Bridge Analysis Applications using midas Civil

MIDAS IT

2019

About MIDAS Information Technology

MIDAS IT

WORLD CLASS 300

KBRAIN POWER

"Engineering Software"

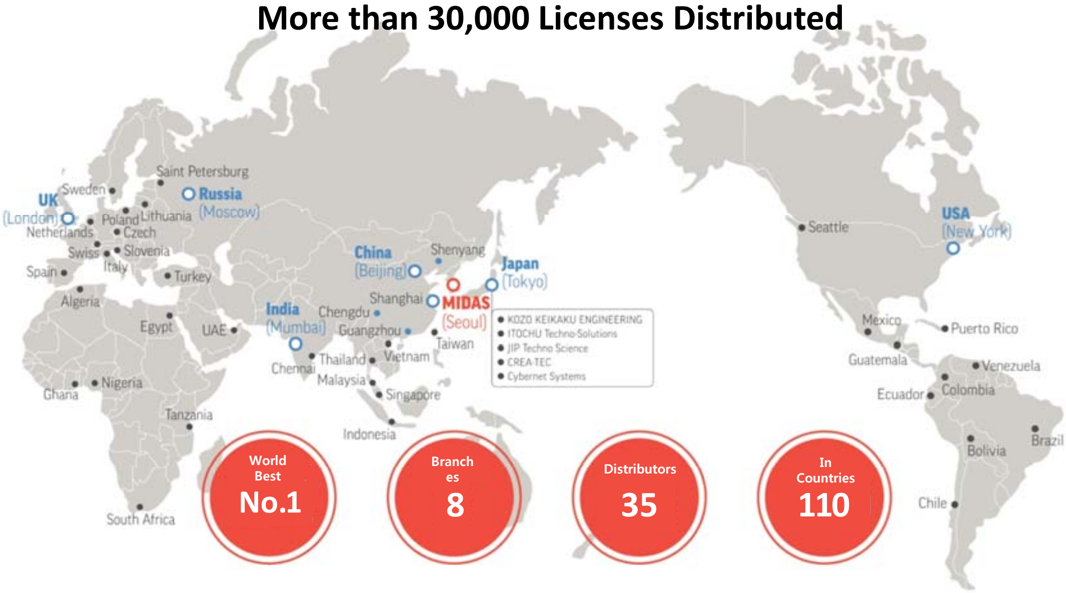
Development & Consulting (from 1989)

| World Class 300 Company, K-Brain Power Company |

| Korean Google |

MIDAS Global Network in 2018

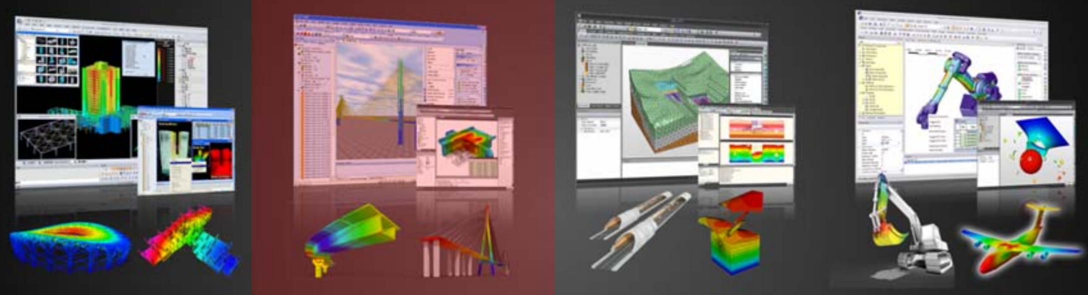
More than 30,000 Licenses Distributed



2018

MIDAS Program

MIDAS Software



Building	Civil/Bridge	Geotechnical	Mechanical
midas Gen Design +	midas Civil midas FEA	midas GTS NX midas SoilWorks	midas NFX CFD 3D/2D

Civil Engineering Industry

(from 2002)

Capabilities of midas Civil

Version Configuration

- Included in Plus version
- Included in Advanced version
- Additional module

*Advanced version has all of the features in Plus version.

Analysis Features

- Linear Static Analysis
- Moving Load Analysis
- Construction Stage Analysis*
- Settlement Analysis
- Buckling Analysis
- P-delta Analysis
- Geometric Nonlinear Analysis
- Material Nonlinear Analysis

- Dynamic Analysis
  - Eigen Value Analysis
  - Response Spectrum Analysis
  - Pushover Analysis
  - Linear Time History Analysis
  - Boundary Nonlinear Analysis
  - Inelastic Time History Analysis
- Large Displacement Analysis
  - Suspension Bridge Wizard
  - Cable Stayed Bridge Wizard
  - Cable Tuning
- Heat of Hydration Analysis
- Rail Structure Interaction Analysis

*Construction Stage Analysis can be handed up to 10 stages in midas Civil Plus version. Advanced version has unlimited stages of construction.

Capabilities of midas Civil

*Every Design Codes are included from the plus version.

Design Features

PSC Composite General Design
- Eurocode 2-2:05
- AASHTO-LRFD14
- AASHTO-LRFD12

PSC Design
- Eurocode 2-2:05
- AASHTO-LRFD14
- CSA-S6S1-10
- AASHTO-LRFD12
- KSCE-USD05
- JTG D62-04
- AS 5100.5 : 2017

Reinforced Concrete Design
- Eurocode 2-2
- AASHTO-LRFD12
- AASHTO-LFD96
- CSA-S6-00
- JTJ023-85
- IRC:21-2000
- KCI-USD99
- KSCE-USD96
- TWN-BRG-LSD90

Structural Steel Design
- Eurocode 4-2
- AASHTO-LRFD12
- AASHTO-LFD96
- AASHTO-ASD96
- AISC-LRFD2K
- AISC-LRFD93
- AISC-ADS89
- BS5950-90
- JTJ025-86
- IS:800-2007
- TWN-BRG-LSD90
- TWN-BRG-ASD90

Steel Composite Girder Design
- EN 1994-2
- AASHTO-LRFD12

SRC Design
- SSRC79
- AIJ-SRC01
- JGJ138-01
- AIK-SRC2K
- TWN-SRC2K

Project Applications

Wide range of bridge project application


Cable-Stayed Bridge

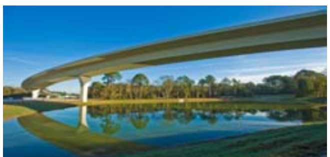

Soil-Structure Interaction


Arch Bridge


Suspension Bridge


Rail Track Analysis


Precast Composite Girder


PSC Box Girder Bridge


Train-Structure Interaction


Steel Composite Girder

Stonecutters Bridge

Kowloon, Hong Kong

Owner: Hong Kong Department of Highways
General Contractor: Hitachi Zosen / Yokogawa Bridge Corporation / Maeda Corporation / Hsin Chong Group
Engineering Consultant: Ove Arup & Partners
Construction Period: 2004 - 2009
Type of Structure: Cable-stayed Bridge
Size of Structure: 1km Main Span, 1.6km Total Length

Stonecutters Bridge

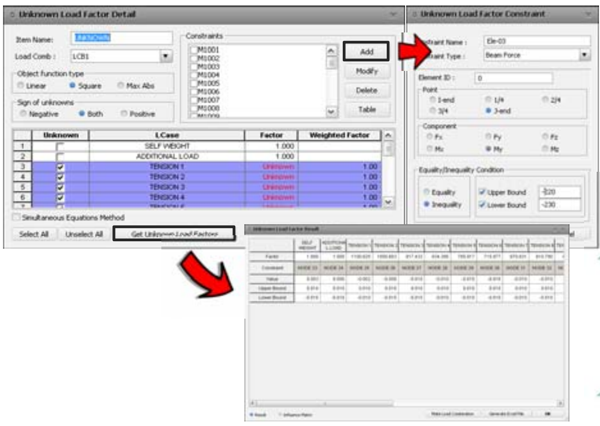
Main Feature of midas Civil

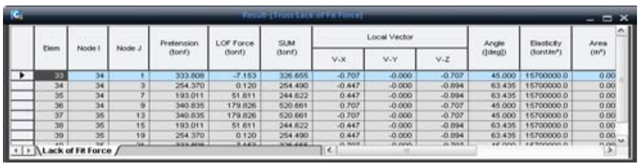
- Cable optimization for the initial loads
- Cable optimization with forward stage analysis

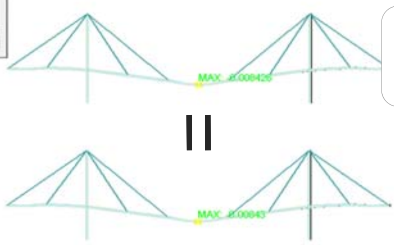
Unknown Load Factors by Optimization & Lack Of Fit

→ **Unknown Load Factor** finds optimized cable force after construction

→ **Lack of Fit** finds additional force during construction to match cable force found by Unknown Load Factor at the final stage







Displacements of forward stage analysis at the last stage using Lack of Fit Force
[Max. – 0.000426]

=

Displacements at the completed state
[Max. – 0.00043]

Three Sisters Bridge

Pittsburgh, USA

Owner: Allegheny County
Engineering Consultant: Michael Baker International
Type of Structure: Self-anchored Suspension Bridge
Size of Structure
- Andy Warhol Bridge 135m Main Span, 323m Total Length
- Rachel Carson Bridge 120m Main Span, 303m Total Length
- Roberto Clemente Bridge 130m Main Span, 303m Total Length

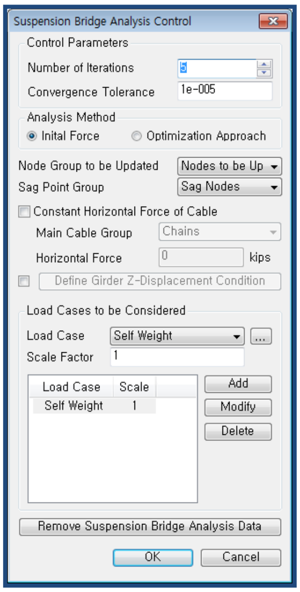
Three Sisters Bridge

Main Feature of midas Civil

- Initial equilibrium state anaysis

Suspension Bridge Analysis

→ **Location of nodes** on the cable will be updated automatically
→ **Cable force** will be updated automatically



Node coordinate Update

Node	Z(ft)
292	809.452858
294	742.191537
307	792.742685
309	754.951934
323	779.457484
325	770.949826
339	774.484017
341	780.831631
355	770.618726
357	791.967997
371	767.867468
373	804.357896
387	766.209513
389	809.452857
403	765.751692
405	801.017965
419	766.209511
421	792.742683
435	767.867464

\Nodes(GCS) / N

→

Node	Z(ft)
292	810.480893
294	742.191903
307	792.775094
309	754.950606
323	779.517193
325	770.945706
339	774.556092
341	780.826305
355	770.701392
357	791.962311
371	767.958392
373	804.353695
387	766.305392
389	810.480893
403	765.751692
405	801.072103
419	766.305392
421	792.775094
435	767.958392

\Nodes(GCS) / N

Cable force Update

Element	Sub Type	Tension (kN)
74	Cable	4448.2230
75	Cable	4448.2230
76	Cable	4448.2230
77	Cable	4448.2230
78	Cable	4448.2230
79	Cable	4448.2230
80	Cable	4448.2230
81	Cable	4448.2230
82	Cable	4448.2230
83	Cable	4448.2230
84	Cable	4448.2230
85	Cable	4448.2230
86	Cable	4448.2230
87	Cable	4448.2230
88	Cable	4448.2230
89	Cable	4448.2230
90	Cable	4448.2230
91	Cable	4448.2230
92	Cable	4448.2230

MIDAS/Civil | Elements

→

Element	Sub Type	Tension (kN)
76	Cable	13565.2004
77	Cable	13793.1808
78	Cable	14045.9850
79	Cable	14332.8463
80	Cable	14651.6547
81	Cable	15000.1948
82	Cable	15376.8687
83	Cable	14030.5151
84	Cable	13999.0551
85	Cable	13969.1865
86	Cable	13758.7527
87	Cable	13569.3533
88	Cable	13409.5238
89	Cable	13280.9752
90	Cable	13183.4108
91	Cable	13119.2124
92	Cable	13085.2449
93	Cable	13085.2449
94	Cable	13119.2124

MIDAS/Civil | Elements

Lee Roy Selmon Flyovers

Florida, USA

Owner: Tampa-Hillsborough Expressway Authority
General Contractor: WSP | Parsons Brinckerhoff
Engineering Consultant: WSP | Parsons Brinckerhoff
Construction Period: 2010 - 2014
Type of Structure: PSC Box Girder Bridge
Size of Structure: 2.5Km Total Length

Lee Roy Selmon Flyovers

Main Feature of midas Civil

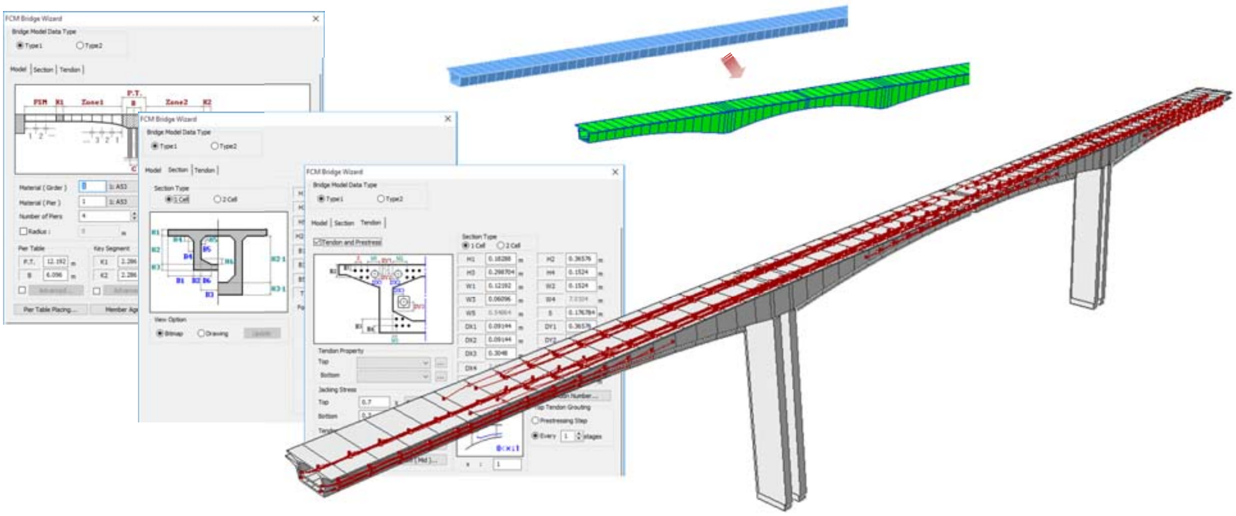
- Wizard (FCM, ILM)
- Creep/Shrinkage
- Camber
- Warping stress

FCM Bridge Wizard

→ **Automatic Generation of model** for balanced cantilever bridge

→ **All information** be reflected into model with construction sequence

→ **Tendon information** will be contained in each segment , so the geometry will be automatically reflected



Lee Roy Selmon Flyovers

Main Feature of midas Civil

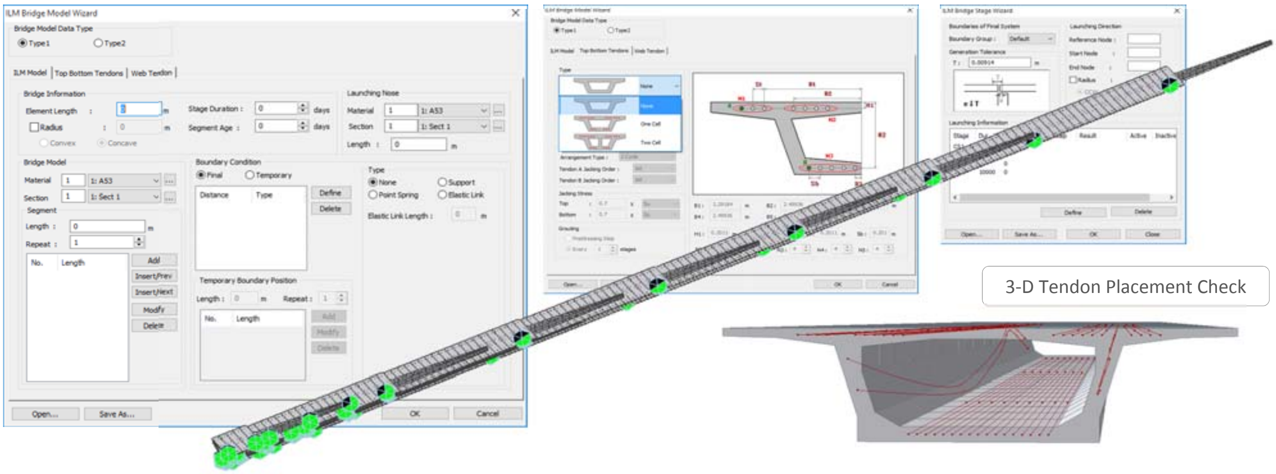
- Wizard (FCM, ILM)
- Creep/Shrinkage
- Camber
- Warping stress

ILM Bridge Wizard

→ **Automatic Generation of model** for Incremental Launching Method bridge

→ **All information** be reflected into model with construction sequence

→ **Tendon information** will be contained in each segment , so the geometry will be automatically reflected



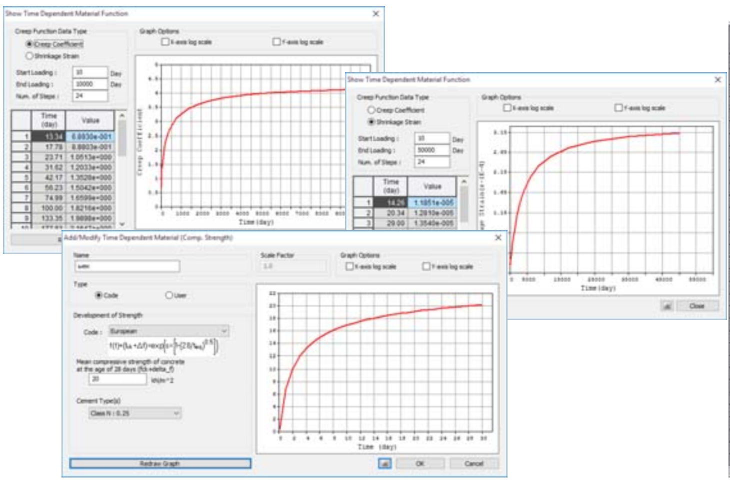
Lee Roy Selmon Flyovers

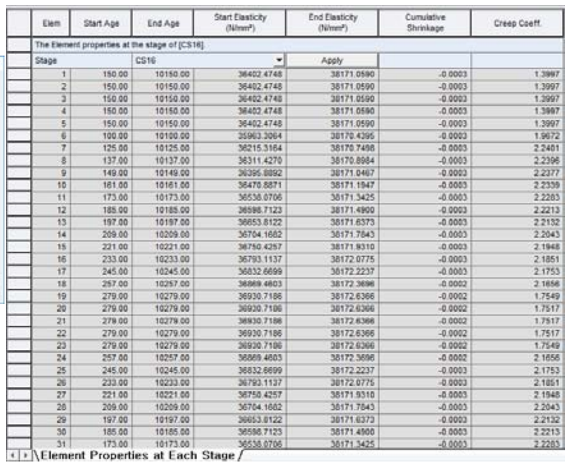
Main Feature of midas Civil

- Wizard (FCM, ILM)
- Creep/Shrinkage
- Camber
- Warping stress

Creep/Shrinkage

→ **Creep/ Shrinkage/ Compressive strength are calculated automatically along the stages** as per CEB-FIP(2010) / CEB-FIP(1990) / CEB-FIP(1978) / ACI209(1982) Code / ACI Code / PCA(1986) / Combined (ACI209(1982) & PCA(1986)) / AASHTO(2006) / INDIA (IRC:18-2000) / European / AS 3600-2009 / AS/RTA 5100.5-2011 & 2016 / NZ Bridge(SP/M/022)





The Element properties at the stage of [CS16].

Stage: CS16 — Apply

Elem	Start Age	End Age	Start Elasticity (N/mm²)	End Elasticity (N/mm²)	Cumulative Shrinkage	Creep Coeff.
1	150.00	10150.00	36402.4748	38171.0590	-0.0003	1.3997
2	150.00	10150.00	36402.4748	38171.0590	-0.0003	1.3997
3	150.00	10150.00	36402.4748	38171.0590	-0.0003	1.3997
4	150.00	10150.00	36402.4748	38171.0590	-0.0003	1.3997
5	150.00	10150.00	36402.4748	38171.0590	-0.0003	1.3997
6	100.00	10100.00	35963.3064	38170.4395	-0.0003	1.9672
7	125.00	10125.00	36215.3164	38170.7498	-0.0003	2.2401
8	137.00	10137.00	36311.4270	38170.8984	-0.0003	2.2396
9	149.00	10149.00	36395.8892	38171.0467	-0.0003	2.2377
10	161.00	10161.00	36470.8871	38171.1947	-0.0003	2.2339
11	173.00	10173.00	36538.0706	38171.3425	-0.0003	2.2283
12	185.00	10185.00	36598.7123	38171.4900	-0.0003	2.2213
13	197.00	10197.00	36653.8122	38171.6373	-0.0003	2.2132
14	209.00	10209.00	36704.1662	38171.7843	-0.0003	2.2043
15	221.00	10221.00	36750.4257	38171.9310	-0.0003	2.1948
16	233.00	10233.00	36793.1137	38172.0775	-0.0003	2.1851
17	245.00	10245.00	36832.6699	38172.2237	-0.0003	2.1753
18	257.00	10257.00	36869.4603	38172.3696	-0.0002	2.1656
19	279.00	10279.00	36930.7186	38172.6366	-0.0002	1.7549
20	279.00	10279.00	36930.7186	38172.6366	-0.0002	1.7517
21	279.00	10279.00	36930.7186	38172.6366	-0.0002	1.7517
22	279.00	10279.00	36930.7186	38172.6366	-0.0002	1.7517
23	279.00	10279.00	36930.7186	38172.6366	-0.0002	1.7549
24	257.00	10257.00	36869.4603	38172.3696	-0.0002	2.1656
25	245.00	10245.00	36832.6699	38172.2237	-0.0003	2.1753
26	233.00	10233.00	36793.1137	38172.0775	-0.0003	2.1851
27	221.00	10221.00	36750.4257	38171.9310	-0.0003	2.1948
28	209.00	10209.00	36704.1662	38171.7843	-0.0003	2.2043
29	197.00	10197.00	36653.8122	38171.6373	-0.0003	2.2132
30	185.00	10185.00	36598.7123	38171.4900	-0.0003	2.2213
31	173.00	10173.00	36538.0706	38171.3425	-0.0003	2.2283

\Element Properties at Each Stage /

Lee Roy Selmon Flyovers

Main Feature of midas Civil

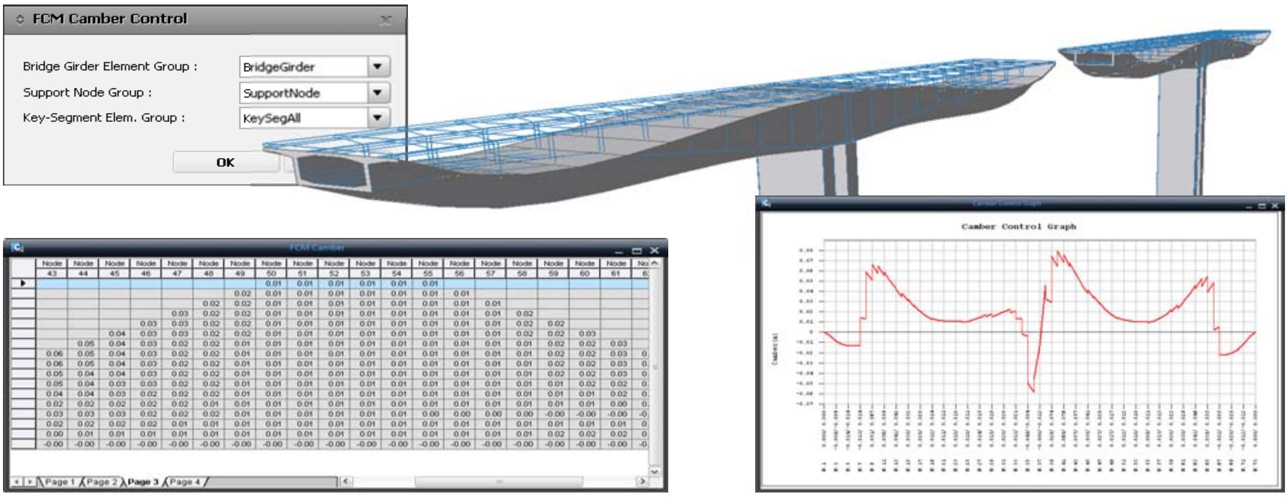
- Wizard (FCM, ILM)
- Creep/Shrinkage
- Camber
- Warping stress

Camber Check

→ **Camber result** in Table and Graph

→ In the table, camber value on the top of each column.

