midas Civil Training

DESIGN THE FUTURE WITH MIDAS

Super-T Bridge

Hands on Training

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Prestressed Composite Girder Bridge Analysis & Design

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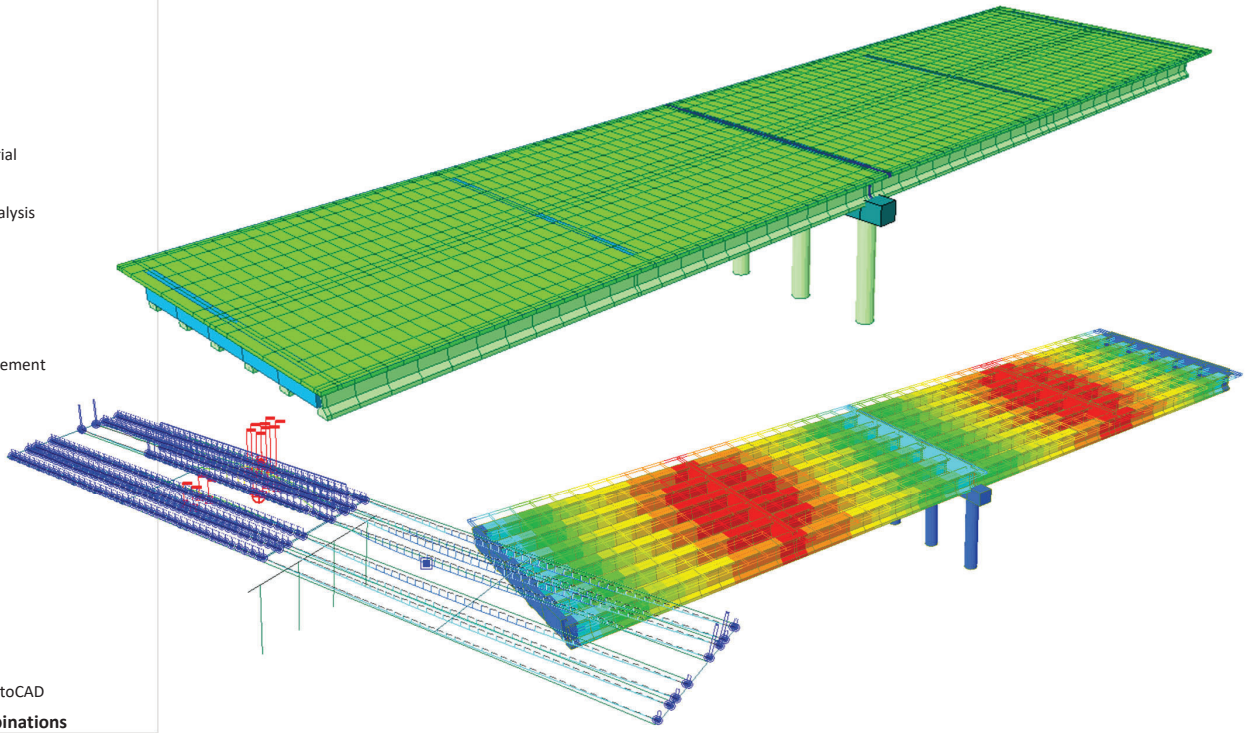
Prestressed Composite Girder Bridge Analysis & Design



Overview

Overview

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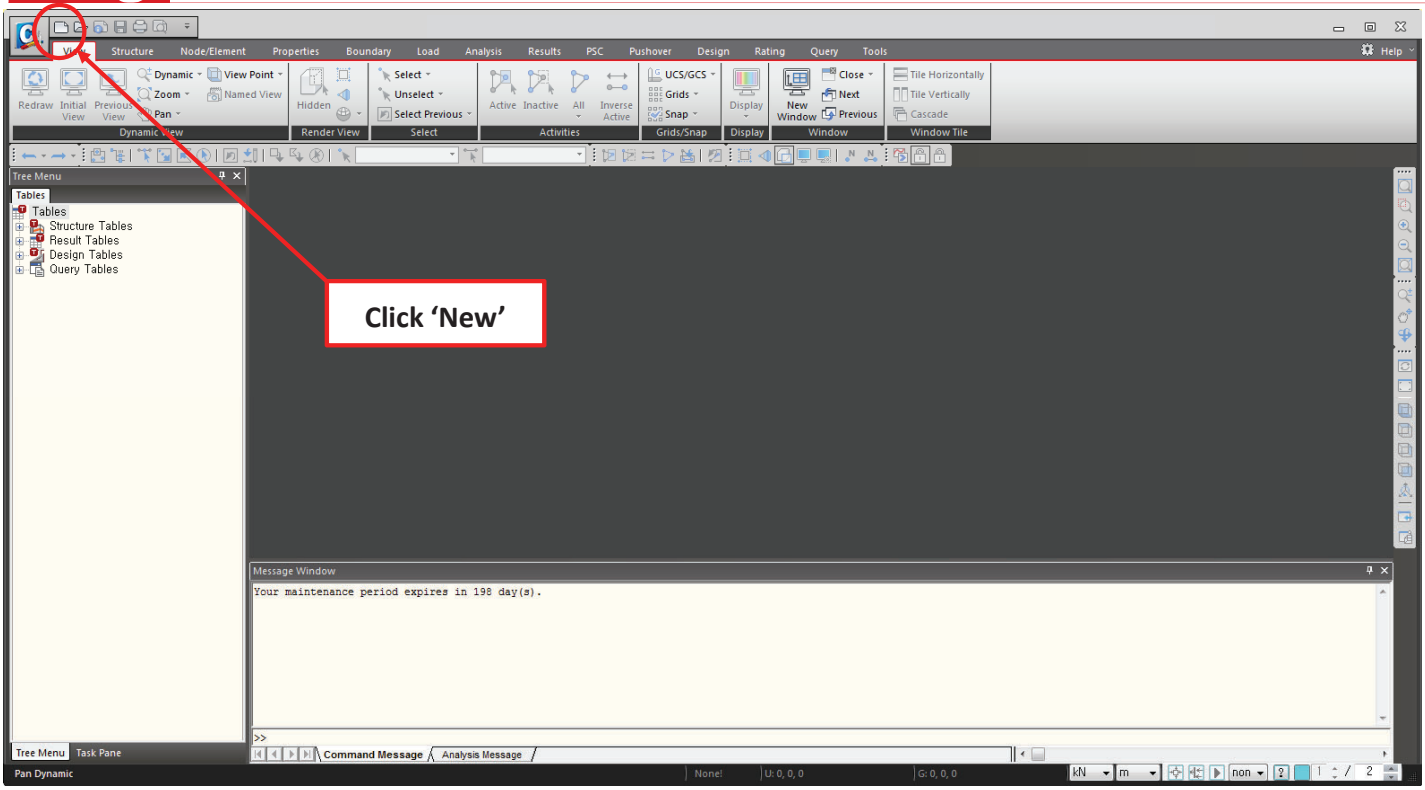
Step 1. Properties

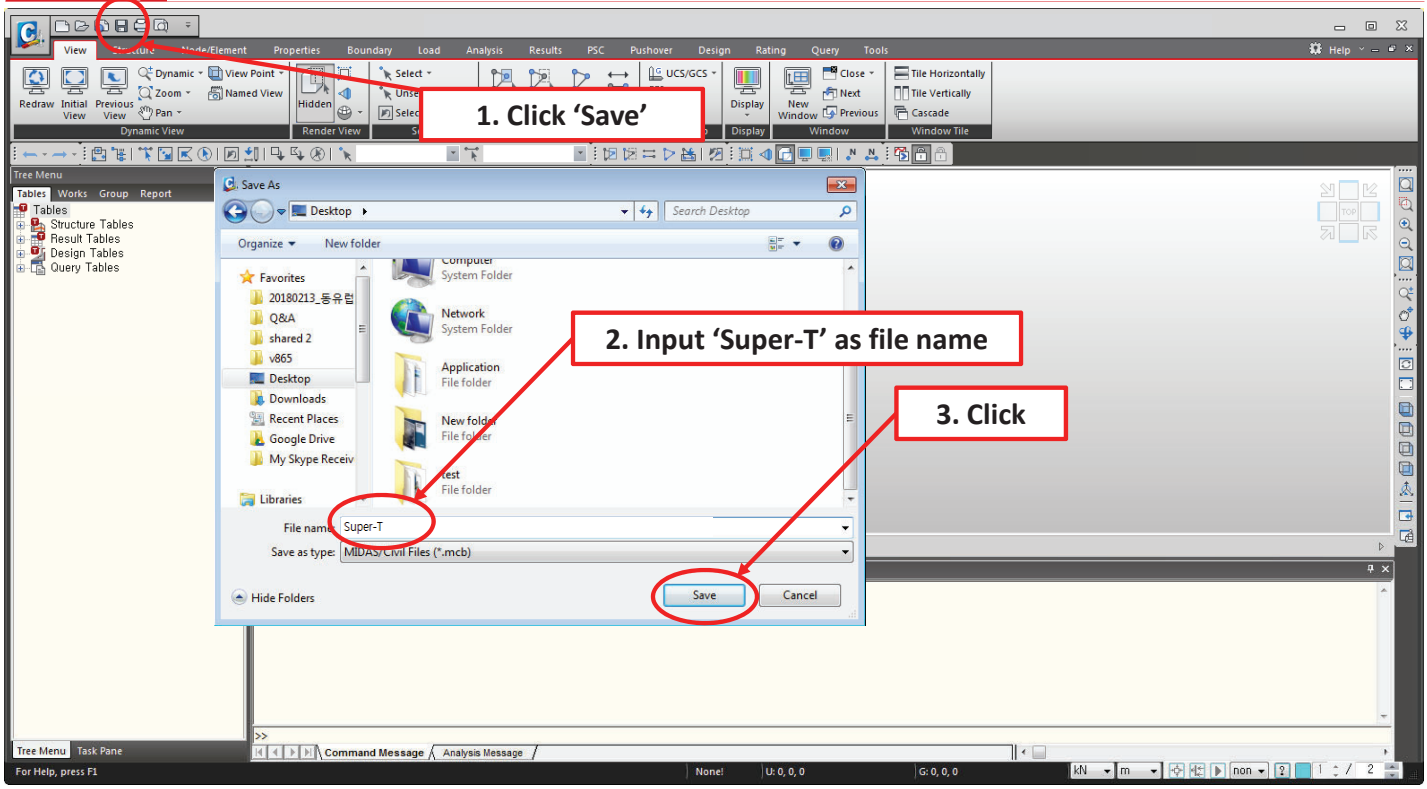
3 Start



Procedure

Create a new project file.

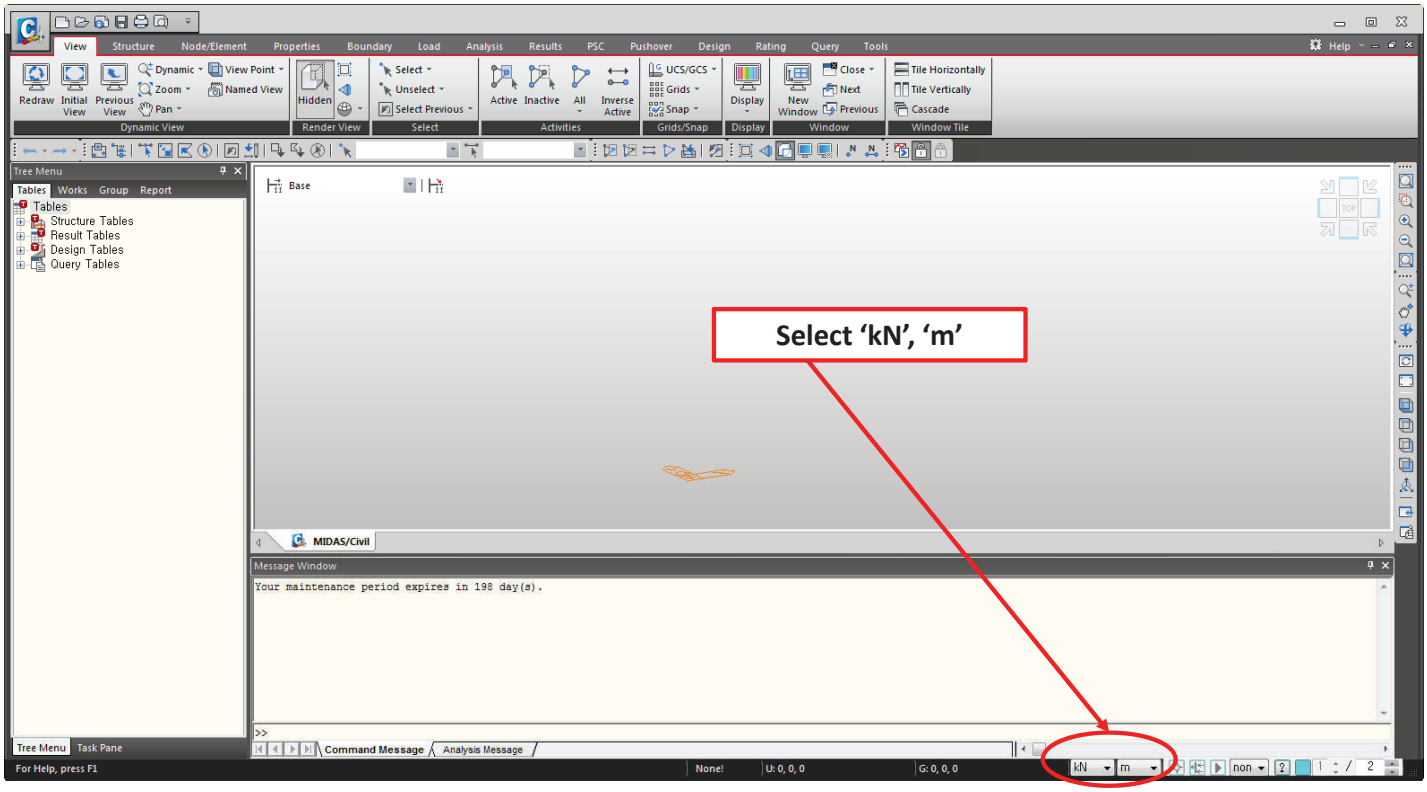
4 Start



Procedure

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

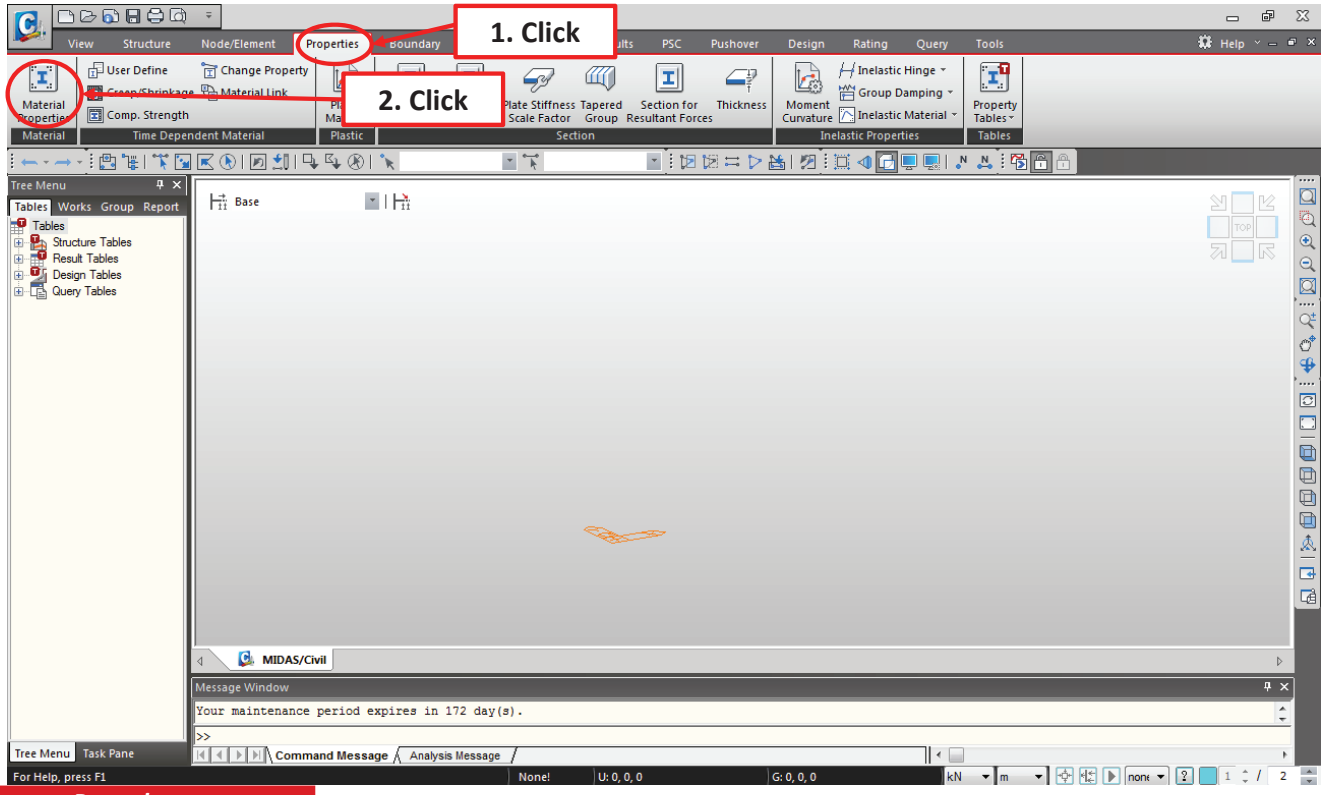
5 Start



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.

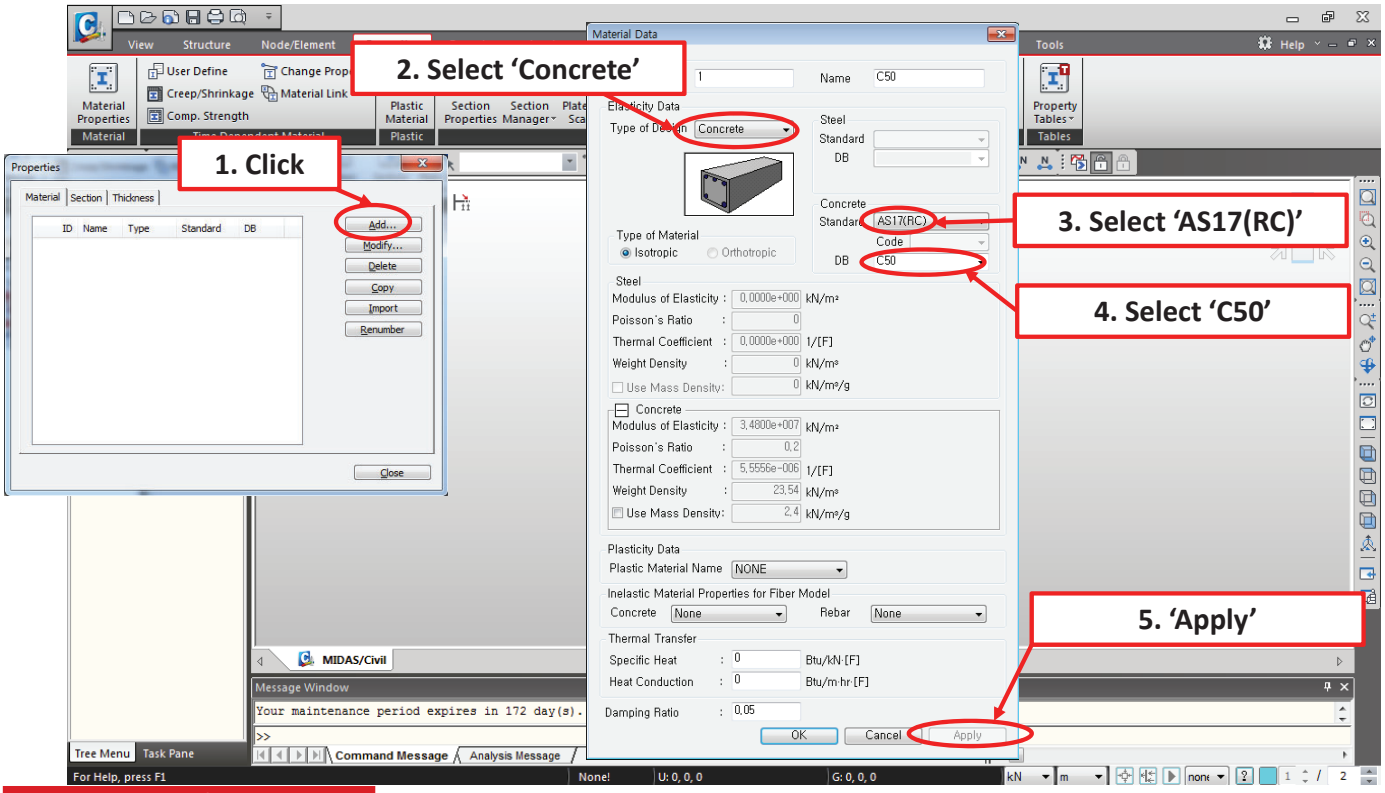
6 Material / Section



Procedure

Define material

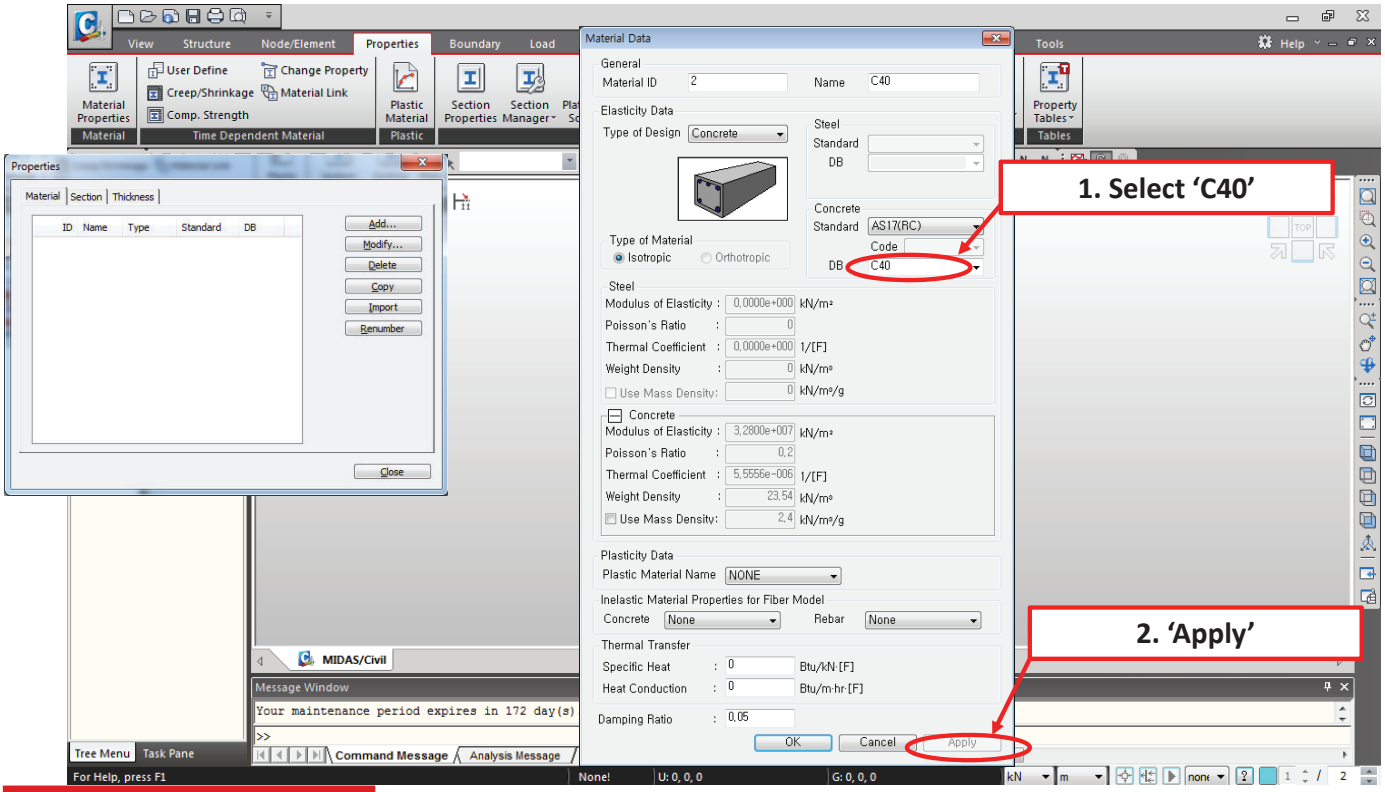
7 Material / Section



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.

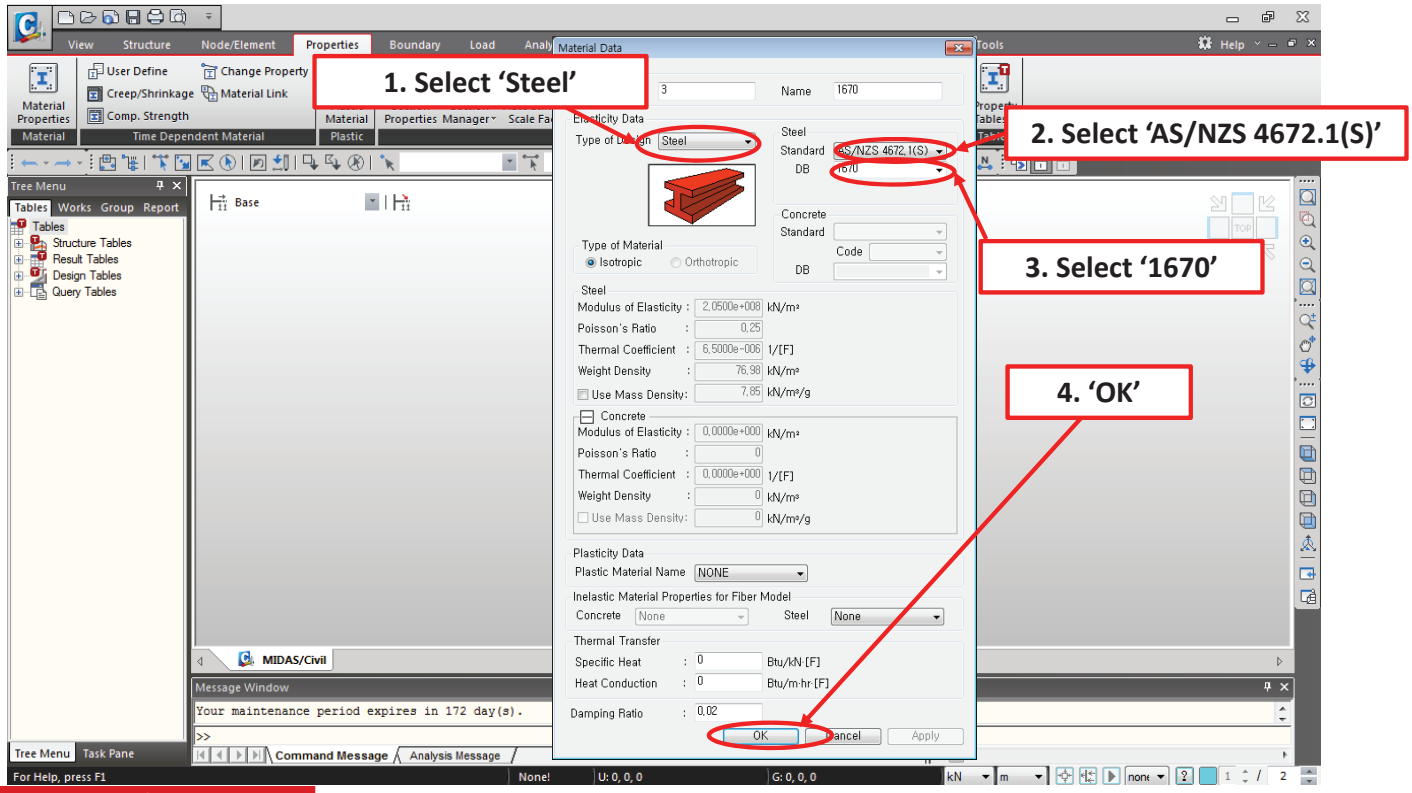
8 Material / Section



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.

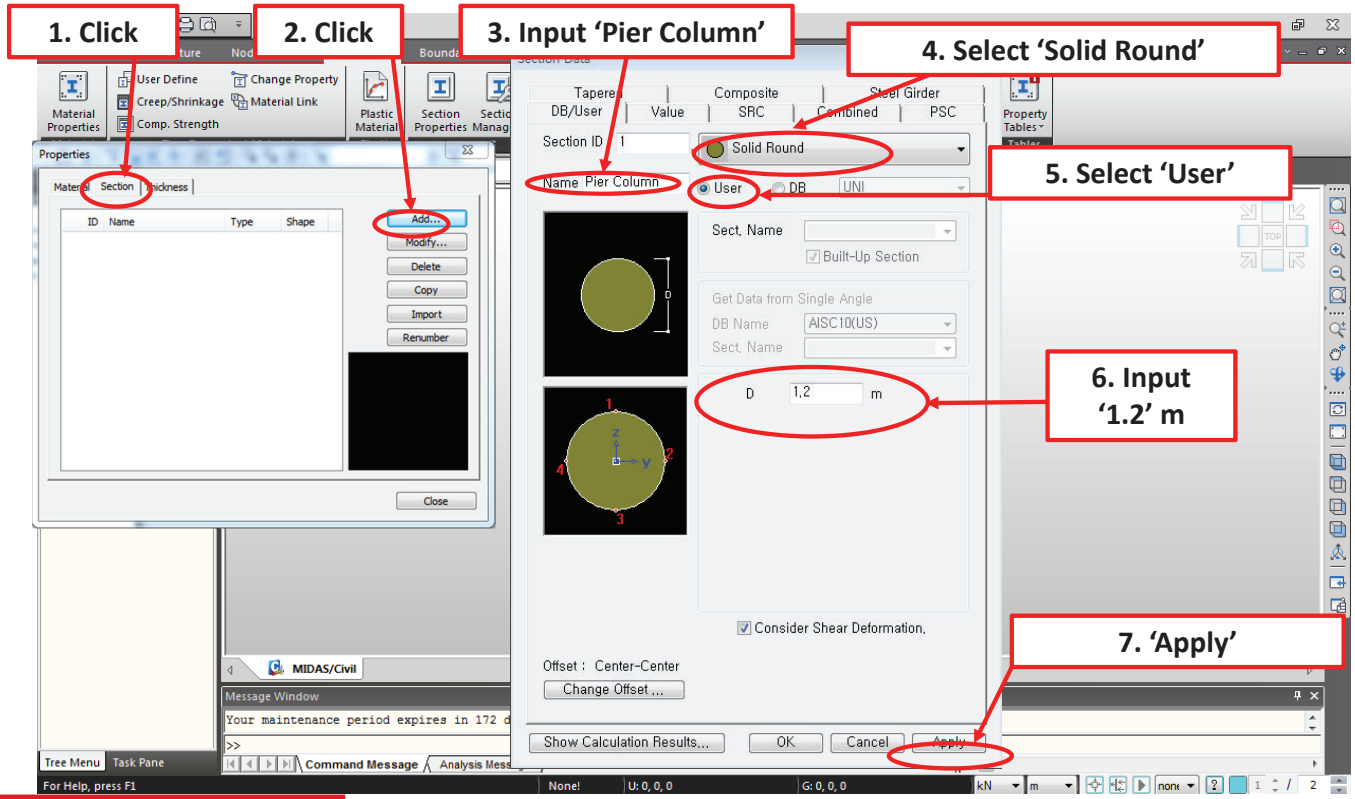
9 Material / Section



Procedure

Define material for the tendon

10 Material / Section

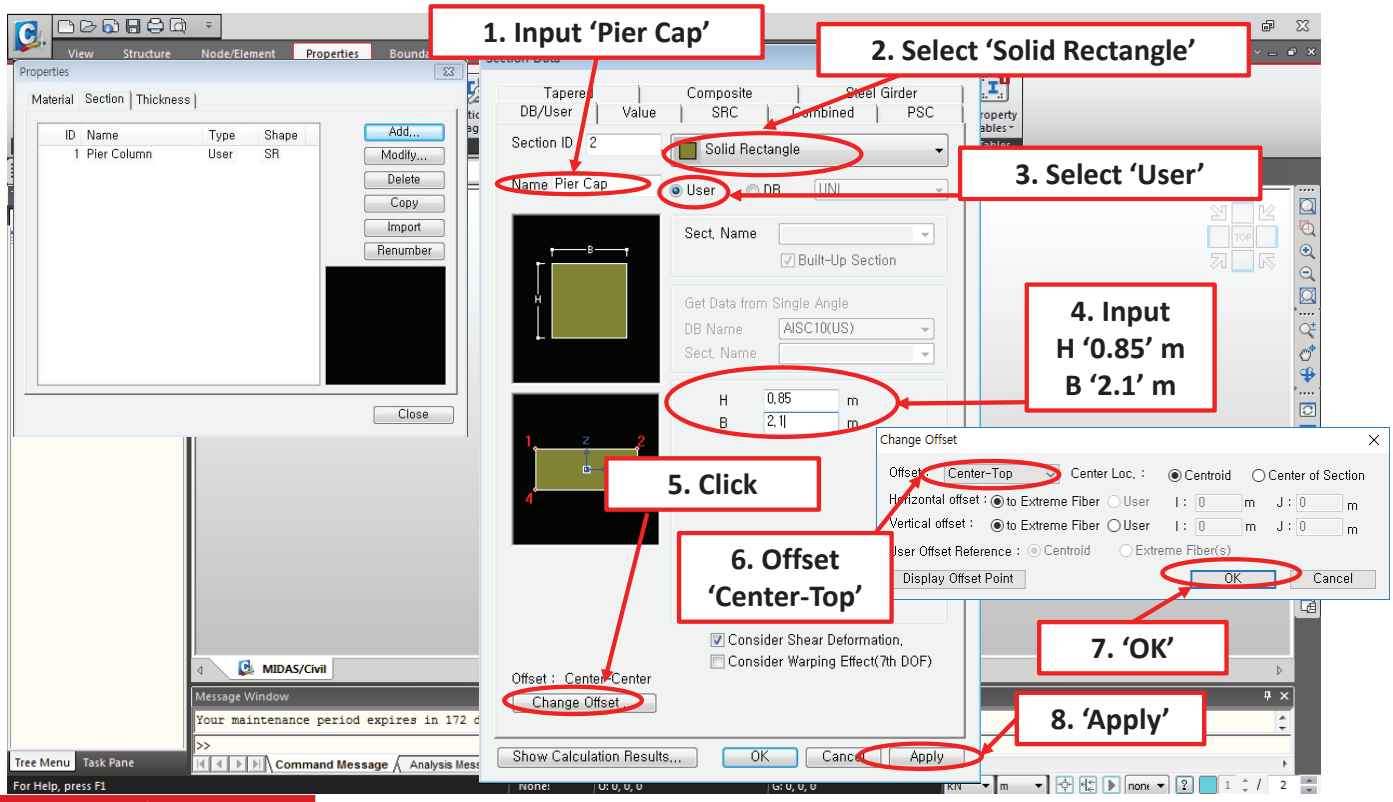


Procedure

Define section for pier.

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

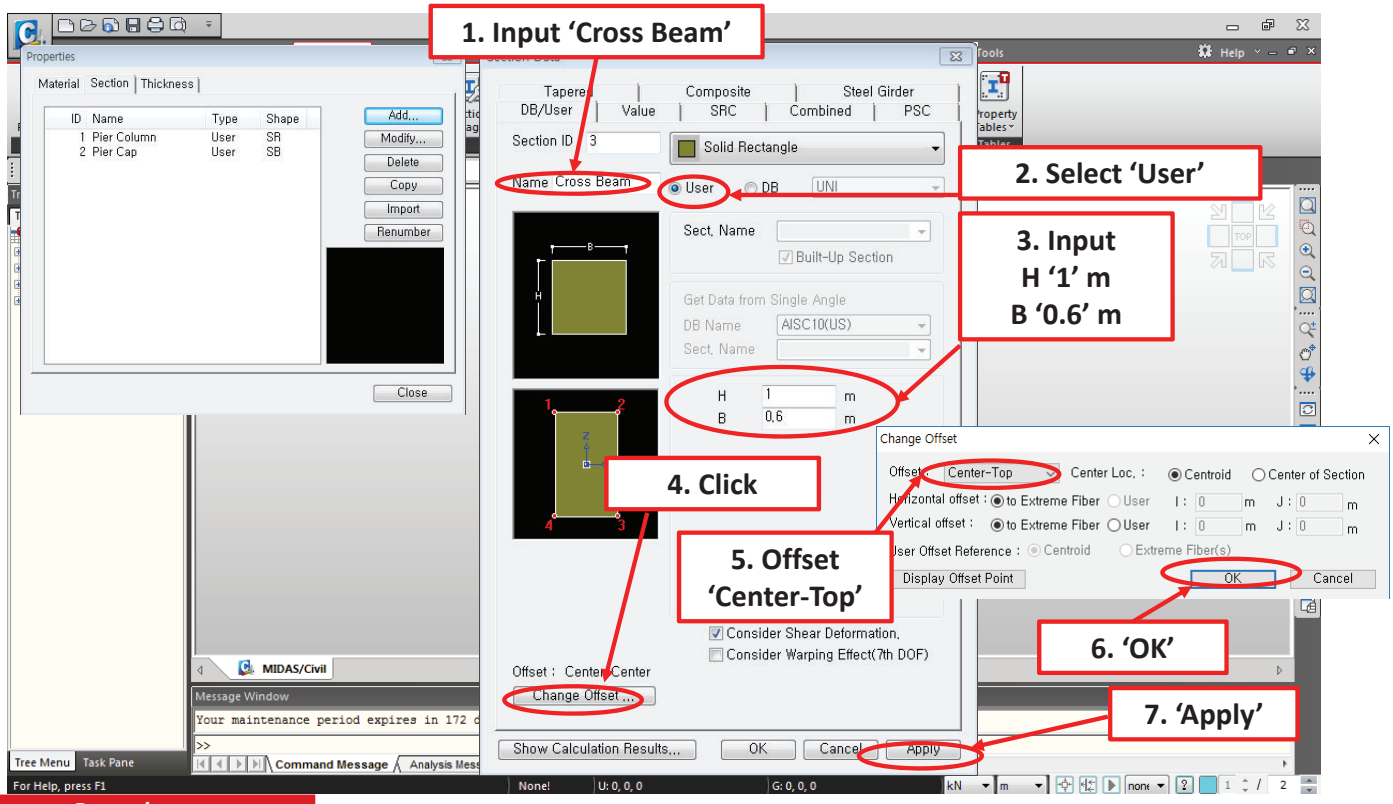
11 Material / Section



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.

12 Material / Section



Procedure

Define section for cross beam

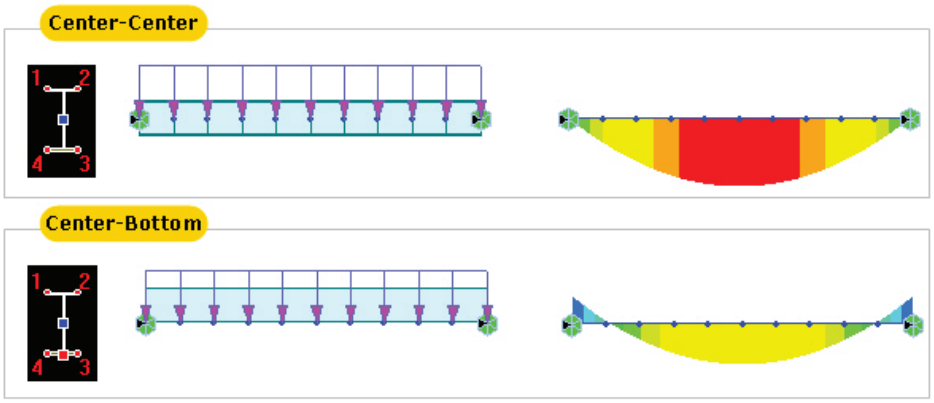
Offset: Specify the section Offset from the location options.

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.

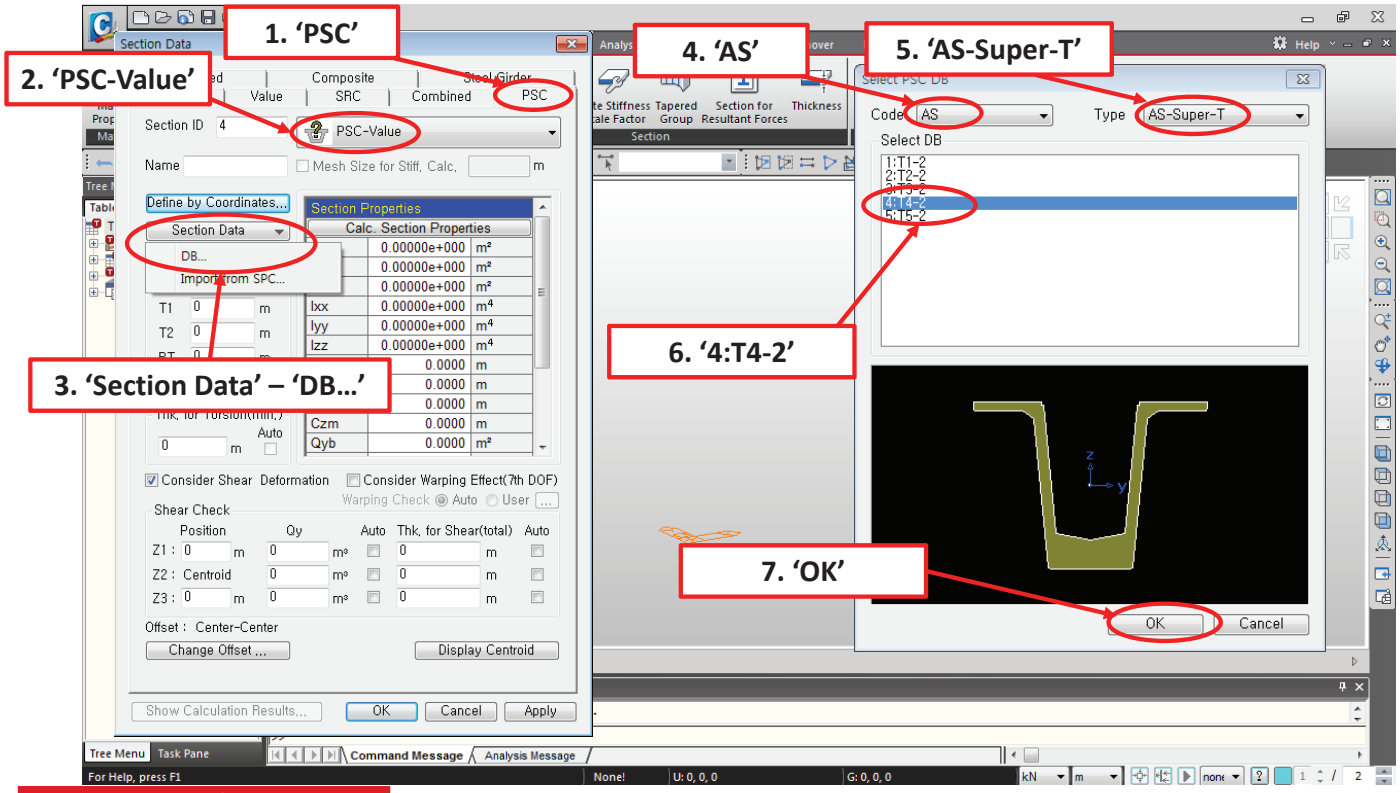
Note 2
Node-based loads such as Nodal Loads and Specified Displacements are always applied at the nodes. However, element-based loads such as Beam Loads and Temperature Loads are applied on the center line of the element section. Please find the difference in the following example.



