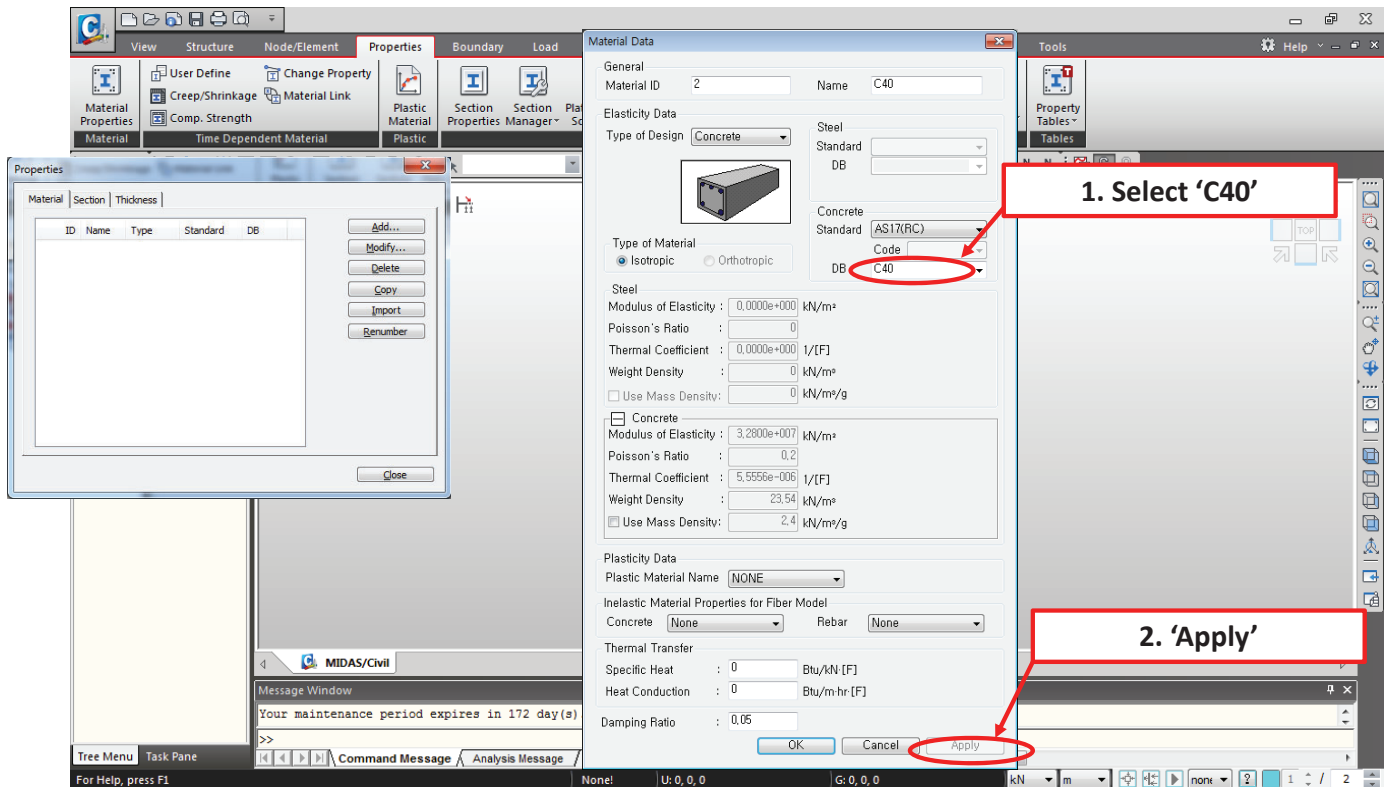
Procedure

Define material for the girder. AS17 is equal to Australian Standard 5100.5 2017. Select 'None' as 'Standard' to modify the values such as Modulus of Elasticity.

MIDASIT

8

Material / Section



Procedure

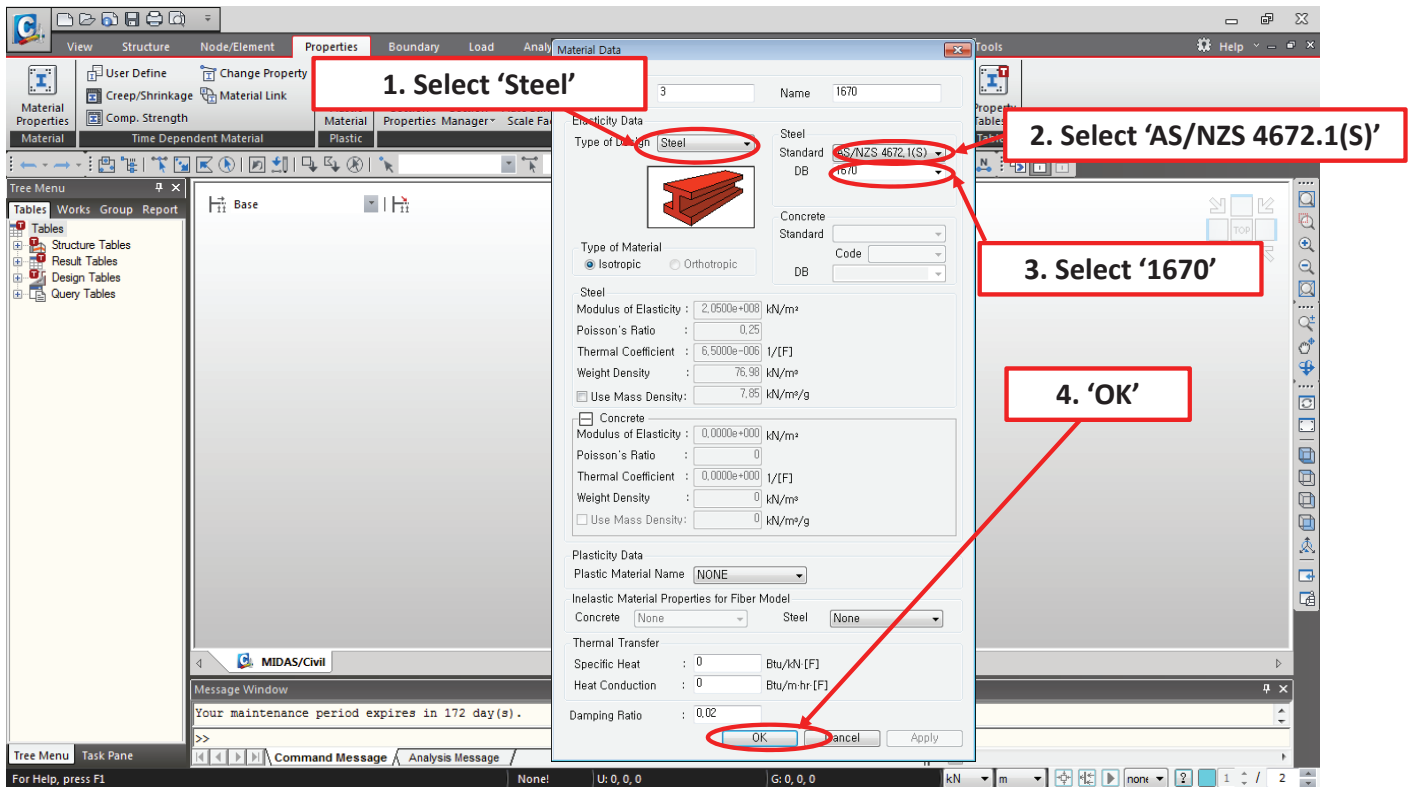
Define material for the slab.

Click 'Apply' to apply the input data on the dialog and not to close the dialog. Click 'OK' to apply the input data on the dialog and to close the dialog.

MIDASIT

9

Material / Section



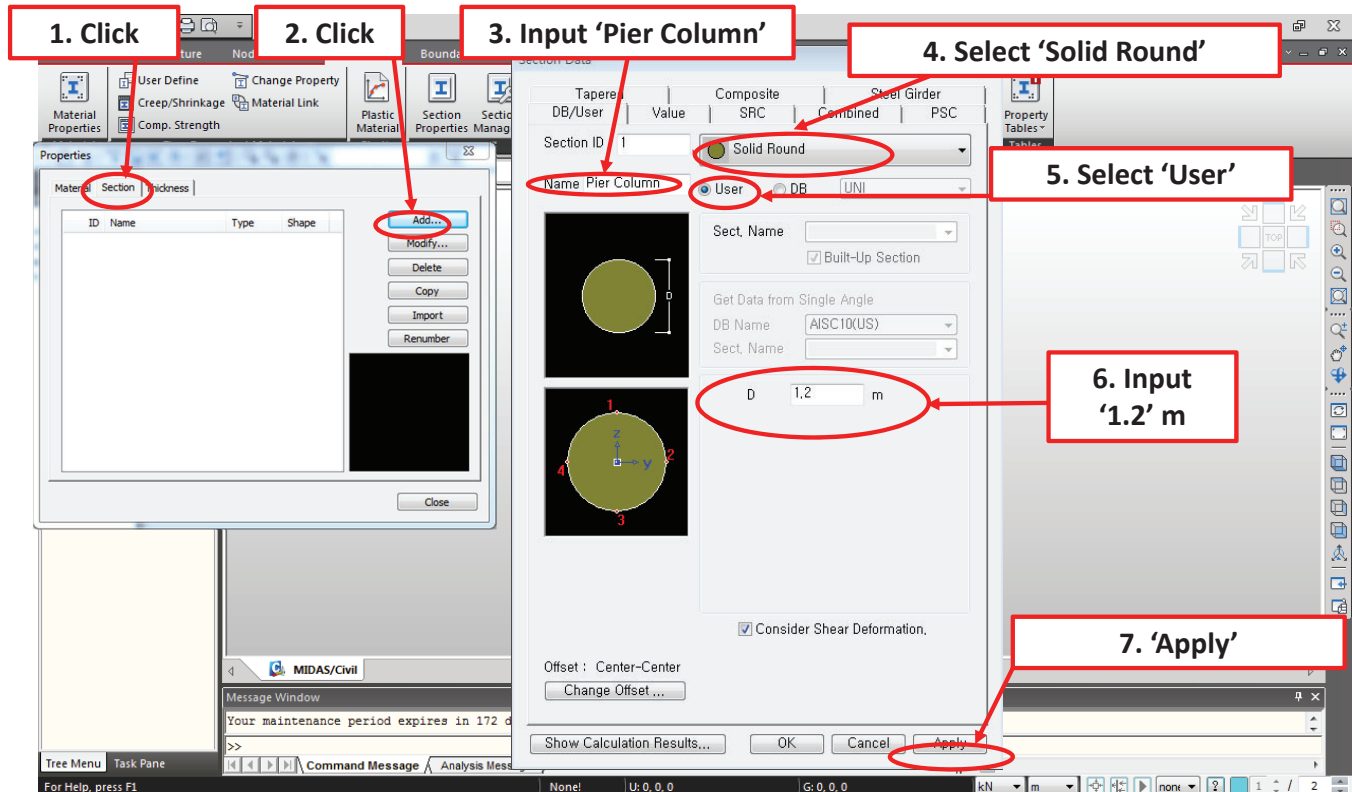
Procedure

Define material for the tendon

MIDASIT

10

Material / Section

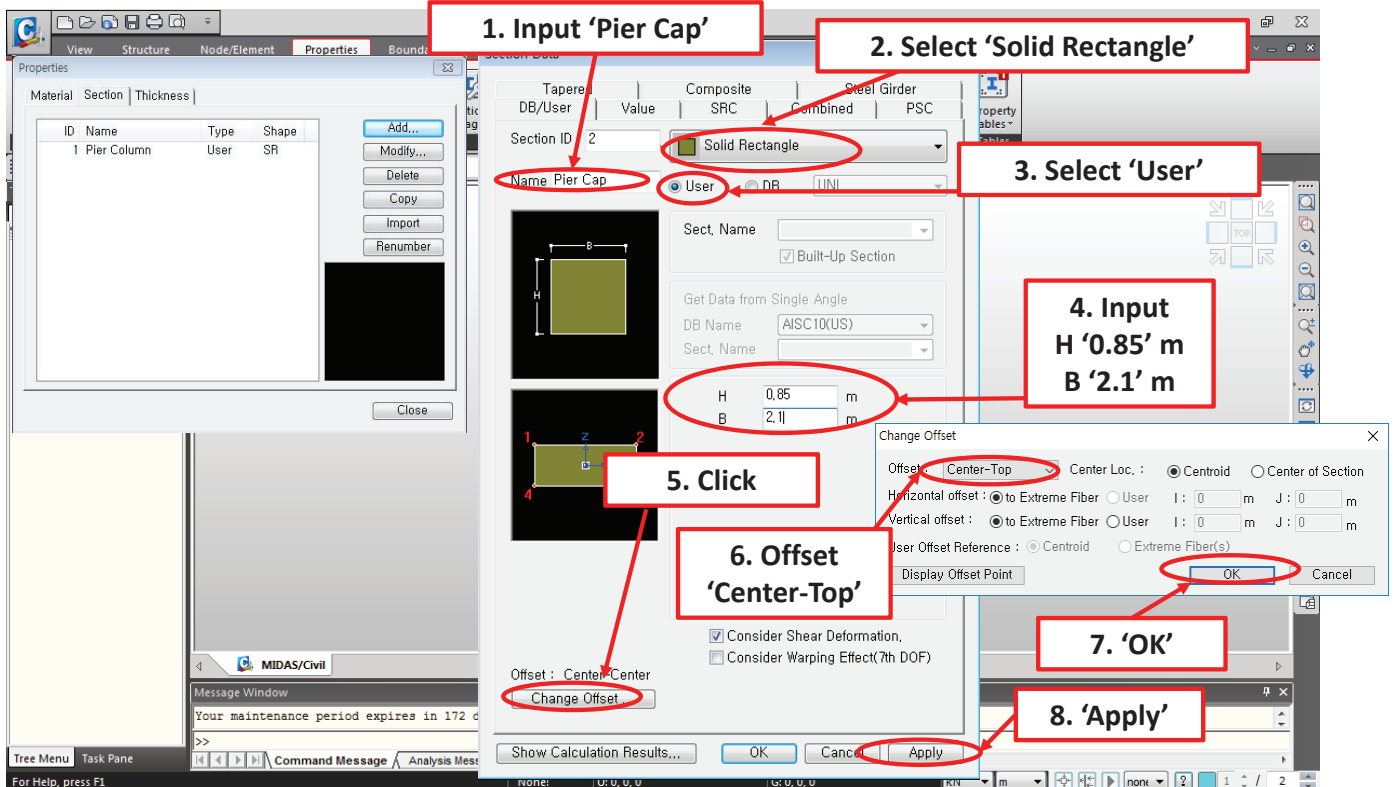


Procedure

Define section for pier.

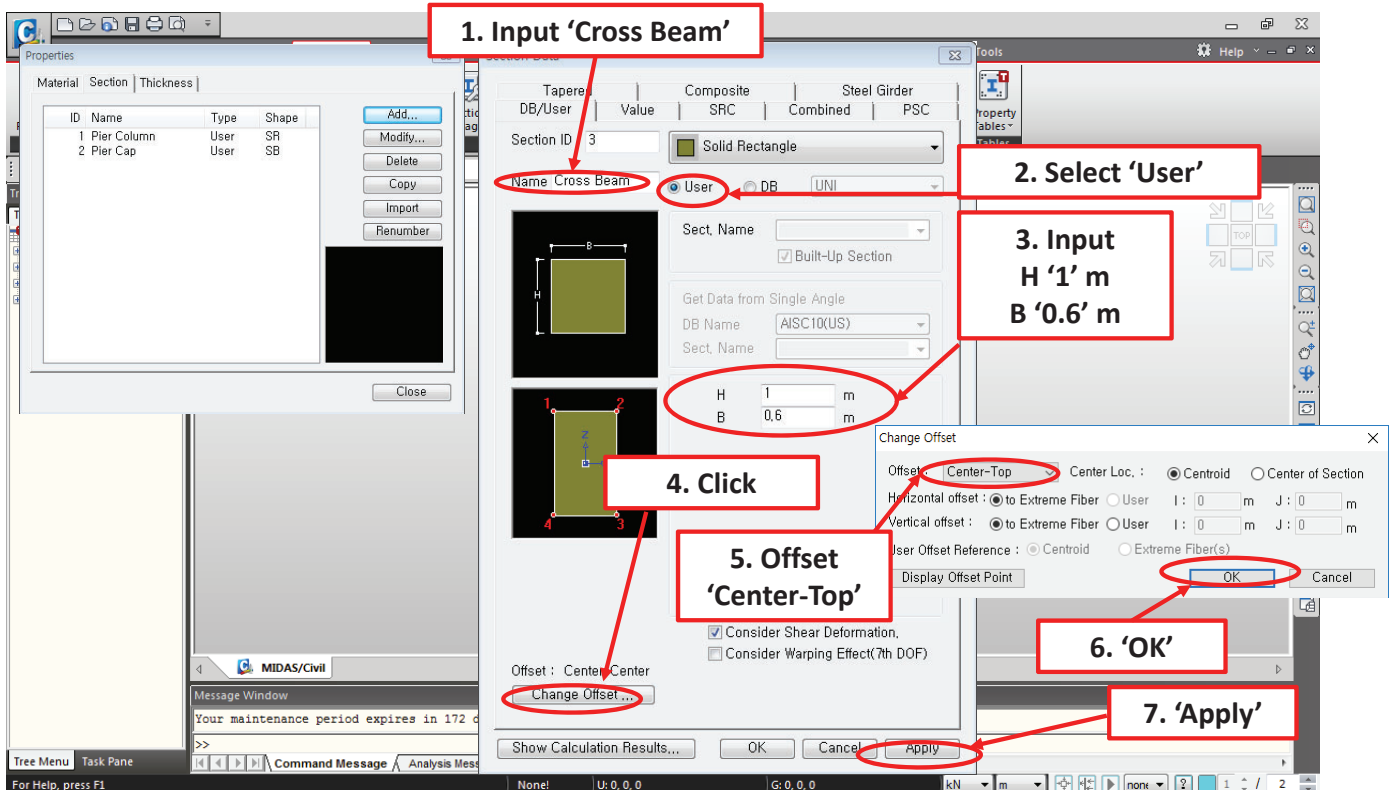
Check 'Show Calculation Results..' to view sectional properties such as area, moment of inertia and etc..

MIDASIT

**Procedure**

Define section for pier cap. Element line locates on the center of section shape and it can be on the center-top when 'Change Offset' is applied.

MIDASIT

**Procedure**

Define section for cross beam

MIDASIT

Offset: Specify the section Offset from the location options.

Horizontal Offset: Specify the Offset in the transverse direction. "to Extreme Fiber" assigns the offset to the outer-most point. For a specific location of Offset, select "User" and enter the distance from the "Centroid" to the desired Offset location. Unless the Offset is "Center-Center" the Horizontal Offset can be entered as the "User" type. For a tapered (non-prismatic) section, data input for the J-end also becomes activated.

Vertical Offset: Specify the Offset in the vertical direction. "to Extreme Fiber" assigns the offset to the outer-most point. For a specific location of Offset, select "User" and enter the distance from "Centroid" to the desired Offset location. Unless the Offset is "Center-Center" the Vertical Offset can be entered as the "User" type. For a tapered (non-prismatic) section, data input for the J-end also becomes activated.

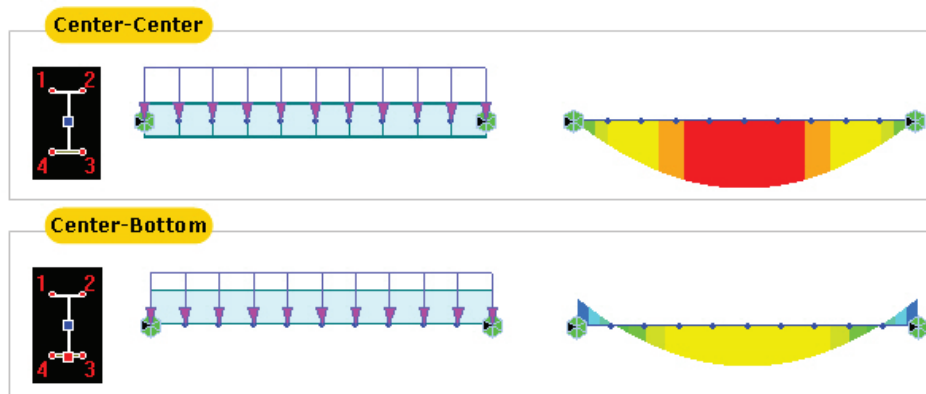
Note 1

When Offset distance is specified, a positive (+) sign applies to Center-to-outward for Centroid reference and Extreme-to-inward for Extreme Fiber reference.

Note 2

Node-based loads such as Nodal Loads and Specified Displacements are always applied at the nodes. However, element-based loads such as Beam Loads and Temperature Loads are applied on the center line of the element section. Please find the difference in the following example.

MIDASIT



User Offset Reference: When section offset distance is specified as the "User" type, define the reference location.

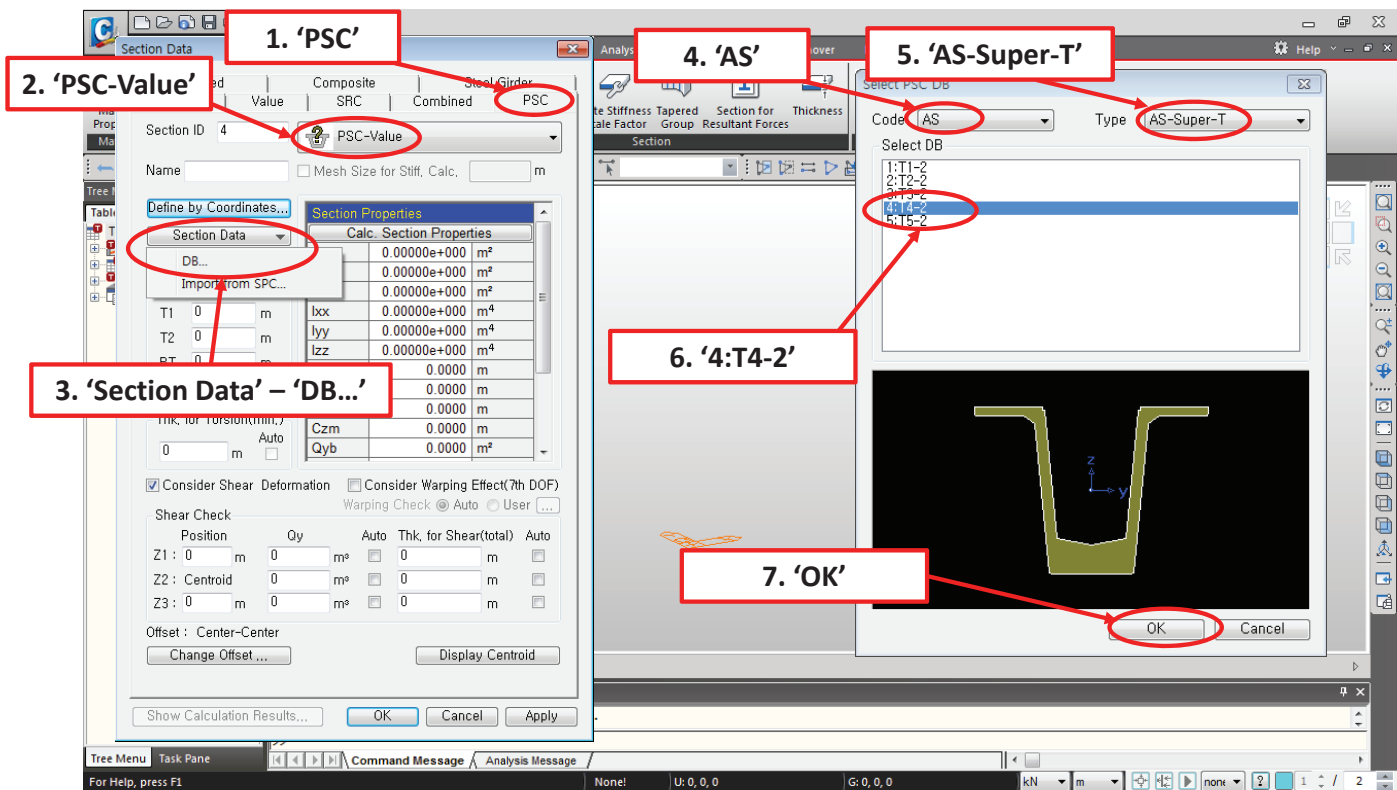
Centroid: Specify the offset distance relative to the centroid of the section.

Extreme Fiber(s): Specify the offset distance relative to Left/Right & Top/Bottom.

Note 3

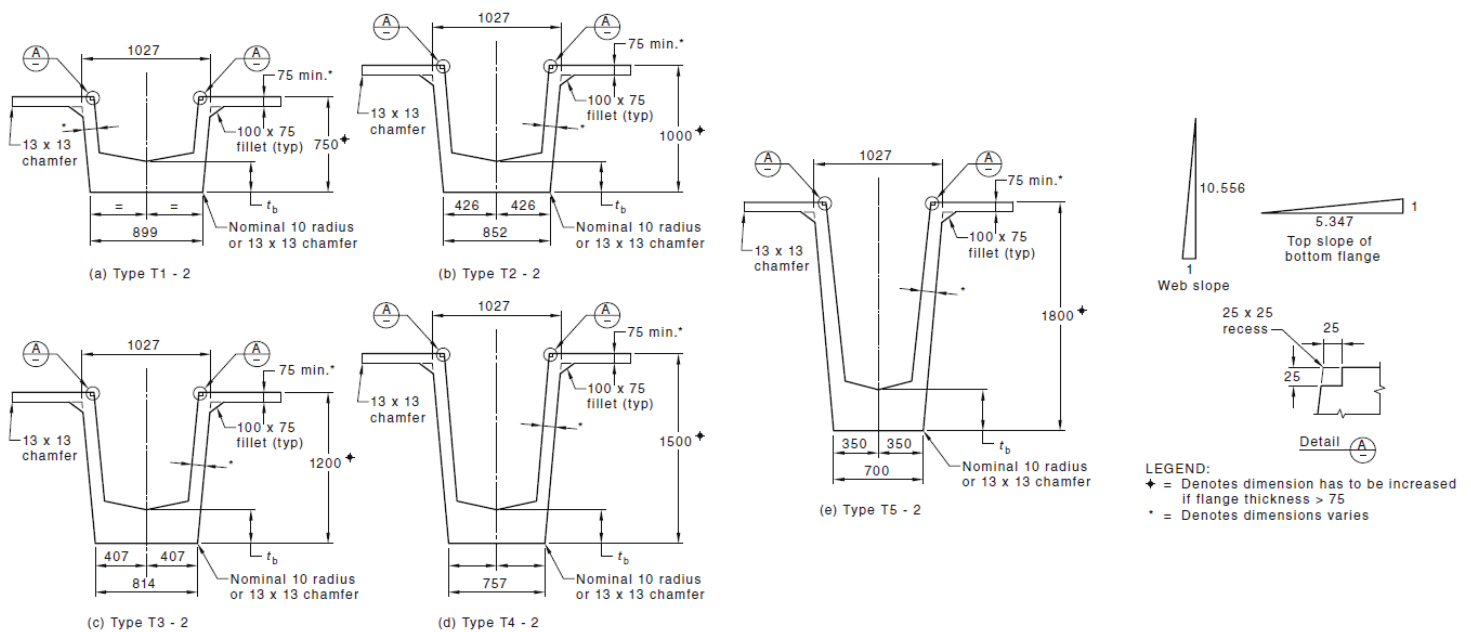
When User type is specified, the Offset distance and direction are entered relative to Centroid irrespective of the Center option (Centroid or Center of Section). For example, specifying "Offset: Left-Center", "Center Loc.: Center of Section" and "Horizontal offset: 0.5 " User type" will result in an Offset 0.5" to the left of the Centroid. And if the Offset option is "Left-Center" and the Center option is Center of Section the User type for Horizontal offset becomes activated and the User type for Vertical offset becomes inactivated. The Horizontal offset defined as User type here becomes the Centroid, and the Vertical offset fixed to Center becomes the "Center of Section"

MIDASIT

**Procedure**

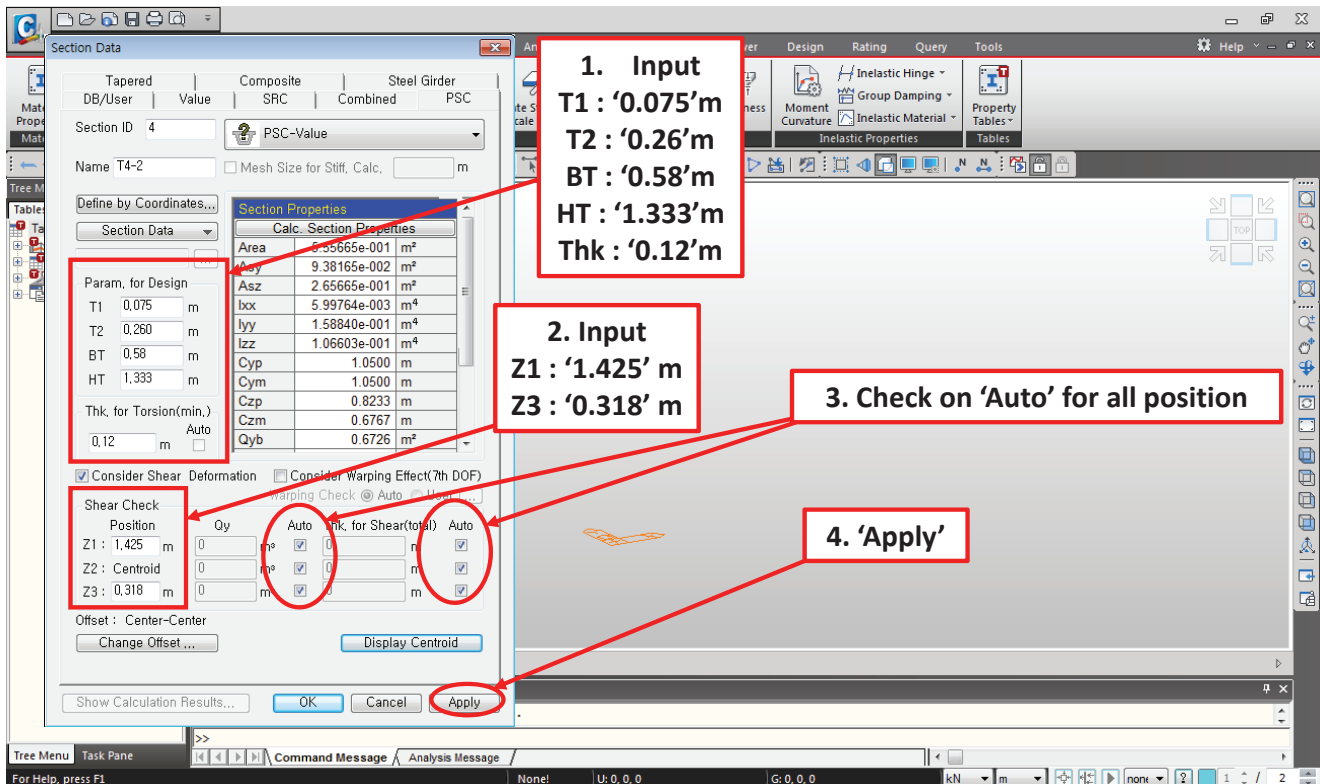
Define section for the girder

MIDASIT

**Procedure**

Super-T section from AS5100.5 2017

MIDASIT

**Procedure**

Click 'Display Centroid' to check stress points on the cross section. Stress results are shown at the stress points.

MIDASIT

Param. for Design: Enter the section dimensions to be used for design, referring to PSC Viewer. The dimensions are used for calculating the shear strength. If 0 is inputted in T2, then the program automatically recognizes the section as a Tee section, and uses BT as web thickness. The parameters for closed section and open section are calculated using the following equations:

For closed section: $k_t = 2F \cdot t$

For open section: $k_t = \sum \frac{1}{3} b t^3$

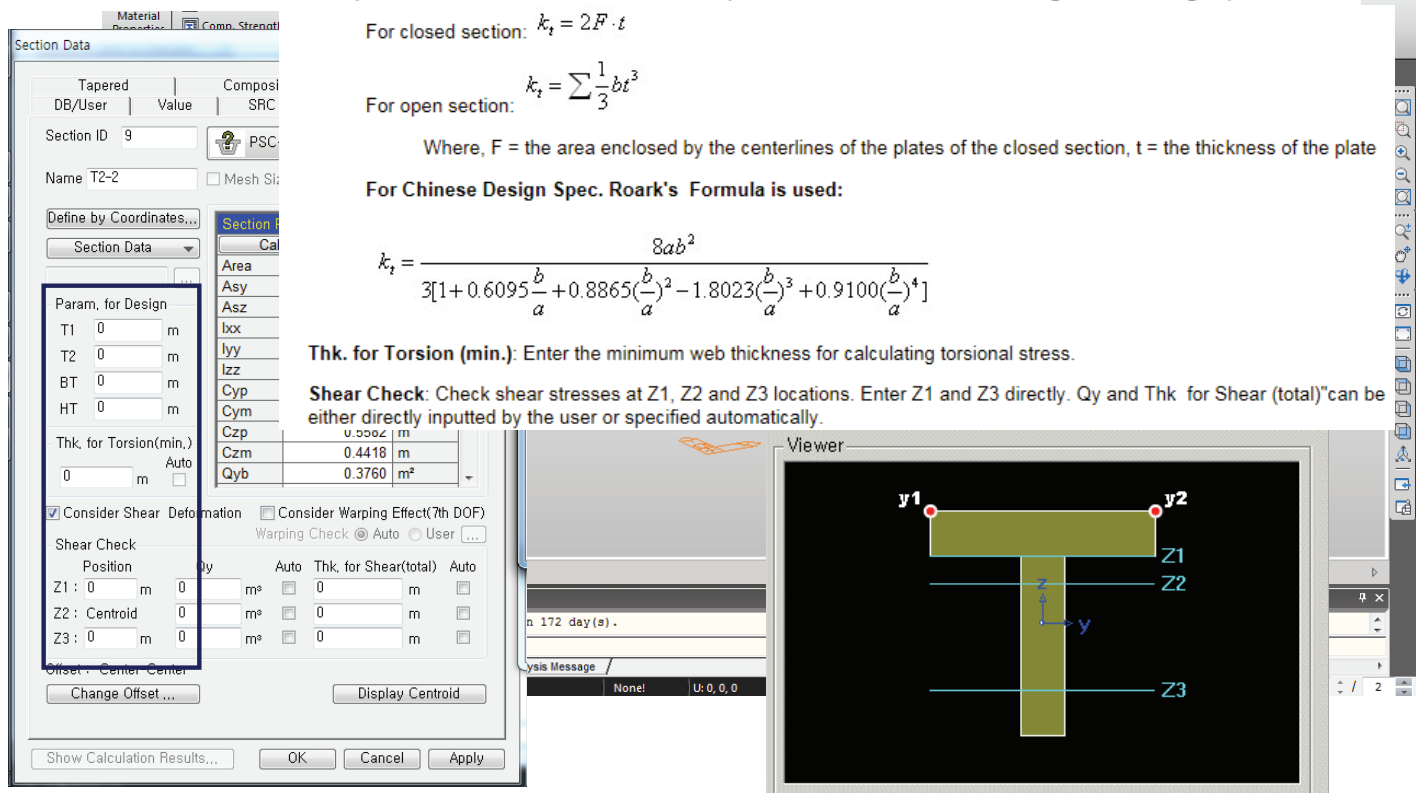
Where, F = the area enclosed by the centerlines of the plates of the closed section, t = the thickness of the plate

For Chinese Design Spec. Roark's Formula is used:

$$k_t = \frac{8ab^2}{3[1 + 0.6095\frac{b}{a} + 0.8865(\frac{b}{a})^2 - 1.8023(\frac{b}{a})^3 + 0.9100(\frac{b}{a})^4]}$$

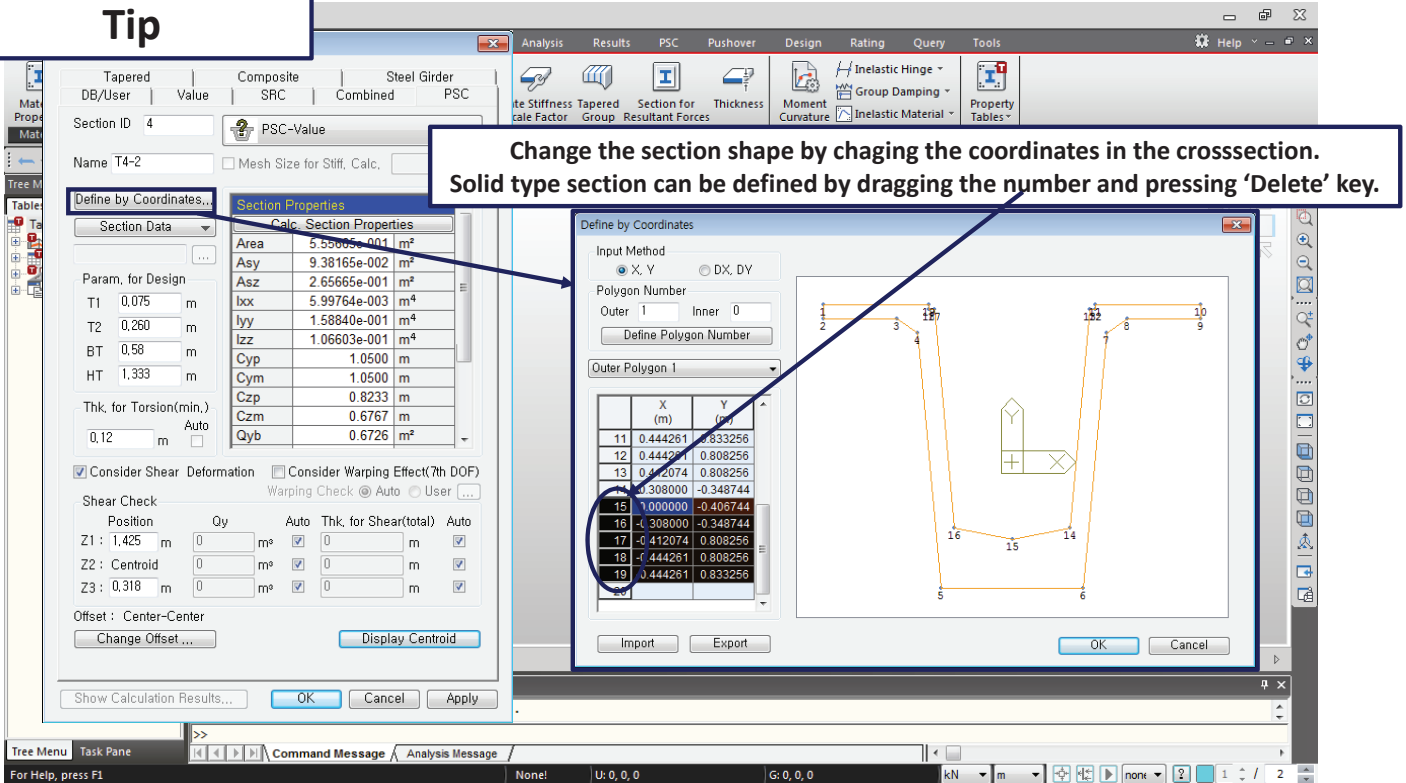
Thk. for Torsion (min.): Enter the minimum web thickness for calculating torsional stress.

Shear Check: Check shear stresses at Z1, Z2 and Z3 locations. Enter Z1 and Z3 directly. Qy and Thk for Shear (total)"can be either directly inputted by the user or specified automatically.