→ **Value changed along with the stages up to zero displacement** at the final stage can be monitored



Lee Roy Selmon Flyovers

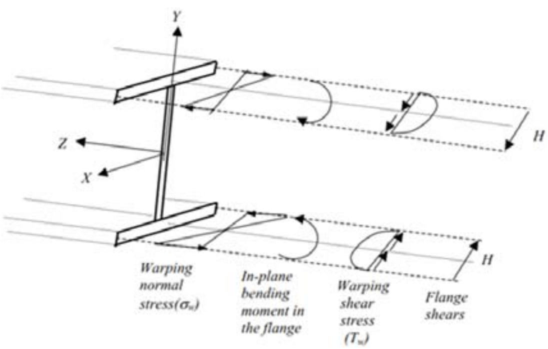
Main Feature of midas Civil

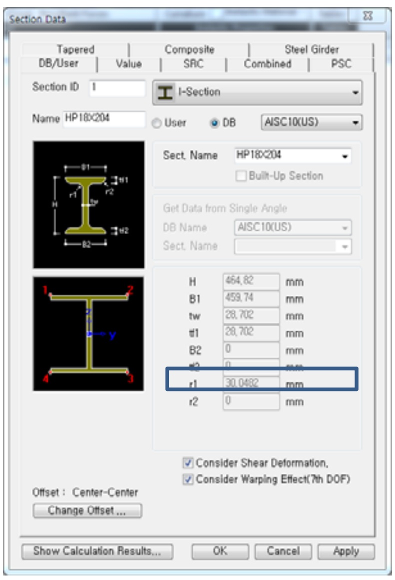
- Wizard (FCM, ILM)
- Creep/Shrinkage
- Camber
- Warping stress

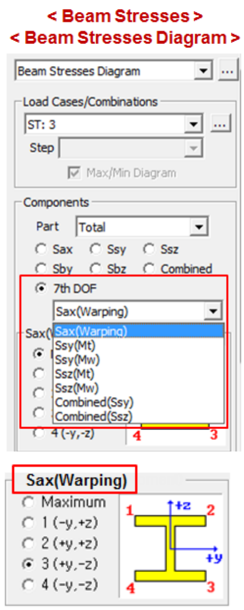
Warping stress

→ Basically, beam element behave rigid for warping and distortion

→ But midas Civil shows **warping stress as results for beam elements**







Seismic Soil-Foundation-Structure Interaction Model

Samoa, USA

Engineer: Anoosh Shamsabadi, P.E.
Type of Structure: Steel Composite Girder Bridge
Size of Structure: 764m Total Length

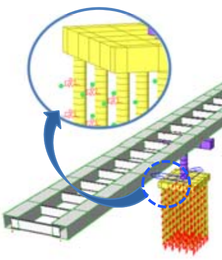
Seismic Soil-Foundation-Structure Interaction Model

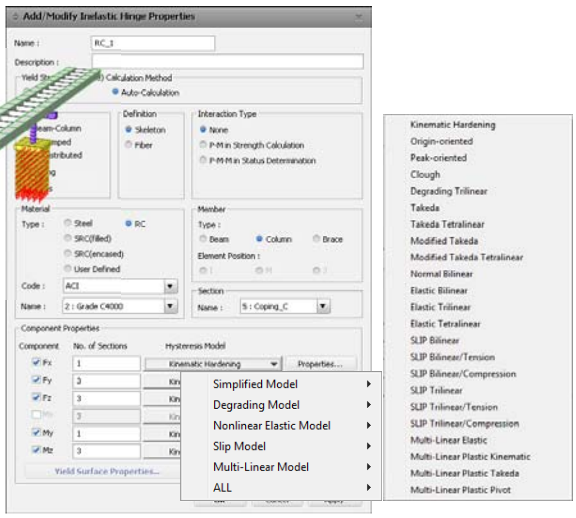
Main Feature of midas Civil

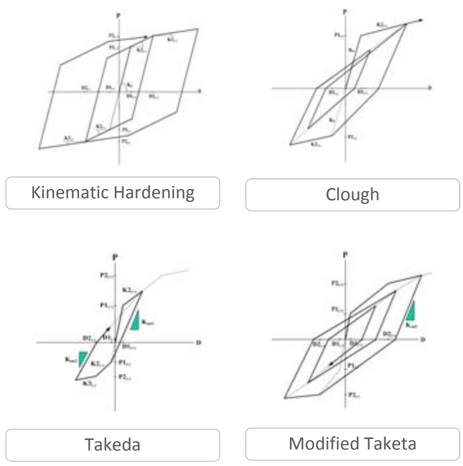
- Damper, Isolator
- Nonlinear hinge
- Seismic soil-foundation-structure interaction

Inelastic Hinge Properties

→ **Pile Springs(Point/ Surface)** to simulate ground conditions
→ **Inelastic hinge property** applied to inelastic time history analysis only
→ **Linear and Non-linear soil** condition can be considered







Seismic Soil-Foundation-Structure Interaction Model

Main Feature of midas Civil

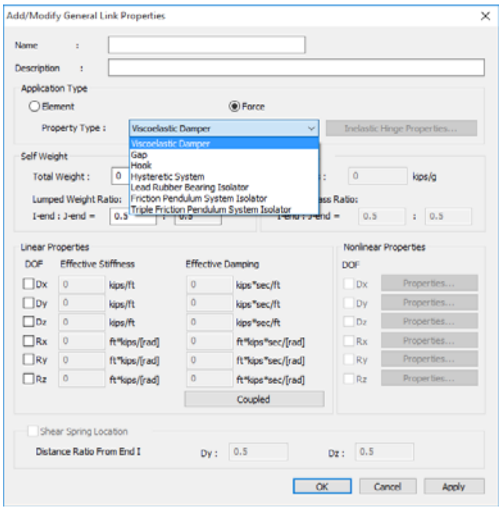
- Damper, Isolator
- Nonlinear hinge
- Seismic soil-foundation-structure interaction

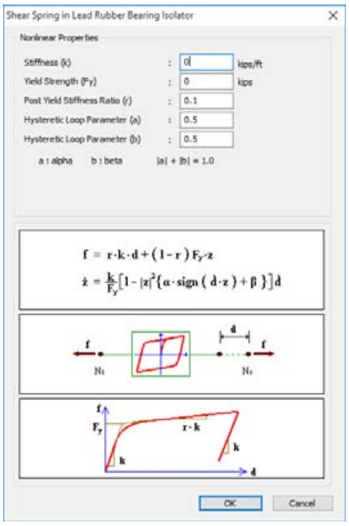
Boundary Nonlinear Properties

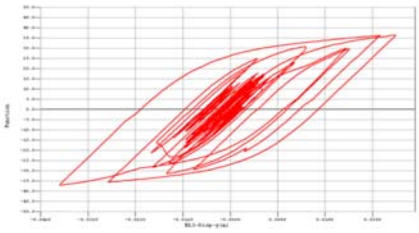
→ **Pile Springs(Point/ Surface)** to simulate ground conditions

→ **Inelastic hinge property** applied to inelastic time history analysis only

→ **Linear and Non-linear soil** condition can be considered







Rail Track Analysis Model

Rail Track Analysis Model

Main Feature of midas Civil

- RTA wizard / Report

Rail Track Analysis Wizard / Report

→ **Thermal load/ Train Load/ Acceleration load** can be considered

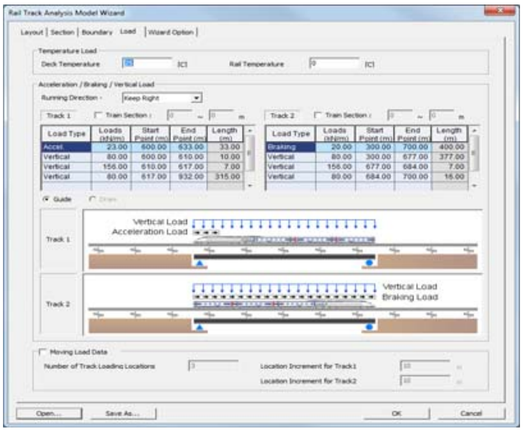
→ **Elastic link with multi linear type** are automatically generated

→ **Vertical load variation according to vehicle position** can be considered

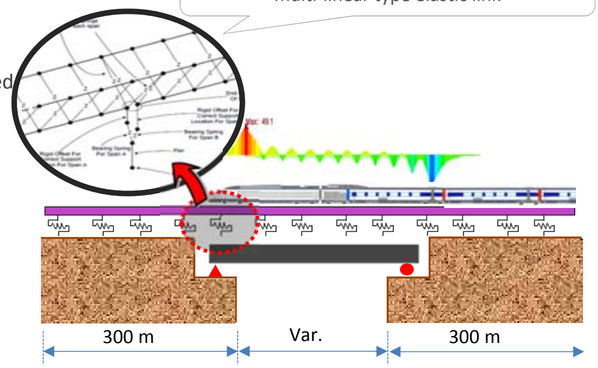
Model with Temperature Load | Model with train load (gravity direction) | Model with train acceleration and braking force

+

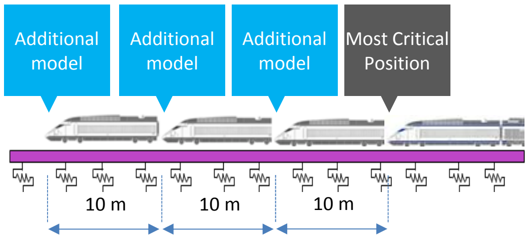
Construction Stage model with all load cases



Auto-generation of multi-linear type elastic link



Generation of additional moving load analysis models with referring to the most critical position



Train-Structure Interaction Analysis

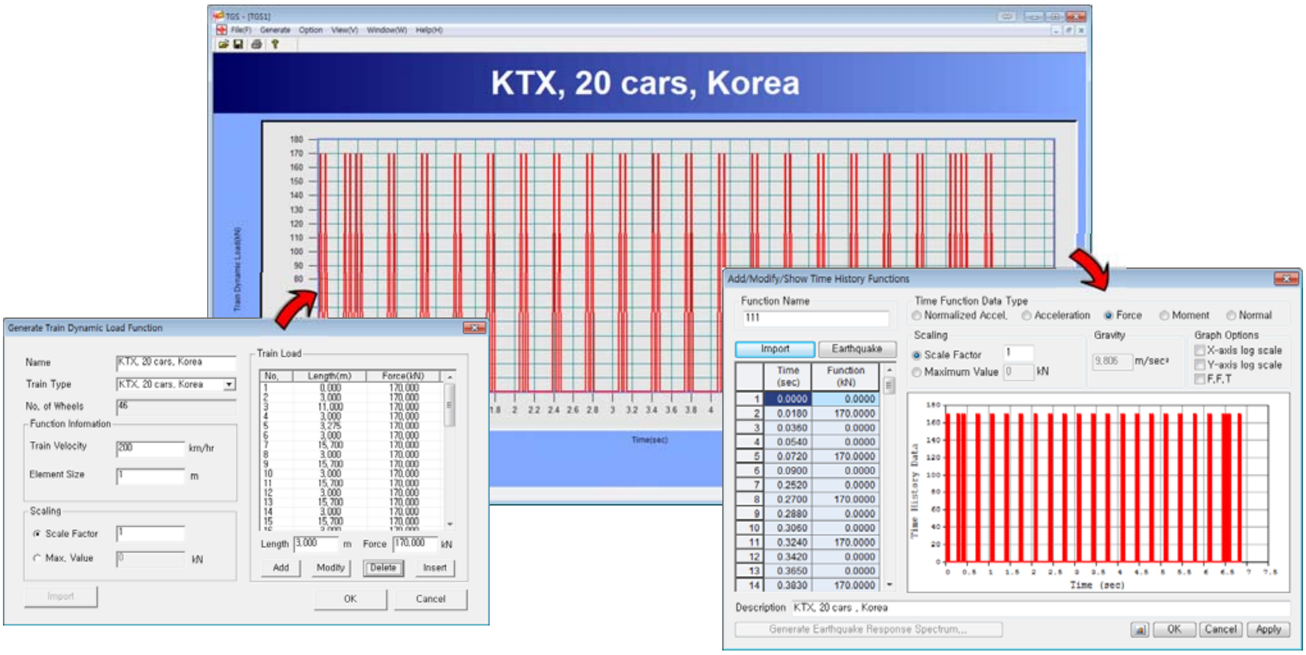
Train-Structure Interaction Analysis

Main Feature of midas Civil

- Train Load Data Generator

Train Load Data Generator

→ **Train Load will be generated** considering velocity and element size by input each axle load and distance



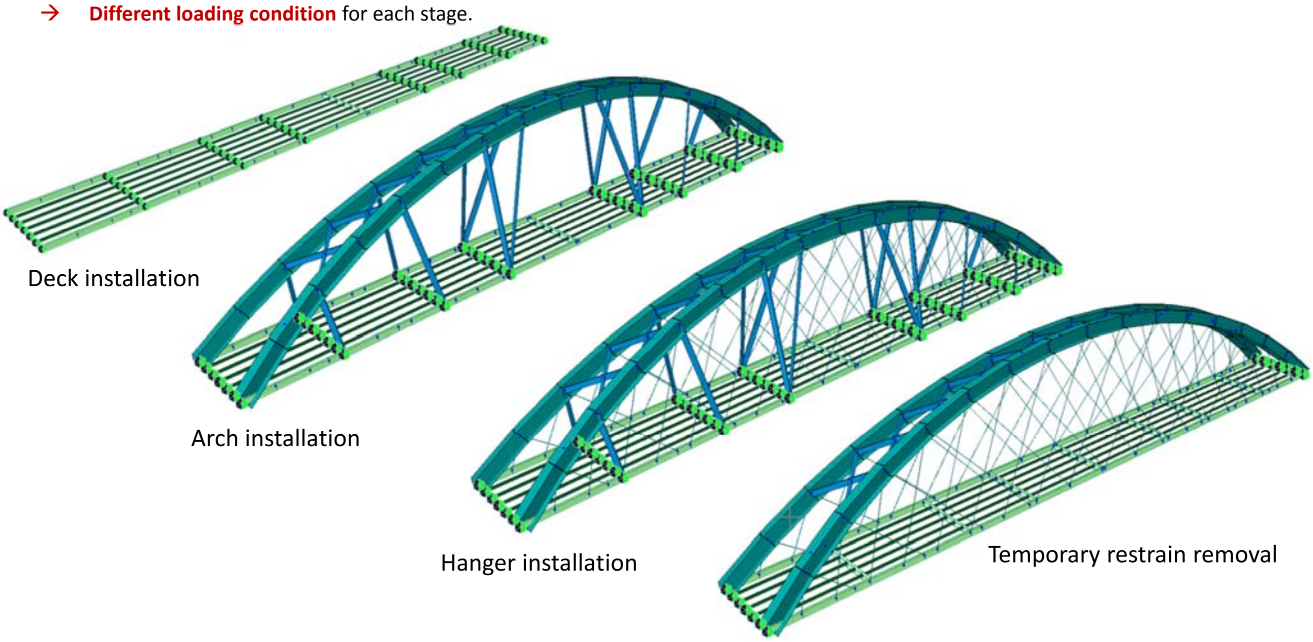
Network Arch

Network Arch

Main Feature of midas Civil
- Construction stage analysis

Construction Stage Analysis

→ **Construction Sequence** seamlessly simulated in a single model will all stages and accumulative results
→ **Boundary Condition** changes to reflect different conditions through the stages
→ **Different loading condition** for each stage.



Precast Composite Girder

Precast Composite Girder

Main Feature of midas Civil

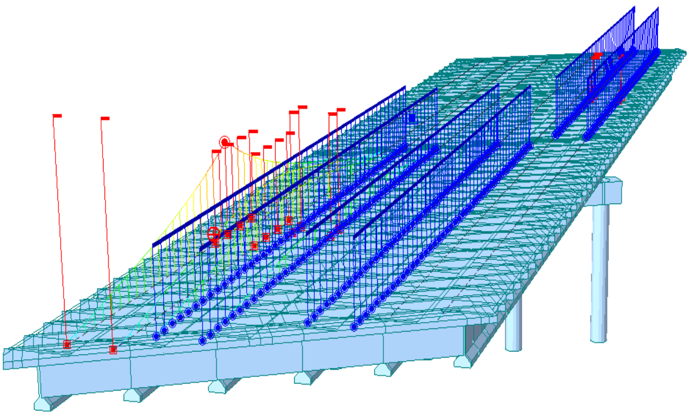
- Moving Load Analysis
- Tendon Template

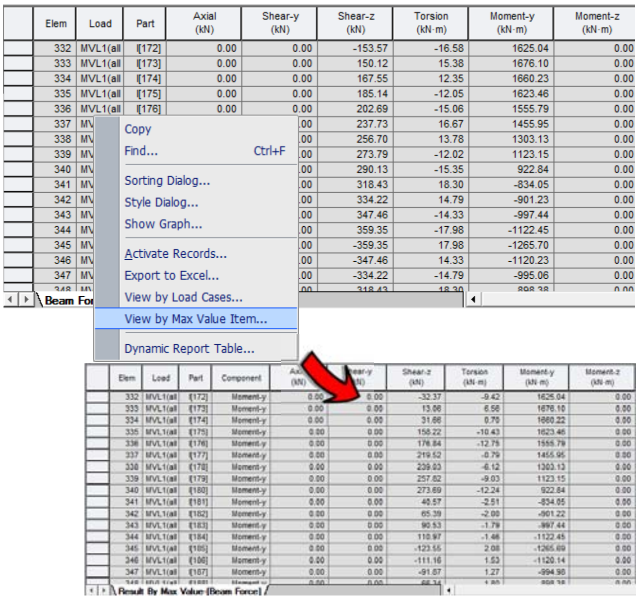
Moving Load analysis

→ **Standard Vehicles** from various international standard defined with two clicks

→ **Vehicle Optimization** to obtain the most adverse loading pattern as per the code specifications

→ **Envelope Results/ Moving Load Tracer** to check the worst effects and the load pattern for them





Elem	Load	Part	Axial (kN)	Shear-y (kN)	Shear-z (kN)	Torsion (kN·m)	Moment-y (kN·m)	Moment-z (kN·m)
332	MVL1(all	I[172]	0.00	0.00	-153.57	-16.58	1625.04	0.00
333	MVL1(all	I[173]	0.00	0.00	150.12	15.38	1676.10	0.00
334	MVL1(all	I[174]	0.00	0.00	167.55	12.35	1660.23	0.00
335	MVL1(all	I[175]	0.00	0.00	185.14	-12.05	1623.46	0.00
336	MVL1(all	I[176]	0.00	0.00	202.69	-15.06	1555.79	0.00
337	MV			.00	237.73	16.67	1455.95	0.00
338	MV			.00	256.70	13.78	1303.13	0.00
339	MV			.00	273.79	-12.02	1123.15	0.00
340	MV			.00	290.13	-15.35	922.84	0.00
341	MV			.00	318.43	18.30	-834.05	0.00
342	MV			.00	334.22	14.79	-901.23	0.00
343	MV			.00	347.46	-14.33	-997.44	0.00
344	MV			.00	359.35	-17.98	-1122.45	0.00
345	MV			.00	-359.35	17.98	-1265.70	0.00
346	MV			.00	-347.46	14.33	-1120.23	0.00
347	MV			.00	-334.22	-14.79	-995.06	0.00

Precast Composite Girder

Main Feature of midas Civil

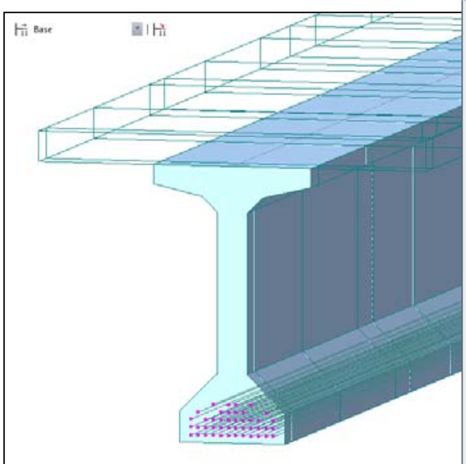
- Moving Load Analysis
- Tendon Template

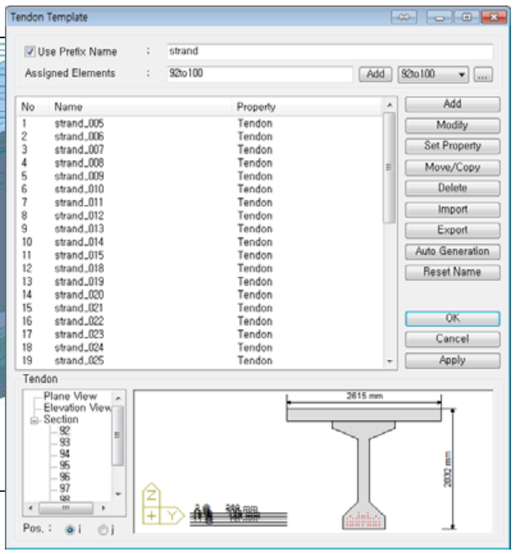
Moving Load analysis

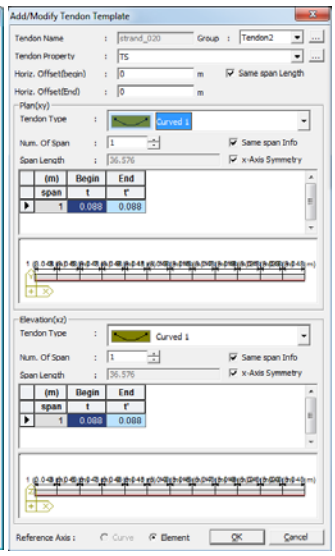
→ Auto-generation of the **UK PSC section database.**

→ **Straight tendons and harped tendons** can be defined based on the span and section information.