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"

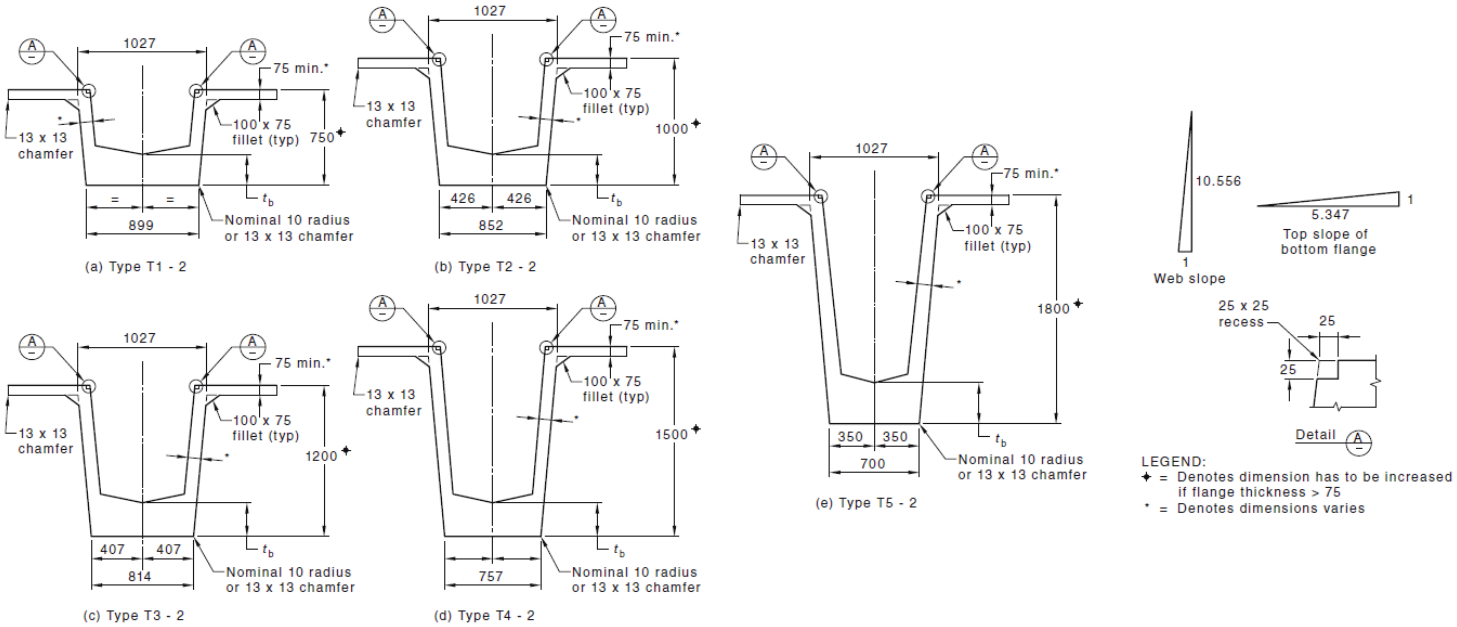
15 Material / Section



Procedure

Define section for the girder

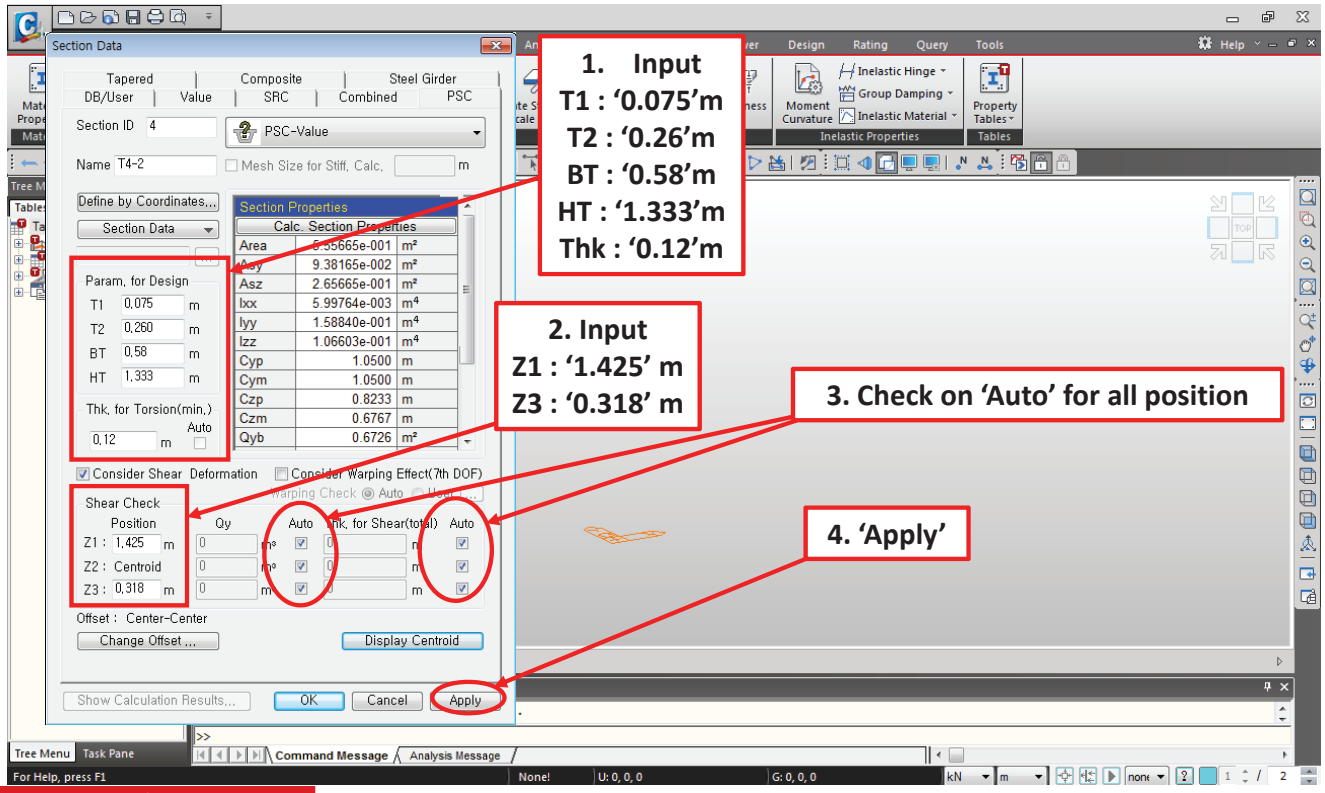
16 Material / Section



Procedure

Super-T section from AS5100.5 2017

17 Material / Section



Procedure

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

18 Material / Section

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

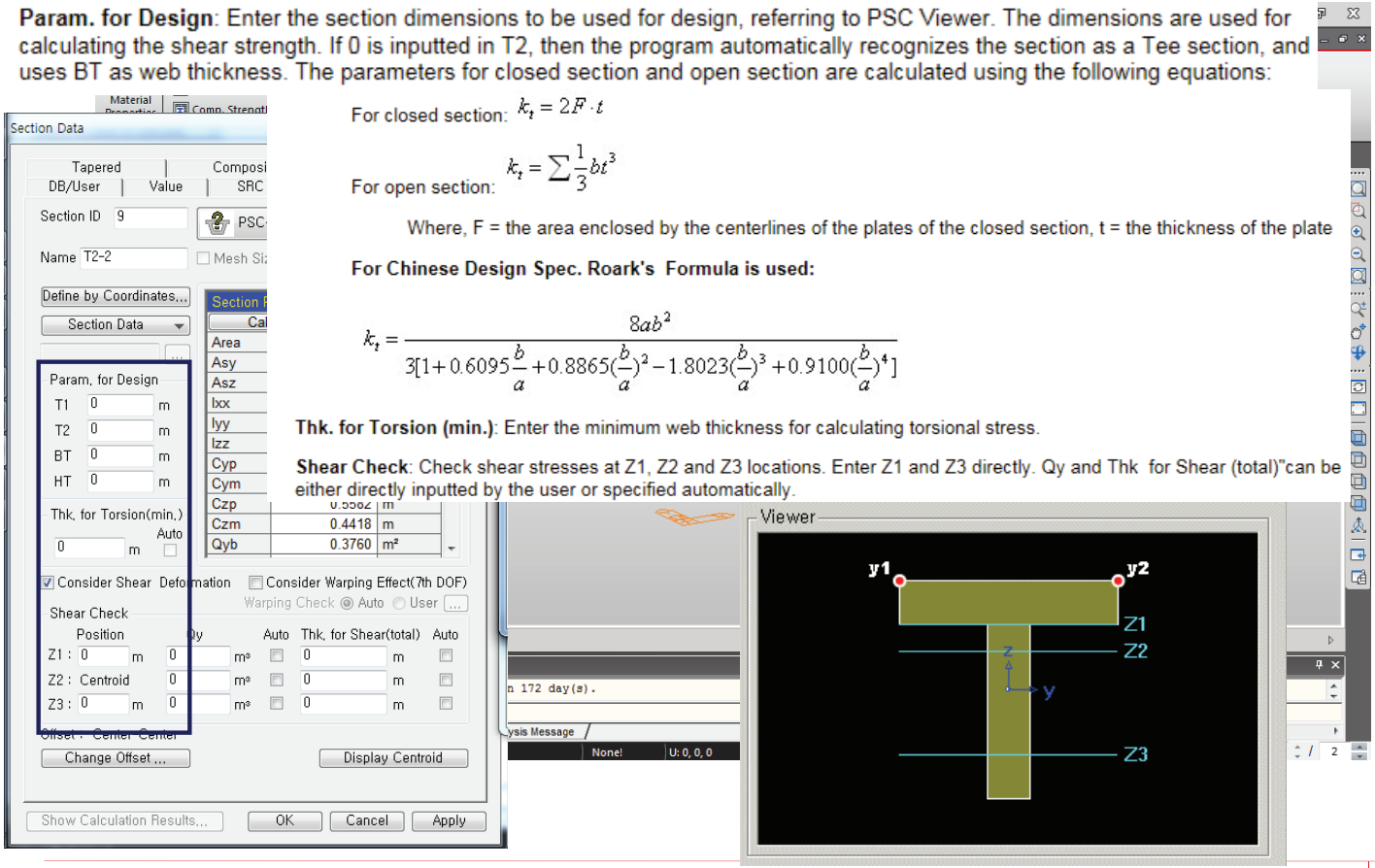
Where, F = the area enclosed by the centerlines of the plates of the closed section, t = the thickness of the plate

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

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

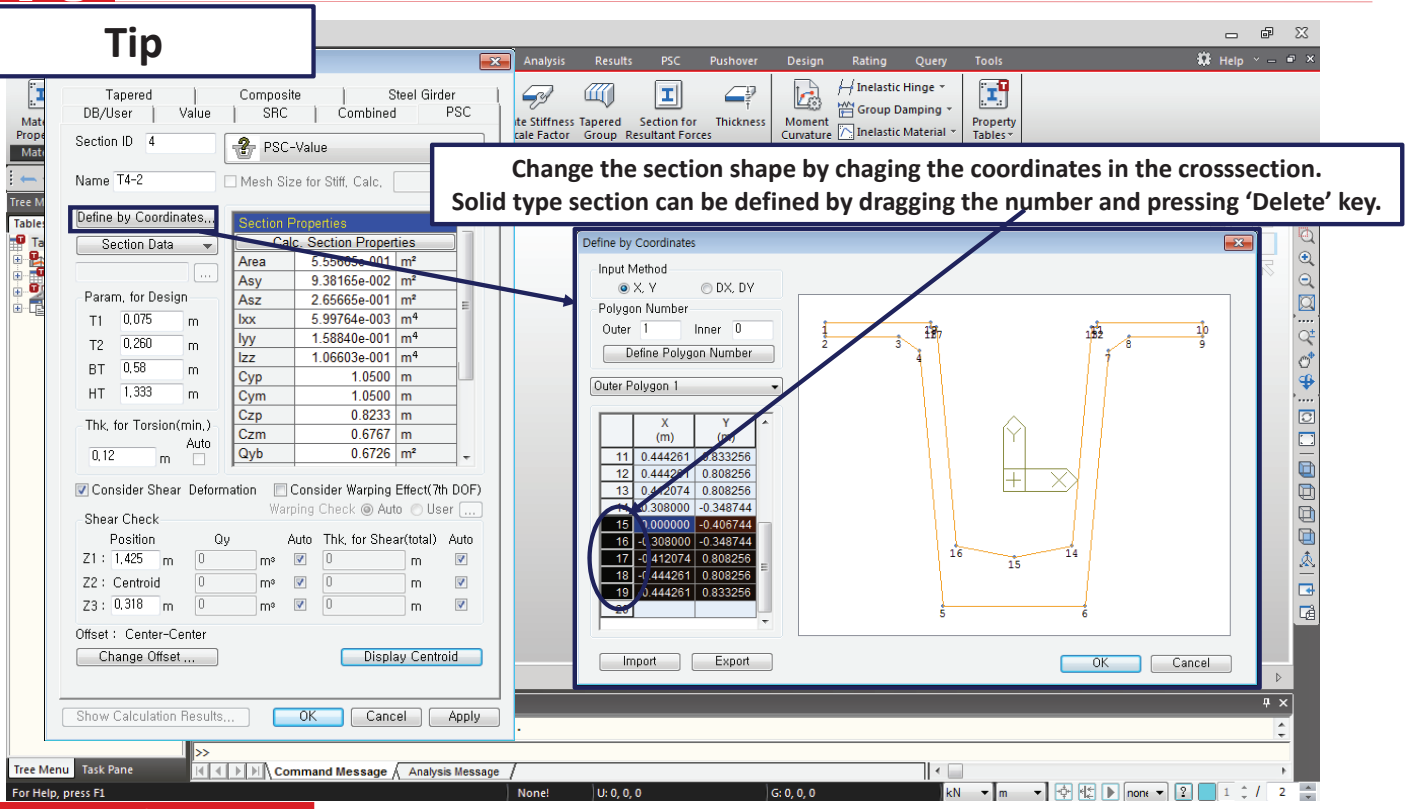
Thk. for Torsion (min.): Enter the minimum web thickness for calculating torsional stress.

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.



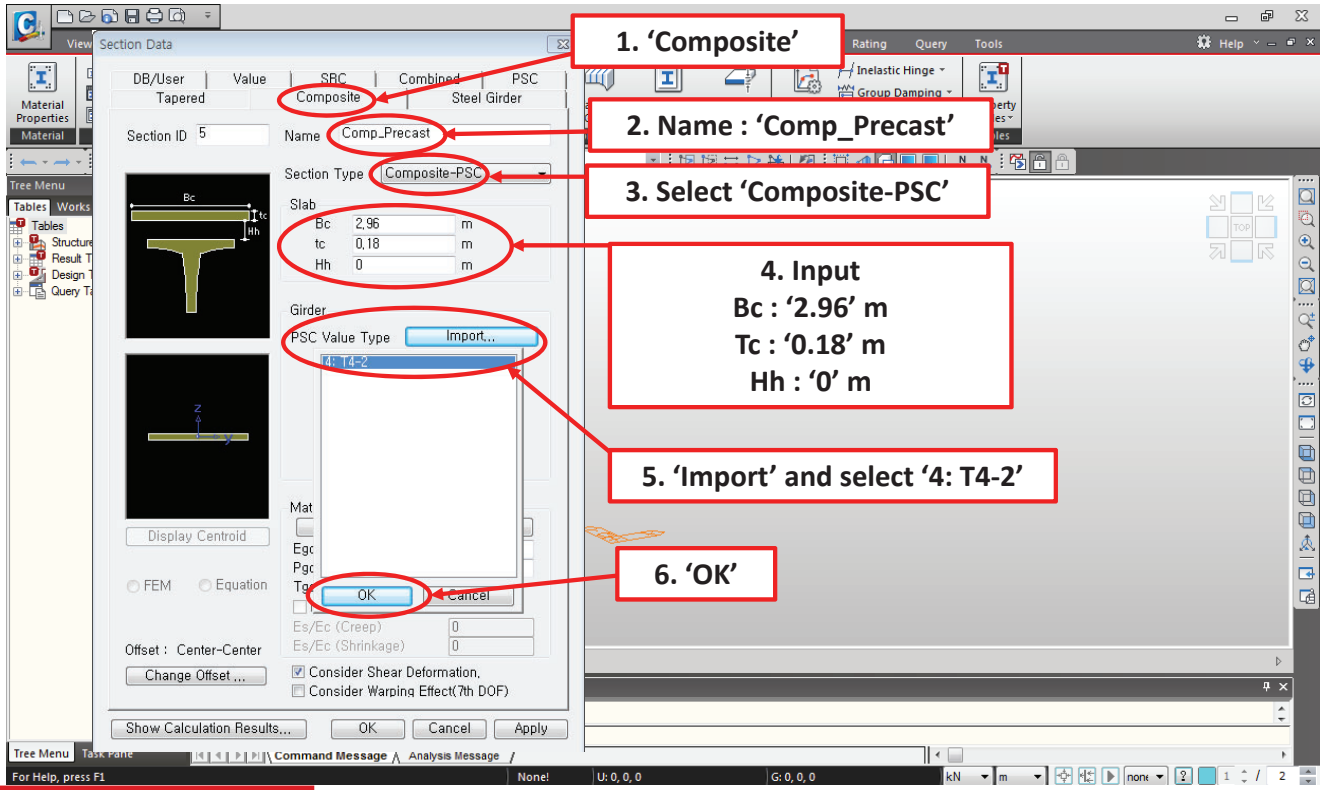
19 Material / Section

Tip



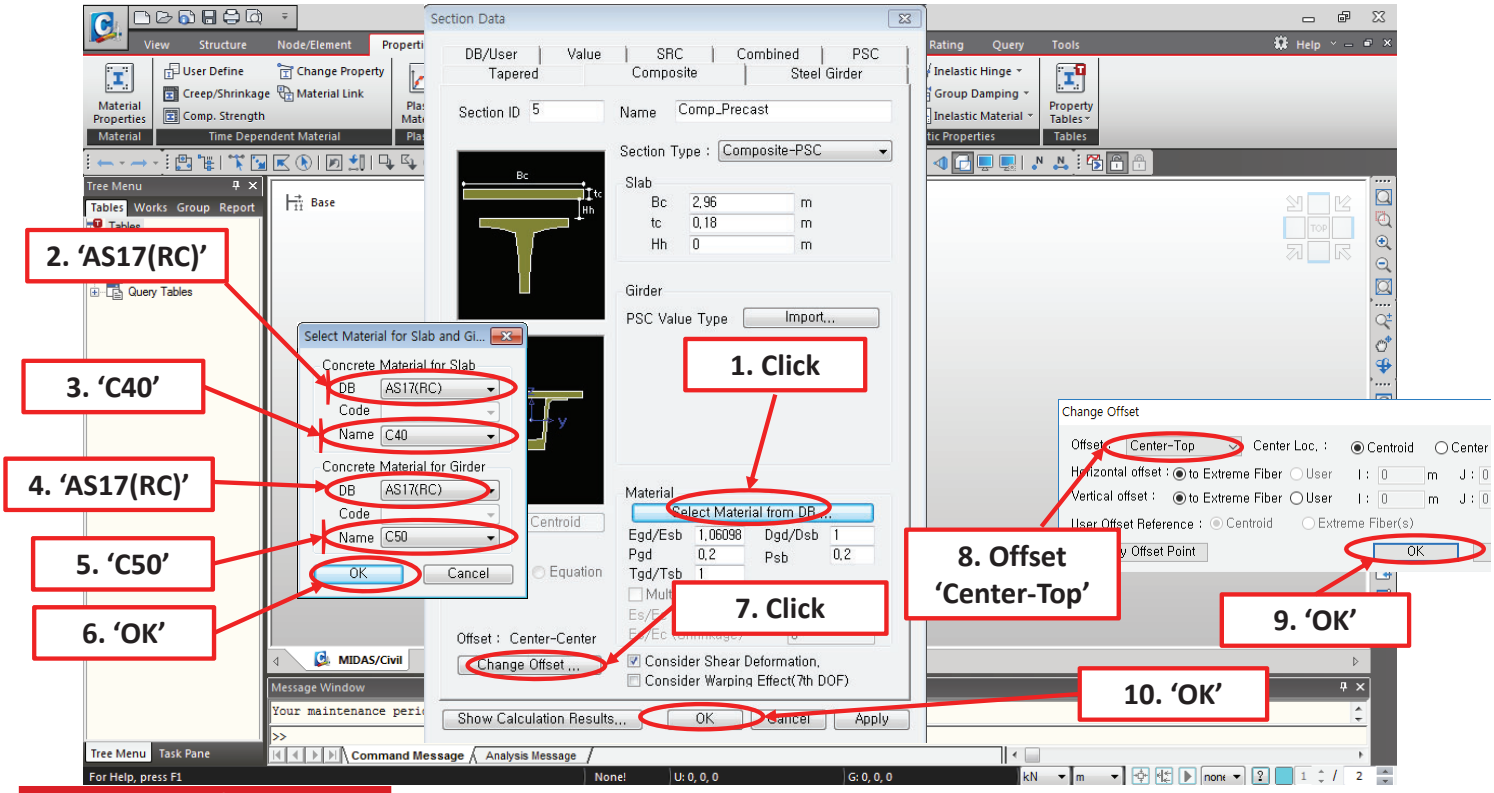
Procedure

20 Material / Section



Procedure

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



Procedure

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

Overview

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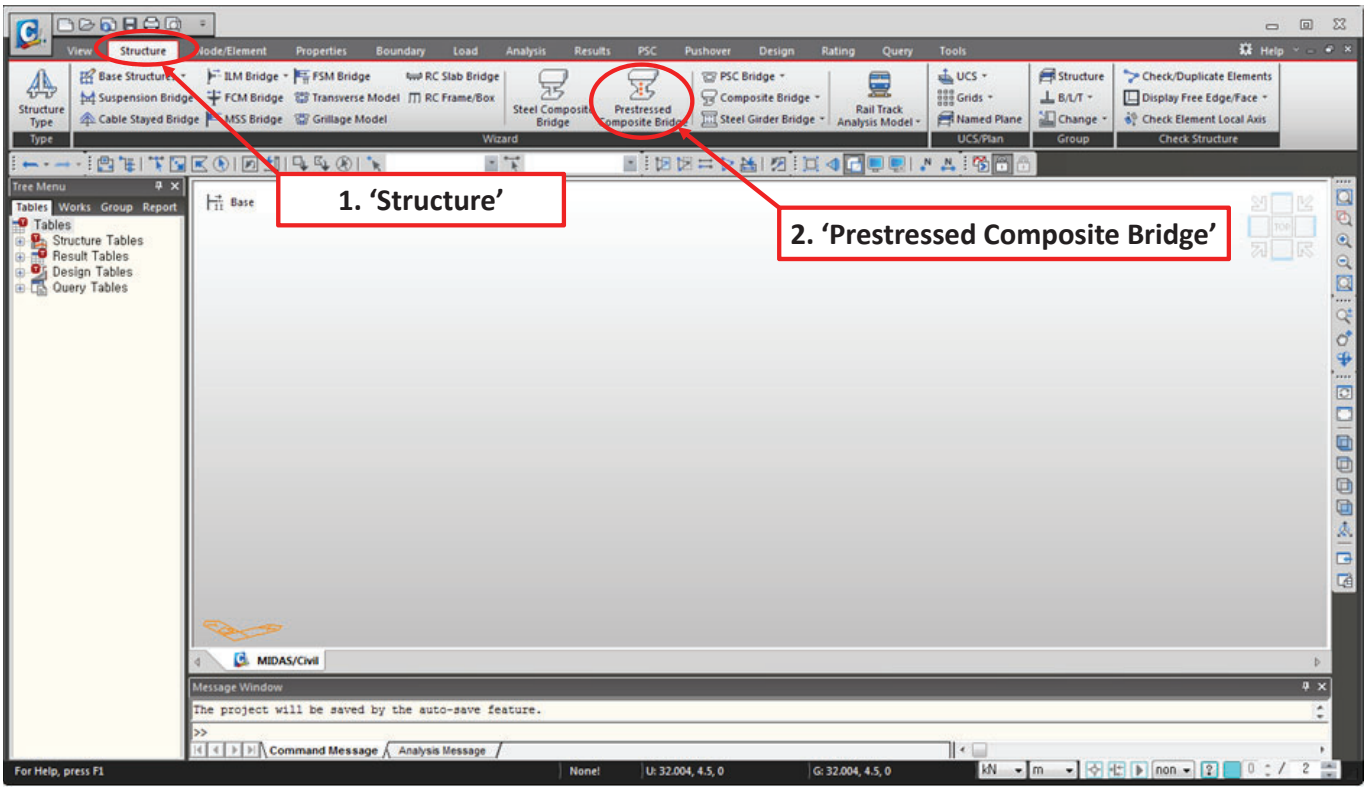
Step 2. Prestressed Composite Birdge Wizard

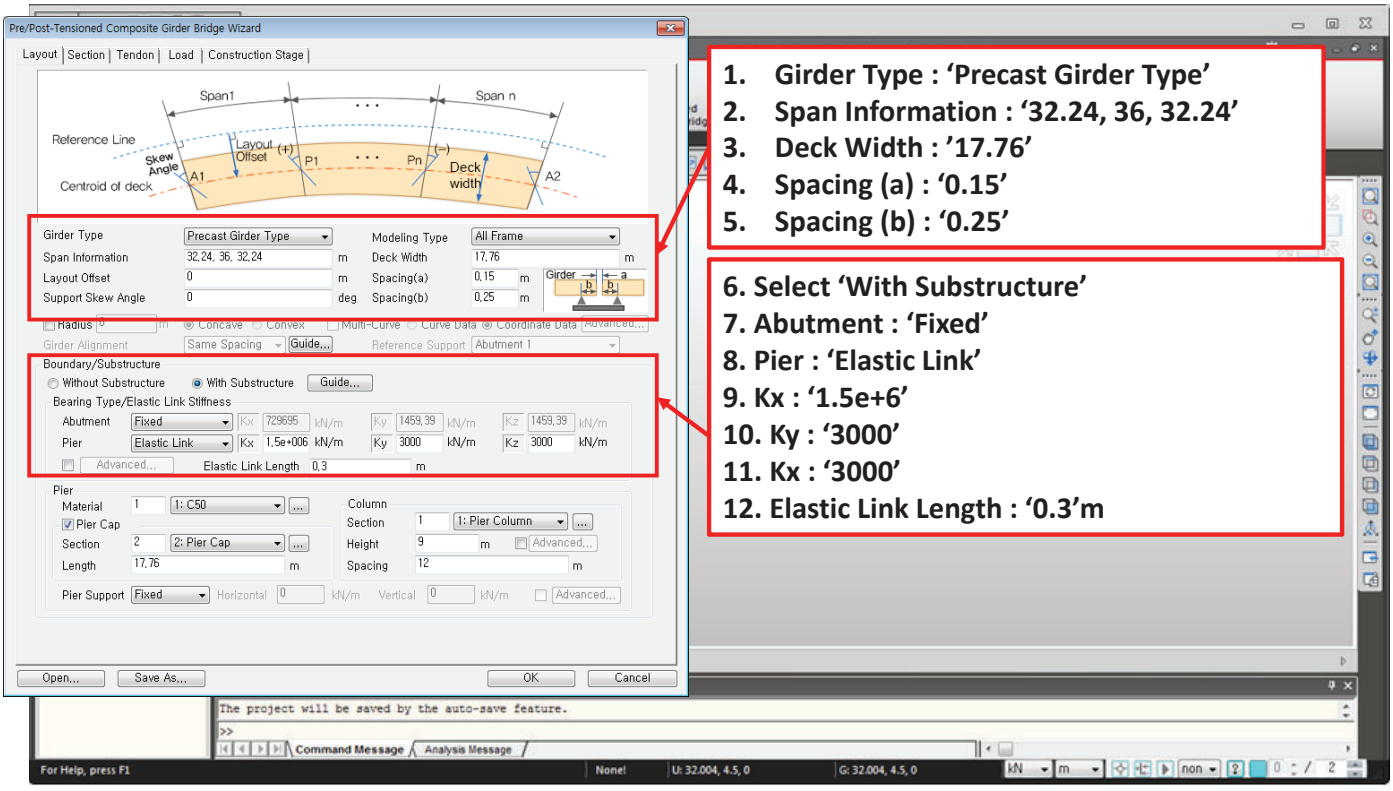
23 Prestressed Composite Bridge Wizard



Procedure

Execute Prestress Composite Bridge wizard.

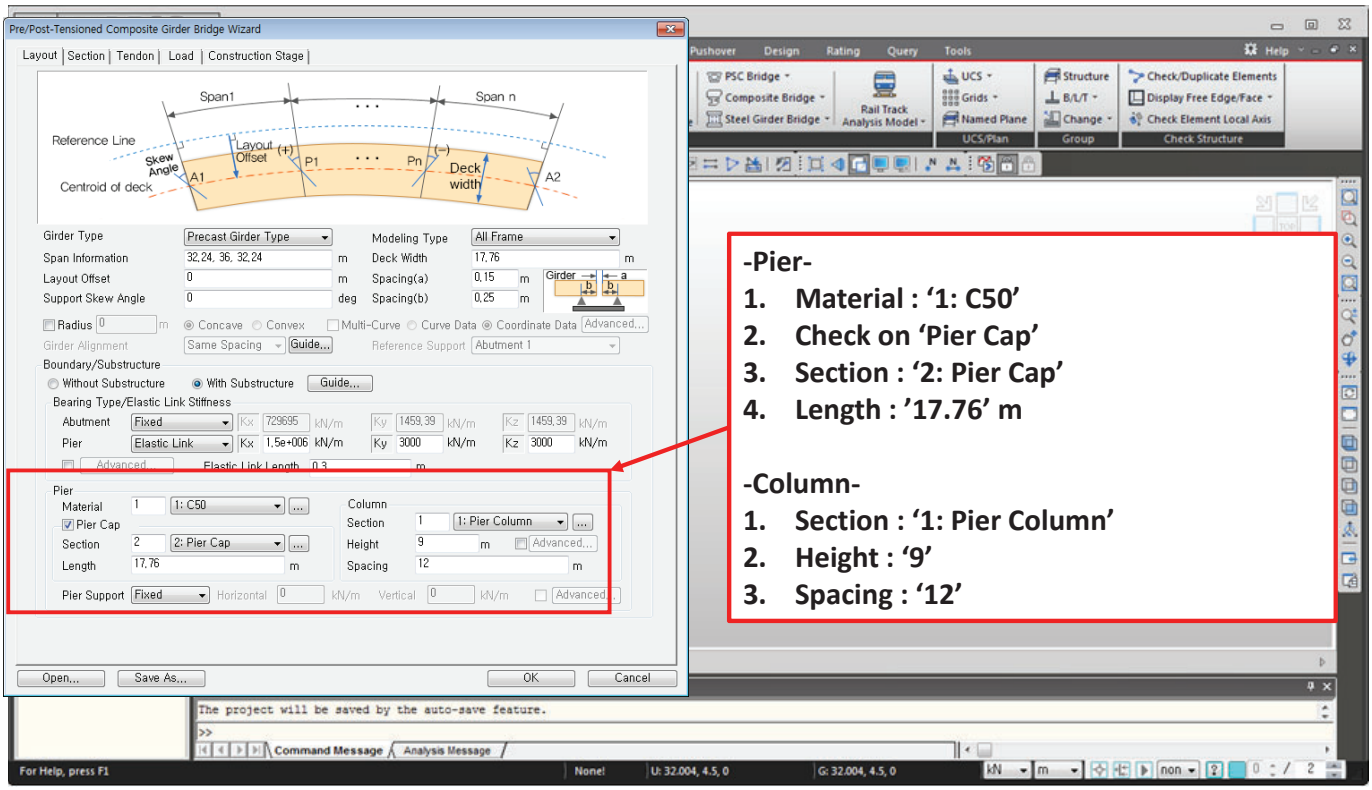
24 Prestressed Composite Bridge Wizard



Procedure

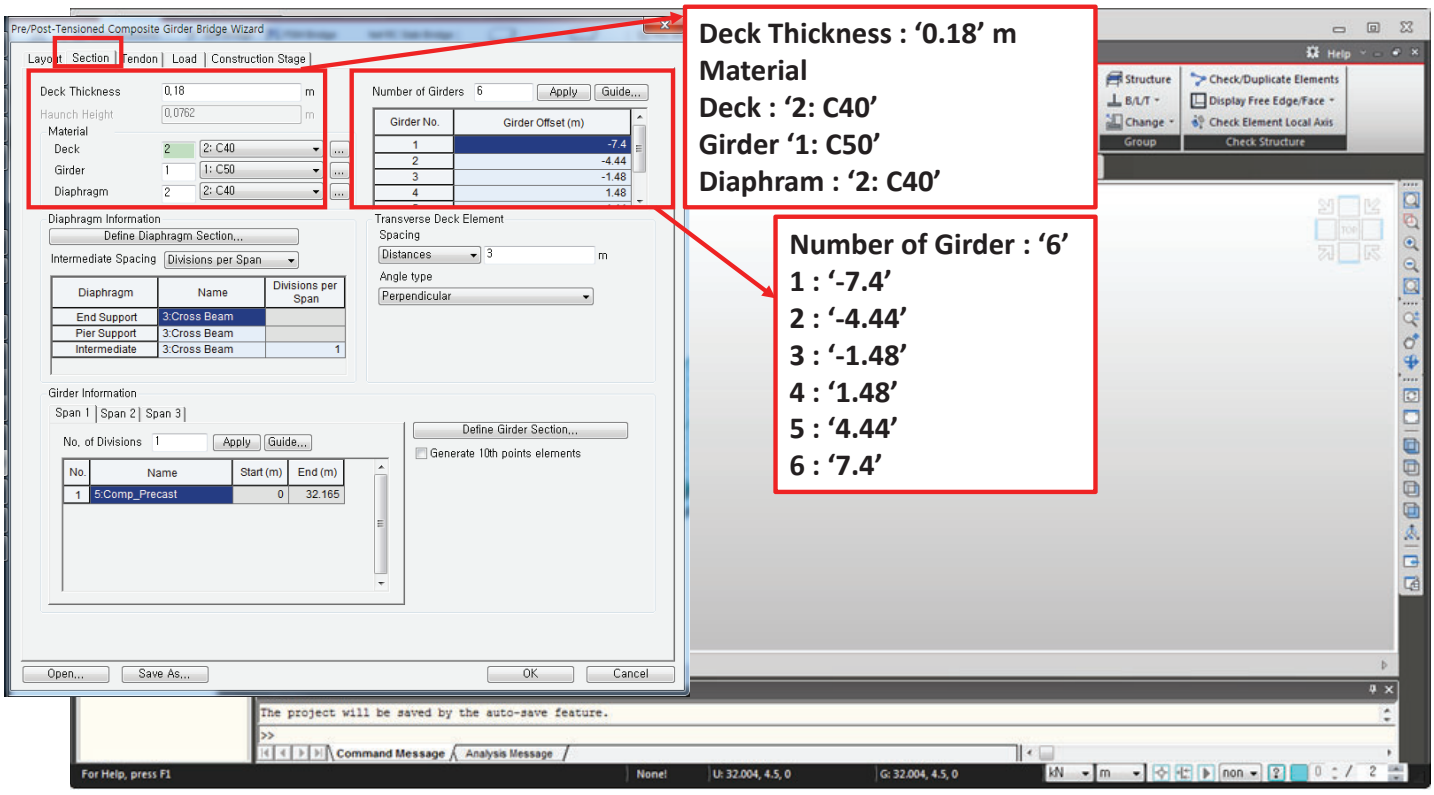
Shell(Plate) elements are generated for the slab if 'Modelling Type' is 'Deck as Plate, Girder as Frame'.
Kx is vertical direction, Ky is transverse direction and Kz is longituial direction for bearing stiffness.

25 Prestressed Composite Bridge Wizard



Procedure

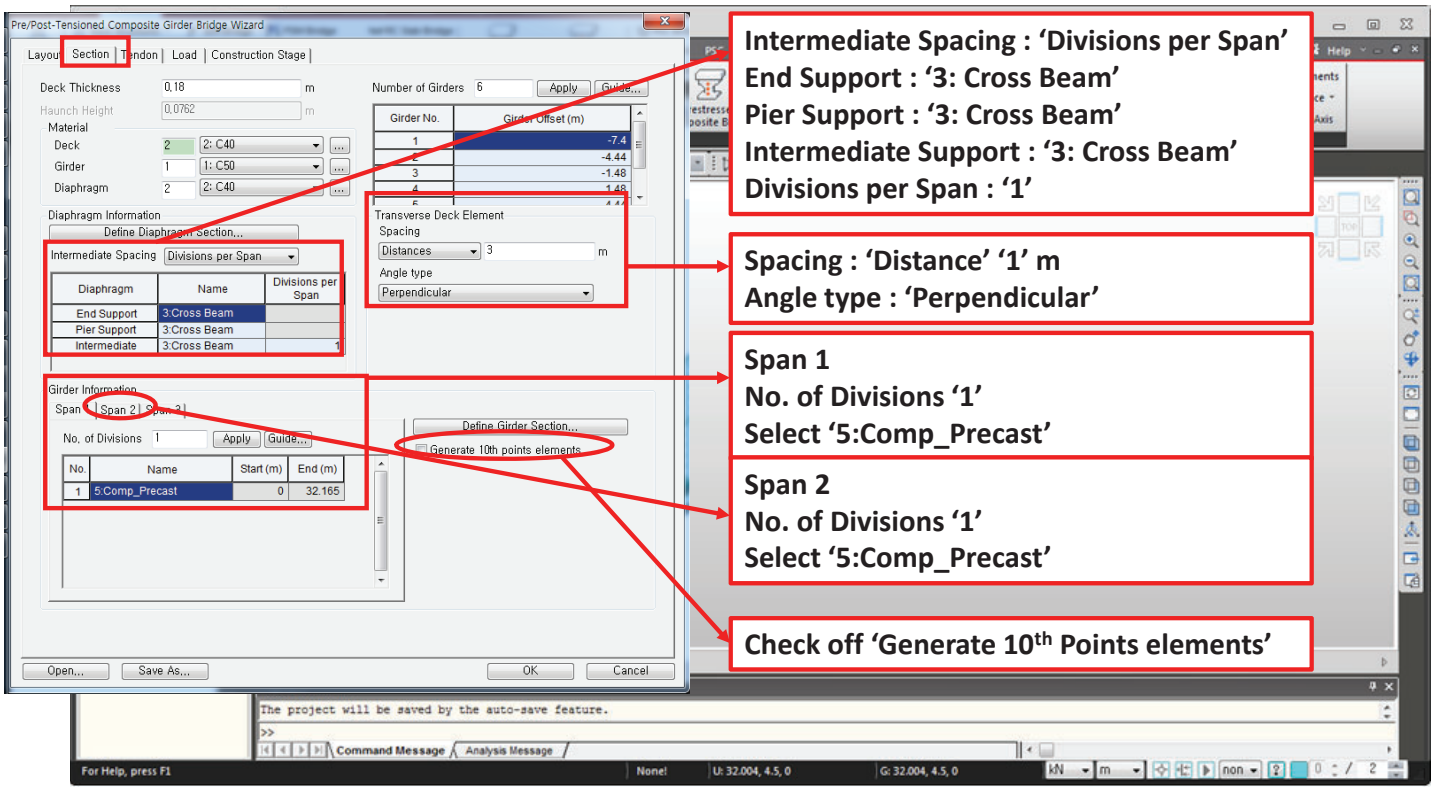
26 Prestressed Composite Bridge Wizard



Procedure

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

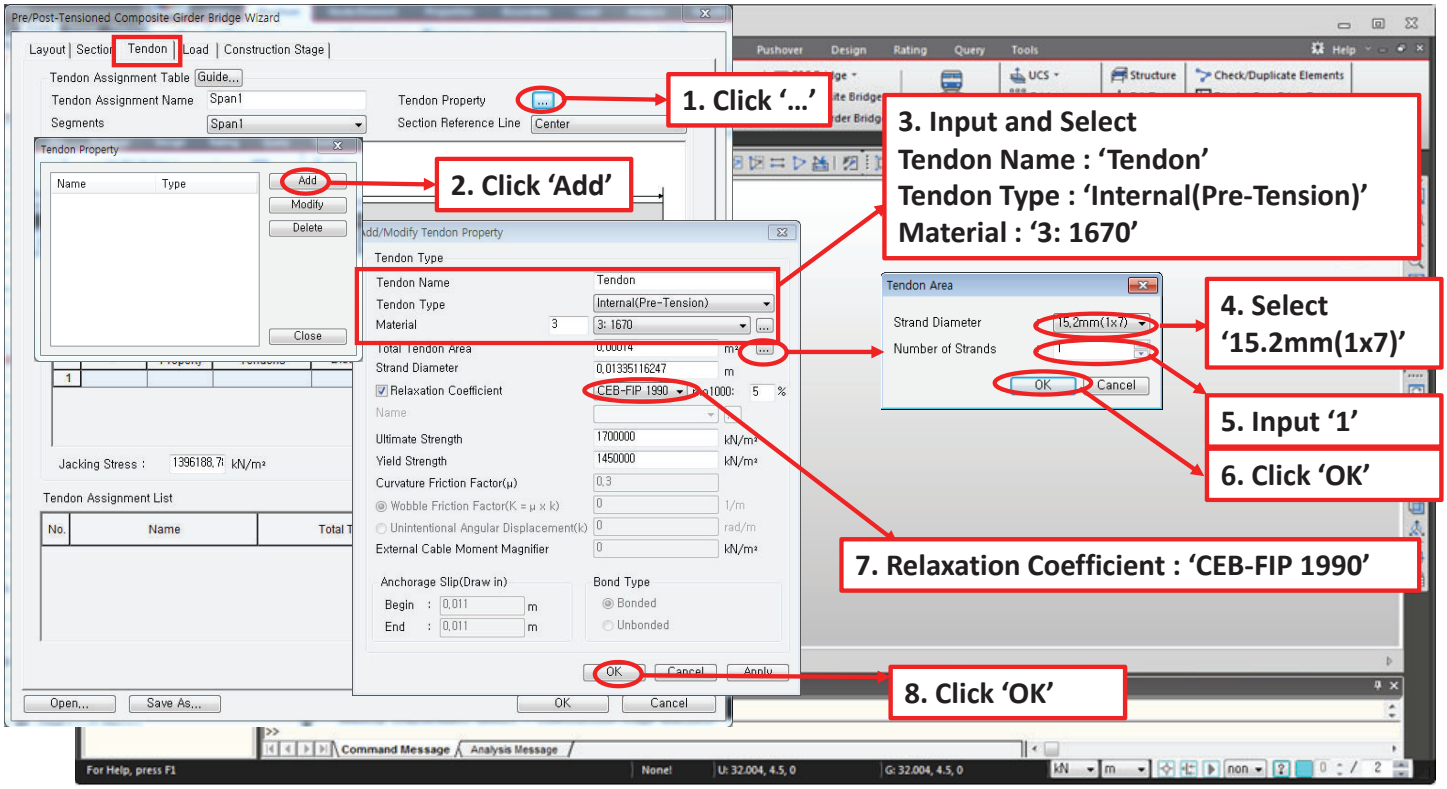
27 Prestressed Composite Bridge Wizard



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.

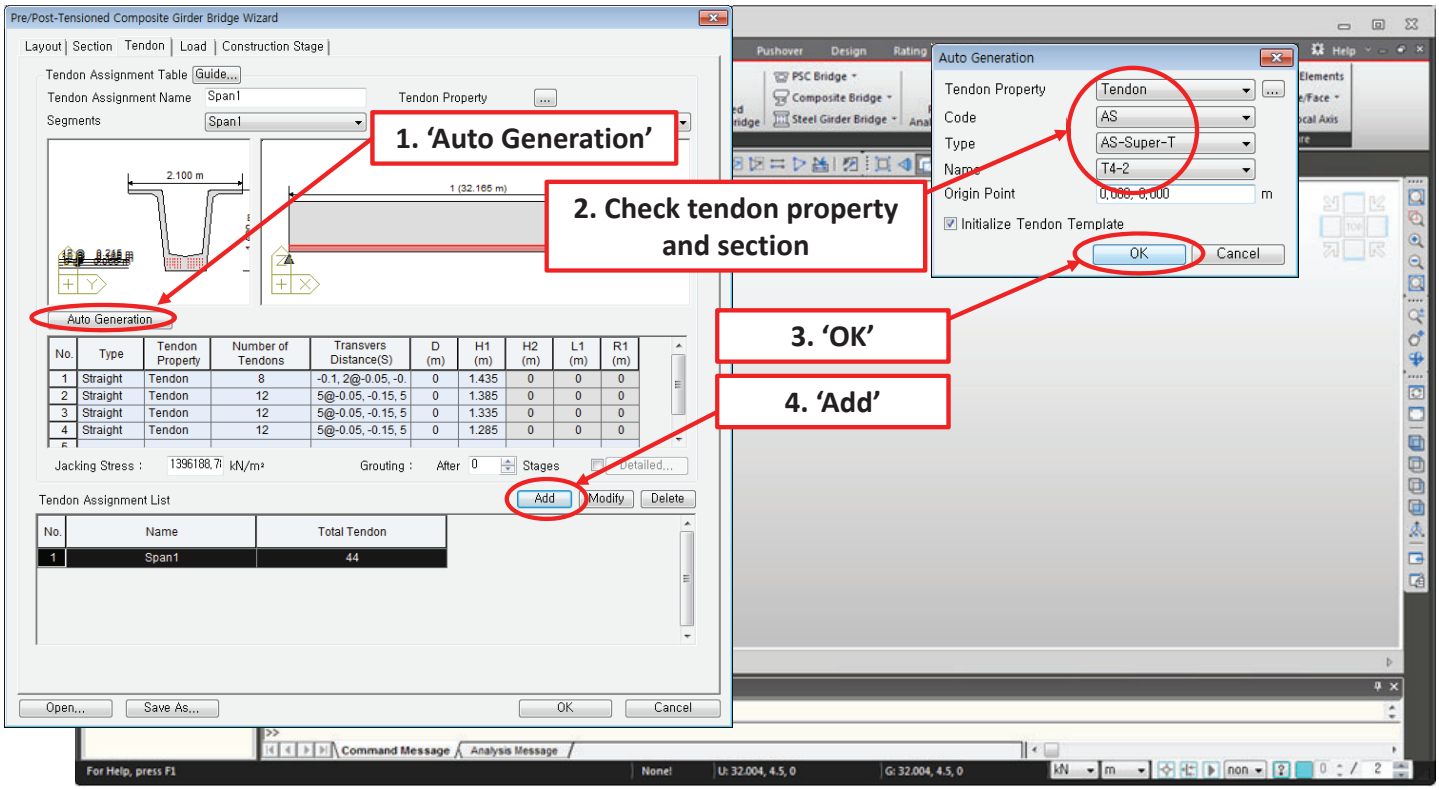
28 Prestressed Composite Bridge Wizard



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.