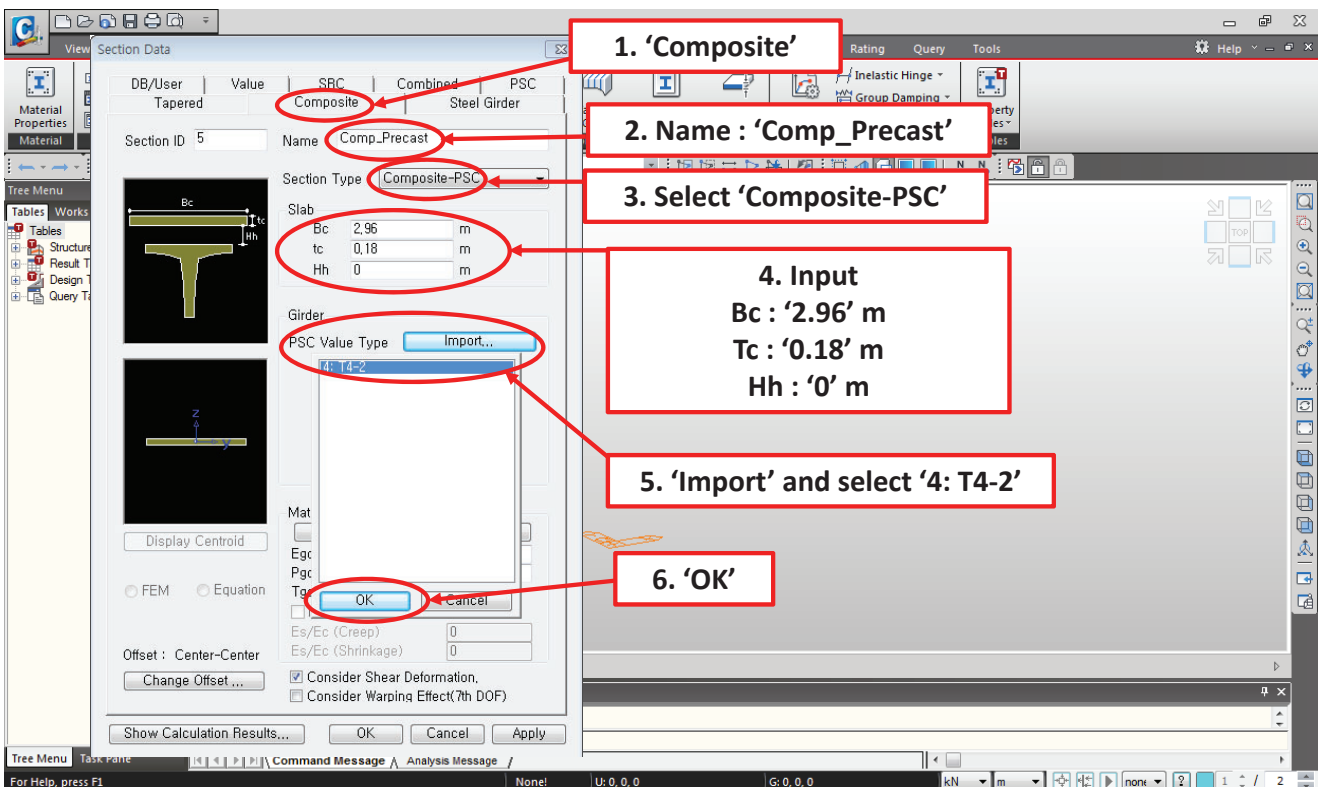
MIDASIT

Tip



Procedure

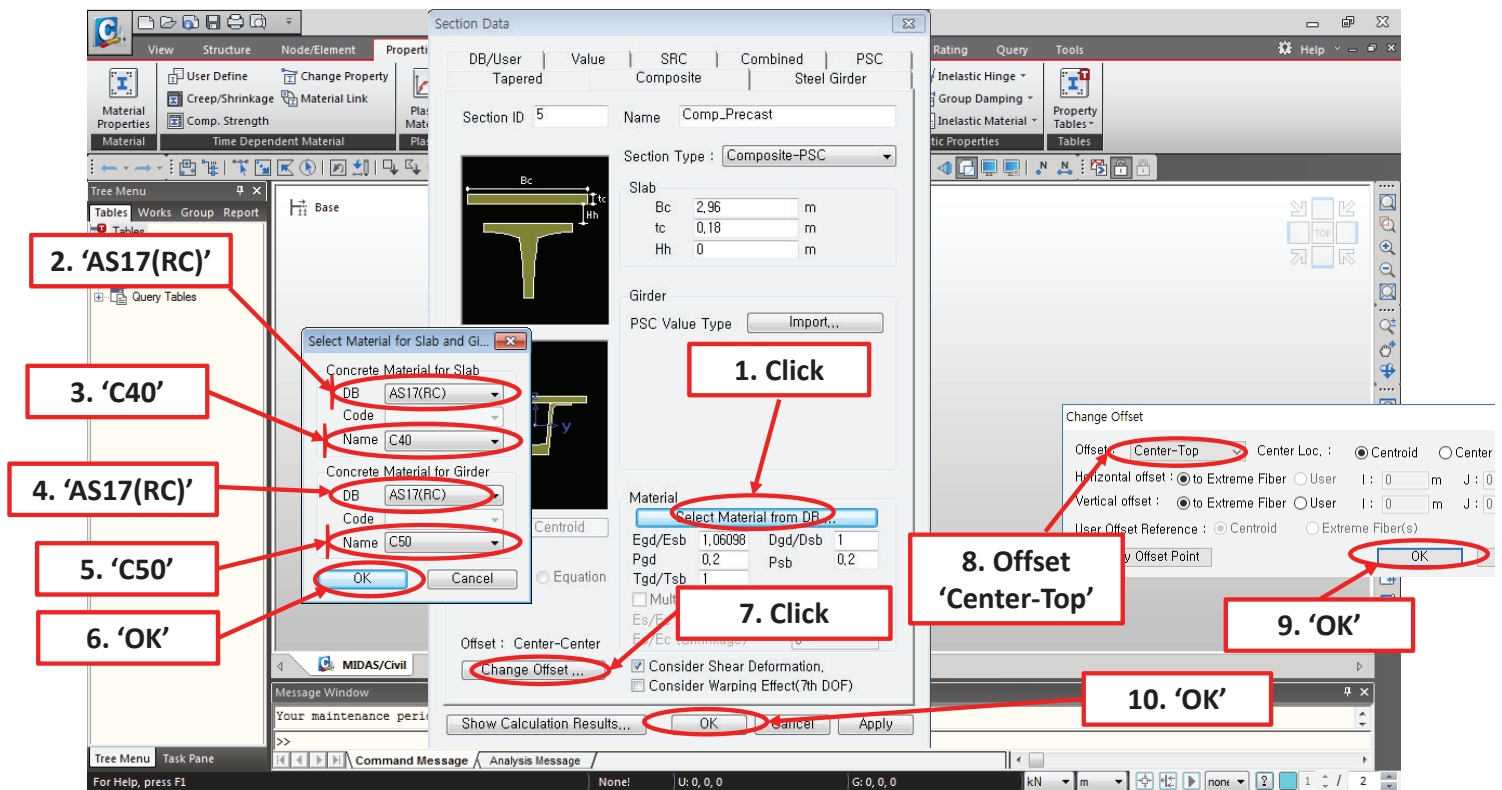
MIDASIT



Procedure

Define section for composite girder. Import the girder section which was defined under PSC tap.

MIDASIT

**Procedure**

Define section for composite girder. The ratio of material properties decides composite sectional properties. Check with 'Show Calculation Results...' button.

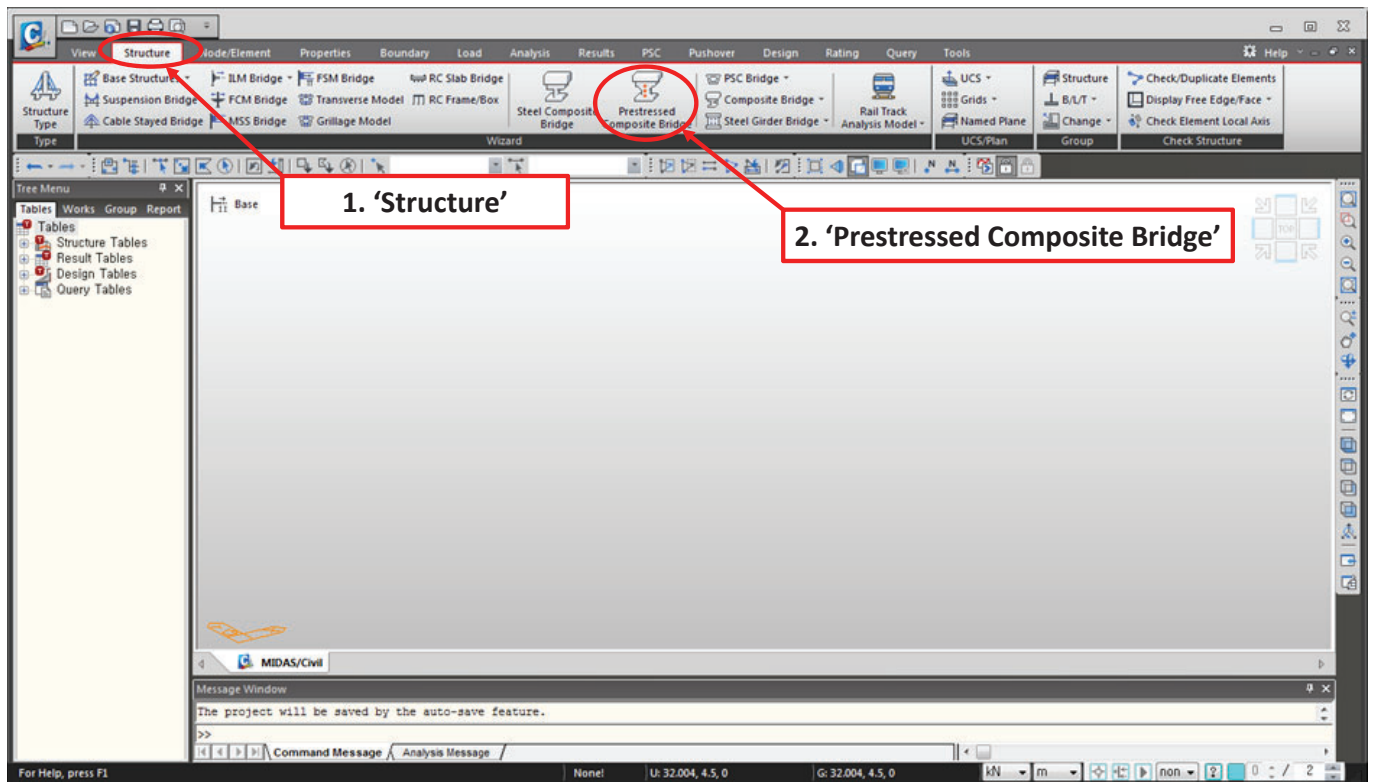
MIDASIT

Overview

- **Properties**
 - Material / Section
- **Prestressed Composite Bridge Wizard**
 - Layout
 - Section
 - Tendon
 - Load
 - Construction Stage
- **Load**
 - Time Dependent Material
 - Moving load
 - Response Spectrum Analysis
- **Analysis**
 - Moving Load
- **Results**
 - Load Combination
 - Reaction/Force/Displacement
 - Moving Tracer
 - Concurrent Force
 - Tendon Losses
 - Mode Shape
- **Design**
 - PSC Design
- **Tips**
 - Smart Report
 - MCT Command Shell
 - Tendon Template
 - Import tendon from AutoCAD
- **Appendix. Load Combinations**

Step 2. Prestressed Composite Bridge Wizard

Prestressed Composite Bridge Wizard

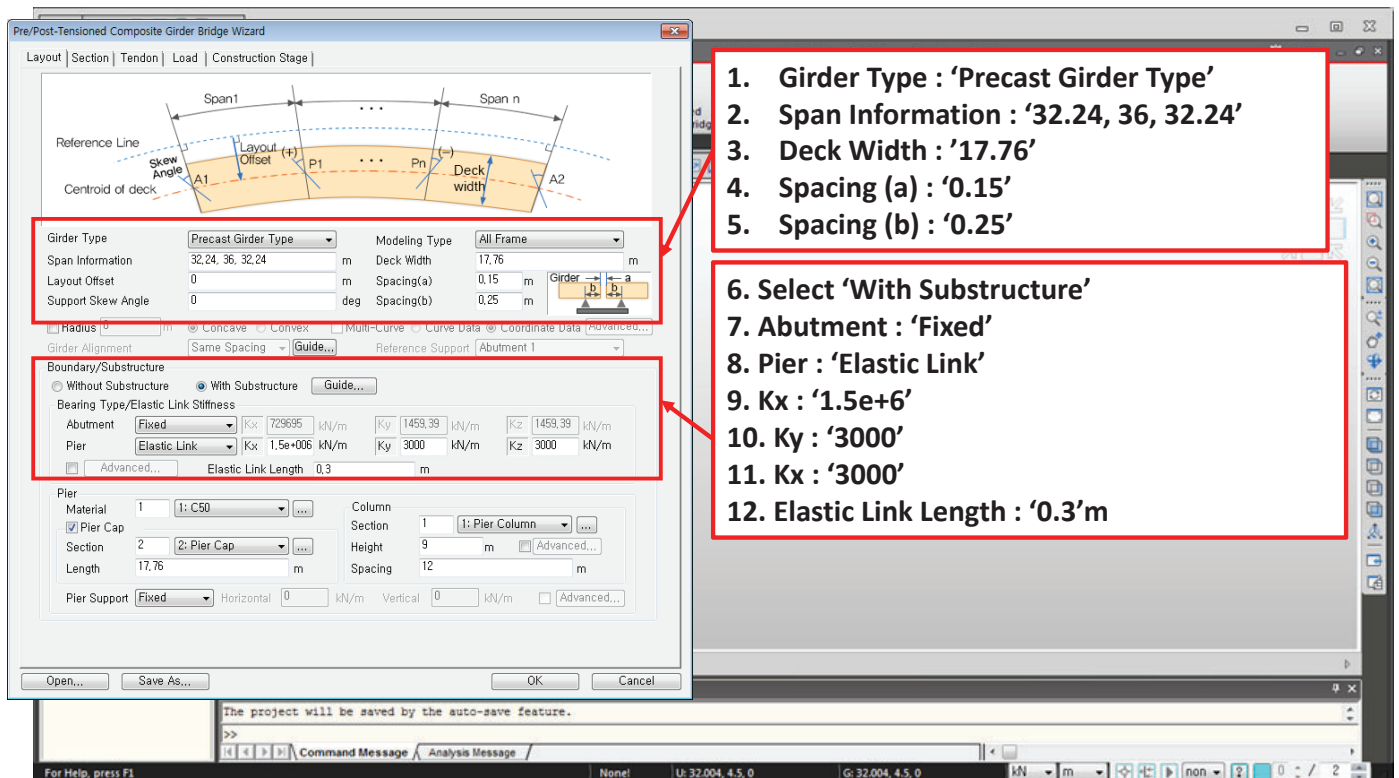


Procedure

Execute Prestress Composite Bridge wizard.

MIDASIT

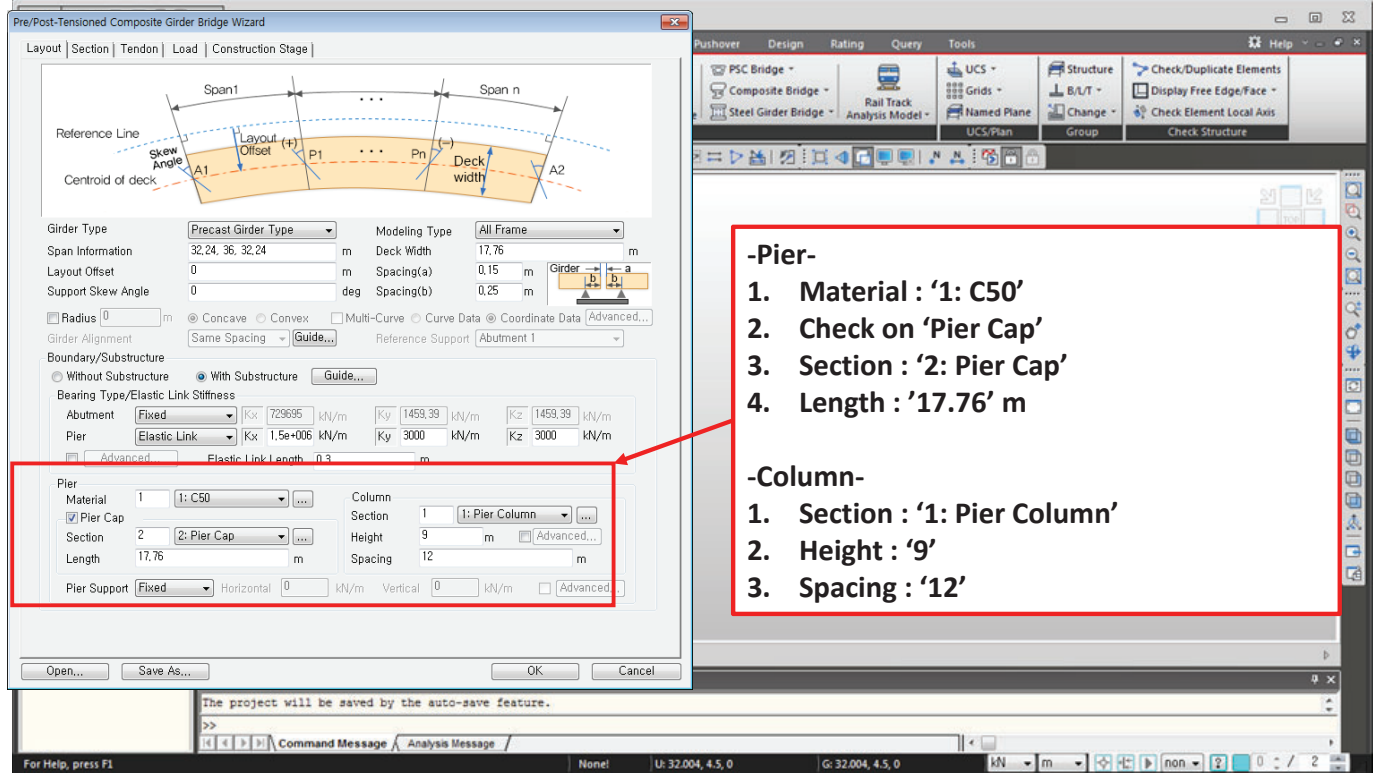
Prestressed Composite Bridge Wizard



Procedure

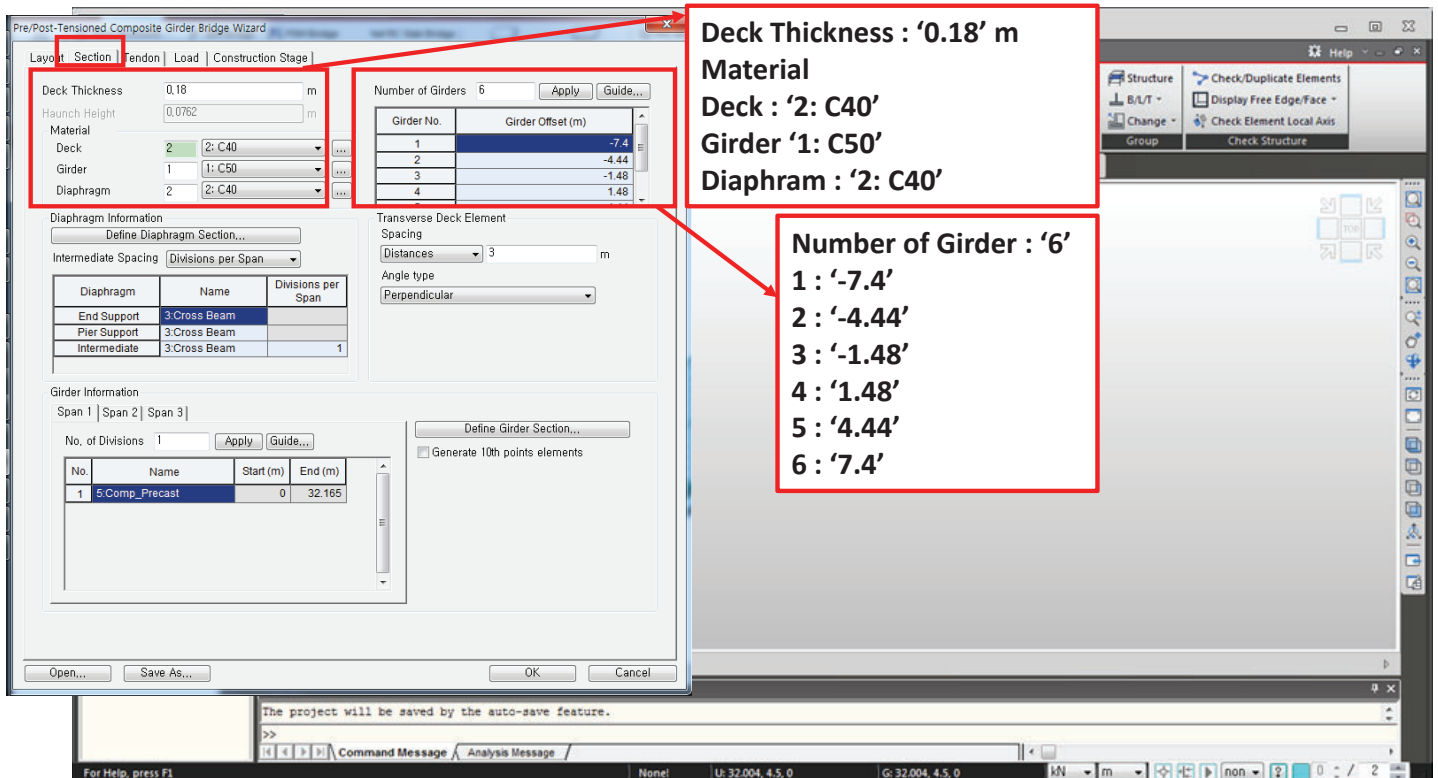
Shell(Plate) elements are generated for the slab if 'Modelling Type' is 'Deck as Plate, Girder as Frame'. Kx is vertical direction, Ky is transverse direction and Kz is longitudinal direction for bearing stiffness.

MIDASIT



Procedure

MIDASIT



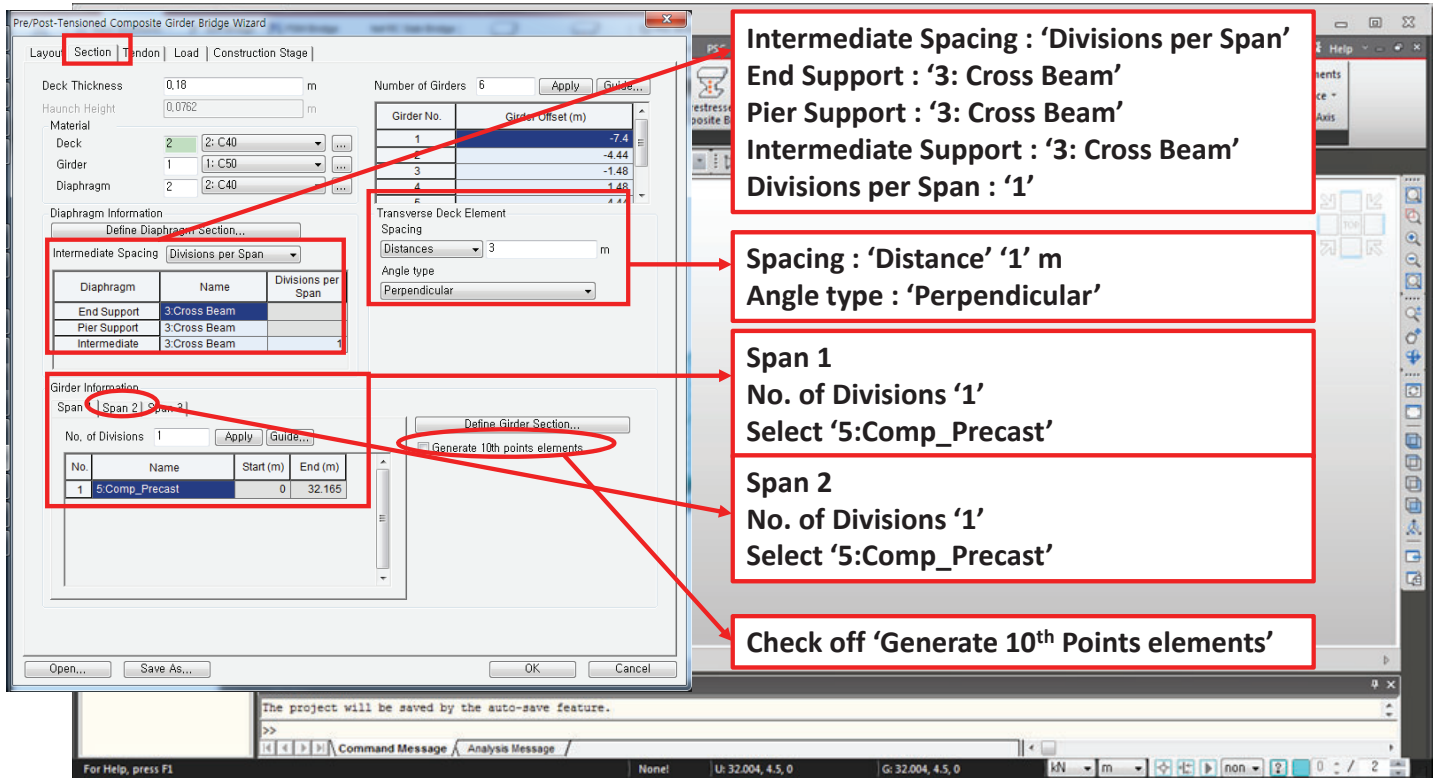
Procedure

Move to other cells by pressing 'Tap' or 'Shift + Tap' key or arrows on the keyboard. Overwrite input data by just typing the value after moving to other cells.

MIDASIT

27

Prestressed Composite Bridge Wizard



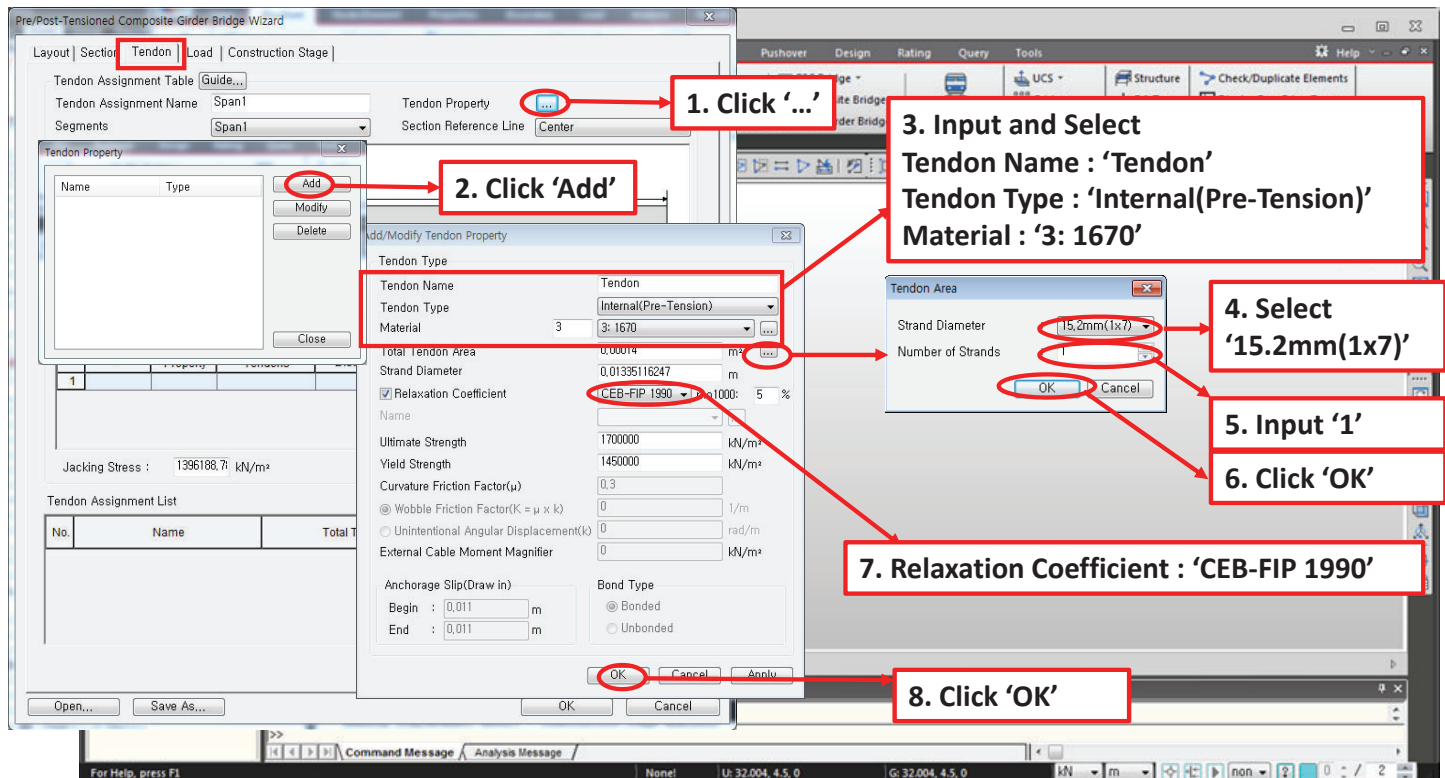
Procedure

Diaphragm Information is to define cross beams. 'Generate 10th Points elements' option is to cut elements as per AASHTO LRFD code. Input the number on 'No. of Divisions' if there are more than 1 different girder section within one span.

MIDASIT

28

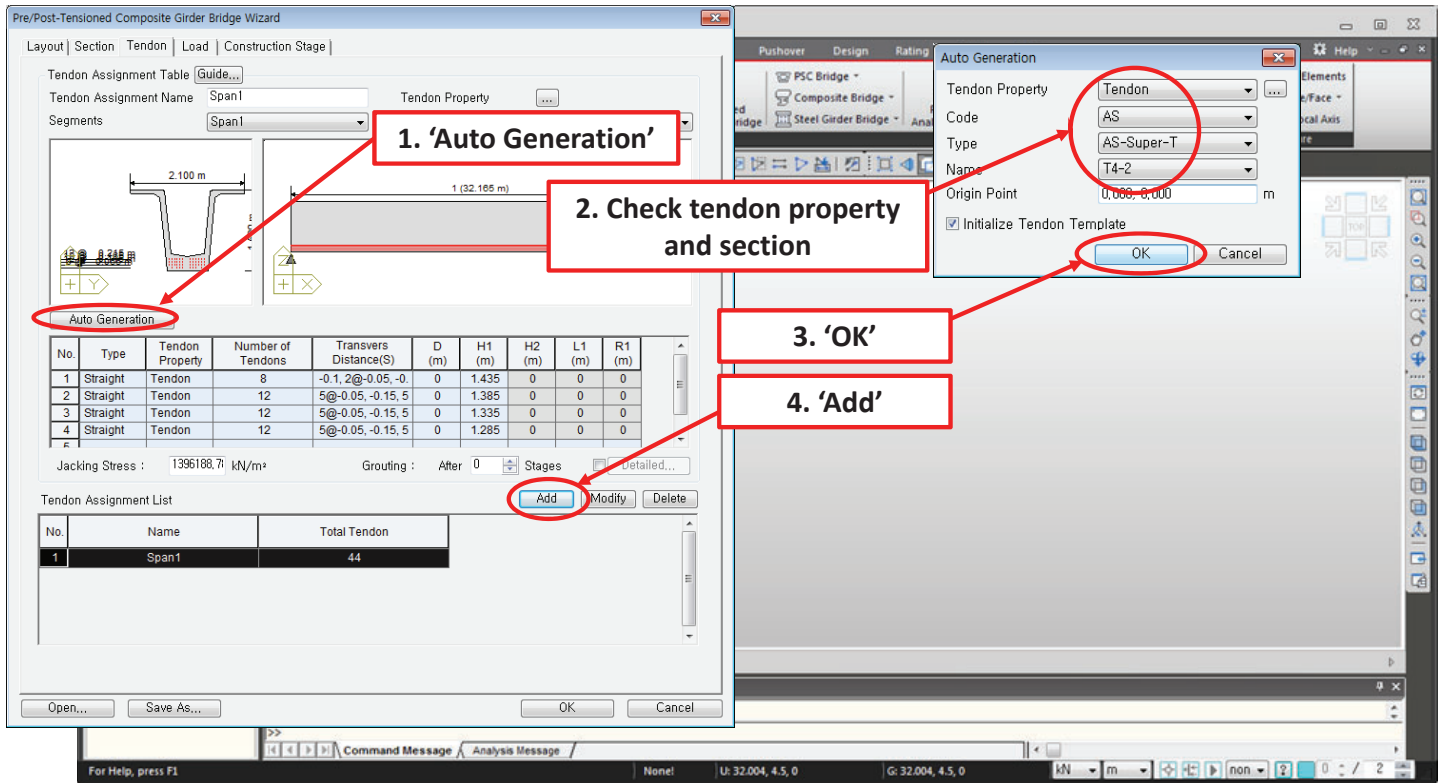
Prestressed Composite Bridge Wizard



Procedure

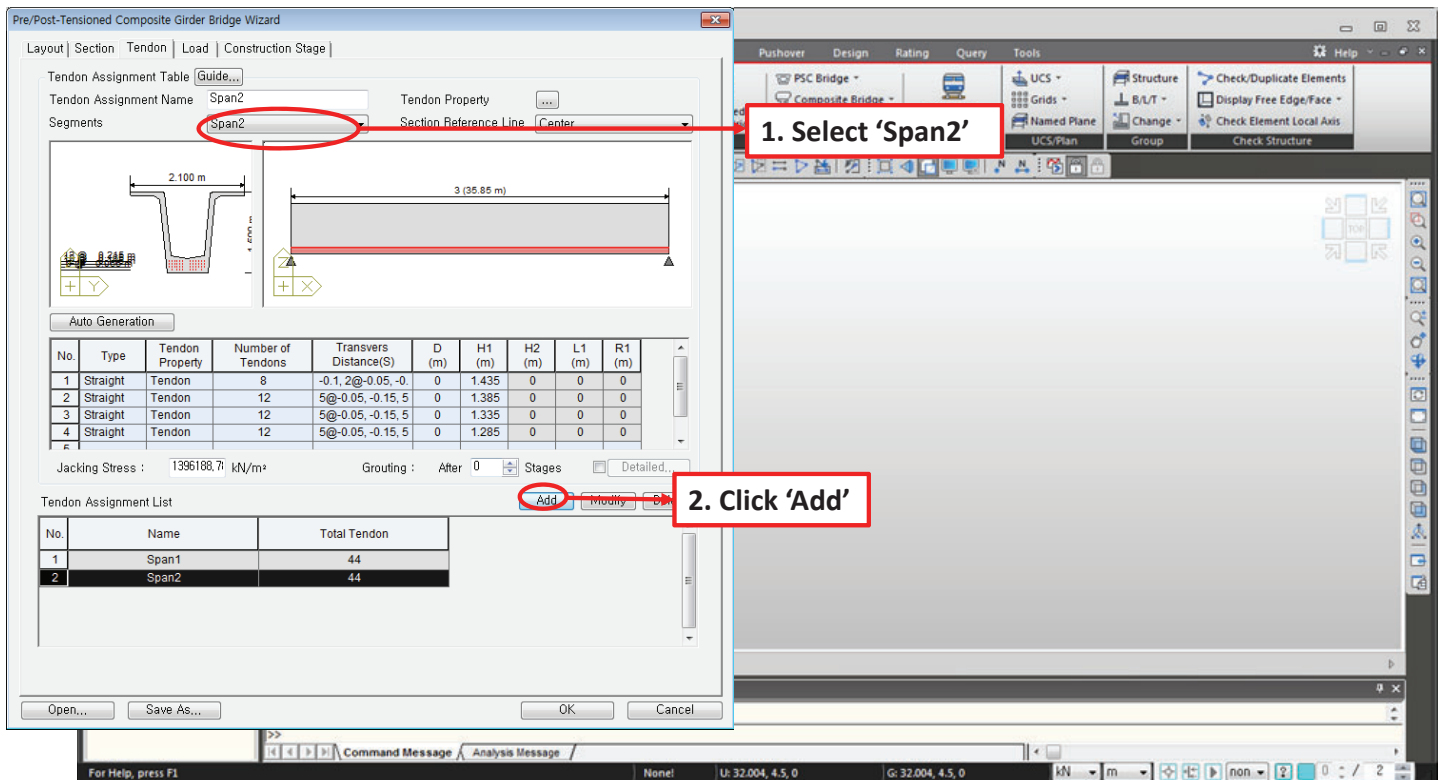
Define tendon property. Total Tendon Area can be calculated automatically or can be input manually. Select 'User Defined' option to define your own creep/shrinkage/relaxation function. Input data for function can be pasted from Microsoft Excel Spread Sheet.

MIDASIT

**Procedure**

D : Transverse location of the tendon in the cross section / H : Vertical location of the tendon from the top of the section / Grouting : Grouting stage after jacking the tendon. Go to 'Detailed...' to define debonding length.