→ **Import & Export function** to utilize tendon template for other project.







Nowolazurowa Fly over

Warsaw, Poland

Owner: Road Investments Management Authority in Warsaw
General Contractor: SKANSKA
Engineering Consultant: SKANSKA
Construction Period: 2014 - 2015
Type of Structure: Steel Composite Girder Bridge
Size of Structure: 34m Main Span, 420m Total Length

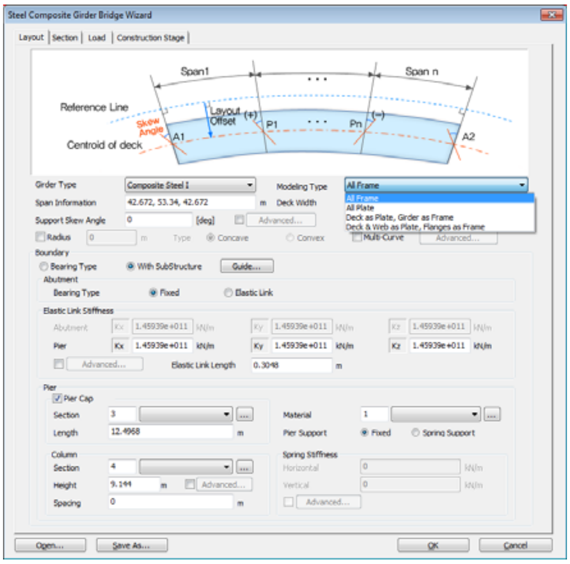
Nowolazurowa Fly over

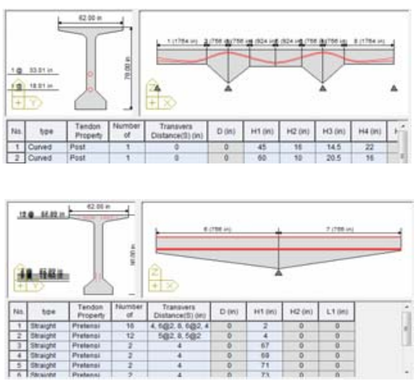
Main Feature of midas Civil

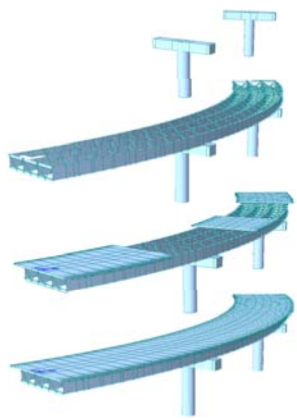
- Steel Composite Girder Bridge Wizard
- Beam element with Composite section
- Virtual beam

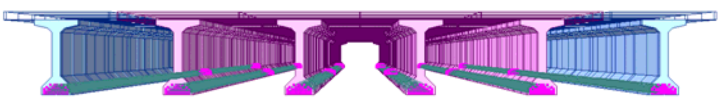
Steel Composite Girder Bridge Wizard

→ **Multi curve / Construction stage / tendon** can be generated based on structural layout and construction procedure
→ **Automatic Loads** based on basic layout
→ **Automatic Boundary Conditions** with temporary and permanent conditions considered









Nowolazurowa Fly over

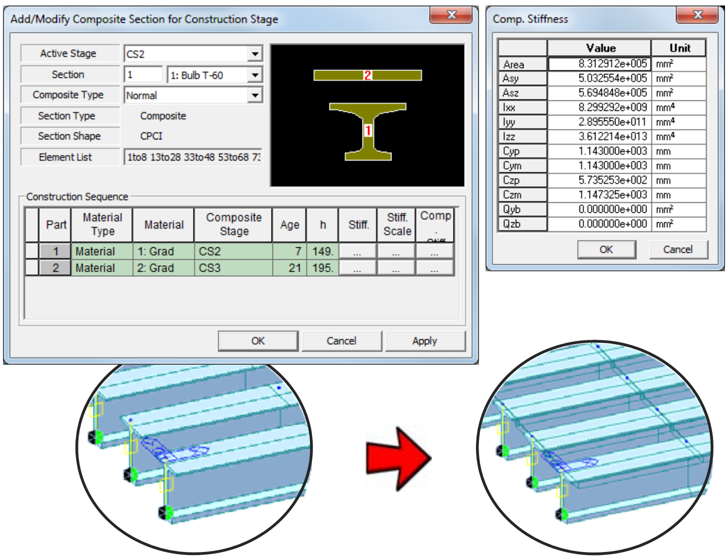
Main Feature of midas Civil

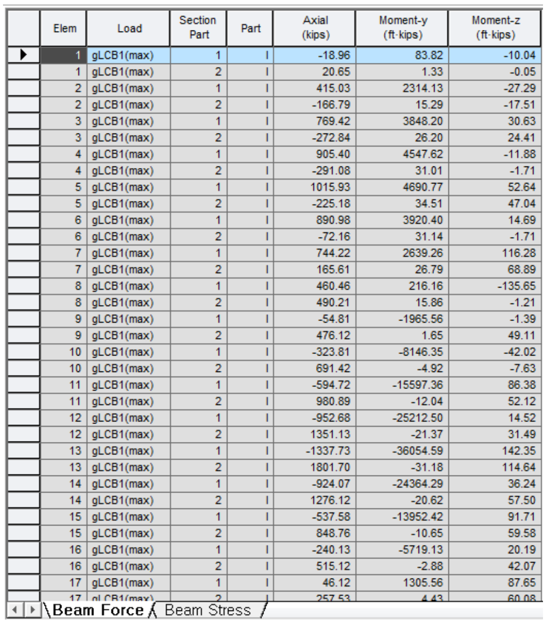
- Steel Composite Girder Bridge Wizard
- Beam element with Composite section
- Virtual beam

Beam element with Composite section

→ **Composite Section for Construction Stage** to consider before composite and after composite section properties

→ **Each slab and girder force/stress is calculated separately.**





Elem	Load	Section Part	Part	Axial (kips)	Moment-y (ft·kips)	Moment-z (ft·kips)
1	gLCB1(max)	1	I	-18.96	83.82	-10.04
1	gLCB1(max)	2	I	20.65	1.33	-0.05
2	gLCB1(max)	1	I	415.03	2314.13	-27.29
2	gLCB1(max)	2	I	-166.79	15.29	-17.51
3	gLCB1(max)	1	I	769.42	3848.20	30.63
3	gLCB1(max)	2	I	-272.84	26.20	24.41
4	gLCB1(max)	1	I	905.40	4547.62	-11.88
4	gLCB1(max)	2	I	-291.08	31.01	-1.71
5	gLCB1(max)	1	I	1015.93	4690.77	52.64
5	gLCB1(max)	2	I	-225.18	34.51	47.04
6	gLCB1(max)	1	I	890.98	3920.40	14.69
6	gLCB1(max)	2	I	-72.16	31.14	-1.71
7	gLCB1(max)	1	I	744.22	2639.26	116.28
7	gLCB1(max)	2	I	165.61	26.79	68.89
8	gLCB1(max)	1	I	460.46	216.16	-135.65
8	gLCB1(max)	2	I	490.21	15.86	-1.21
9	gLCB1(max)	1	I	-54.81	-1965.56	-1.39
9	gLCB1(max)	2	I	476.12	1.65	49.11
10	gLCB1(max)	1	I	-323.81	-8146.35	-42.02
10	gLCB1(max)	2	I	691.42	-4.92	-7.63
11	gLCB1(max)	1	I	-594.72	-15597.36	86.38
11	gLCB1(max)	2	I	980.89	-12.04	52.12
12	gLCB1(max)	1	I	-952.68	-25212.50	14.52
12	gLCB1(max)	2	I	1351.13	-21.37	31.49
13	gLCB1(max)	1	I	-1337.73	-36054.59	142.35
13	gLCB1(max)	2	I	1801.70	-31.18	114.64
14	gLCB1(max)	1	I	-924.07	-24364.29	36.24
14	gLCB1(max)	2	I	1276.12	-20.62	57.50
15	gLCB1(max)	1	I	-537.58	-13952.42	91.71
15	gLCB1(max)	2	I	848.76	-10.65	59.58
16	gLCB1(max)	1	I	-240.13	-5719.13	20.19
16	gLCB1(max)	2	I	515.12	-2.88	42.07
17	gLCB1(max)	1	I	46.12	1305.56	87.65
17	gLCB1(max)	2	I	257.53	4.43	60.08

Beam Force / Beam Stress

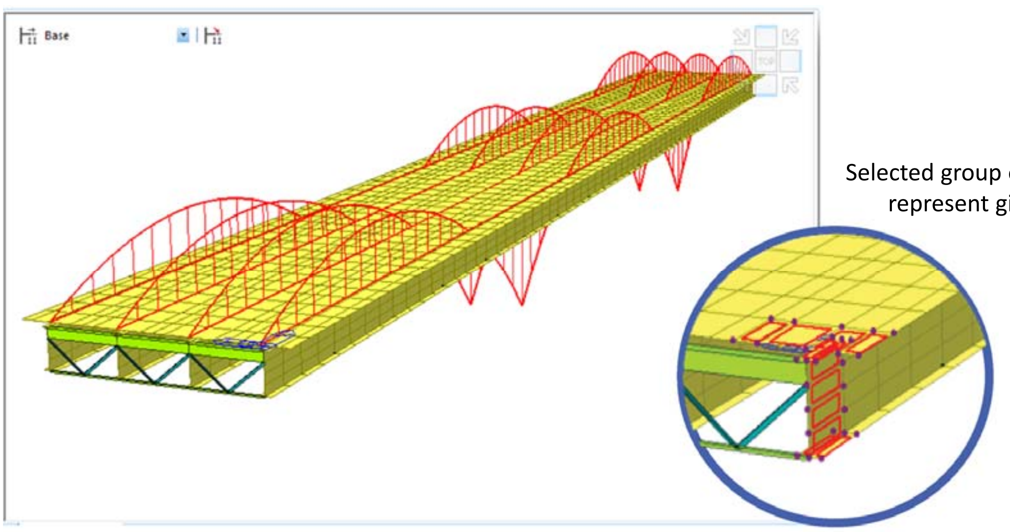
Nowolazurowa Fly over

Main Feature of midas Civil

- Steel Composite Girder Bridge Wizard
- Beam element with Composite section
- Virtual beam

Virtual beam

→ The resultant forces of **a section consisting of plate/plane stress elements and beam/truss elements** can be checked



Selected group of elements that represent girder section

midas Civil Basic Training

- Simple Beam -

TECH TALK

MIDAS

Contents

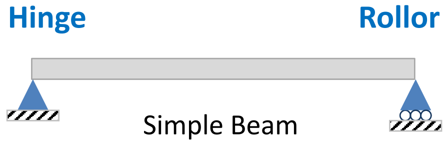
TECH TALK

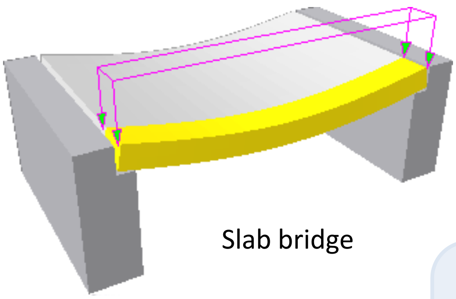
1. Overview

1.1 Example

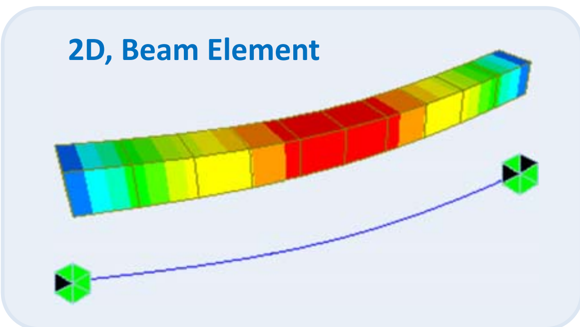
1.2 Learning Goal

1.1 Example





Slab bridge

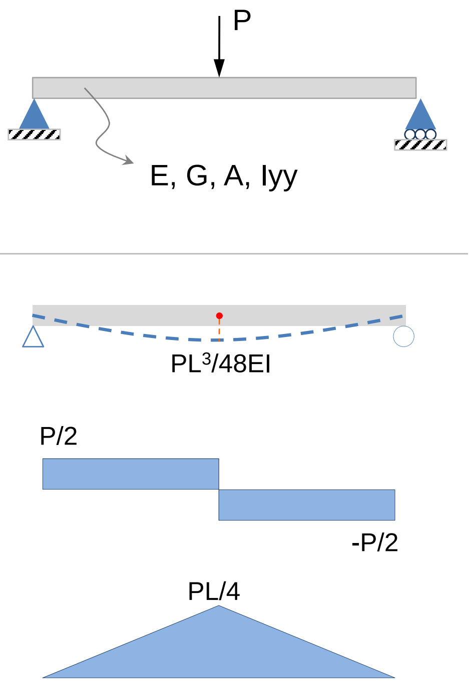


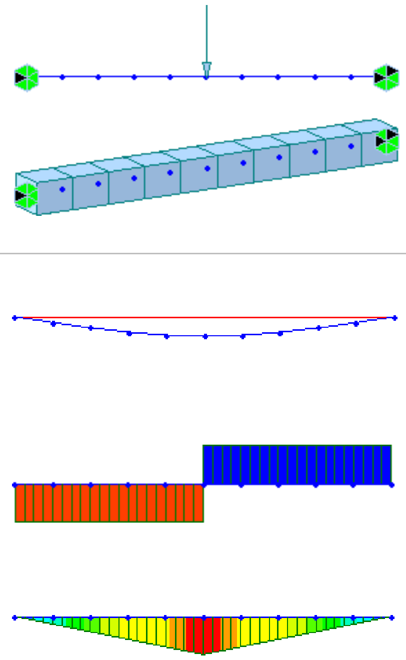
1.2 Learning Goal

TECH TALK

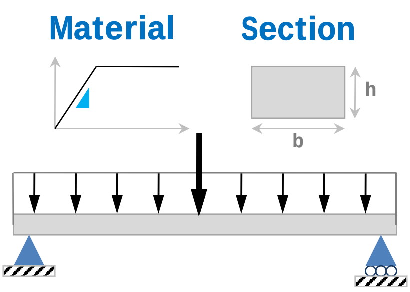
Hand Calculation

midas Civil





TECH TALK



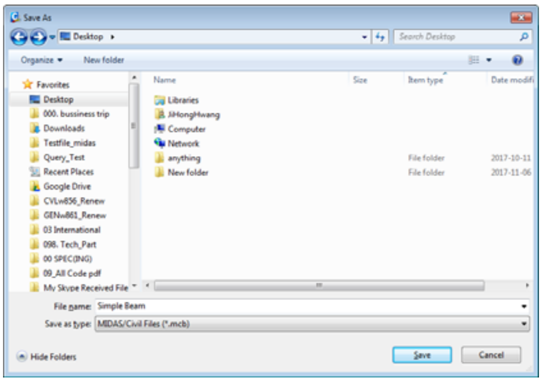
2. Modeling

- 2.1 Set up the work environment
- 2.2 Define property
- 2.3 Modeling
- 2.4 Set boundary conditions
- 2.5 Apply the loads

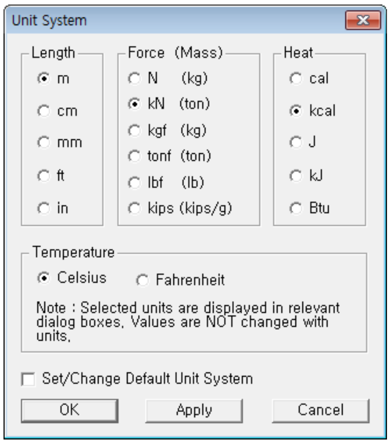
2.1 Setting up the work environment

TECH TALK

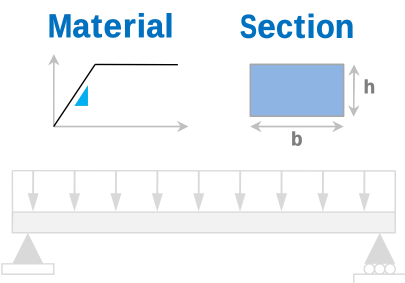
Save file



Set unit system



TECH TALK



2. Modeling

2.1 Set up the work environment

∨ 2.2 Define property

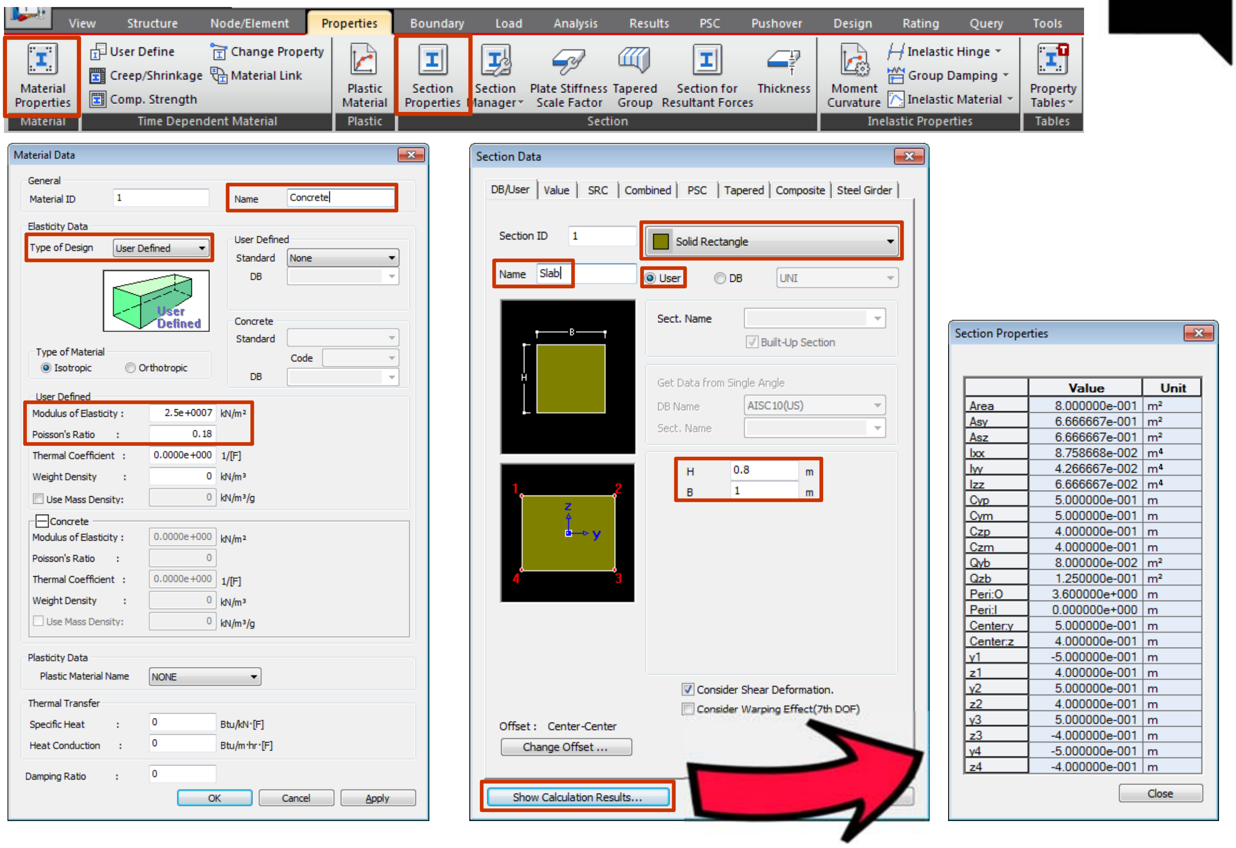
2.3 Modeling

2.4 Set boundary conditions

2.5 Apply the loads

2.2 Define property

TECH TALK

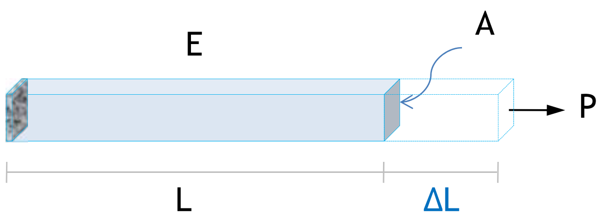


	Value	Unit
Area	8.000000e-001	m²
Asy	6.666667e-001	m²
Asz	6.666667e-001	m²
Ixx	8.758668e-002	m⁴
Iyy	4.266667e-002	m⁴
Izz	6.666667e-002	m⁴
Cyp	5.000000e-001	m
Cym	5.000000e-001	m
Czp	4.000000e-001	m
Czm	4.000000e-001	m
Qyb	8.000000e-002	m²
Qzb	1.250000e-001	m²
Peri:O	3.600000e+000	m
Peri:I	0.000000e+000	m
Center:y	5.000000e-001	m
Center:z	4.000000e-001	m
y1	-5.000000e-001	m
z1	4.000000e-001	m
y2	5.000000e-001	m
z2	4.000000e-001	m
y3	5.000000e-001	m
z3	-4.000000e-001	m
y4	-5.000000e-001	m
z4	-4.000000e-001	m

2.2 Define property

TECH TALK

Property : Rigidity

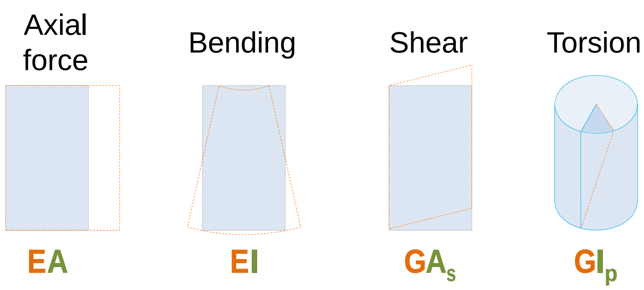


$$\Delta L = \frac{PL}{EA}$$

$$\frac{EA}{L} \cdot \Delta L = P$$

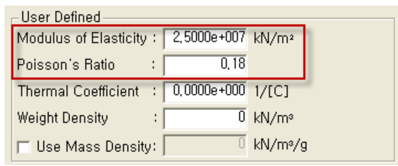
$$[k] \cdot \{D\} = \{P\}$$

Rigidity (Material, Section)

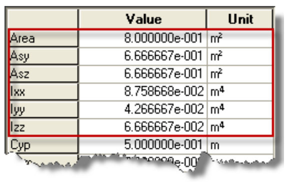


EA EI GA_s GI_p

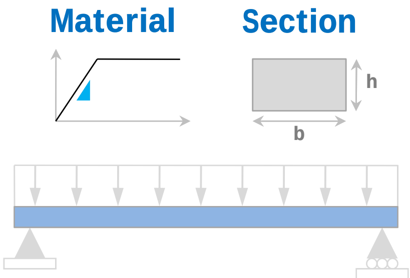
Material



Section



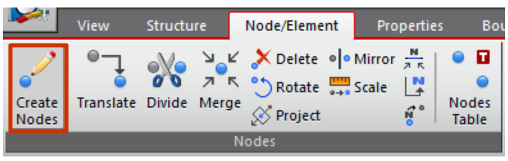
	Value	Unit
Area	8.000000e-001	m²
Asy	6.666667e-001	m²
Asz	6.666667e-001	m²
Ixx	8.758668e-002	m⁴
Iyy	4.266667e-002	m⁴
Izz	6.666667e-002	m⁴
Cyp	5.000000e-001	m