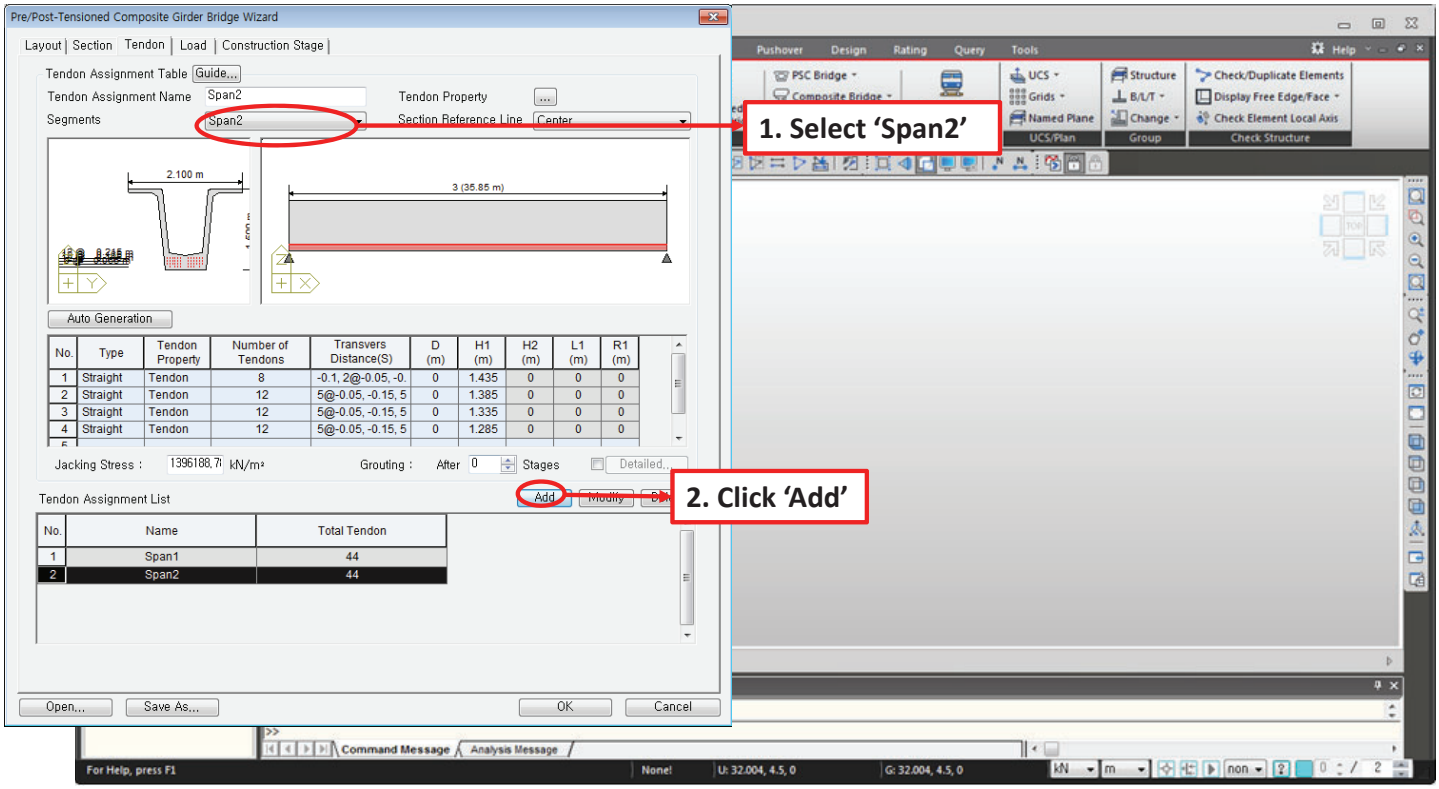
29 Prestressed Composite Bridge Wizard



Procedure

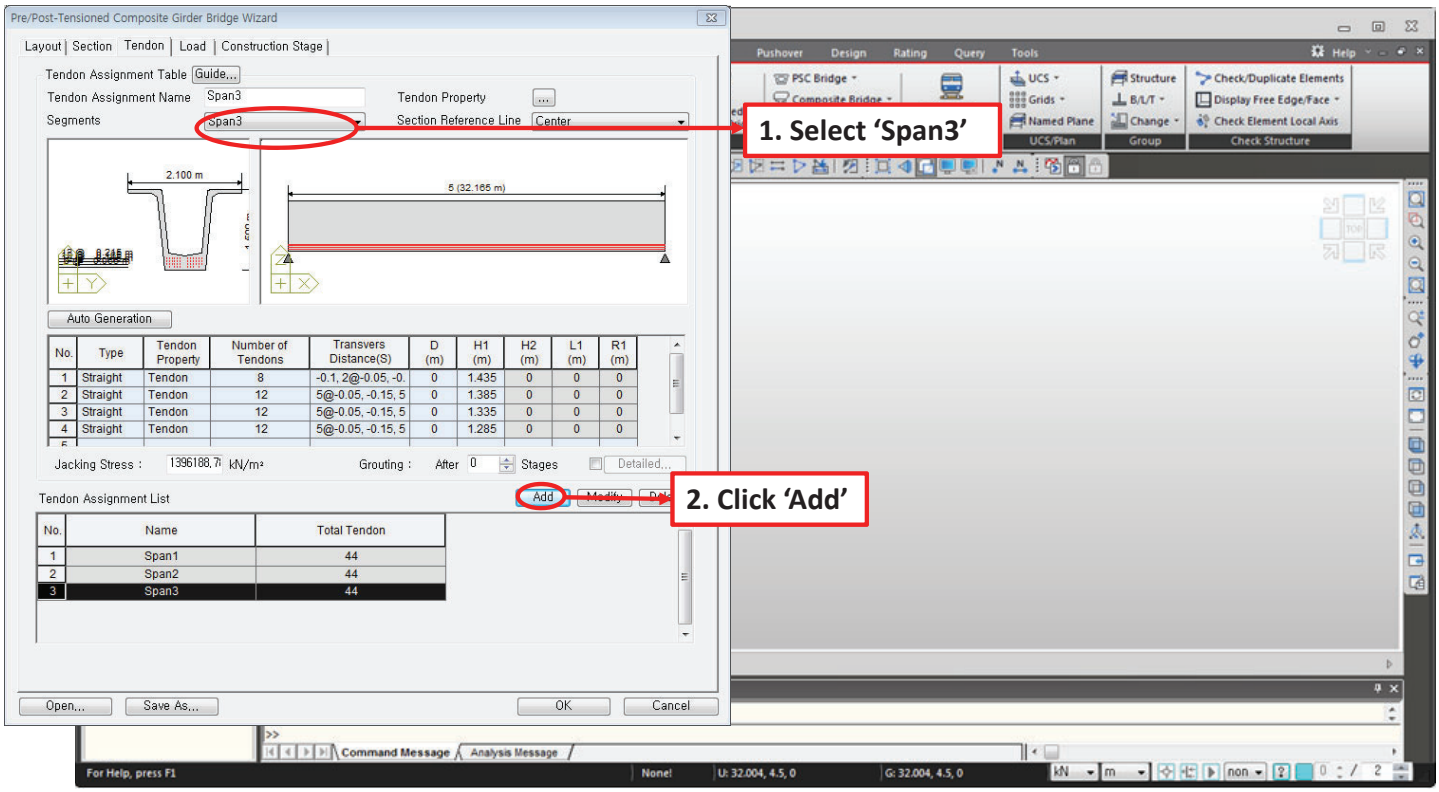
D : Transverse location of the tendon in the cross section / H : Vertical location of the tendon from the top of the section / Grouting : Grouting stage after jacking the tendon. Go to 'Detailed…' to define debonding length.

30 Prestressed Composite Bridge Wizard



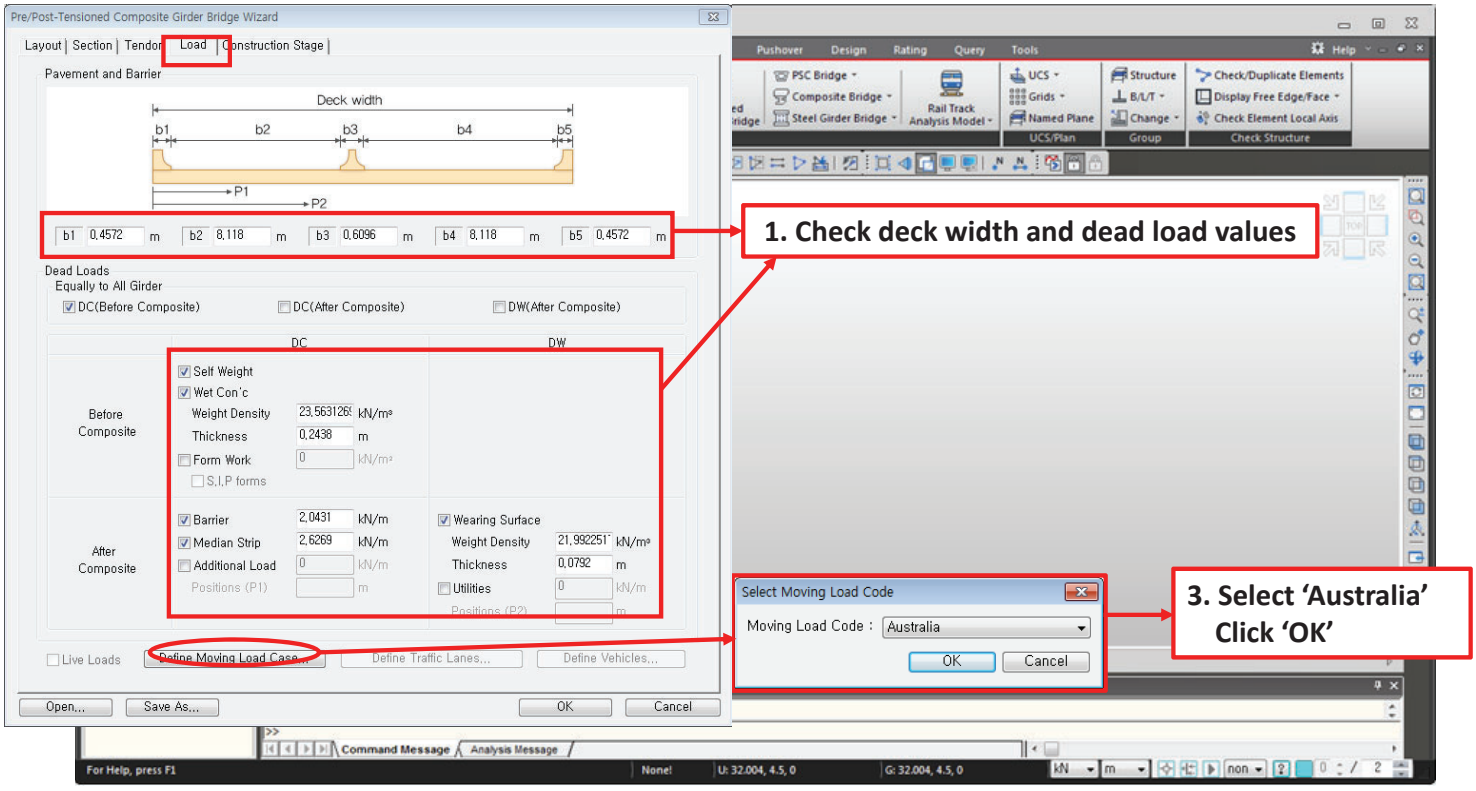
Procedure

31 Prestressed Composite Bridge Wizard



Procedure

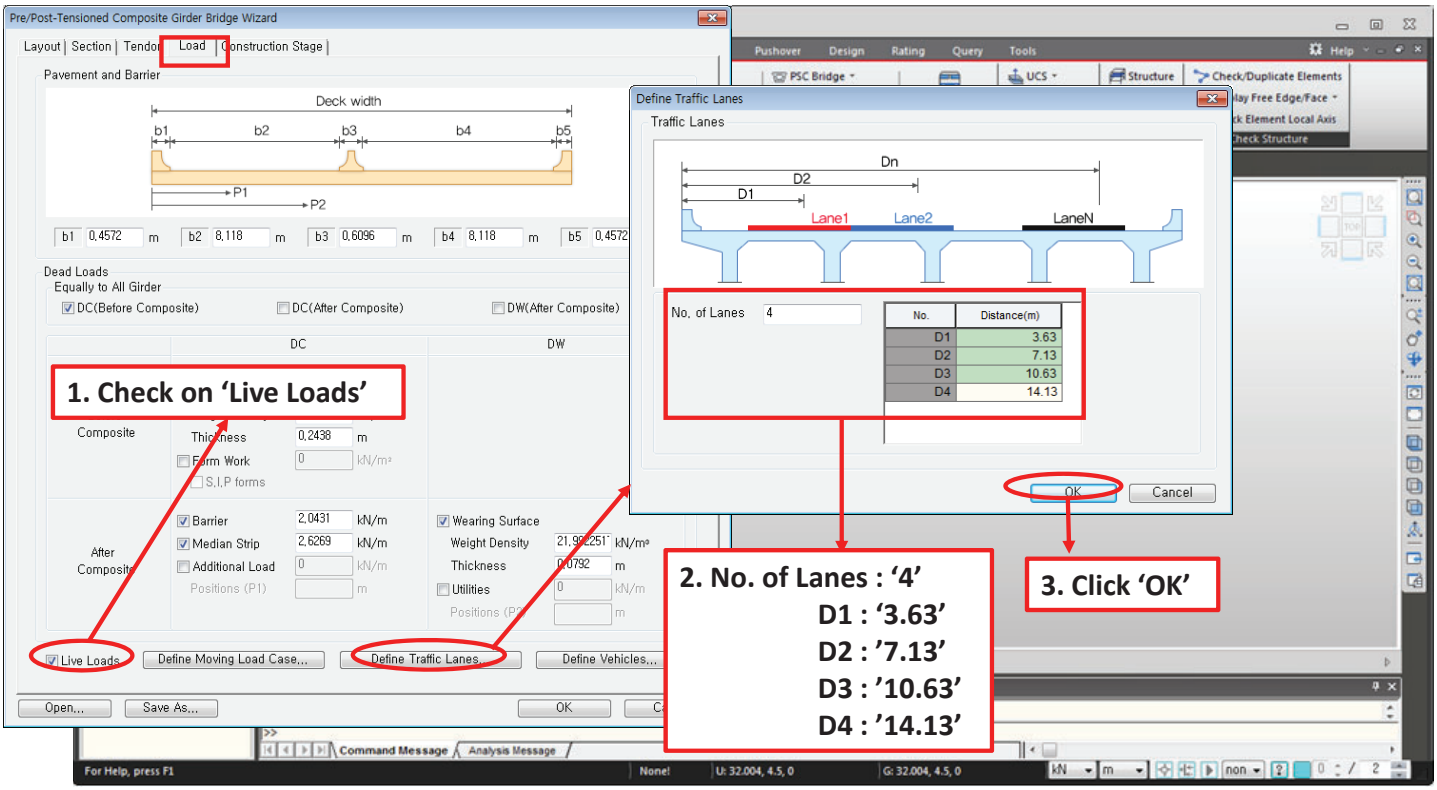
32 Prestressed Composite Bridge Wizard



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.

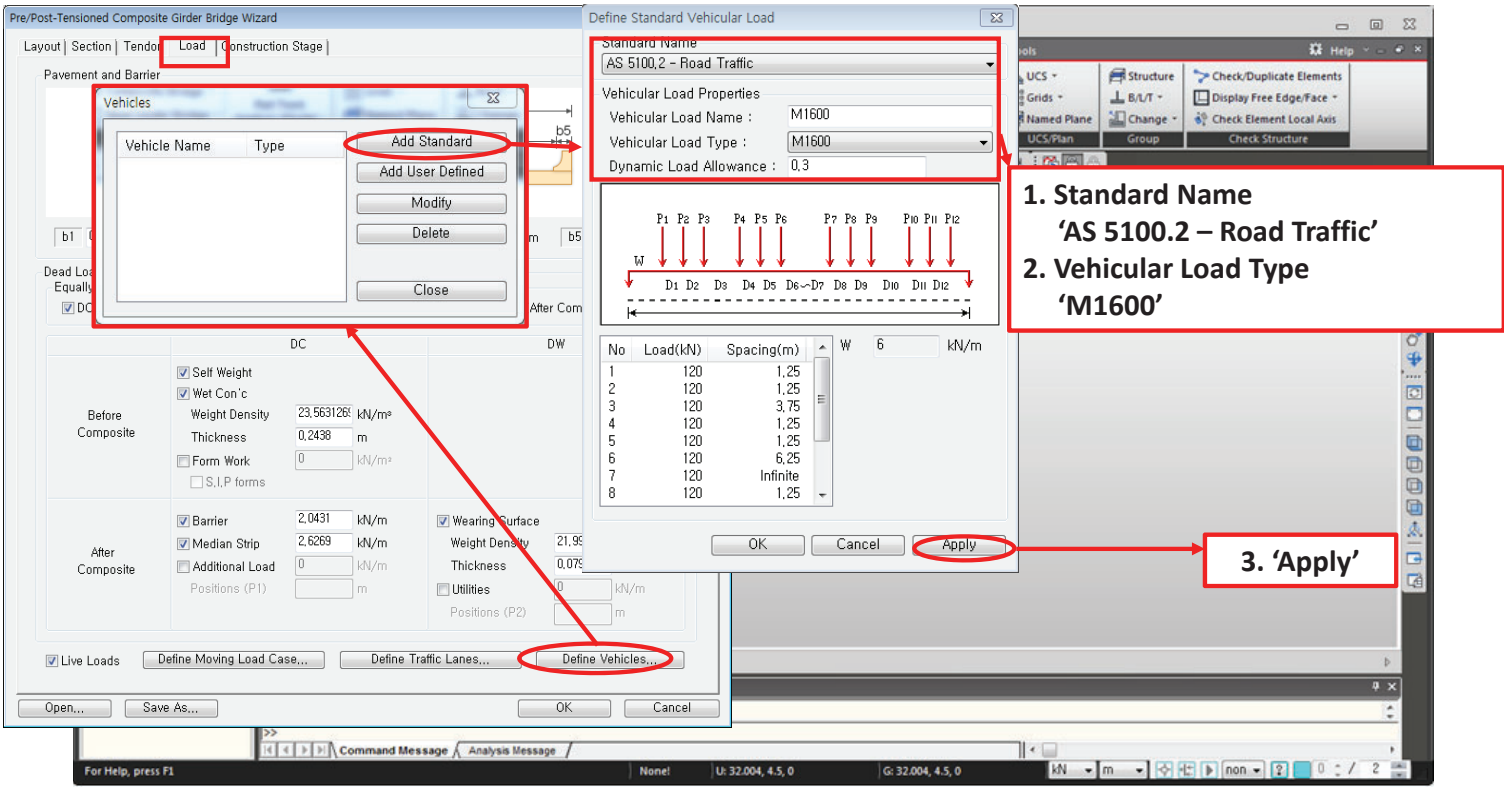
33 Prestressed Composite Bridge Wizard



Procedure

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

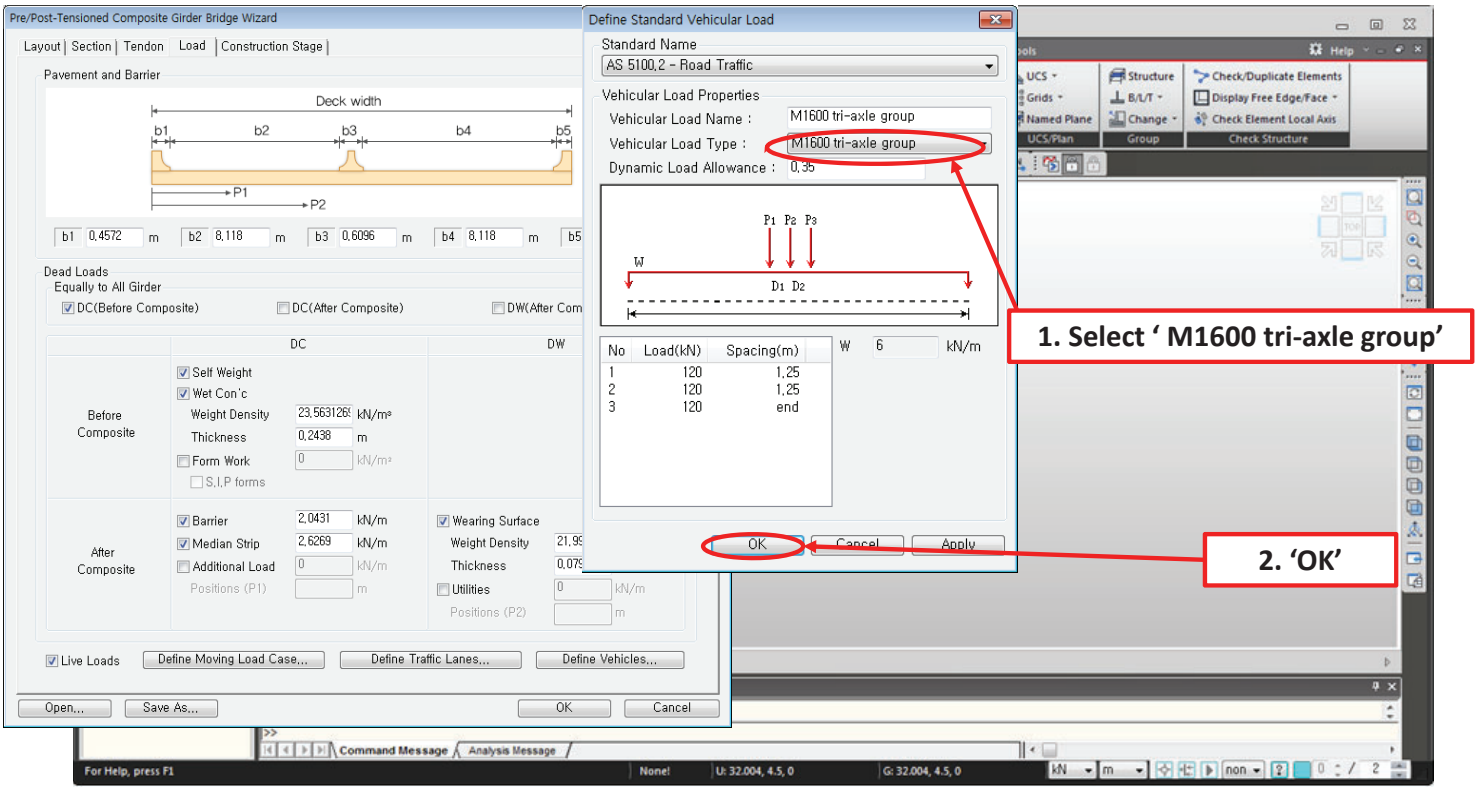
34 Prestressed Composite Bridge Wizard



Procedure

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

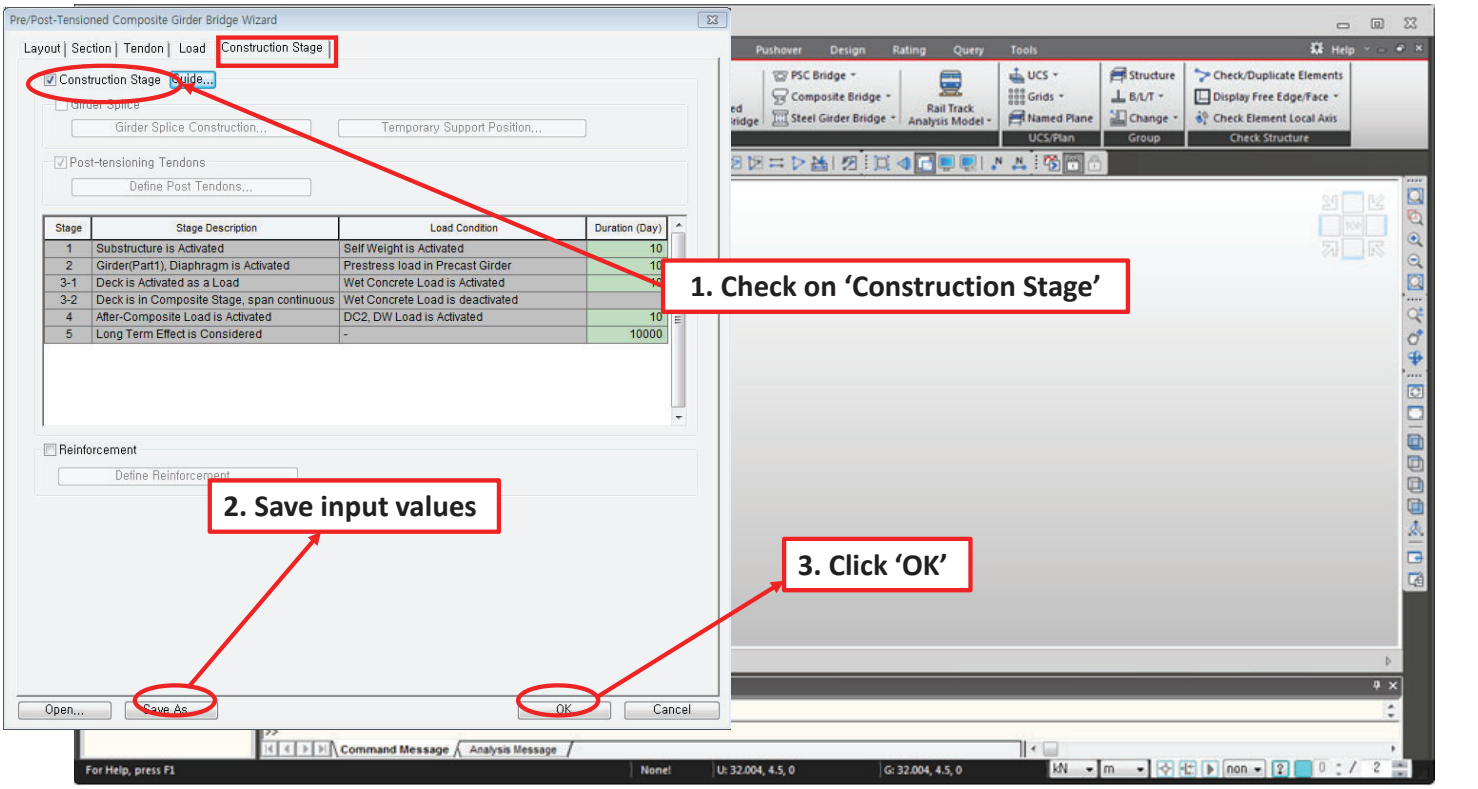
35 Prestressed Composite Bridge Wizard



Procedure

Vehicles are provided based on the design codes.

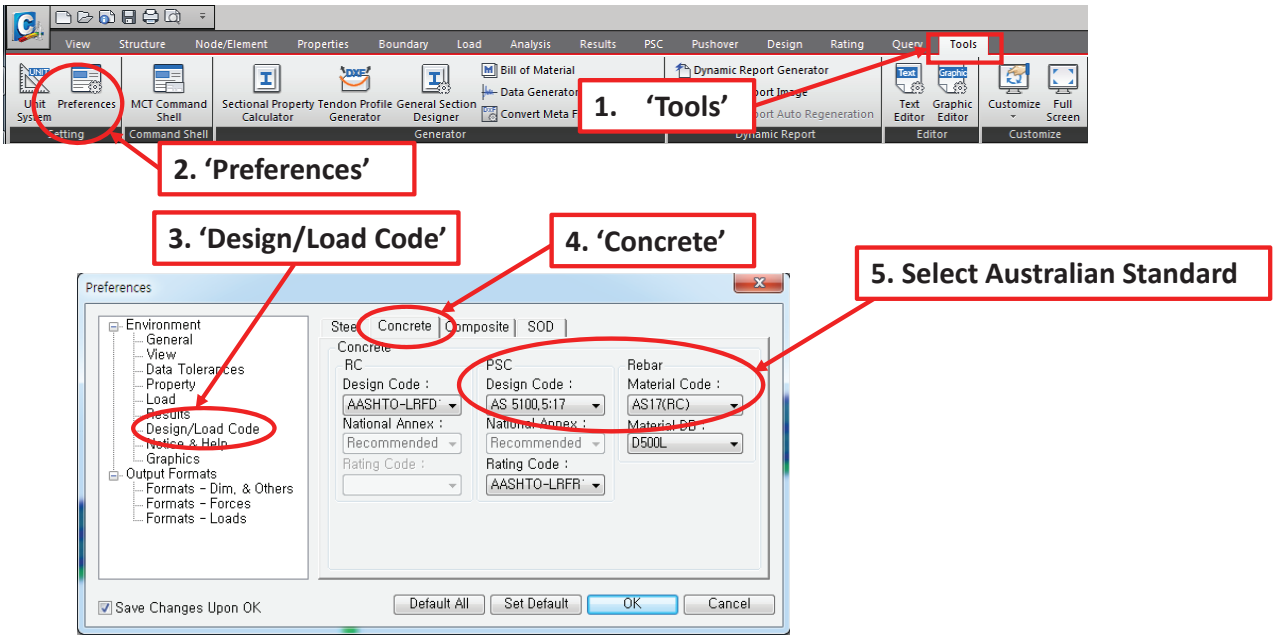
36 Prestressed Composite Bridge Wizard



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.

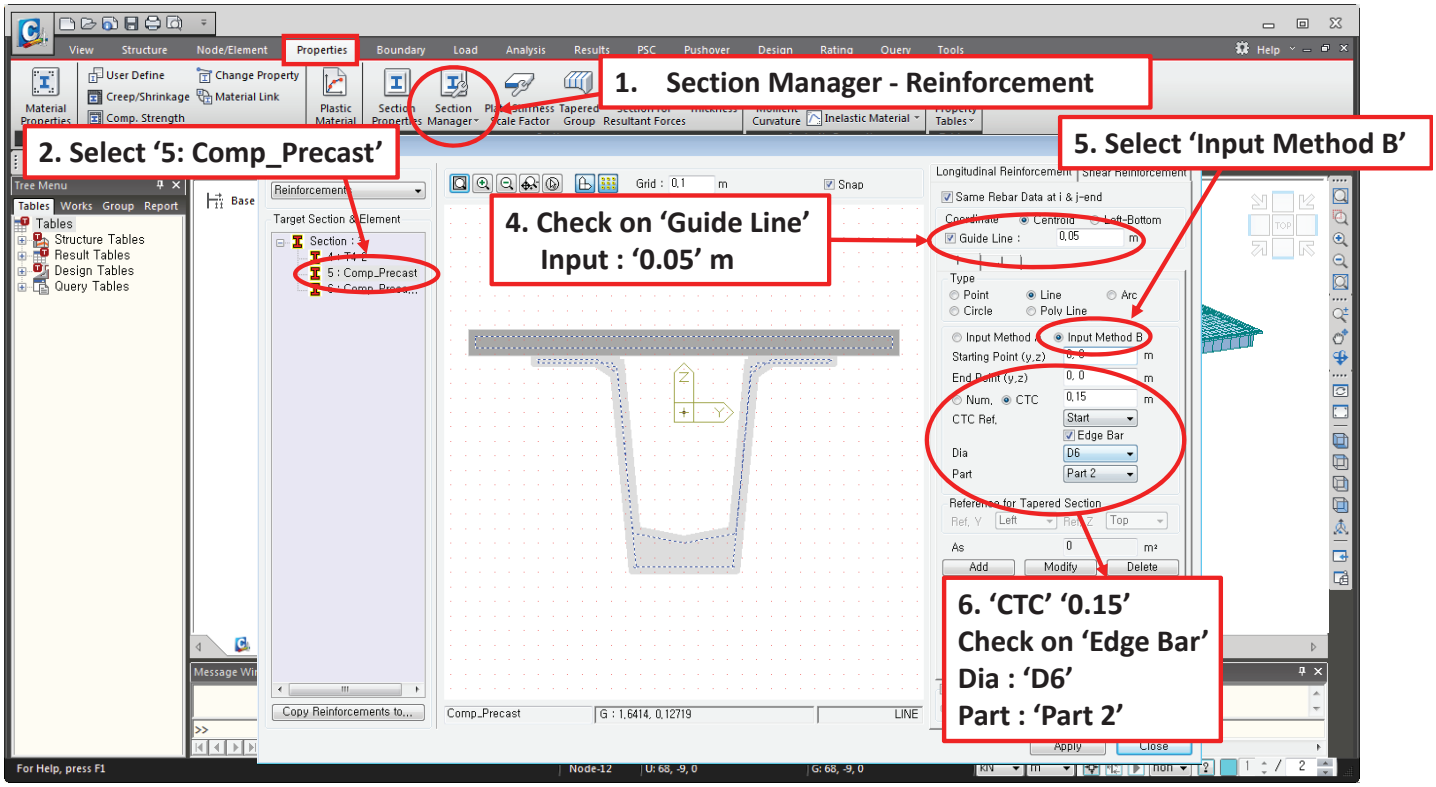
37 Prestressed Composite Bridge Wizard



Procedure

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

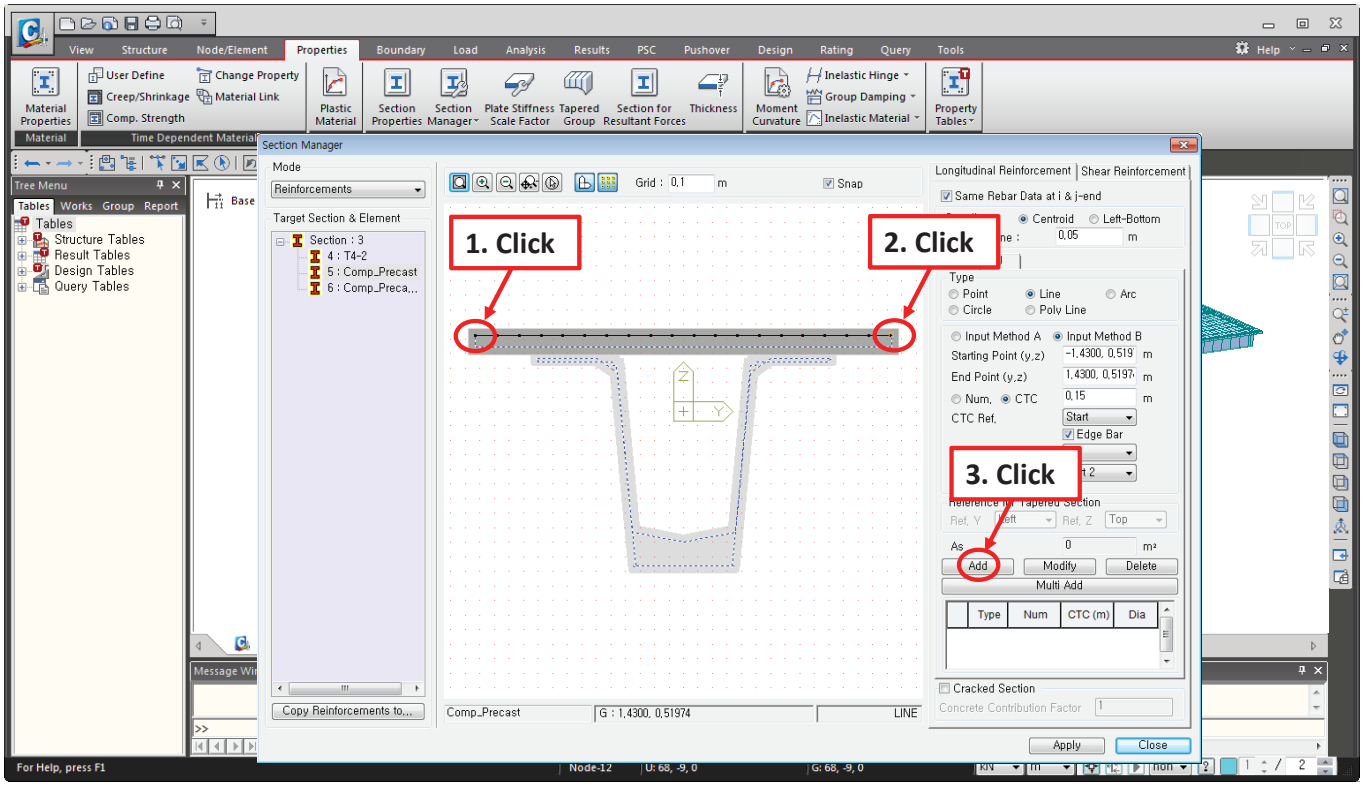
38 Prestressed Composite Bridge Wizard



Procedure

Input cover value on ‘Guide Line’.
Part 1 : Gitder / Part 2 : Slab

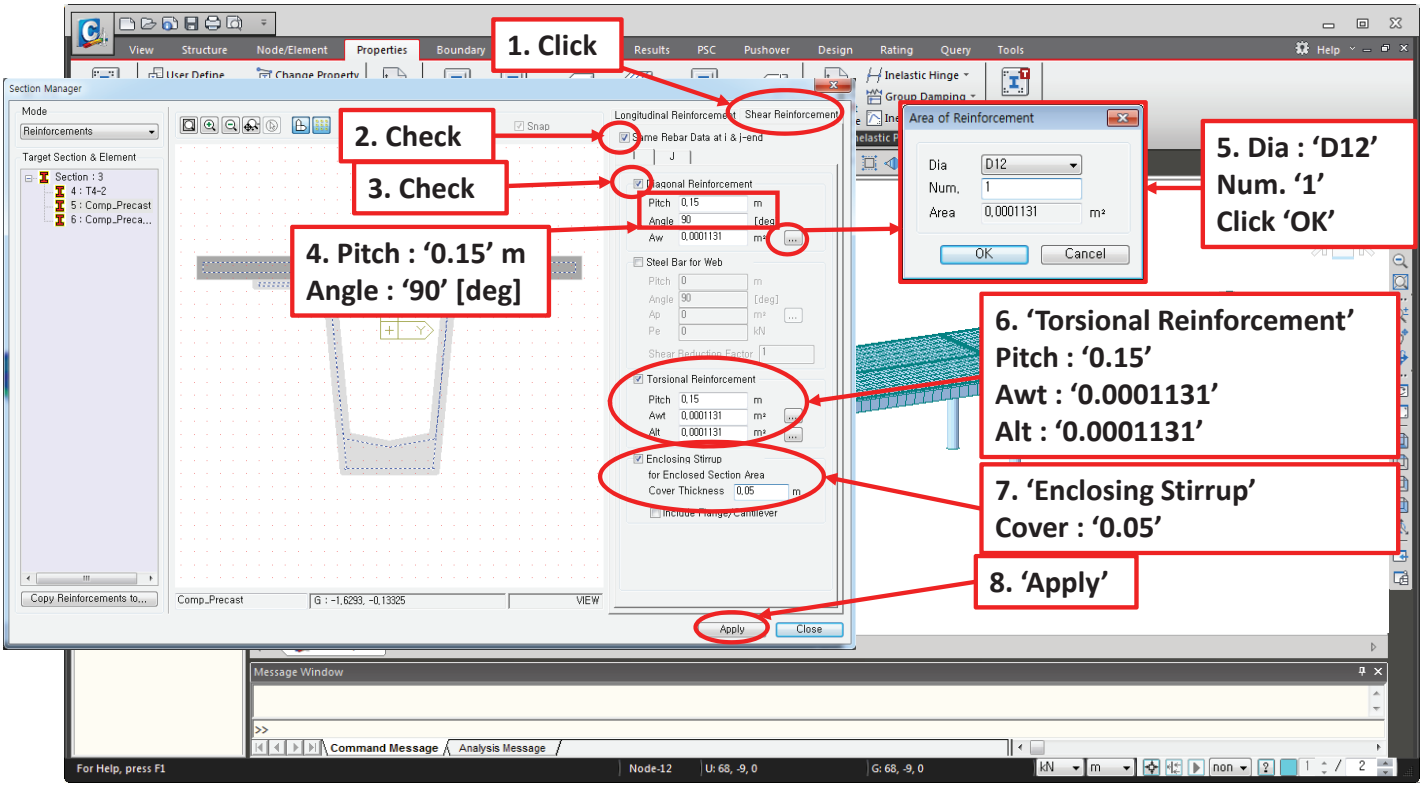
39 Prestressed Composite Bridge Wizard



Procedure

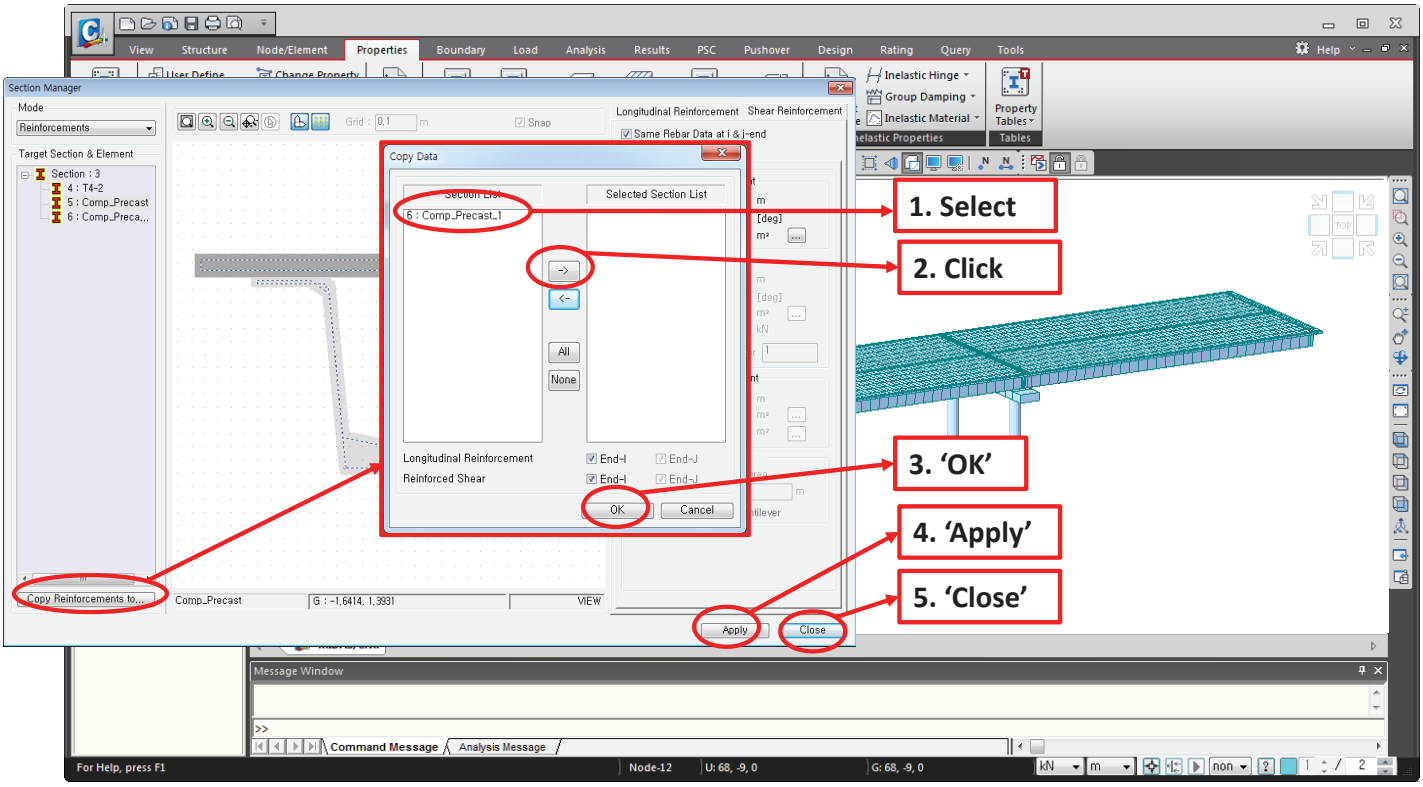
Snap the corner of the Guide line.
Zoom-in or Zoom-out by scrolling the mouse.