MIDASIT

**Procedure**

MIDASIT

31

Prestressed Composite Bridge Wizard

1. Select 'Span3'

2. Click 'Add'

3. Click 'Add'

4. Click 'Add'

5. Click 'Add'

No.	Type	Tendon Property	Number of Tendons	Transvers Distance(S)	D (m)	H1 (m)	H2 (m)	L1 (m)	R1 (m)
1	Straight	Tendon	8	-0.1, 2@-0.05, -0.	0	1.435	0	0	0
2	Straight	Tendon	12	5@-0.05, -0.15, 5	0	1.385	0	0	0
3	Straight	Tendon	12	5@-0.05, -0.15, 5	0	1.335	0	0	0
4	Straight	Tendon	12	5@-0.05, -0.15, 5	0	1.285	0	0	0

No.	Name	Total Tendon
1	Span1	44
2	Span2	44
3	Span3	44

Procedure

MIDASIT

32

Prestressed Composite Bridge Wizard

1. Check deck width and dead load values

2. Check deck width and dead load values

3. Select 'Australia' Click 'OK'

4. Click 'OK'

5. Click 'OK'

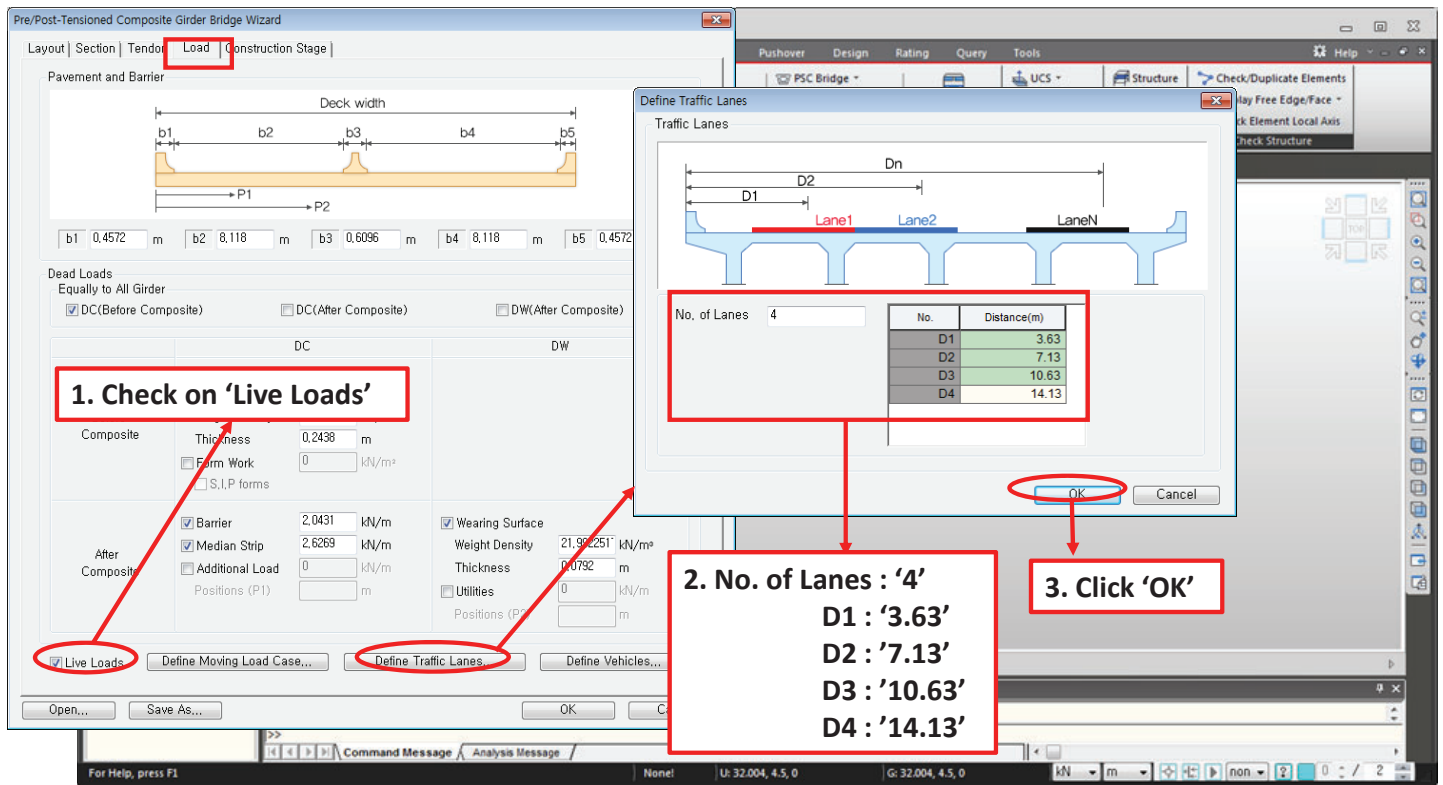
Deck width	
b1	0.4572 m
b2	8.118 m
b3	0.6096 m
b4	8.118 m
b5	0.4572 m

Dead Loads	
Before Composite	<input checked="" type="checkbox"/> Self Weight <input checked="" type="checkbox"/> Wet Con'c Weight Density: 23.563126 kN/m³ Thickness: 0.2438 m <input type="checkbox"/> Form Work: 0 kN/m² <input type="checkbox"/> S.I.P forms
After Composite	<input checked="" type="checkbox"/> Barrier: 2.0431 kN/m <input checked="" type="checkbox"/> Median Strip: 2.6269 kN/m <input type="checkbox"/> Additional Load: 0 kN/m Positions (P1): m <input checked="" type="checkbox"/> Wearing Surface: 21.992251 kN/m³ Thickness: 0.0792 m <input type="checkbox"/> Utilities: 0 kN/m Positions (P2): m

Procedure

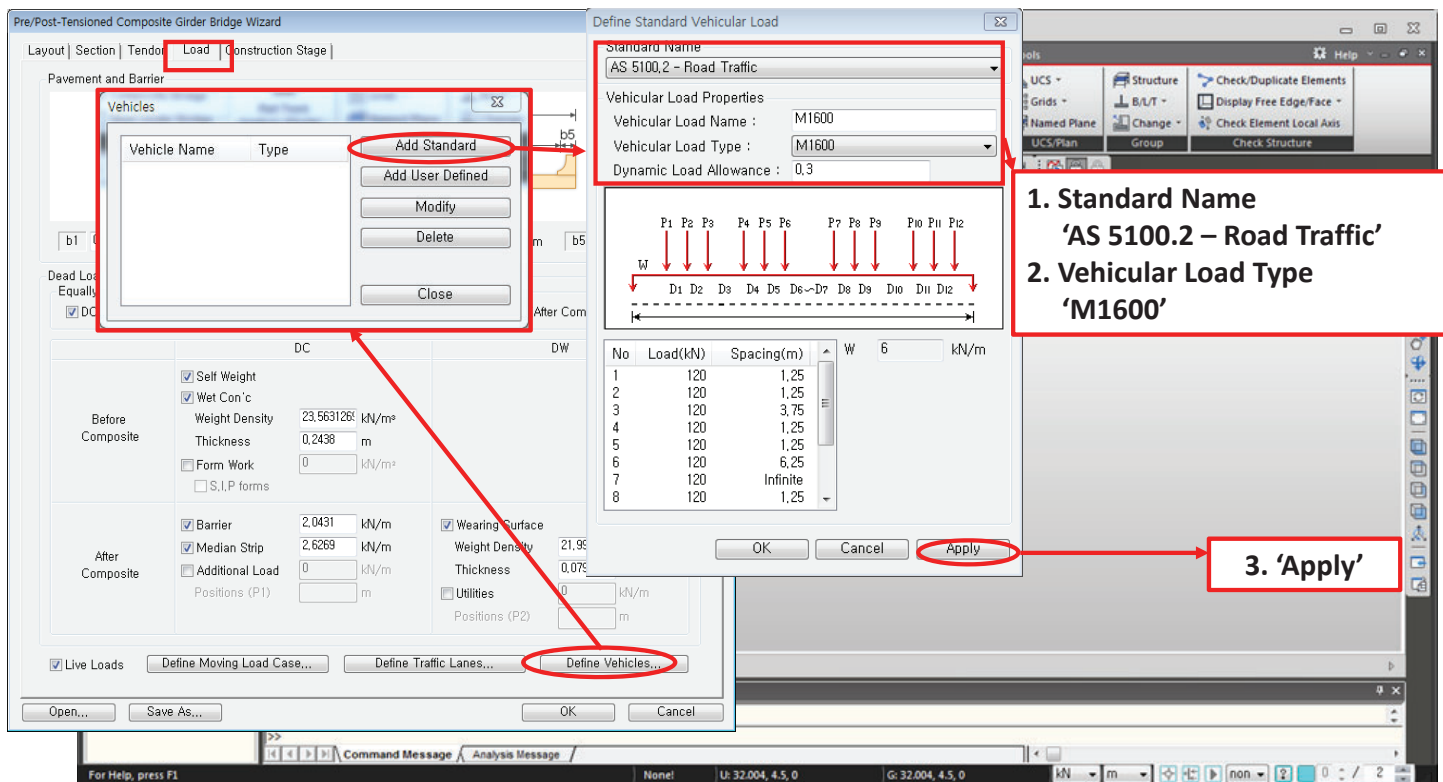
When 'Equally to All girder' is checked on, total dead loads are divided by the number of girder, and load values are same for each girder. Or the loads on each girder may be different because of the division ratio of dead load with different distances between the girders.

MIDASIT

**Procedure**

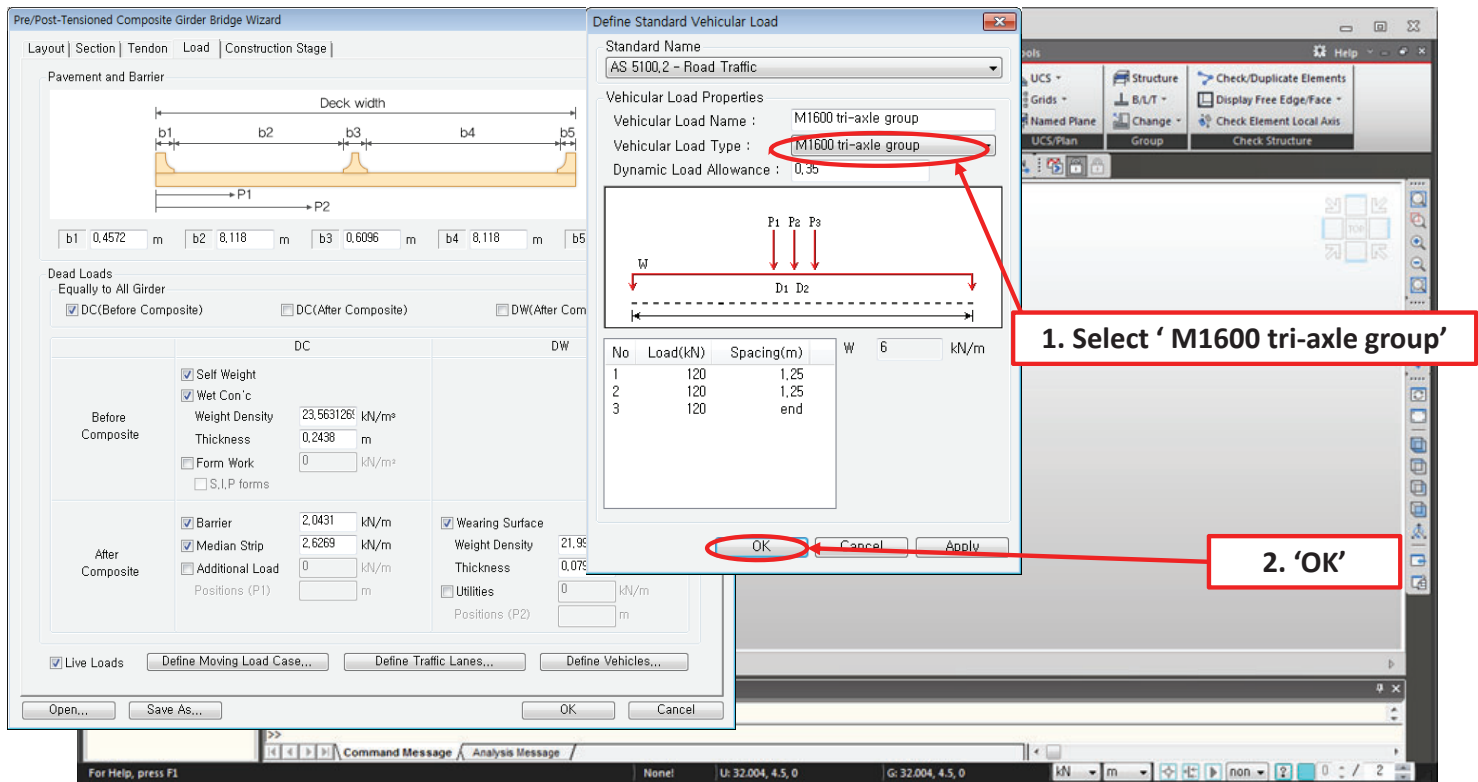
D1~D4 : Transverse distance from the left side of the bridge.

MIDASIT

**Procedure**

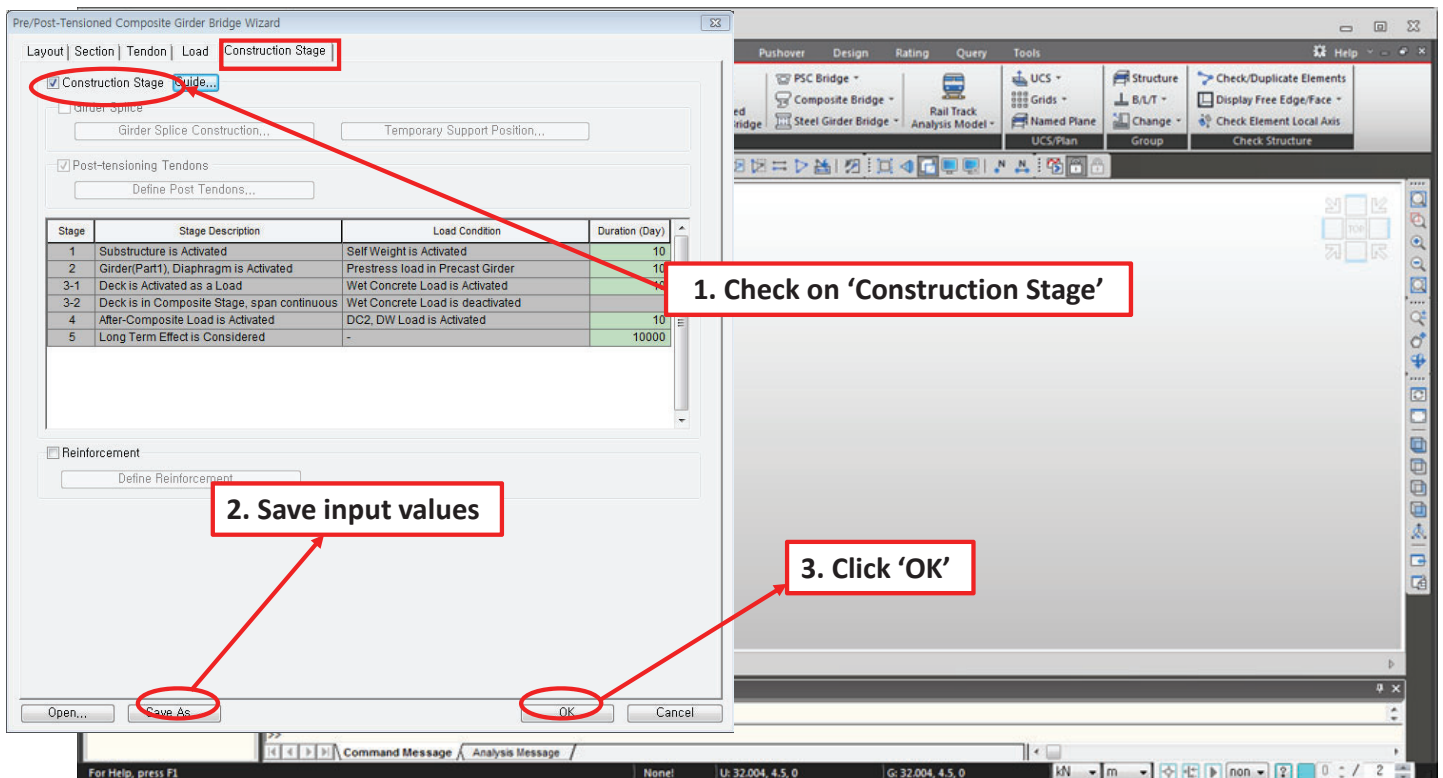
Vehicles are provided based on the design codes. Use 'Add User Defined' to define special vehicles.

MIDASIT

**Procedure**

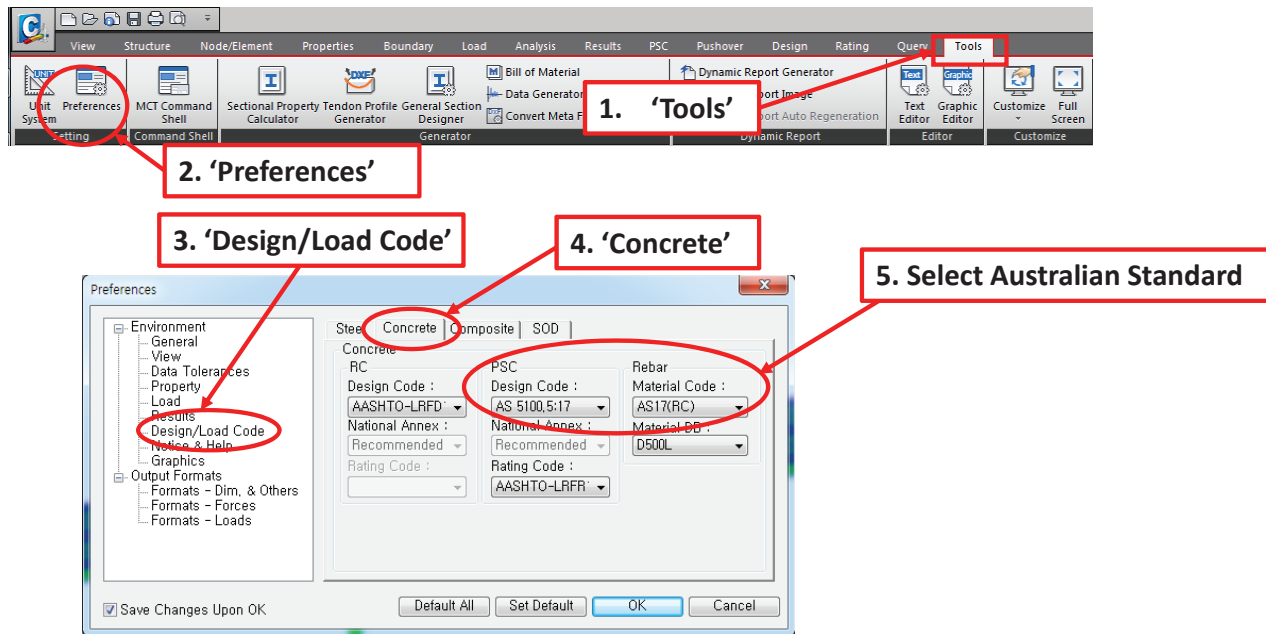
Vehicles are provided based on the design codes.

MIDASIT

**Procedure**

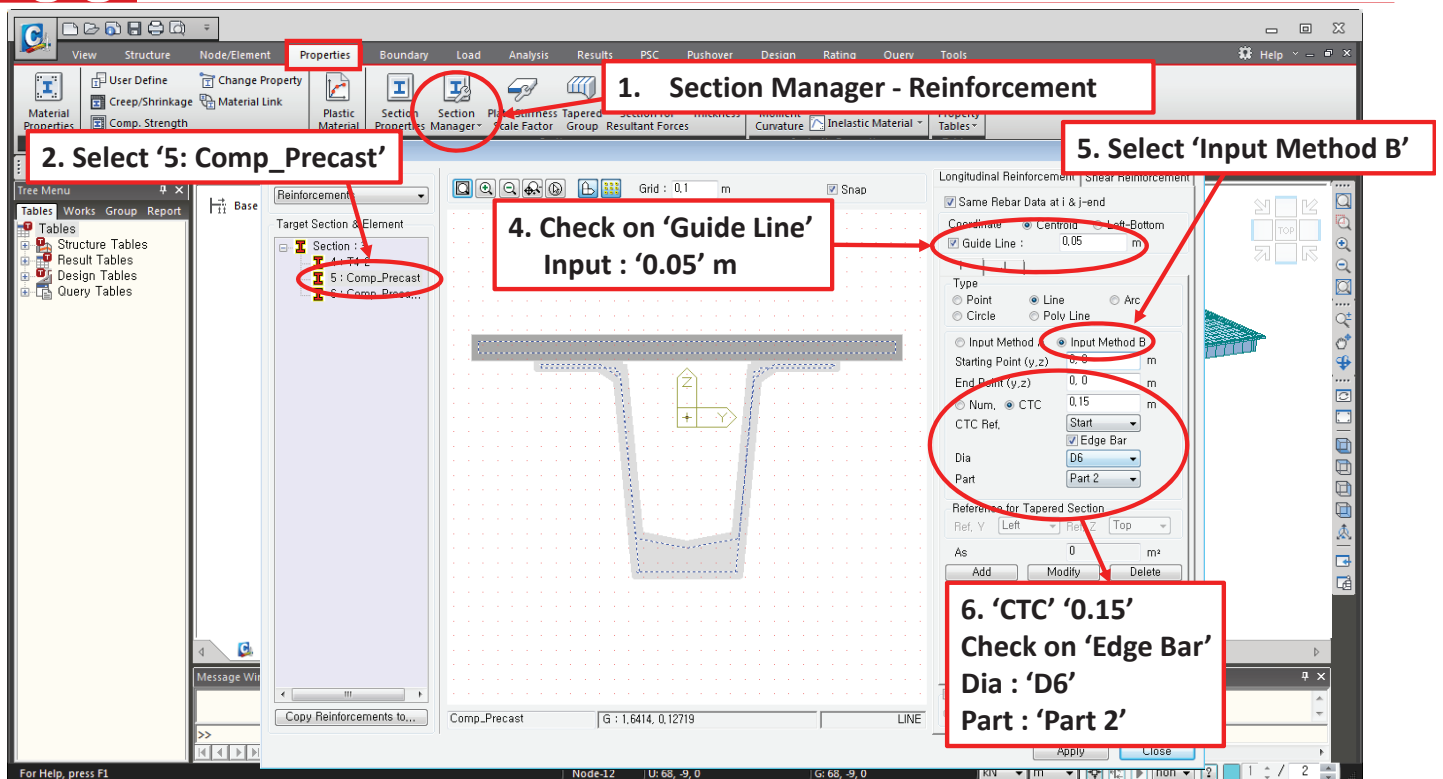
Construction stage analysis generate creep/shrinkage/tendon primary and secondary load cases. Time dependent material properties option has to be defined to view creep/shrinkage effect.

MIDASIT

**Procedure**

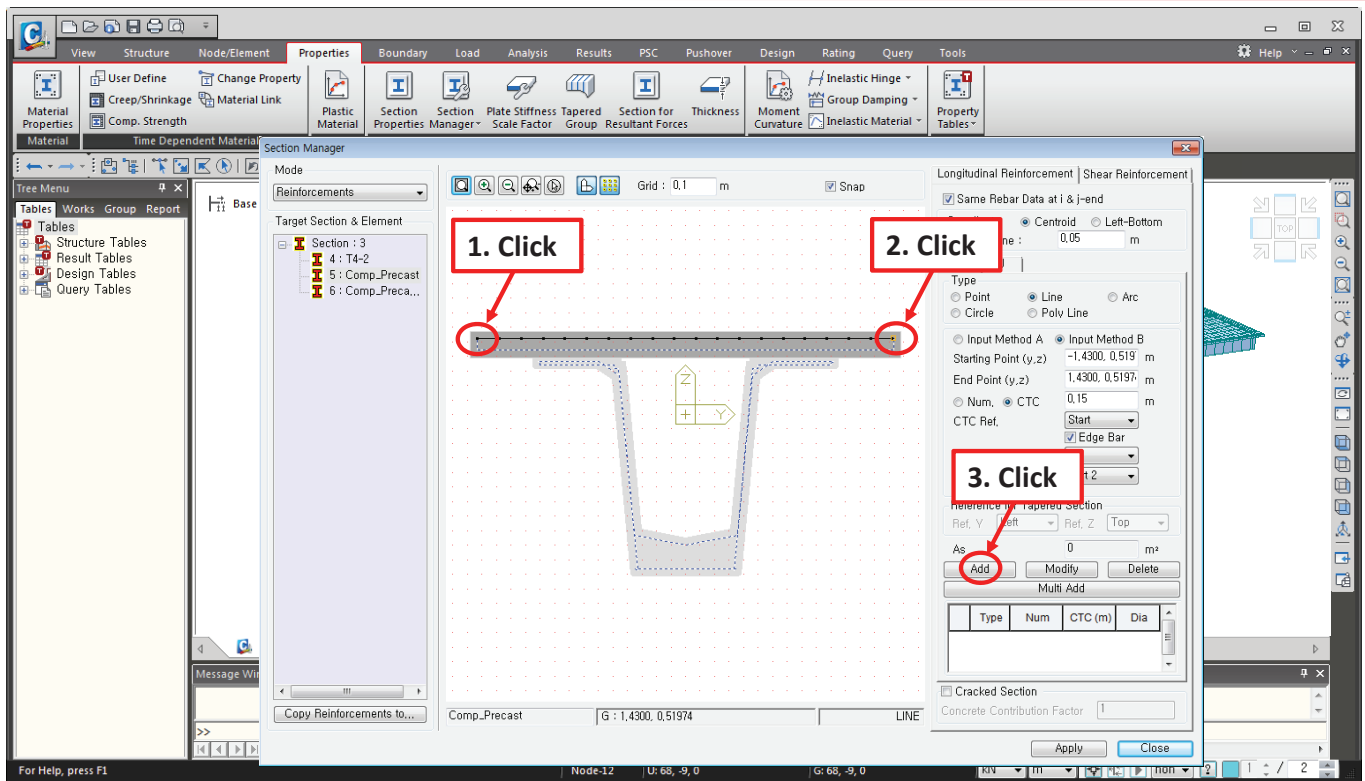
The unit of rebar changes depends on the setting of Preferences.

MIDASIT

**Procedure**

Input cover value on 'Guide Line'.
Part 1 : Gitter / Part 2 : Slab

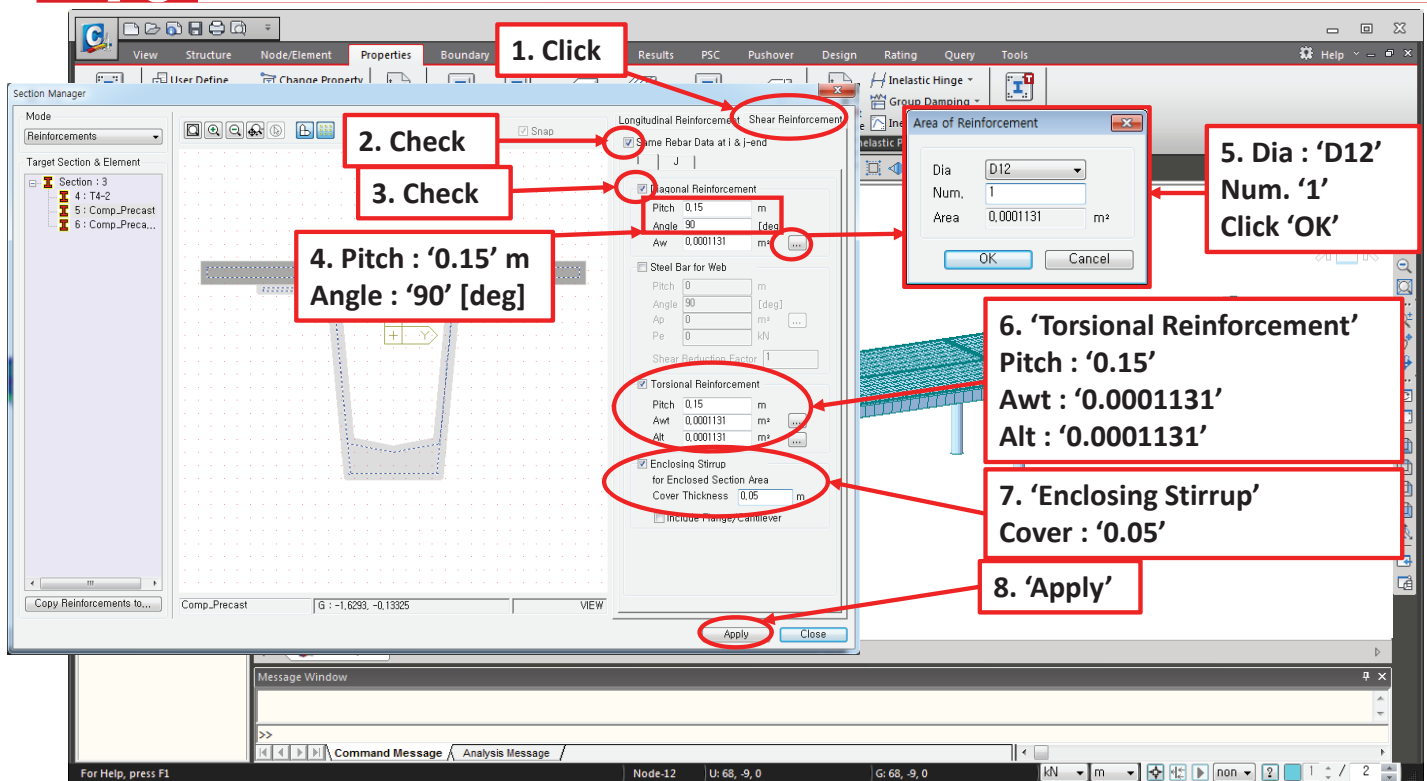
MIDASIT

**Procedure**

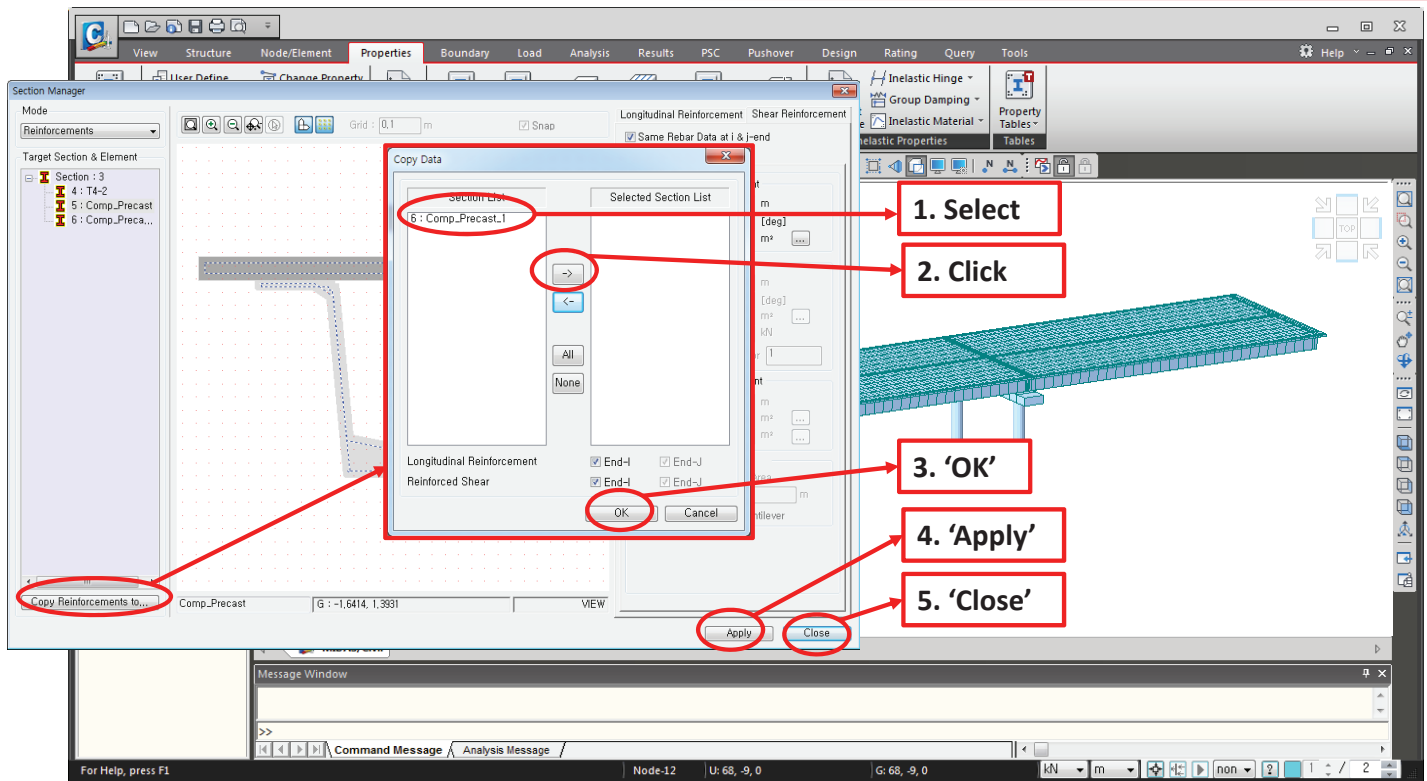
Snap the corner of the Guide line.

Zoom-in or Zoom-out by scrolling the mouse.

MIDASIT

**Procedure**

MIDASIT



Procedure

Copy reinforcement details to other sections

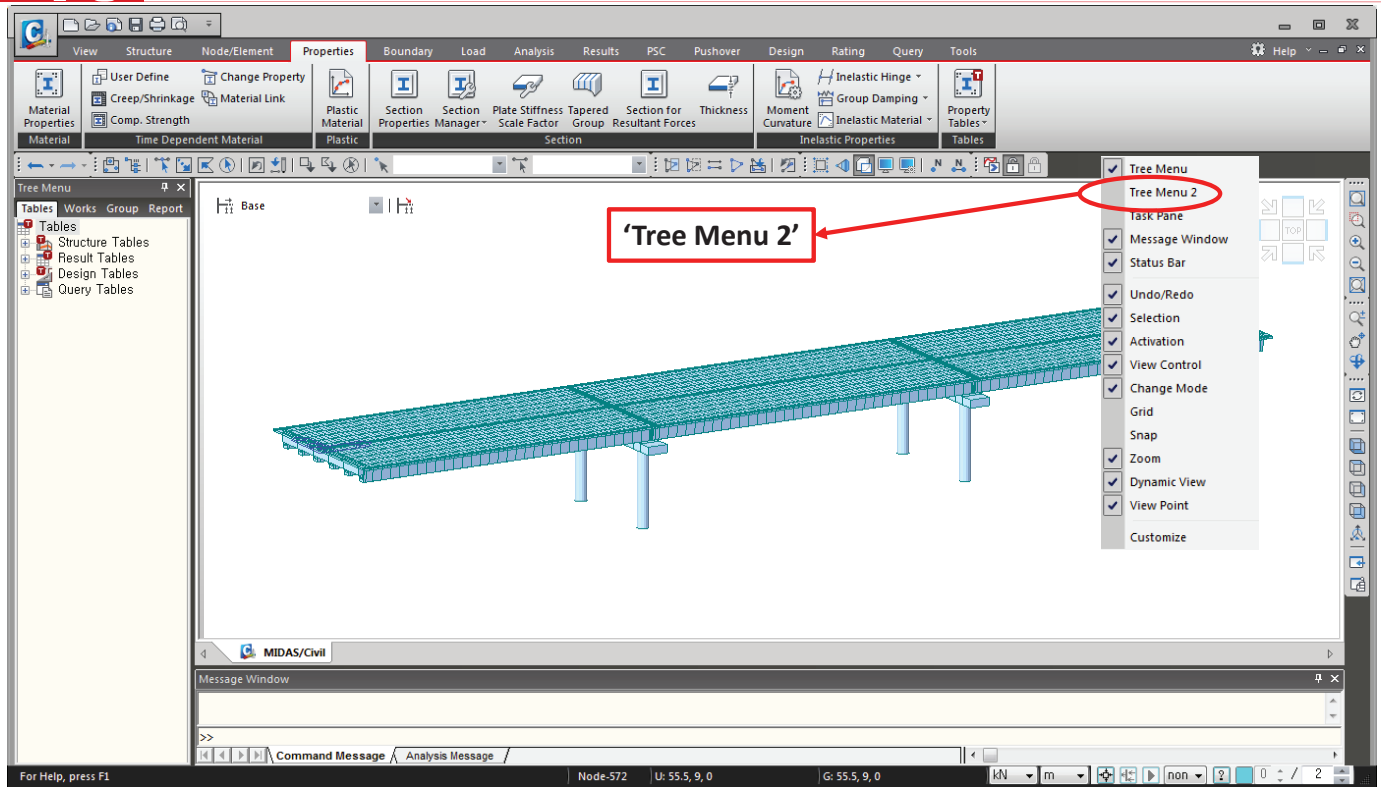
MIDASIT

Overview

- **Properties**
 - Material / Section
- **Prestressed Composite Bridge Wizard**
 - Layout
 - Section
 - Tendon
 - Load
 - Construction Stage
- **Load**
 - Time Dependent Material
 - Moving load
 - Response Spectrum Analysis
- **Analysis**
 - Moving Load
- **Results**
 - Load Combination
 - Reaction/Force/Displacement
 - Moving Tracer
 - Concurrent Force
 - Tendon Losses
 - Mode Shape
- **Design**
 - PSC Design
- **Tips**
 - Smart Report
 - MCT Command Shell
 - Tendon Template
 - Import tendon from AutoCAD
- **Appendix. Load Combinations**

Step 3. Load

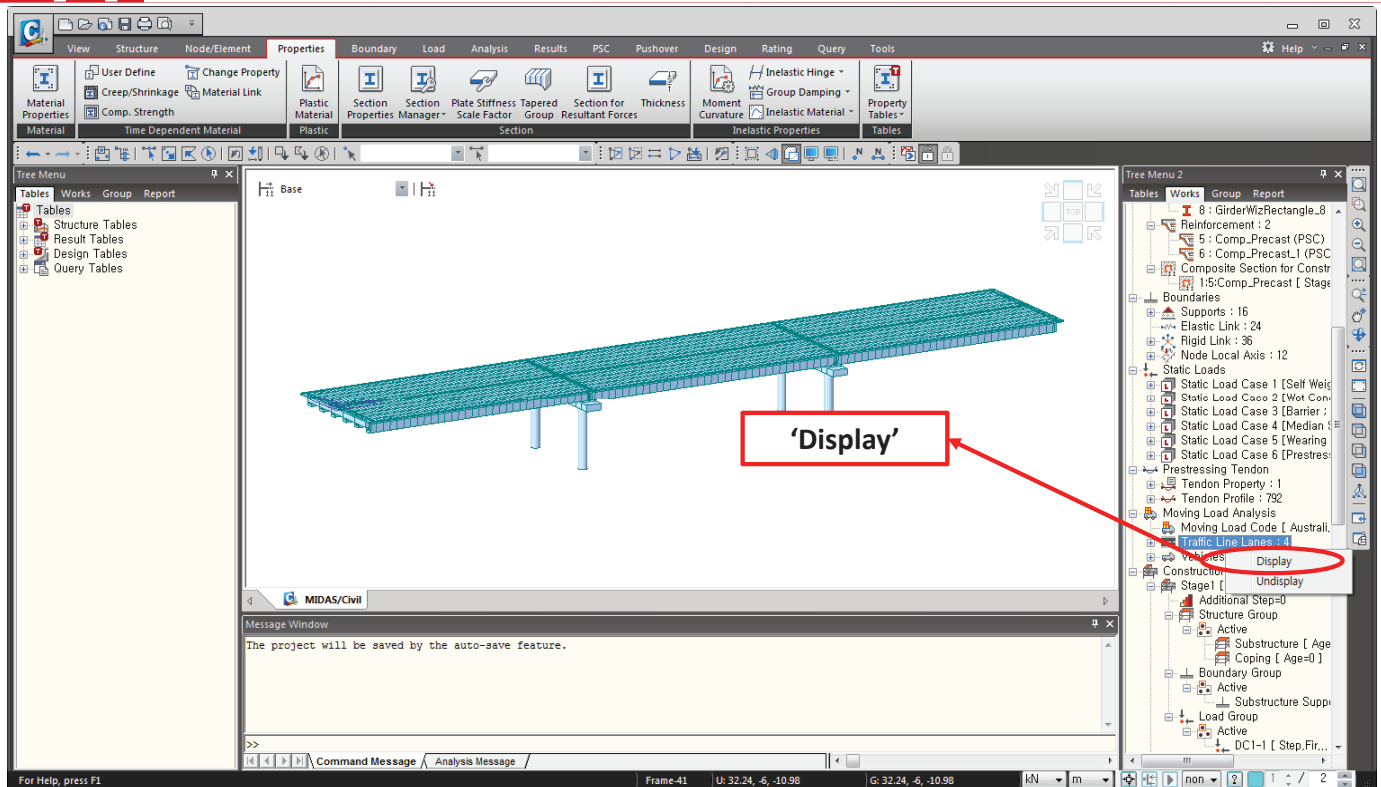
- TDM / Moving Load / Response Spectrum



Procedure

Click right button on your mouse. And check data in the model file under 'Works' menu.

MIDAS



Procedure

Display or Undisplay Traffic Line Lane which has been defined by the wizard from the context menu. Check and modify other functions as well using Works tree menu.