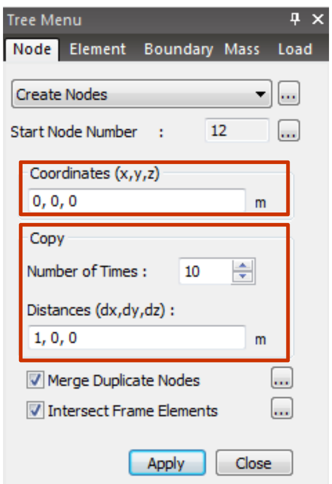


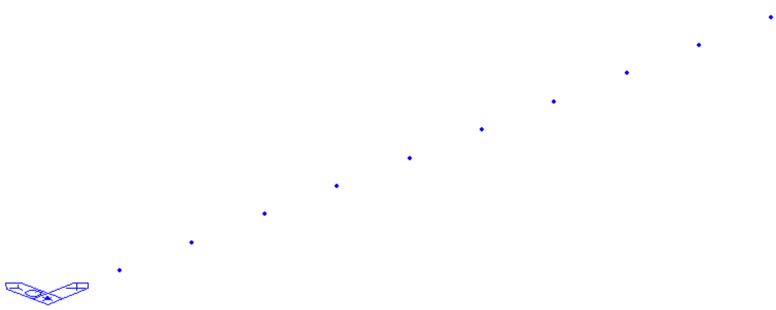
2. Modeling

2.3 Modeling

Create nodes



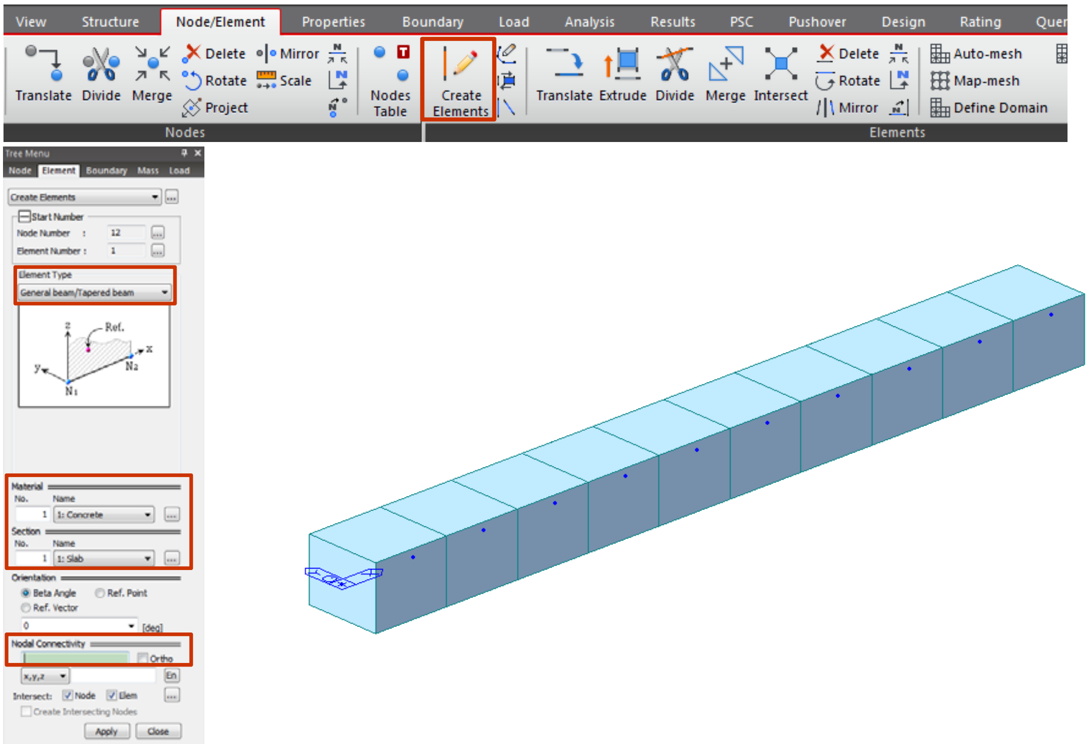




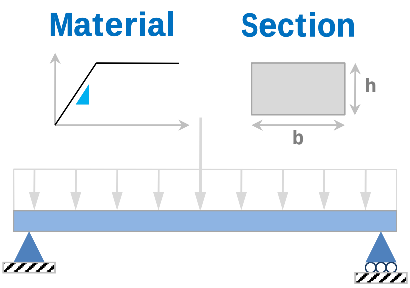
2.3 Modeling

TECH TALK

Create elements



TECH TALK



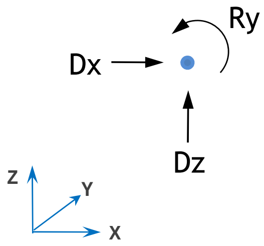
2. Modeling

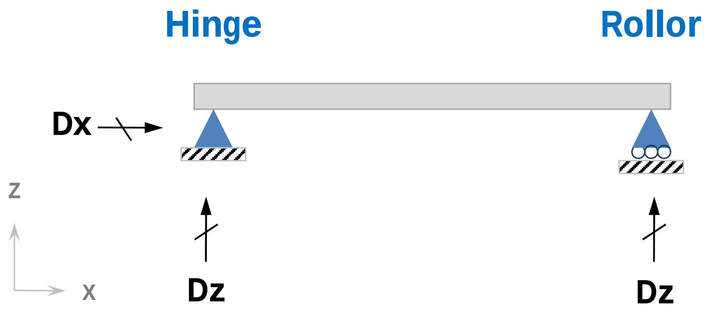
- 2.1 Set up the work environment
- 2.2 Define property
- 2.3 Modeling
- V 2.4 Set boundary conditions
- 2.5 Apply the loads

Step 1

2.4 Set boundary conditions

Define Boundary



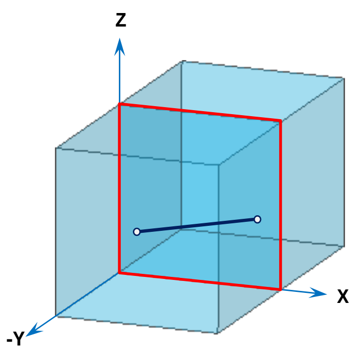


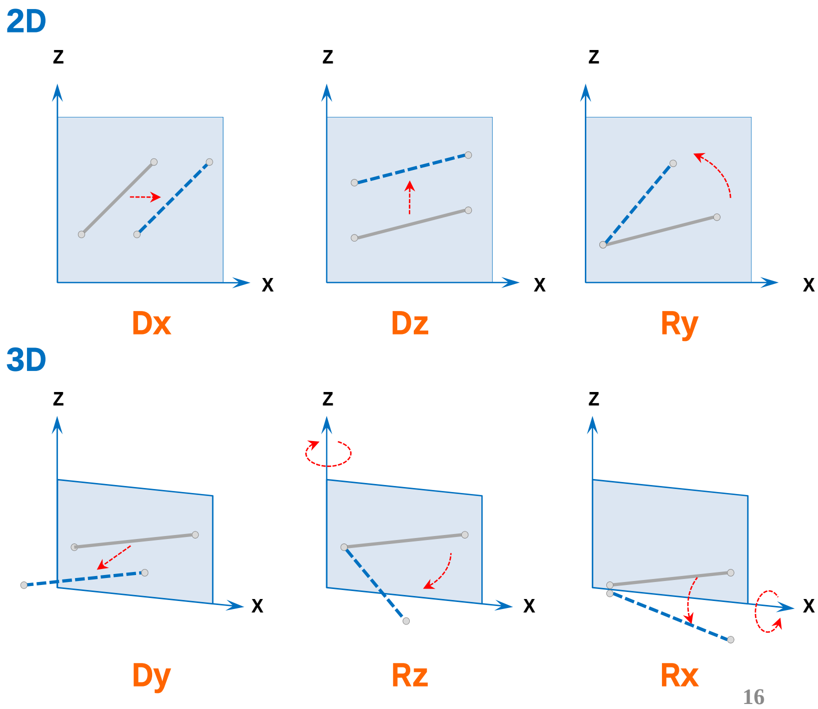
+ +

Dy, Rx, Rz **Dy, Rx, Rz**

2.4 Set boundary conditions

Scale from 2D to 3D

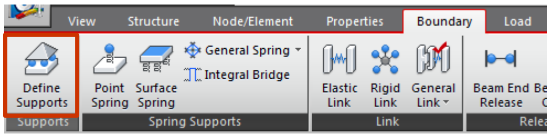


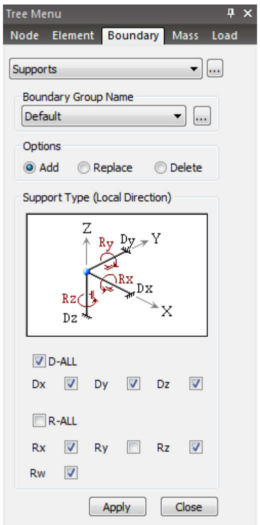


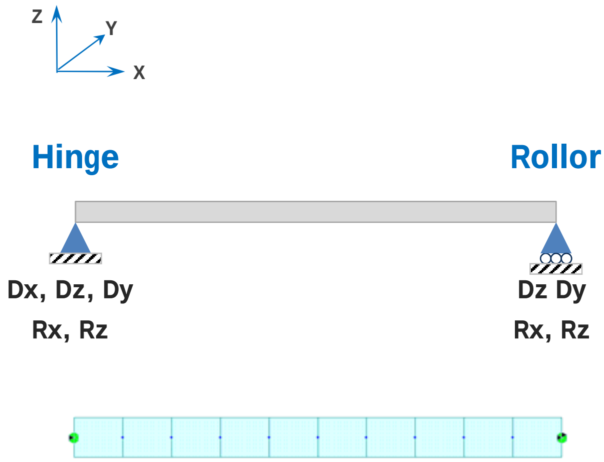
2.4 Set boundary conditions

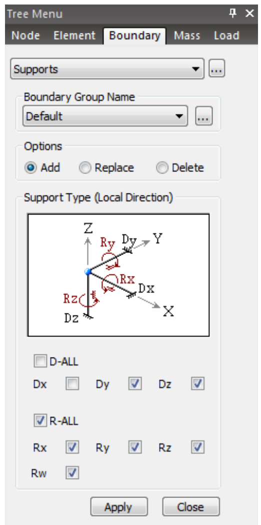
TECH TALK

Define Boundary

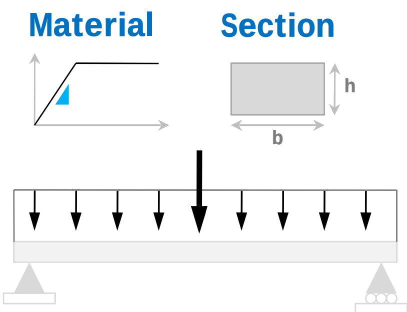








TECH TALK



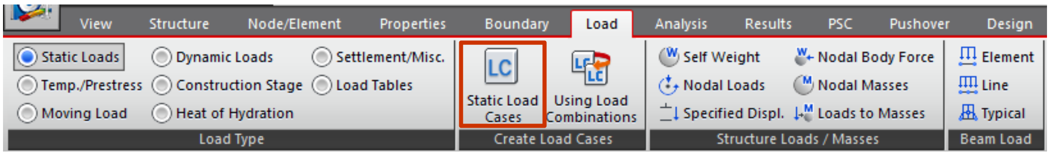
2. Modeling

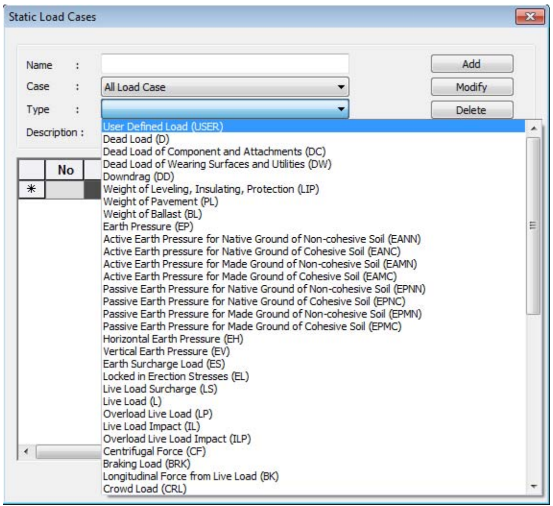
- 2.1 Set up the work environment
- 2.2 Define property
- 2.3 Modeling
- 2.4 Set boundary conditions
- V 2.5 Apply the loads

Step2

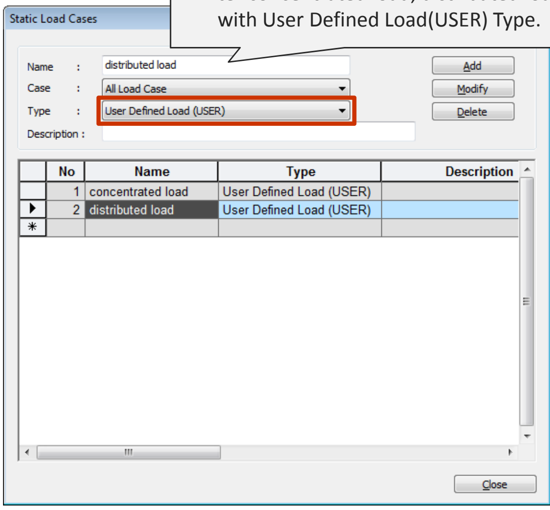
2.5 Apply the loads

Define Load case





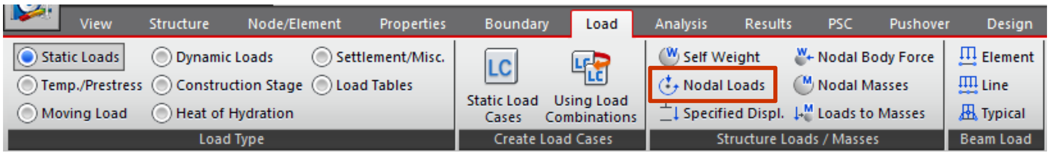
Enter concentrated load, distributed load with User Defined Load(USER) Type.

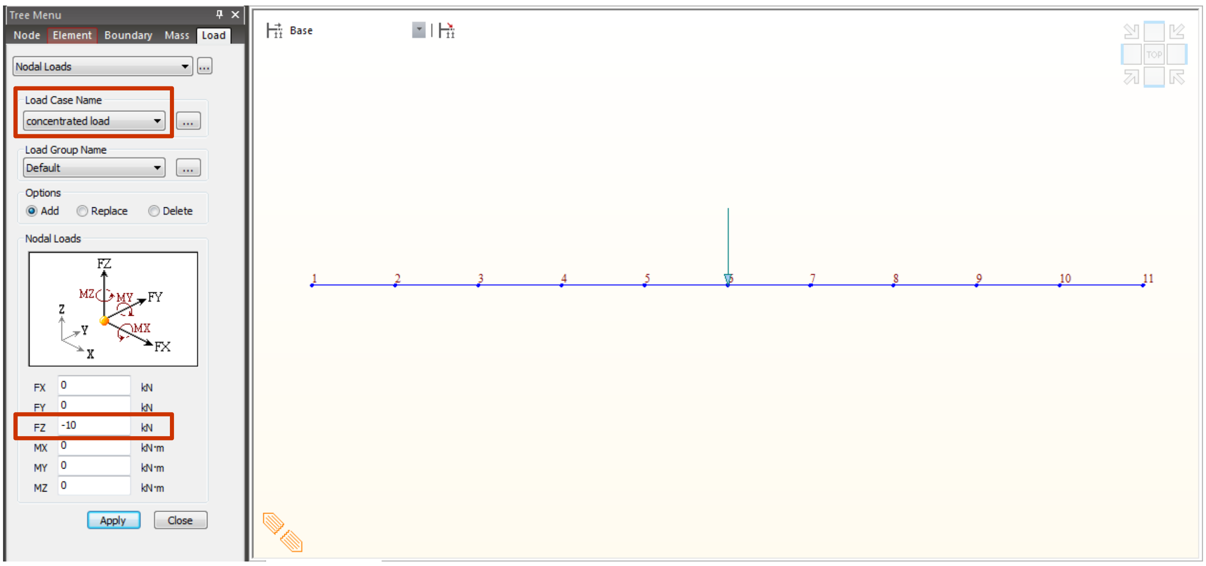


2.5 Apply the loads

Apply the loads

(1) Nodal Loads

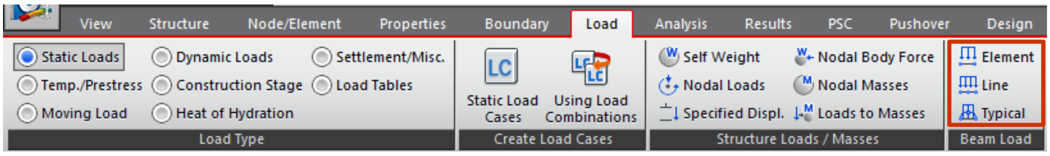




2.5 Apply the loads

TECH TALK

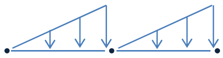
Apply the loads (2) Elements Loads



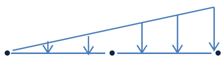
USE: For specifying the regular beam forces such as uniformly/ non-uniformly distributed forces etc.

TYPE: The following types of beam loads can be specified:

1) Element beam Loads
 ; for each element



2) Line beam Loads
 ; for a set of elements

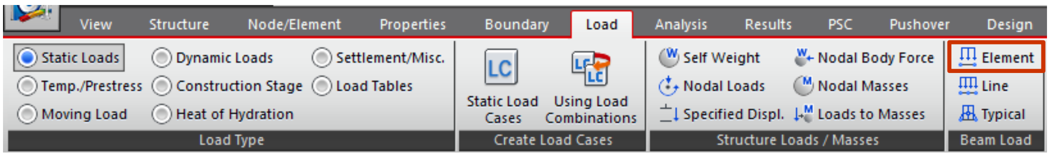


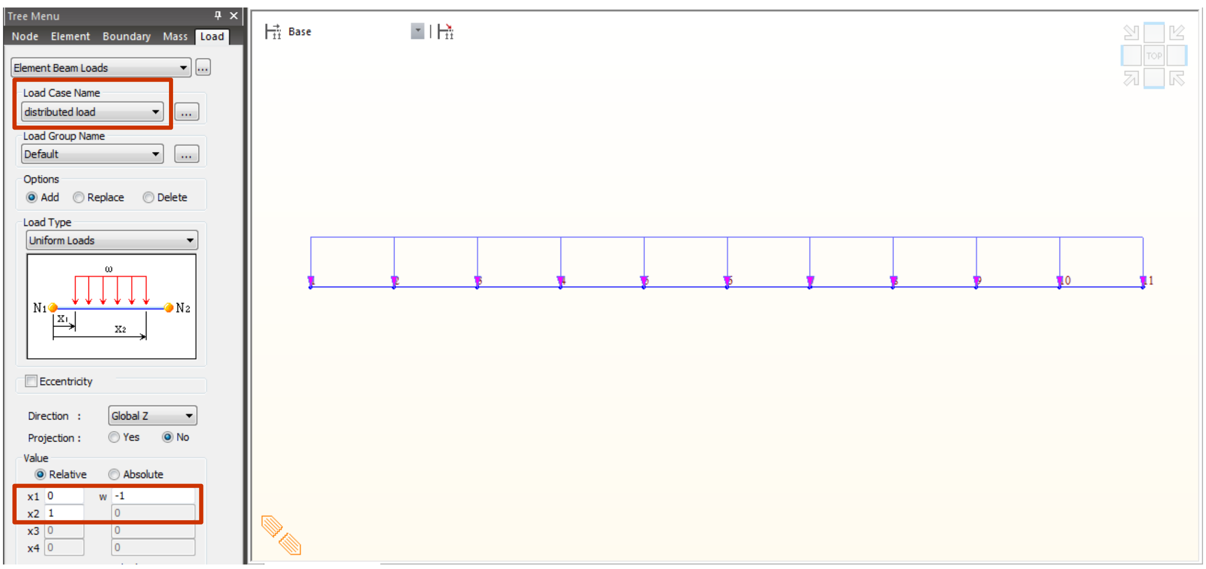
3) Typical Beam Loads
 ; Special Distribution