40 Prestressed Composite Bridge Wizard



Procedure

41 Prestressed Composite Bridge Wizard



Procedure

Copy reinforcement details to other sections

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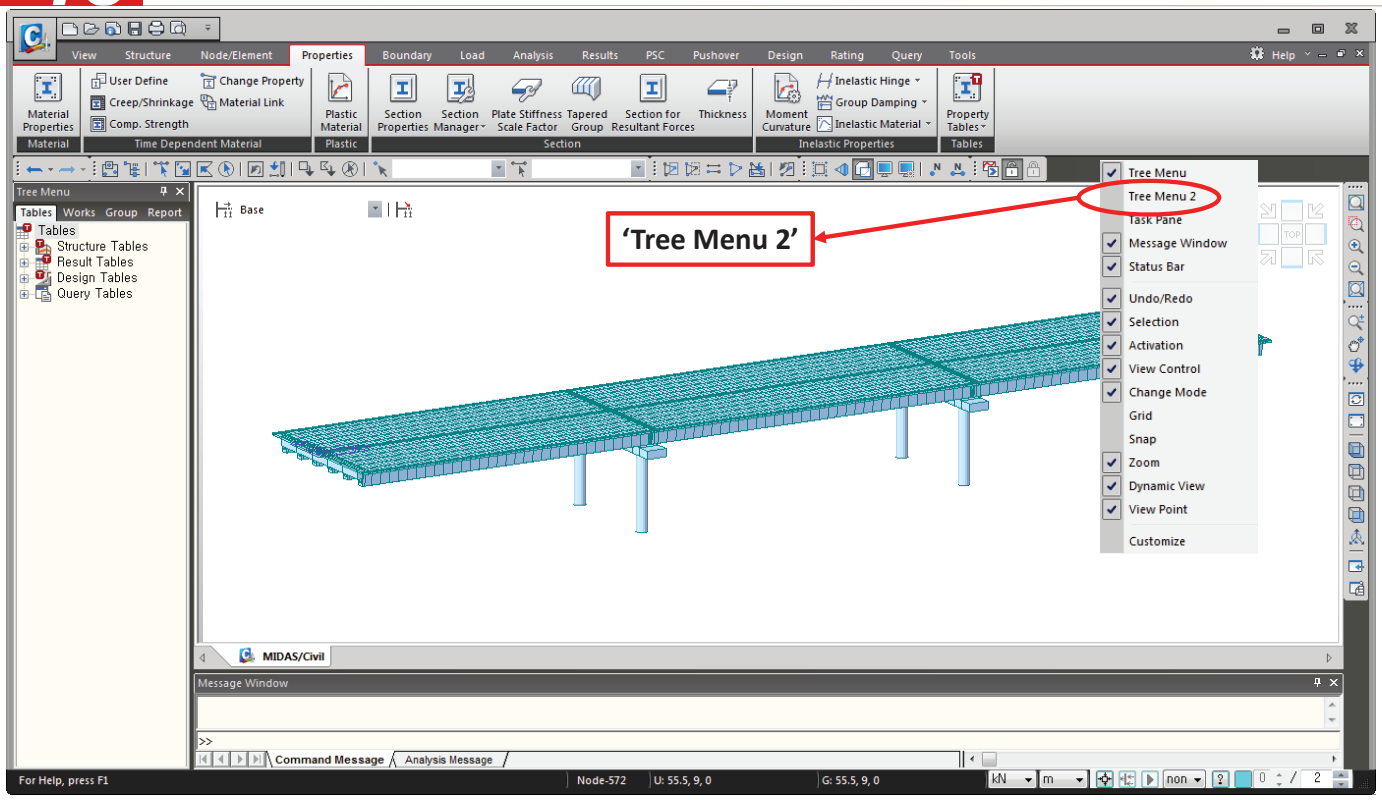
Step 3. Load

- TDM / Moving Load / Response Spectrum

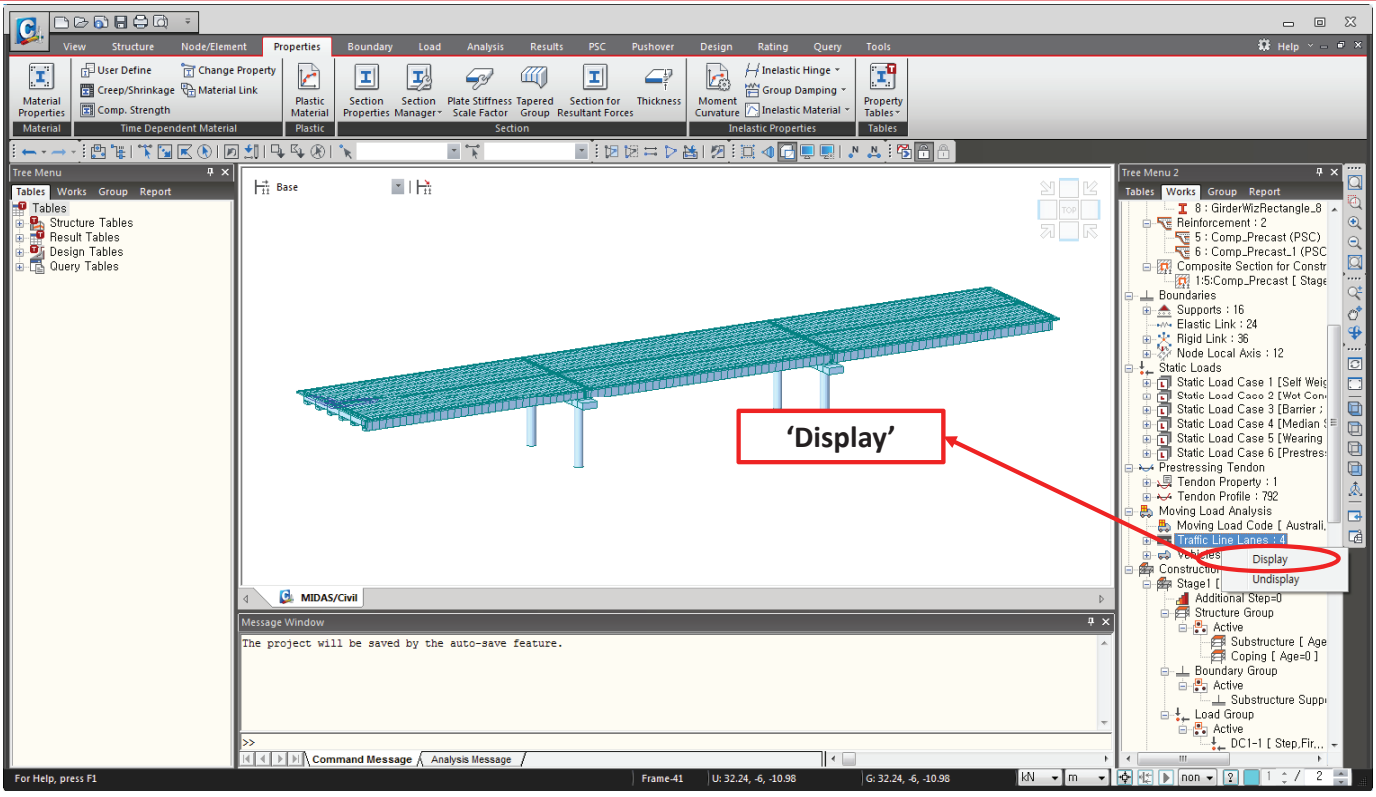
43 Time dependent Material



Procedure

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

44 Time dependent Material



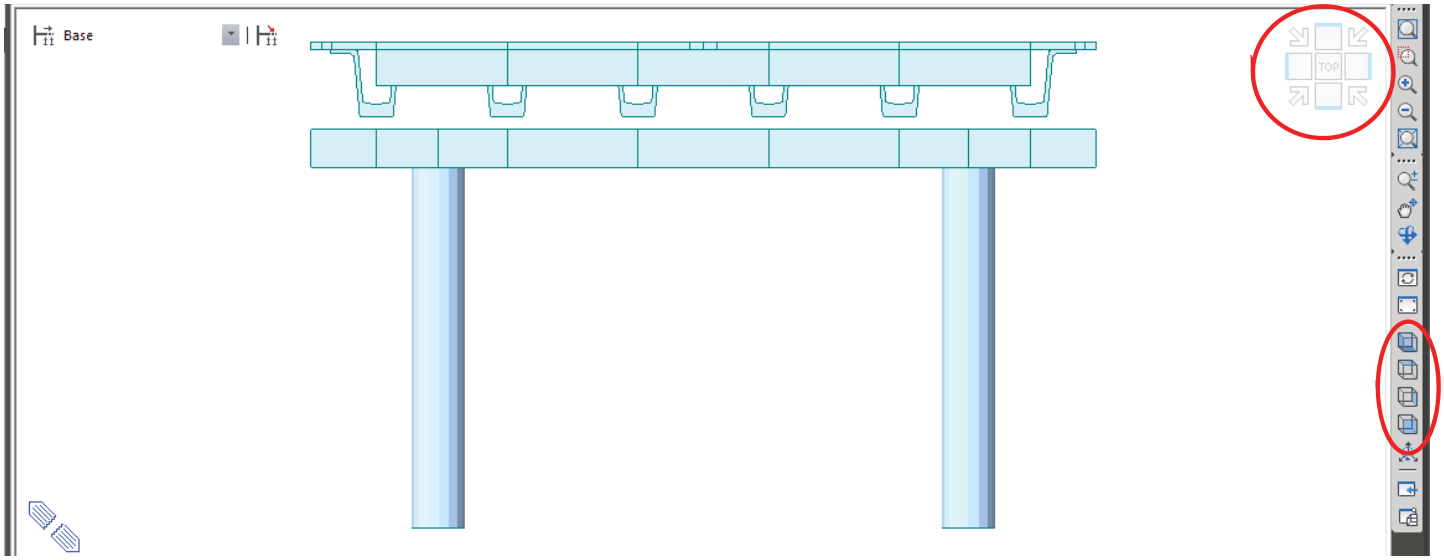
Procedure

Display or Undispaly 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.

45 Time dependent Material

Tip

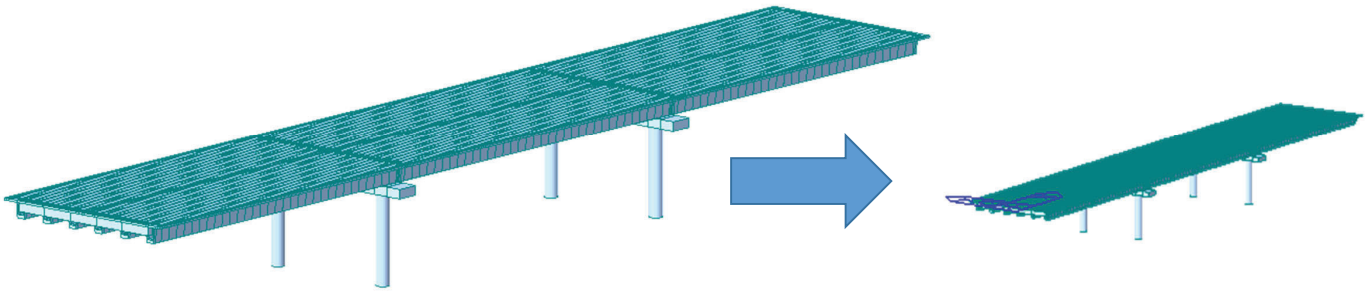
Use ‘Dynamic View Control’ or view icons to change the model angle



46 Time dependent Material

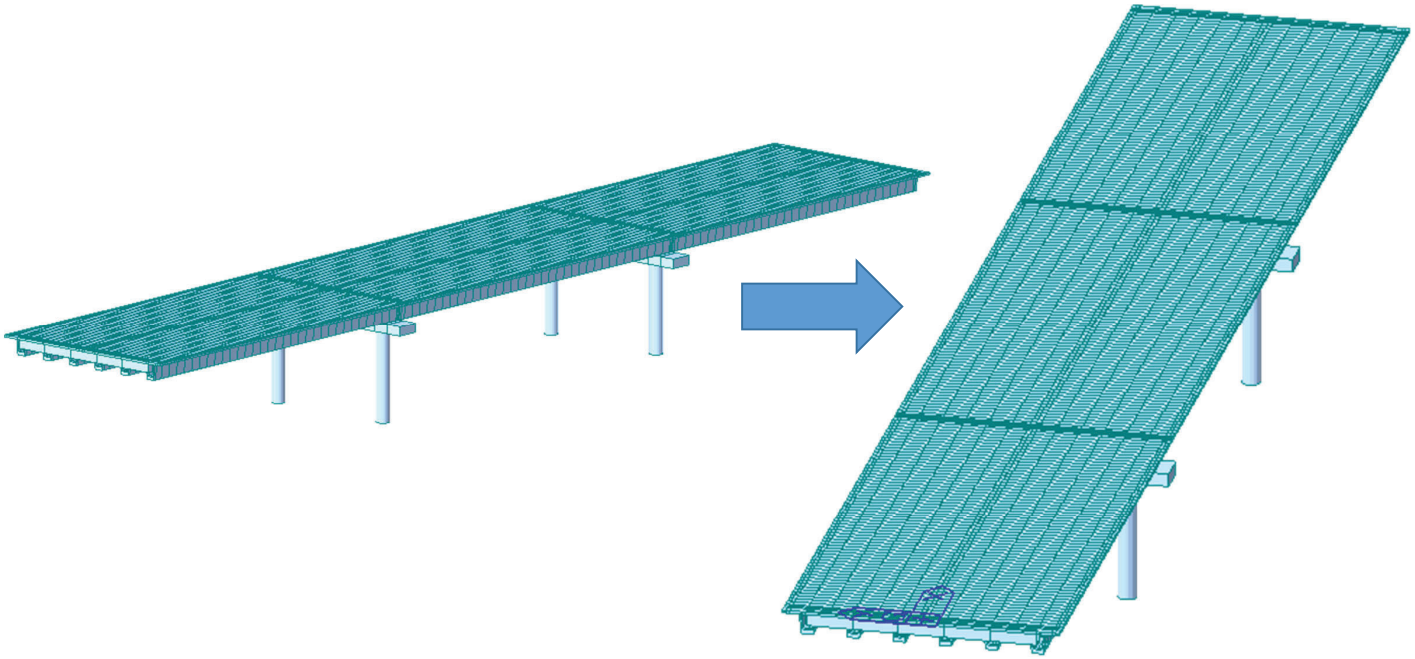
Tip

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



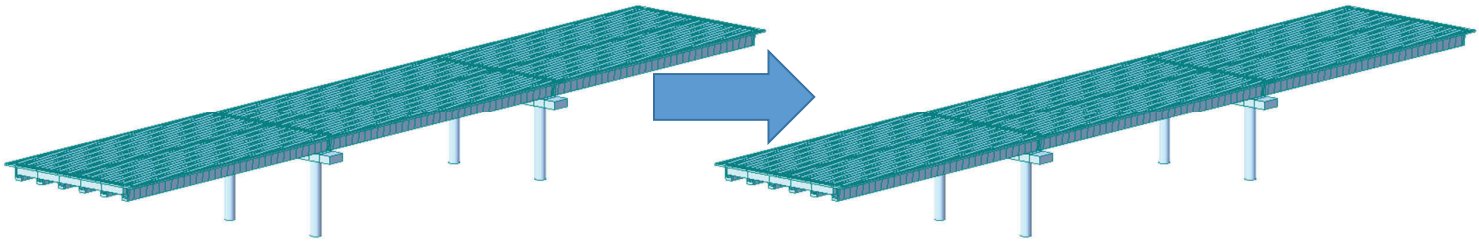
Tip

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



Tip

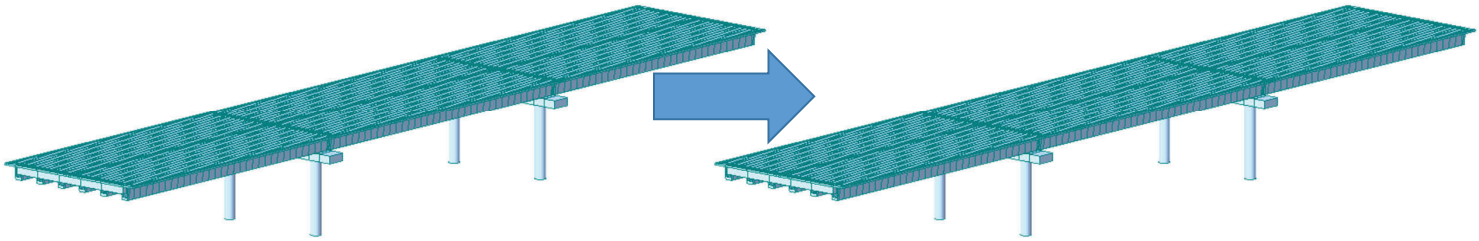
Move mouse cursor pressing mouse wheel to move the model



49 Time dependent Material

Tip

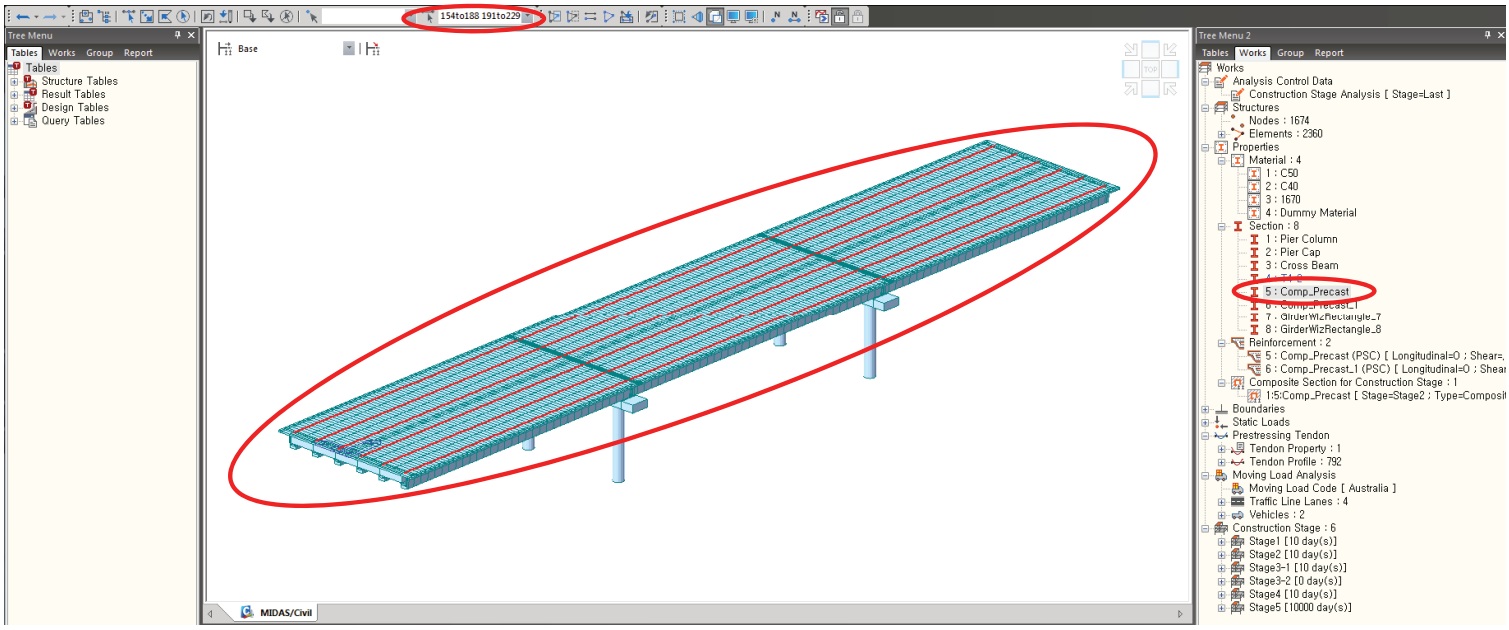
Move mouse cursor pressing mouse wheel to move the model



50 Time dependent Material

Tip

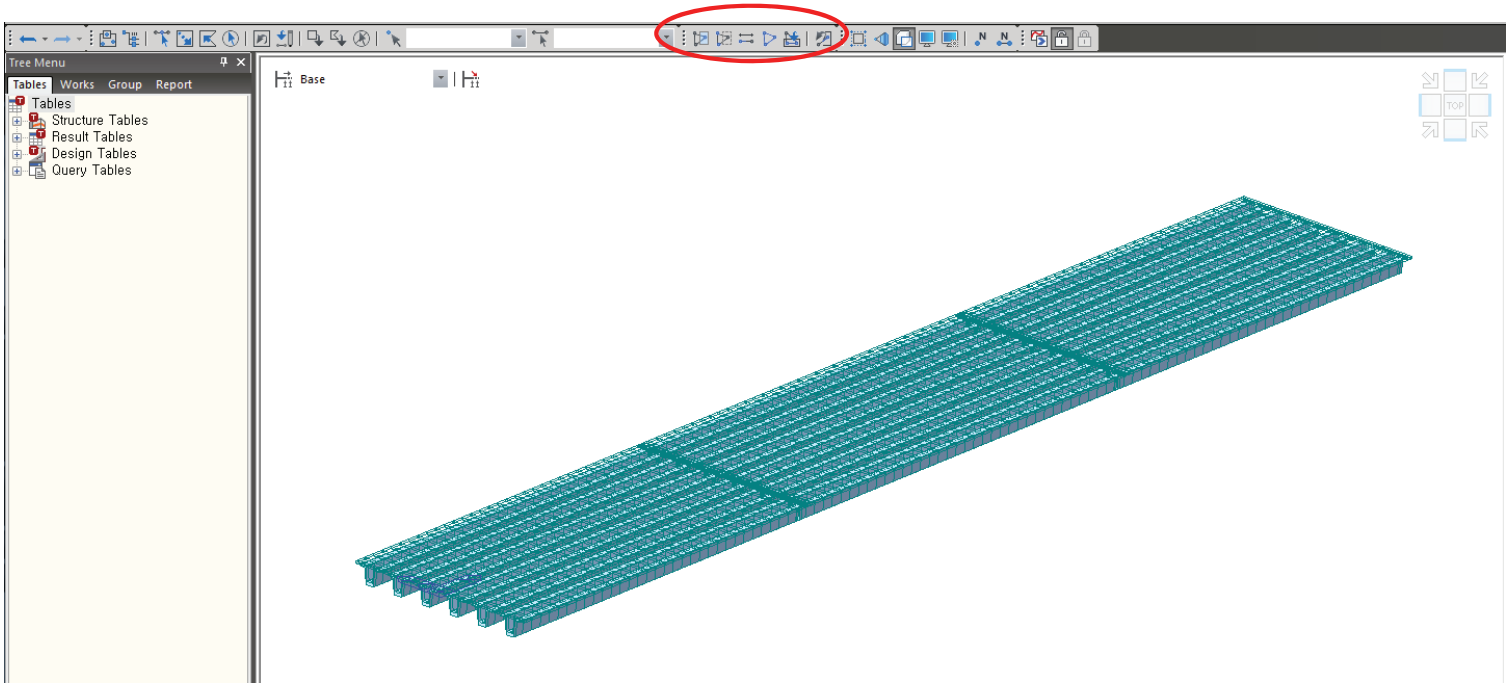
Double click any section or material, then assigned elements will be selected.
And Element number will be shown.



51 Time dependent Material

Tip

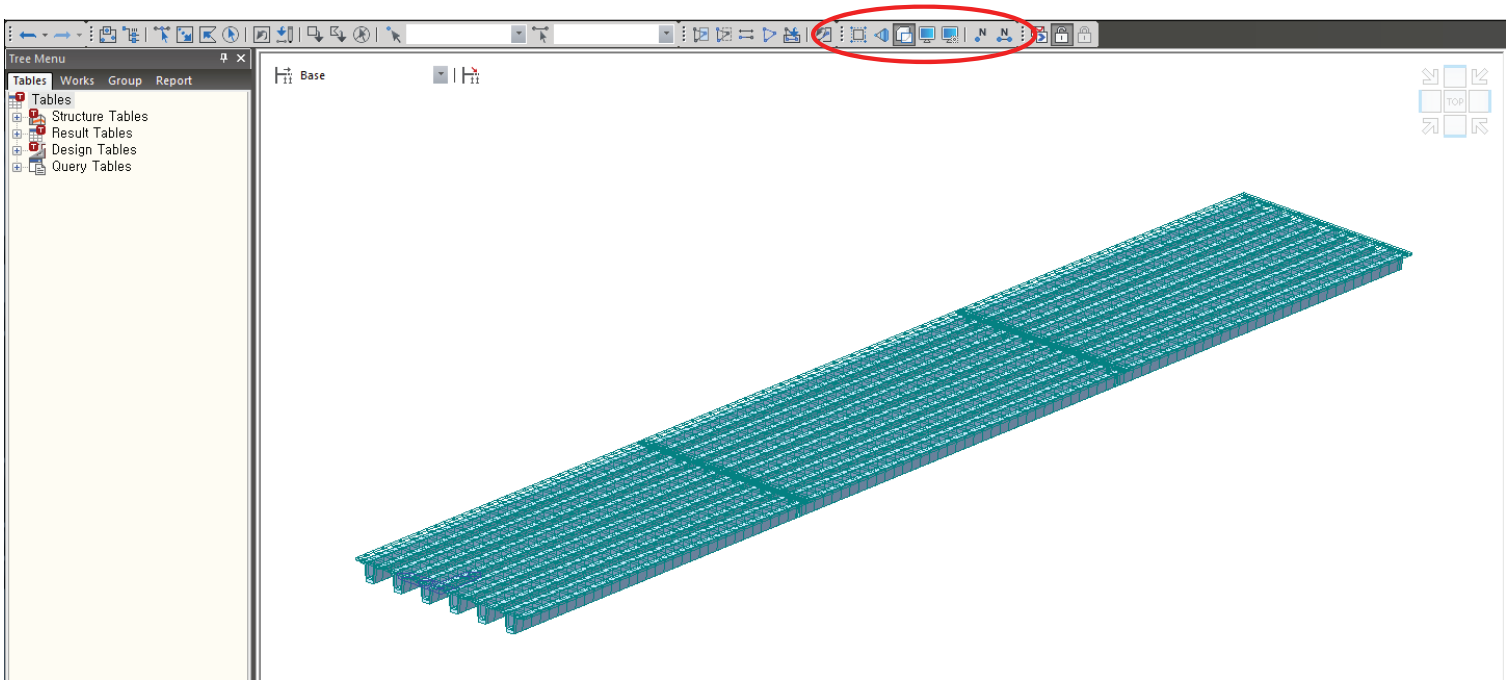
Use activation functions to activate or deactivate certain elements.
It is also valid when viewing results.



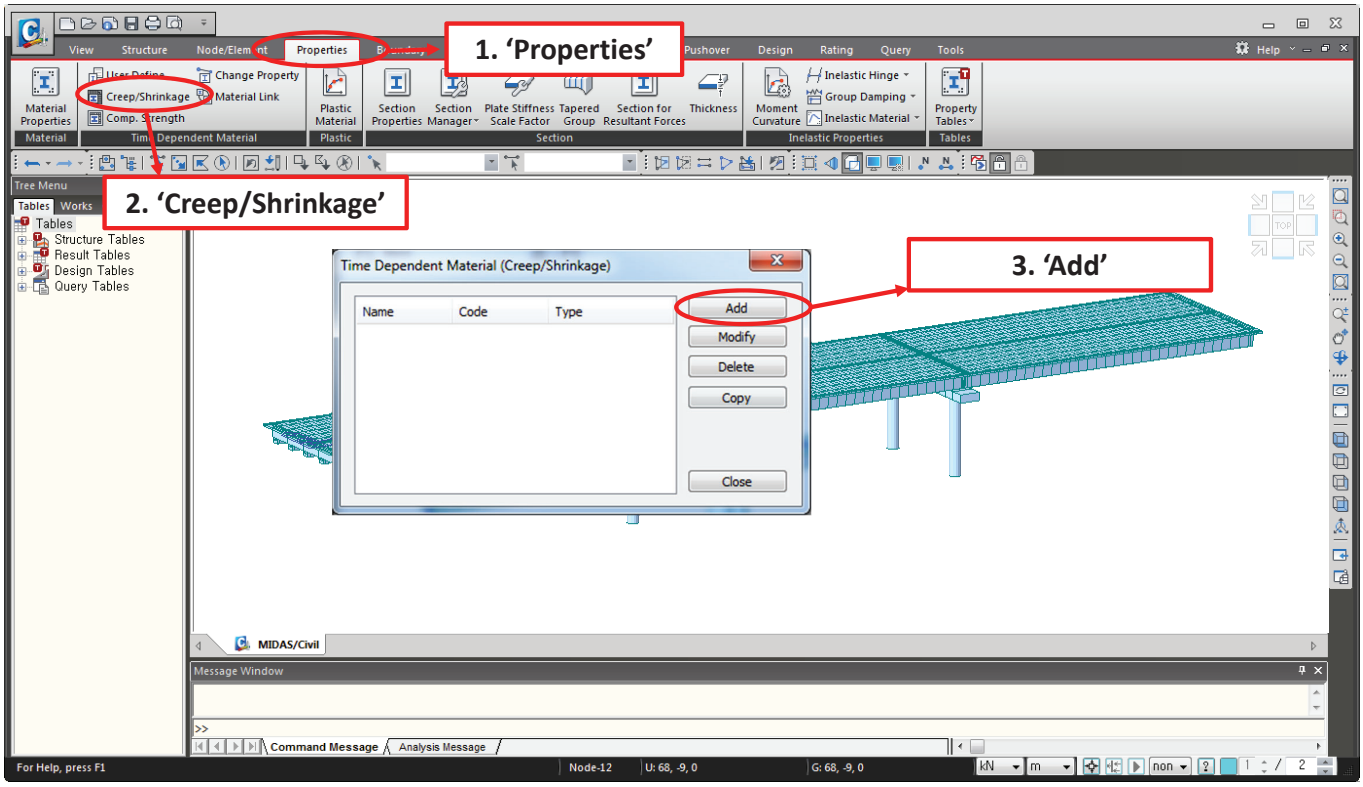
52 Time dependent Material

Tip

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



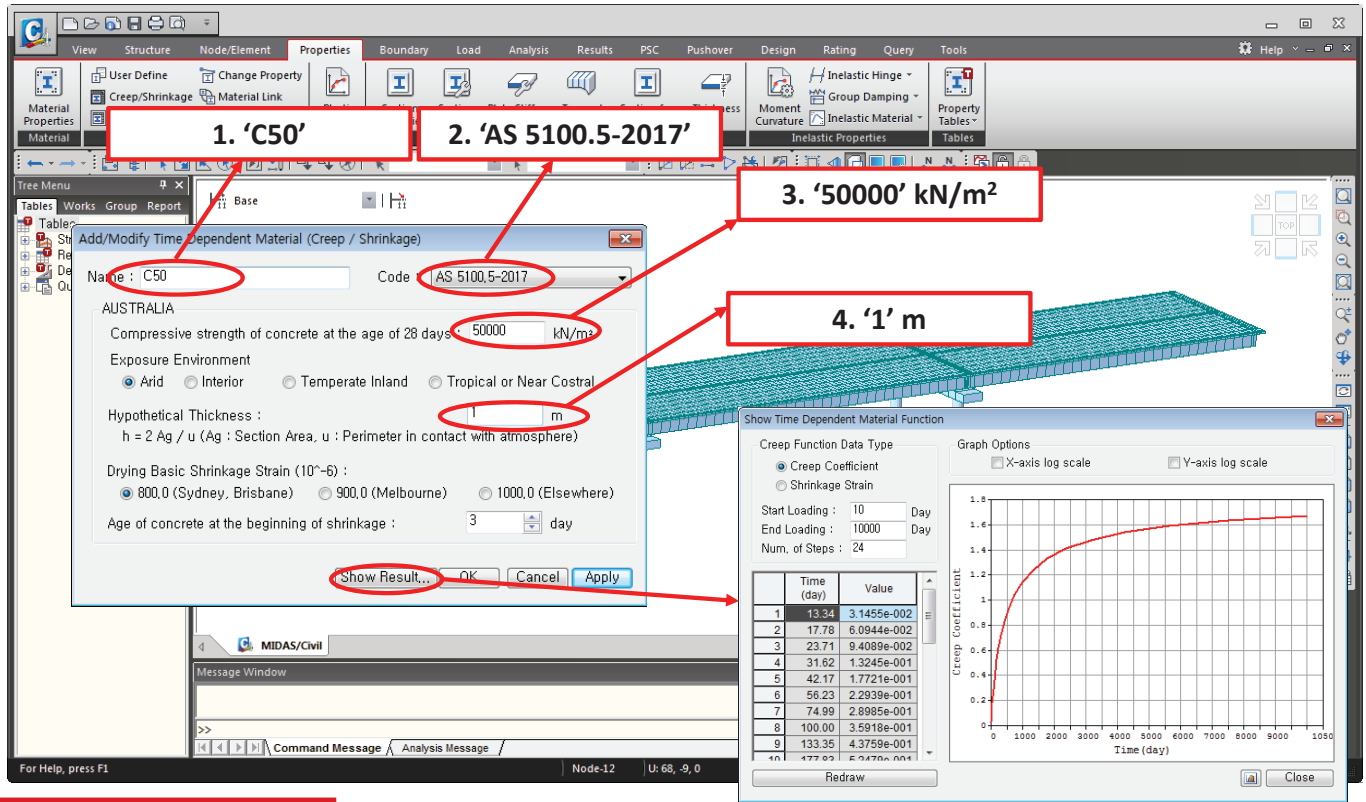
53 Time dependent Material



Procedure

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

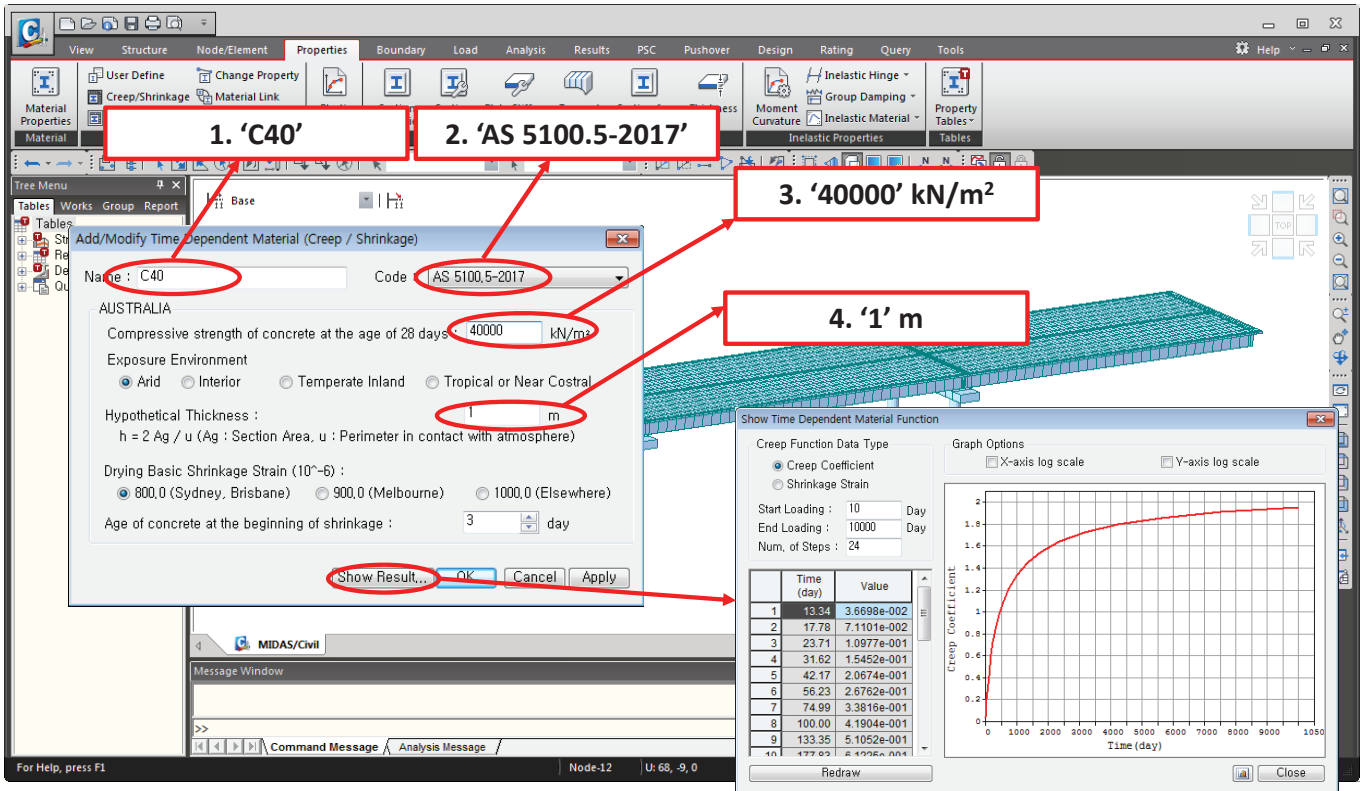
54 Time dependent Material



Procedure

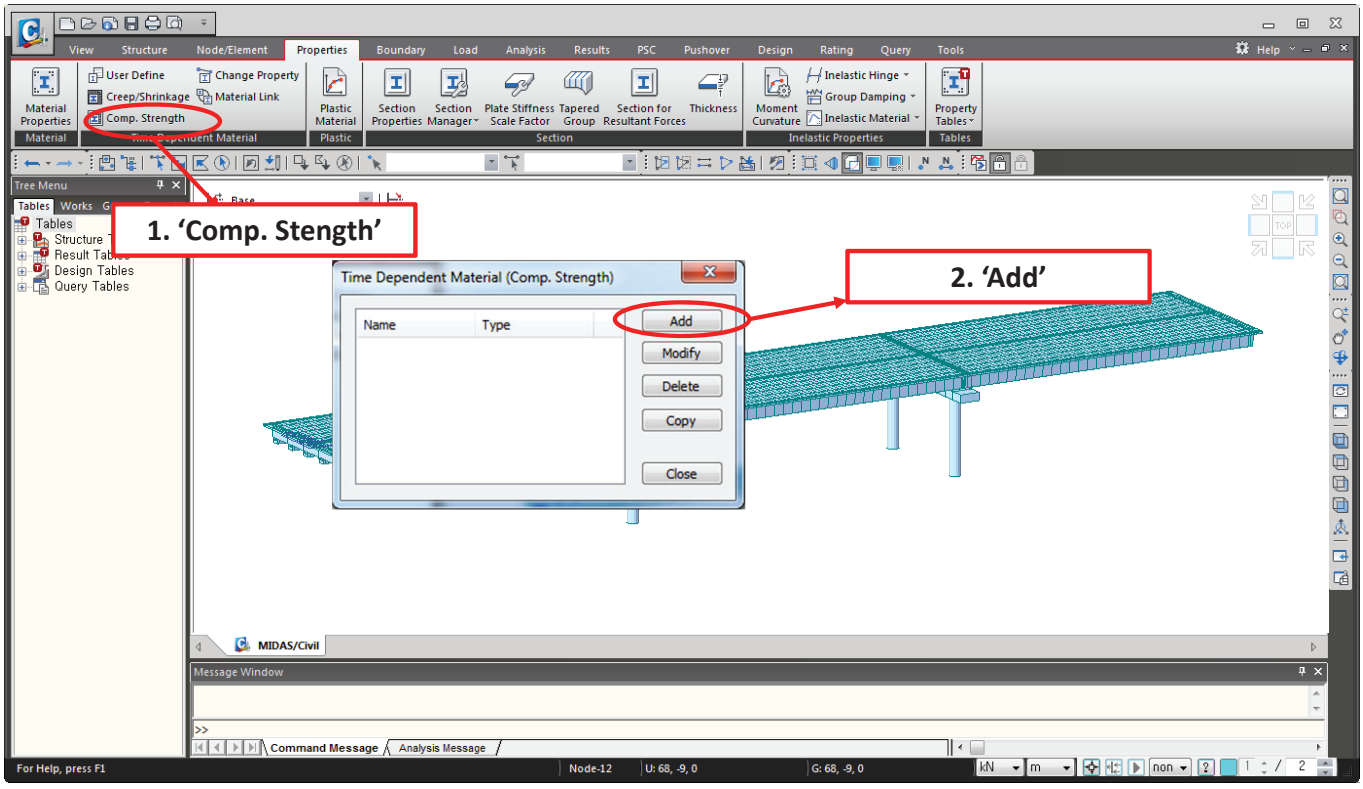
Different Creep Coefficient and Shrinkage Strain along the time will be applied to the model with Construction stage analysis.
Input 1m for Notional size of member and use Composite Section for CS function later on.