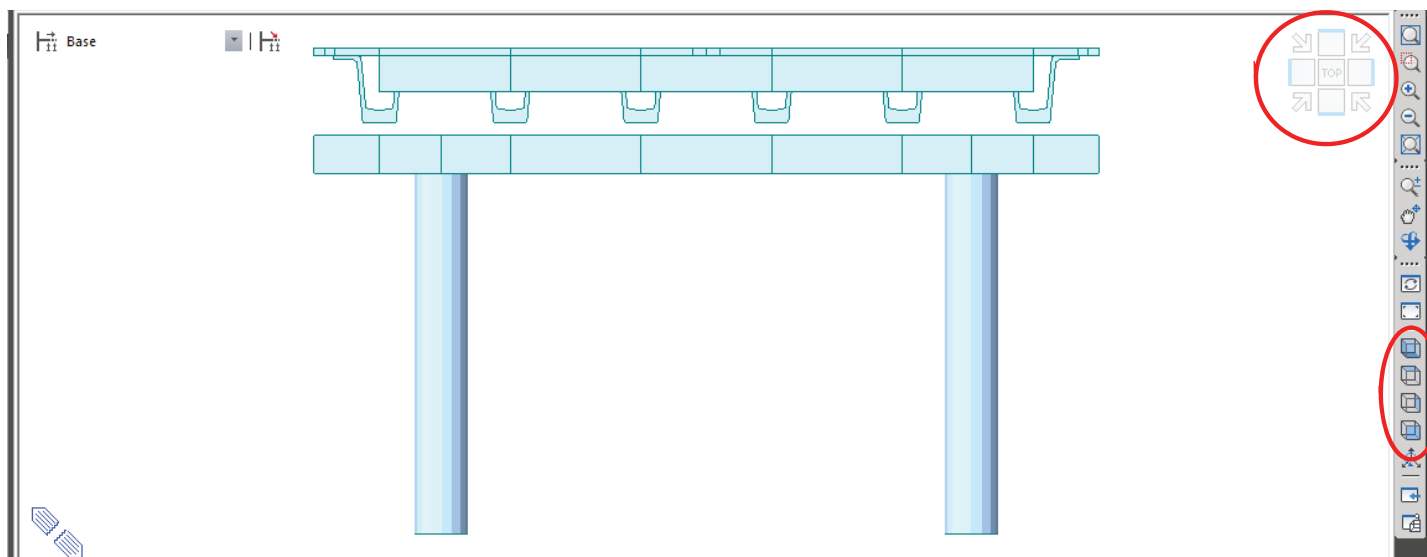
MIDAS

45

Time dependent Material

Tip

Use 'Dynamic View Control' or view icons to change the model angle



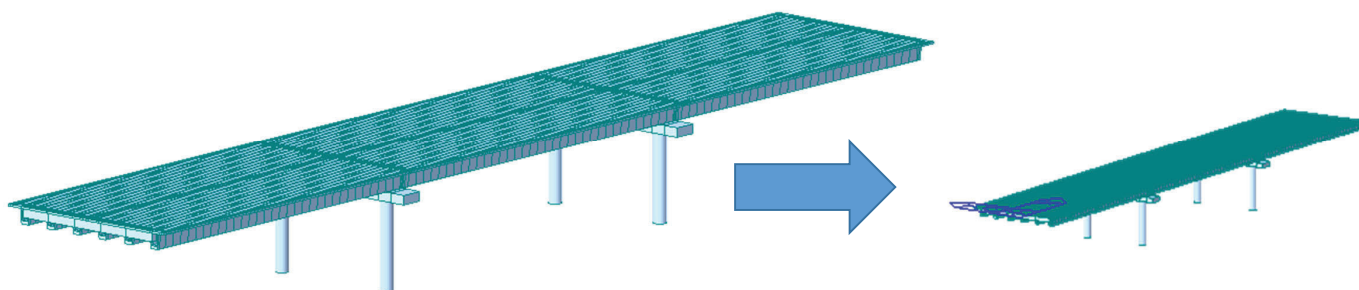
MIDASIT

46

Time dependent Material

Tip

Scroll the mouse wheel to zoom in and out the model
Click once if it keeps zooming



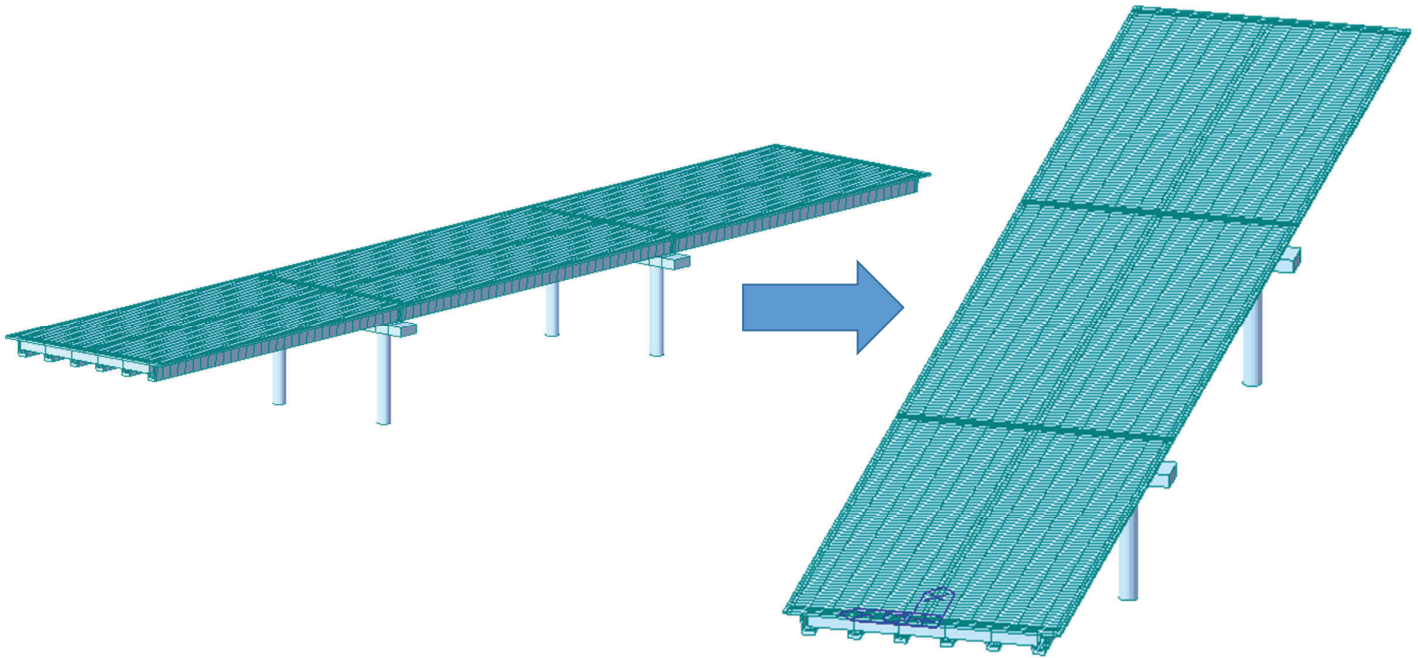
MIDASIT

47

Time dependent Material

Tip

Move mouse cursor **pressing 'Ctrl+mouse wheel'** to change the model angle



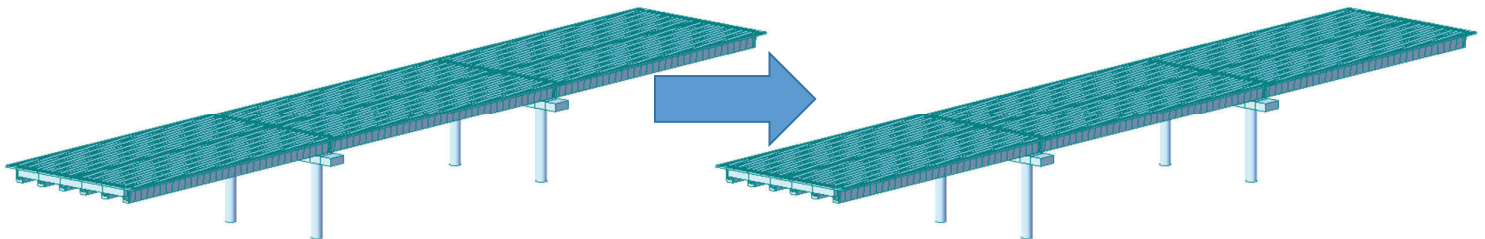
MIDASIT

48

Time dependent Material

Tip

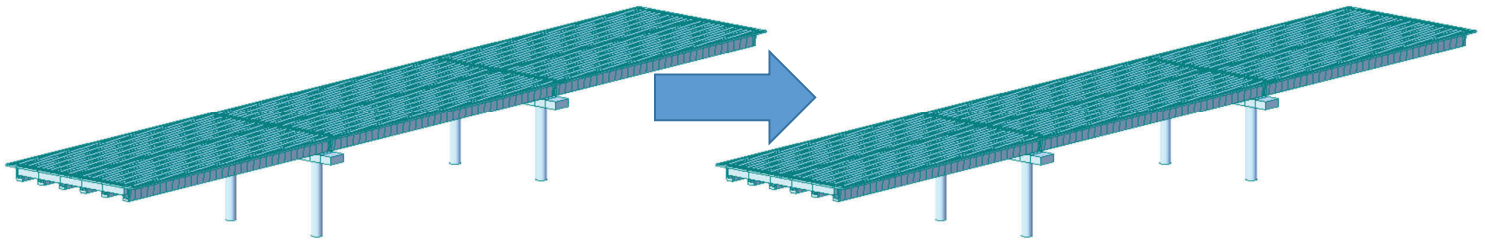
Move mouse cursor **pressing mouse wheel** to move the model



MIDASIT

Tip

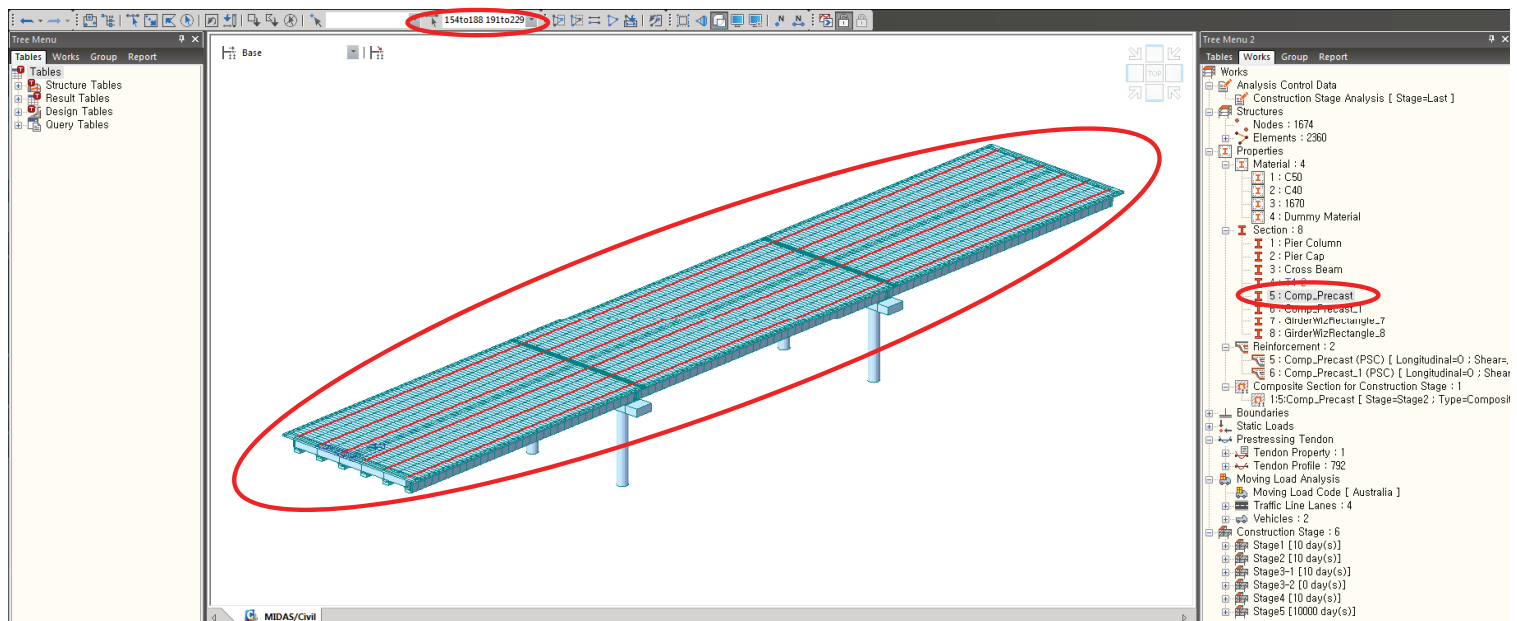
Move mouse cursor **pressing mouse wheel** to move the model



MIDAS IT

Tip

Double click any section or material, then assigned elements will be selected.
And Element number will be shown.



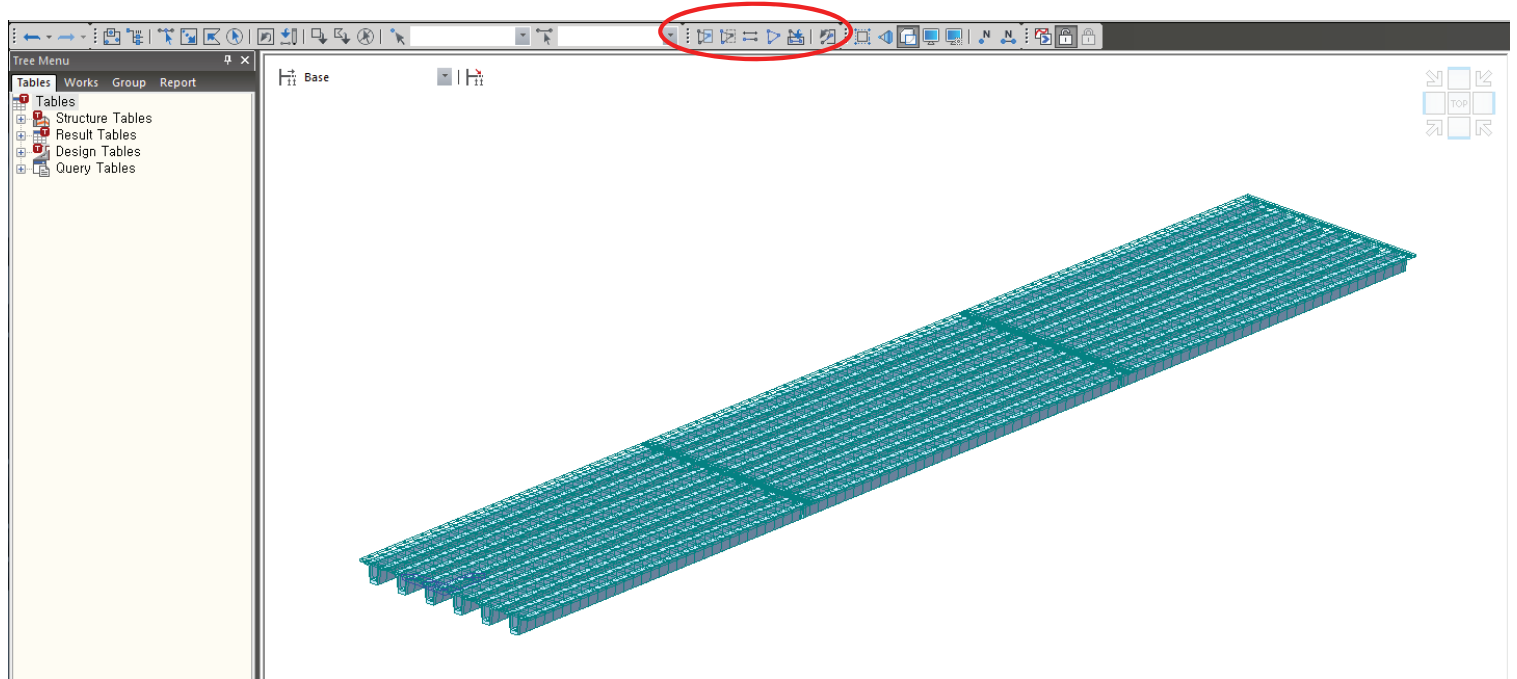
MIDAS IT

51

Time dependent Material

Tip

Use activation functions to activate or deactivate certain elements.
It is also valid when viewing results.



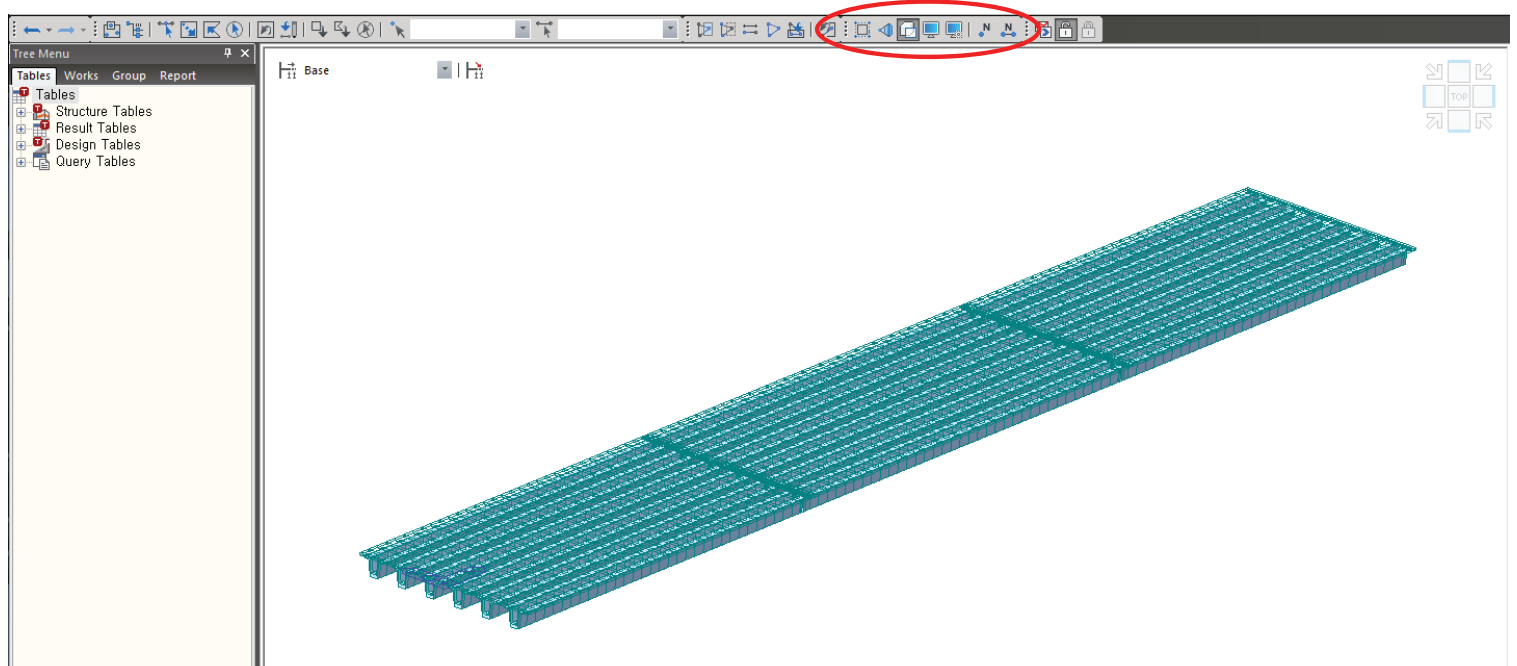
MIDASIT

52

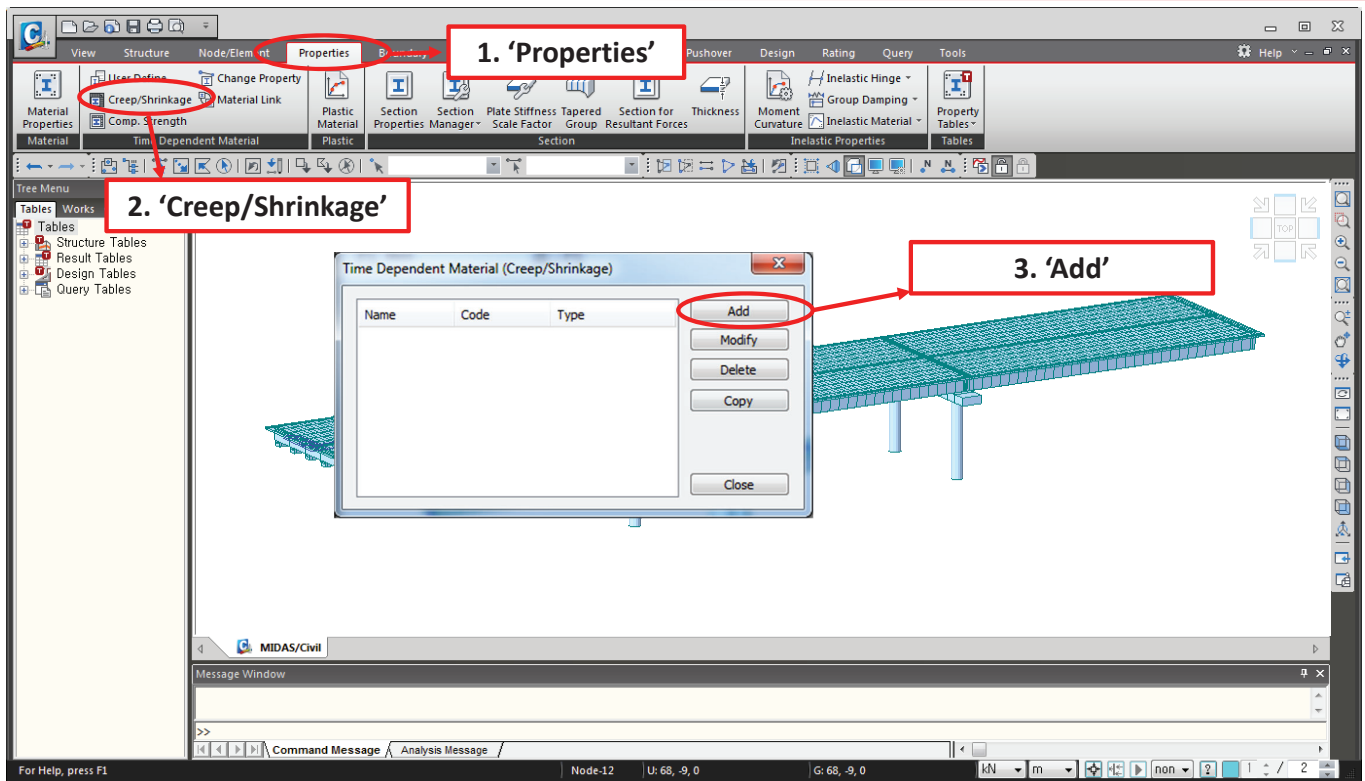
Time dependent Material

Tip

Try out various display options.
Check the online manual(F1) for more information(Start-View-Display)



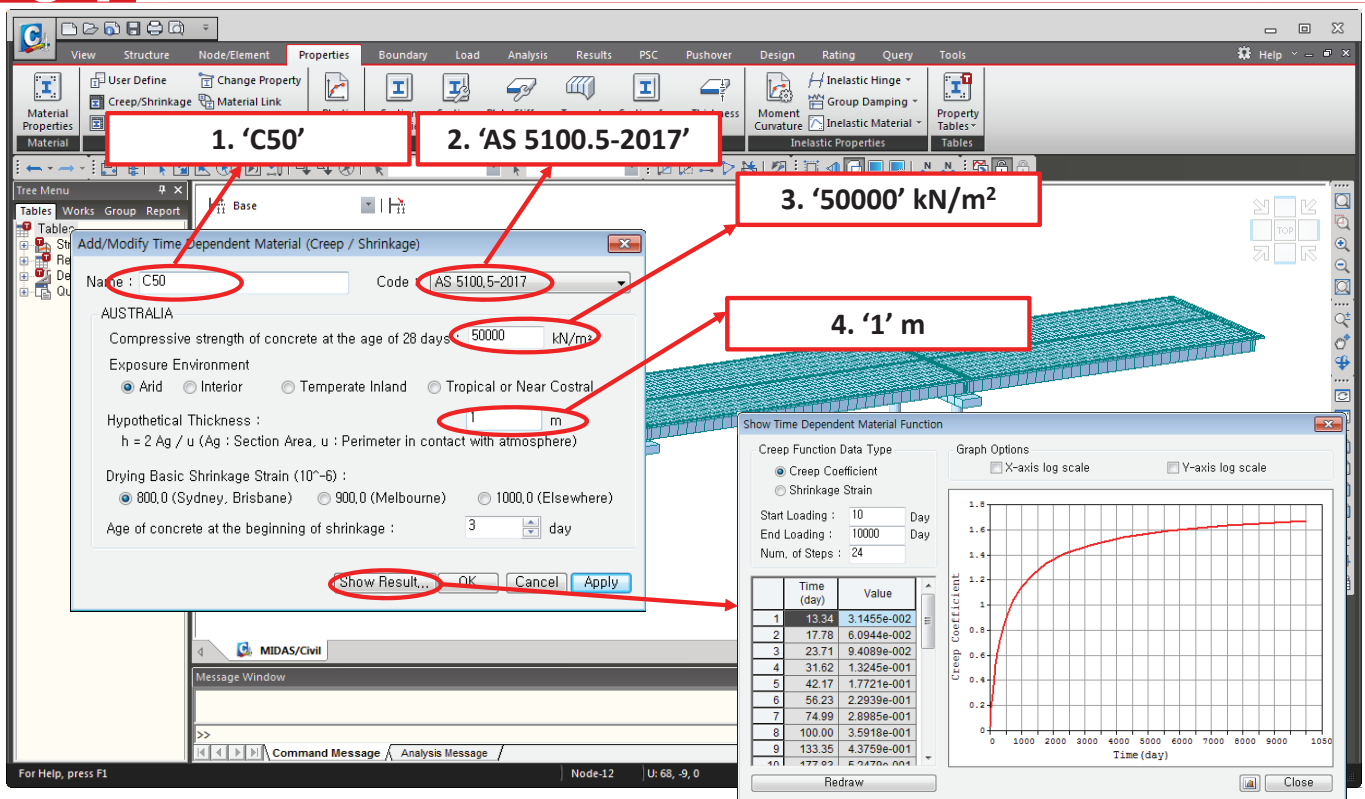
MIDASIT



Procedure

Define Creep/Shrinkage and Compressive Strength which change along the time under Time Dependent Material menu.

MIDASIT



Procedure

Different Creep Coefficient and Shrinkage Strain along the time will be applied to the model with Construction stage analysis. Input 1m for Notional size of member and use Composite Section for CS function later on.

MIDASIT

1. 'C40'

2. 'AS 5100.5-2017'

3. '40000' kN/m²

4. '1' m

Message Window

Command Message

Analysis Message

Node-12 U: 68, -9, 0

For Help, press F1

Time (day)	Value
1	13.34 3.6698e-002
2	17.78 7.1101e-002
3	23.71 1.0977e-001
4	31.62 1.5452e-001
5	42.17 2.0674e-001
6	56.23 2.6762e-001
7	74.99 3.3816e-001
8	100.00 4.1904e-001
9	133.35 5.1052e-001
10	177.63 6.1926e-001

Procedure

MIDASIT

1. 'Comp. Strength'

2. 'Add'

Message Window

Command Message

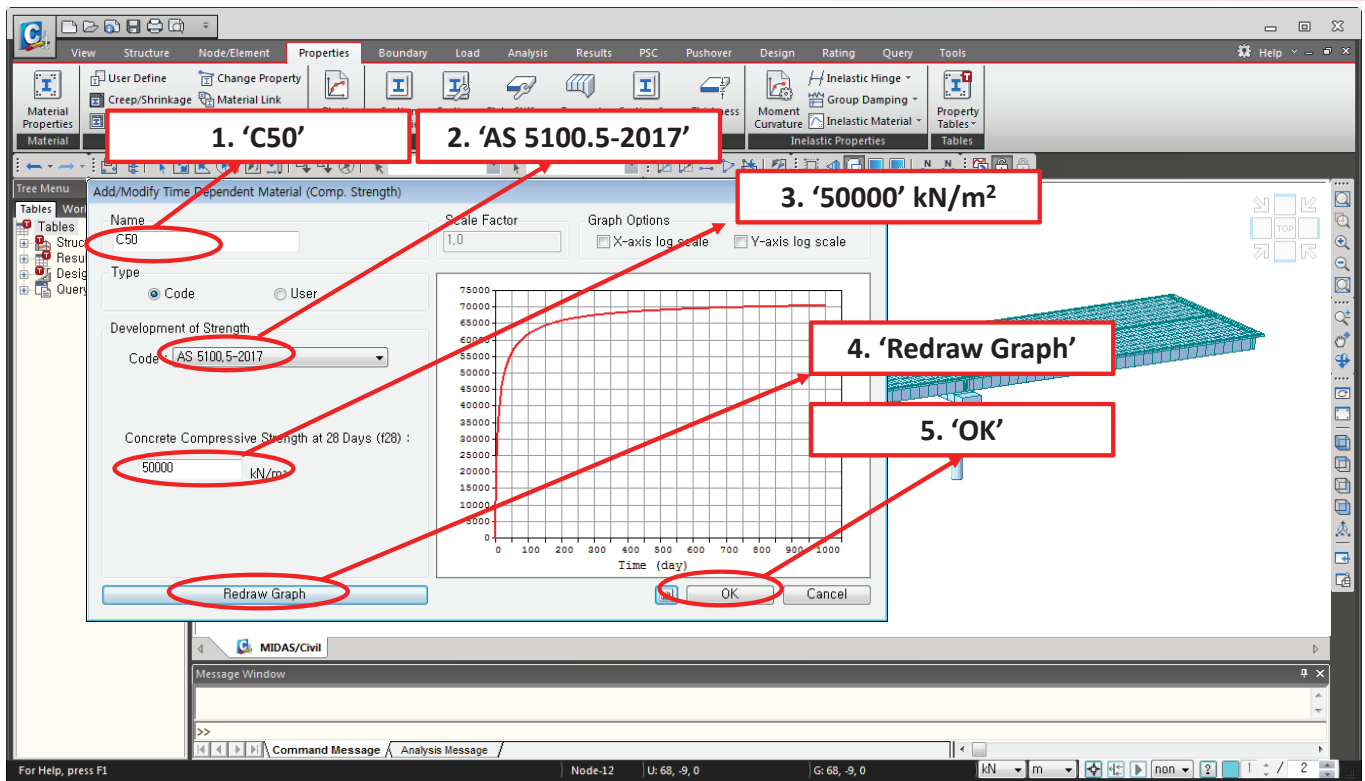
Analysis Message

Node-12 U: 68, -9, 0 G: 68, -9, 0

For Help, press F1

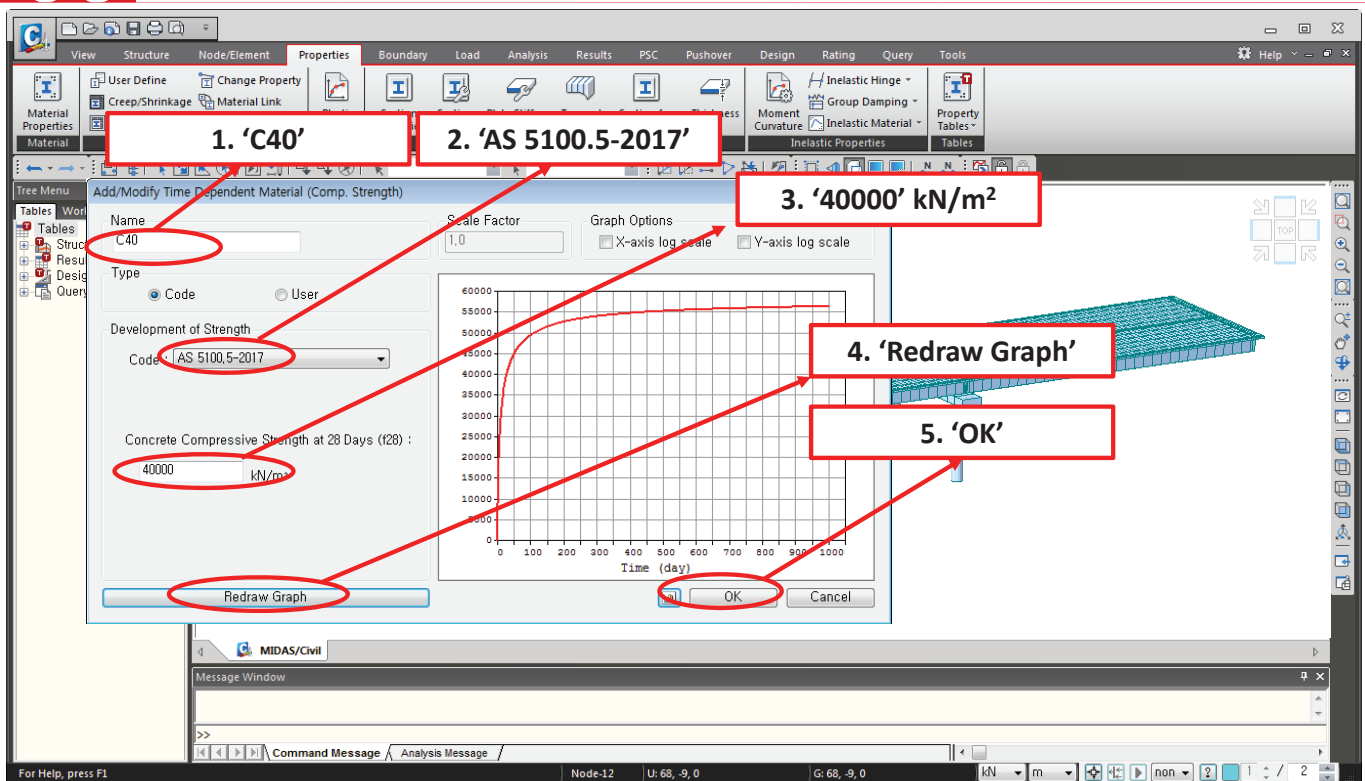
Procedure

MIDASIT



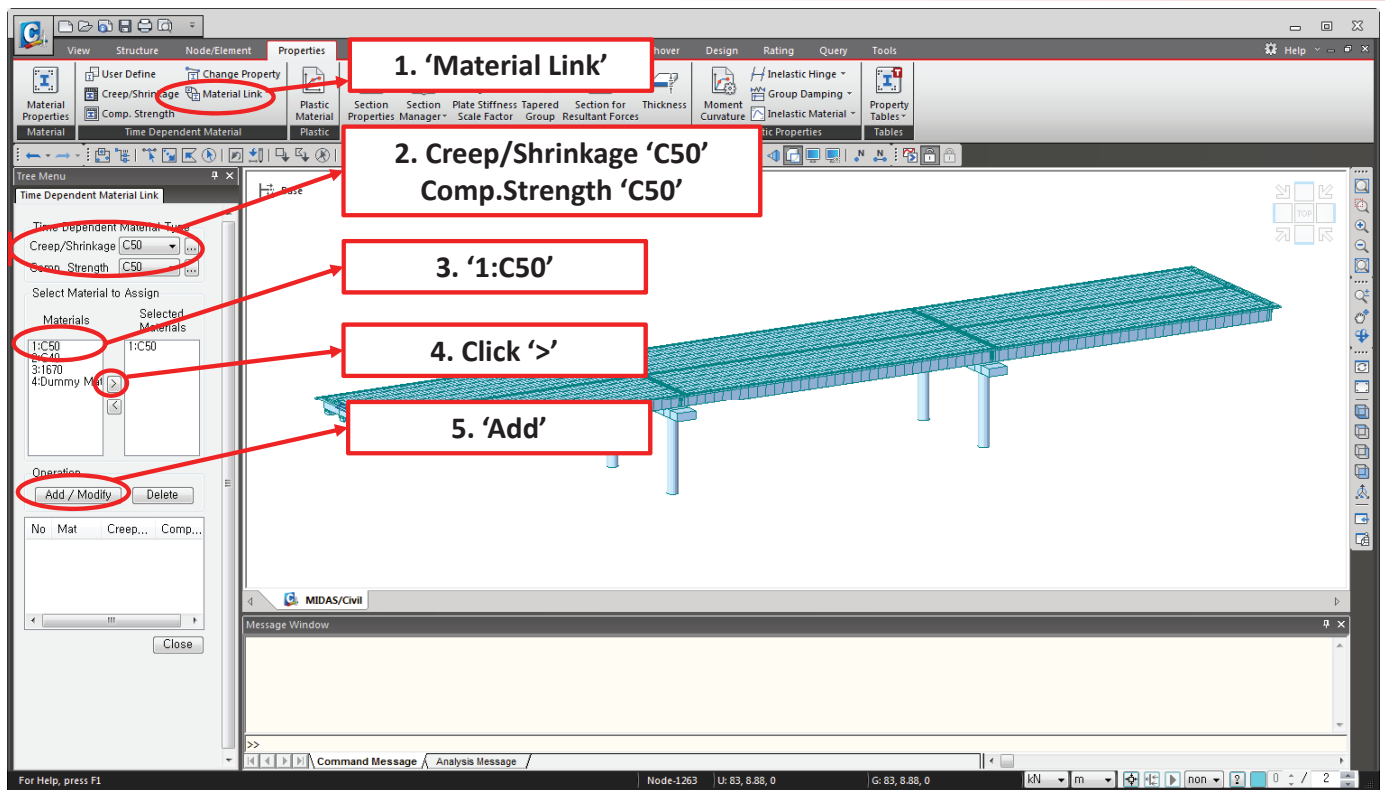
Procedure

MIDASIT



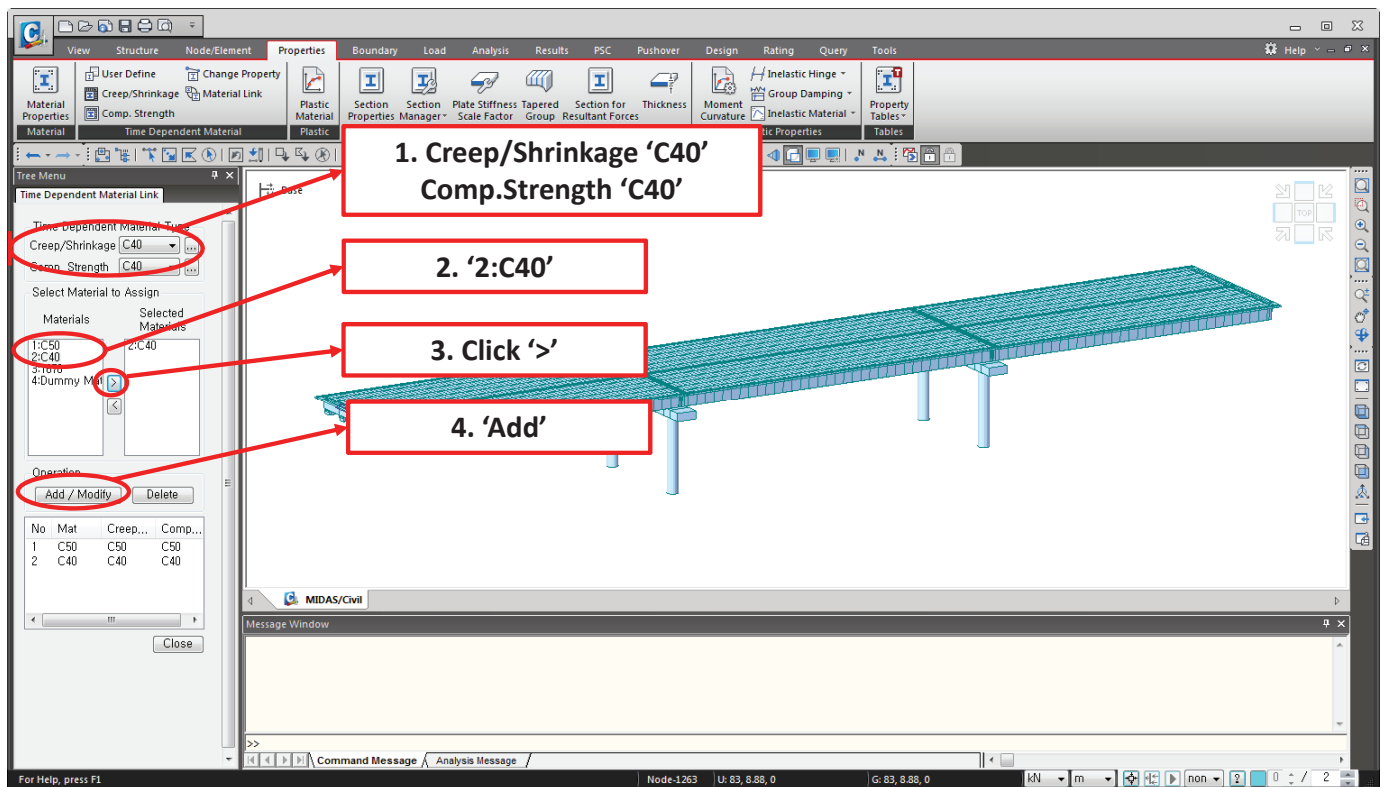
Procedure

MIDASIT

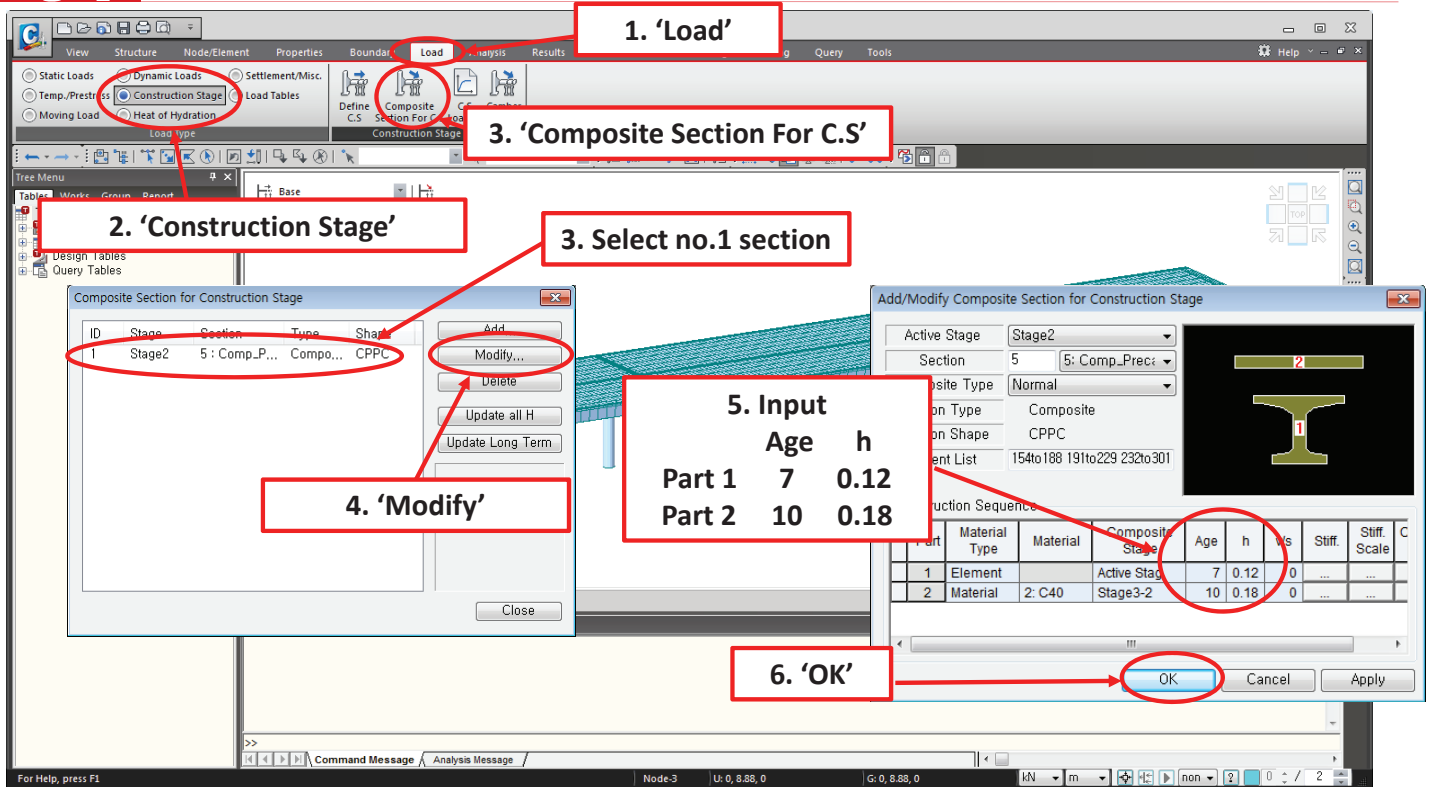
**Procedure**

Apply time dependent material to Material which has been defined at the first step.