2.5 Apply the loads

TECH TALK

Apply the loads (2) Elements Loads

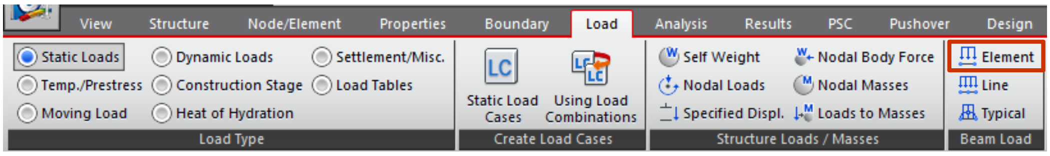


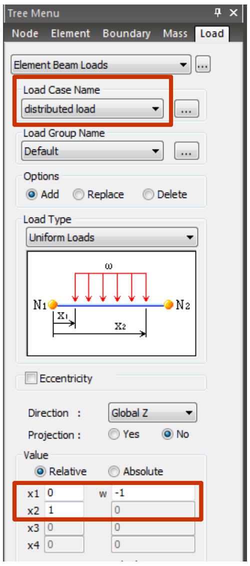


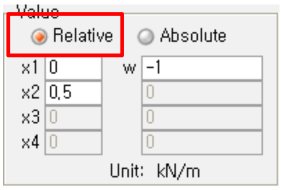
2.5 Apply the loads

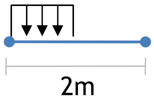
TECH TALK

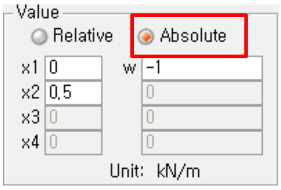
Apply the loads (2) Elements Loads

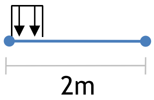






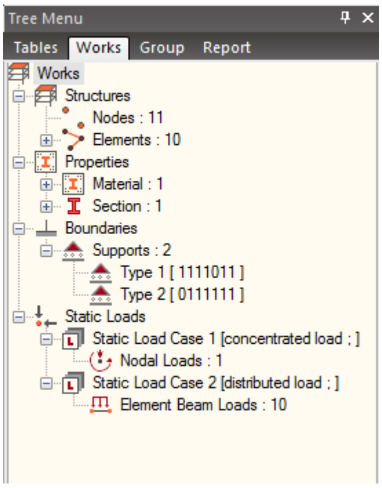


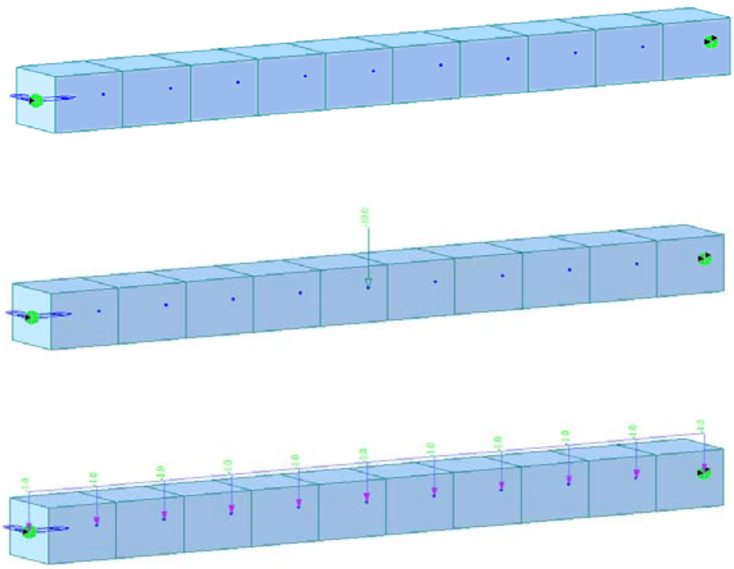




TECH TALK

Check modeling input information





TECH TALK

3. Check the results

∨ 3.1 Reaction force

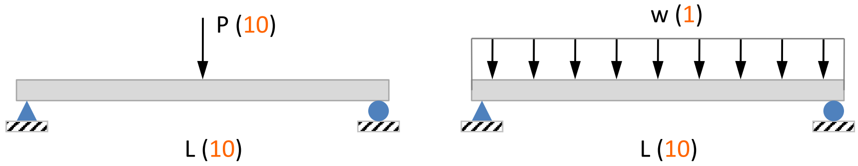
3.2 Deformation

3.3 Member force

3.4 Stress

3.1 Reaction force

TECH TALK



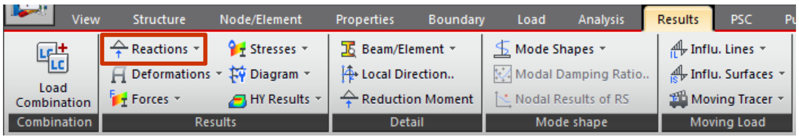
Unit : kN, m

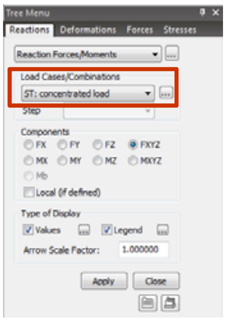
Reaction	P/2 (5)	P/2 (5)	wL/2 (5)	wL/2 (5)

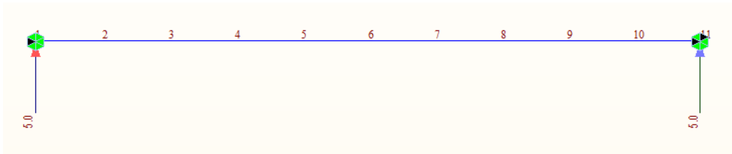
3.1 Reaction force

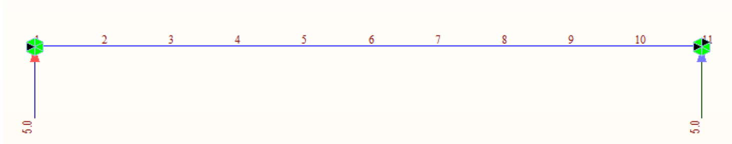
TECH TALK

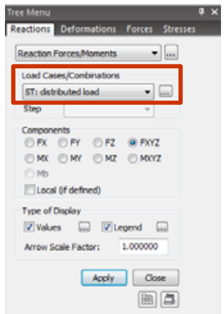
Check the reaction force









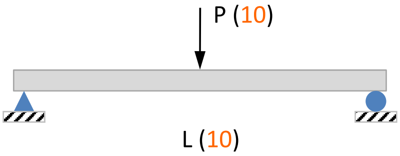


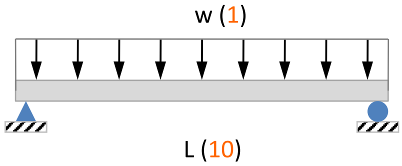
3.2 Displacement

TECH TALK

E (2.5e7)

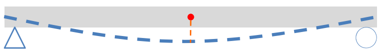
I (0.04267)



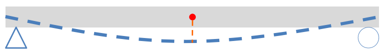


Unit : kN, m

Deflection



$PL^3/48EI$ (0.195mm)

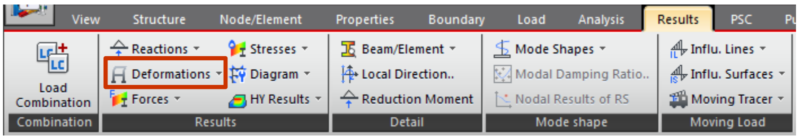


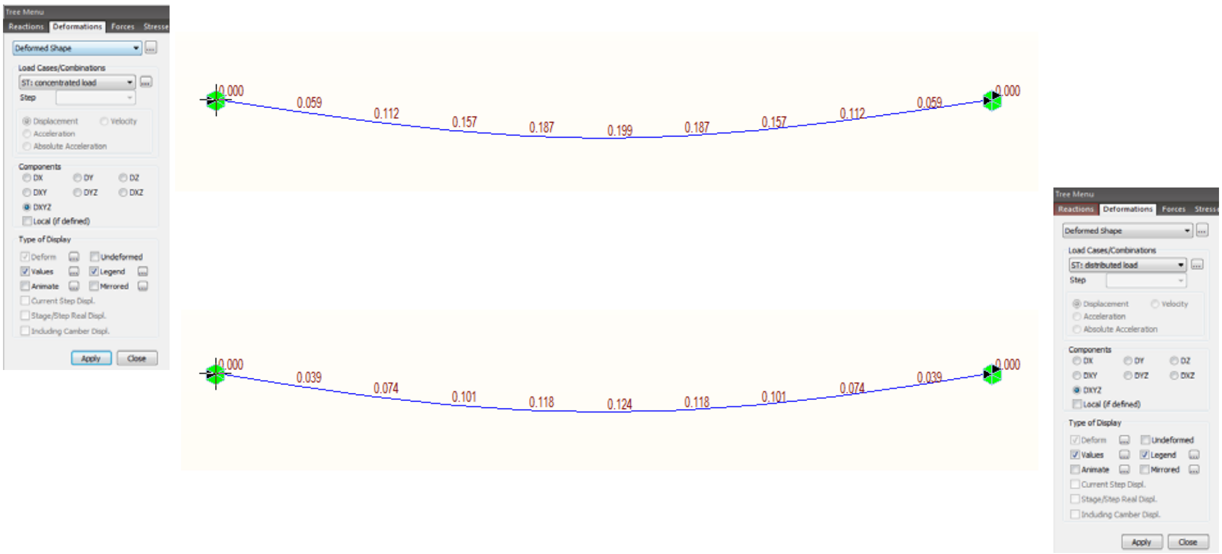
$5wL^4/384EI$ (0.122mm)

3.2 Deformation

TECH TALK

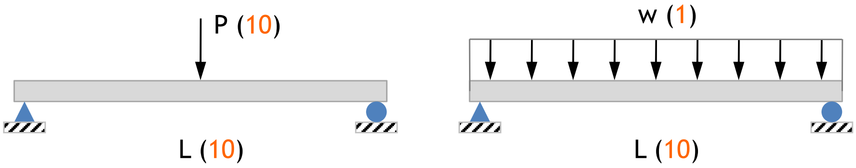
Check the deformation





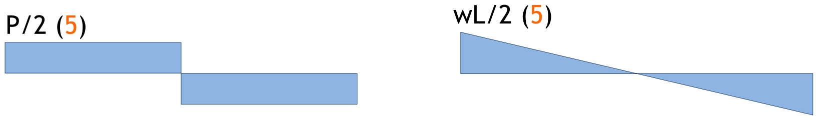
3.3 Member force

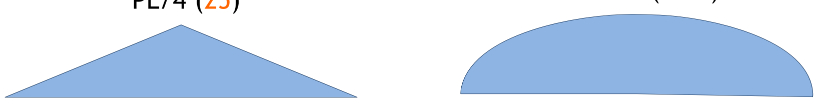
TECH TALK



Unit : kN, m

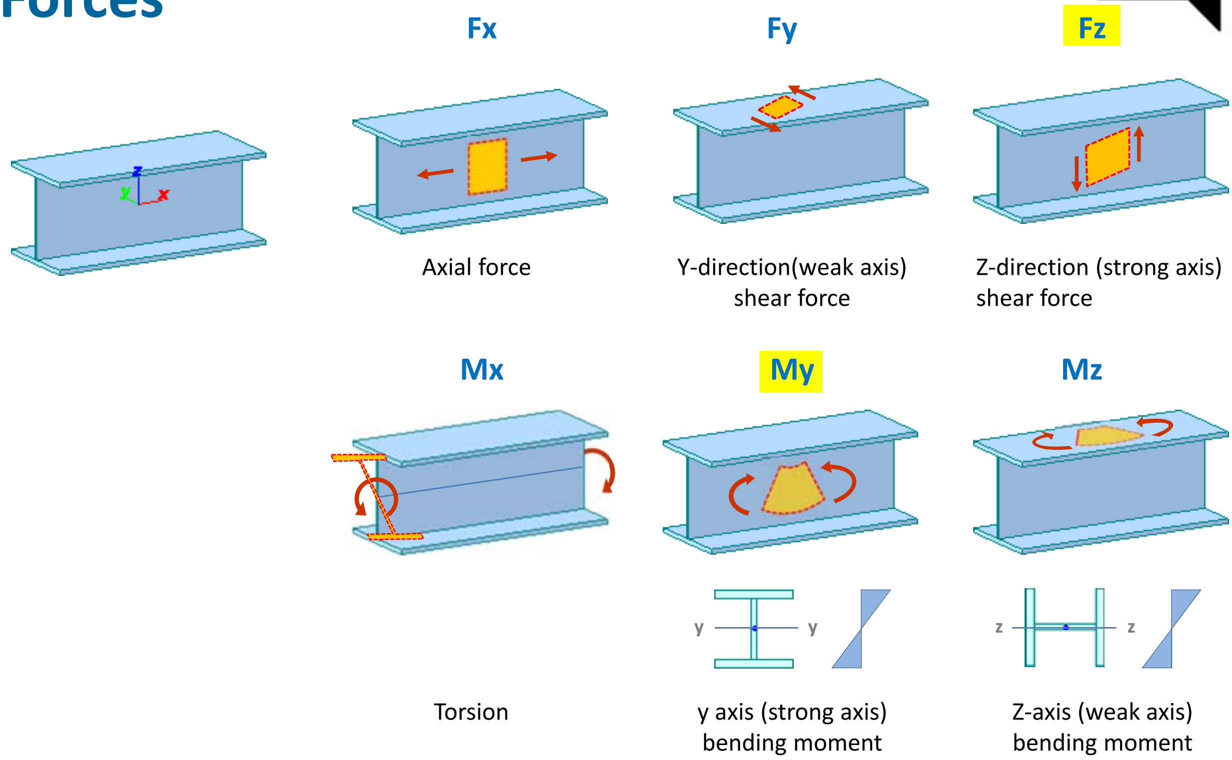
	Concentrated load	Distributed load
Reaction	P/2 (5), P/2 (5)	wL/2 (5), wL/2 (5)
Shear Force	P/2 (5), -P/2 (-5)	wL/2 (5), -wL/2 (-5)
Bending Moment	PL/4 (25)	$wL^2/8$ (12.5)





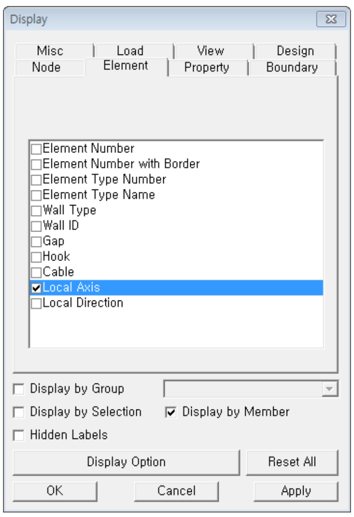
3.3 Member force

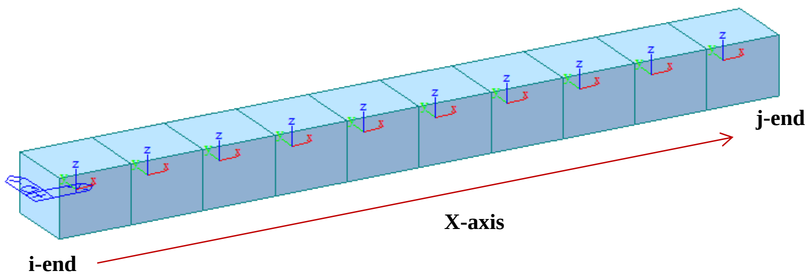
Forces



3.3 Member force

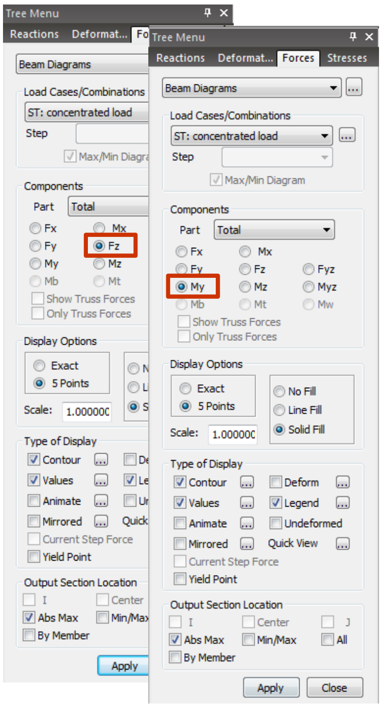
Confirm the local axis

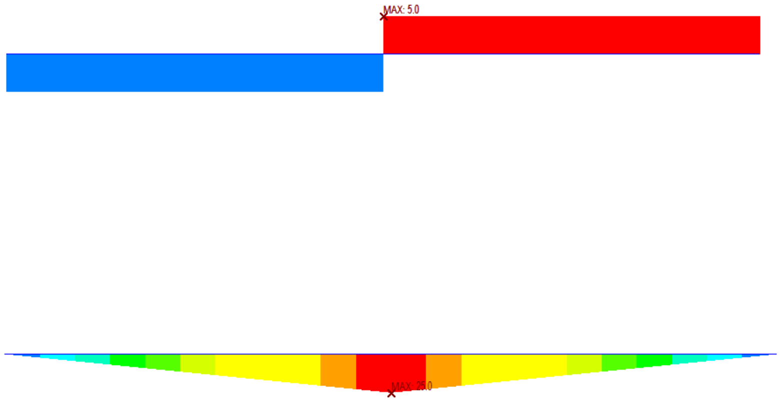




3.3 Member force

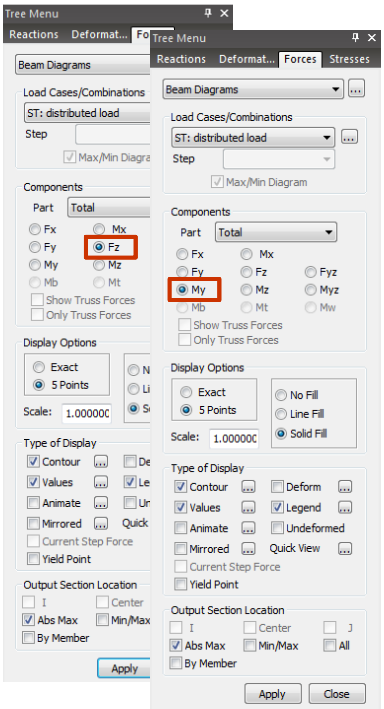
Confirm the Member force

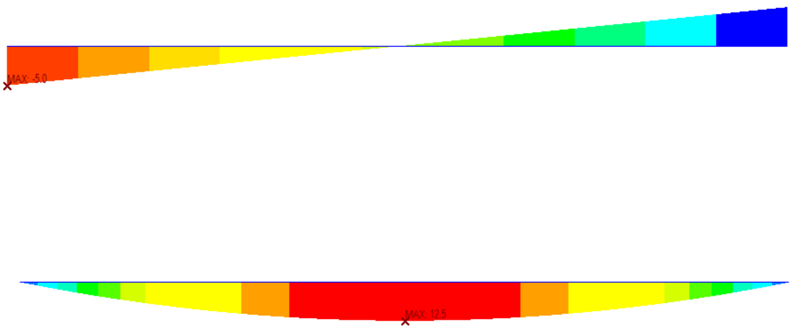




3.3 Member force

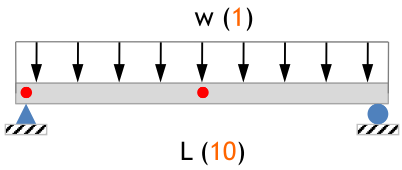
Confirm the Member force

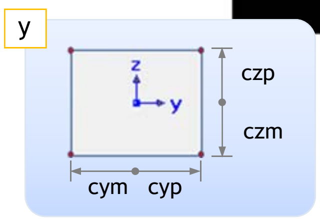




3.3 Stress

TECH TALK





Unit : kN, m

Section Properties

	Value	Unit
Area	8.000000e-001	m²
Ixx	8.758668e-002	m⁴
Iyy	4.266667e-002	m⁴
Izz	6.666667e-002	m⁴
Cyp	5.000000e-001	m
Cym	5.000000e-001	m
Czp	4.000000e-001	m
Czm	4.000000e-001	m
Qyb	8.000000e-002	m²
Qzb	1.250000e-001	m²
Peri:O	3.600000e+000	m
Peri:I	0.000000e+000	m
Center:y	5.000000e-001	m
Center:z	4.000000e-001	m
y1	-5.000000e-001	m
z1	4.000000e-001	m
y2	5.000000e-001	m
z2	4.000000e-001	m
y3	5.000000e-001	m
z3	-4.000000e-001	m
y4	-5.000000e-001	m
z4	-4.000000e-001	m

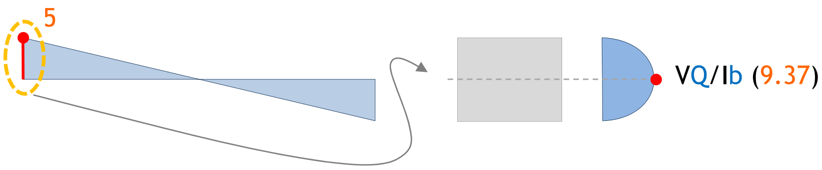
Close

y

Q/b

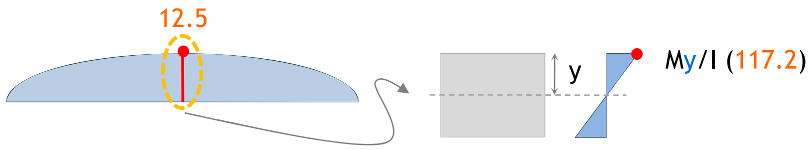
SFD

Shear Stress



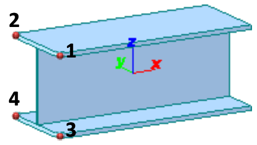
BMD

Bending Stress



3.3 Stress

TECH TALK



Section Properties

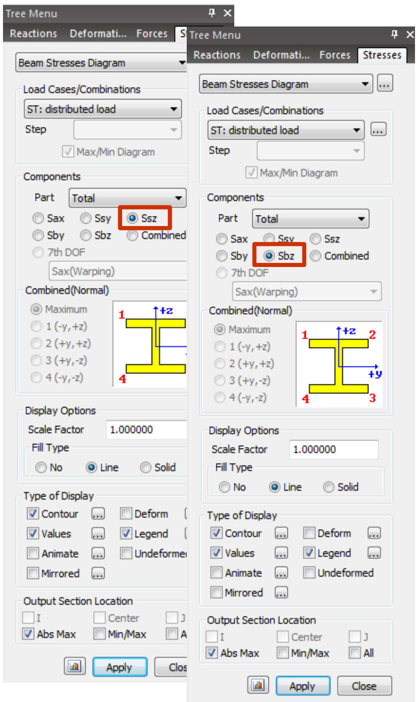
	Value	Unit
Area	8.000000e-001	m²
Ixx	8.758668e-002	m⁴
Iyy	4.266667e-002	m⁴
Izz	6.666667e-002	m⁴
Cyp	5.000000e-001	m
Cym	5.000000e-001	m
Czp	4.000000e-001	m
Czm	4.000000e-001	m
Qyb	8.000000e-002	m²
Qzb	1.250000e-001	m²
Peri:O	3.600000e+000	m
Peri:I	0.000000e+000	m
Center:y	5.000000e-001	m
Center:z	4.000000e-001	m
y1	-5.000000e-001	m
z1	4.000000e-001	m
y2	5.000000e-001	m
z2	4.000000e-001	m
y3	5.000000e-001	m
z3	-4.000000e-001	m
y4	-5.000000e-001	m
z4	-4.000000e-001	m

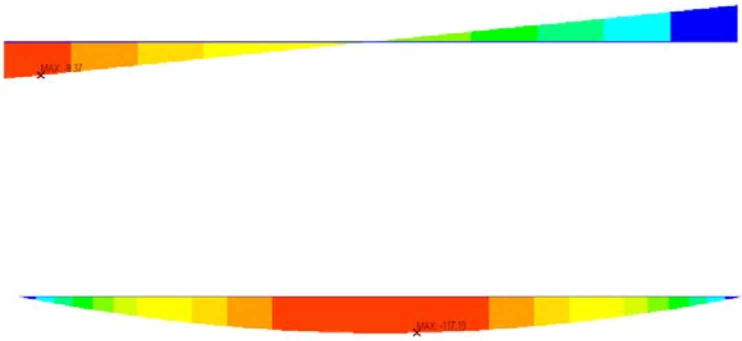
Close

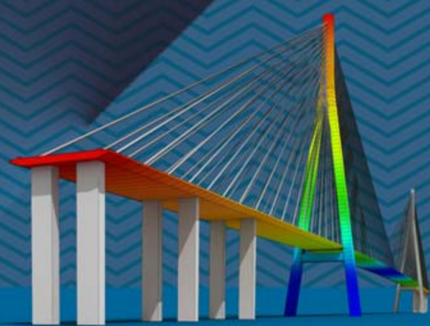
Sax (σ_{axial})	Axial stress	$\frac{P}{A}$	$\frac{Fx}{Area}$
Ssy (σ_{shear})	Weak axis shear stress	$\frac{VQ}{Ib}$	$\frac{Fy}{Izz} \cdot Qyb$
Ssz	Strong shear stress		$\frac{Fz}{} \cdot Qzb$
Sby ($\sigma_{bending}$)	Weak axis bending stress	$\frac{My}{I}$	max(Cyp, Cym) $\frac{Mz}{Izz} \cdot Cy$
Sbz	Bending stress		$\frac{My}{} \cdot Cz$ (y1, y2, y3, y4)
Combined	Vertical stress	$\frac{P}{A} + \frac{My}{I}$	$\frac{Fx}{Area} + \frac{Mz}{Izz} \cdot y + \frac{My}{Iyy} \cdot z$

TECH TALK

Confirm the Stress







MIDAS

Thank You!