55 Time dependent Material



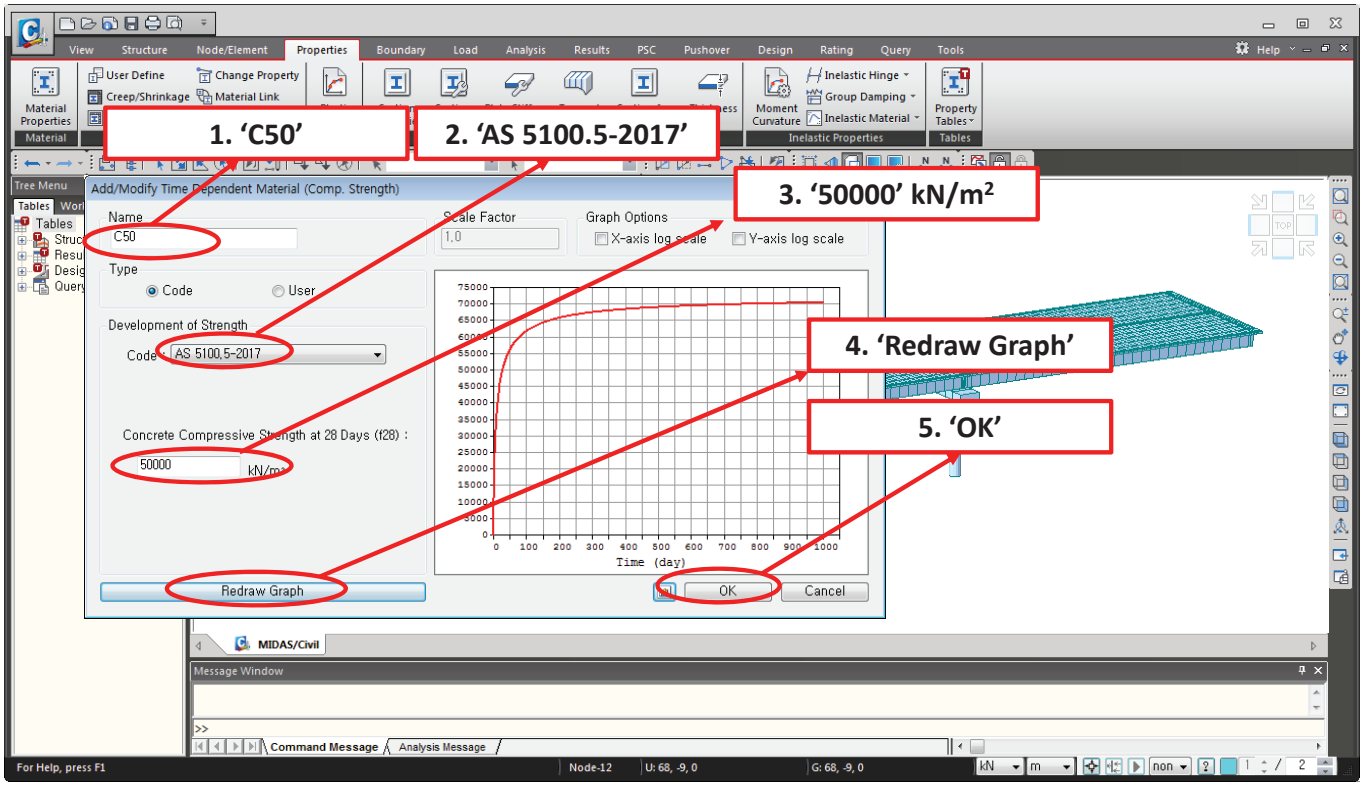
Procedure

56 Time dependent Material



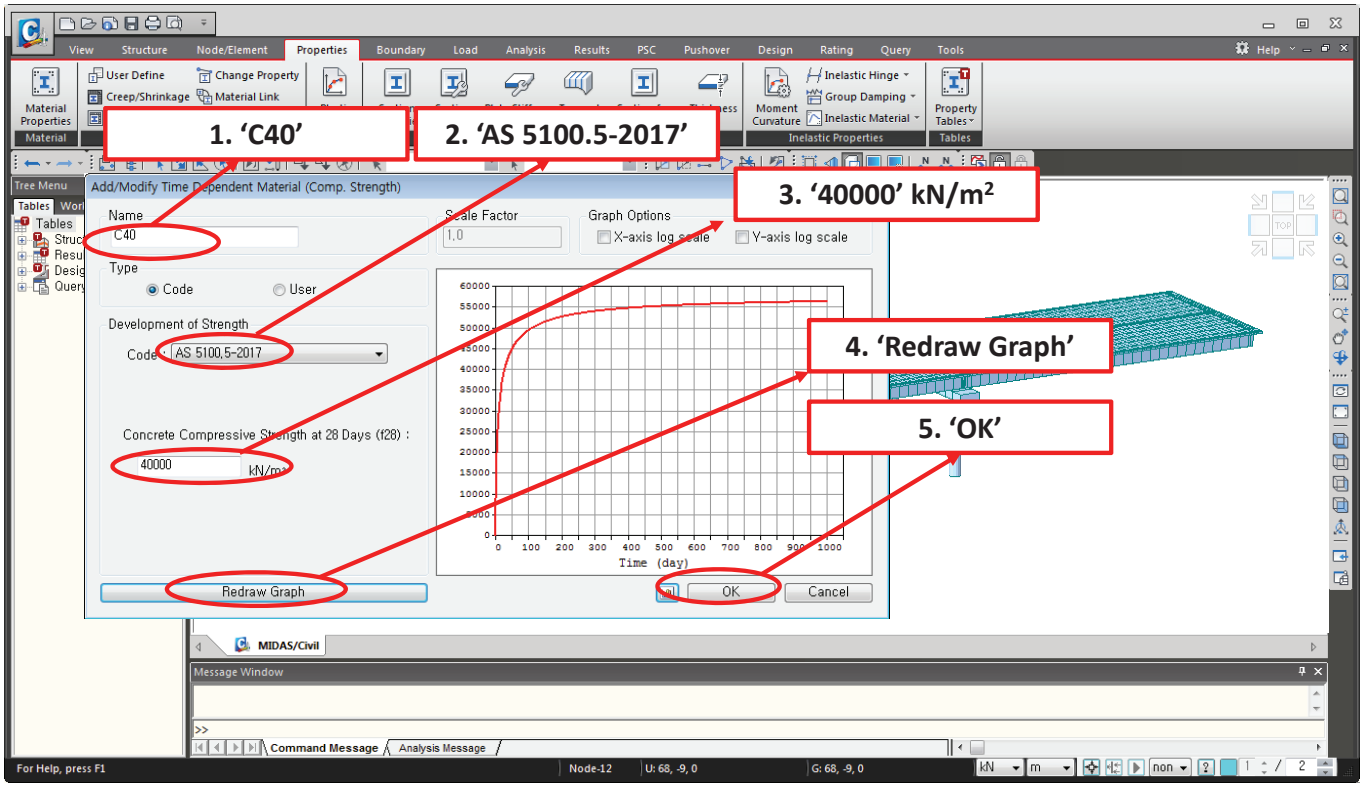
Procedure

57 Time dependent Material



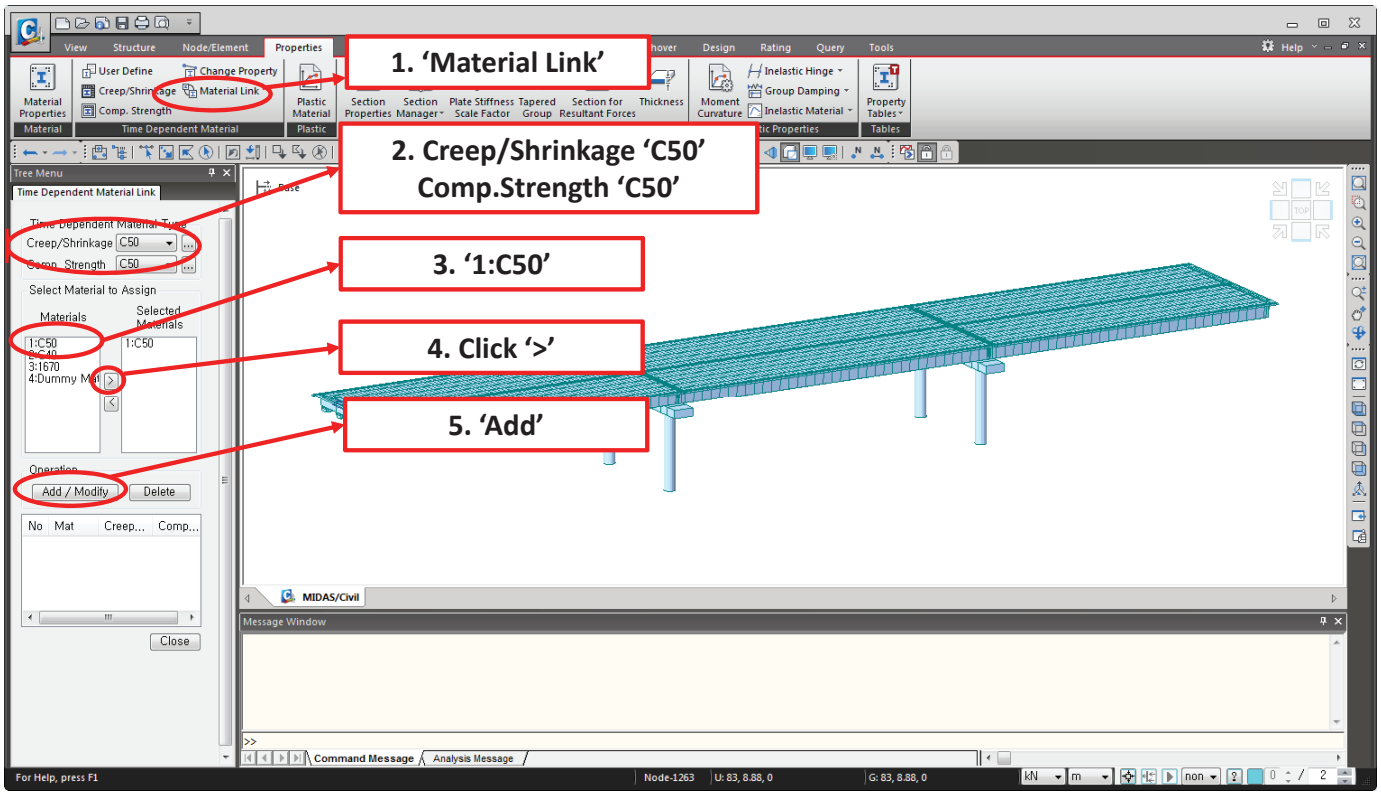
Procedure

58 Time dependent Material



Procedure

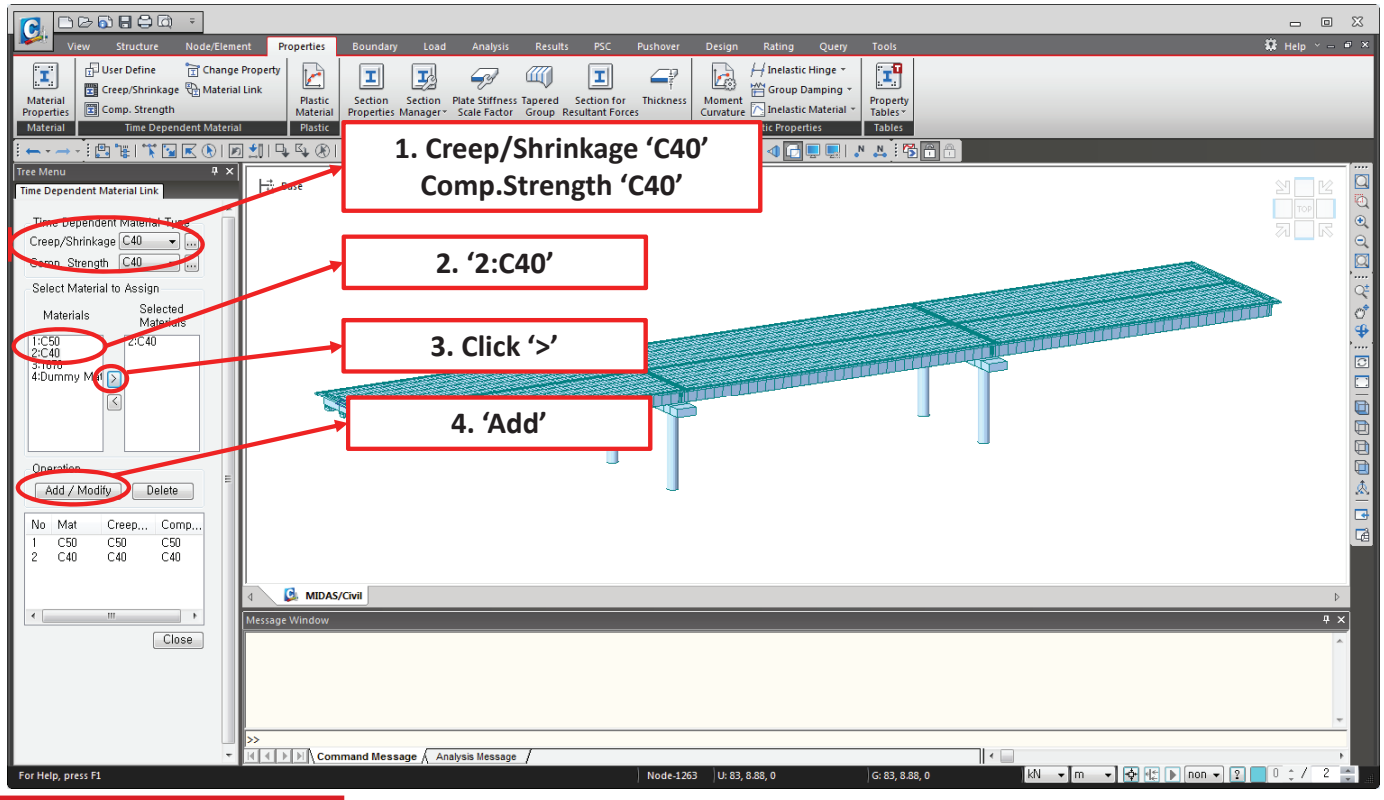
59 Time dependent Material



Procedure

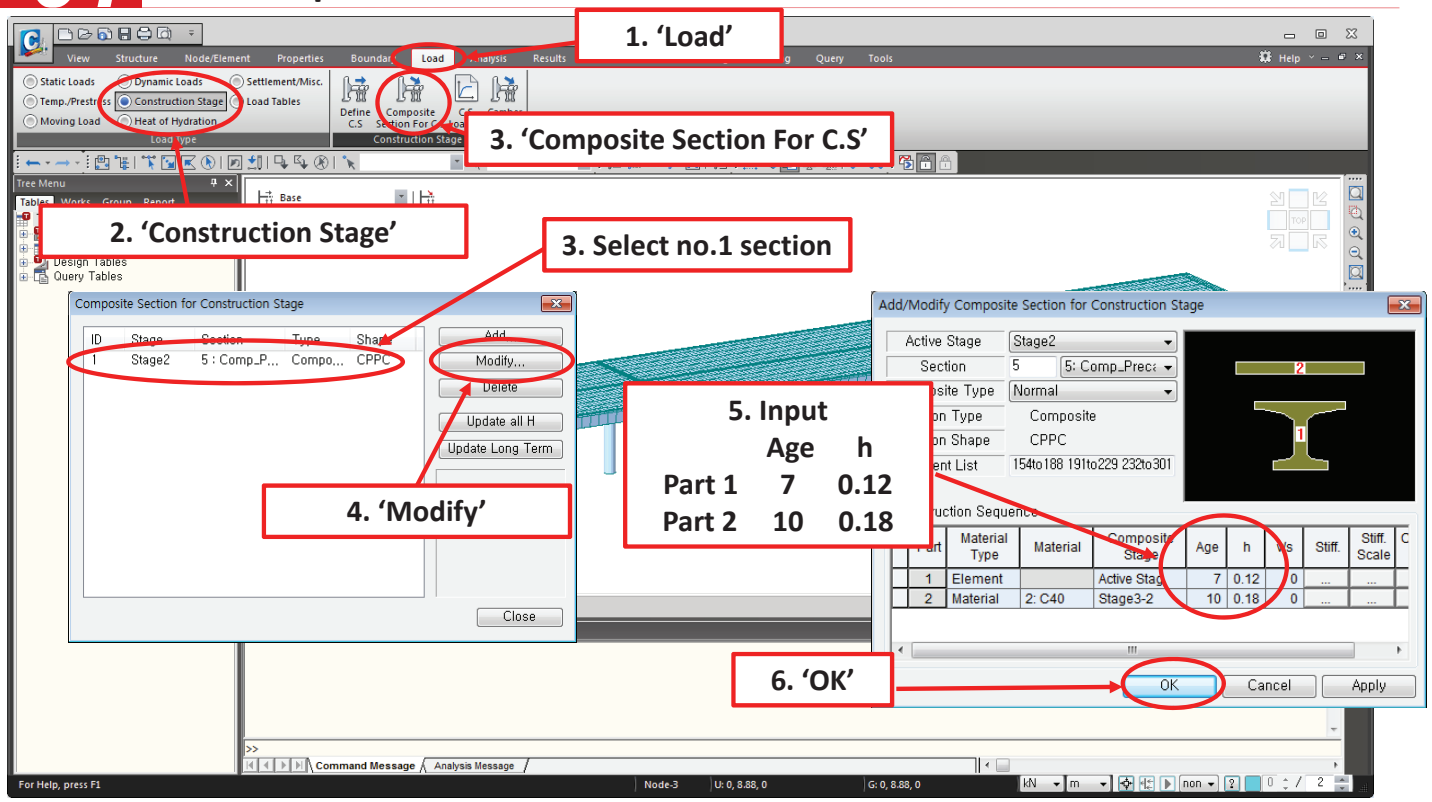
Apply time dependent material to Material which has been defined at the first step.

60 Time dependent Material



Procedure

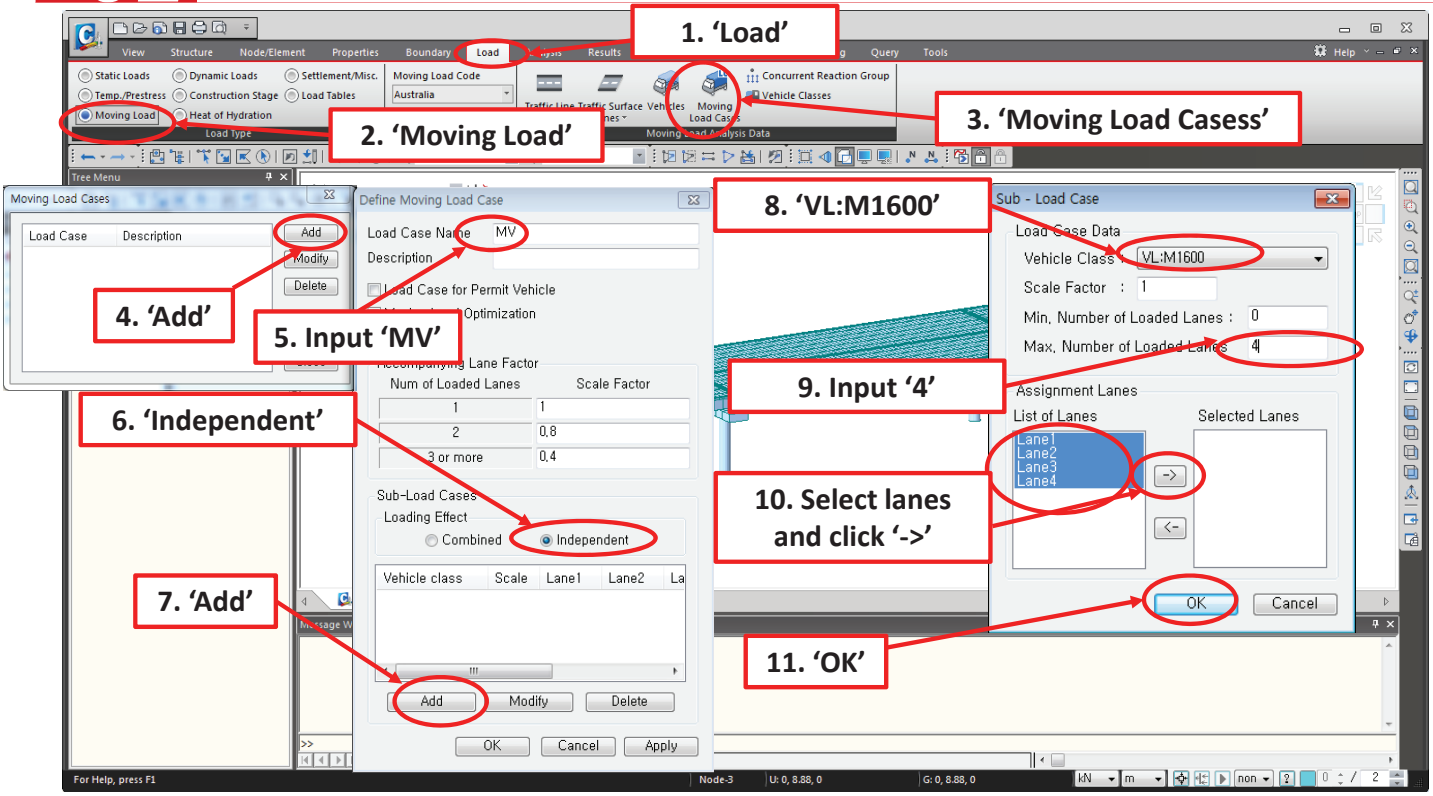
61 Time dependent Material



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.

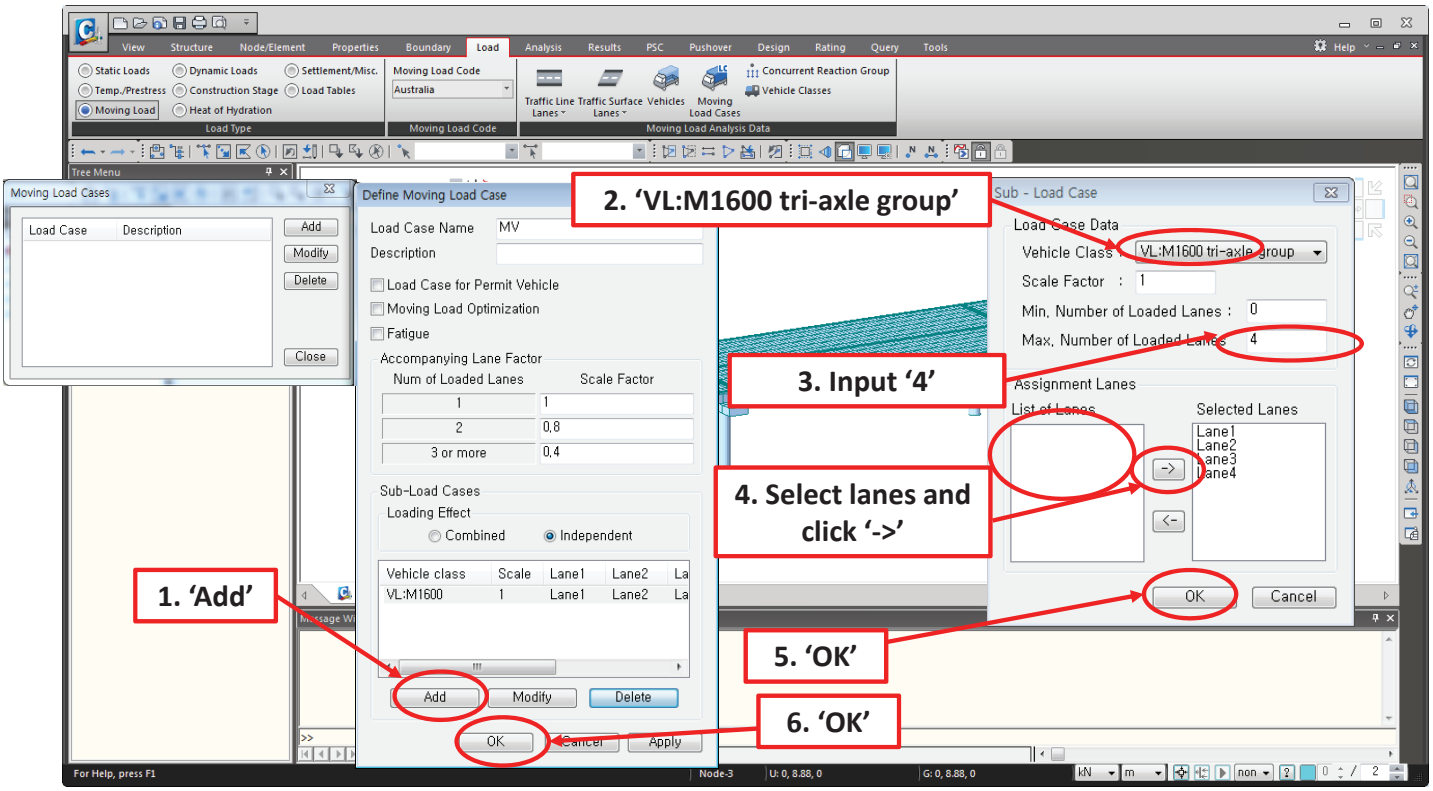
62 Moving Load



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.

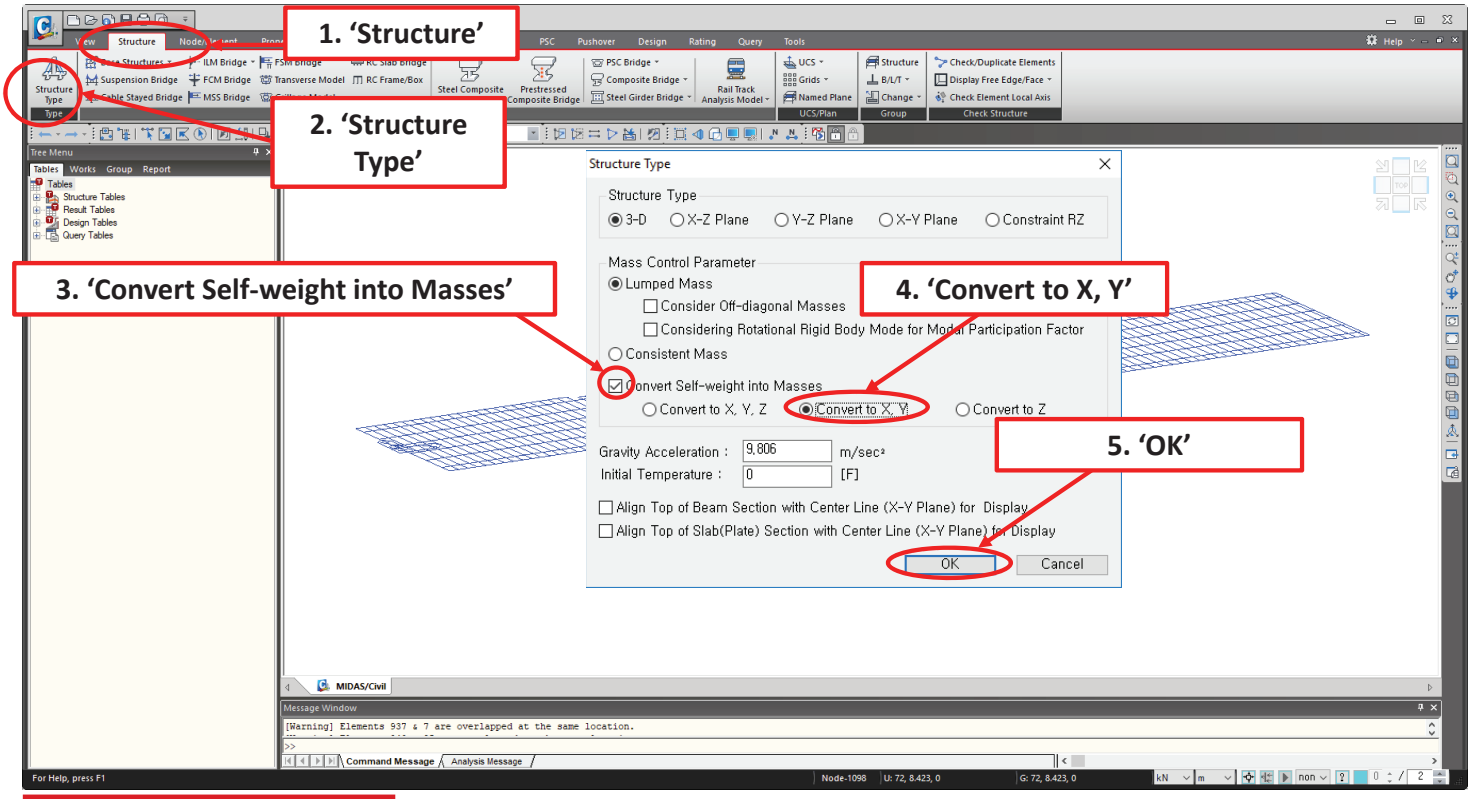
63 Moving Load



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.

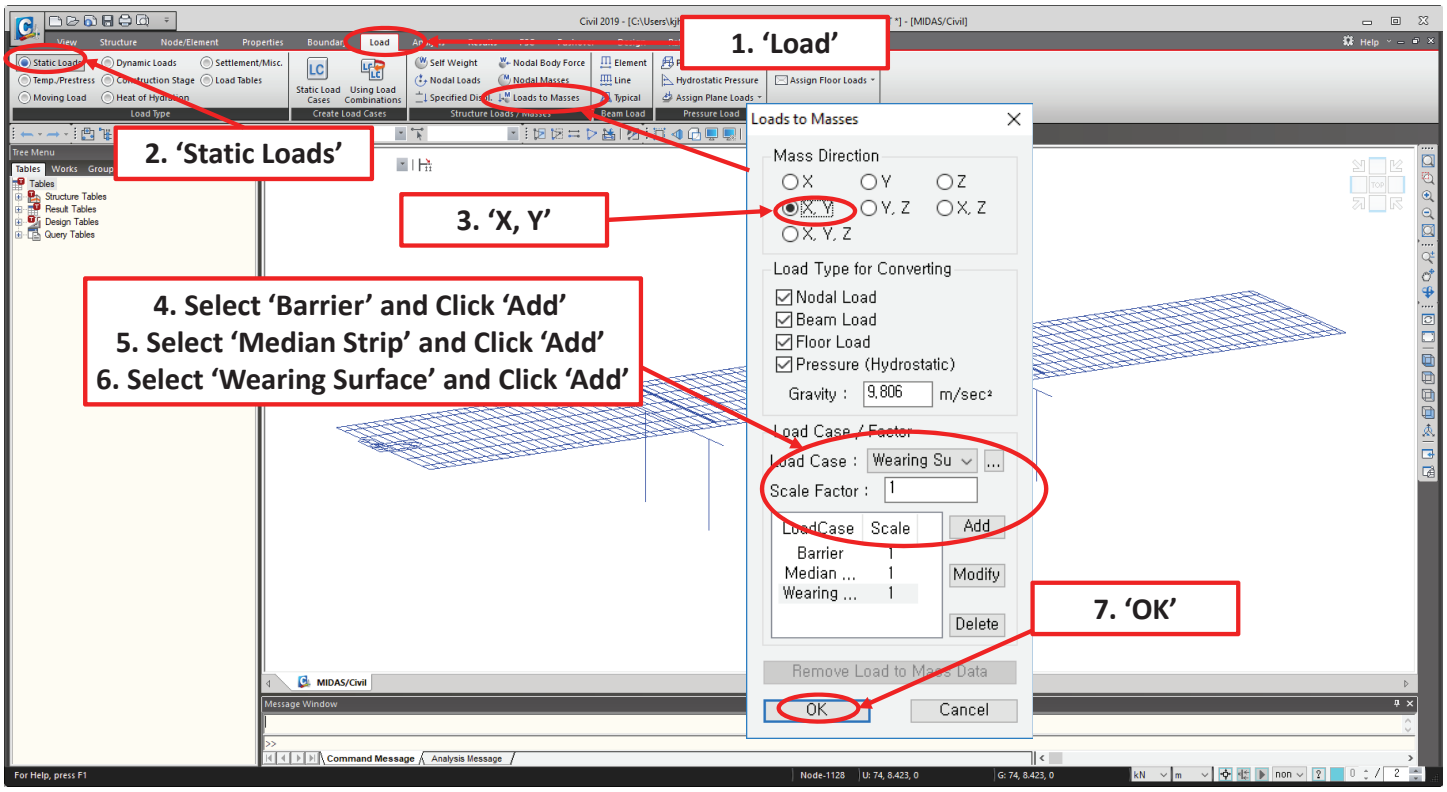
64 Define mass



Procedure

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

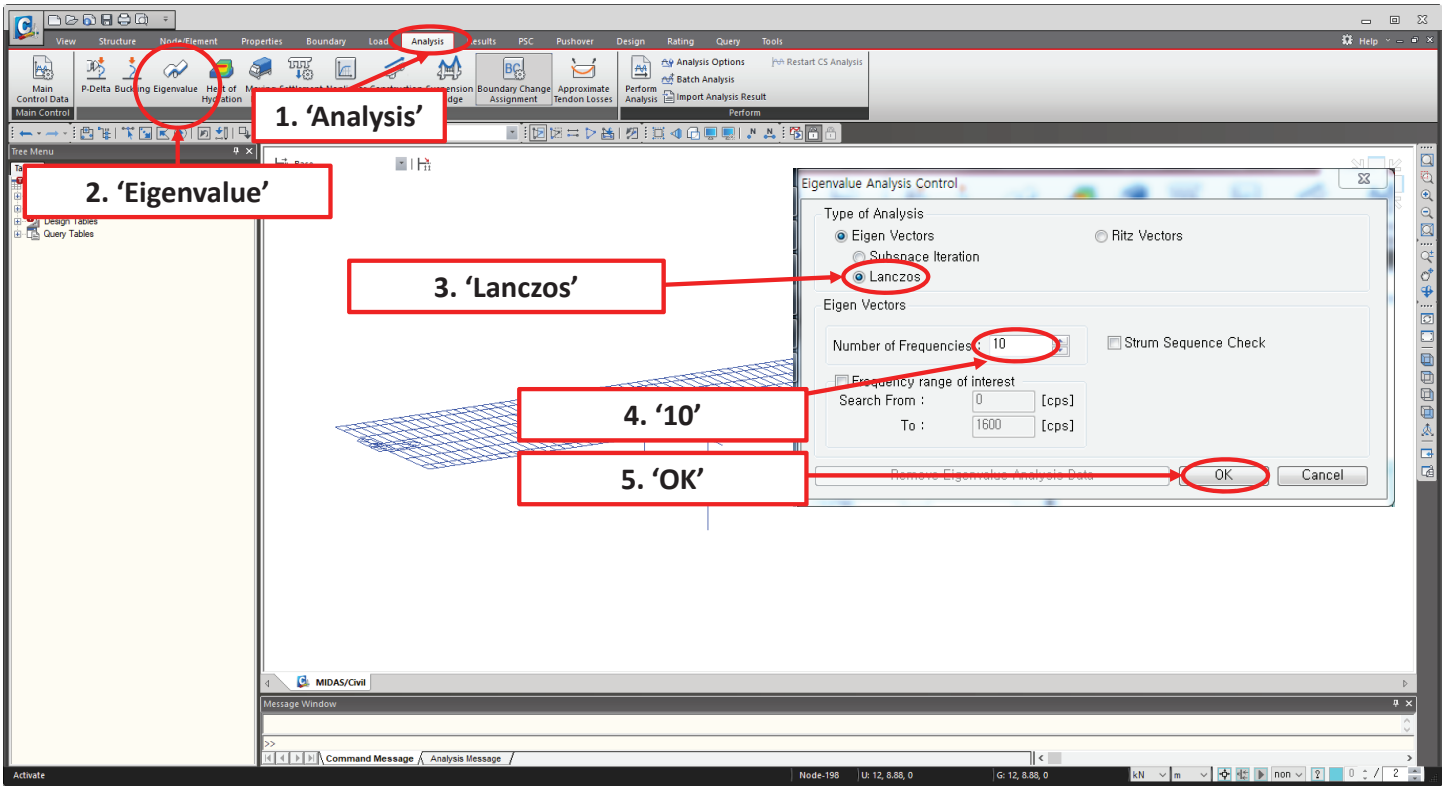
65 Define mass



Procedure

Convert the permanent dead load cases to masses.