MIDASIT

**Procedure**

MIDASIT

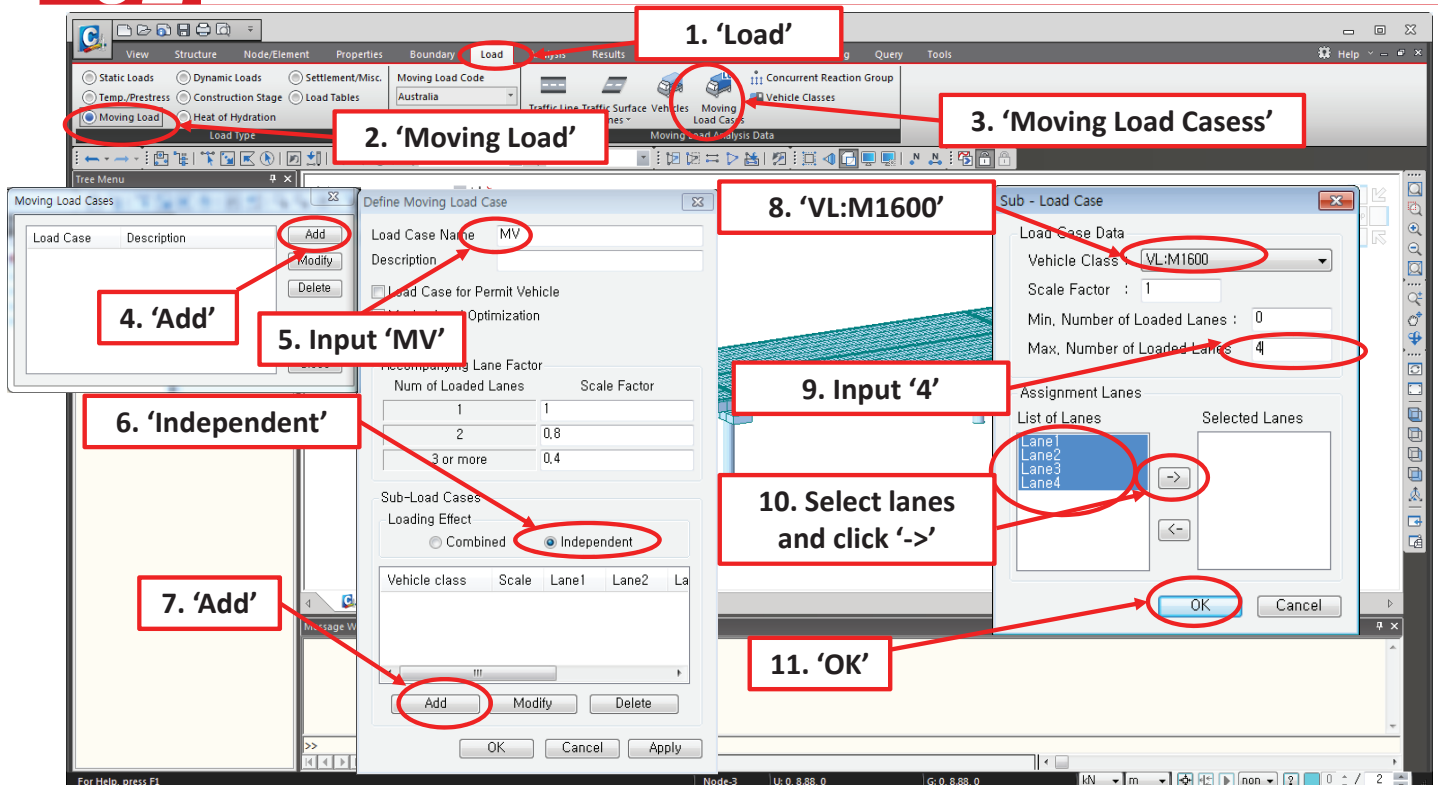


Procedure

h : Notional size of member to consider Creep/Shrinkage for composite section

Different element age for each girder and slab are applied to construction stage analysis and the element age on 'Define C.S.' will be ignored.

MIDASIT

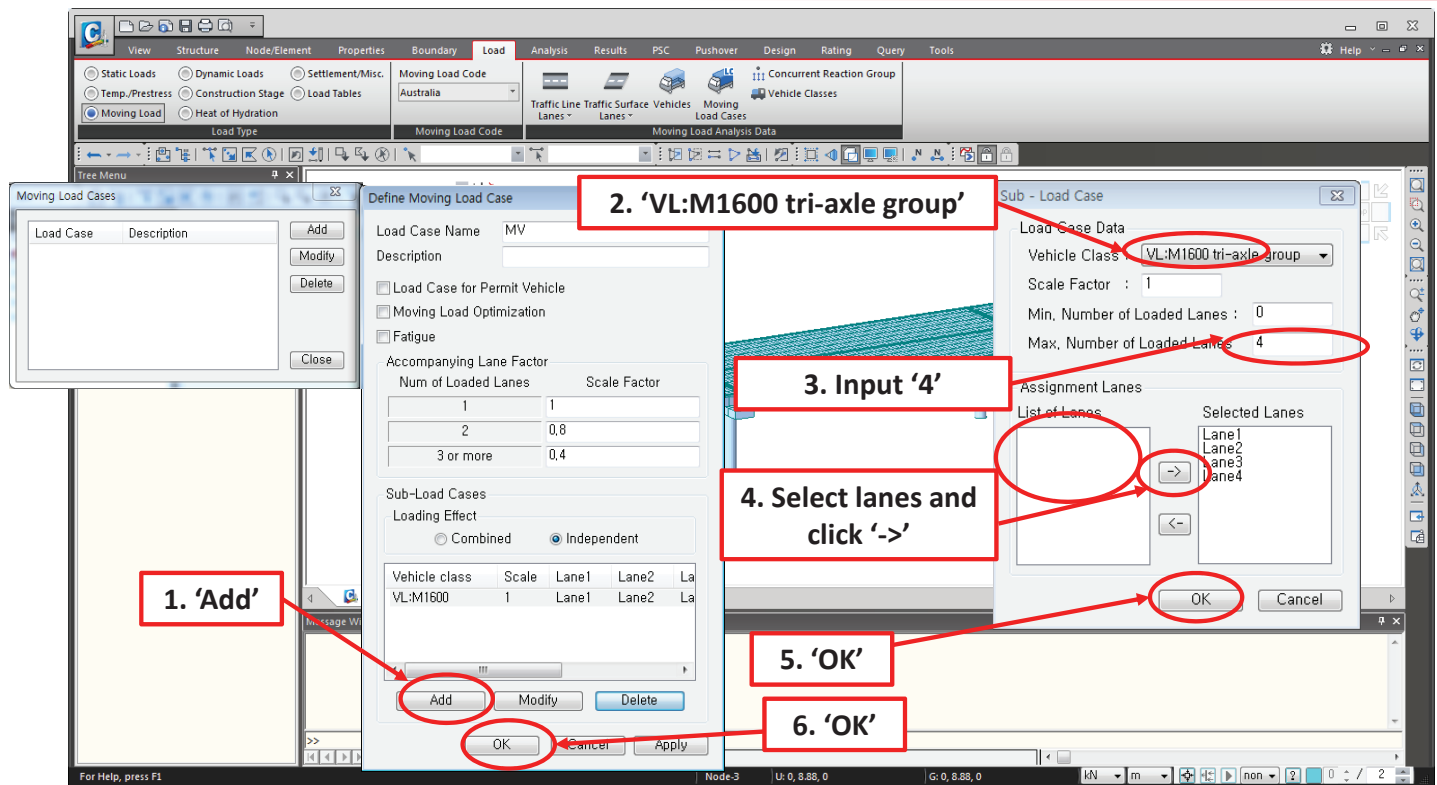


Procedure

All cases from zero lanes to four lanes are considered and the Min&Max results will be shown.

Moving Load Optimization option can be applied when Traffic Lane is used as 'Moving Load Optimization' function.

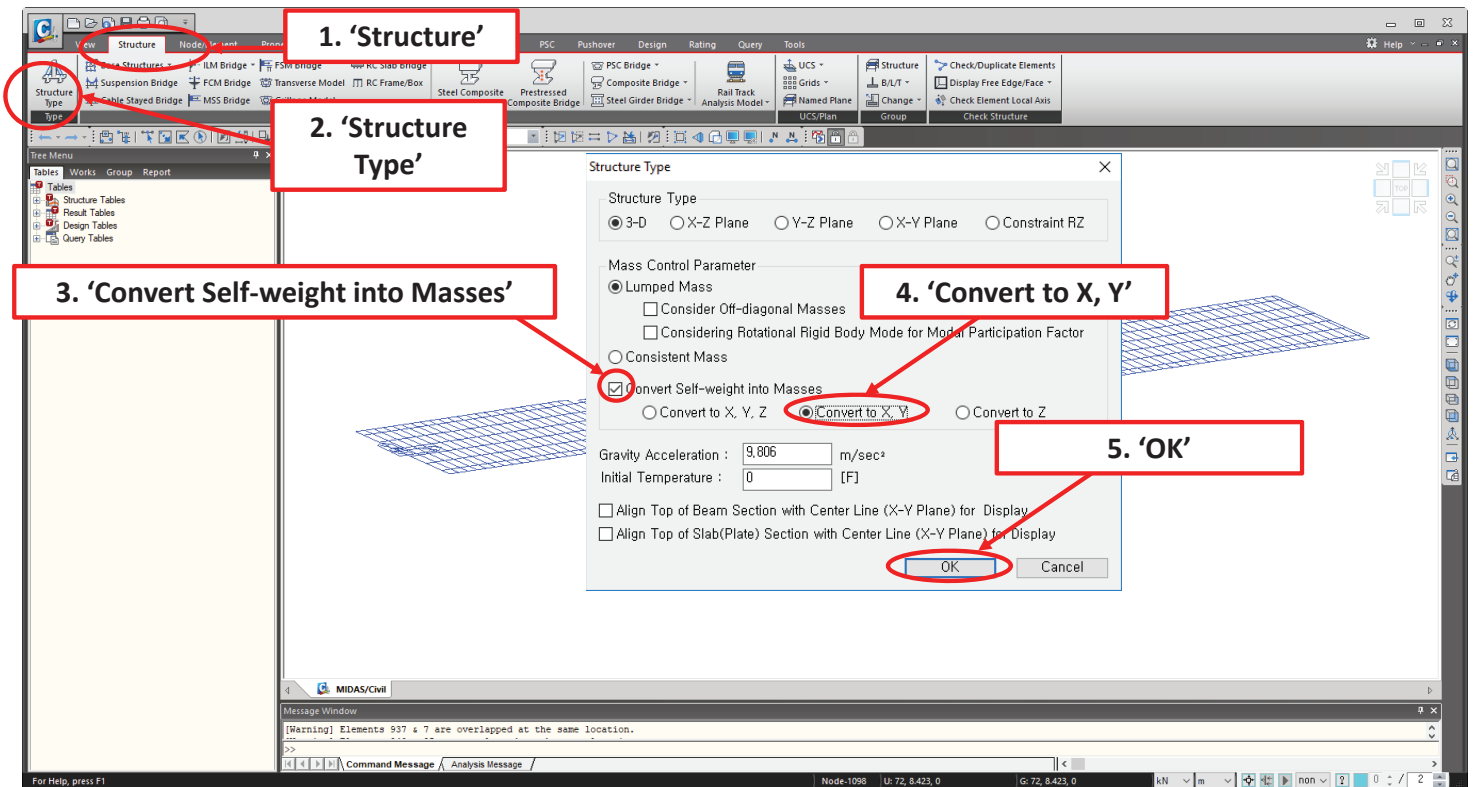
MIDASIT



Procedure

All cases from zero lanes to four lanes are considered and the Min&Max results will be shown.
Moving Load Optimization option can be applied when Traffic Lane is used as 'Moving Load Optimization' function.

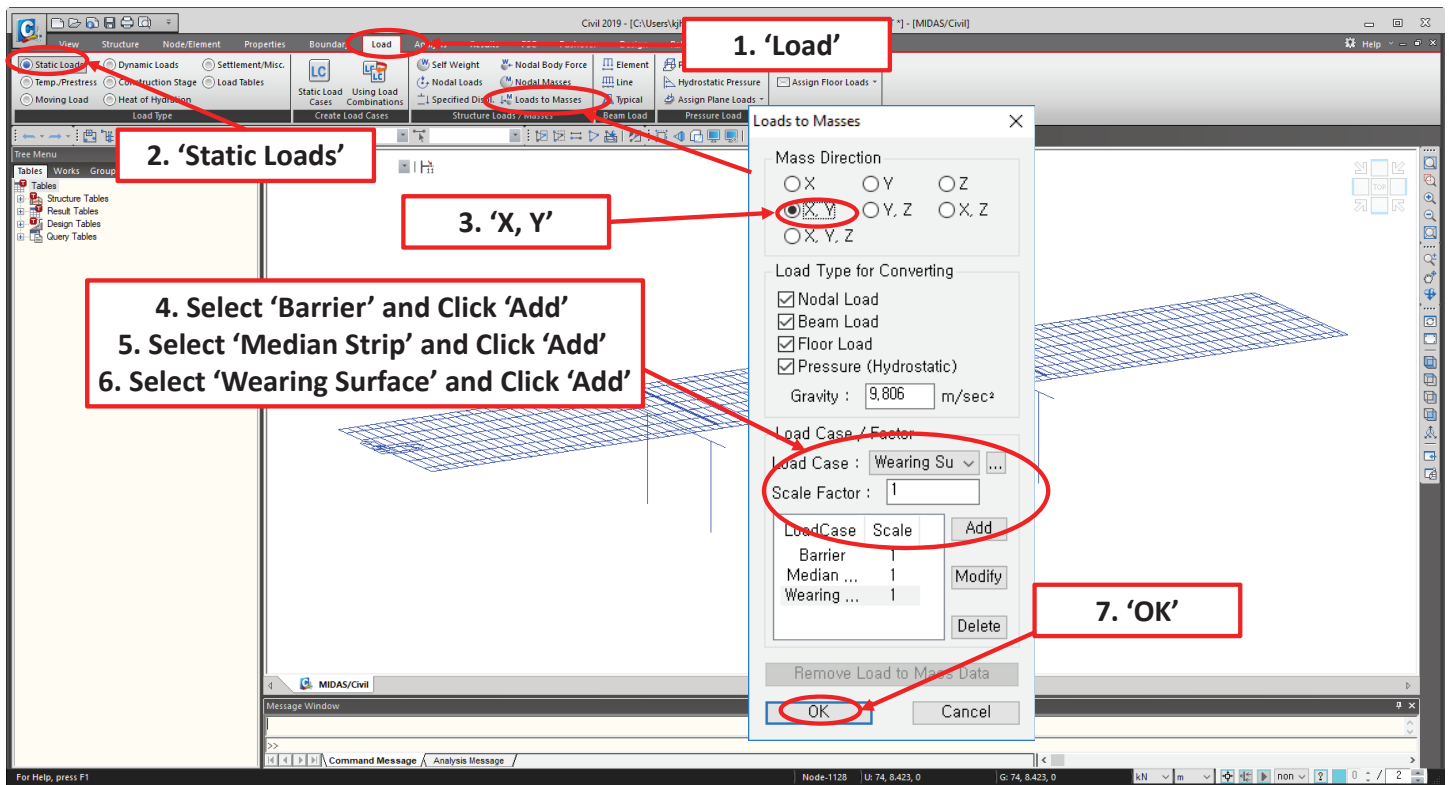
MIDASIT



Procedure

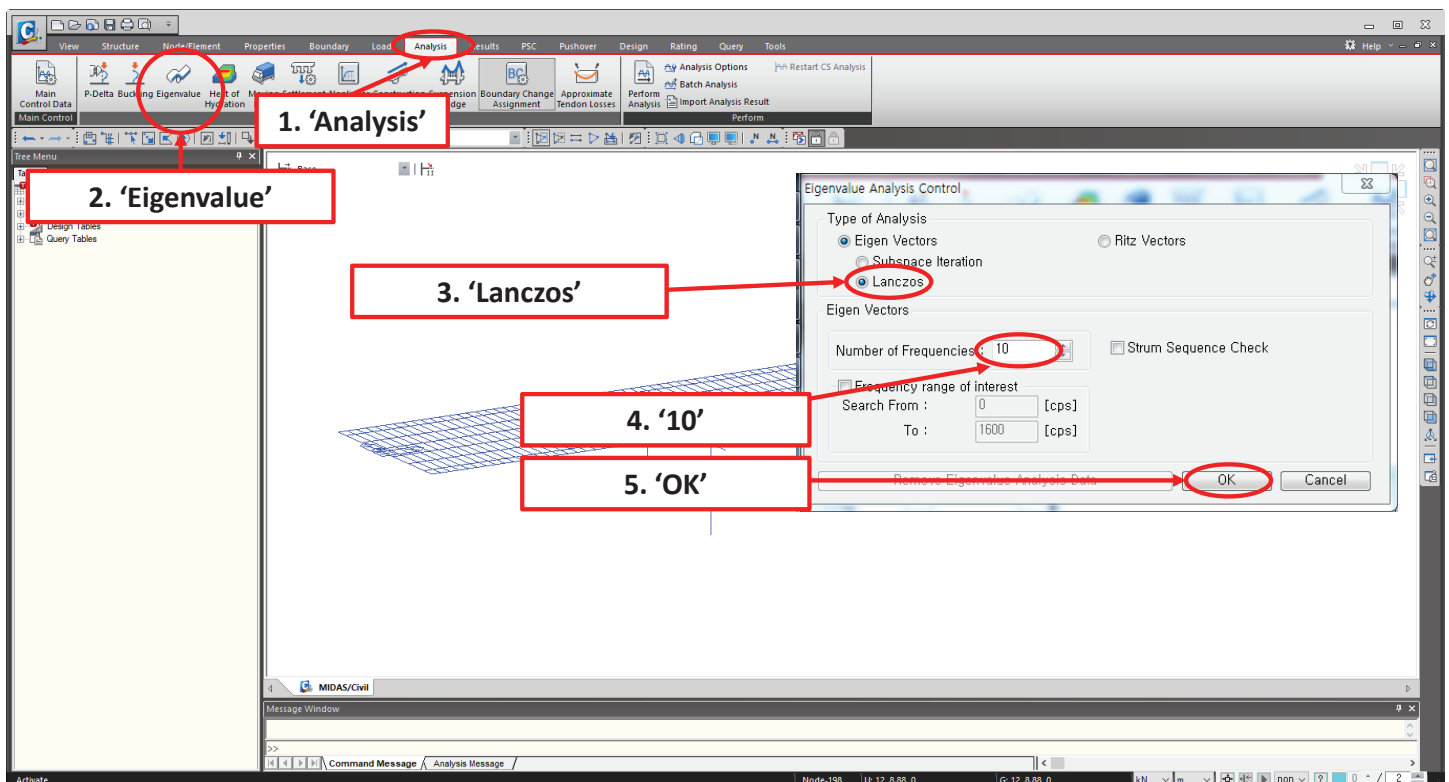
Select 'Convert to X,Y' to consider horizontal effect of Response Spectrum analysis.

MIDASIT

**Procedure**

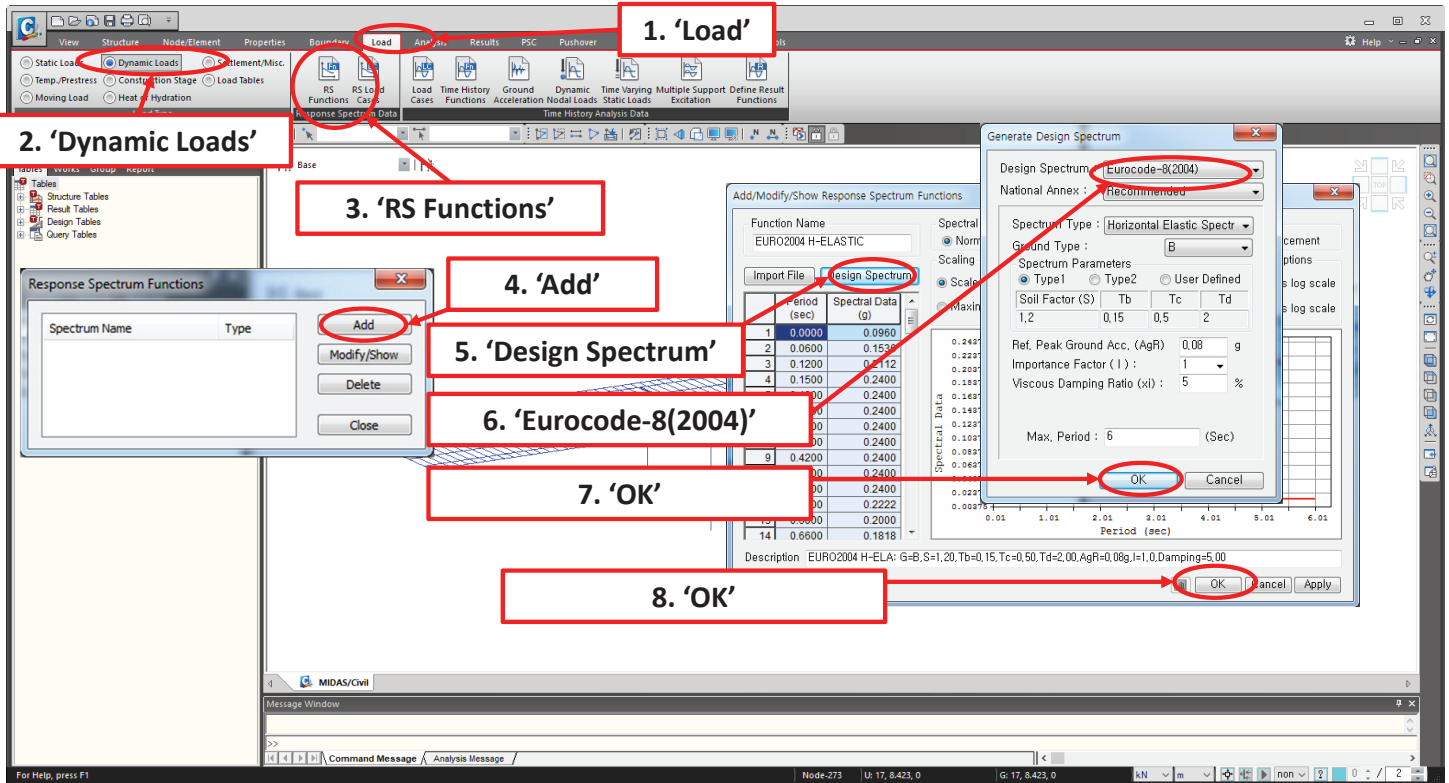
Convert the permanent dead load cases to masses.

MIDASIT

**Procedure**

Lanczos is common method and put more number of frequencies if more modes are required.

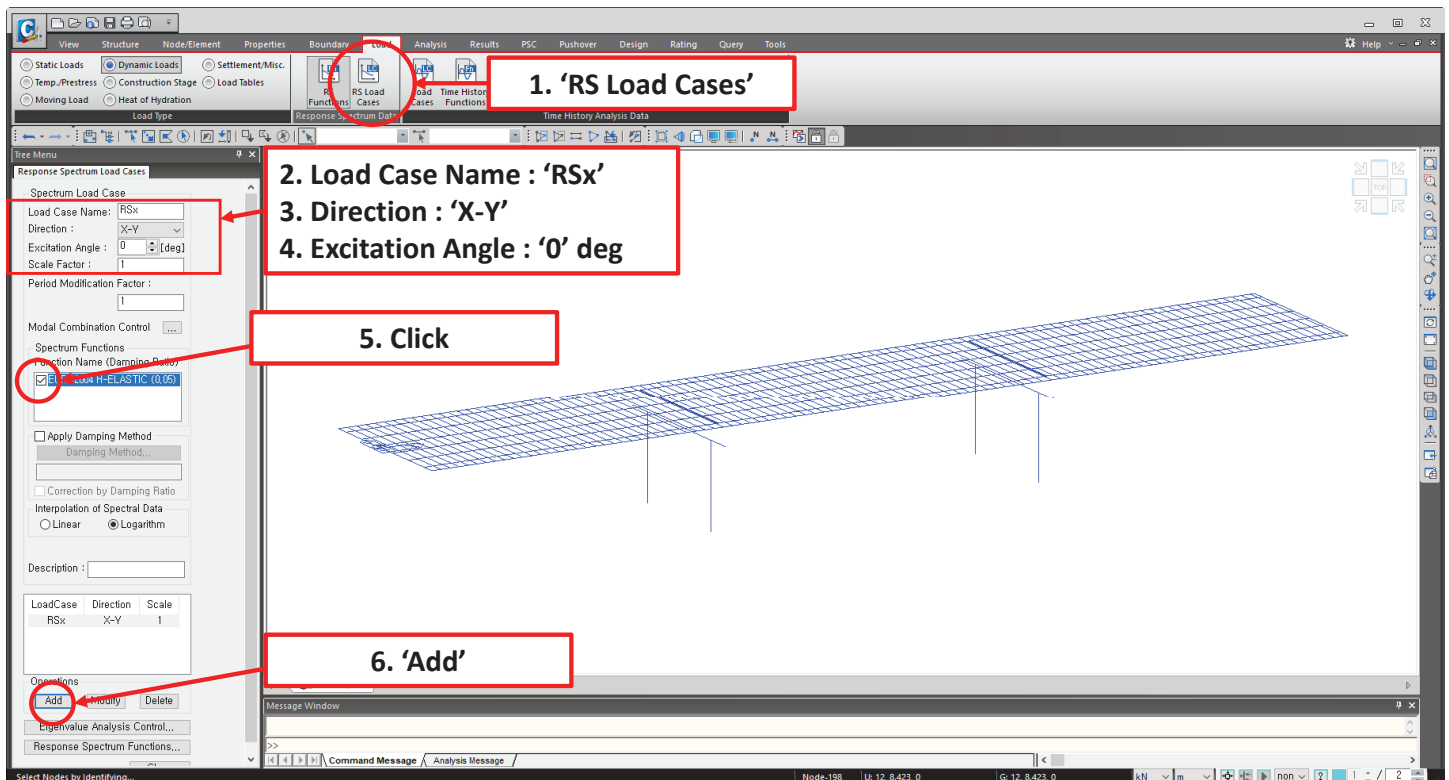
MIDASIT



Procedure

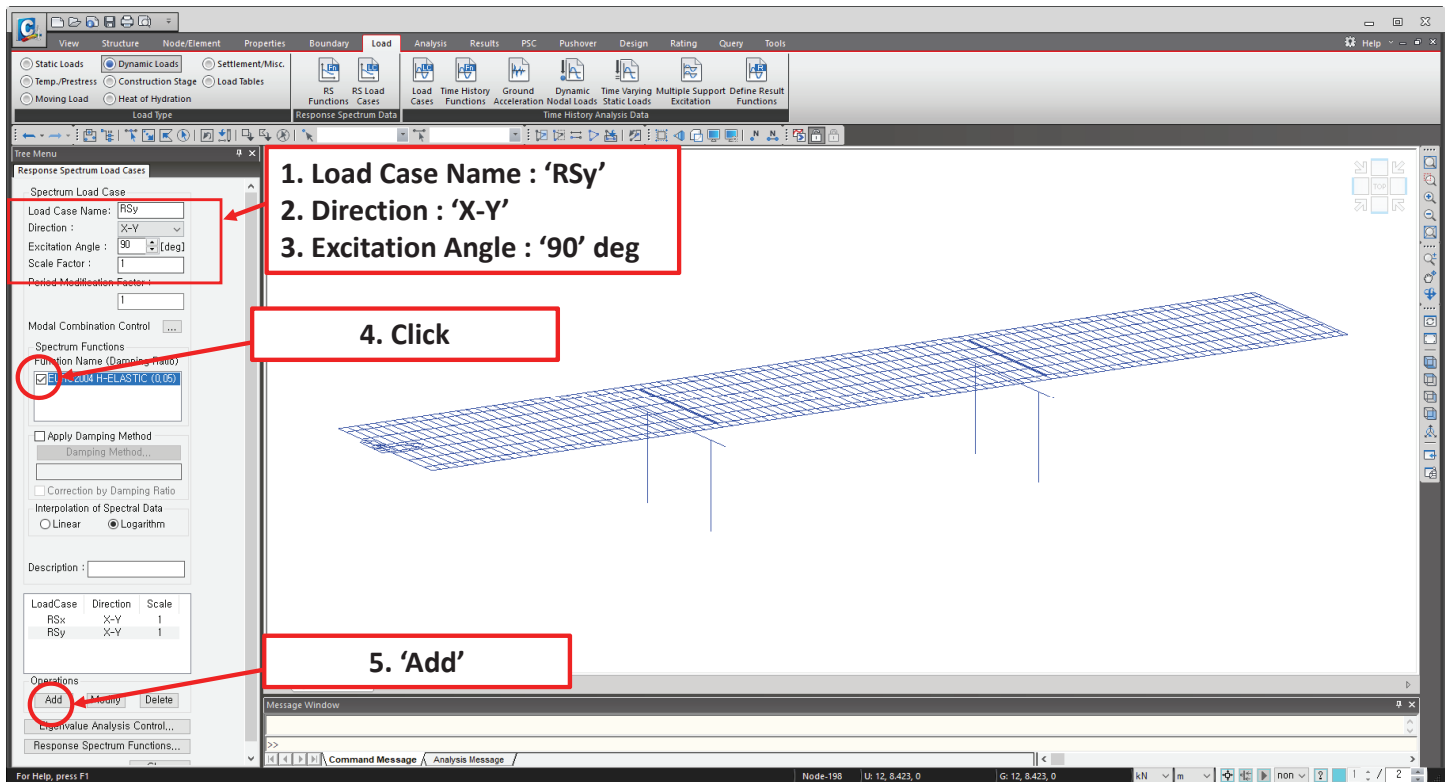
Copy & paste the data from the excel if it is preferred.

MIDASIT



Procedure

MIDASIT



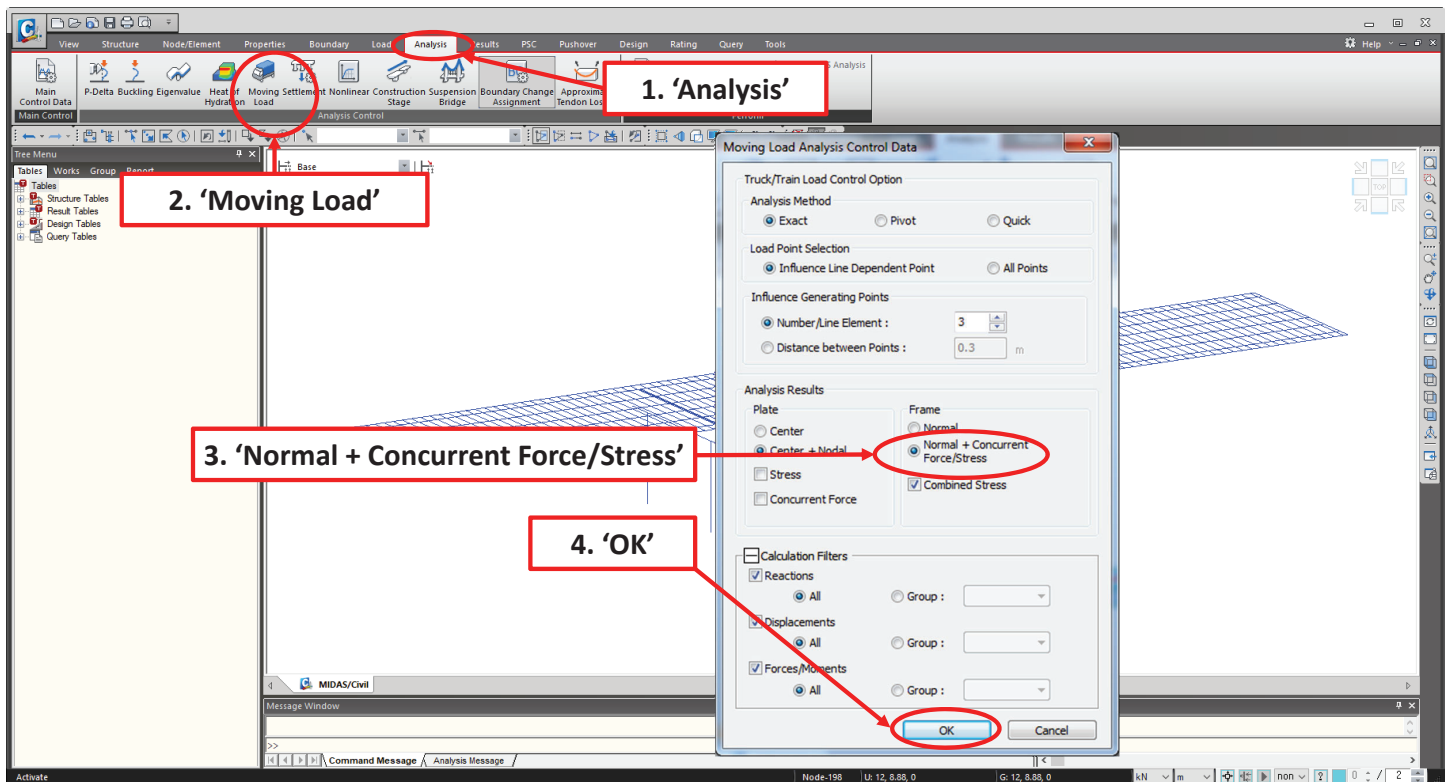
Procedure

MIDASIT

Overview

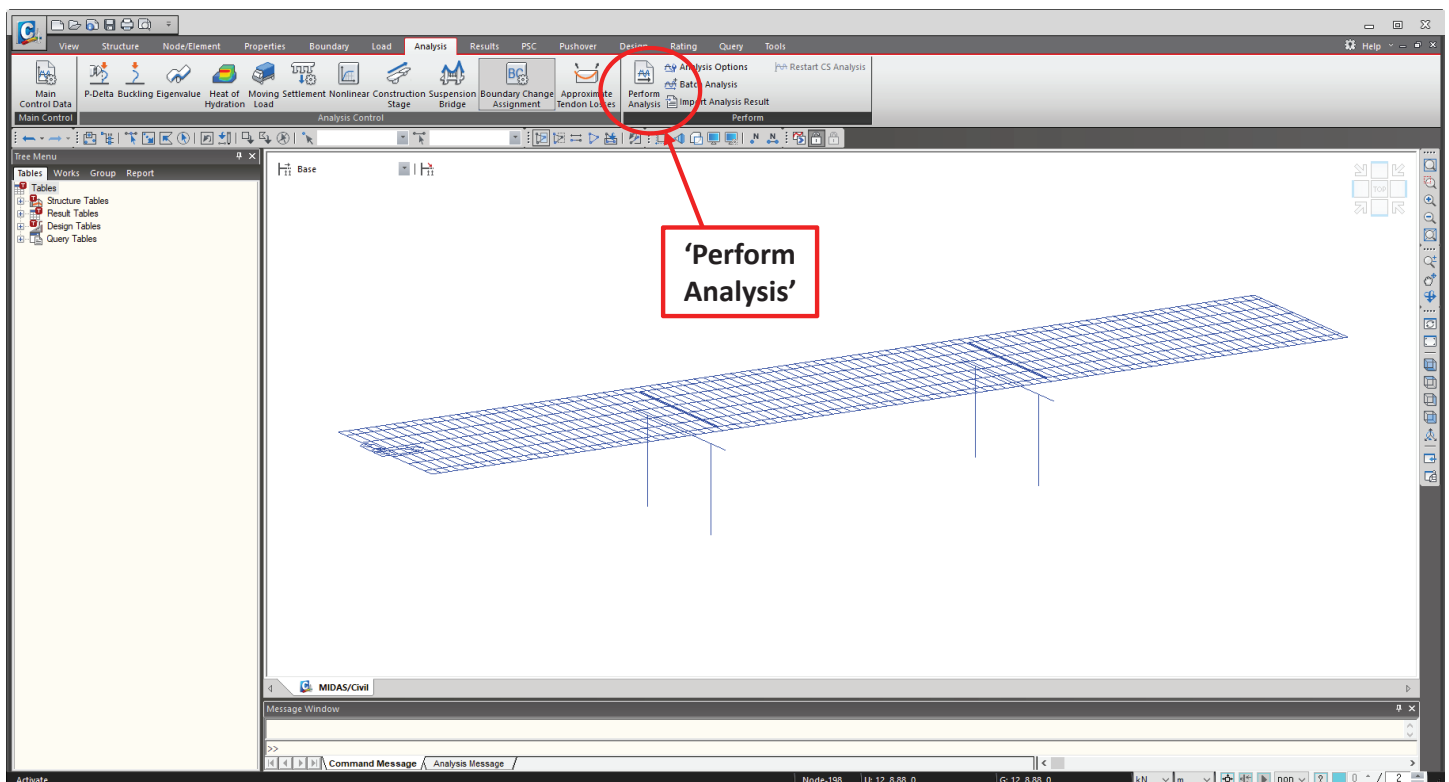
- **Properties**
 - Material / Section
- **Prestressed Composite Bridge Wizard**
 - Layout
 - Section
 - Tendon
 - Load
 - Construction Stage
- **Load**
 - Time Dependent Material
 - Moving load
 - Response Spectrum Analysis
- **Analysis**
 - Moving Load
- **Results**
 - Load Combination
 - Reaction/Force/Displacement
 - Moving Tracer
 - Concurrent Force
 - Tendon Losses
 - Mode Shape
- **Design**
 - PSC Design
- **Tips**
 - Smart Report
 - MCT Command Shell
 - Tendon Template
 - Import tendon from AutoCAD
- **Appendix. Load Combinations**

Step 4. Analysis

**Procedure**

Check off items which are not necessary to check for the project. It reduces analysis time.