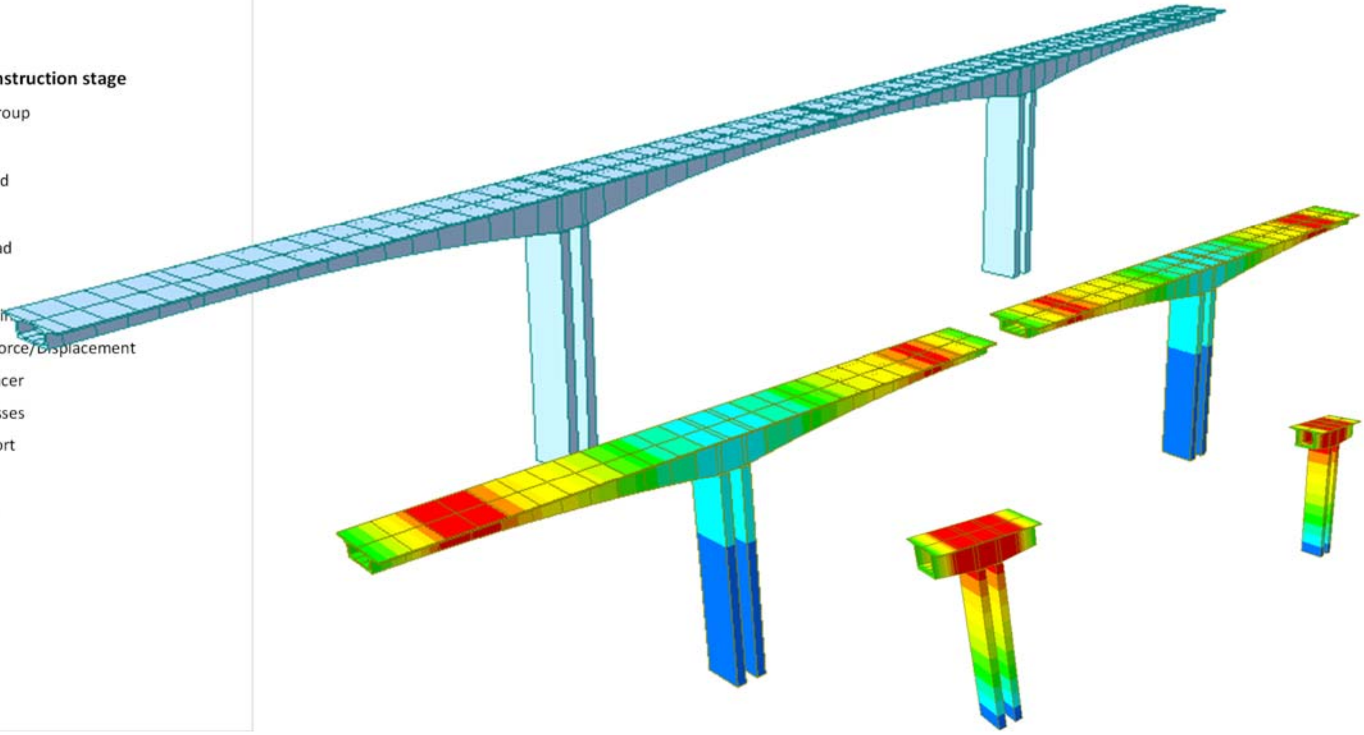
Bridging Your Innovations to Realities

midas Civil

Free Cantilever Method Bridge Analysis & Design

Overview

- **Properties**
  - Material / Section
- **FCM bridge wizard**
  - Model
  - Section
  - Tendon
- **Modify construction stage**
  - Add load group
- **Load**
  - Moving load
- **Analysis**
  - Moving Load
- **Results**
  - Load Combination
  - Reaction/Force/Displacement
  - Moving Tracer
  - Tendon Losses
  - Smart Report
- **Design**
  - PSC Design



Overview

- **Properties**
  - Material / Section
- **FCM bridge wizard**
  - Model
  - Section
  - Tendon
- **Modify construction stage**
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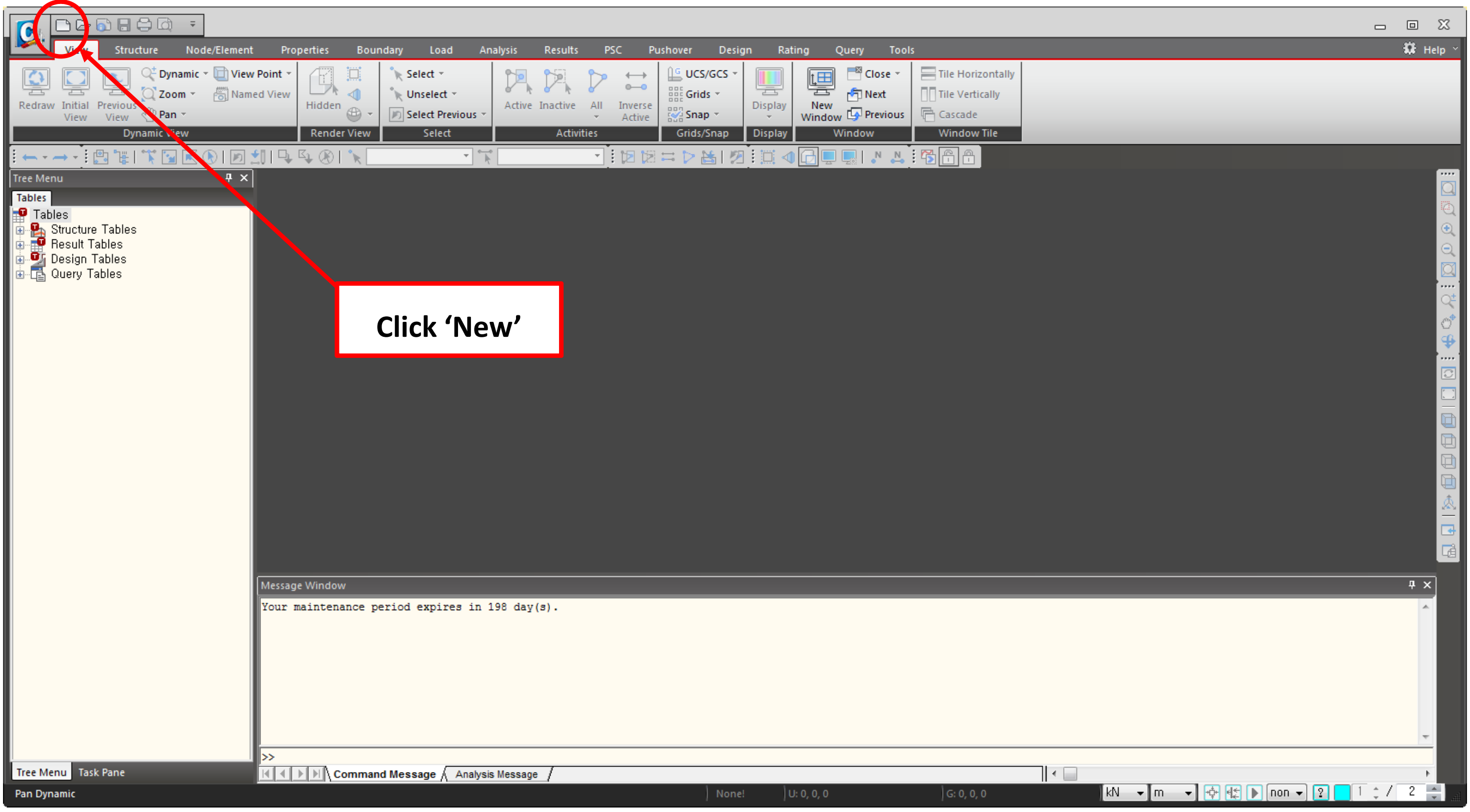
  - Load Combination
  - Reaction/Force/Displacement
  - Moving Tracer
  - Tendon Losses
  - Smart Report
- **Design**
  - PSC Design

Step 1. Properties

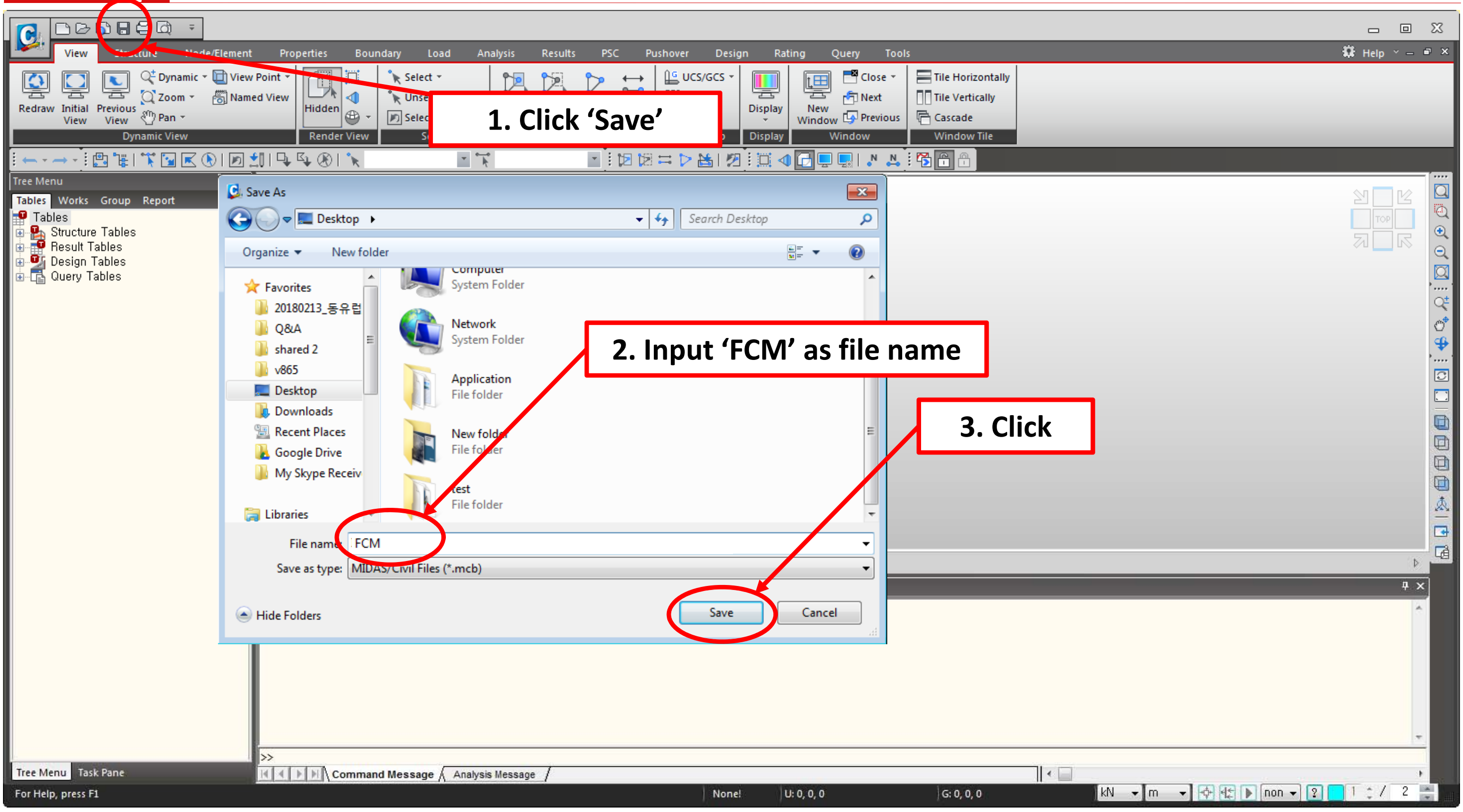
3 Start



Procedure

Create a new project file.

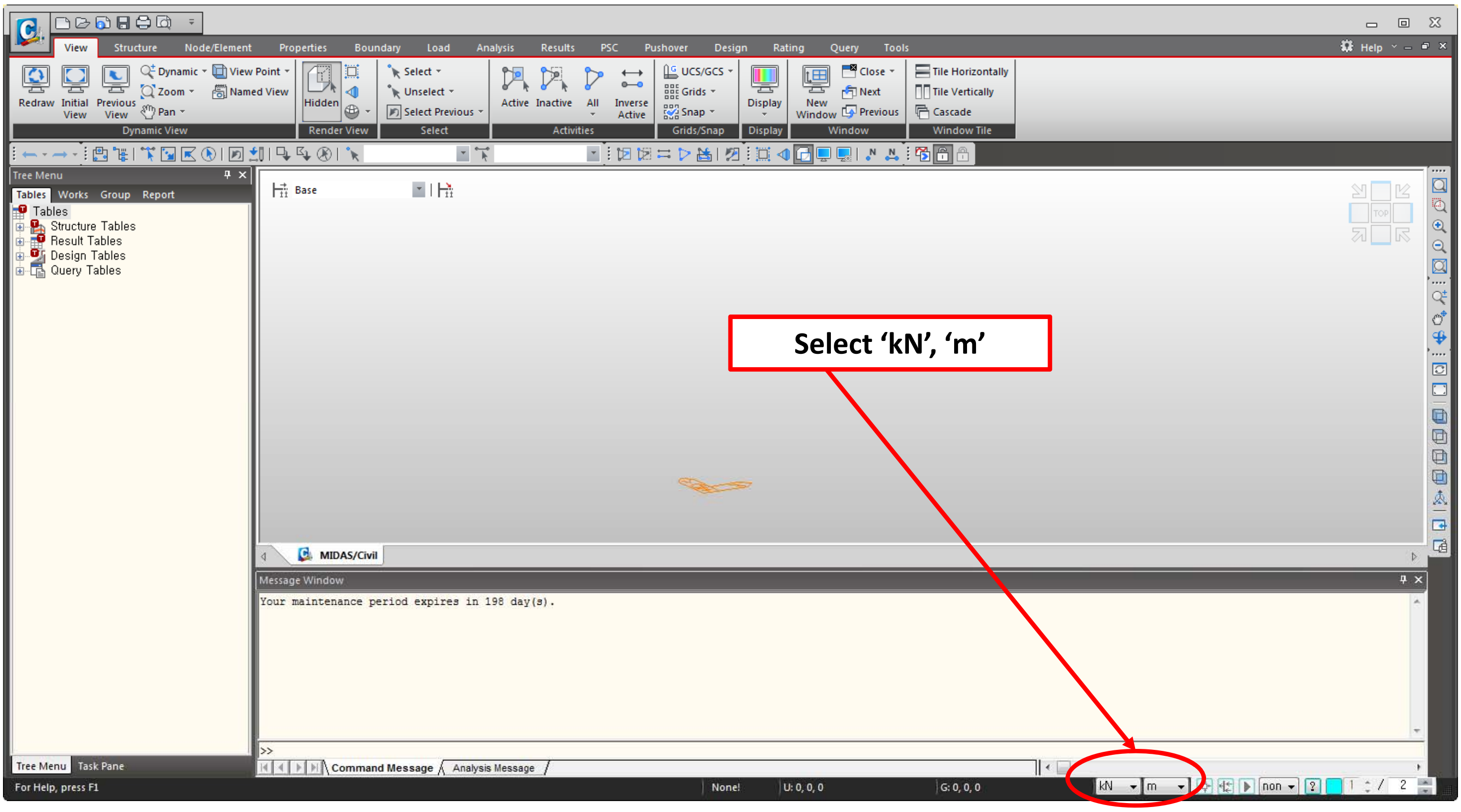
4 Start



Procedure

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

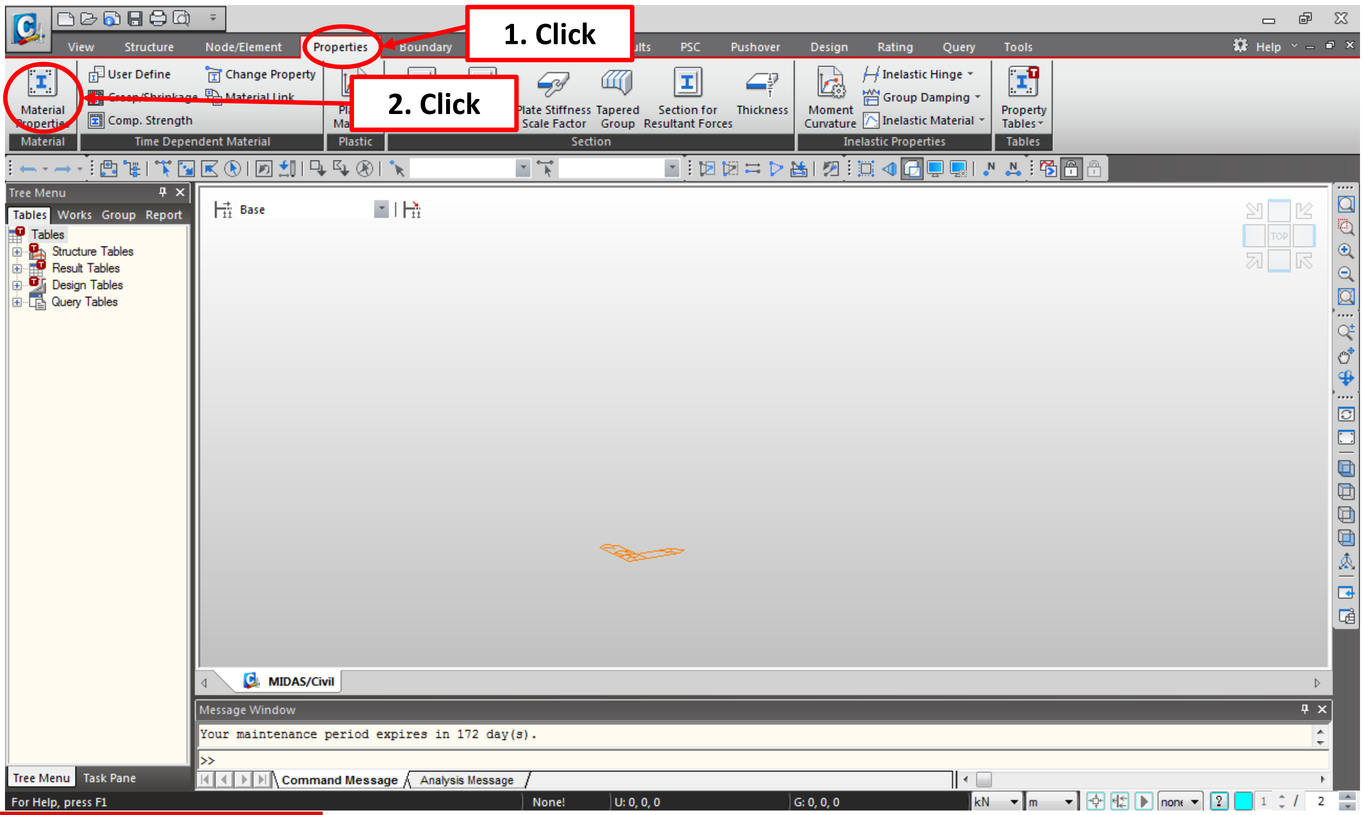
5 Start



Procedure

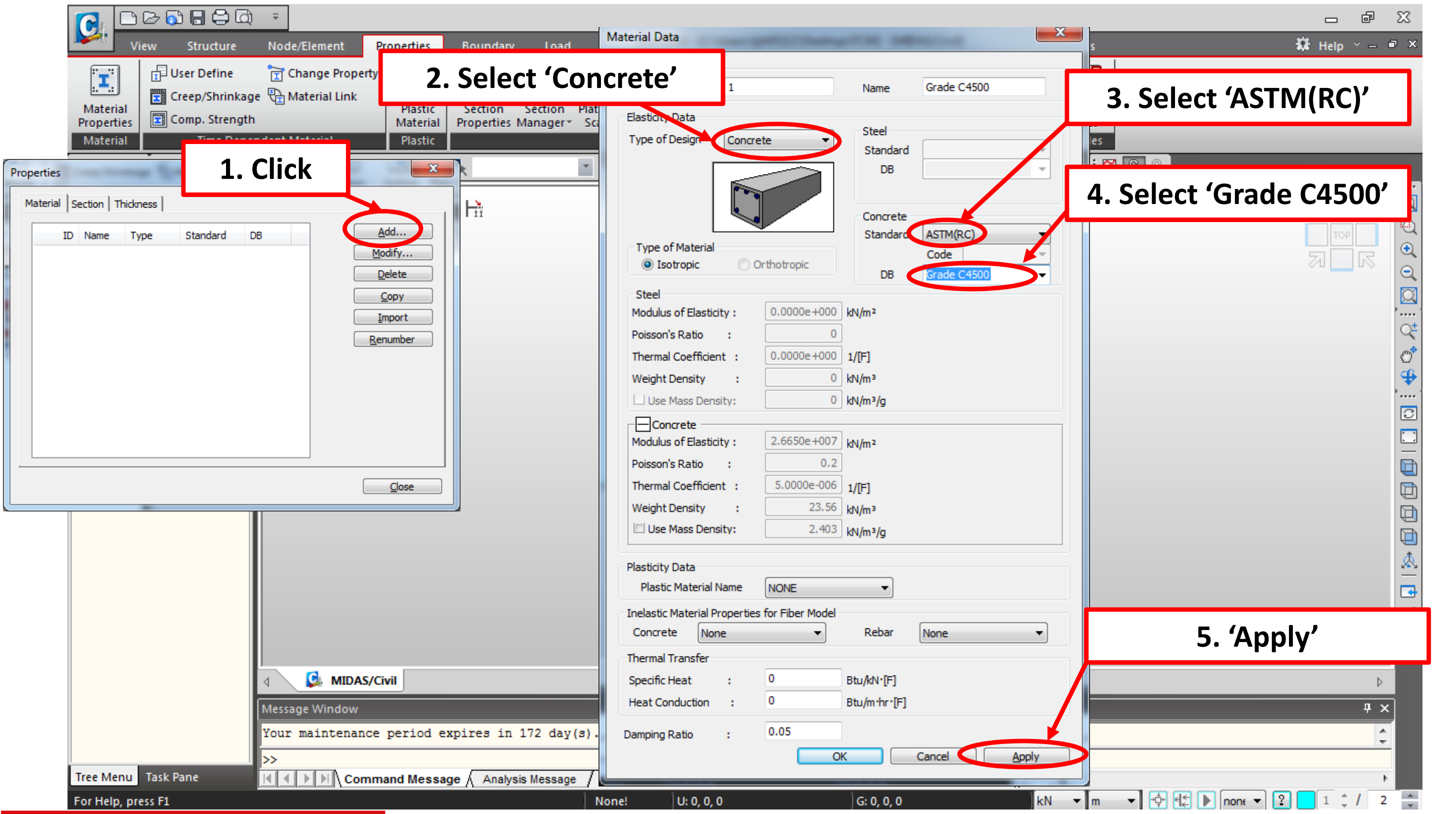
At any point of pre- and post-processing, the unit can be changed at the Status Bar without opening the Unit System dialog box. Also, every input and output values are converted accordingly at every change.