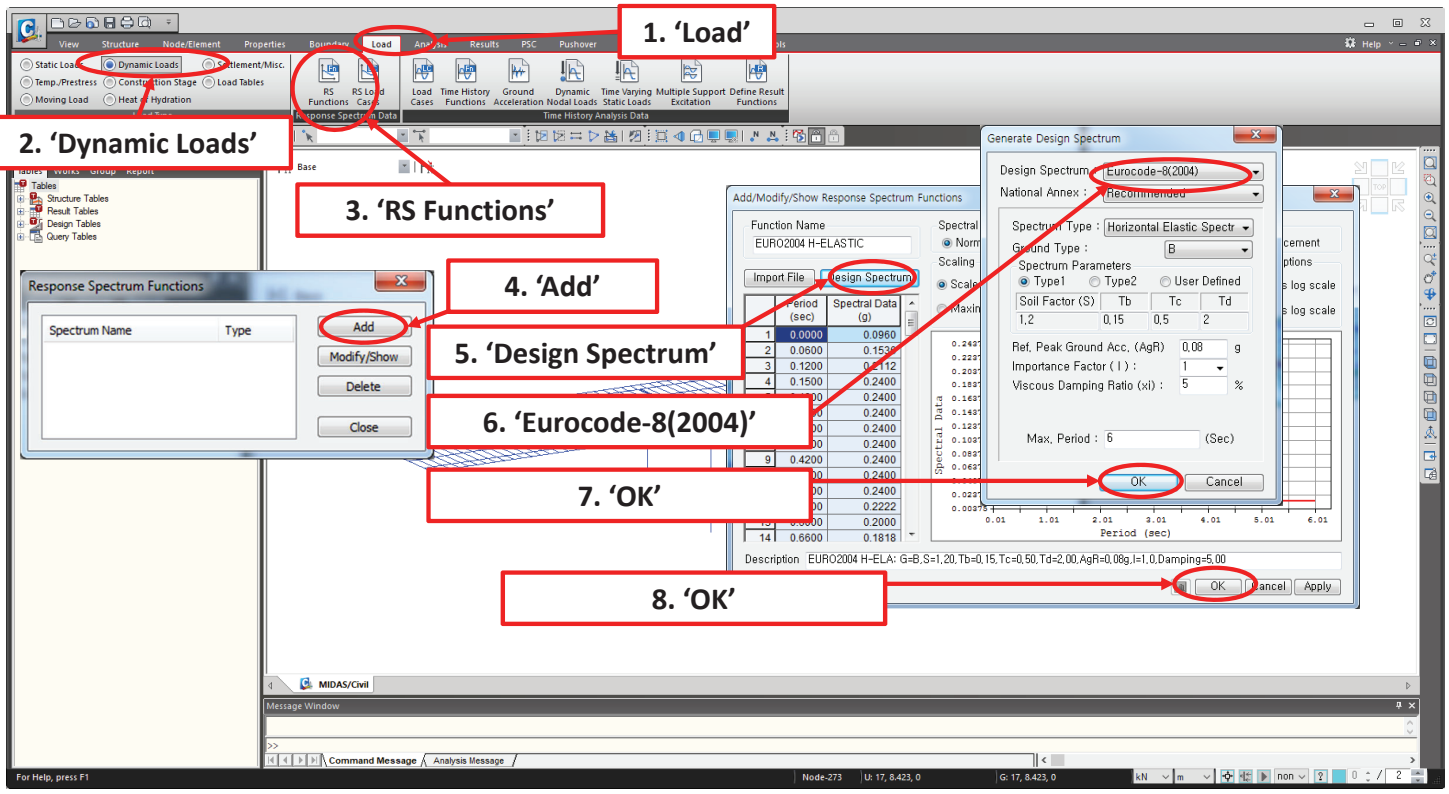
66 Eigenvalue analysis



Procedure

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

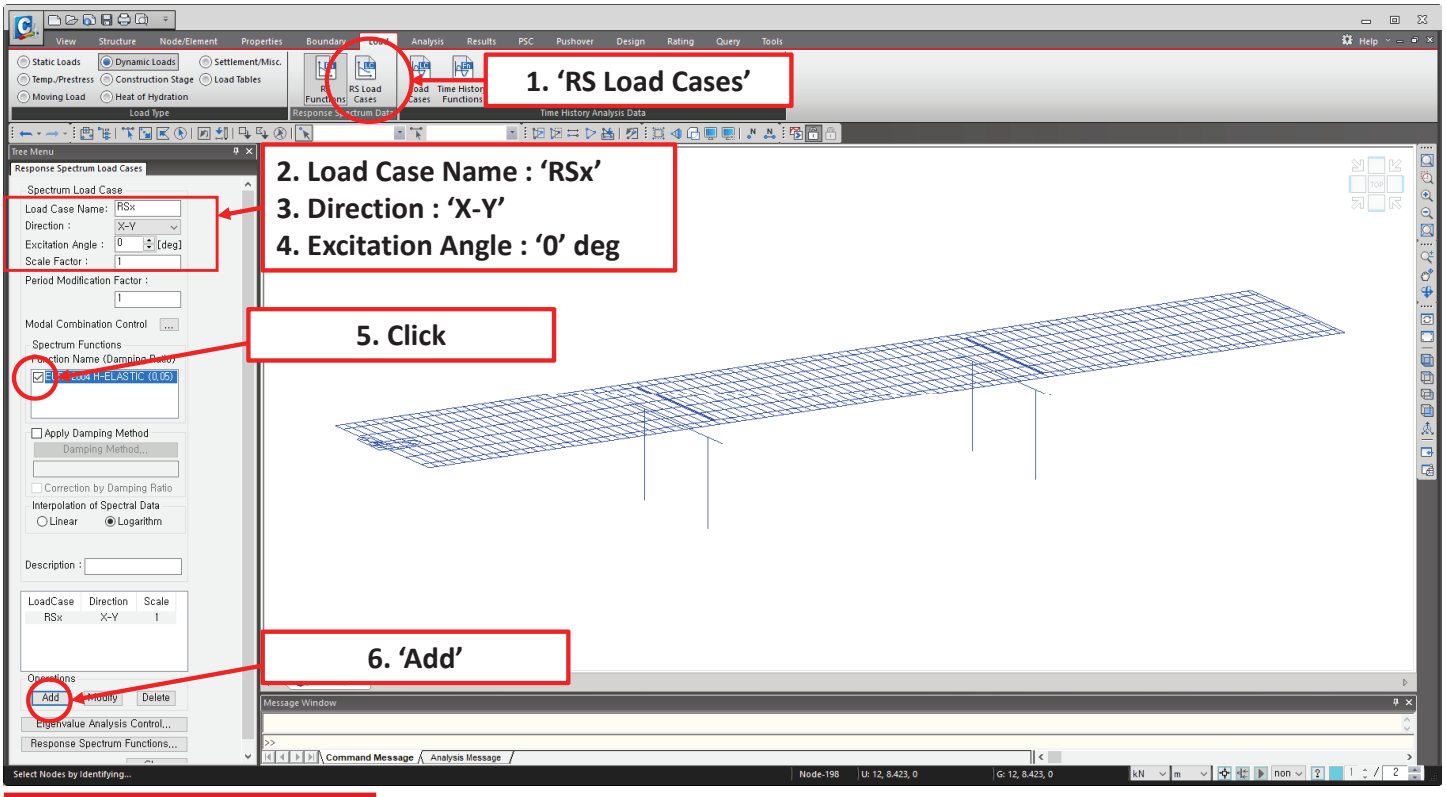
67 Response Spectrum analysis



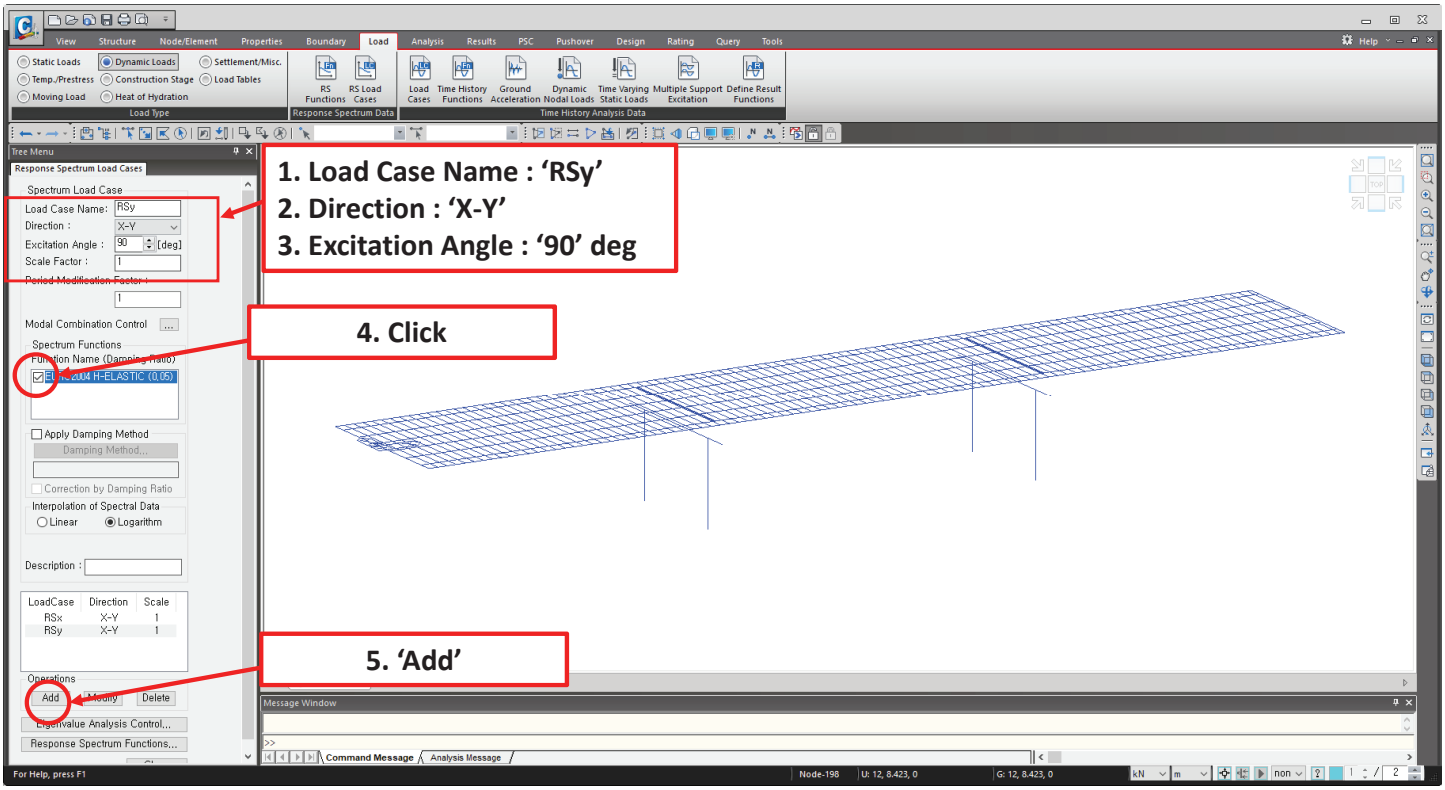
Procedure

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

68 Response Spectrum analysis



Procedure



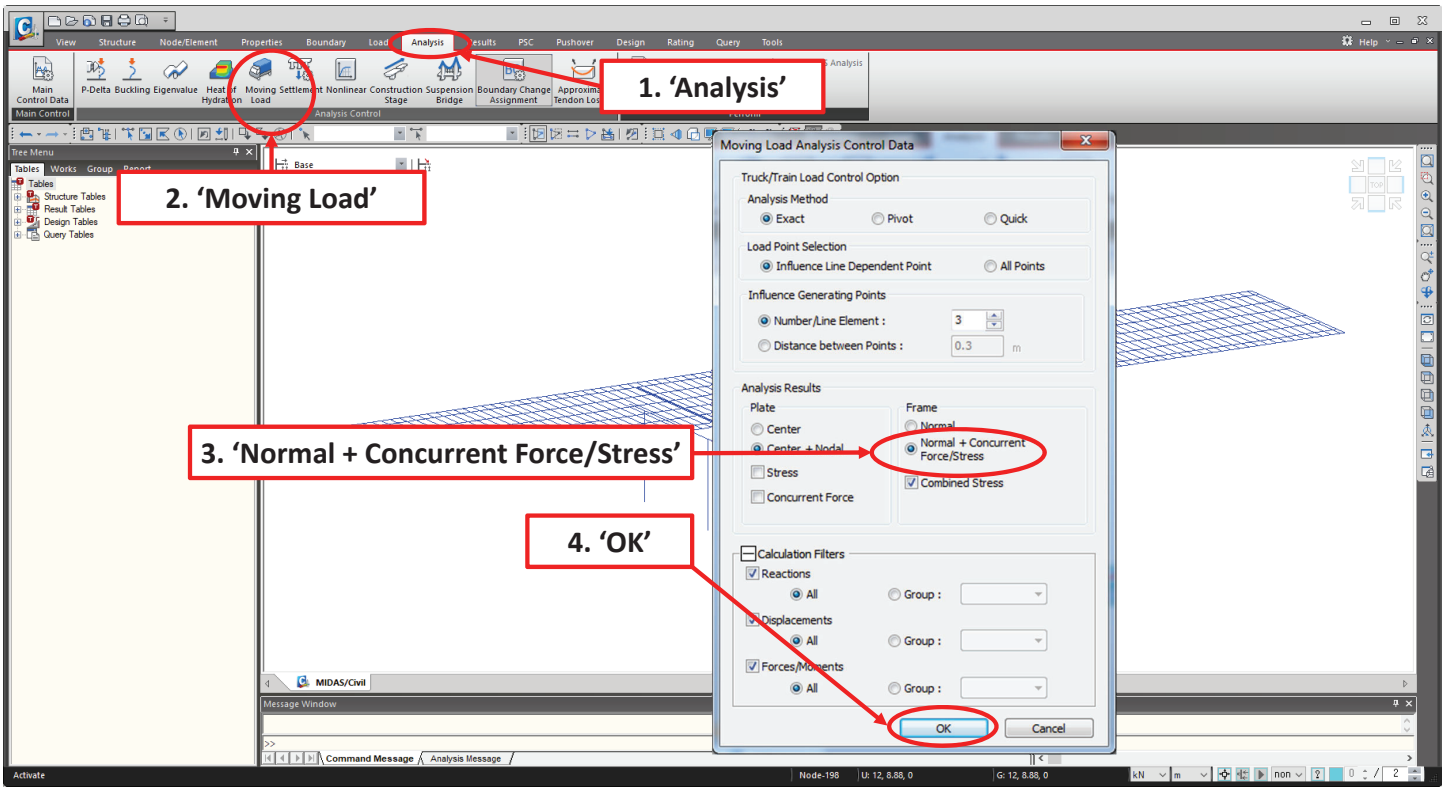
Procedure

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

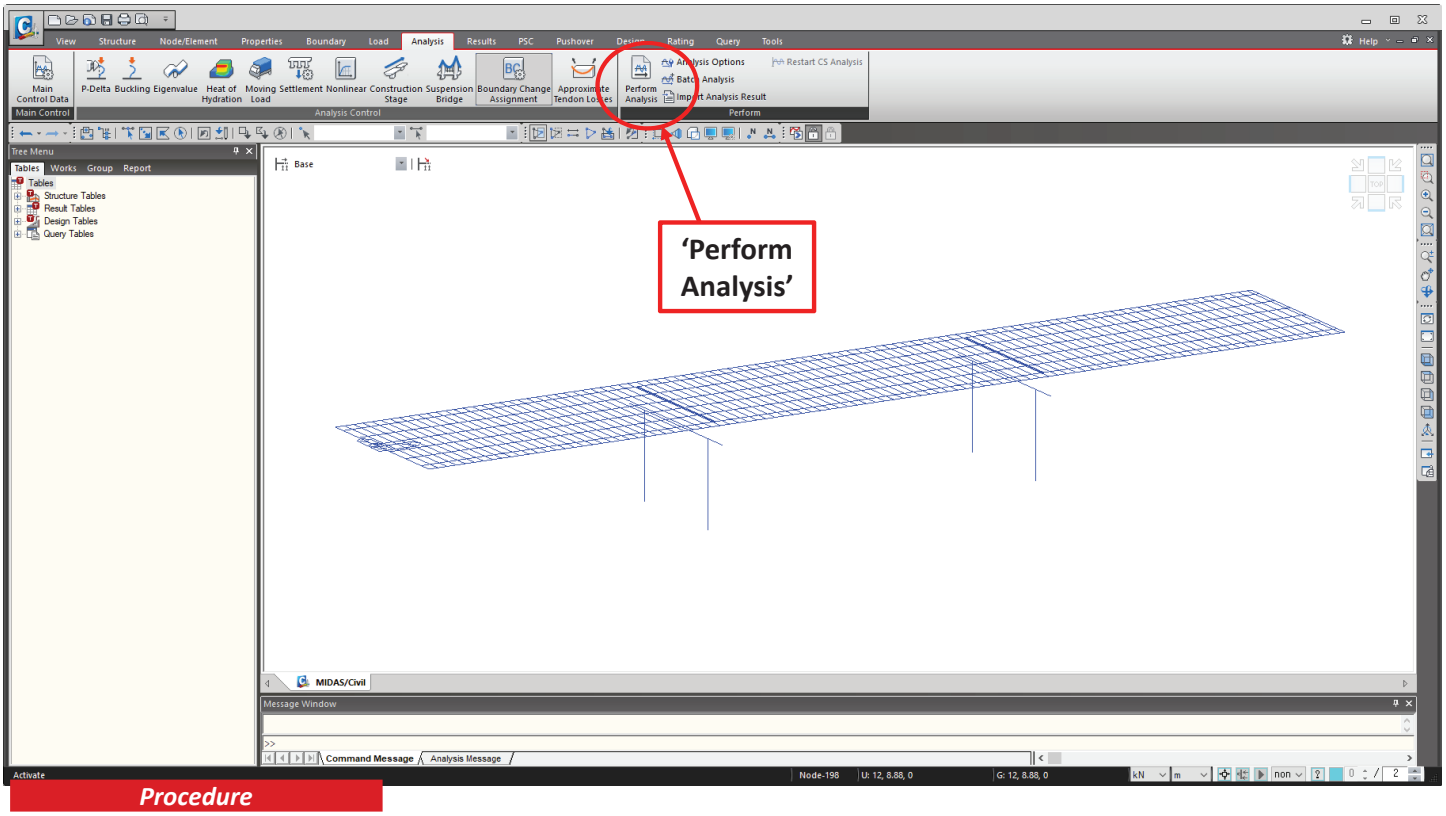
71 Perform Analysis



Procedure

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

72 Perform Analysis



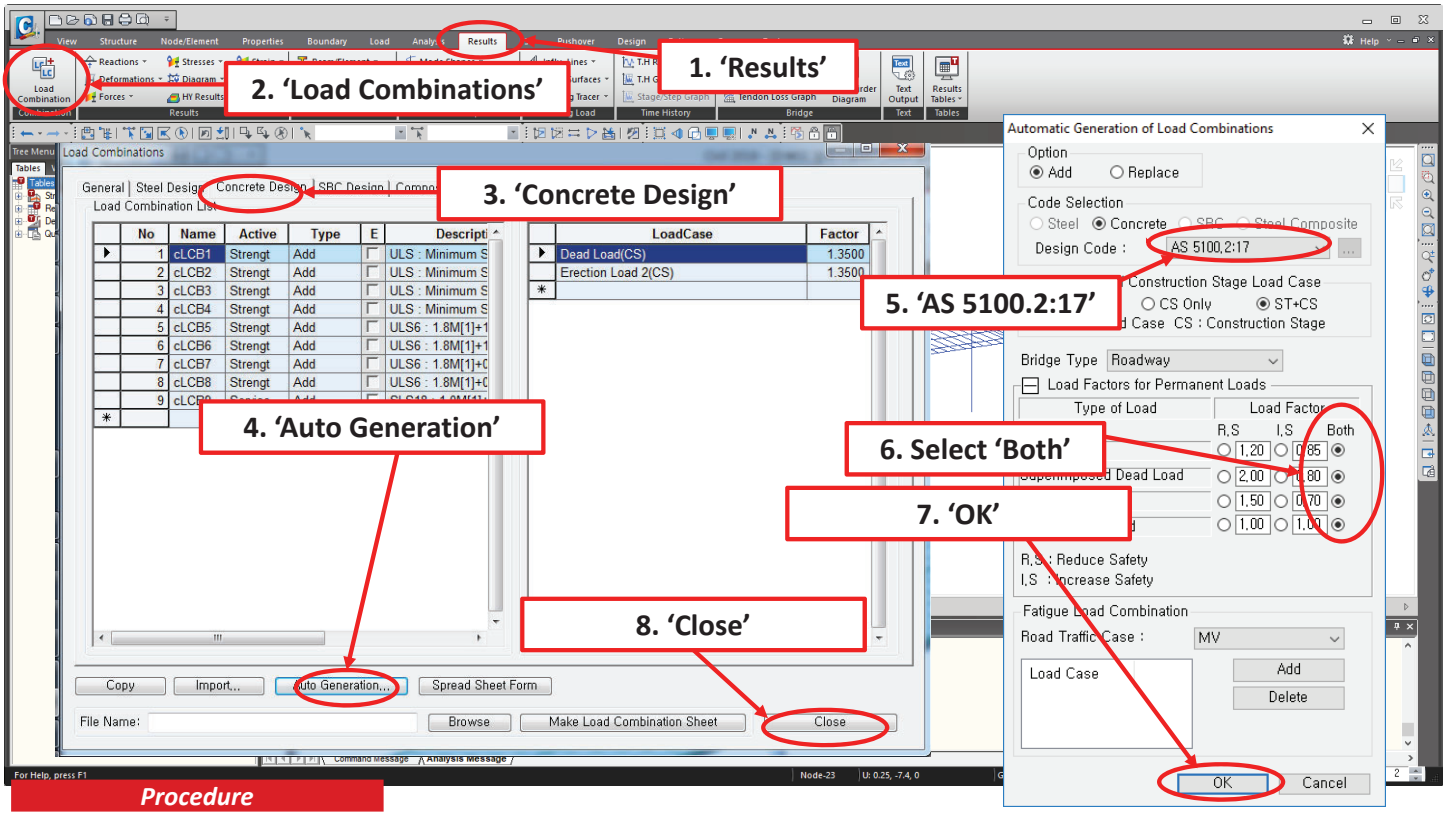
Procedure

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

Overview

Step 5. Results

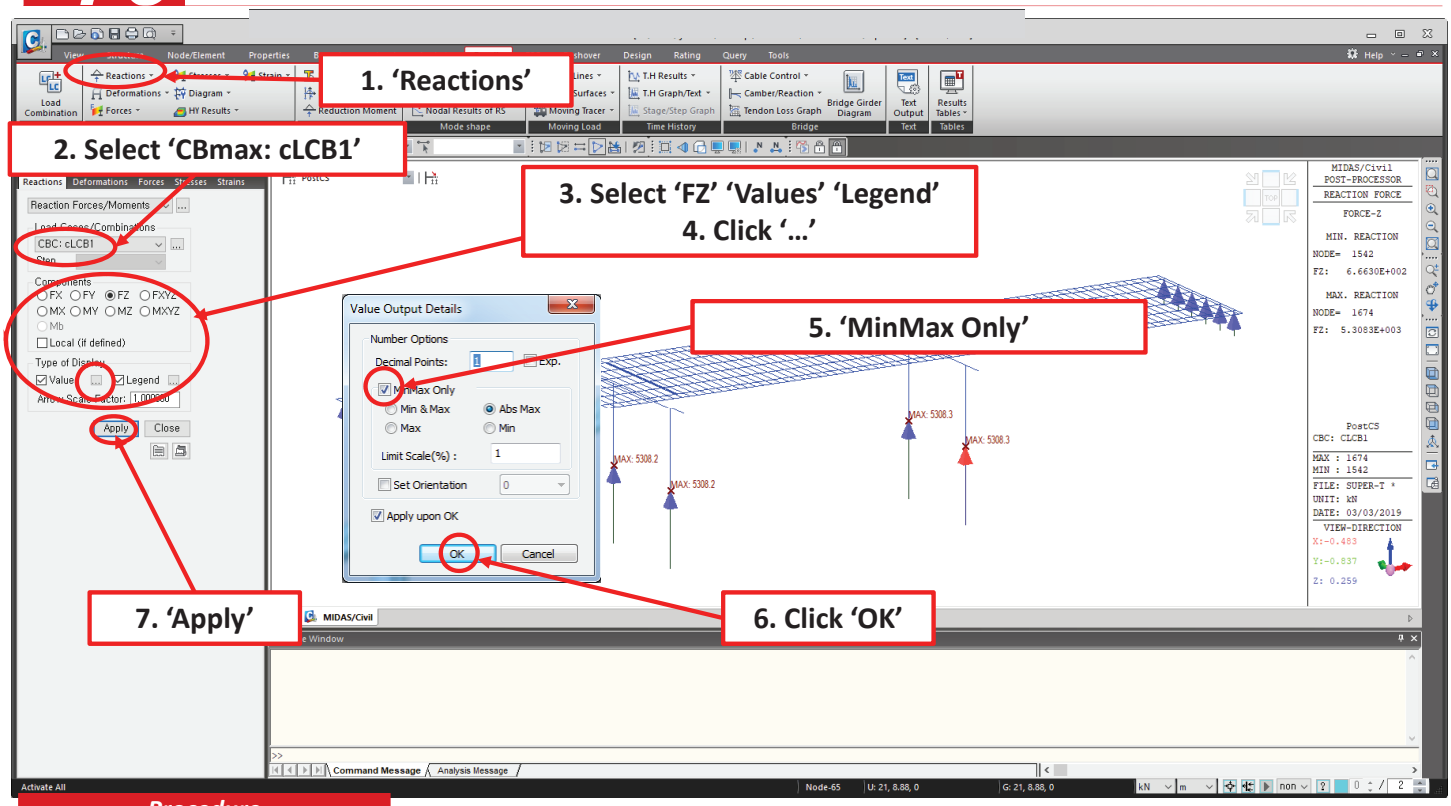
74 Load Combination



Procedure

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

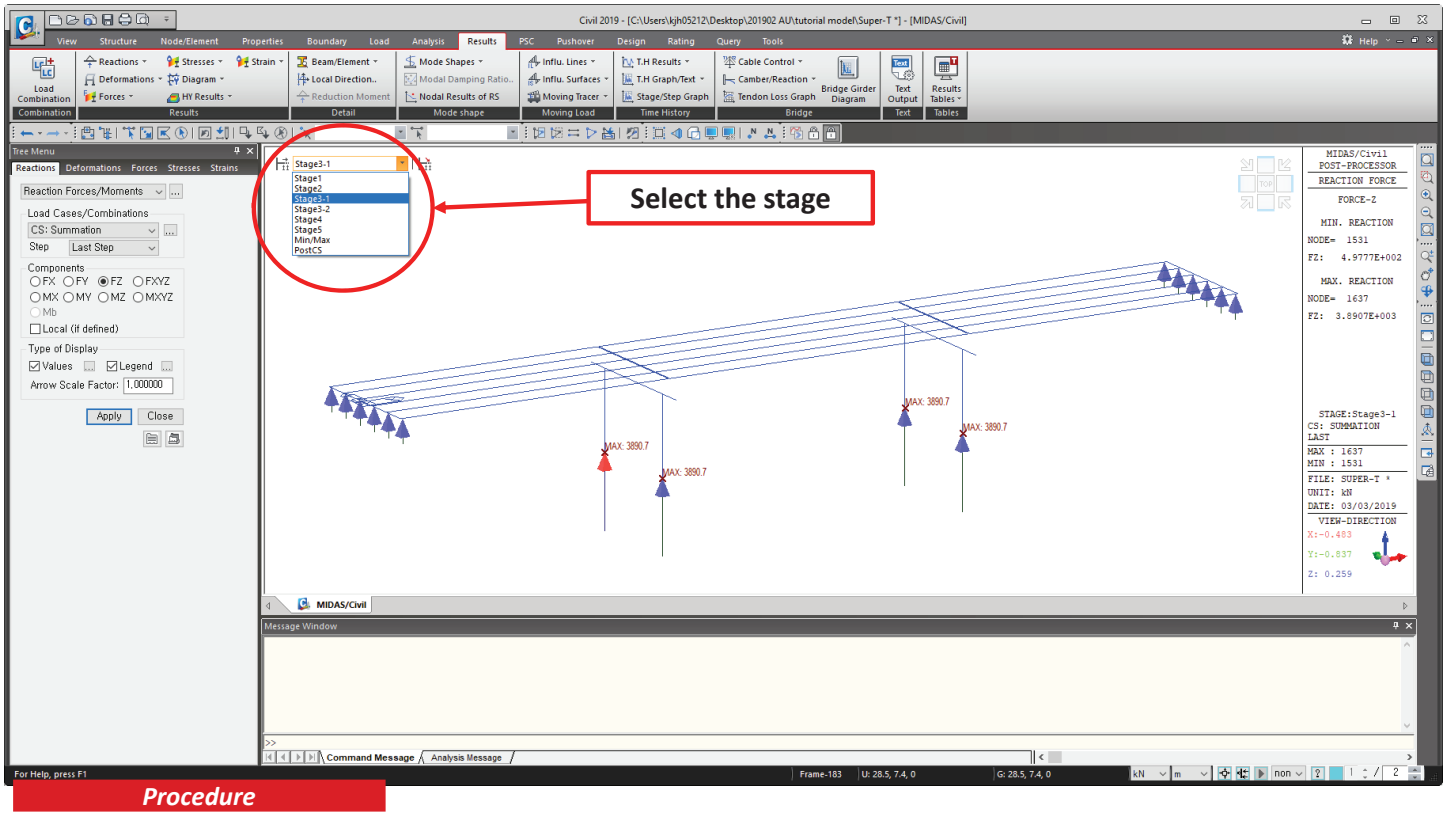
75 Reaction / Force / Displacement



Procedure

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

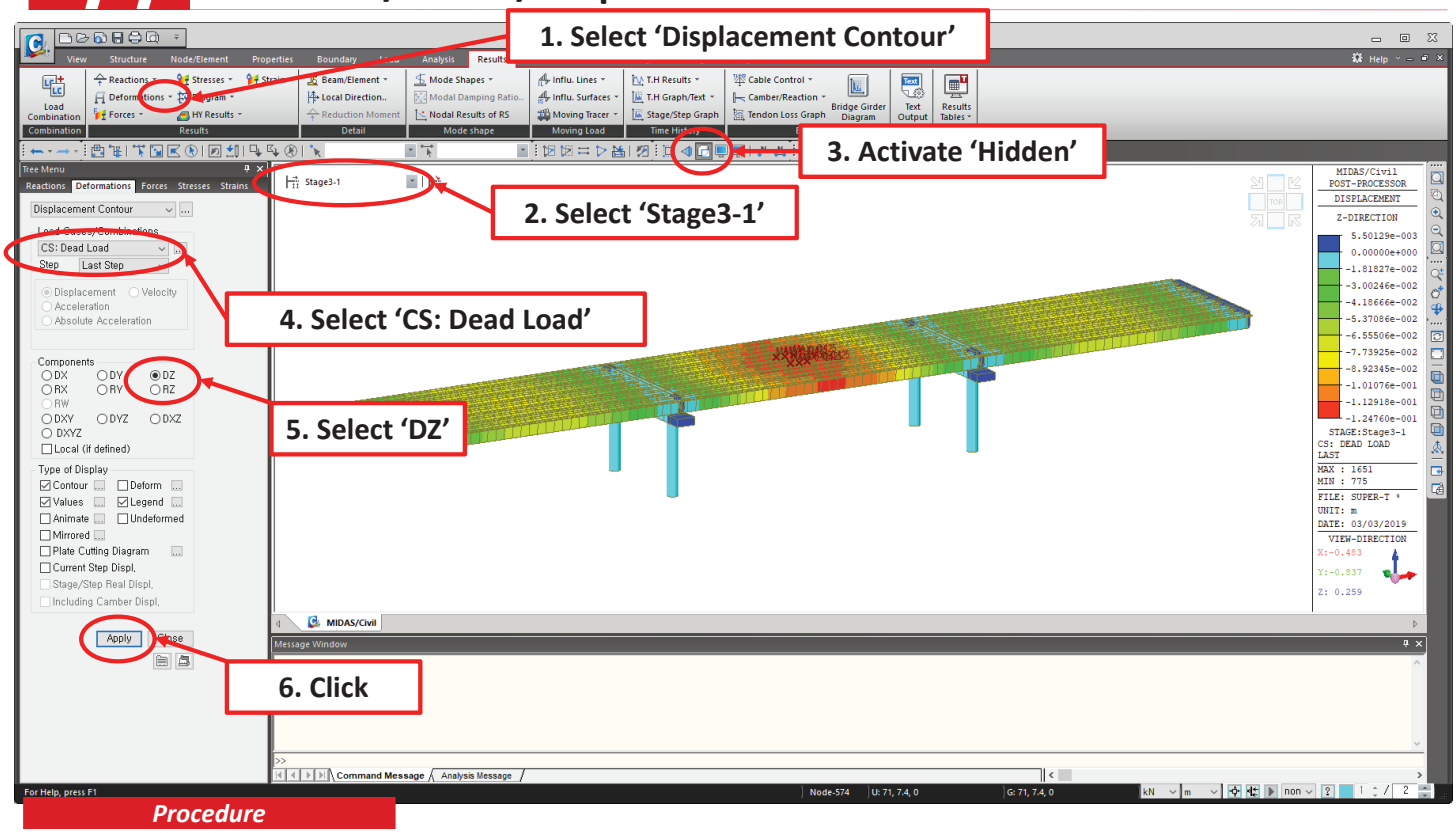
76 Reaction / Force / Displacement



Procedure

Check the results along the stages.

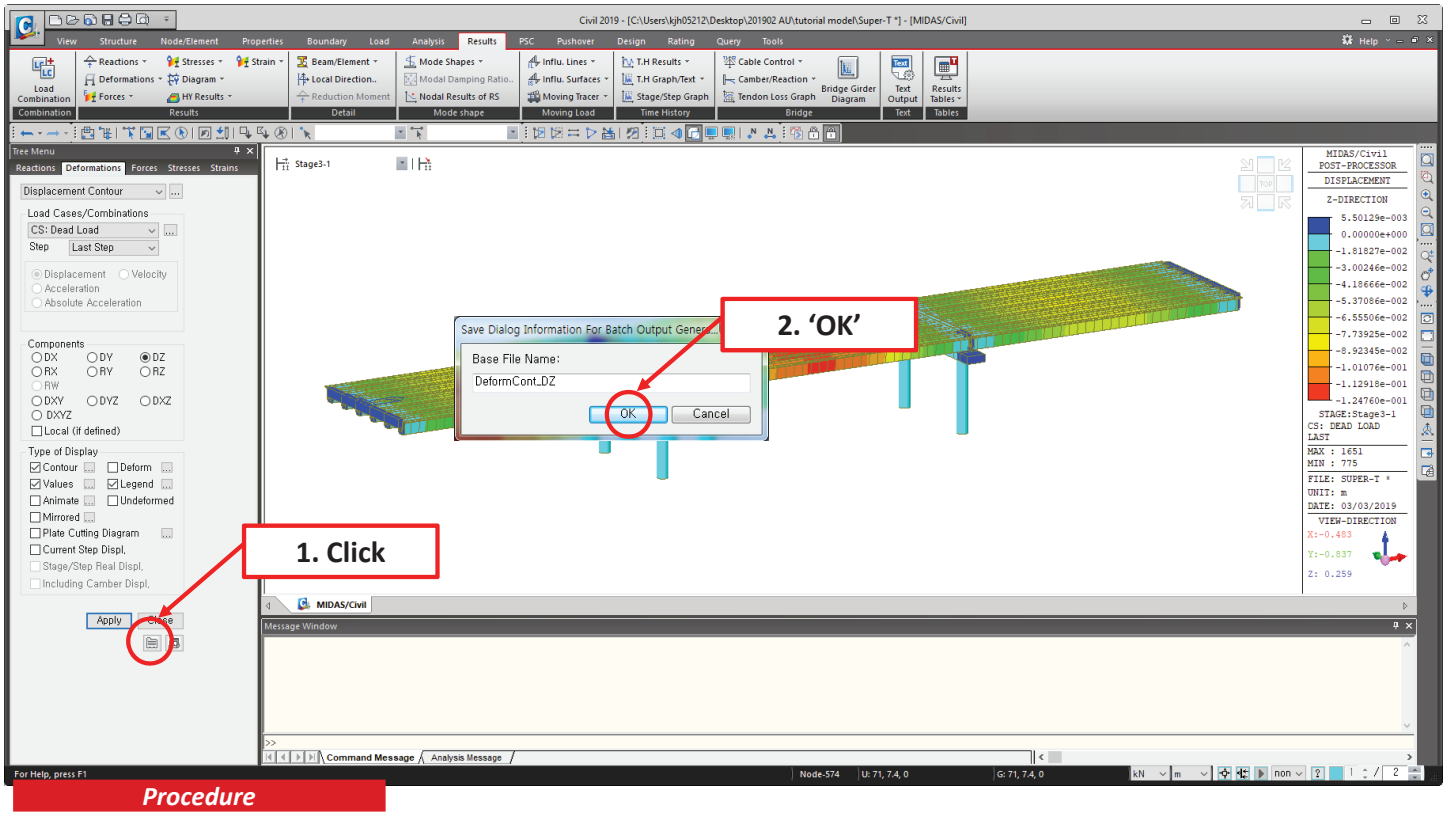
77 Reaction / Force / Displacement



Procedure

Check the results under dead load along the stages.

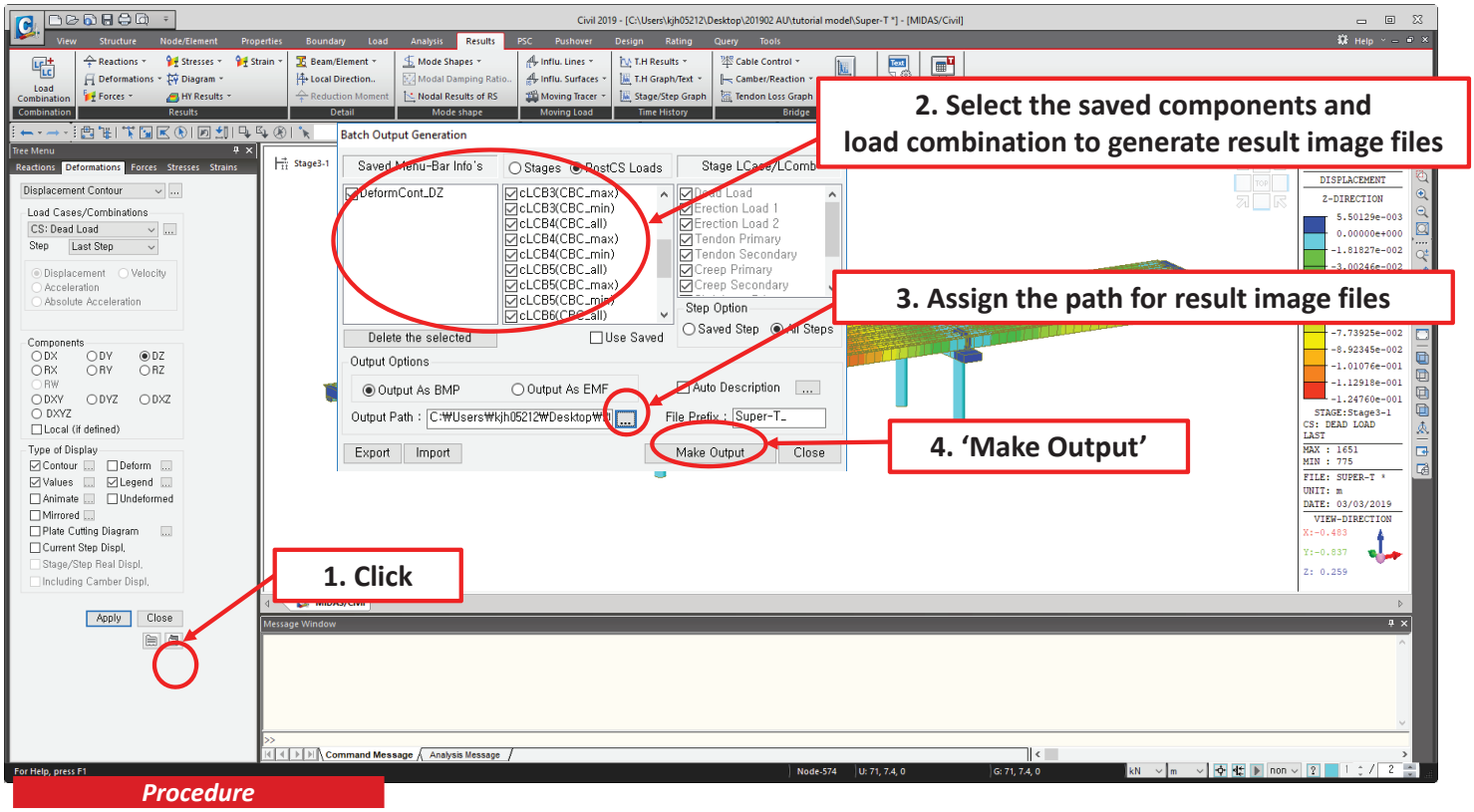
78 Reaction / Force / Displacement



Procedure

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

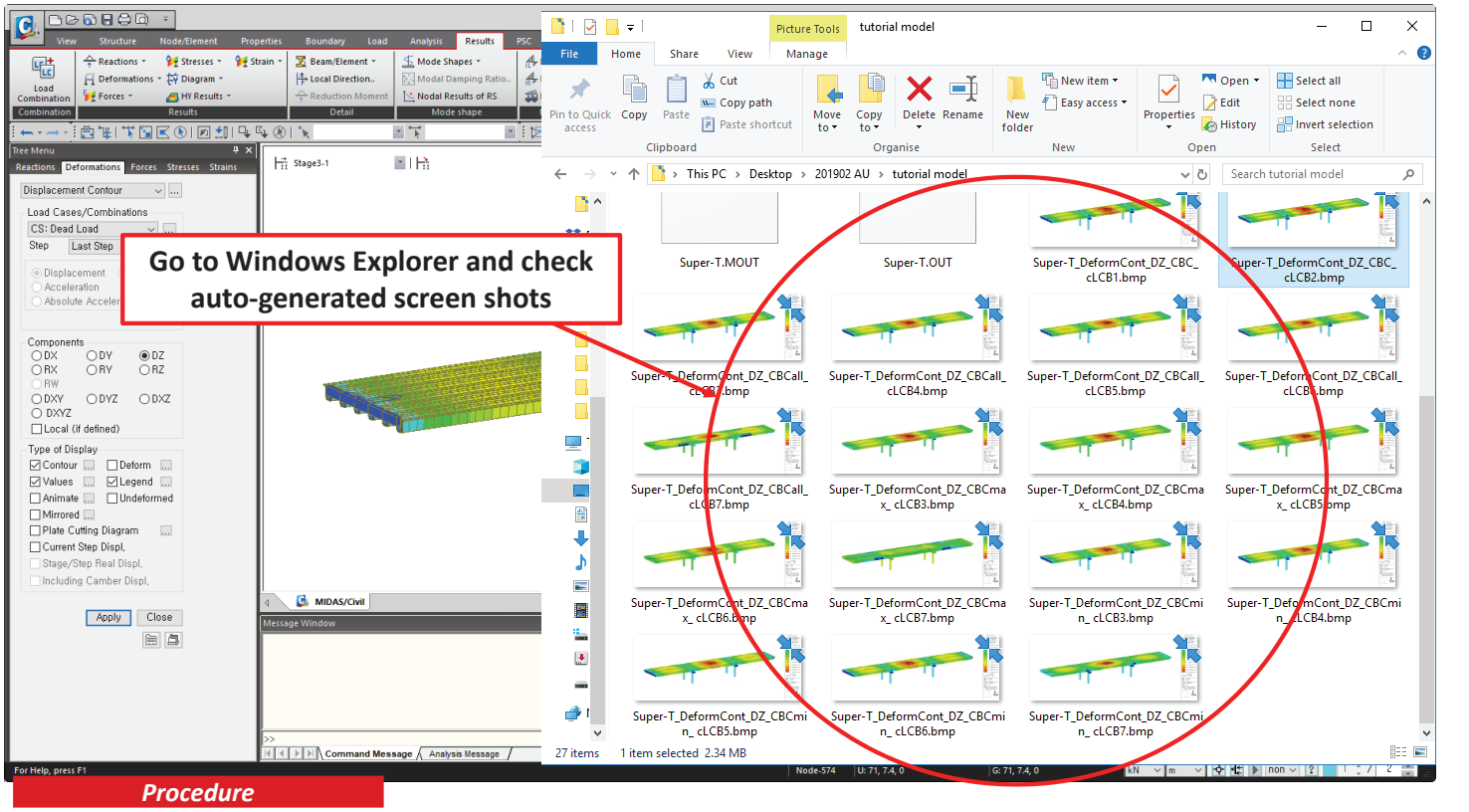
79 Reaction / Force / Displacement



Procedure

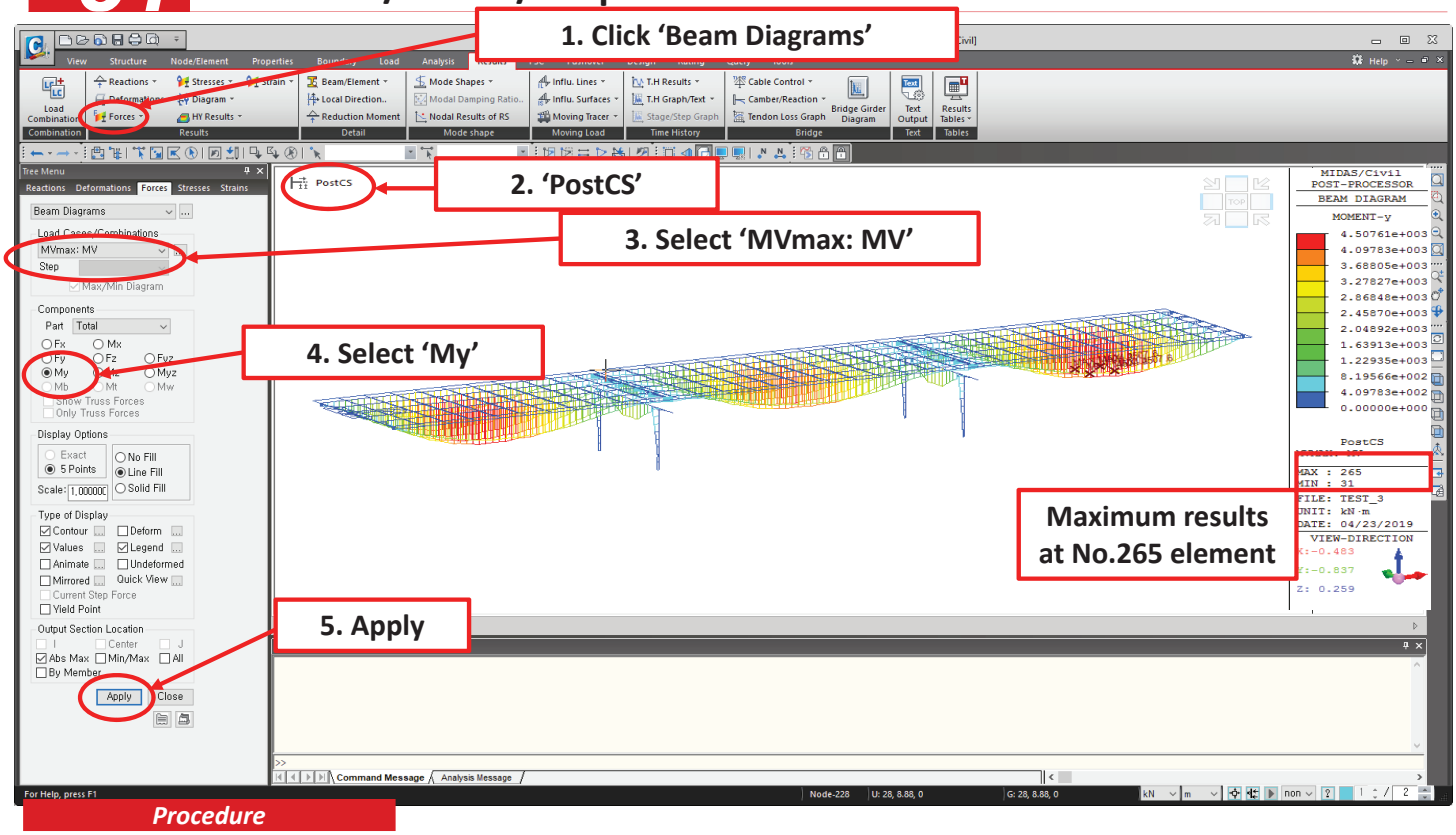
Select the saved components and load cases(load combinations) to create screen shots.

80 Reaction / Force / Displacement



Procedure

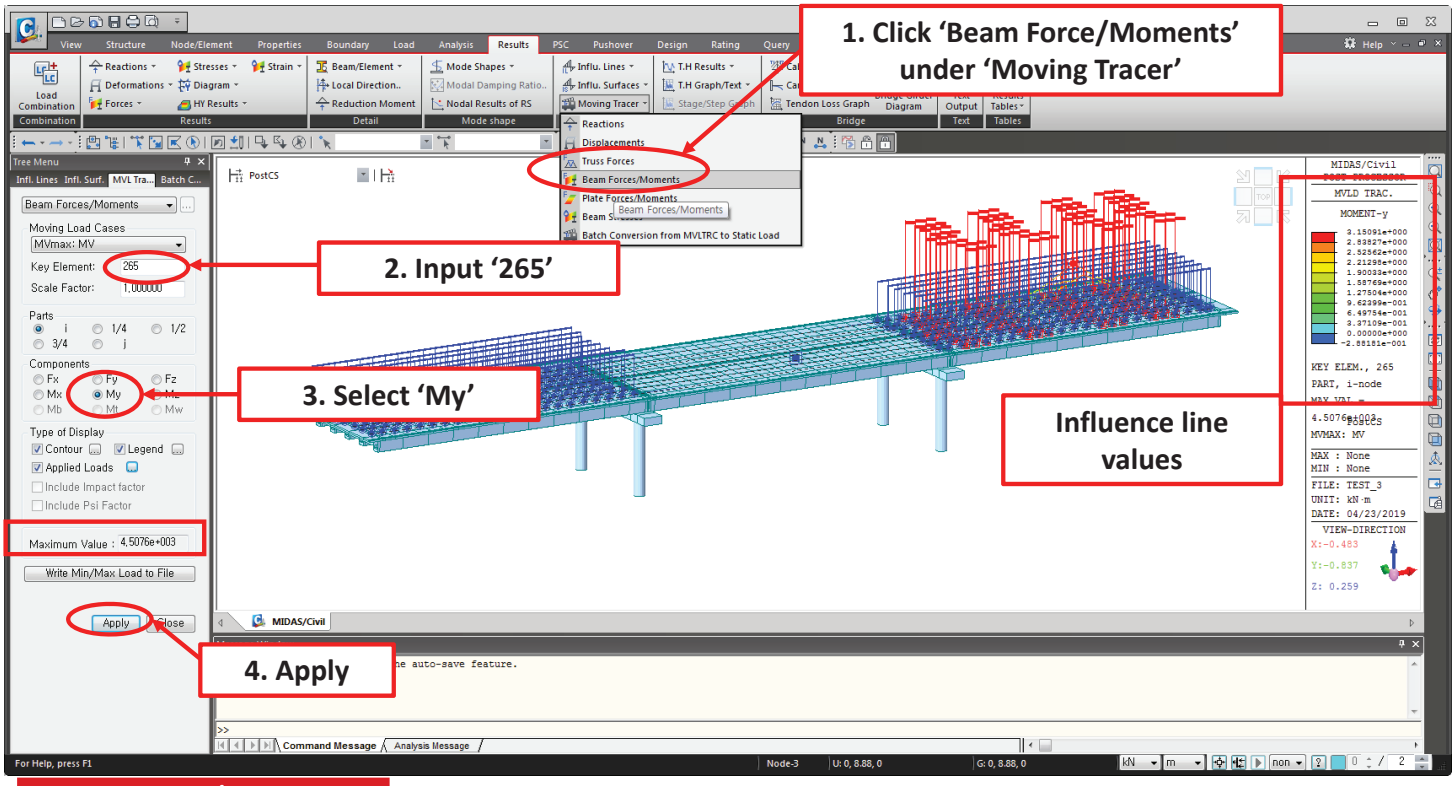
81 Reaction / Force / Displacement



Procedure

Check the beam moment diagram under moving load

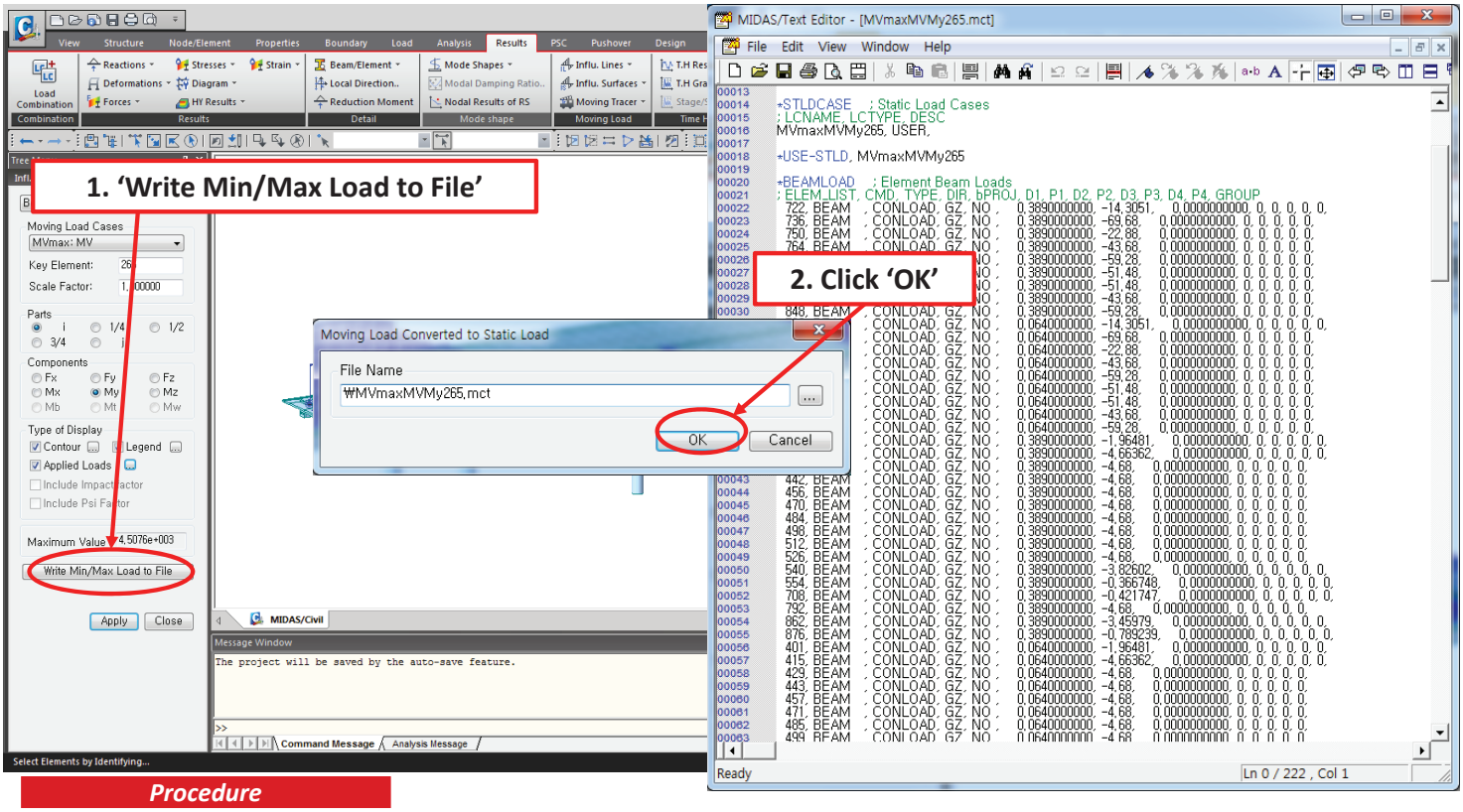
82 Moving Tracer



Procedure

Check the ciritical location of the vehicles.

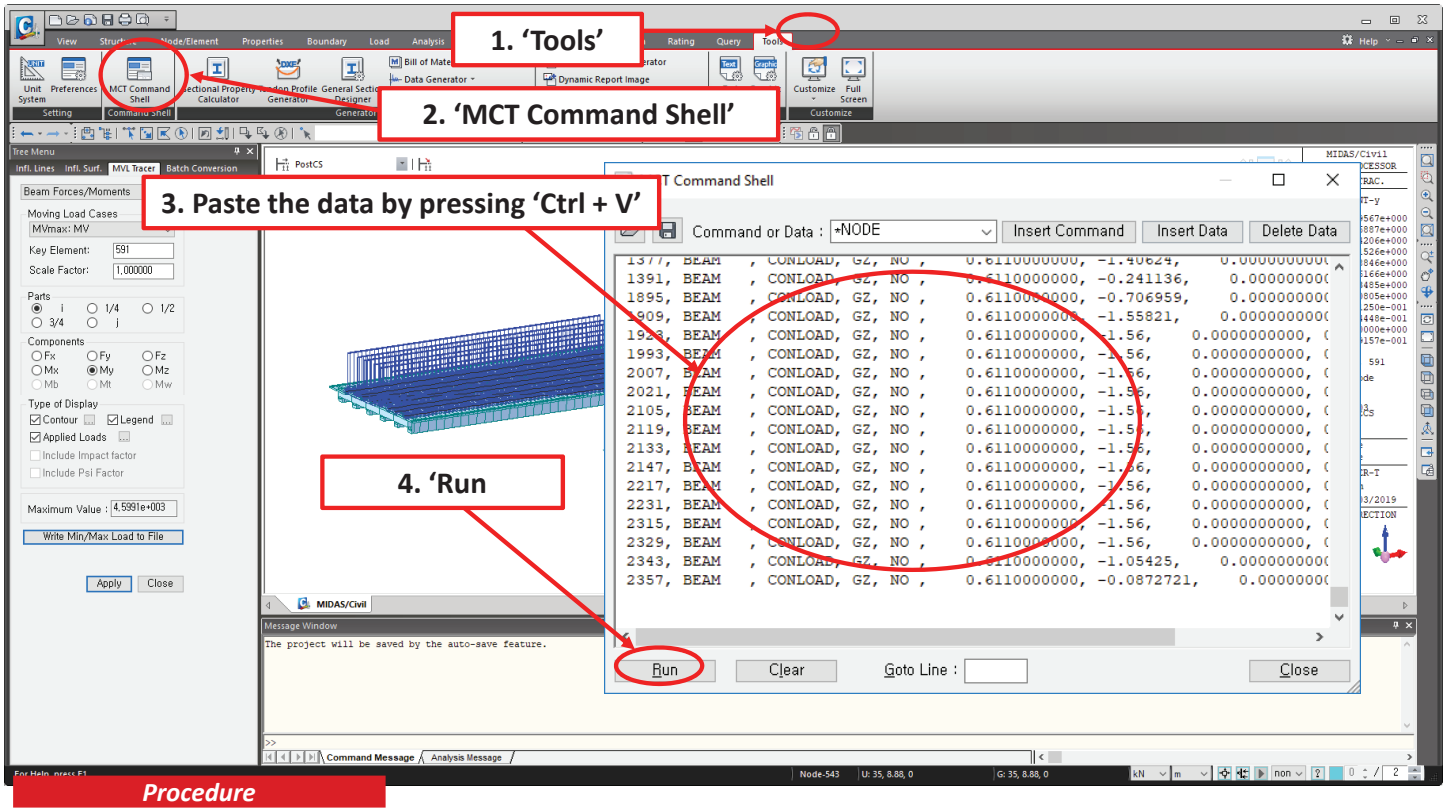
83 Moving Tracer



Procedure

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

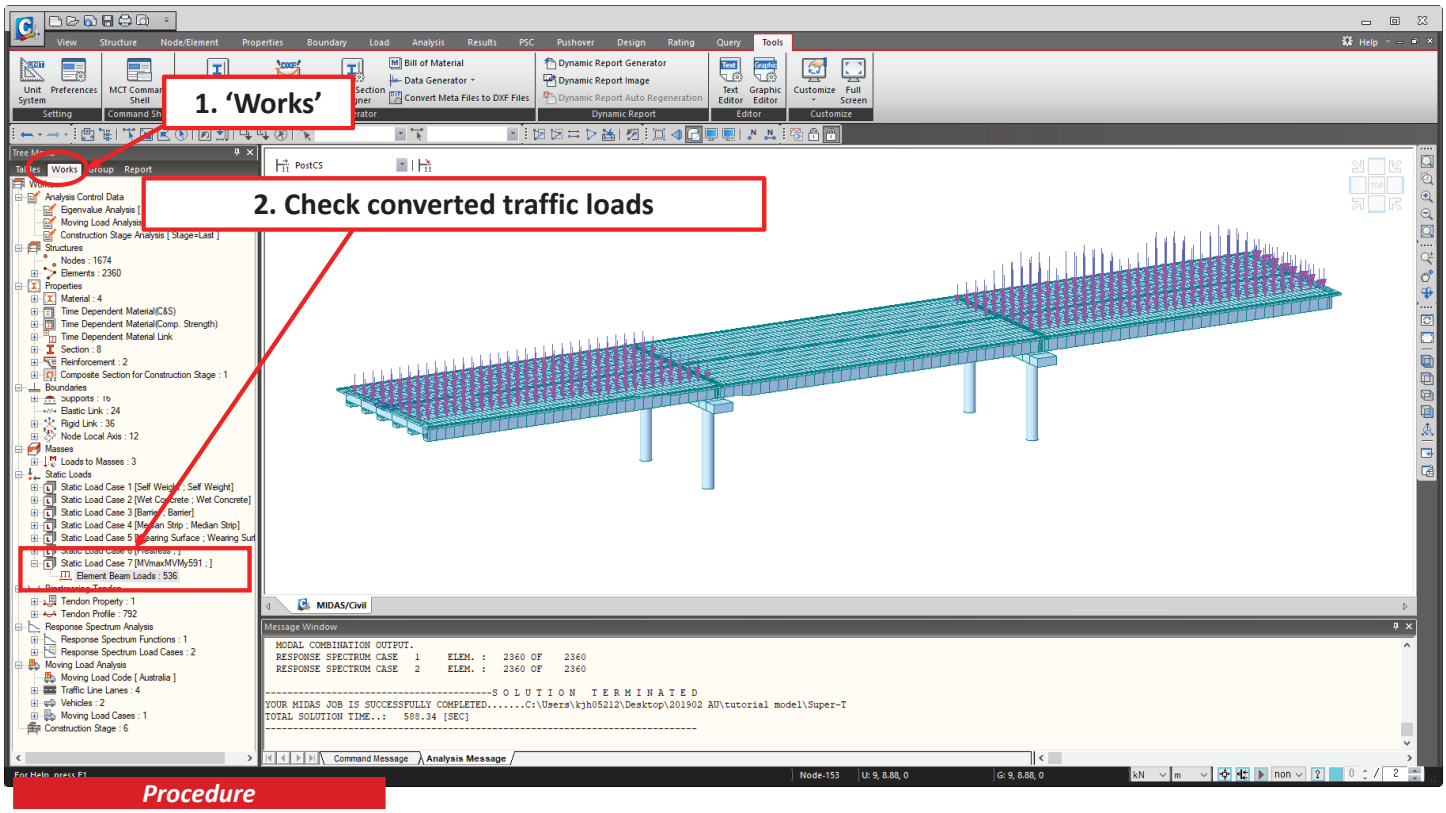
84 Moving Tracer



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.