MIDASIT

**Procedure**

Perform structural analysis. Message Window should be checked whether there is an error.

MIDASIT

Overview

Properties

- Material / Section

Prestressed Composite Bridge Wizard

- Layout
- Section
- Tendon
- Load
- Construction Stage

Load

- Time Dependent Material
- Moving load
- Response Spectrum Analysis

Analysis

- Moving Load

Results

- Load Combination
- Reaction/Force/Displacement
- Moving Tracer
- Concurrent Force
- Tendon Losses
- Mode Shape

Design

- PSC Design

Tips

- Smart Report
- MCT Command Shell
- Tendon Template
- Import tendon from AutoCAD

Appendix. Load Combinations

Step 5. Results

74

Load Combination

1. 'Results'

2. 'Load Combinations'

3. 'Concrete Design'

4. 'Auto Generation'

5. 'AS 5100.2:17'

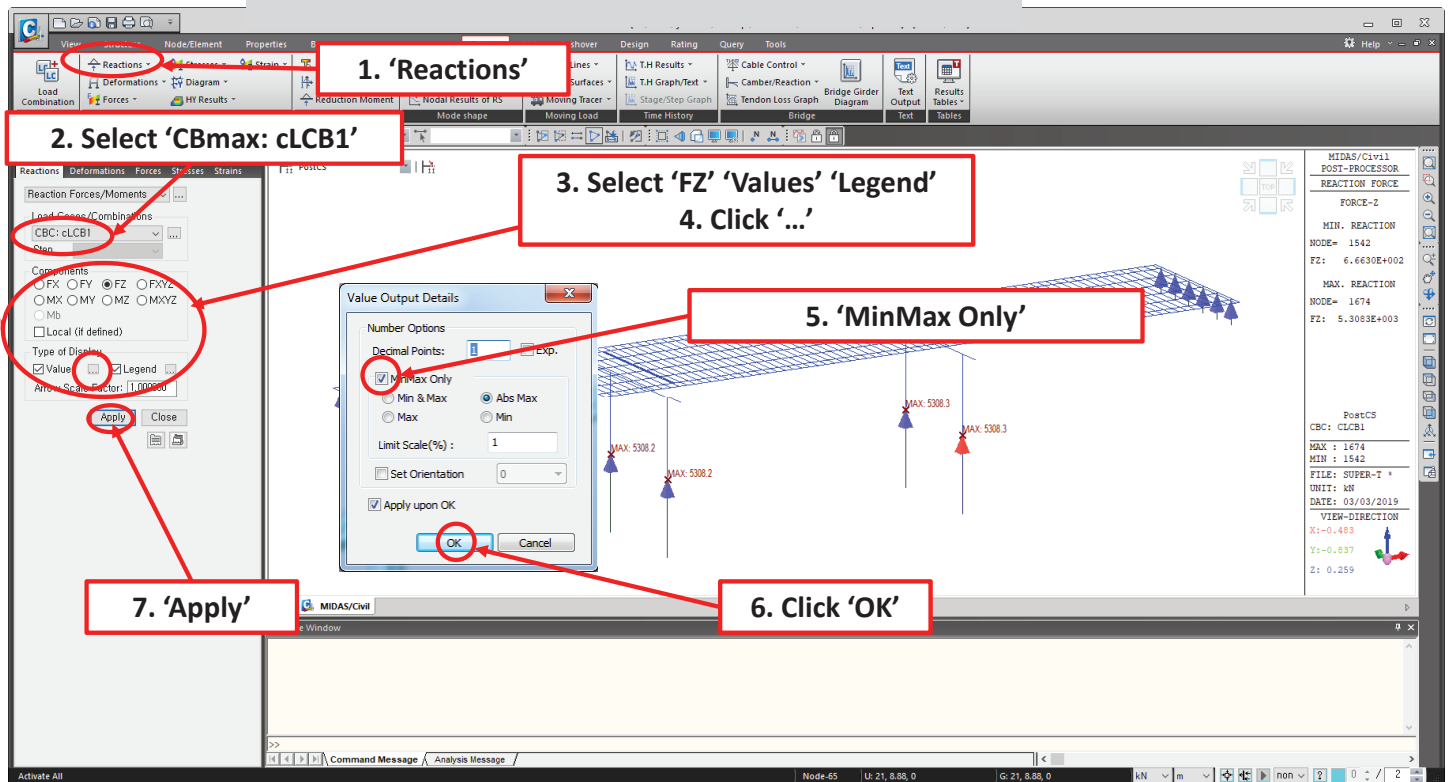
6. Select 'Both'

7. 'OK'

8. 'Close'

Procedure

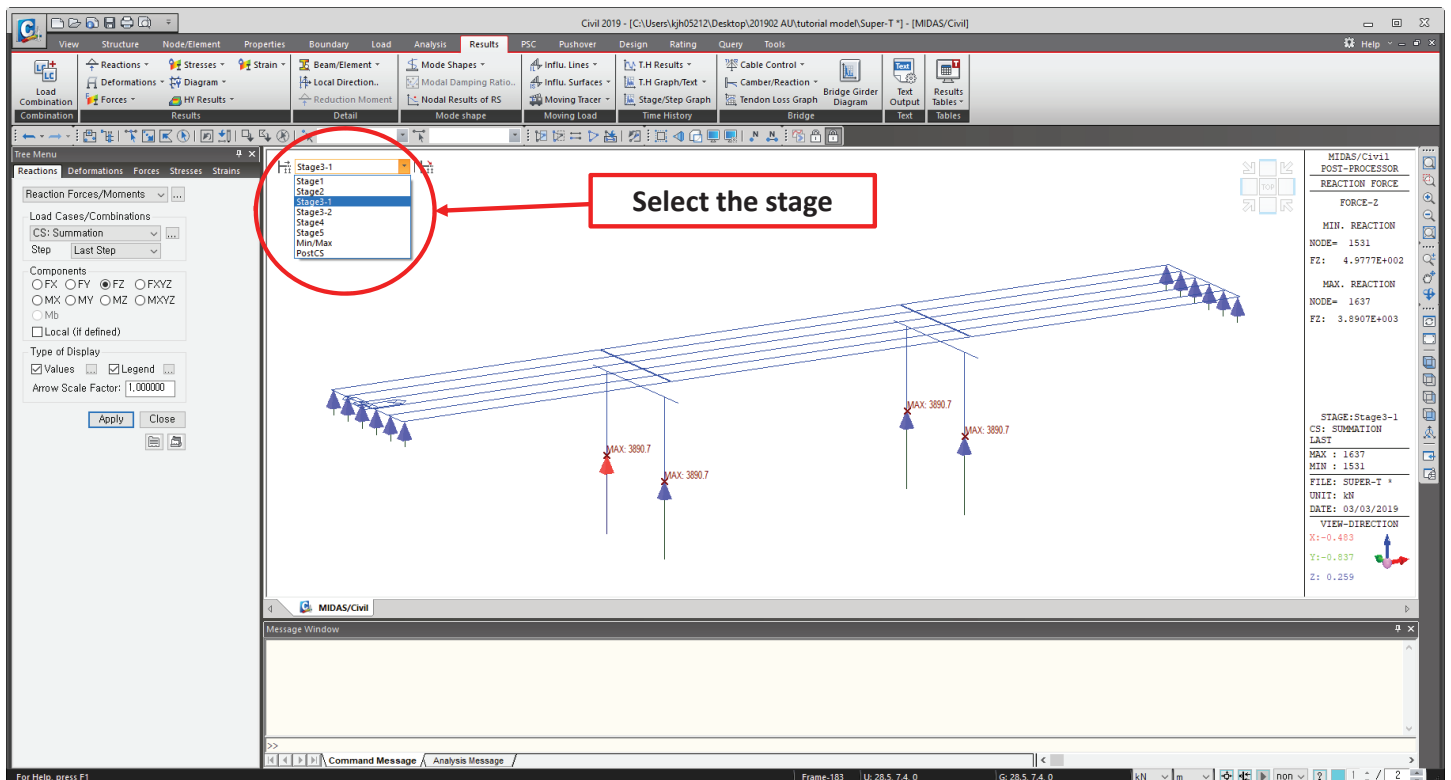
Create automatic load combinations as per AS. Use 'Spread Sheet Form' to copy&paste the data from EXCEL.



Procedure

Check reactions under load combinations. Check on 'Legend' to see the maximum/minimum result on the right side.

MIDASIT



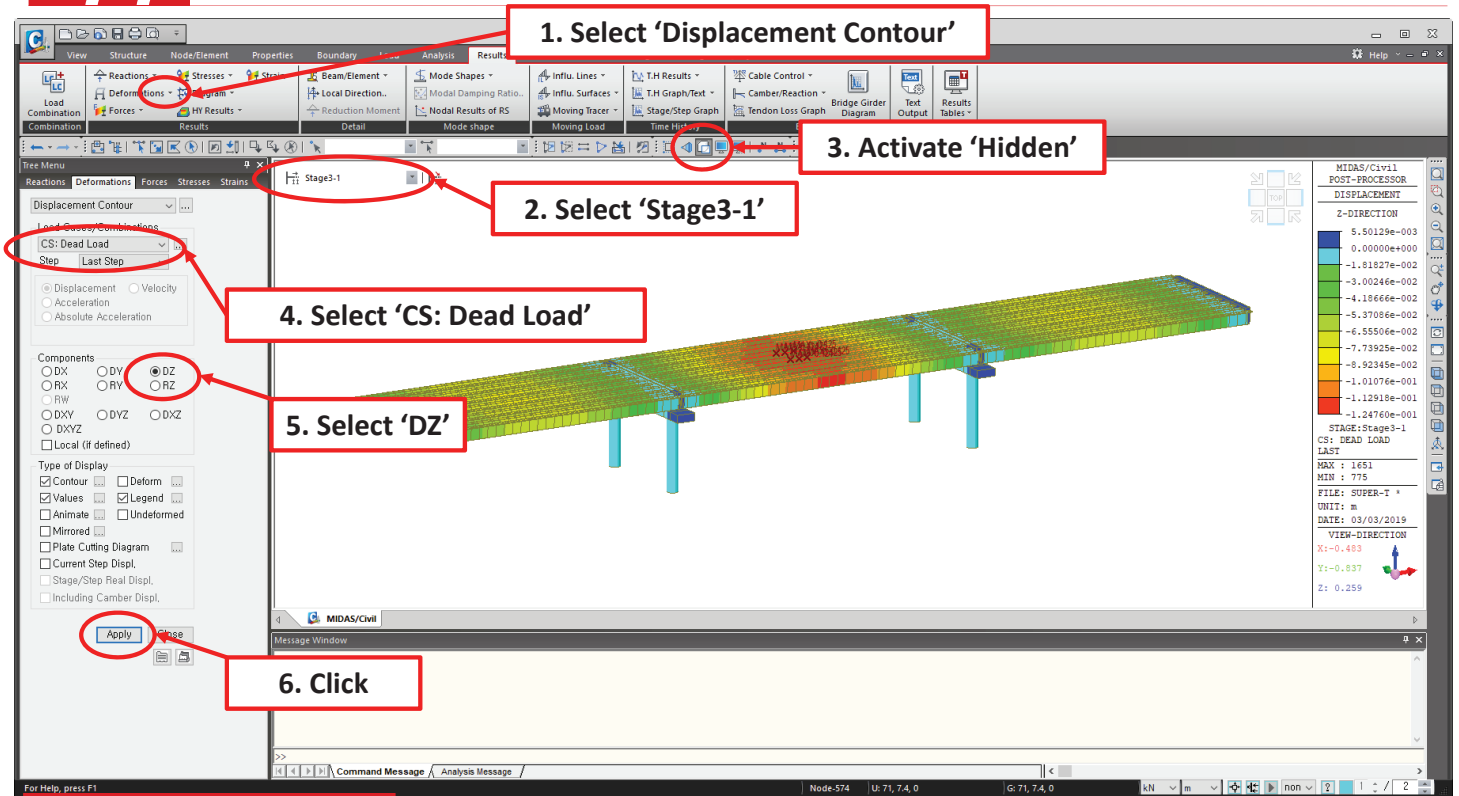
Procedure

Check the results along the stages.

MIDASIT

77

Reaction / Force / Displacement



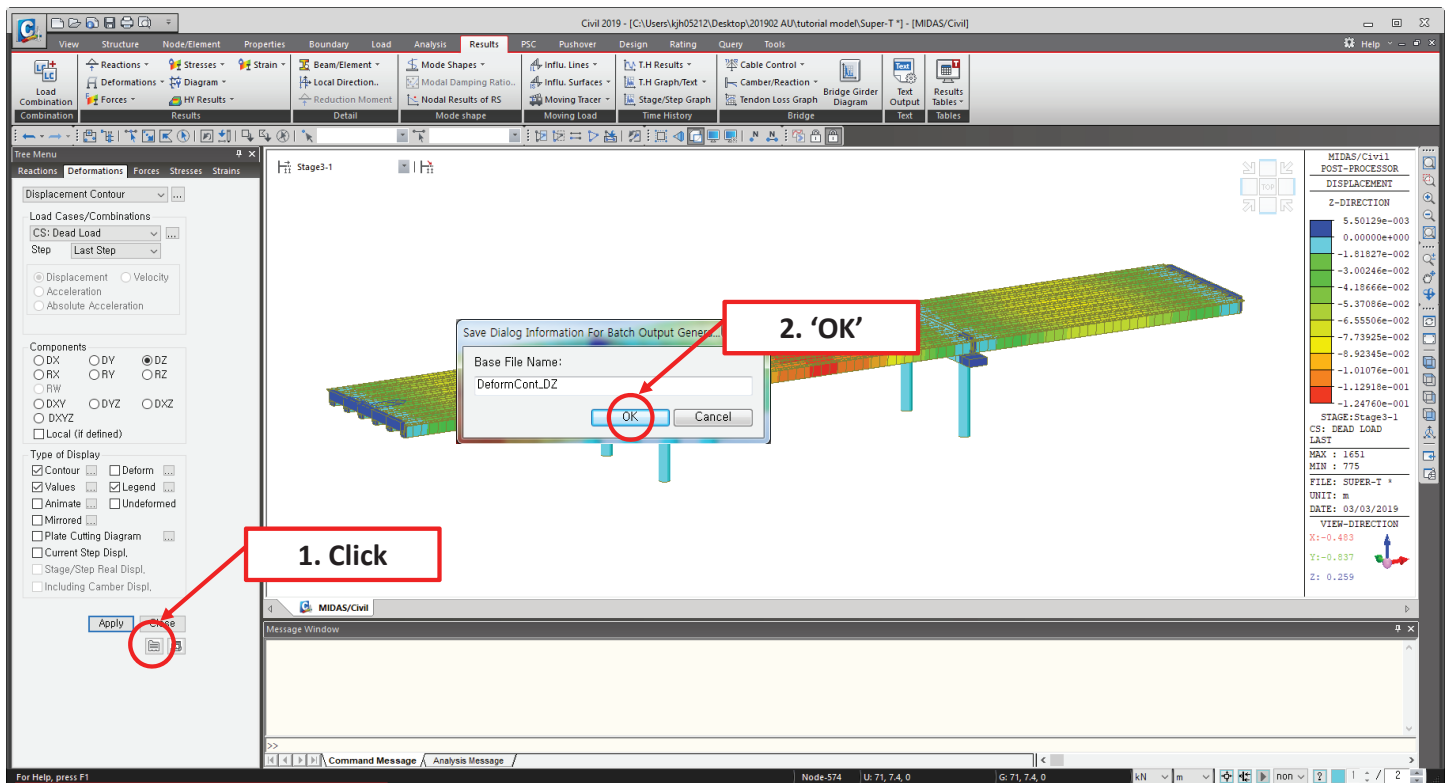
Procedure

Check the results under dead load along the stages.

MIDAS IT

78

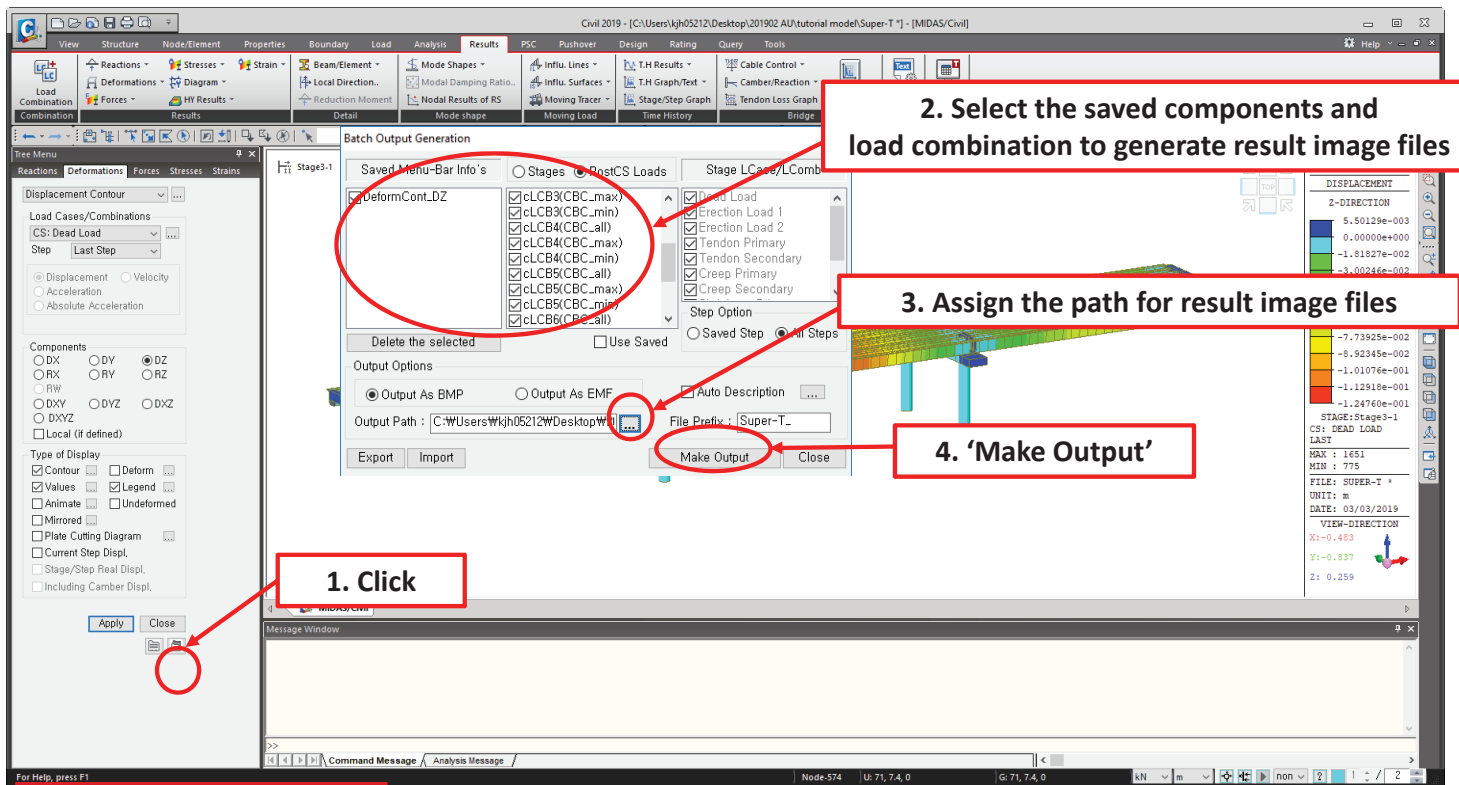
Reaction / Force / Displacement



Procedure

Save Components(DX, DY, DZ and etc.) to create automatic screen shots.

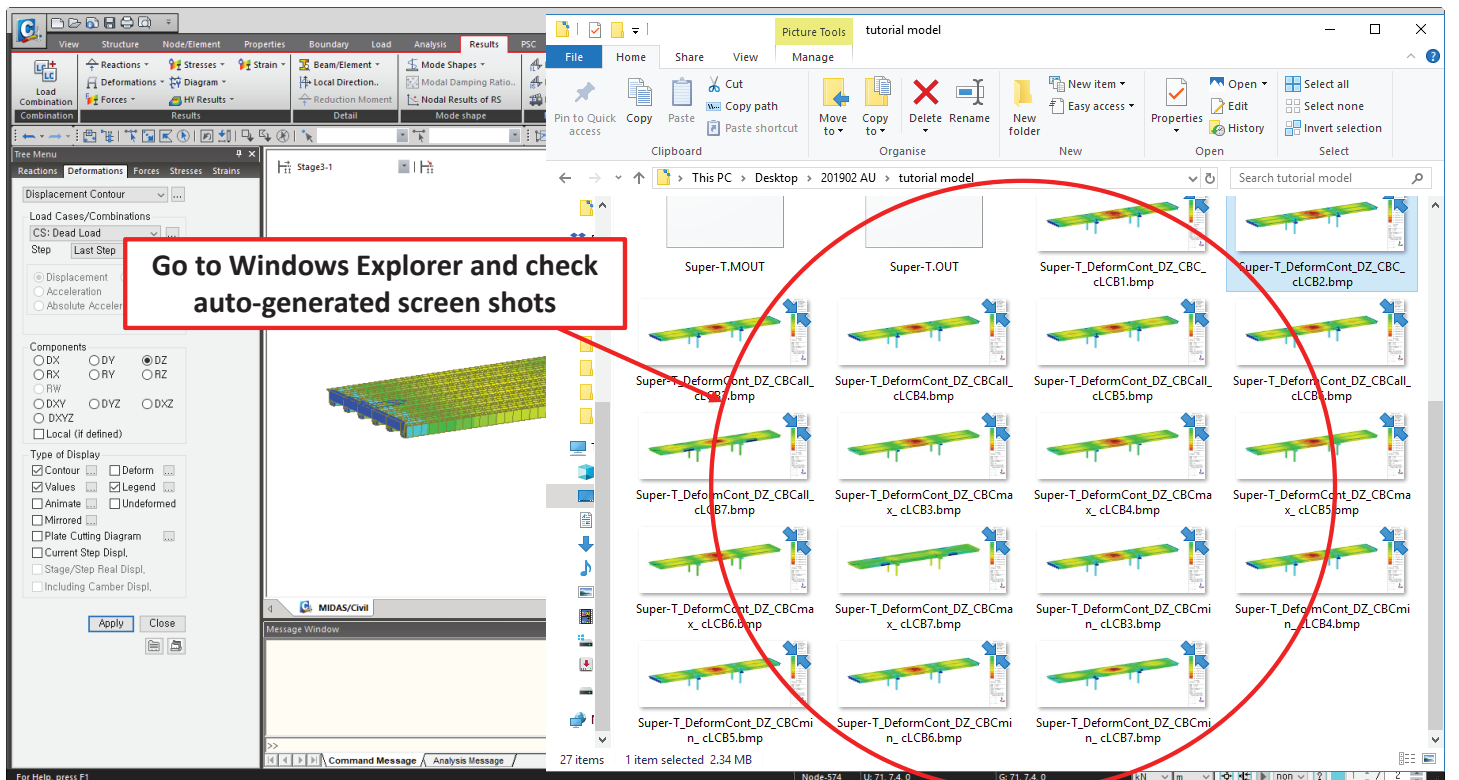
MIDAS IT



Procedure

Select the saved components and load cases(load combinations) to create screen shots.

MIDAS IT



Procedure

MIDAS IT

81

Reaction / Force / Displacement

1. Click 'Beam Diagrams'

2. 'PostCS'

3. Select 'MVmax: MV'

4. Select 'My'

5. Apply

Maximum results at No.265 element

Procedure

Check the beam moment diagram under moving load

MIDASIT

82

Moving Tracer

1. Click 'Beam Force/Moments' under 'Moving Tracer'

2. Input '265'

3. Select 'My'

4. Apply

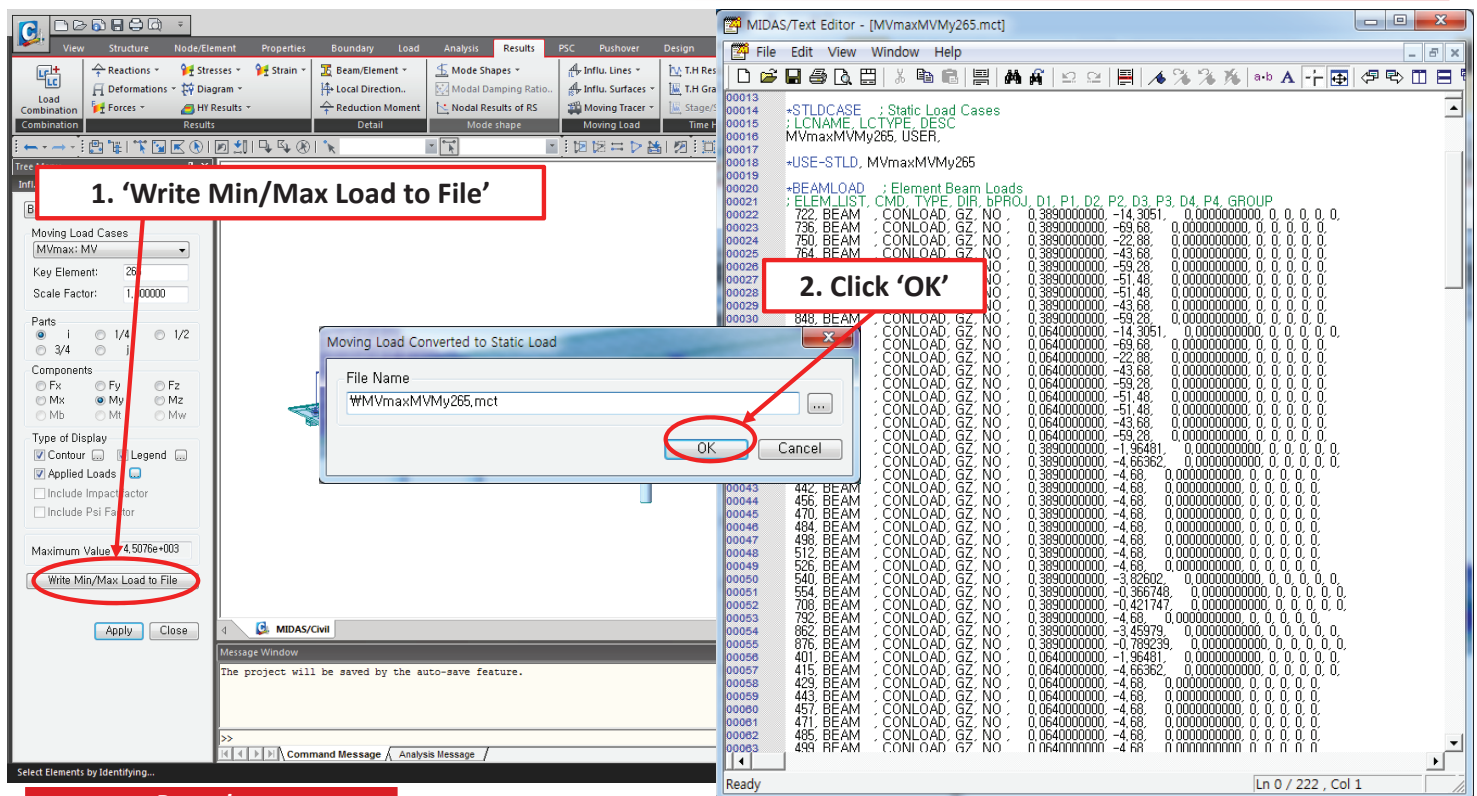
Influence line values

Maximum Value : 4.5076e+003

Procedure

Check the critical location of the vehicles.

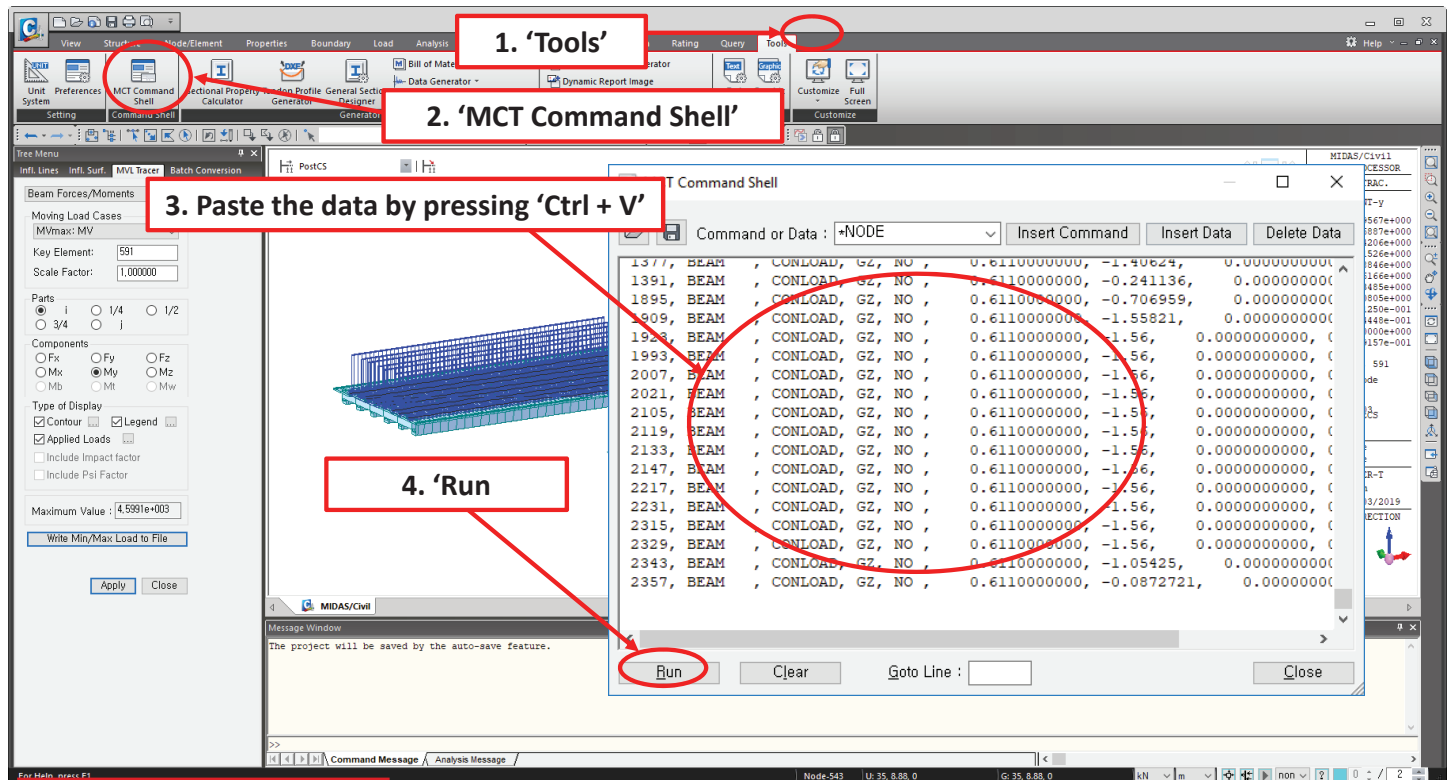
MIDASIT



Procedure

Copy and paste the text into MCT Command Shell under Tools menu.

MIDASIT

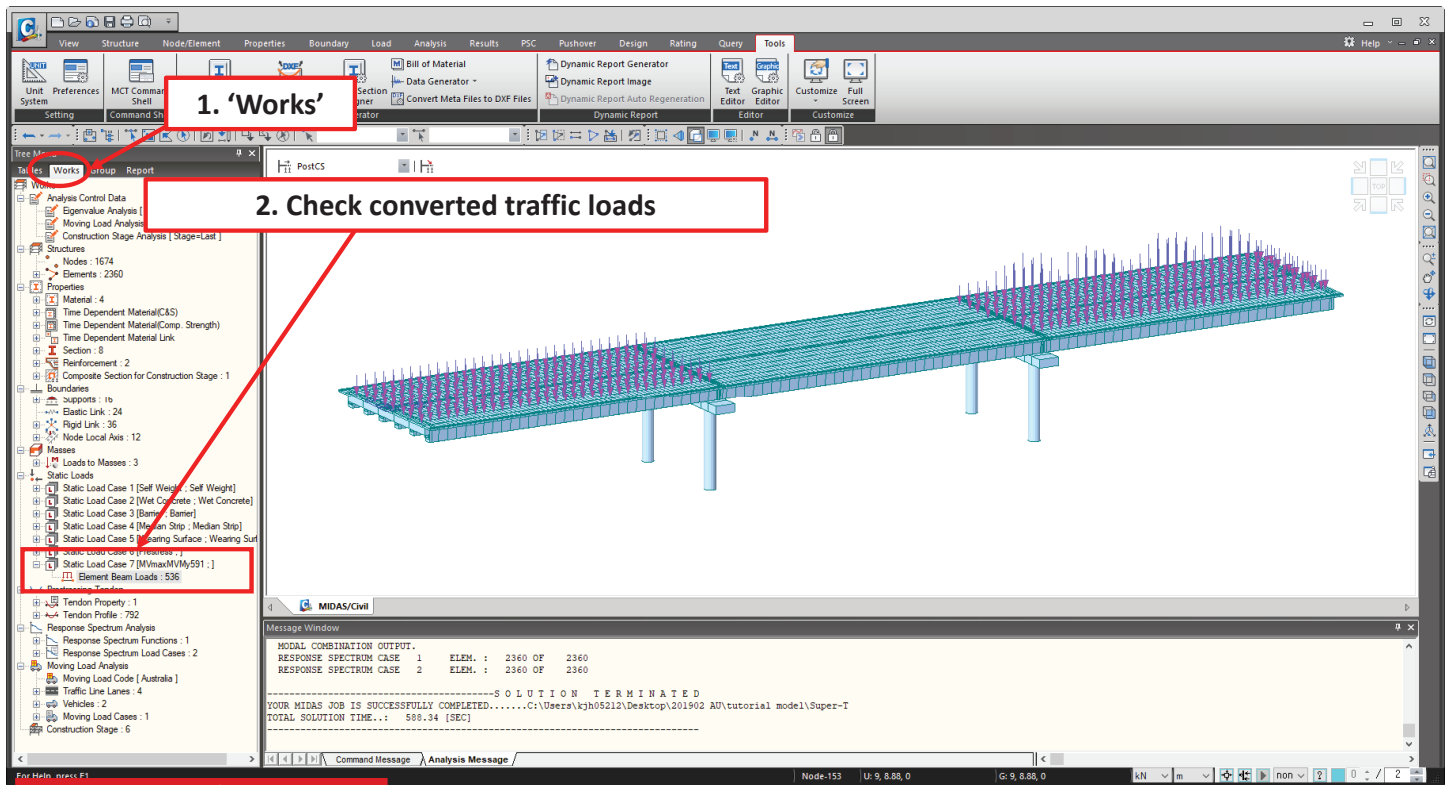


Procedure

Copy and paste the text into MCT Command Shell under Tools menu.

Extract data in the model file as text format using 'Insert Data' if you need. Check MCT Command List on Appendix in the online manual.

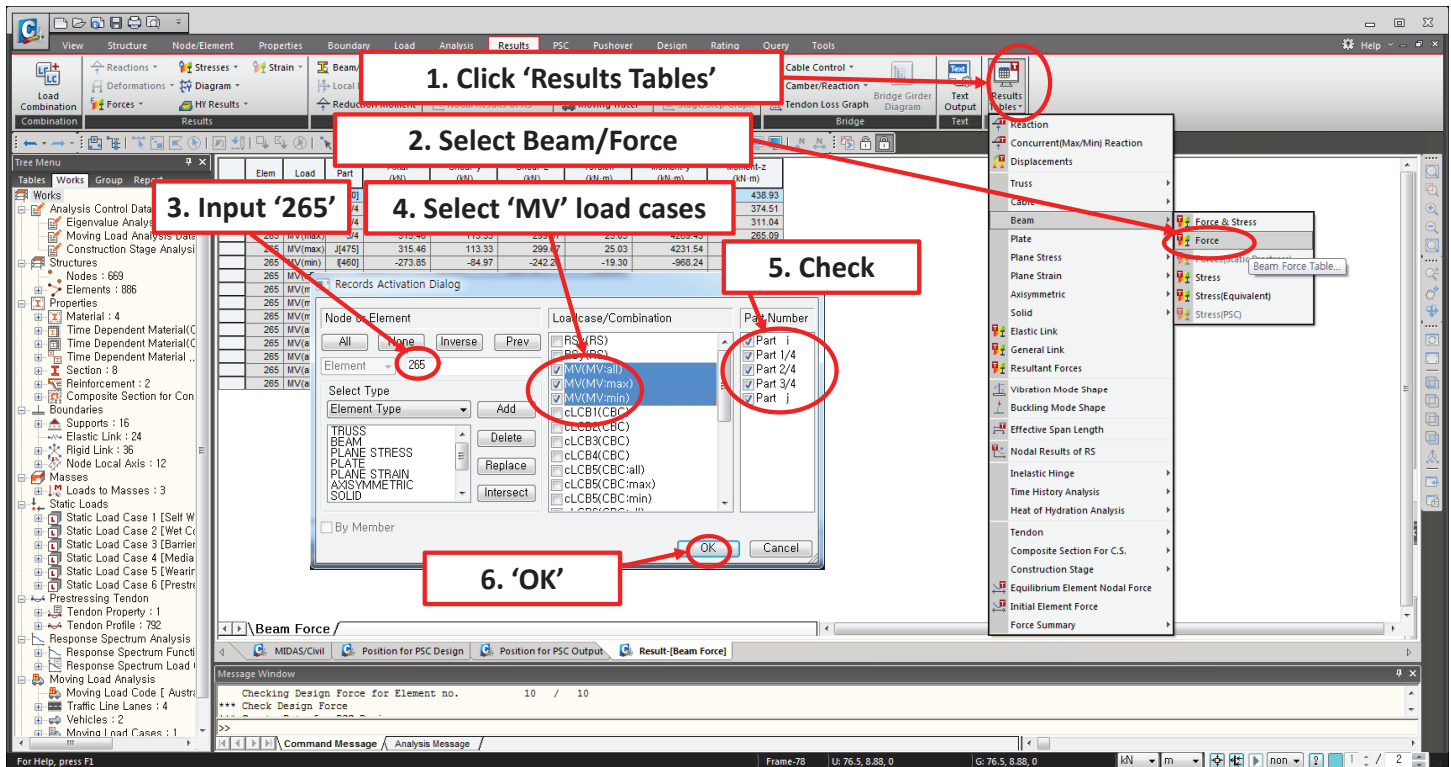
MIDASIT



Procedure

Check imported vertical static load Case.

MIDASIT



Procedure

The output comes from 5 points(Part 1, 1/4, 2/4, 3/4, j) of elements.

MIDASIT

87

Concurrent Force

1. 'View by Max Value Item...'