6 Material / Section



Procedure

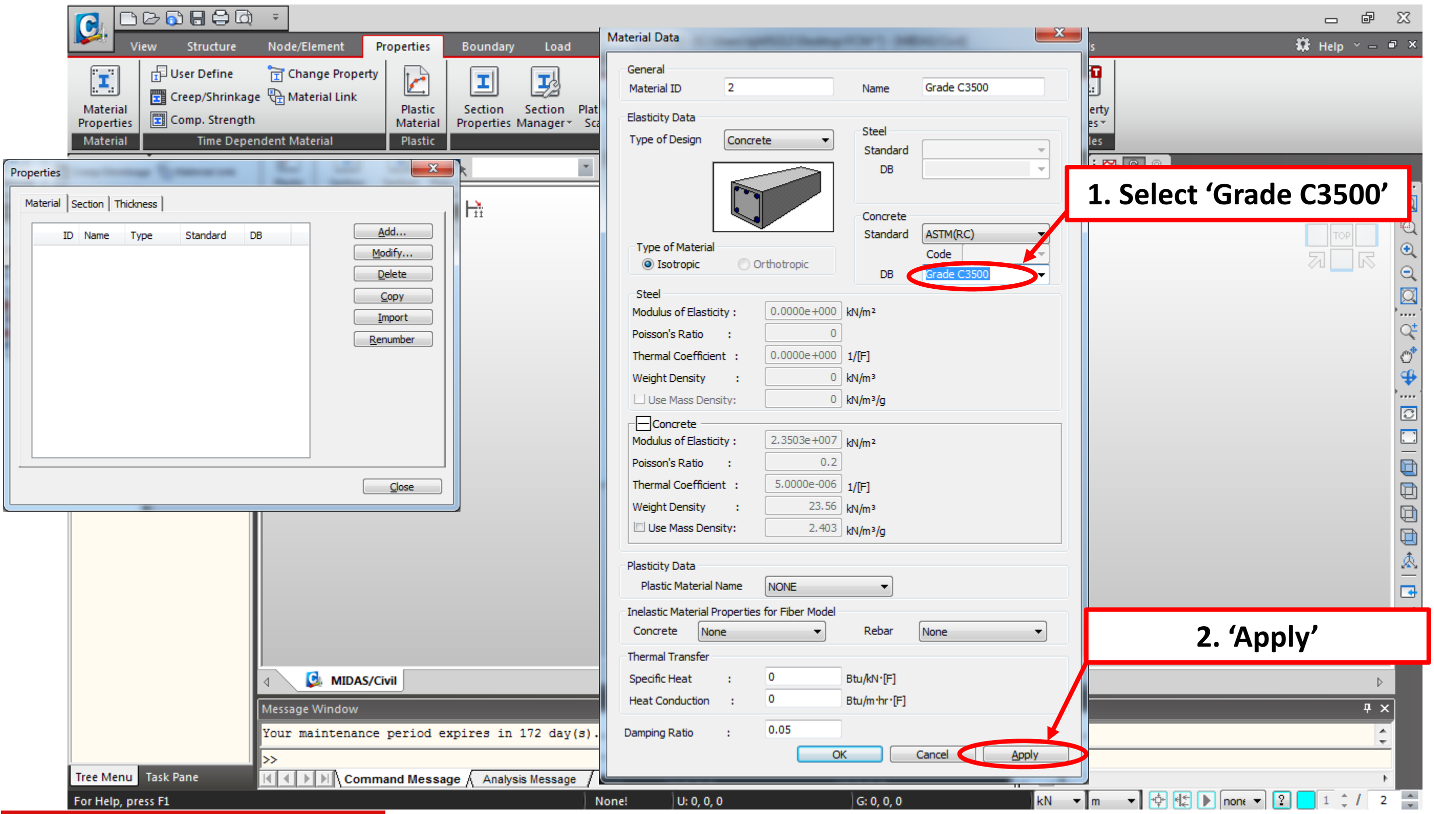
7 Material / Section



Procedure

Define material for the girder

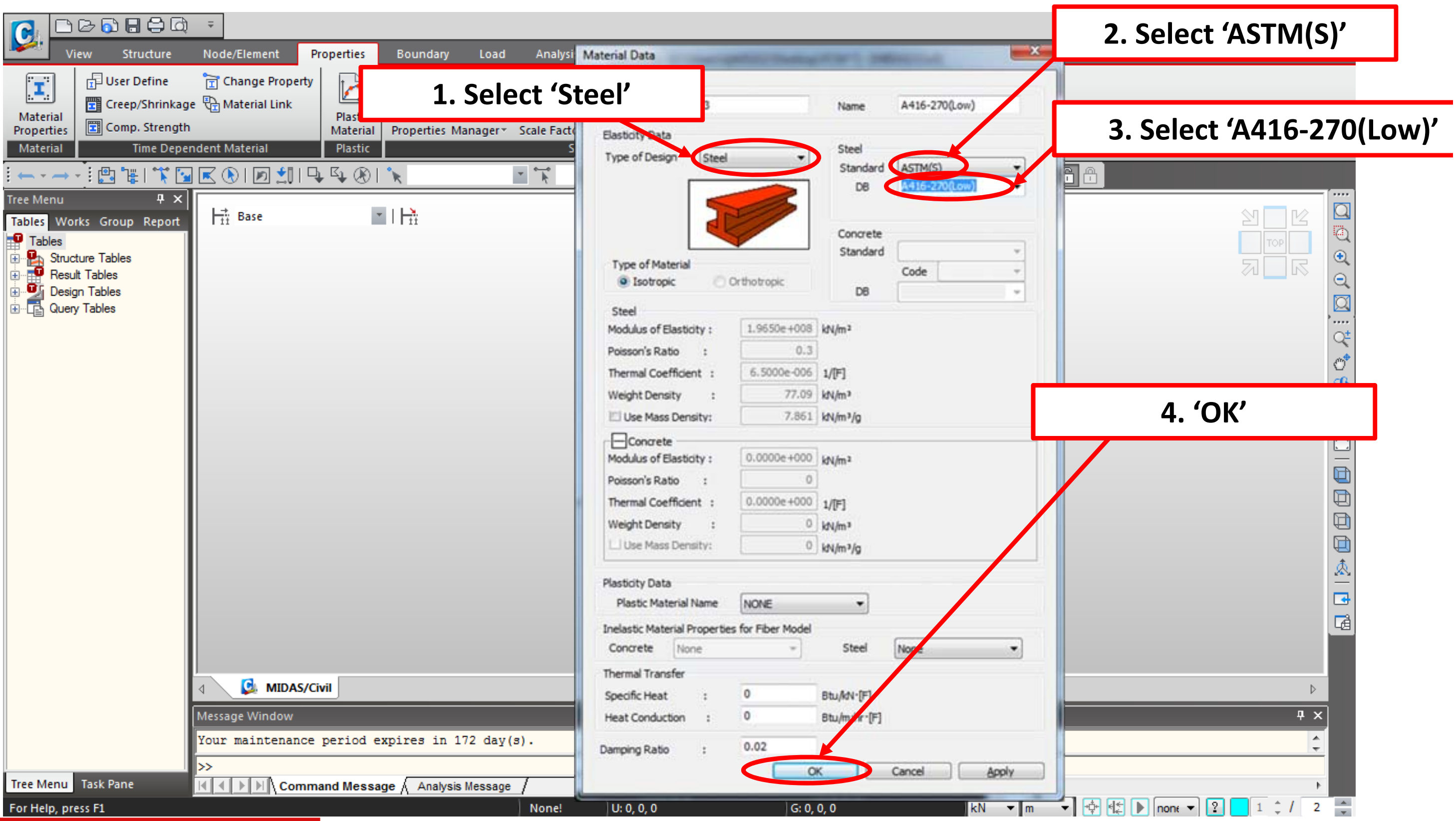
8 Material / Section



Procedure

Define material for the pier

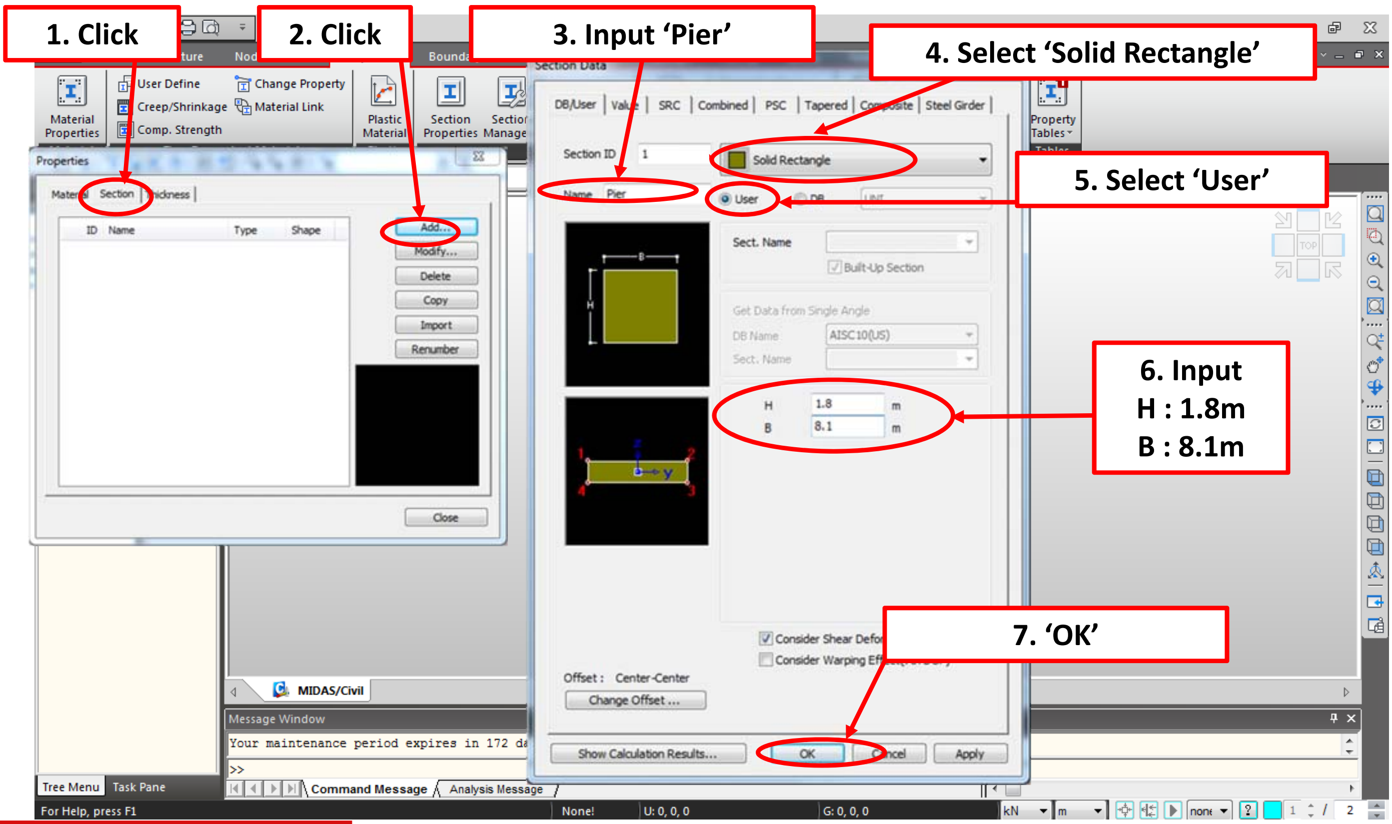
9 Material / Section



Procedure

Define material for the tendon

10 Material / Section



Procedure

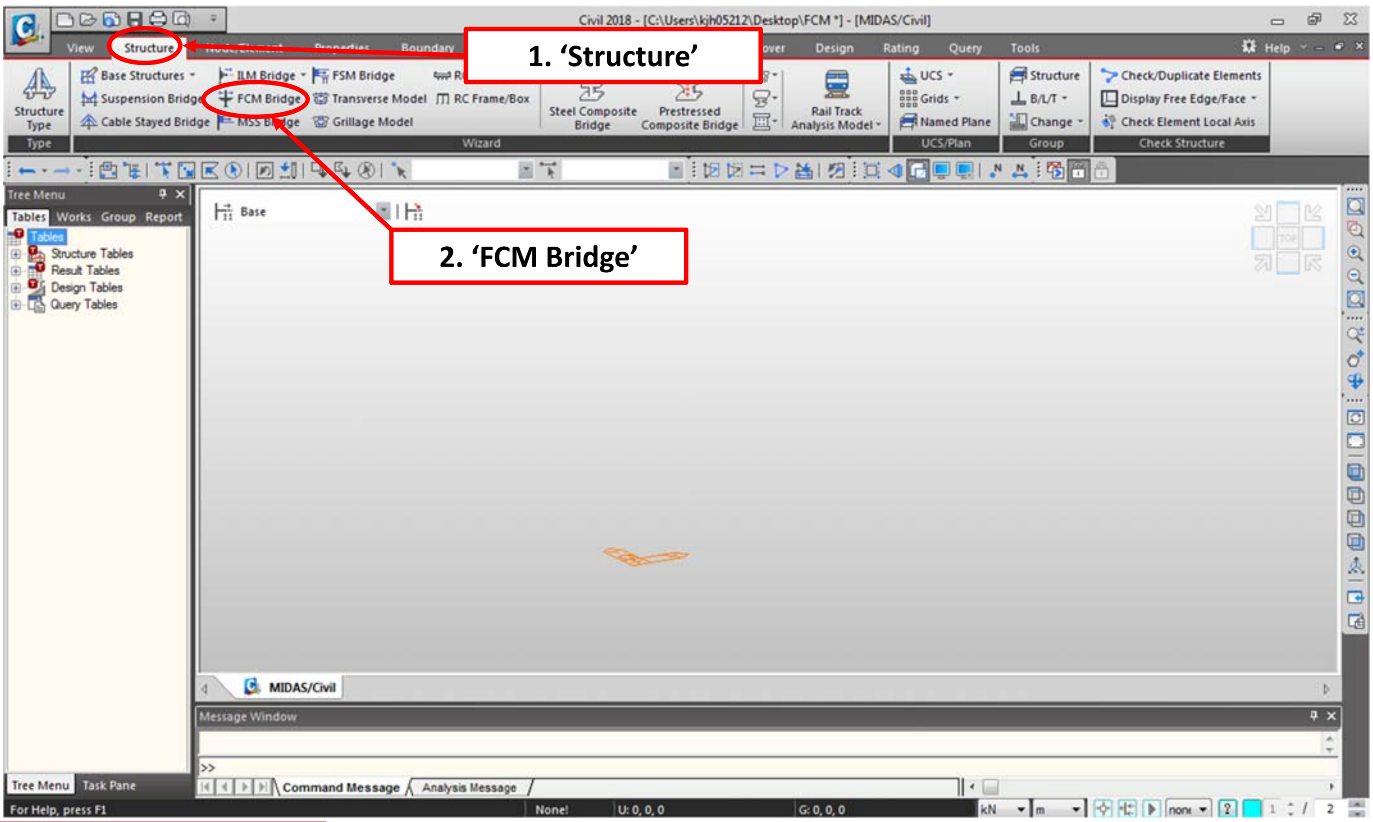
Define section for pier

Overview

- **Properties**
  - Material / Section
- **FCM bridge wizard**
  - Model
  - Section
  - Tendon
- **Modify construction stage**
  - Add load group
- **Load**
  - Moving load
- **Analysis**
  - Moving Load
- **Results**
  - Load Combination
  - Reaction/Force/Displacement
  - Moving Tracer
  - Tendon Losses
  - Smart Report
- **Design**
  - PSC Design

Step 2. FCM bridge wizard

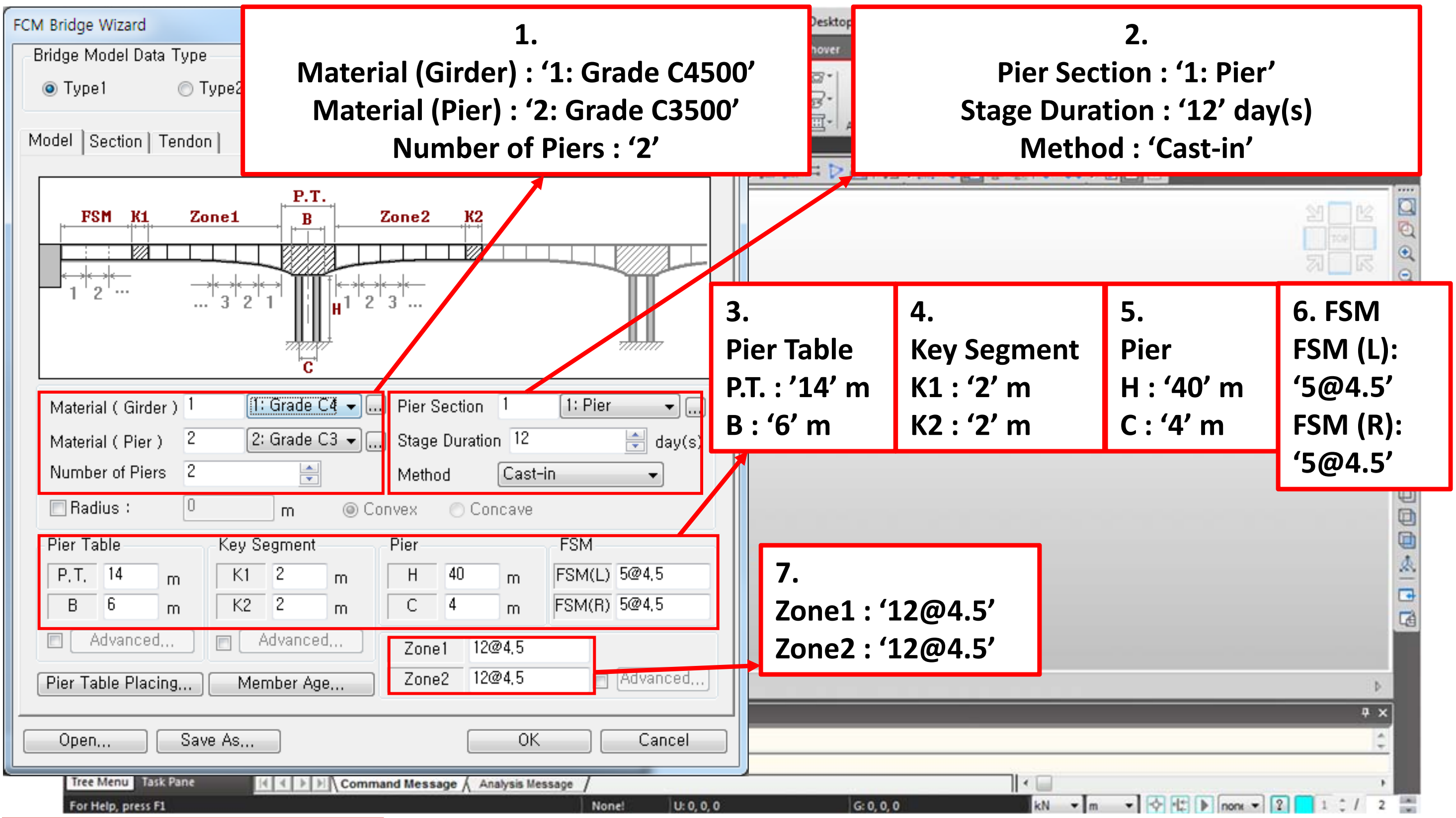
12 FCM bridge Wizard



Procedure

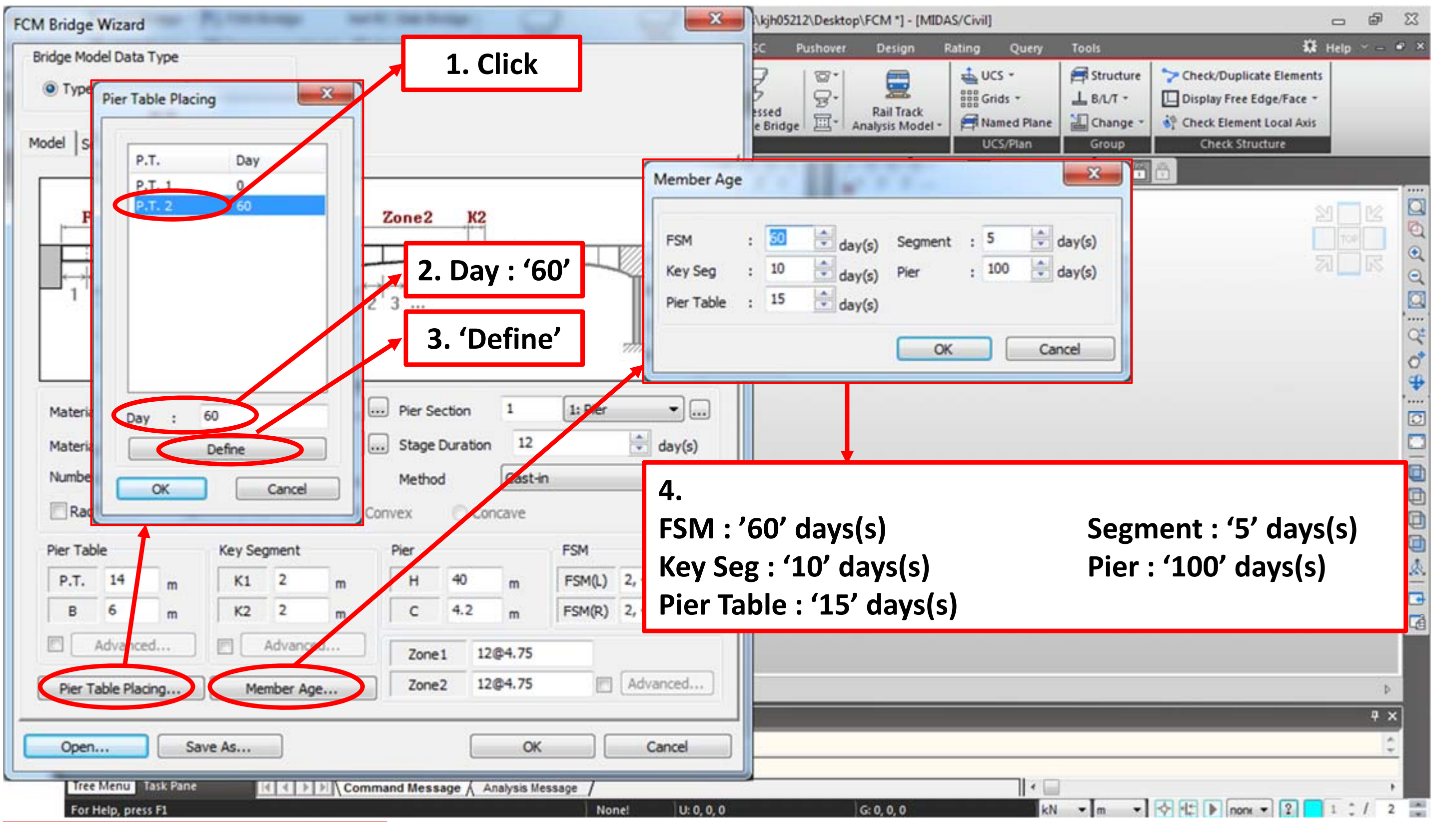
Execute Free Cantilever Method bridge wizard.