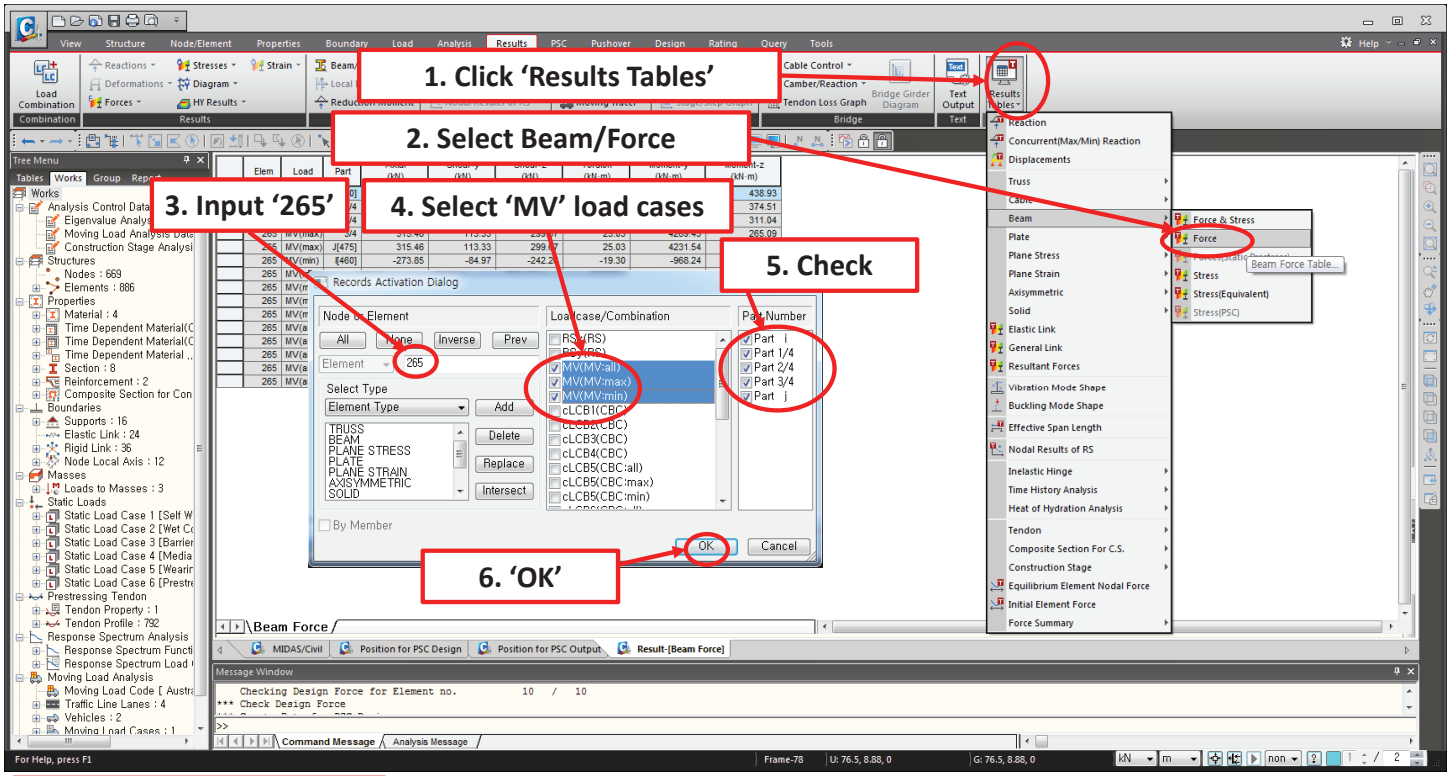
85 Moving Tracer



Procedure

Check imported vertical static load Case.

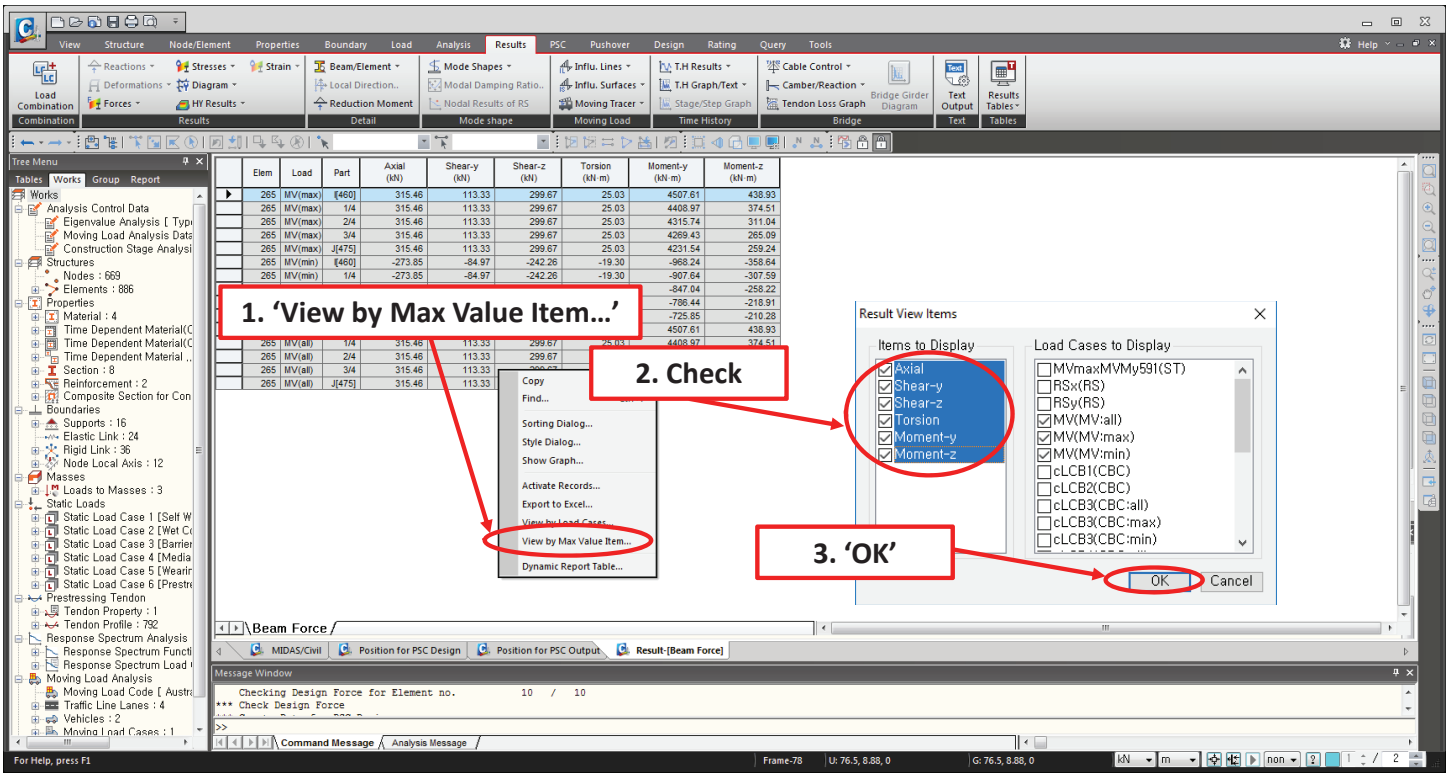
86 Concurrent Force



Procedure

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

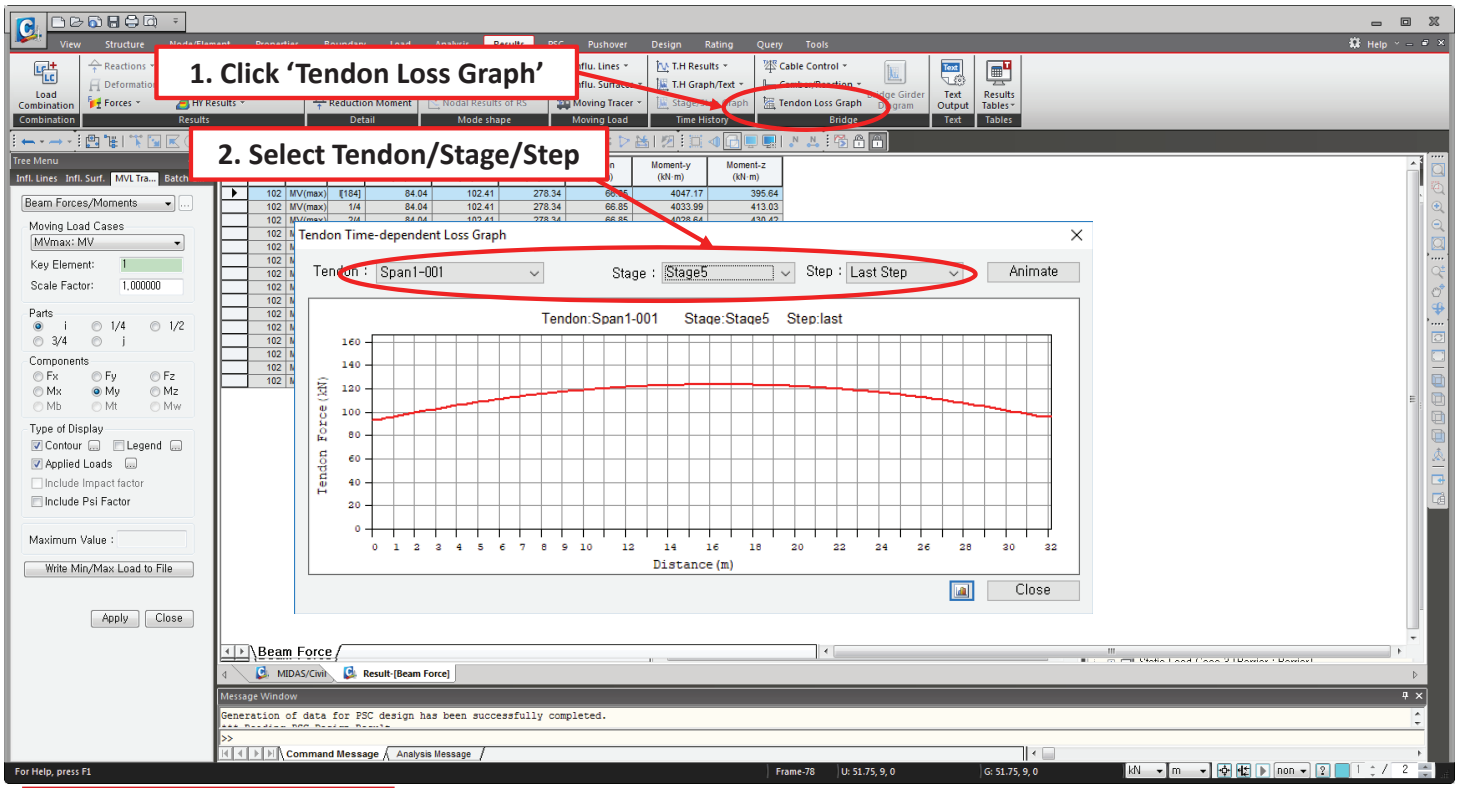
87 Concurrent Force



Procedure

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

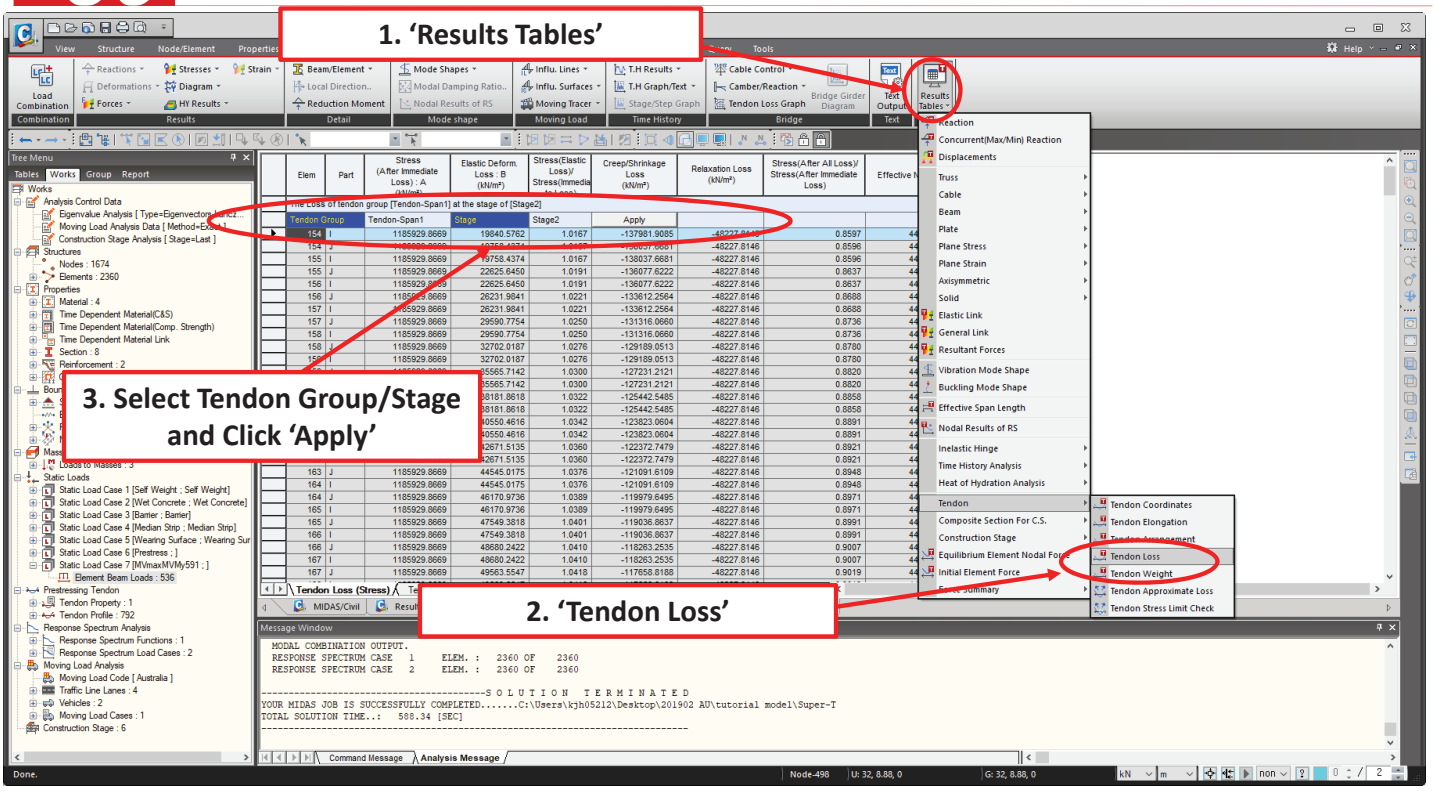
88 Tendon Losses



Procedure

Check tendon losses with graph format.

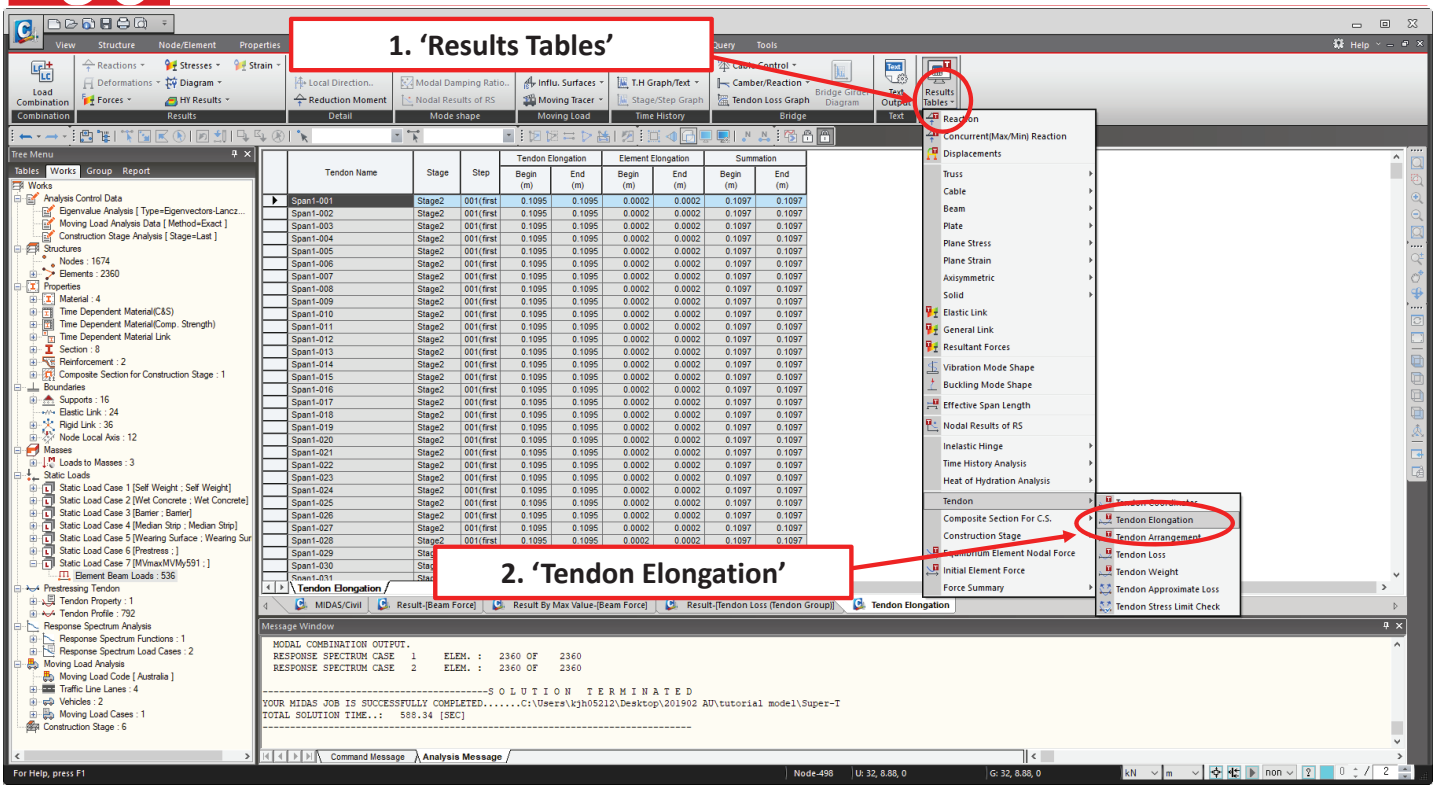
89 Tendon Losses



Procedure

Check tendon losses.

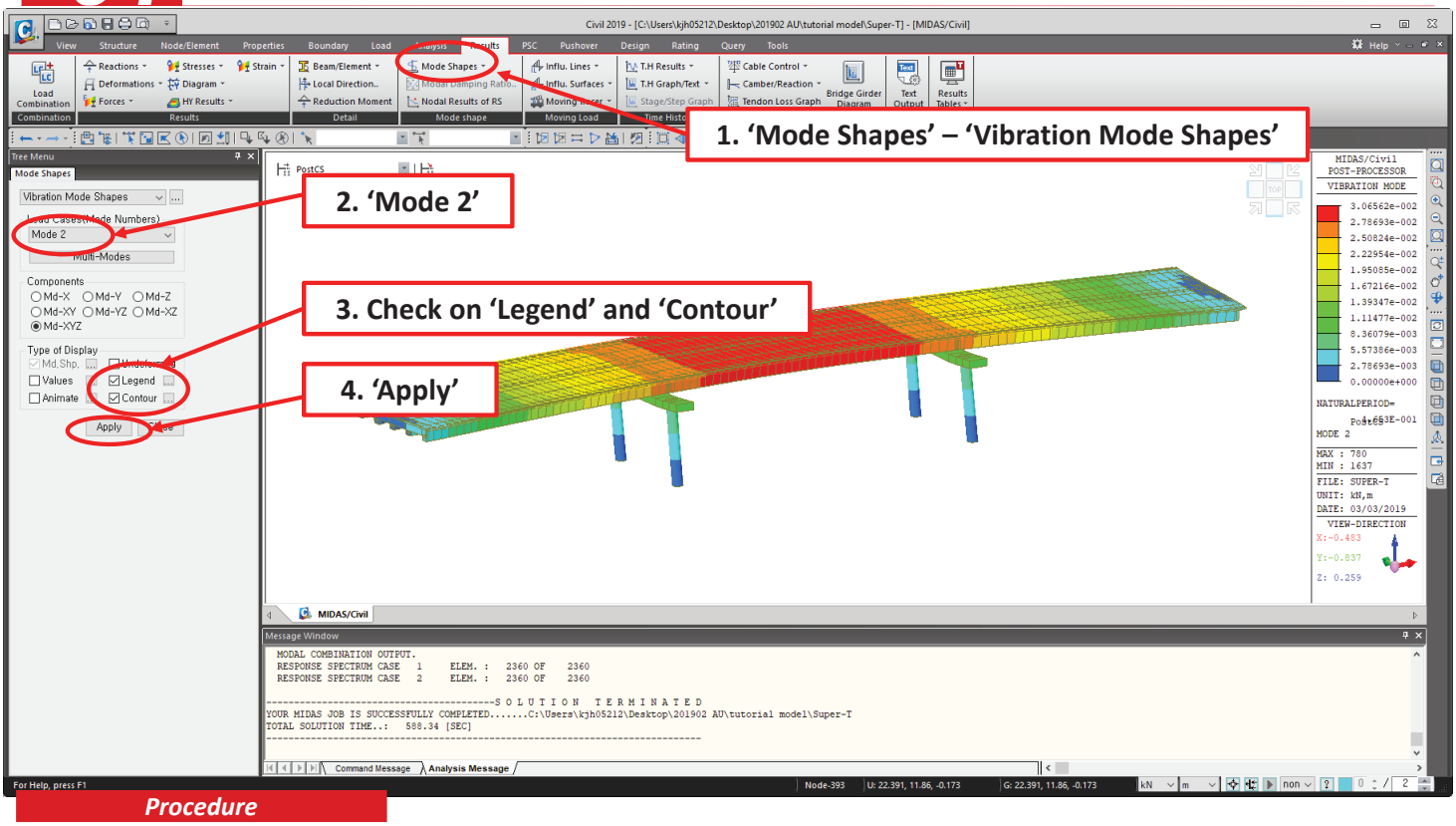
90 Tendon Losses



Procedure

Check tendon elongation.

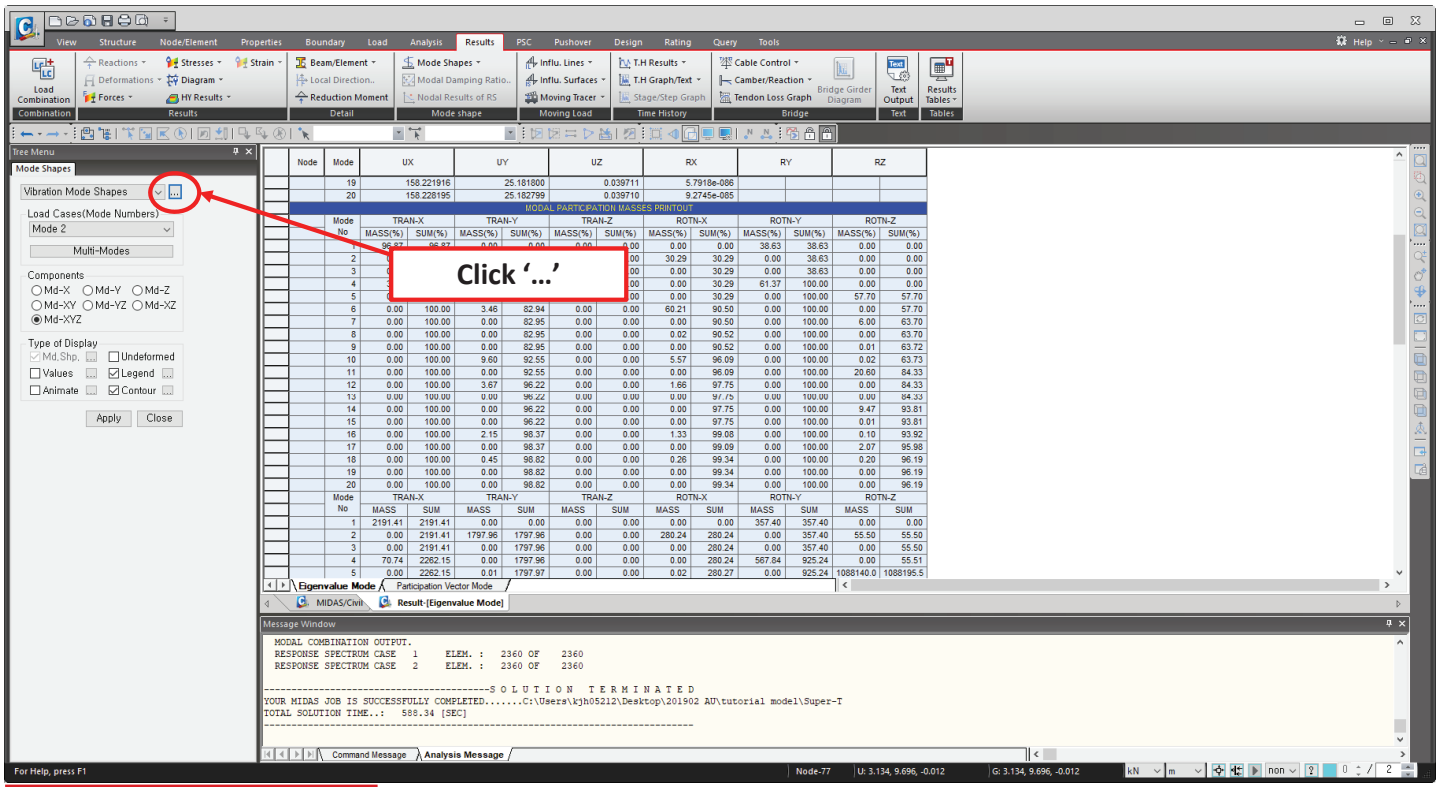
91 Mode Shape



Procedure

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

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.

Overview

- **Properties**
  - Material / Section
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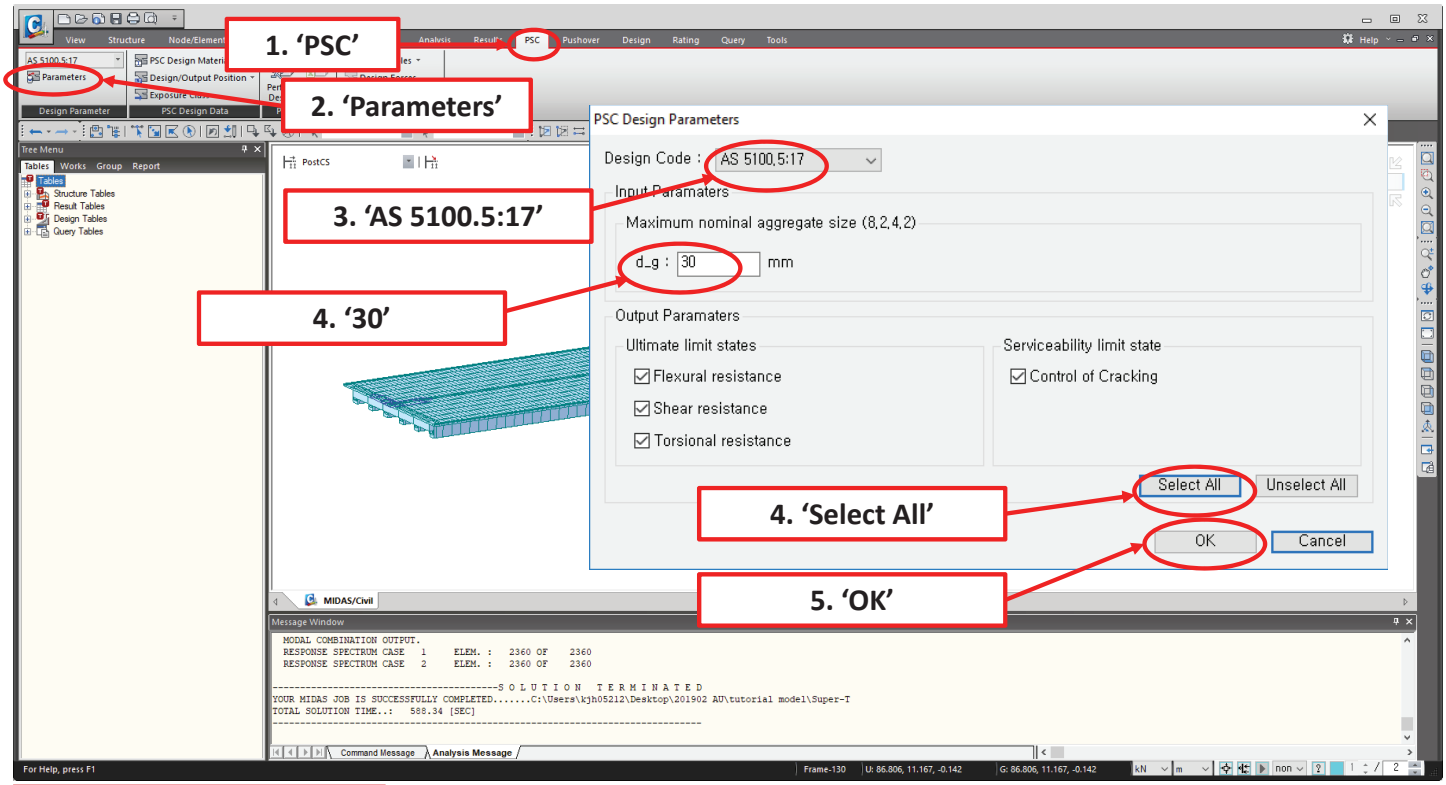
  - Import tendon from AutoCAD
- **Appendix. Load Combinations**

Step 6. Design

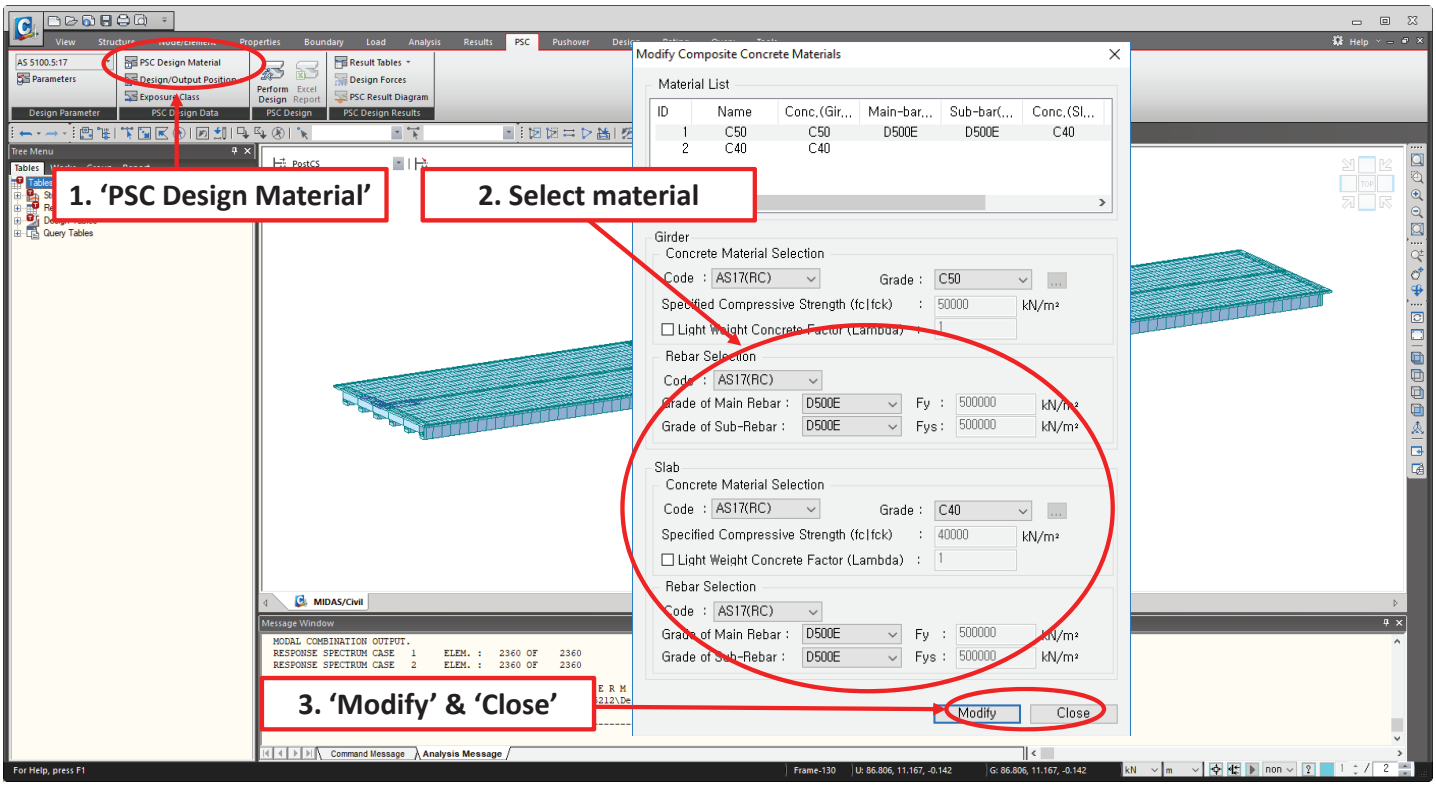
94 PSC Design



Procedure

Decide output parameters

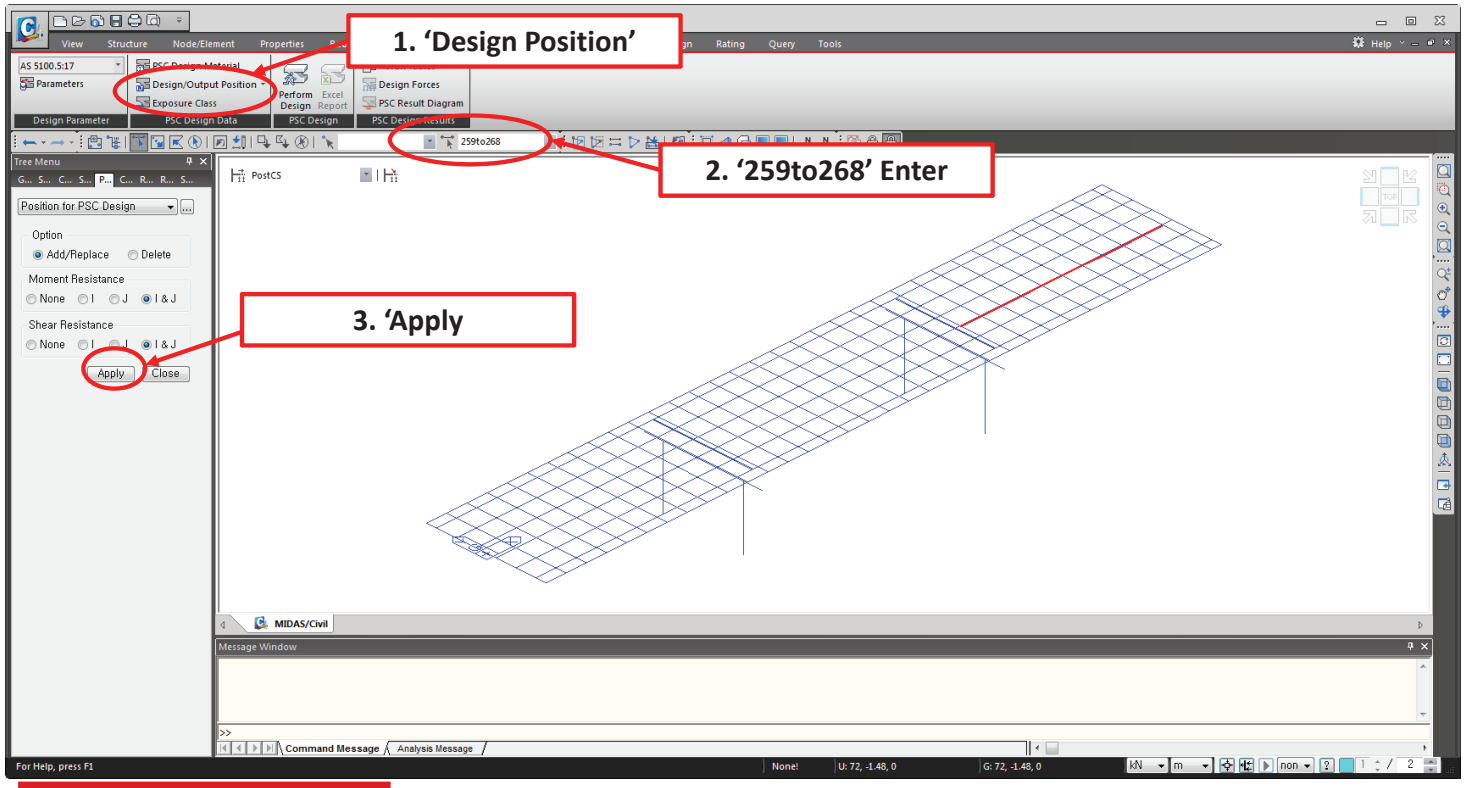
95 PSC Design



Procedure

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

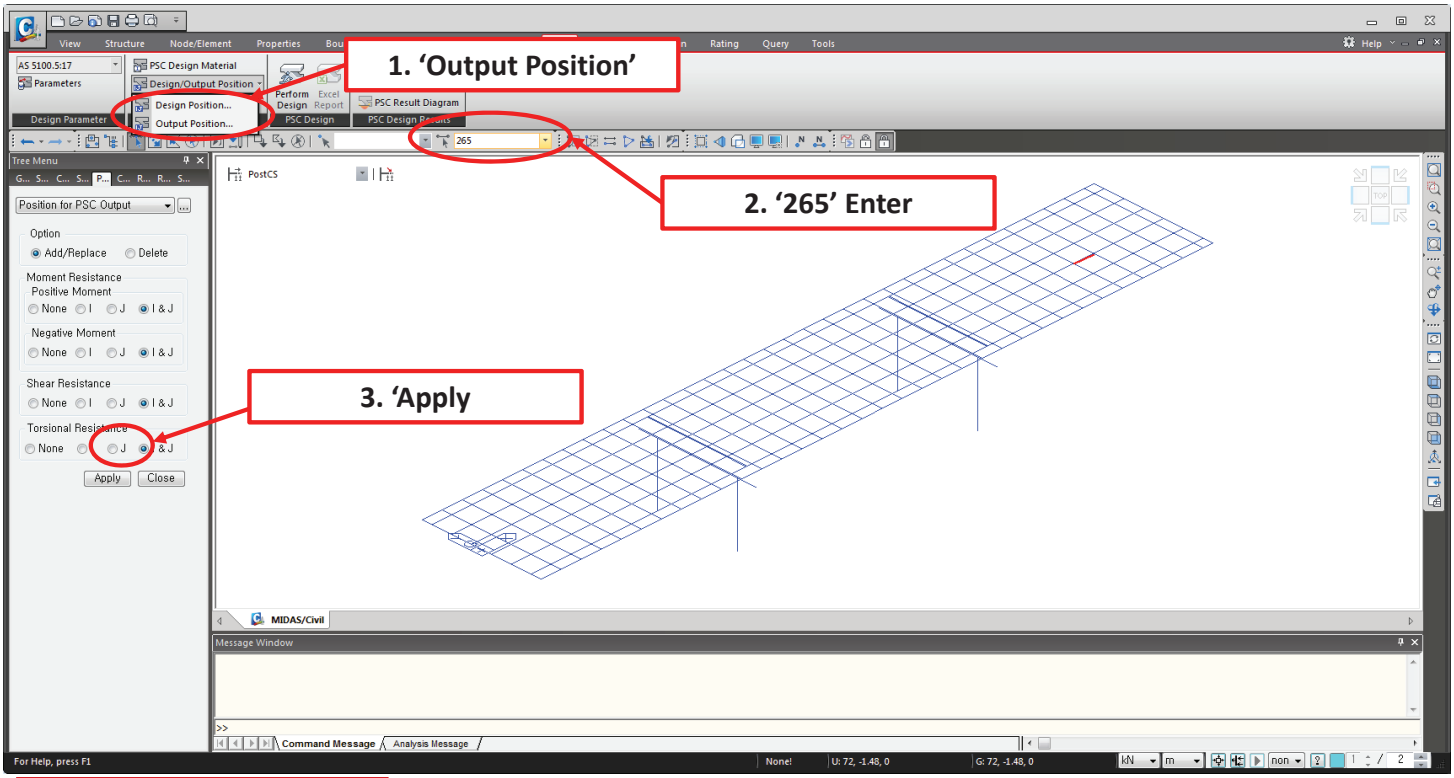
96 PSC Design



Procedure

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

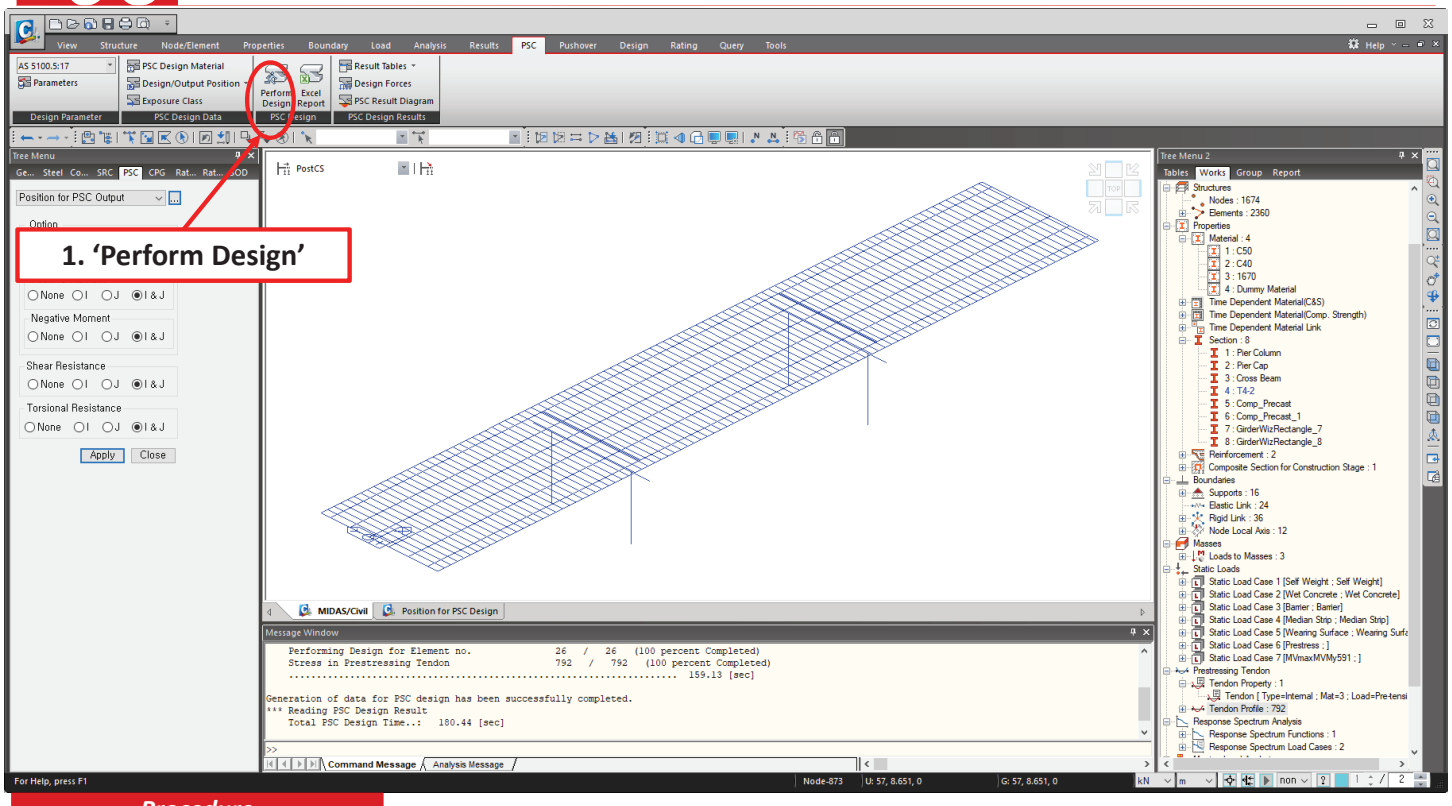
97 PSC Design



Procedure

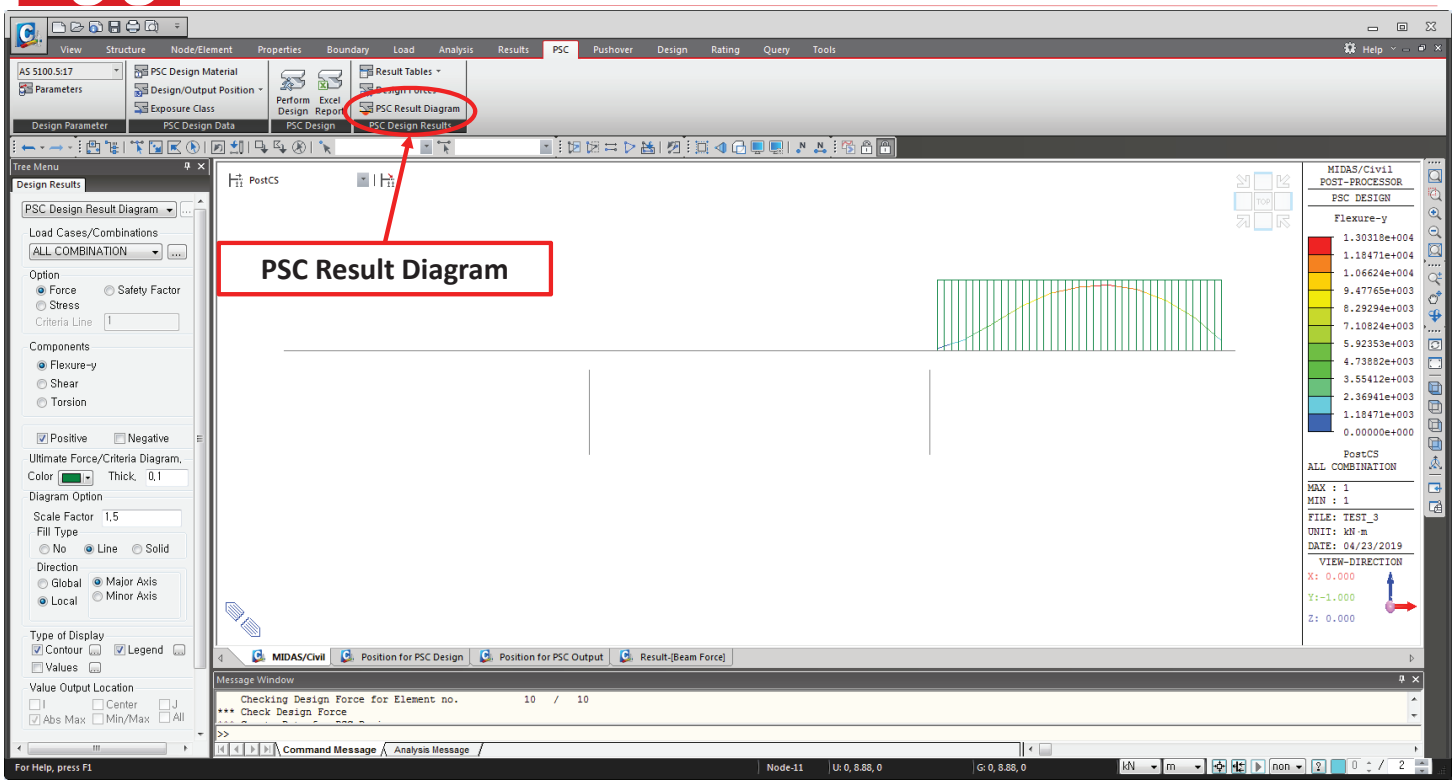
Decide the position to export Excel report