2. Check

3. 'OK'

Elem	Load	Part	Axial (kN)	Shear-y (kN)	Shear-z (kN)	Torsion (kN m)	Moment-y (kN m)	Moment-z (kN m)
265	MV(max)	[460]	315.46	113.33	299.67	25.03	4507.61	438.93
265	MV(max)	1/4	315.46	113.33	299.67	25.03	4408.97	374.51
265	MV(max)	2/4	315.46	113.33	299.67	25.03	4315.74	311.04
265	MV(max)	3/4	315.46	113.33	299.67	25.03	4209.43	265.09
265	MV(max)	J[475]	315.46	113.33	299.67	25.03	4231.54	259.24
265	MV(min)	[460]	-273.85	-84.97	-242.26	-19.30	-968.24	-358.64
265	MV(min)	1/4	-273.85	-84.97	-242.26	-19.30	-907.64	-307.59
							-847.04	-258.22
265	MV(all)	1/4	315.46	113.33	299.67	25.03	4408.97	374.51
265	MV(all)	2/4	315.46	113.33	299.67	25.03	4315.74	311.04
265	MV(all)	3/4	315.46	113.33	299.67	25.03	4209.43	265.09
265	MV(all)	J[475]	315.46	113.33	299.67	25.03	4231.54	259.24

Procedure

'View by Max Value Item...' option provides concurrent forces.

MIDASIT

88

Tendon Losses

1. Click 'Tendon Loss Graph'

2. Select Tendon/Stage/Step

Tendon Time-dependent Loss Graph

Tendon: Span1-001 Stage: Stage5 Step: Last Step

Tendon Force (kN)

Distance (m)

Procedure

Check tendon losses with graph format.

MIDASIT

1. 'Results Tables'

3. Select Tendon Group/Stage and Click 'Apply'

2. 'Tendon Loss'

Procedure

Check tendon losses.

MIDAS IT

1. 'Results Tables'

2. 'Tendon Elongation'

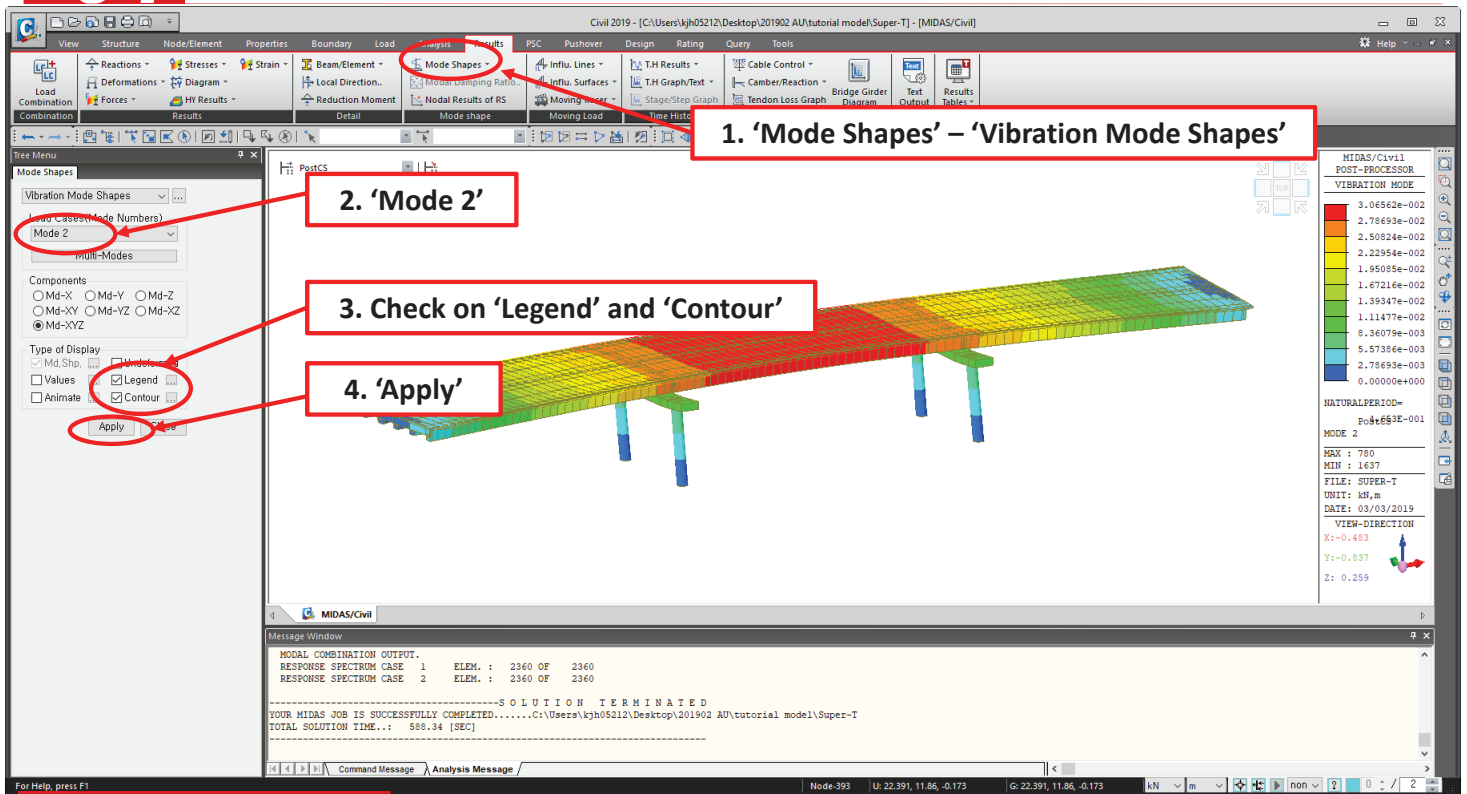
Procedure

Check tendon elongation.

MIDAS IT

91

Mode Shape



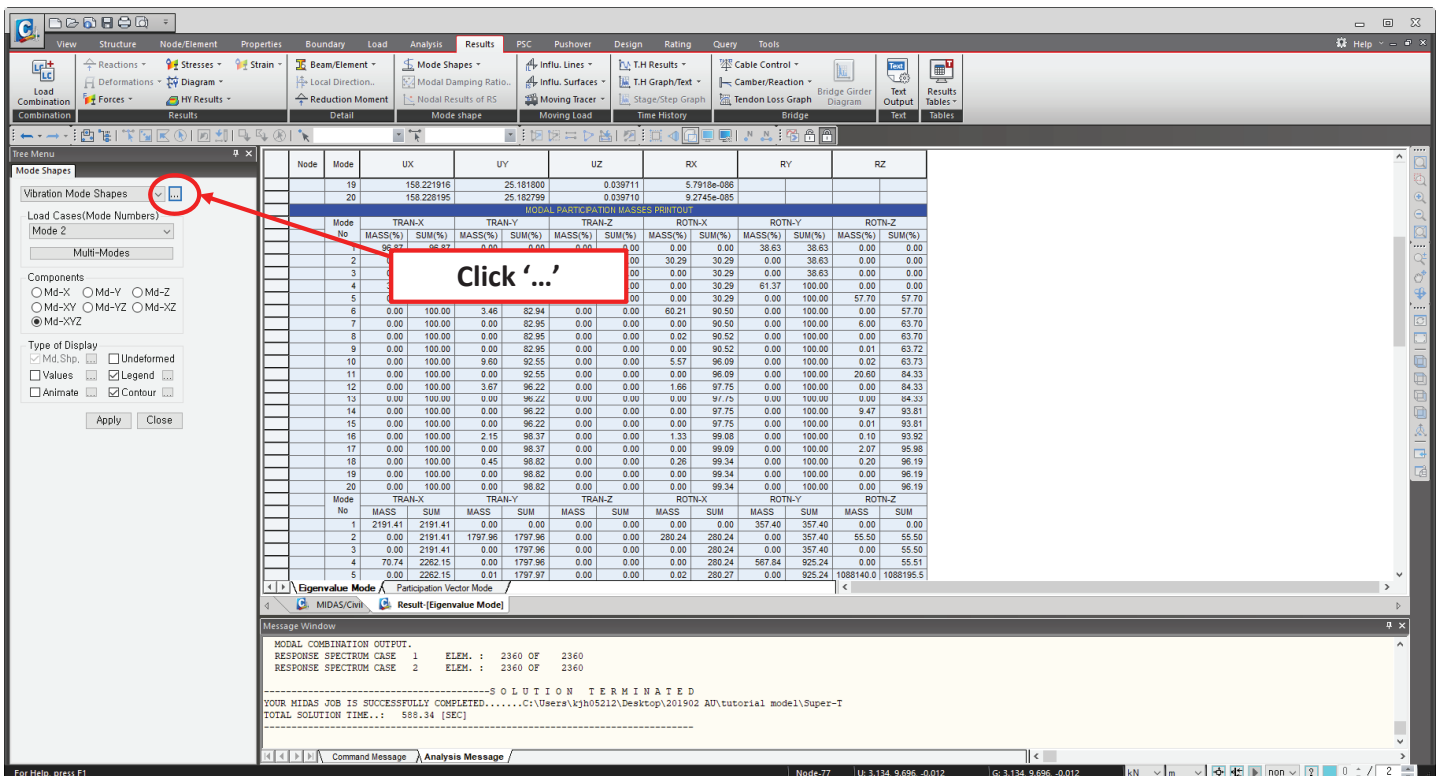
Procedure

Check mode shapes
Check on 'Repeat Full Cycle' on 'Animate ...' option if full cycle of the shape is preferred.

MIDAS IT

92

Mode Shape



Procedure

Accumulated modal participation masses should be over than around 80%.
Increase the number of modes on Analysis menu if it is less than that.

MIDAS IT

Overview

- **Properties**
 - Material / Section
- **Prestressed Composite Bridge Wizard**
 - Layout
 - Section
 - Tendon
 - Load
 - Construction Stage
- **Load**
 - Time Dependent Material
 - Moving load
 - Response Spectrum Analysis
- **Analysis**
 - Moving Load
- **Results**
 - Load Combination
 - Reaction/Force/Displacement
 - Moving Tracer
 - Concurrent Force
 - Tendon Losses
 - Mode Shape
- **Design**
 - PSC Design
- **Tips**
 - Smart Report
 - MCT Command Shell
 - Tendon Template
 - Import tendon from AutoCAD
- **Appendix. Load Combinations**

Step 6. Design

94

PSC Design

1. 'PSC'

2. 'Parameters'

3. 'AS 5100.5:17'

4. '30'

4. 'Select All'

5. 'OK'

PSC Design Parameters

Design Code : AS 5100.5:17

Input Parameters

Maximum nominal aggregate size (8,2,4,2)

d_g : 30 mm

Output Parameters

Ultimate limit states

- ☒ Flexural resistance
- ☒ Shear resistance
- ☒ Torsional resistance

Serviceability limit state

- ☒ Control of Cracking

Select All Unselect All

OK Cancel

Message Window

MODAL COMBINATION OUTPUT.

RESPONSE SPECTRUM CASE	ELEM.	2360 OF	2360
1	ELEM.	2360 OF	2360
2	ELEM.	2360 OF	2360

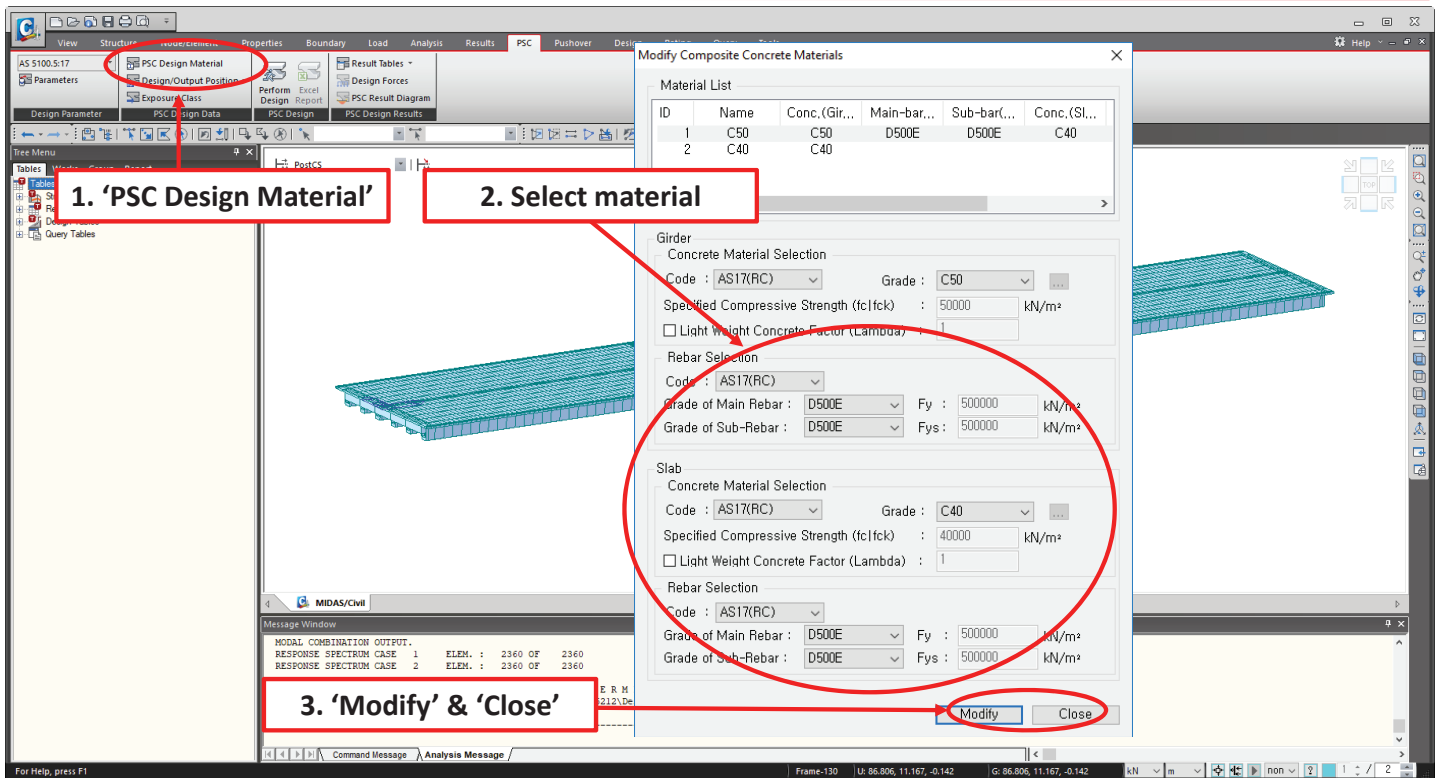
-----SOLUTION TERMINATED-----

YOUR MIDAS JOB IS SUCCESSFULLY COMPLETED.....C:\Users\kjh05212\Desktop\201902 AD\tutorial model\Super-T

TOTAL SOLUTION TIME...: 588.34 [SEC]

Procedure

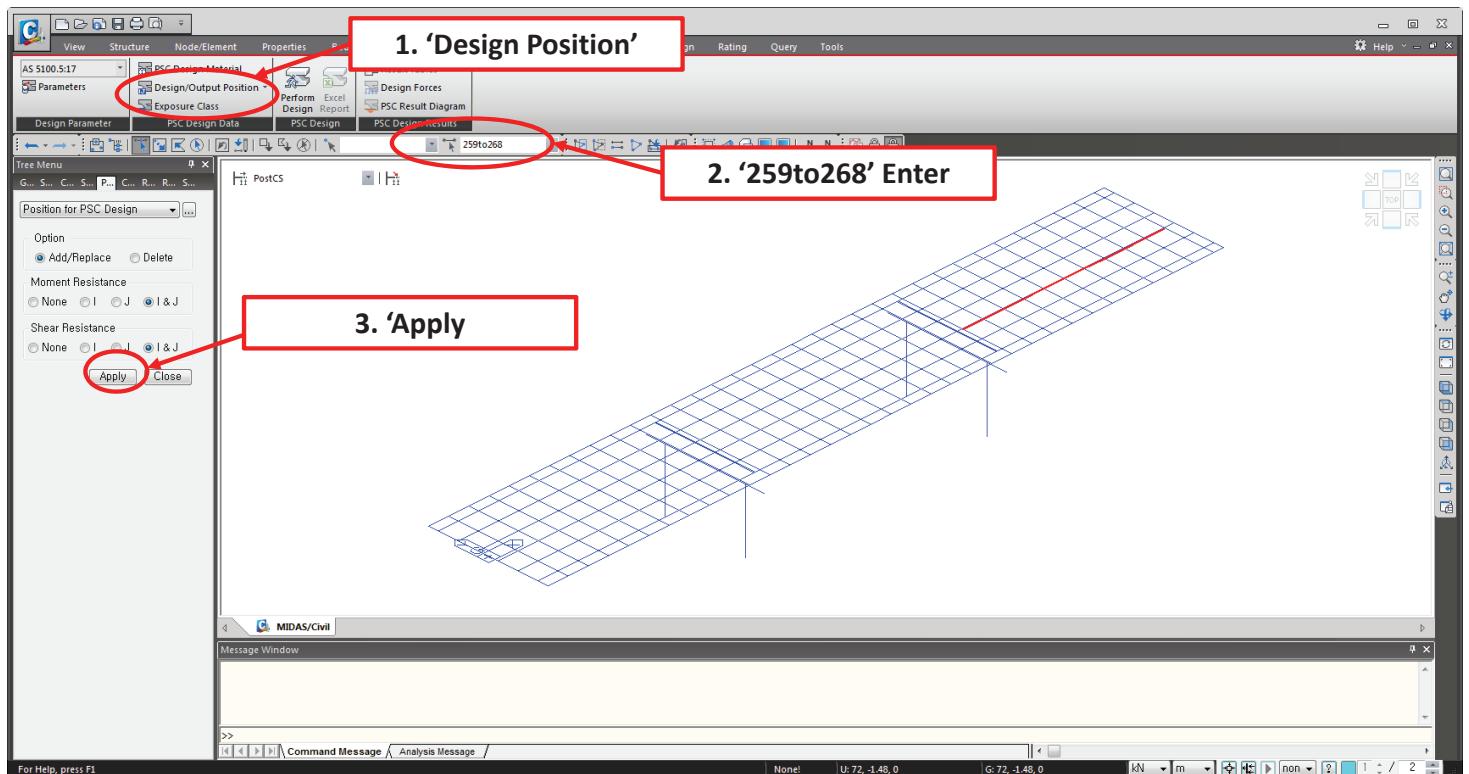
Decide output parameters



Procedure

Decide the position for midas Civil to calculate Capacity of the section

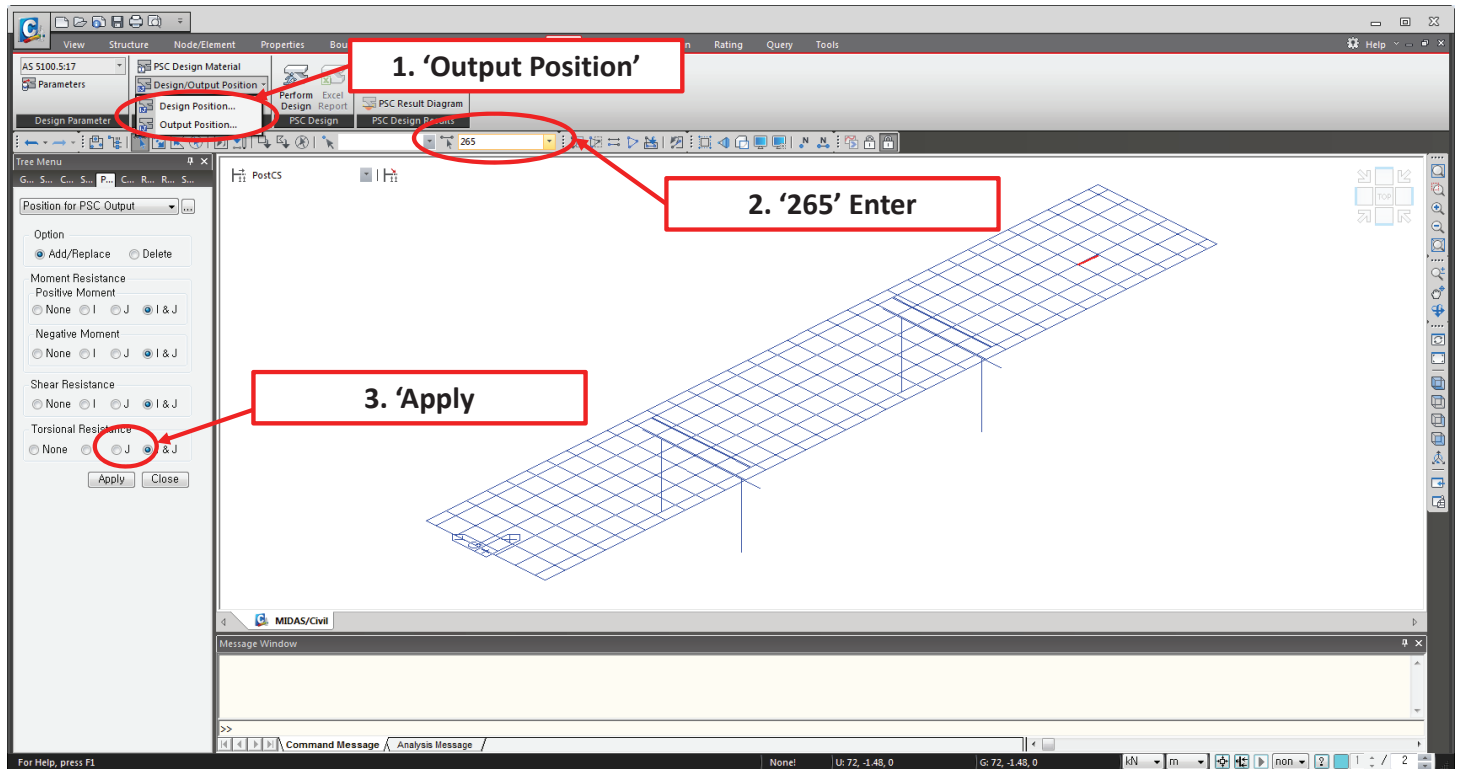
MIDASIT



Procedure

Decide the position for midas Civil to calculate Capacity of the section

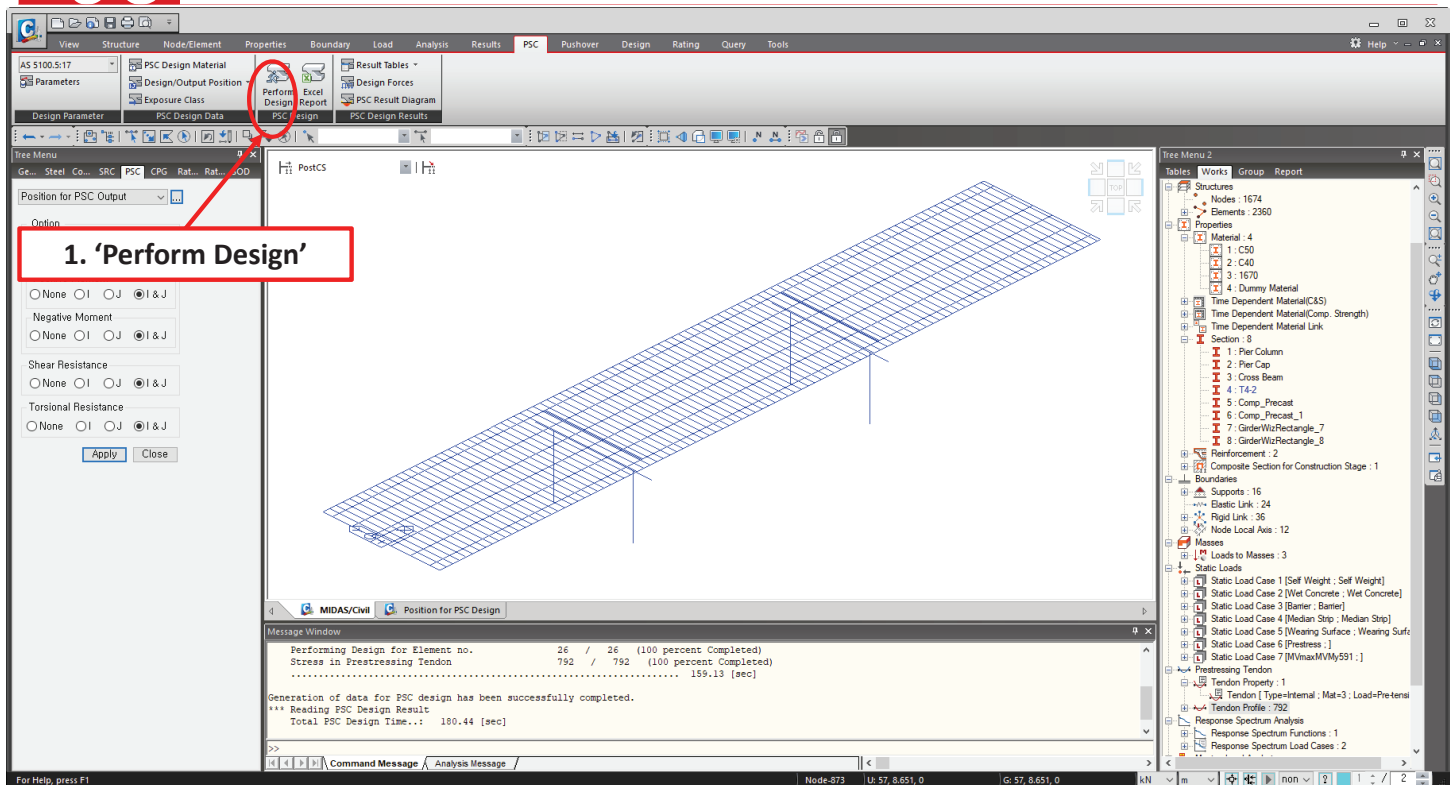
MIDASIT



Procedure

Decide the position to export Excel report

MIDAS IT

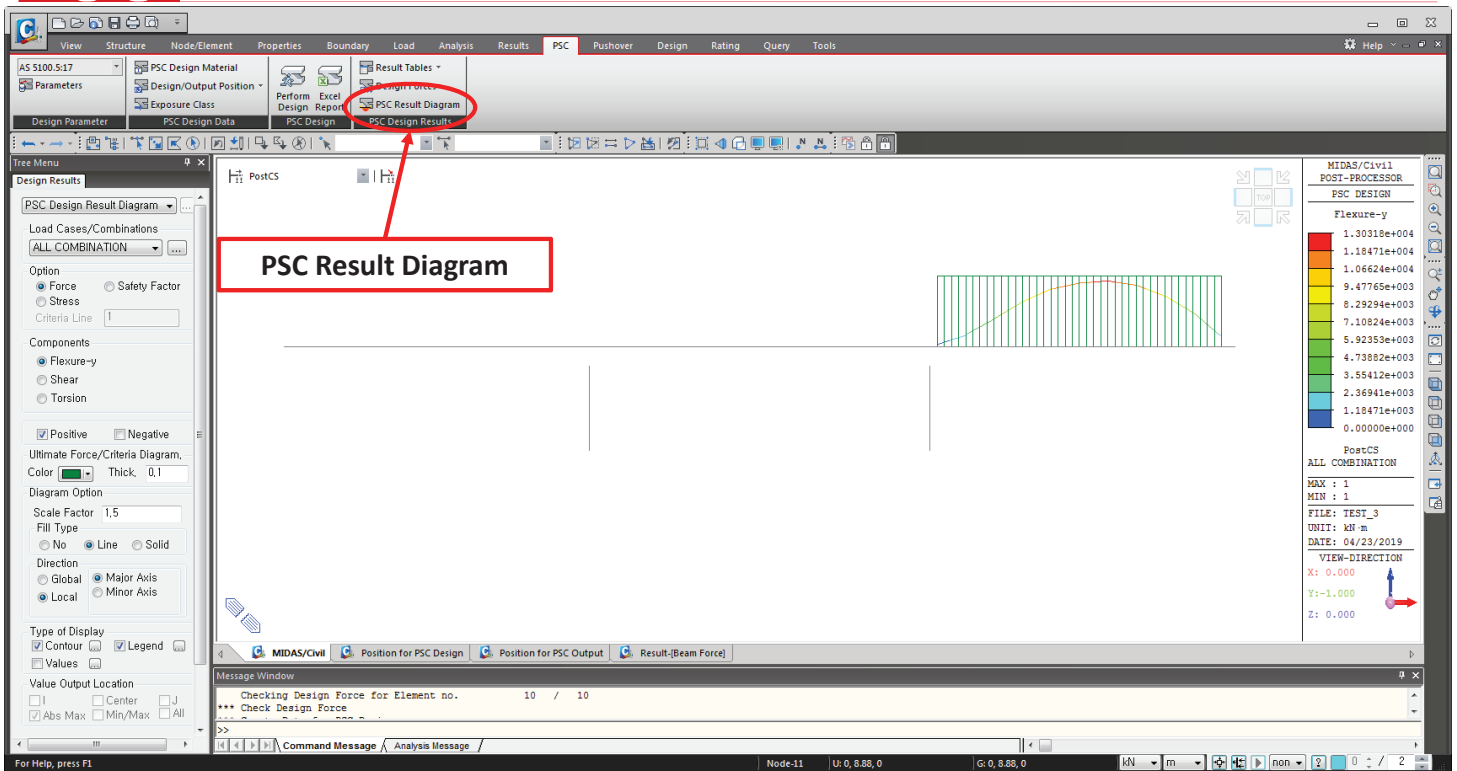


Procedure

MIDAS IT

99

PSC Design



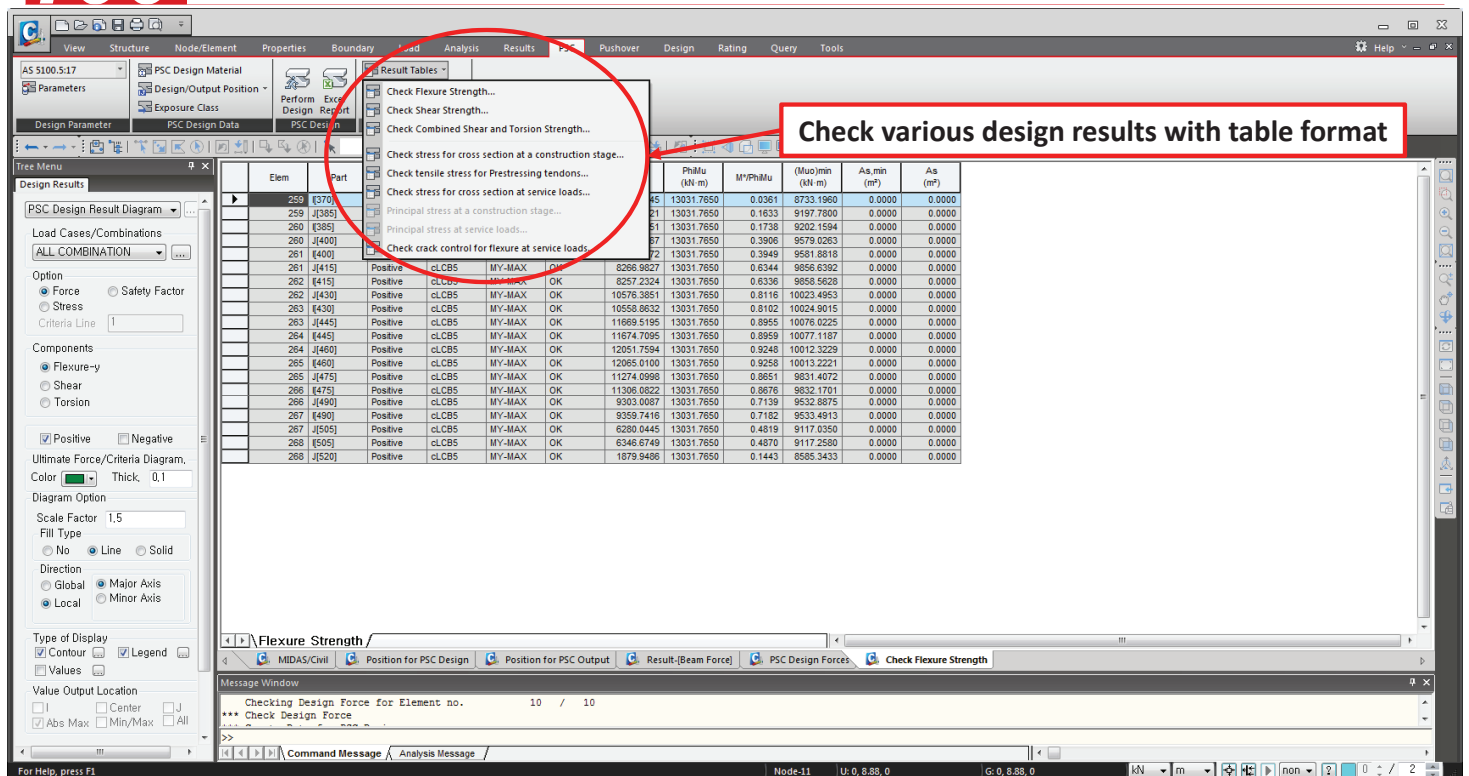
Procedure

Capacity/demand diagram is shown for the element which are assigned on 'Design Position'.

MIDASIT

100

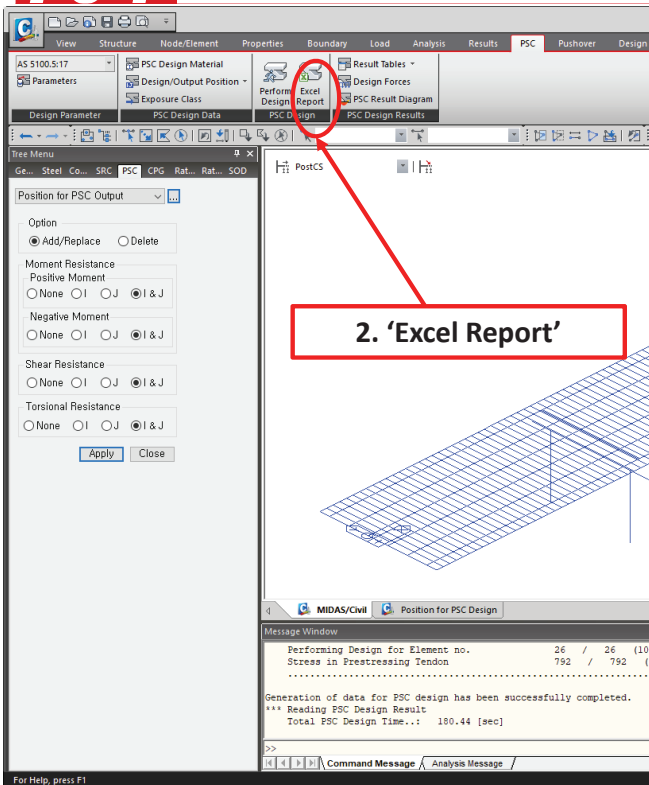
PSC Design



Procedure

Table shows the results for the element which are assigned on 'Design Position'.

MIDASIT



Procedure

1. Design Condition

Design code	Element	Node(I/J)
AS5100 S-17	285	J

■ Section Properties

Section Type		Composite	
- Gross section			
	Before	After	
H (mm)	1500.0	1680.0	H (mm)
B (mm)	2100.0	2960.0	B (mm)
C ₂₂ (mm)	823.3	389.7	C ₂₂ (mm)
C ₂₂ (mm)	676.7	1110.3	C ₂₂ (mm)
A _g (mm ²)	5.557 E+05	1.058 E+06	A _g (mm ²)
I _y (mm ⁴)	1.588 E+11	3.802 E+11	I _y (mm ⁴)
S _y (mm ³)	1.929 E+08	4.075 E+08	S _y (mm ³)
S _x (mm ³)	2.347 E+08	1.431 E+08	S _x (mm ³)
S _{xy} (mm ³)		6.674 E+08	S _{xy} (mm ³)
S _{xy} (mm ³)		9.756 E+08	S _{xy} (mm ³)
- Transformed section			
	Before	After	
H (mm)	1500.0	1680.0	H (mm)
B (mm)	2100.0	2960.0	B (mm)
C ₂₂ (mm)	850.3	418.8	C ₂₂ (mm)
C ₂₂ (mm)	649.7	1081.2	C ₂₂ (mm)
A _g (mm ²)	5.855 E+05	1.090 E+06	A _g (mm ²)
I _y (mm ⁴)	1.669 E+11	4.081 E+11	I _y (mm ⁴)
S _y (mm ³)	1.963 E+08	3.984 E+08	S _y (mm ³)
S _x (mm ³)	2.569 E+08	1.544 E+08	S _x (mm ³)
S _{xy} (mm ³)		6.349 E+08	S _{xy} (mm ³)
S _{xy} (mm ³)		9.078 E+08	S _{xy} (mm ³)

■ Materials

	f _c (MPa)	E _c (MPa)	f _{at} = 0.6√f _c (MPa)	α _c	γ
Girder	50.000	34800.000	4.243	0.85	0.70
Slab	40.000	32800.000	3.795	0.85	0.77

* α_c = 1.0 - 0.003f_c (within the limits of 0.67 ≤ α_c ≤ 0.85)
 * γ = 1.05 - 0.007f_c (within the limits of 0.67 ≤ γ ≤ 0.85)

■ Prestressing steel Information

No.	Tendon name	Bond type	d _p (mm)	A _{ps} (mm ²)	Strength (MPa)		E _p (MPa)
					f _{py}	f _{pu}	
1	S_Span3-174	Bond	1465.0	138.7	1569.1	1863.3	205000.0
2	S_Span3-164	Bond	1515.0	138.7	1569.1	1863.3	205000.0
3	S_Span3-154	Bond	1515.0	138.7	1569.1	1863.3	205000.0
4	S_Span3-144	Bond	1565.0	138.7	1569.1	1863.3	205000.0
5	S_Span3-134	Bond	1615.0	138.7	1569.1	1863.3	205000.0
6	S_Span3-175	Bond	1465.0	138.7	1569.1	1863.3	205000.0
7	S_Span3-165	Bond	1465.0	138.7	1569.1	1863.3	205000.0
8	S_Span3-155	Bond	1515.0	138.7	1569.1	1863.3	205000.0
9	S_Span3-145	Bond	1565.0	138.7	1569.1	1863.3	205000.0
10	S_Span3-135	Bond	1615.0	138.7	1569.1	1863.3	205000.0
11	S_Span3-176	Bond	1465.0	138.7	1569.1	1863.3	205000.0

Overview

■ Properties

- Material / Section

■ Prestressed Composite Bridge Wizard

- Layout
- Section
- Tendon
- Load
- Construction Stage

■ Load

- Time Dependent Material
- Moving load
- Response Spectrum Analysis

■ Analysis

- Moving Load

■ Results

- Load Combination
- Reaction/Force/Displacement
- Moving Tracer
- Concurrent Force
- Tendon Losses
- Mode Shape

■ Design

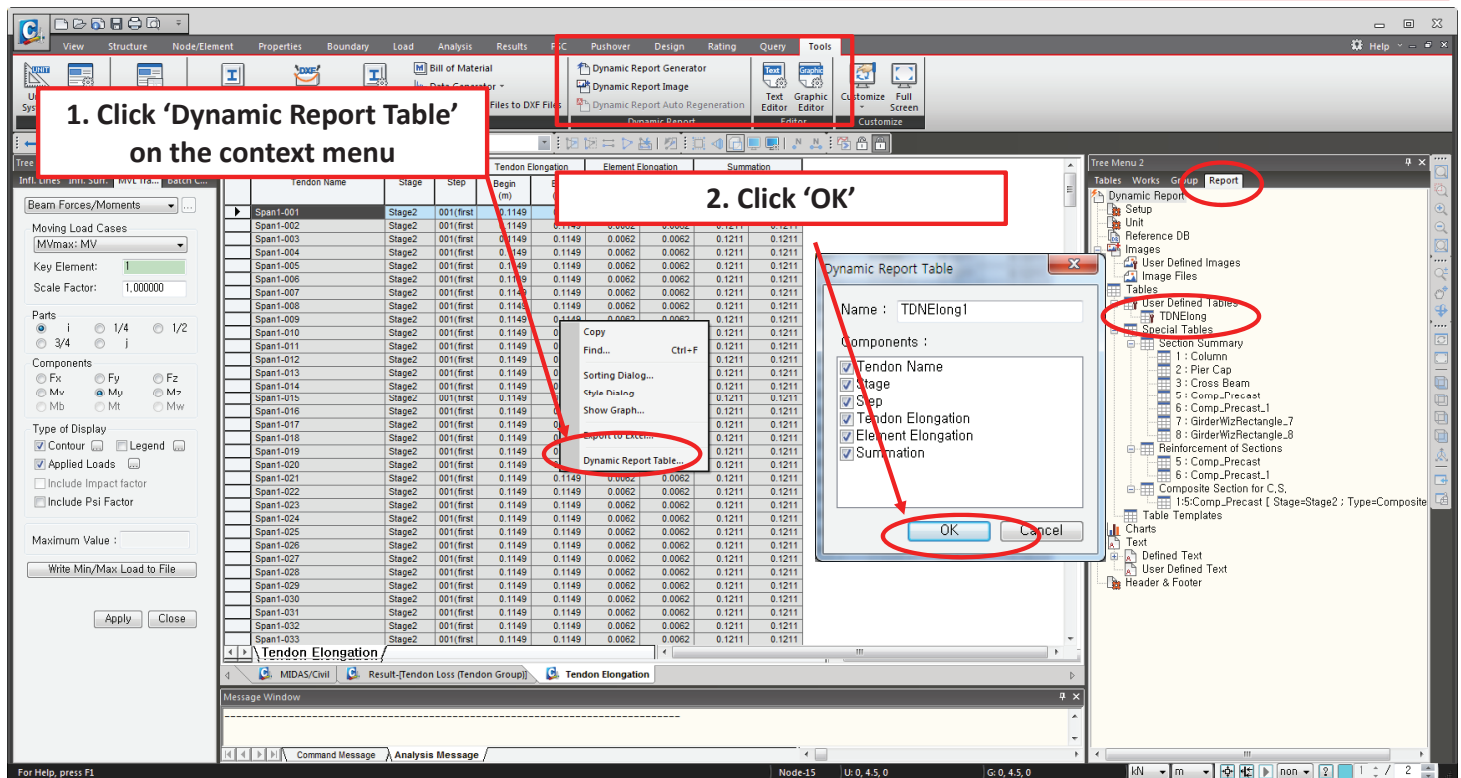
- PSC Design

■ Tips

- Smart Report
- MCT Command Shell
- Tendon Template
- Import tendon from AutoCAD

■ Appendix. Load Combinations

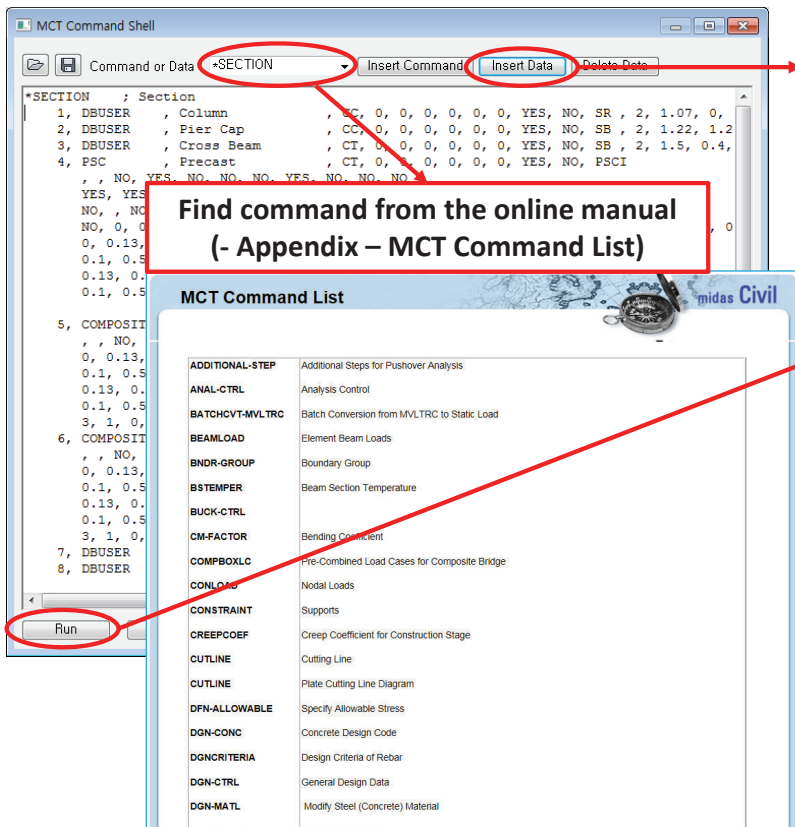
Step 7. Tips



Procedure

Execute Dynamic Report Generator and drag & drop the figures and the tables from Tree Menu to Microsoft Word. Add all input & output figures & tables to Tree Menu by clicking on 'Dynamic Report Table' on the context menu. Modified results will be updated after re-performing analysis automatically by 'Dynamic Report Auto Regeneration'.

MIDASIT



Extract only the text data on the command from the model file.

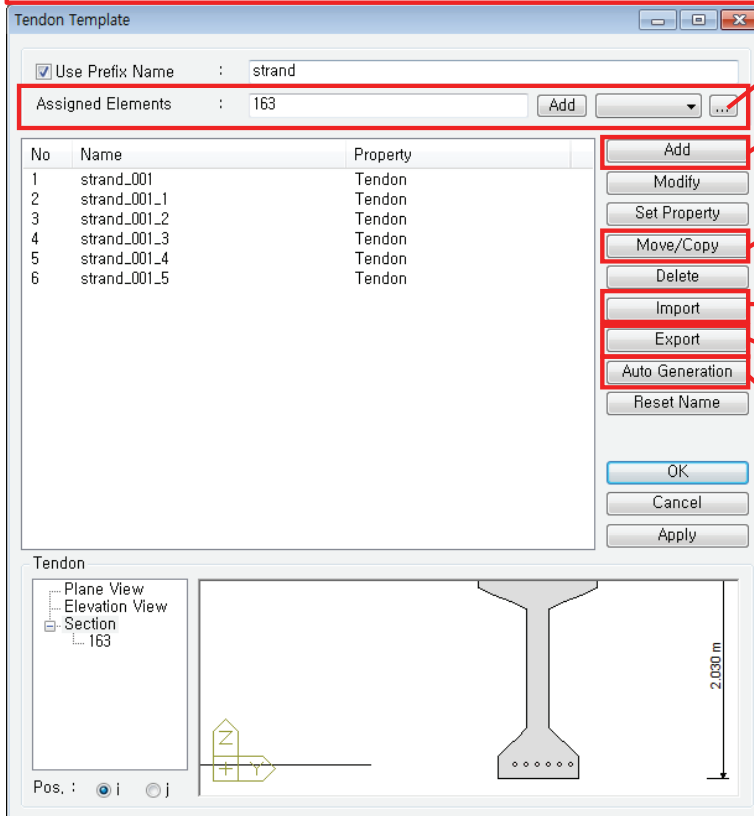
Apply the text data to the model file.

Modify or add functions with text format.

Save text data for specific functions(section, load, boundary, analysis and etc.) so it wouldn't be necessary to input same input data for various model files.

MIDASIT

Menu – Structure – Wizard – PSC Bridge – Tendon Template



Select elements to apply tendons

Add the selected elements

Select tendon from the drawing view at the bottom of the dialog by drag the mouse and move or copy the tendons

Import tendon template from other model files

Export inputted tendon template data

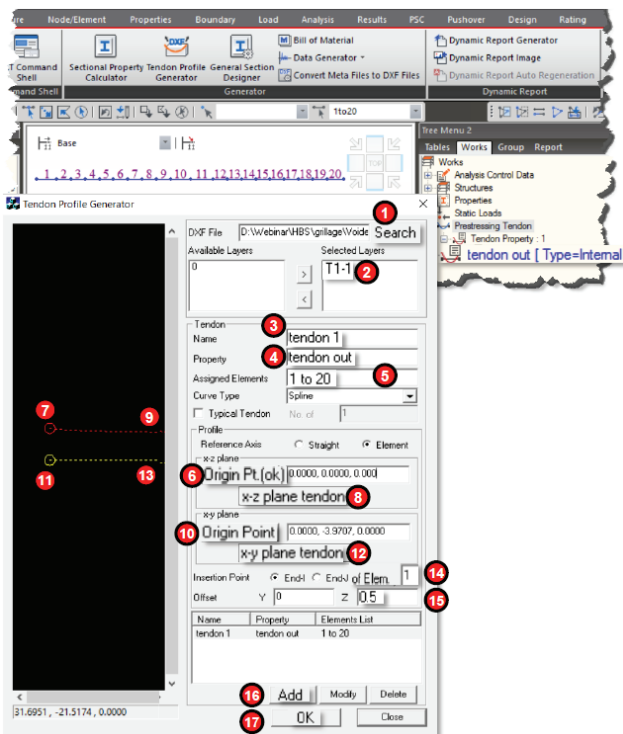
Generate tendons automatically for typical section

Import tendon template from the previous model file if the section is typical for the projects so it is not necessary to model the tendon repeatedly.

MIDAS IT

Menu – Tools – Tendon Profile Generator

1. Import the DXF file which contains the tendon profile.
2. Select the layer with the tendon profile.
3. Enter tendon name.
4. Enter appropriate tendon property. The 'tendon property' should be predefined in the model file.
5. Enter the element numbers to which the tendon profile has to be assigned.
6. Click on locations shown by step no.6 to 9 in sequence. This is to select the starting point of the tendon and the x-z plane coordinates for the tendon
10. Click on locations shown by step no.10 to 13 in sequence. This is to select the starting point of the tendon and the x-y plane coordinates for the tendon
14. Enter the element number at which the tendon has to be inserted.
15. Enter the required offset distance for the profile insertion if necessary.
16. Click 'Add'
17. Then OK to create the tendon coordinates on text format.
18. Copy the content
19. Open MCT Command Shell from **Tools > Command Shell > MCT Command Shell**
20. Paste the contents in the 'MCT command shell' dialogue box
21. Click 'Run'. The profile should now be inserted in the model.



MIDAS IT

Appendix. Load Combinations

Overview

■ Properties

- Material / Section

■ Prestressed Composite Bridge Wizard

- Layout
- Section
- Tendon
- Load
- Construction Stage

■ Load

- Time Dependent Material
- Moving load
- Response Spectrum Analysis

■ Analysis

- Moving Load

■ Results

- Load Combination
- Reaction/Force/Displacement
- Moving Tracer
- Concurrent Force
- Tendon Losses
- Mode Shape

■ Design

- PSC Design

■ Tips

- Smart Report
- MCT Command Shell
- Tendon Template
- Import tendon from AutoCAD

■ Appendix. Load Combinations

Appendix. Load Combinations

108 Appendix. Load Combinations

Automatic load combination function defines load factors based on Static Load Case Type according to AS5100.2:2017. Static Load Cases function includes any load functions from Static Loads and Temp./Prestress Load Type.

The screenshot displays the 'Load Combinations' dialog box within a software application. The dialog is organized into three main panes. The left pane, titled 'Static Load Cases', lists various load types such as Dead Load (D), Live Load (L), and Earth Pressure (EP). The center pane, 'Load Combinations', features a table with columns for 'No', 'Name', 'Active', 'Type', 'E', and 'Description'. It lists several load cases, including 'cLCB1' through 'cLCB7', with their respective descriptions and active status. The right pane, 'Automatic Generation of Load Combinations', provides options for generating load combinations based on different codes and standards. It includes sections for 'Option' (Add or Replace), 'Code Selection' (Steel, Concrete, SRC, or Steel Composite), 'Design Code' (AS 5100.2:17), 'Manipulation of Construction Stage Load Case' (ST Only, CS Only, or ST+CS), 'Bridge Type' (Roadway), 'Load Factors for Permanent Loads' (Type of Load, R.S., I.S., Both), and 'Fatigue Load Combination' (Road Traffic Case: MV). The 'File Name' field at the bottom is set to 'C:\Users\Wjkh05212\Desktop\W201902_AJW\Wturi'.

No	Name	Active	Type	E	Description
1	cLCB1	Strengt	Add		ULS : Minimum S
2	cLCB2	Strengt	Add		ULS : Minimum S
3	cLCB3	Strengt	Add		ULS6 : 1.8M[1]+2
4	cLCB4	Strengt	Add		ULS6 : 1.8M[1]+C
5	cLCB5	Strengt	Add		ULS7 : 1.8M[1]+2
6	cLCB6	Strengt	Add		ULS7 : 1.8M[1]+C
7	cLCB7	Service	Add		SLS18 : 1.0M[1]+

Static Load Case Type		*Excluded
Dead Load	D	
Dead Load of Component and Attachments	DC	
Dead Load of Wearing Surfaces and Utilities	DW	
Downdrag	DD	X
Weight of Leveling, Insulating, Protection	LIP	X
Weight of Pavement	PL	X
Weight of Ballast	BL	X
Earth Pressure	EP	
Active Earth Pressure for Native ground of Non-cohesive Soil	EANN	X
Active Earth Pressure for Native Ground of Cohesive Soil	EANC	X
Active Earth Pressure for Made Ground of Non-cohesive Soil	EAMN	X
Active Earth Pressure for Made Ground of Cohesive Soil	EAMC	X
Passive Earth Pressure for Native ground of Non-cohesive Soil	EPNN	X
Passive Earth Pressure for Native Ground of Cohesive Soil	EPNC	X
Passive Earth Pressure for Made Ground of Non-cohesive Soil	EPMN	X
Passive Earth Pressure for Made Ground of Cohesive Soil	EPMC	X
Horizontal Earth Pressure	EH	
Vertical Earth Pressure	EV	
Earth Surcharge Load	ES	X
Locked in Erection Stresses	EL	X
Live Load Surcharge	LS	X
Live Load	L	X
Overload Live load	LP	X
Live Load Impact	IL	X
Overload Live Load Impact	ILP	X
Centrifugal Force	CF	

Static Load Case Type		*Excluded
Crowd Load	CRL	X
Prestress	PS	
Buoyancy	B	
Ground Water Pressure	WP	
Fluid Pressure	FP	
Stream Flow Pressure	SF	X
Wave Pressure	WPR	X
Wind Load on Structure	W	
Wind Load on Live Load	WL	X
Settlement	STL	
Creep	CR	
Shrinkage	SH	
Temperature	T	
Temperature Gradient	TPG	
Collision Load	CO	
Vehicular Collision Force	CT	
Vessel Collision Force	CV	
Earthquake	E	
Friction	FR	X
Ice Pressure	IP	X
Construction Stage Load	CS	X
Erection Load	ER	X
Rib Shortening	RS	X
Grade Effect	GE	X
Roof Live Load	LR	X
Snow Load	S	X
Rain Load	R	X
Soil Heaving	SHV	X

*Excluded : Excluded load case types are not included in the automatic load combinations.

Load combination has to be defined manually for the excluded load case types if it is necessary.

MIDASIT

midas Civil decides load factors according to AS5100.2 based on load type of Static Load Cases.

For example, if user define a load case which type is Dead Load(D) or (DC), 1.20 or(and) 0.85 would be applied as a load factor from auto generation of load combination for Ultimate check. And 2.0 or(and) 0.7 would be applied for Dead Load of Wearing Surfaces and Utilities(DW). Both 'reduces safety' and 'increases safety' factors are generated when 'Both' option is checked on.

AS 5100.2 : 2017

TABLE D1
LOAD FACTORS

Loading		Limit state	
		Ultimate	Serviceability
Dead load of structure that reduces safety	Steel	1.10	1.0
	Concrete	1.20	1.0
	Concrete at transfer of prestress	1.15	N/A
	Timber	1.25	1.0
Dead load of structure that increases safety	Steel	0.90	1.0
	Concrete	0.85	1.0
	Concrete at transfer of prestress	0.90	N/A
	Timber	0.80	1.0
Superimposed dead load that reduces safety	Permanent	2.0	1.3
	Removable	2.0	1.3
	Special case permanent	1.4	1.0
	Special case removable	1.4	1.0
Superimposed dead load that increases safety	Permanent	0.7	1.3
	Removable	0.0	1.3
	Special case permanent	0.8	1.0
	Special case removable	0.0	1.0

(continued)

Static Load Case Type from midas Civil	
Dead Load	D
Dead Load of Component and Attachments	DC
Dead Load of Wearing Surfaces and Utilities	DW

Automatic Generation of Load Combinations

Option
☒ Add ☐ Replace

Code Selection
☐ Steel ☒ Concrete ☐ SRC ☐ Steel Composite

Design Code : AS 5100.2:17

Manipulation of Construction Stage Load Case
☐ ST Only ☐ CS Only ☒ ST+CS
 ST : Static Load Case CS : Construction Stage

Bridge Type : Roadway

☐ Load Factors for Permanent Loads

Type of Load	Load Factor	R,S	I,S	Both
Dead Load	<input checked="" type="radio"/> 1.20 <input type="radio"/> 0.85			
Superimposed Dead Load	<input checked="" type="radio"/> 2.00 <input type="radio"/> 0.80			
Soil Load	<input checked="" type="radio"/> 1.50 <input type="radio"/> 0.70			
Groundwater Load	<input checked="" type="radio"/> 1.00 <input type="radio"/> 1.00			

R,S : Reduce Safety
 I,S : Increase Safety

Fatigue Load Combination
 Road Traffic Case : M16

Load Case

Add
 Delete

OK Cancel

Same procedure for earth pressure load types

AS 5100.2 : 2017

Soil and groundwater load that reduces safety	Controlled fill with regular testing of soil density	1.25	1.0
	All other fills and in situ soils	1.5	1.2
	Groundwater	1.0	1.0
Soil and groundwater load that increases safety	Controlled fill with regular testing of soil density	0.85	1.0
	All other fills and in situ soils	0.7	1.2
	Groundwater	1.0	1.0

Earth Pressure	EP
Horizontal Earth Pressure	EH
Vertical Earth Pressure	EV
Ground Water Pressure	WP

MIDAS IT

The load combination of 'Pedestrian cyclist path and maintenance traffic loads' is generated when 'Pedestrian/Cyclist' option is selected as Bridge Type.

AS 5100.2 : 2017

Centrifugal force from road traffic (HLP factors shall be determined by the relevant authority)	1.8	1.0
Braking force from road traffic (HLP factors shall be determined by the relevant authority)	1.8	1.0
Pedestrian cyclist path and maintenance traffic loads	1.5	1.0

Centrifugal Force	CF
Braking Load	BRK

MIDAS IT

AS 5100.2 : 2017

Load	Ultimate	Serviceability
Collision load from road traffic	1.0	N/A
Loads on protection beams	1.0	N/A
Collision loads from rail traffic	1.0	N/A
Derailement load case A	1.2	N/A
Derailement load case B	1.0	N/A
Derailement load on kerbs	1.0	N/A
Road traffic barrier loads	1.0	N/A
Road traffic barrier connection loads	1.05	N/A
Road traffic barrier loads transmitted to bridge deck	1.1	N/A
Pedestrian and cyclist path barrier load	1.8	1.0

Collision Load	CO
Vehicular Collision Force	CT
Vessel Collision Force	CV

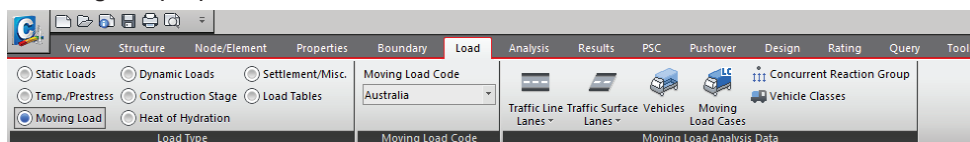
Loading		Limit state	
		Ultimate	Serviceability
Earth pressure from traffic loads		Refer to AS 5100.3	
Earthquake forces (for appropriate ARI)		1.0	1.0
Water flow (for appropriate ARI)		1.3	1.0
Wind loads (for appropriate ARI)		1.0	1.0
Thermal		1.25	1.0
Shrinkage and creep		1.2	1.0
Prestress secondary effects		1.0	1.0
Prestress effects at transfer		1.15	1.0
Differential settlement effects		1.5	1.0
Mining subsidence	Accurate records and information are available	1.5	1.0
	Other sites	2.0	1.0
Forces from bearings		1.3	1.0
Loading		Fatigue limit state	
A160 axle (determined from 70% of the load)		1.0	
M1600 (determined from 70% of the load without UDL)		1.0	
300LA rail traffic		1.0	

Earthquake	E
Fluid Pressure	FP
Buoyancy	B
Wind Load on Structure	W
Temperature	T
Temperature Gradient	TPG
Creep	CR
Shrinkage	SH
Prestress	PS
Settlement	STL

MIDASIT

Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

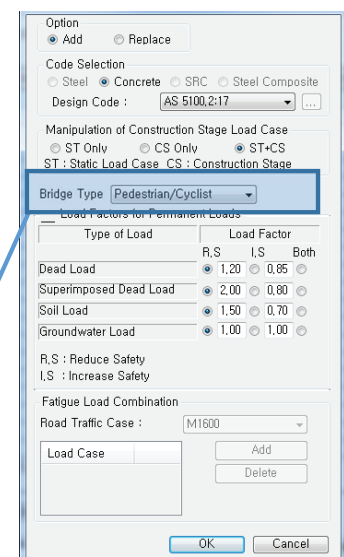
- Moving Load(MV)



Any vehicle loadings on Moving Load Case have 1.8 for ULS and 1.0 for SLS as load factors. 1.5 for ULS and 1.0 for SLS are applied when Pedestrian/Cyclist.

AS 5100.2 : 2017

W80 wheel	1.8	1.0
A160 axle	1.8	1.0
M1600	1.8	1.0
M1600 tri-axle group	1.8	1.0
S1600	1.8	1.0
Heavy load platform (HLP)	1.5	1.0
Half of SM1600 traffic load in unobstructed lanes when applied in conjunction with HLP loading	1.8	1.0
Centrifugal force from road traffic (HLP factors shall be determined by the relevant authority)	1.8	1.0
Braking force from road traffic (HLP factors shall be determined by the relevant authority)	1.8	1.0
Pedestrian cyclist path and maintenance traffic loads	1.5	1.0

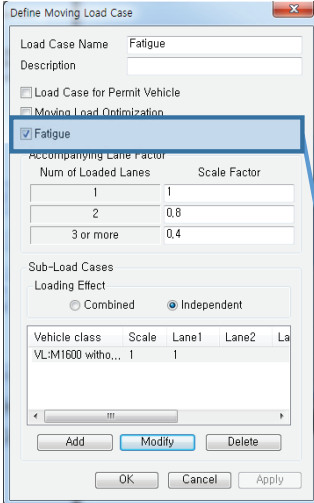
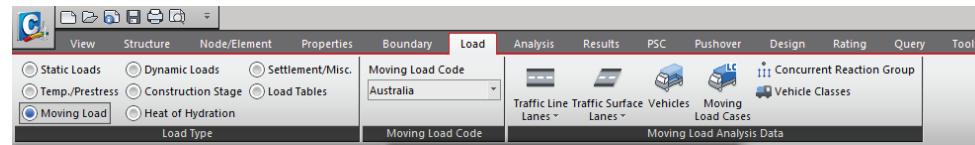


*Automatic load combination considers 'AS5100.2:2017 23.4 SLS load combinations' for SLS load combinations

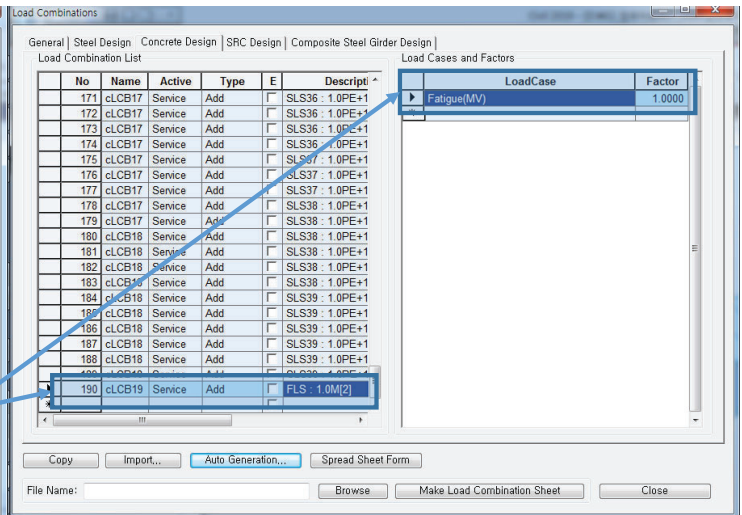
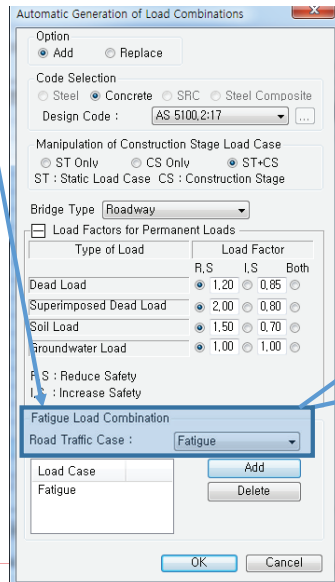
MIDASIT

Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

- Moving Load(MV)



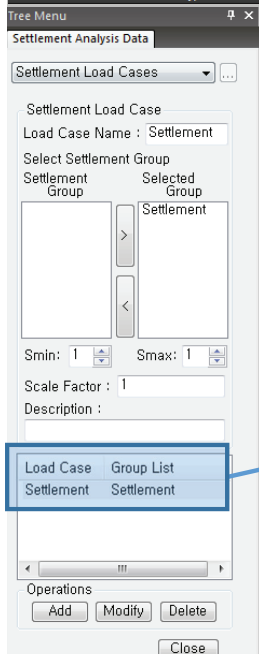
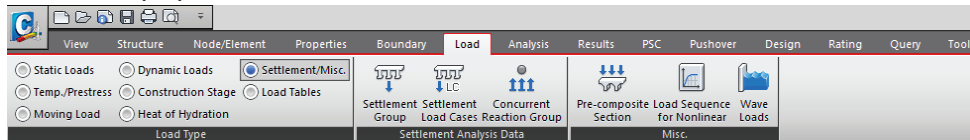
Fatigue load combination is generated when fatigue load case is assigned.



MIDASIT

Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

- Settlement(SM)



Settlement Load Case has 1.5 for ULS and 1.0 for SLS as load factors.

AS 5100.2 : 2017

Loading	Limit state	
	Ultimate	Serviceability
Earth pressure from traffic loads	Refer to AS 5100.3	
Earthquake forces (for appropriate ARI)	1.0	1.0
Water flow (for appropriate ARI)	1.3	1.0
Wind loads (for appropriate ARI)	1.0	1.0
Thermal	1.25	1.0
Shrinkage and creep	1.2	1.0
Prestress secondary effects	1.0	1.0
Prestress effects at transfer	1.15	1.0
Differential settlement effects	1.5	1.0
Mining subsidence	1.5	1.0
Forces from bearings	1.3	1.0
Fatigue limit state		
A160 axle (determined from 70% of the load)	1.0	
M1600 (determined from 70% of the load without UDL)	1.0	
300LA rail traffic	1.0	

MIDASIT

Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

- Construction Stage : Dead Load(CS)

Dead Load(CS) load case appears on Load Combination dialog and includes dead loads such as Self Weight which are activated on construction stage. It has same load factors with D and DC load types.

AS 5100.2 : 2017

TABLE D1
LOAD FACTORS

Loading		Limit state	
		Ultimate	Serviceability
Dead load of structure that reduces safety	Steel	1.10	1.0
	Concrete	1.20	1.0
	Concrete at transfer of prestress	1.15	N/A
	Timber	1.25	1.0
Dead load of structure that increases safety	Steel	0.90	1.0
	Concrete	0.85	1.0
	Concrete at transfer of prestress	0.90	N/A
	Timber	0.80	1.0
Superimposed dead load that reduces safety	Permanent	2.0	1.3
	Removable	2.0	1.3
	Special case permanent	1.4	1.0
	Special case removable	1.4	1.0
Superimposed dead load that increases safety	Permanent	0.7	1.3
	Removable	0.0	1.3
	Special case permanent	0.8	1.0
	Special case removable	0.0	1.0

(continued)

Static Load Case Type from midas Civil	
Dead Load	D
Dead Load of Component and Attachments	DC
Dead Load of Wearing Surfaces and Utilities	DW

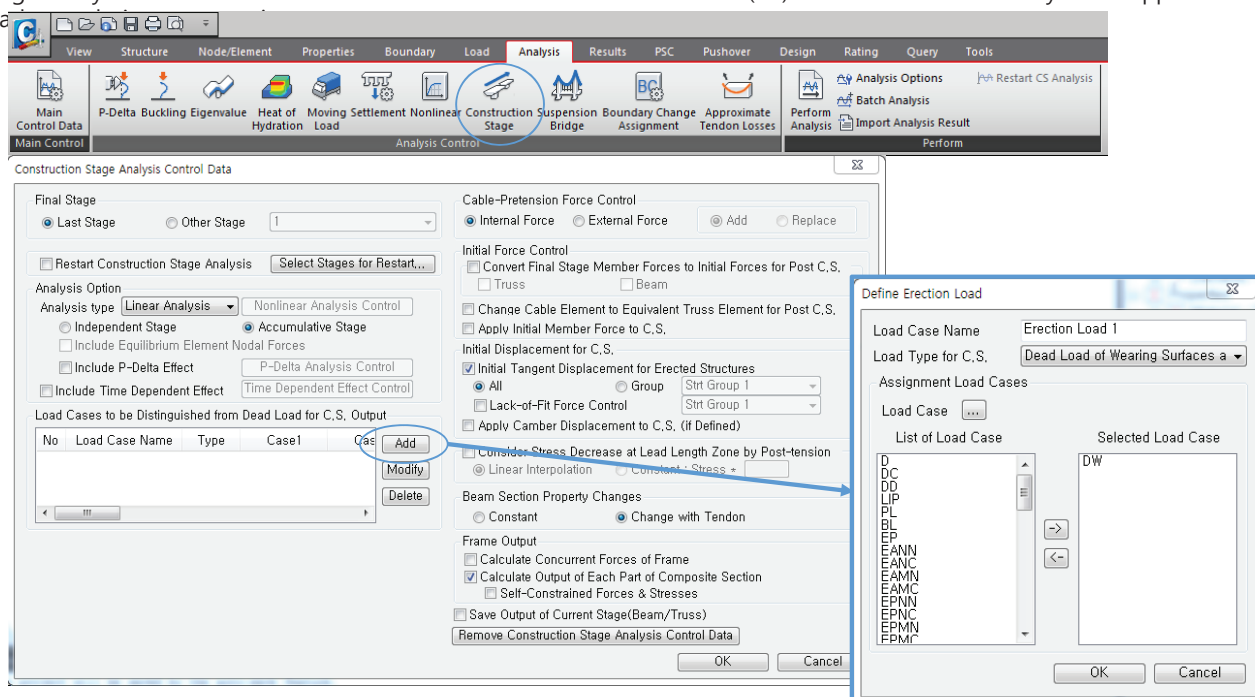
Load cases should have Construction Stage Load (CS) type on Static Load Cases dialog if those are activated on a construction stage. Otherwise, automatic load combination generates both static load case(ST) and Dead Load(CS).

MIDASIT

Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

- Construction Stage : Erection Load(CS)

Erection Load(CS) load case appears on Load Combination dialog and includes load cases which are defined on Construction Stage Analysis Control Data to set different load factors from Dead Load(CS) load case. It is necessary to be applied to DW load.

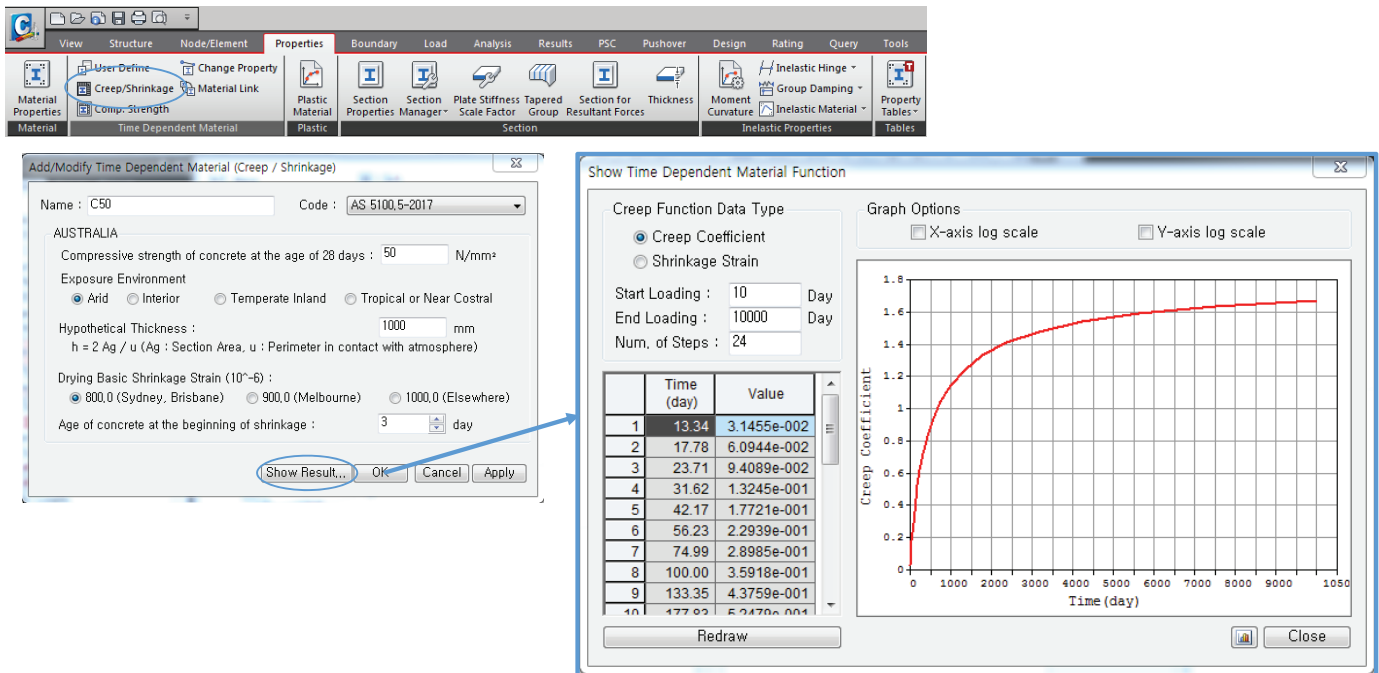


MIDASIT

Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

- Construction Stage : Creep Primary(CS) / Creep Secondary(CS) / Shrinkage Primary(CS) / Shrinkage Secondary(CS)

Creep/Shrinkage function with construction stage analysis generates primary and secondary load cases for both creep and shrinkage. Automatic load combination includes secondary load cases.

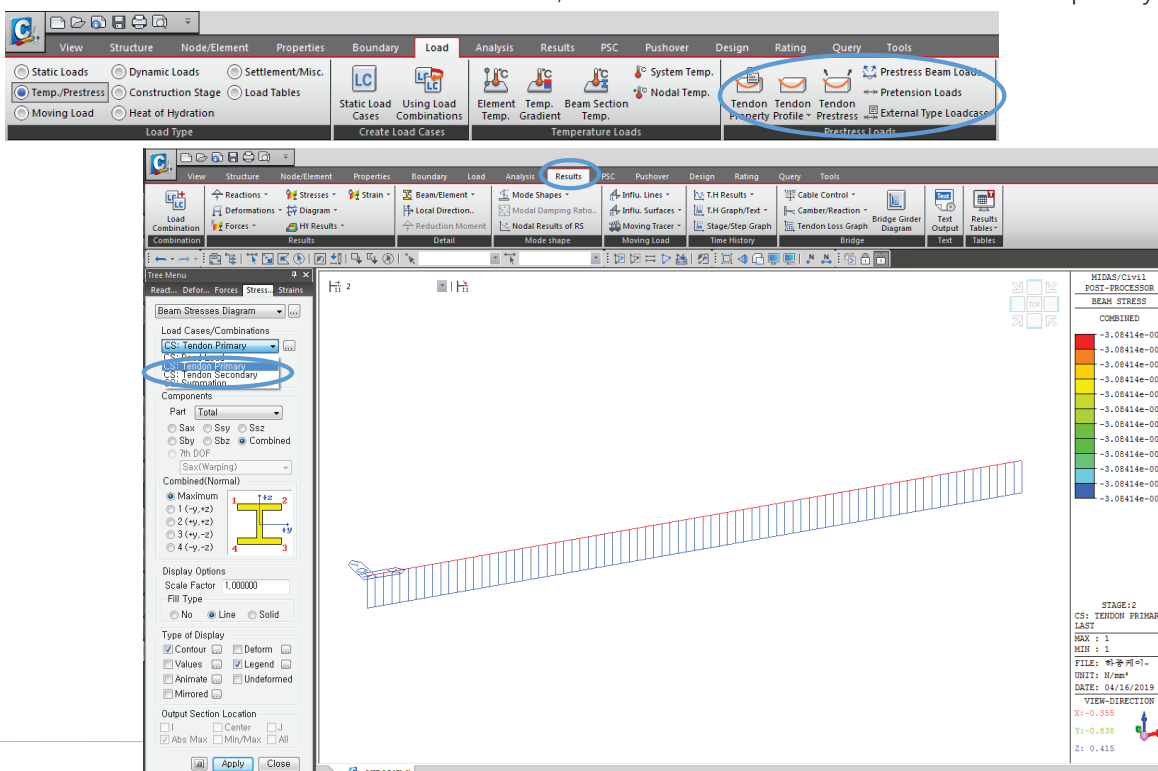


MIDASIT

Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

- Construction Stage : Tendon Primary(CS) / Tendon Secondary(CS)

Prestress load function with construction stage analysis generates primary and secondary load cases and both load cases are included in the automatic load combination. Also, each load cases are shown under the results separately.



MIDASIT

The following Load Cases are automatically generated when construction stage analysis is completed.

Load Case	Results	Description
1. CS: Dead Load		Results due to all loadings excluding Erection Load and the effects of Creep, Shrinkage and Tendon Prestress
2. CS: Erection Load		Results due to dead loads, which are separated from CS: Dead Load, defined in Construction Stage Analysis Control Data dialog
3. CS : Tendon Primary	Reaction	
	Deformation	Deformation resulting from tendon prestress
	Force	Member forces resulting from tendon prestress
4. CS: Tendon Secondary	Reaction	Reactions caused by Tendon Prestress in an indeterminate structure.
	Force	Member forces caused by Tendon Prestress in an indeterminate structure.
5. CS: Creep Primary	Reaction	
	Deformation	Deformation due to imaginary forces required to cause creep stain
	Force	Imaginary forces required to cause creep stain
6. CS: Creep Secondary	Reaction	Reactions caused by creep in an indeterminate structure
	Force	Member forces caused by creep in an indeterminate structure
7. CS: Shrinkage Primary	Reaction	
	Deformation	Deformation due to imaginary forces required to cause shrinkage stain
	Force	Imaginary forces required to cause shrinkage stain
8. CS: Shrinkage Secondary	Reaction	Reactions caused by shrinkage in an indeterminate structure
	Force	Member forces caused by shrinkage in an indeterminate structure
CS: Summation	Reaction	1+2+4+6+8
	Deformation	1+2+3+5+7
	Force(Stress)	1+2(+3)+4+6+8

- Tendon Primary (CS) vs. Secondary (CS)

Tendon Primary represents member forces caused by Tendon Prestress forces. Tendon Secondary represents member forces resulting from Tendon Prestress forces acting in an indeterminate structure. To check analysis results, Primary and Secondary can be regarded as internal forces and external forces respectively. For design, however, the program internally recalculates member forces due to Primary considering the translation of neutral axis so as to use them as internal forces, and member forces due to Secondary are used as external forces.