98 PSC Design



Procedure

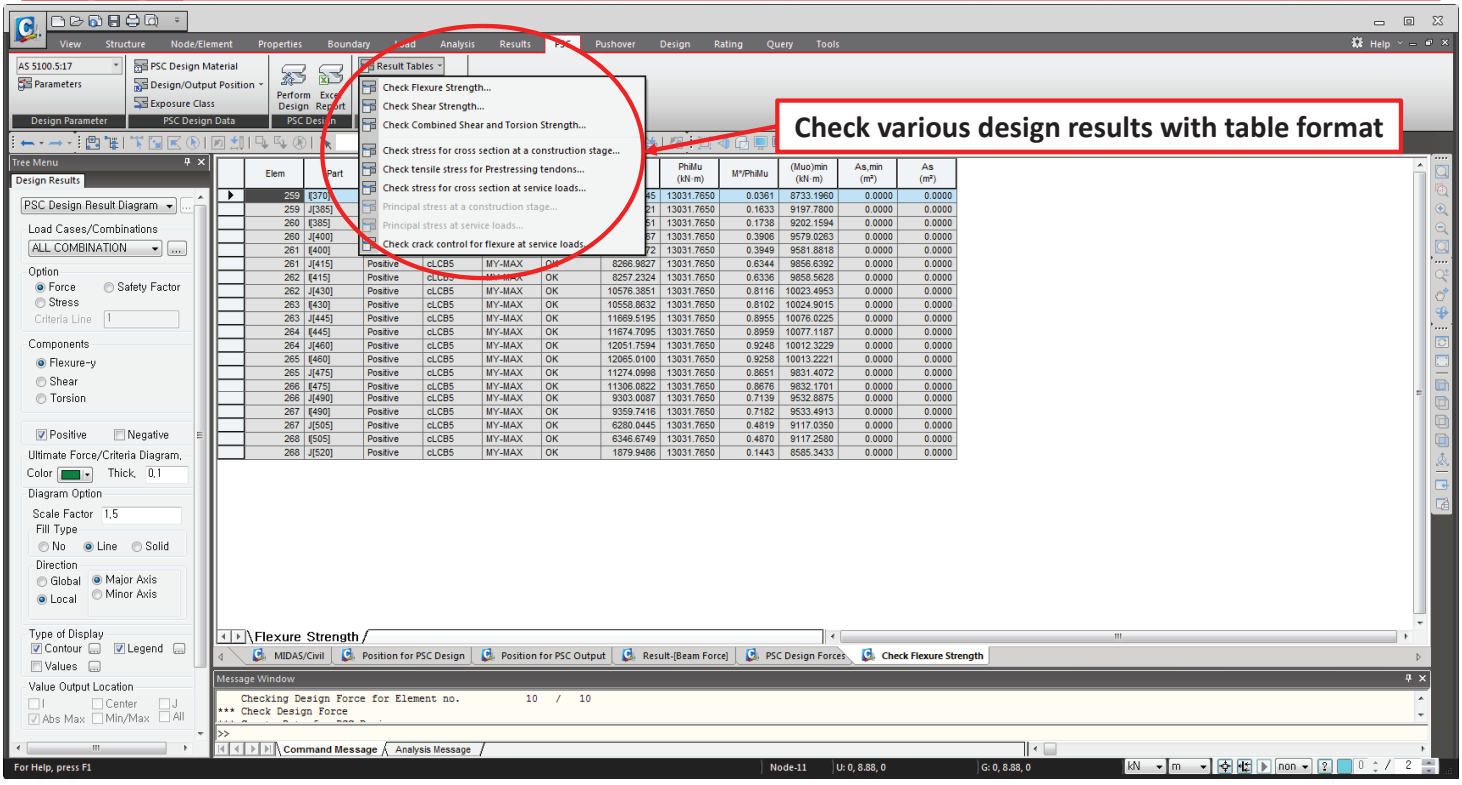
99 PSC Design



Procedure

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

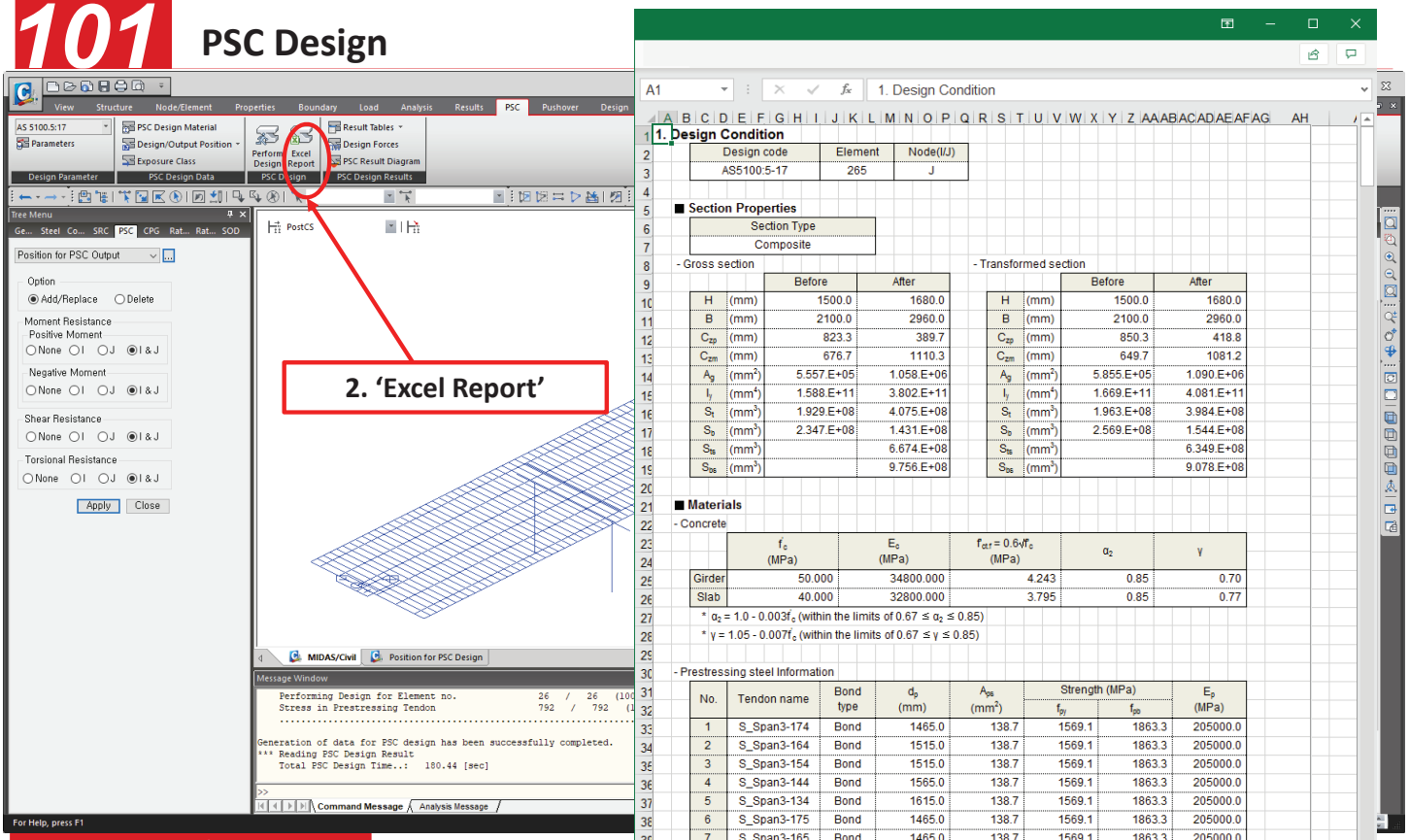
100 PSC Design



Procedure

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

101 PSC Design



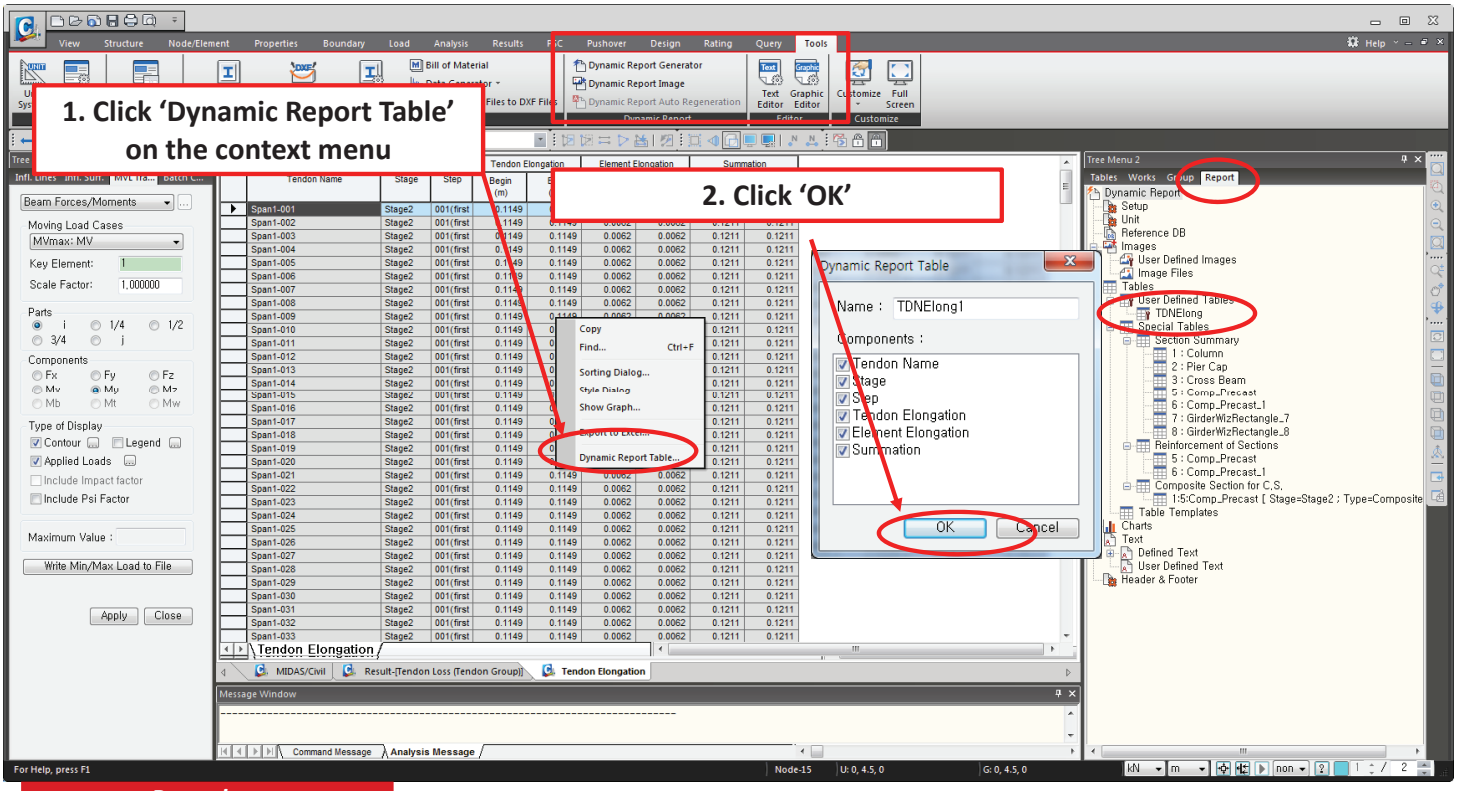
Procedure

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

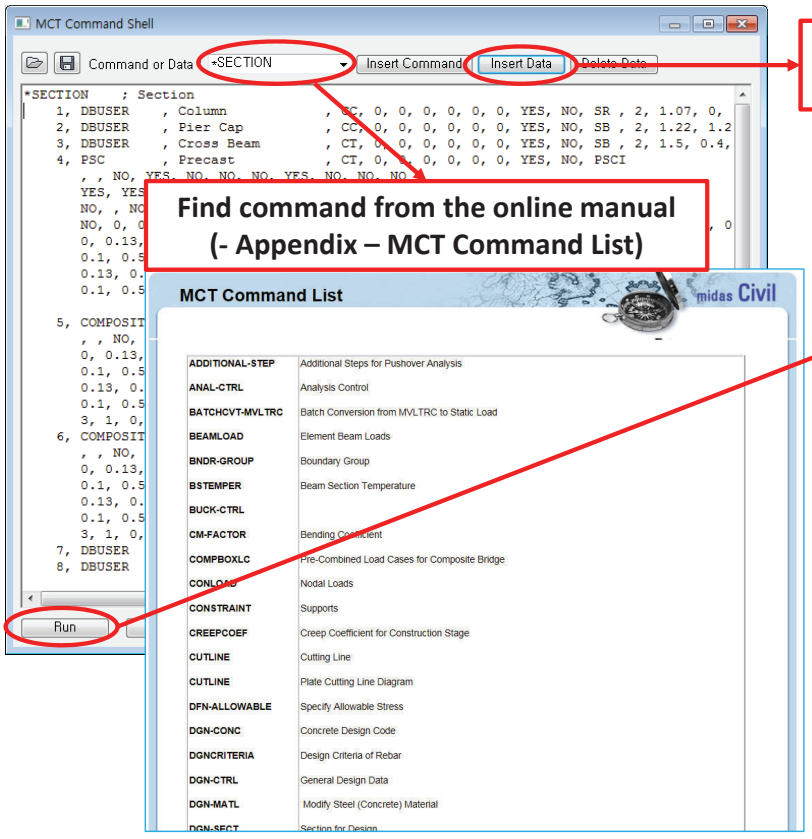
103 Smart Report



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'.

104 MCT Command Shell



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

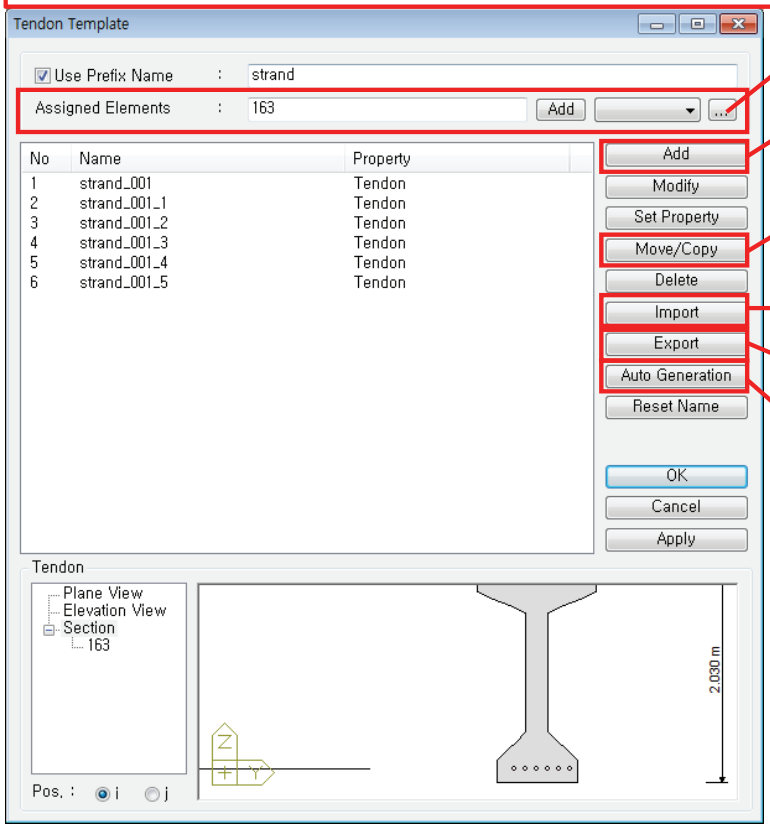
Apply the text data to the model file.

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.

105 Tendon Template

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

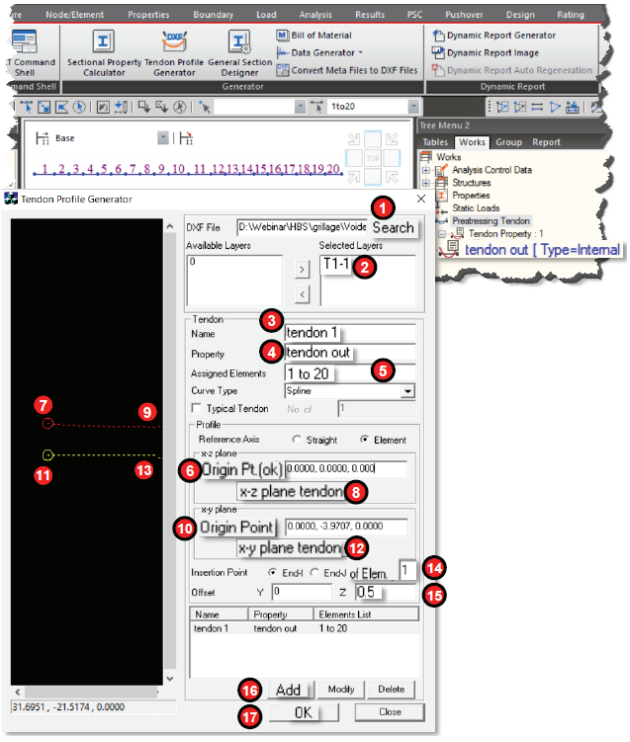
Import tendon template from other model files

Export inputted tendon template data

Generate tendons automatically for typical section

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

106 Import tendon from AutoCAD



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.

Appendix. Load Combinations

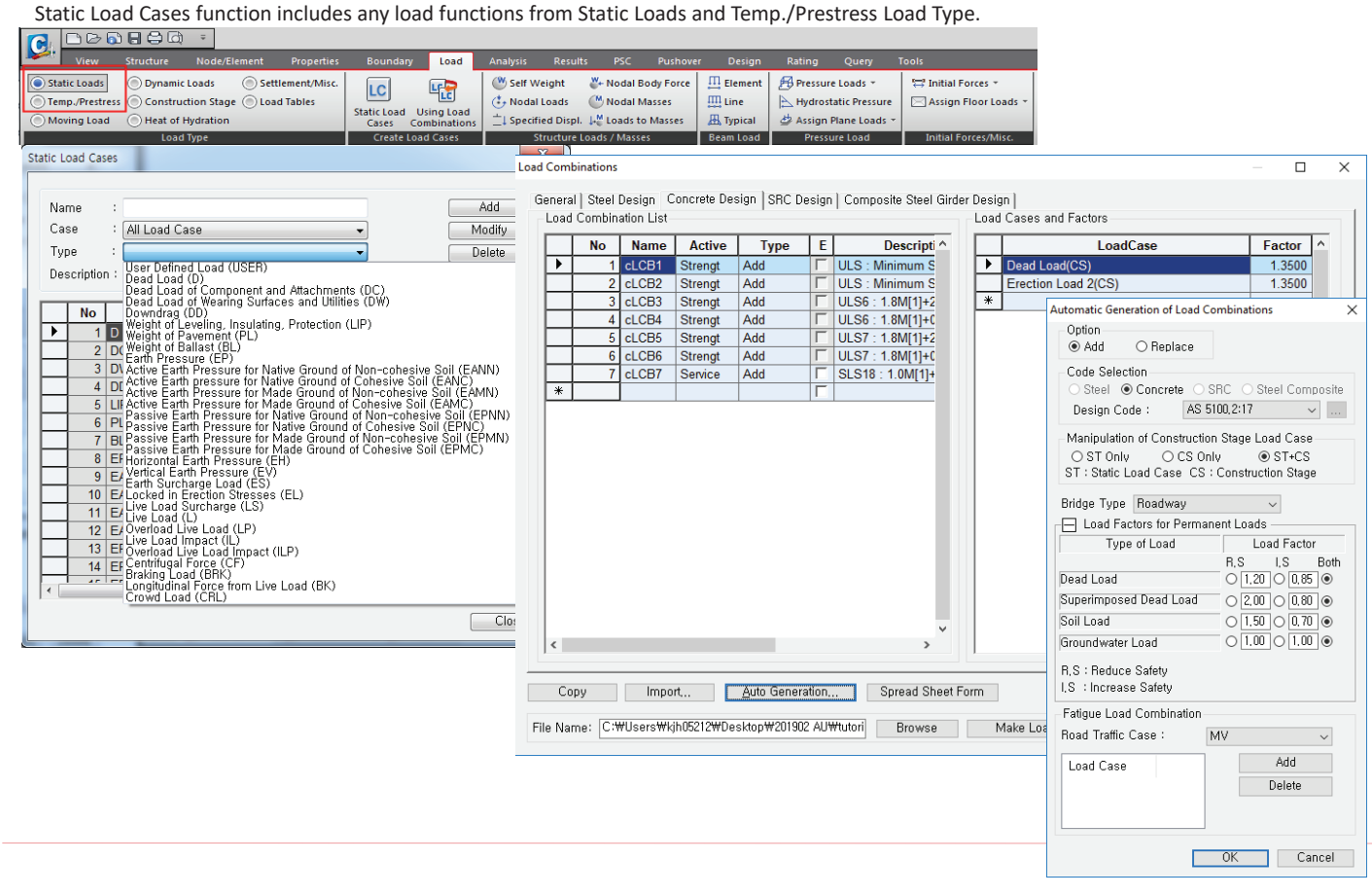
2

Overview

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.



Appendix. Load Combinations

List of Static Load Case Type in midas Civil

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.

Appendix. Load Combinations

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.

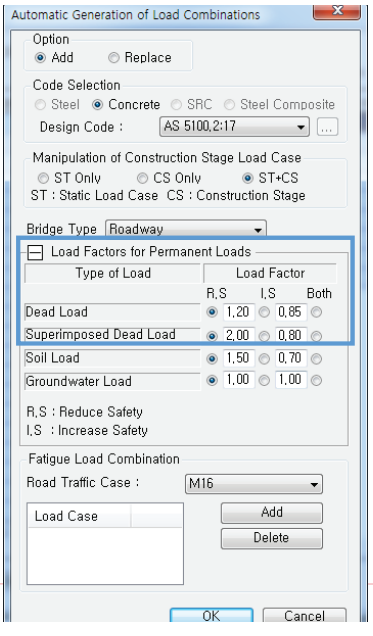
AS 5100.2 : 2017

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



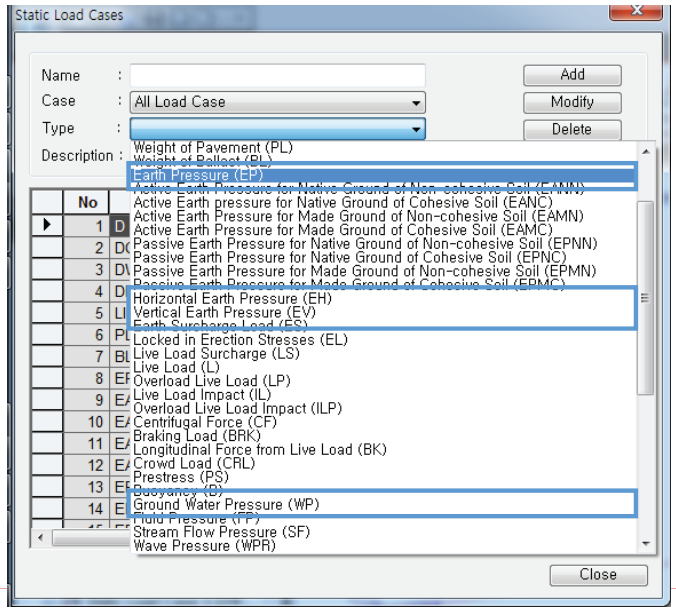
Appendix. Load Combinations

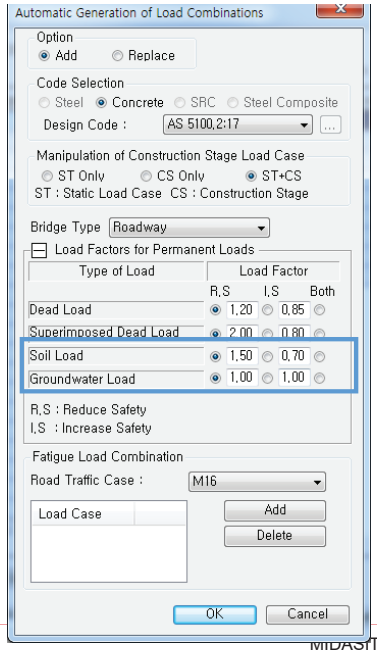
Same procedure for earth pressure load types

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





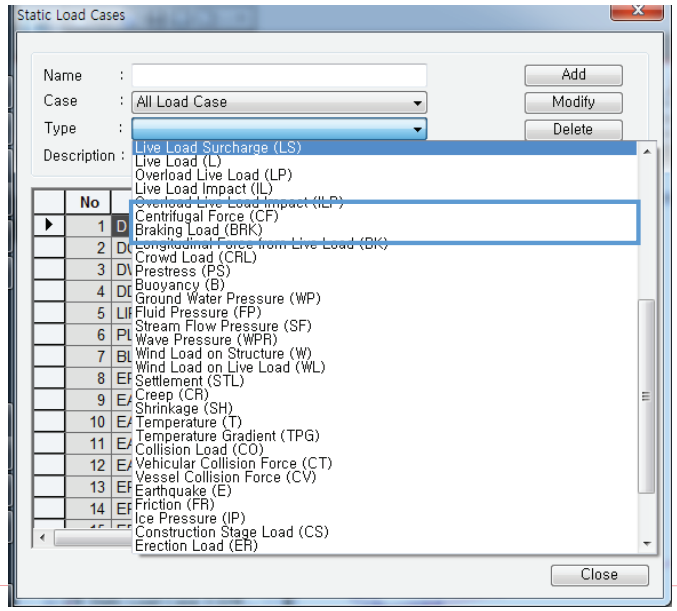
Appendix. Load Combinations

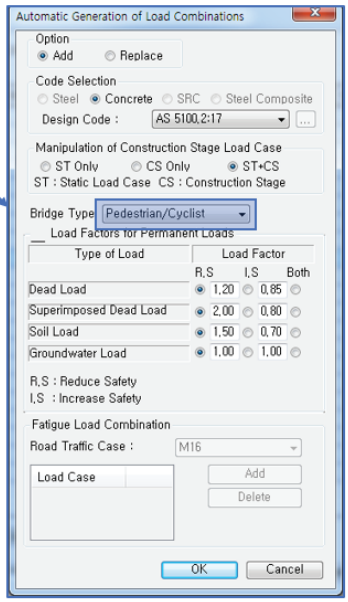
The load combination of 'Pedestrian cyclist path and maintenance traffic loads' is generated when 'Pedestrian/Cyclist' option is selected as Bridge Type.

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





Appendix. Load Combinations

AS 5100.2 : 2017

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
Derailment load case A	1.2	N/A
Derailment load case B	1.0	N/A
Derailment 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

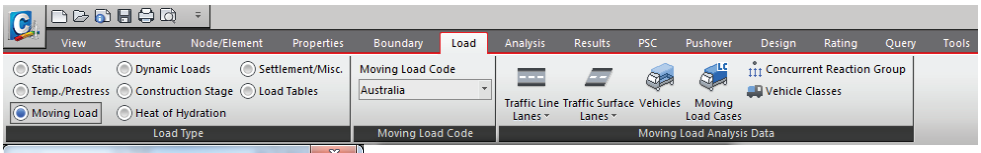
Loading		Limit state	
		Ultimate	Serviceability
Earth pressure from traffic loads		Refer to AS 5100.3	
Earthquake forces (for appropriate ARI)		1.0	1.0
Water flow (for appropriate ARI)		1.3	1.0
Wind loads (for appropriate ARI)		1.0	1.0
Thermal		1.25	1.0
Shrinkage and creep		1.2	1.0
Prestress secondary 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	

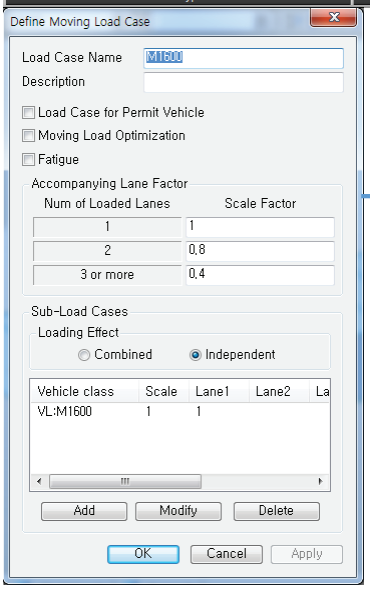
Earthquake	E
Fluid Pressure	FP
Buoyancy	B
Wind Load on Structure	W
Temperature	T
Temperature Gradient	TPG
Creep	CR
Shrinkage	SH
Prestress	PS
Settlement	STL

Appendix. Load Combinations

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)

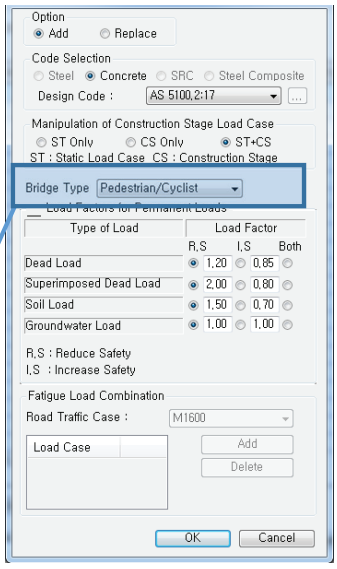




Any vehicle loadings on Moving Load Case have 1.8 for ULS and 1.0 for SLS as load factors.
1.5 for ULS and 1.0 for SLS are applied when Pedestrian/Cyclist.

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

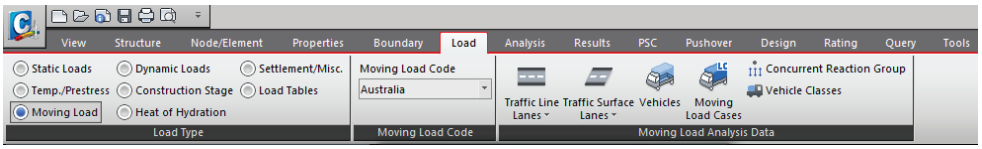


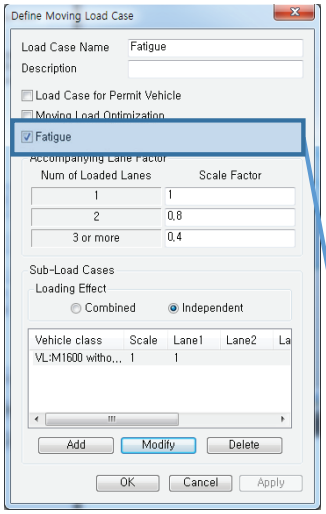
*Automatic load combination considers 'AS5100.2:2017 23.4 SLS load combinations' for SLS load combinations

Appendix. Load Combinations

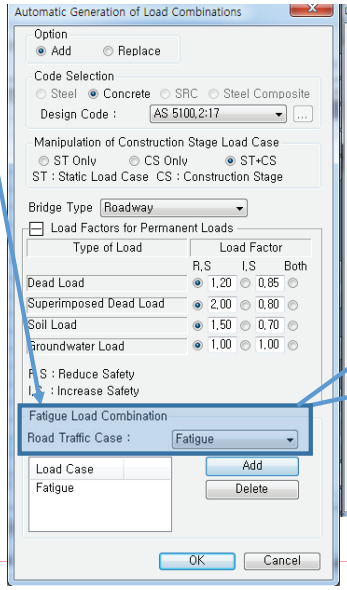
Moving Load, Settlement and Construction Stage(Creep/Shrinkage/Tendon/Dead) Load Types on Load menu generate load cases on the automatic load combinations.

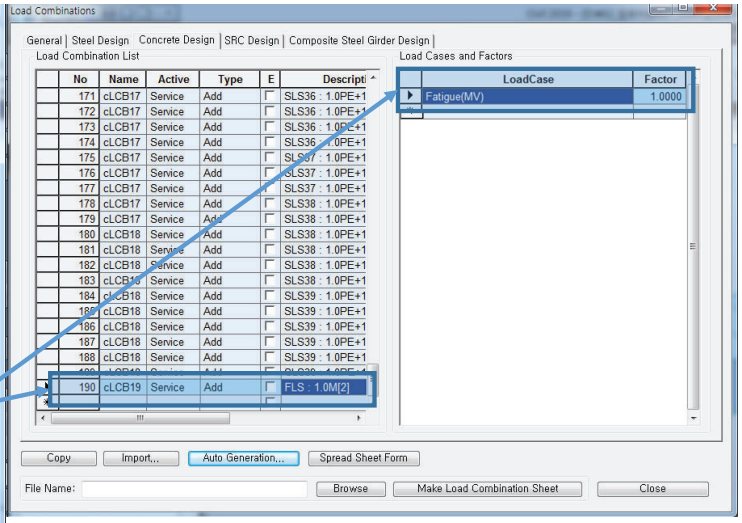
- Moving Load(MV)





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

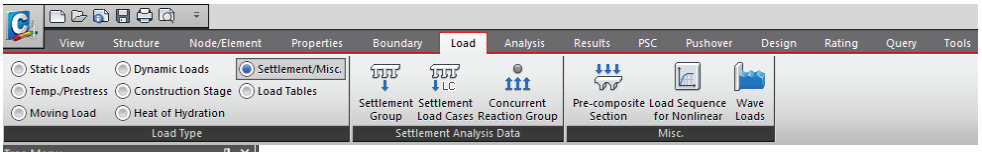


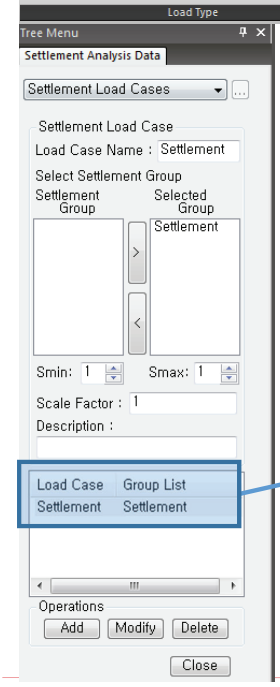


Appendix. Load Combinations

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	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	

Appendix. Load Combinations

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

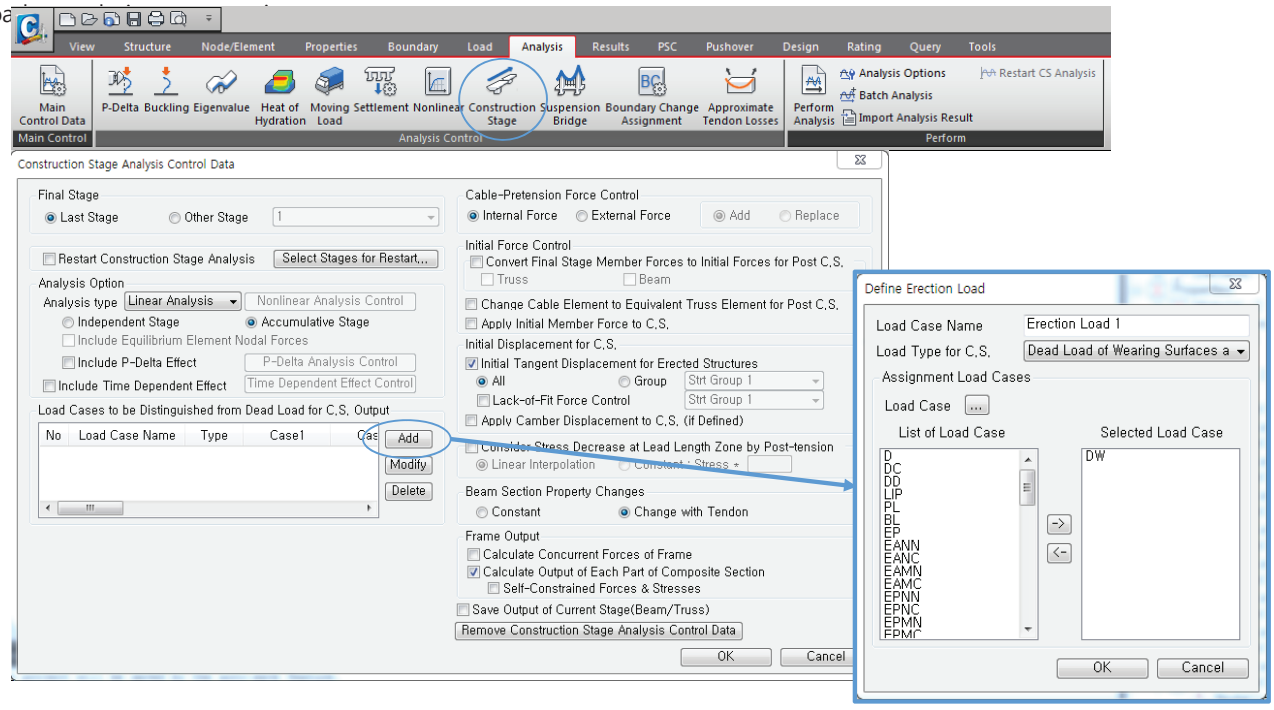
Load cases should have Construction Stage Load (CS) type on Static Load Cases dialog if those are activated on a construction stage. Otherwise, automatic load combination generates both static load case(ST) and Dead Load(CS).

Appendix. Load Combinations

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 loa

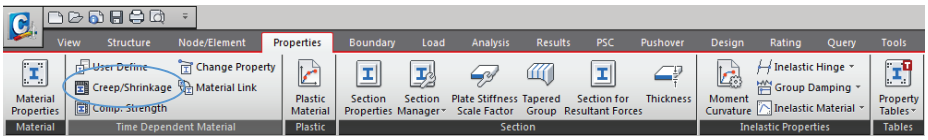


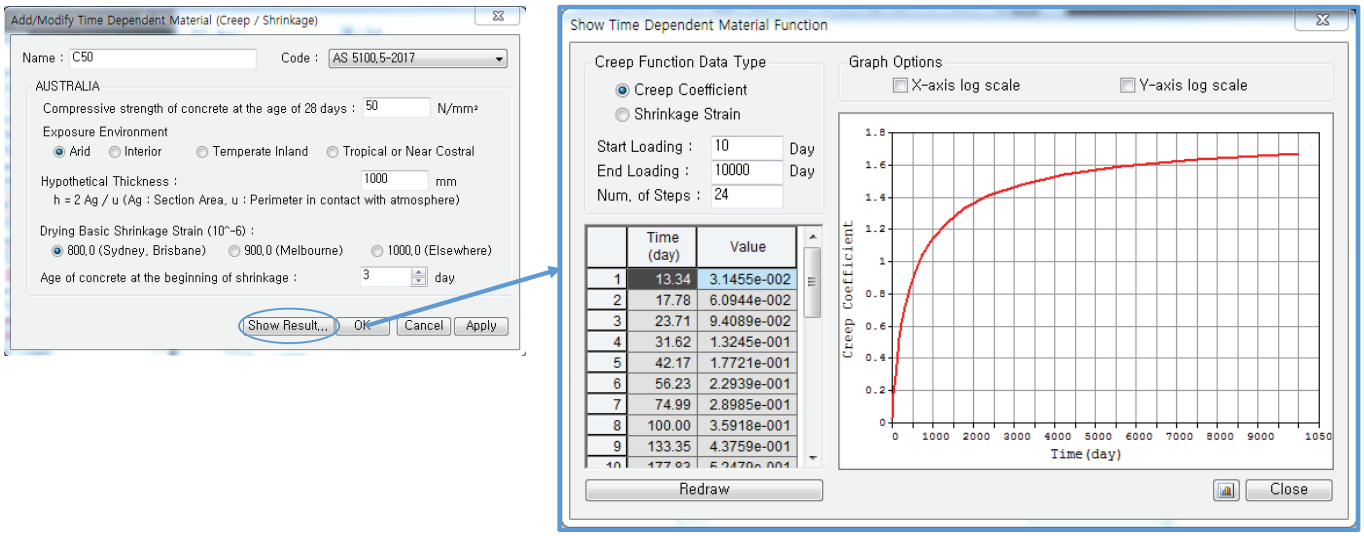
Appendix. Load Combinations

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.



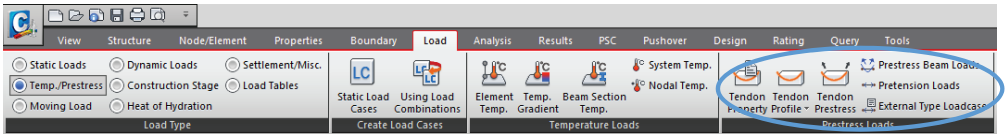


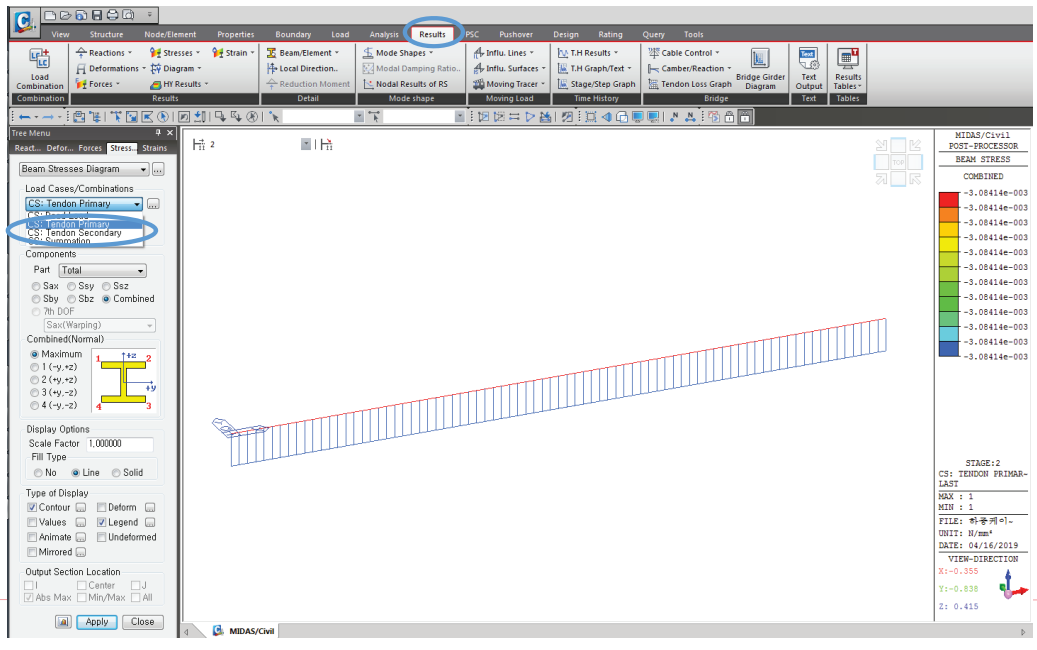
Appendix. Load Combinations

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.





Appendix. Load Combinations

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.