13 FCM bridge Wizard



Procedure

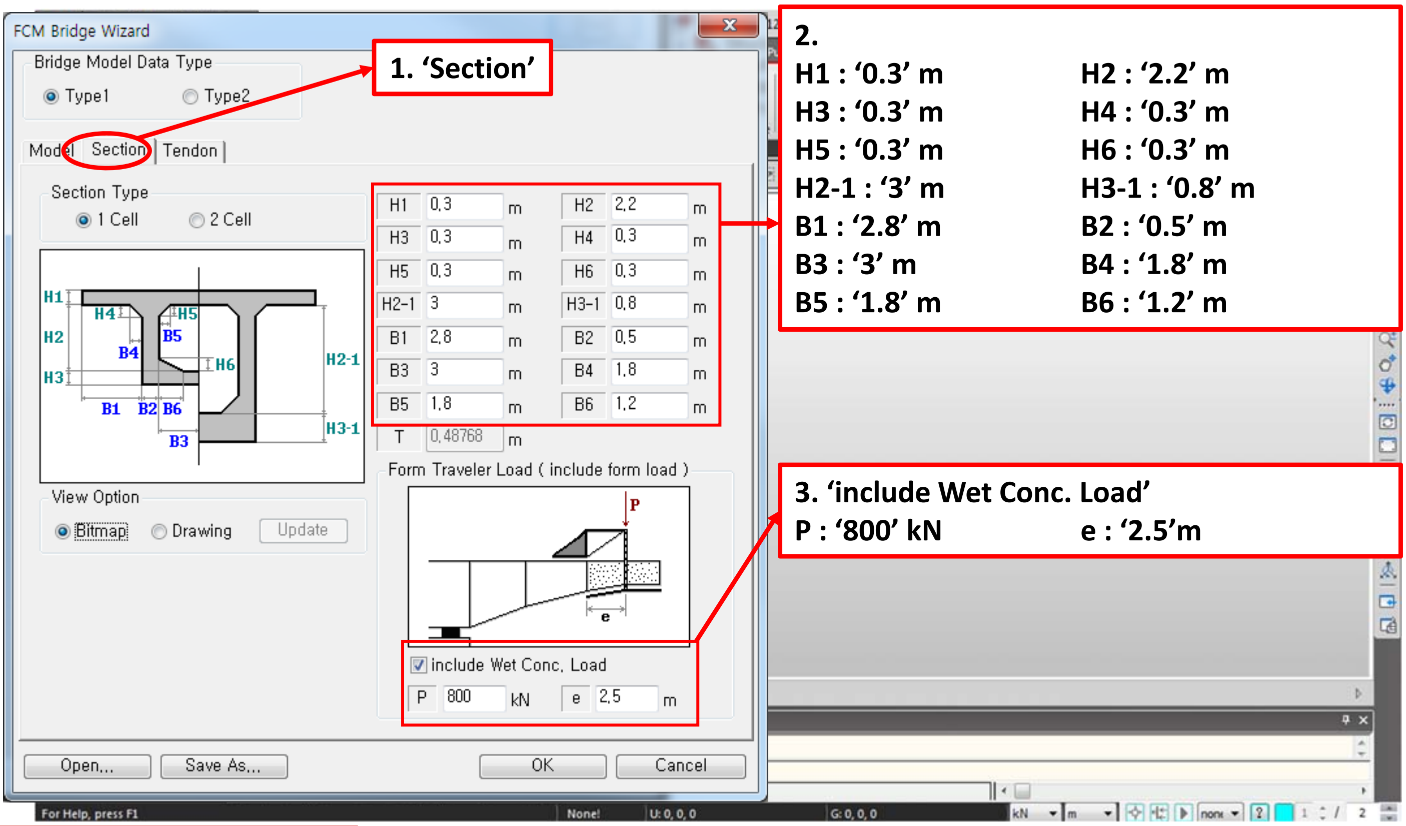
14 FCM bridge Wizard



Procedure

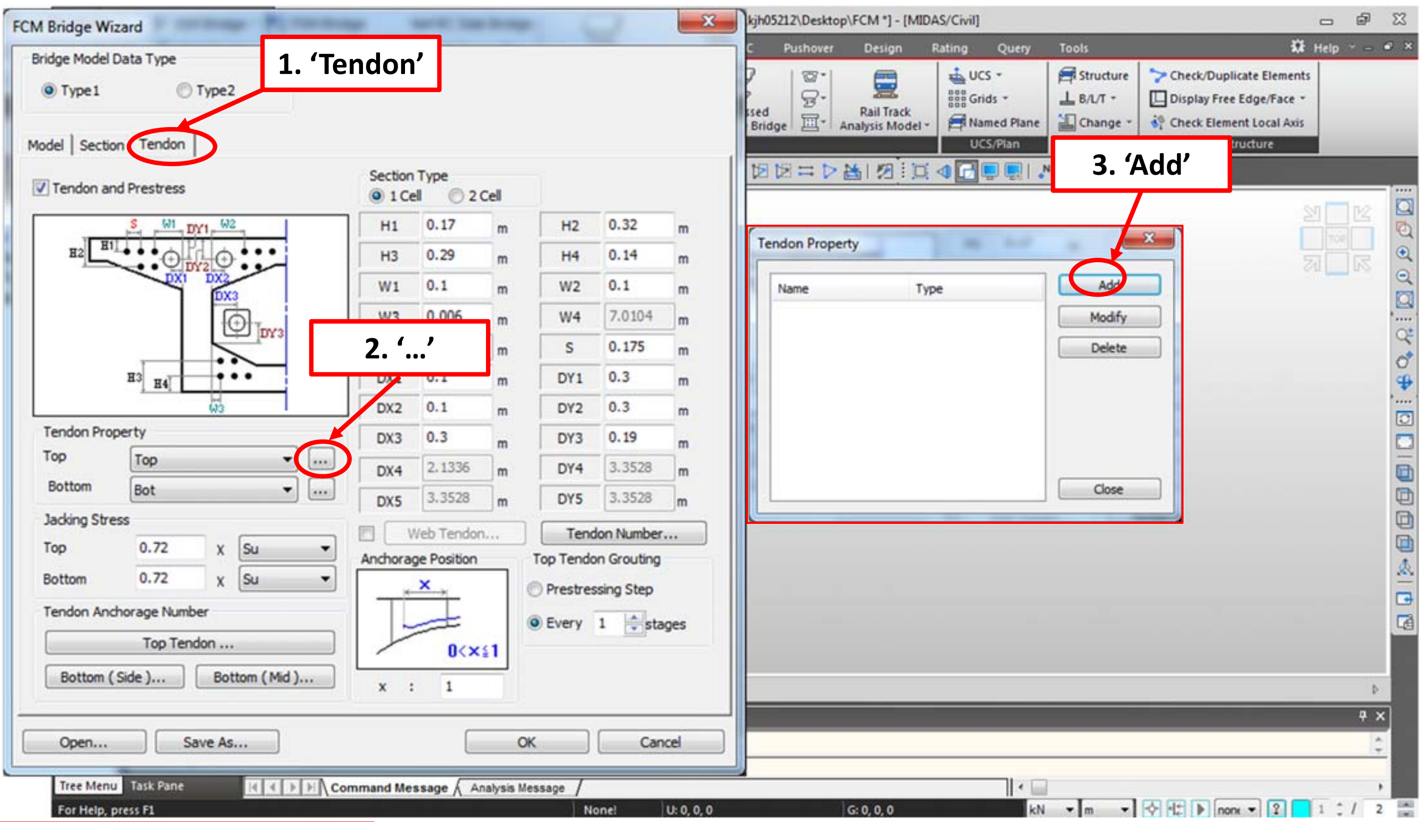
Use ‘Tap’ key and ‘Shift’+‘Tap’ key to move the cursor

15 FCM bridge Wizard



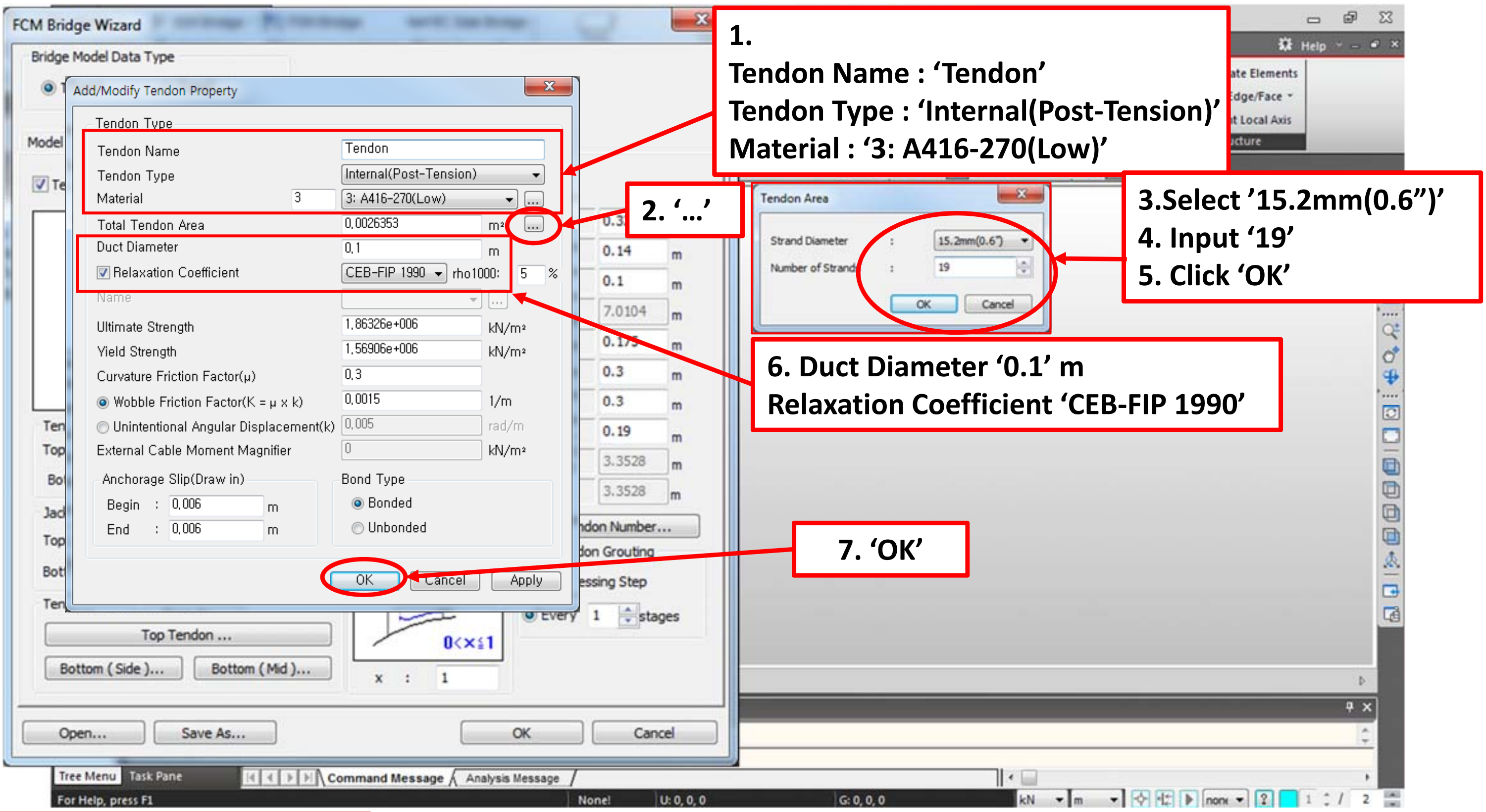
Procedure

16 FCM bridge Wizard



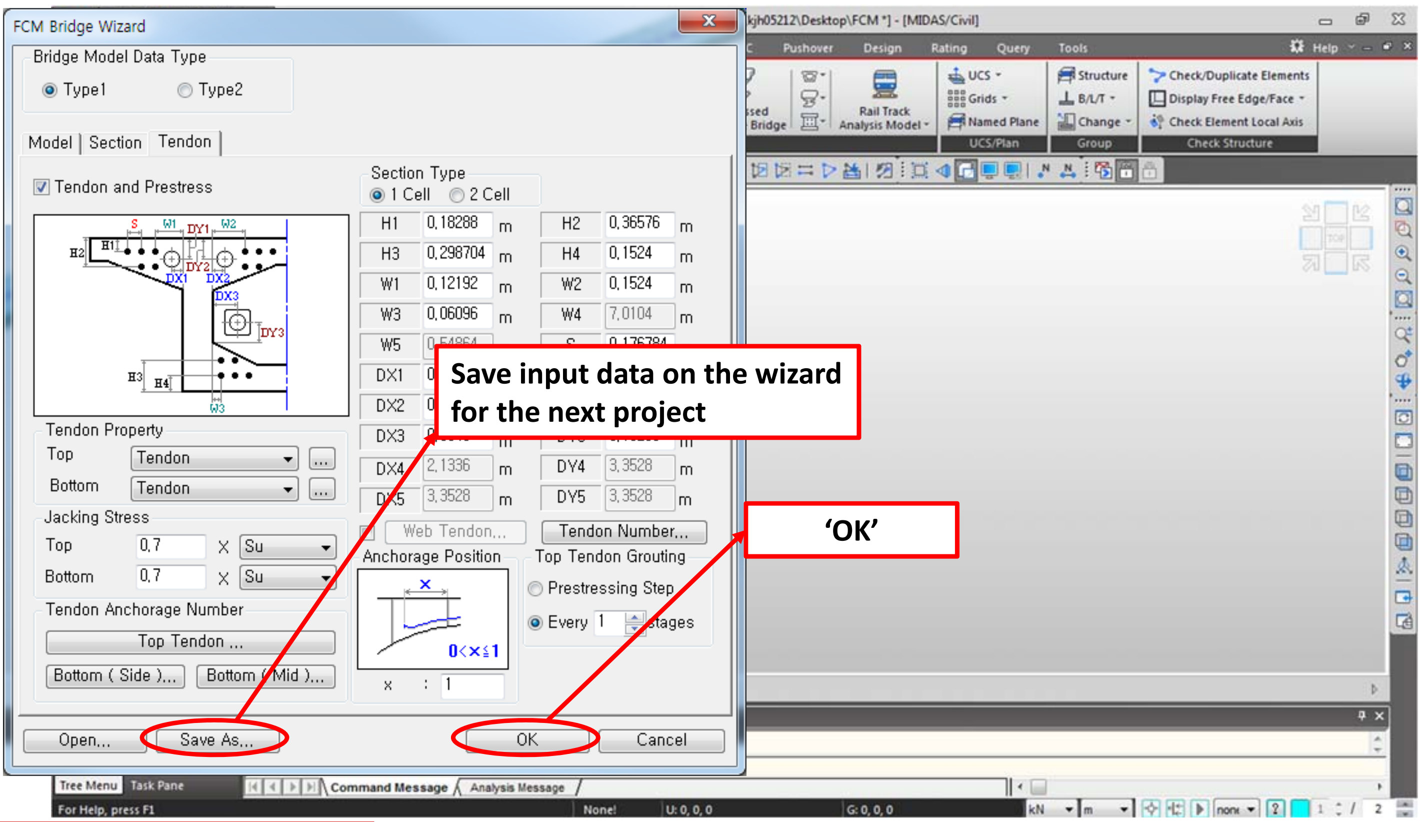
Procedure

17 FCM bridge Wizard



Procedure

18 FCM bridge Wizard

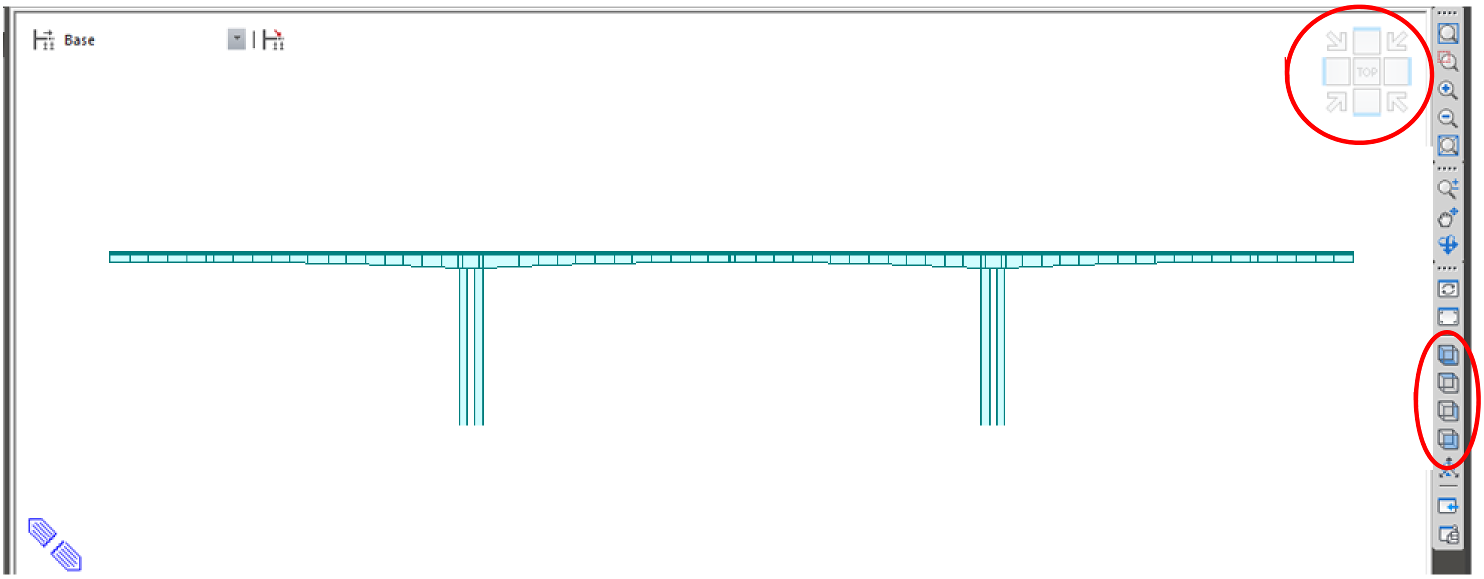


Procedure

19 Tip

Tip

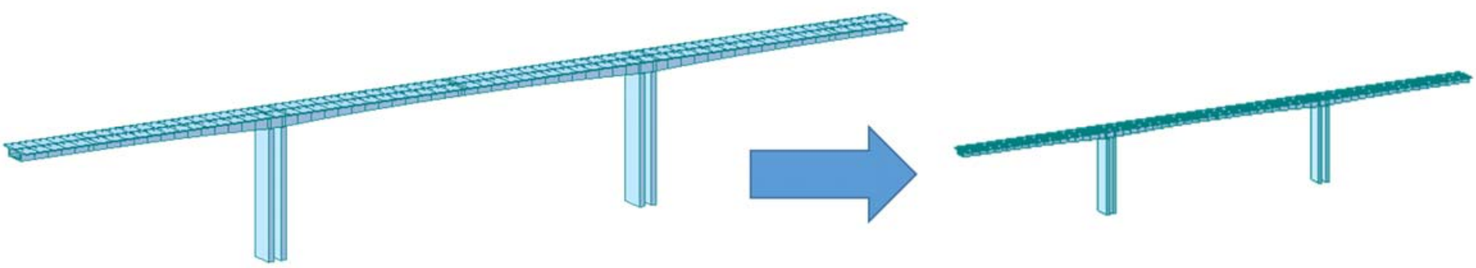
Use 'Dynamic View Control' or view icons to change the model angle



20 Tip

Tip

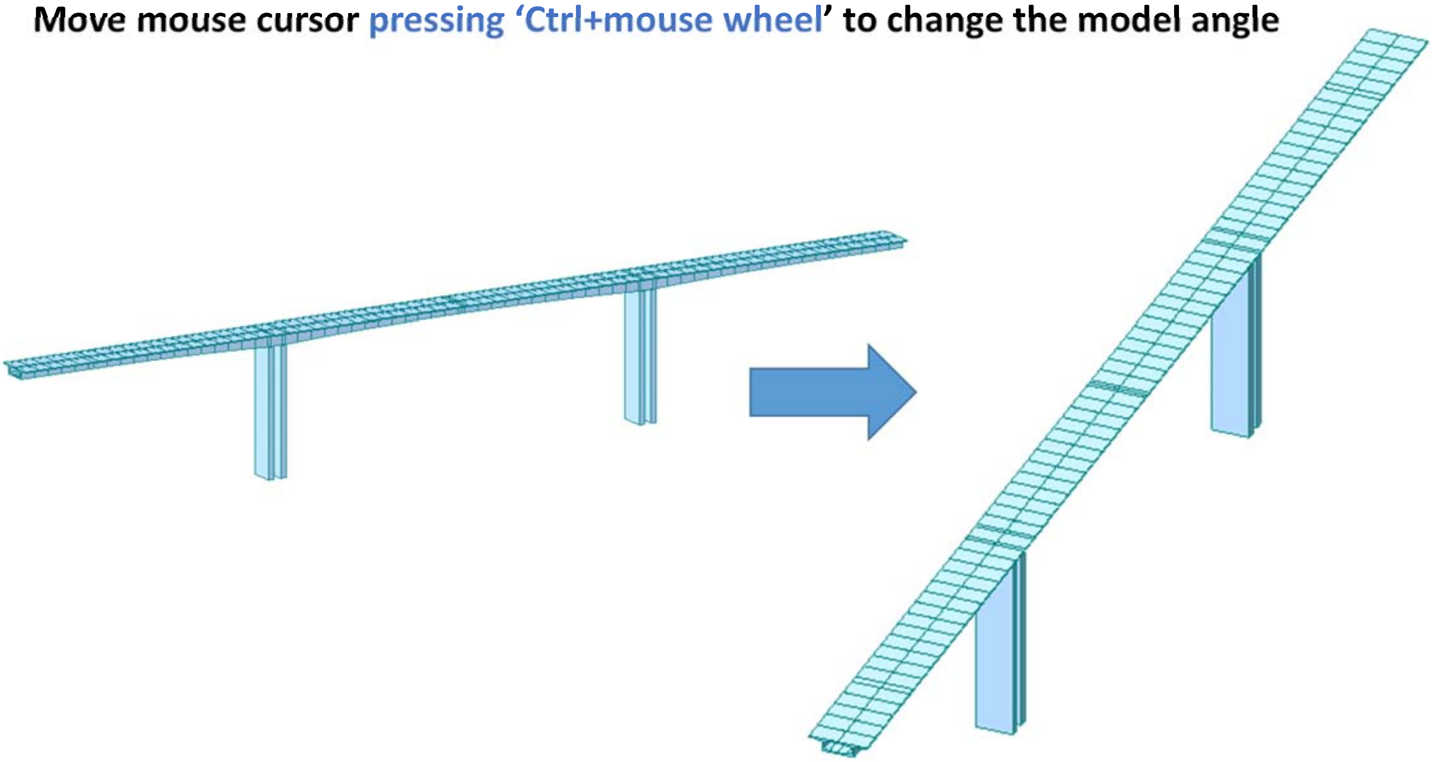
Scroll the mouse wheel to zoom in and out the model
Click once if it keeps zooming



***Click anywhere on the model view if it keeps zooming in and out**

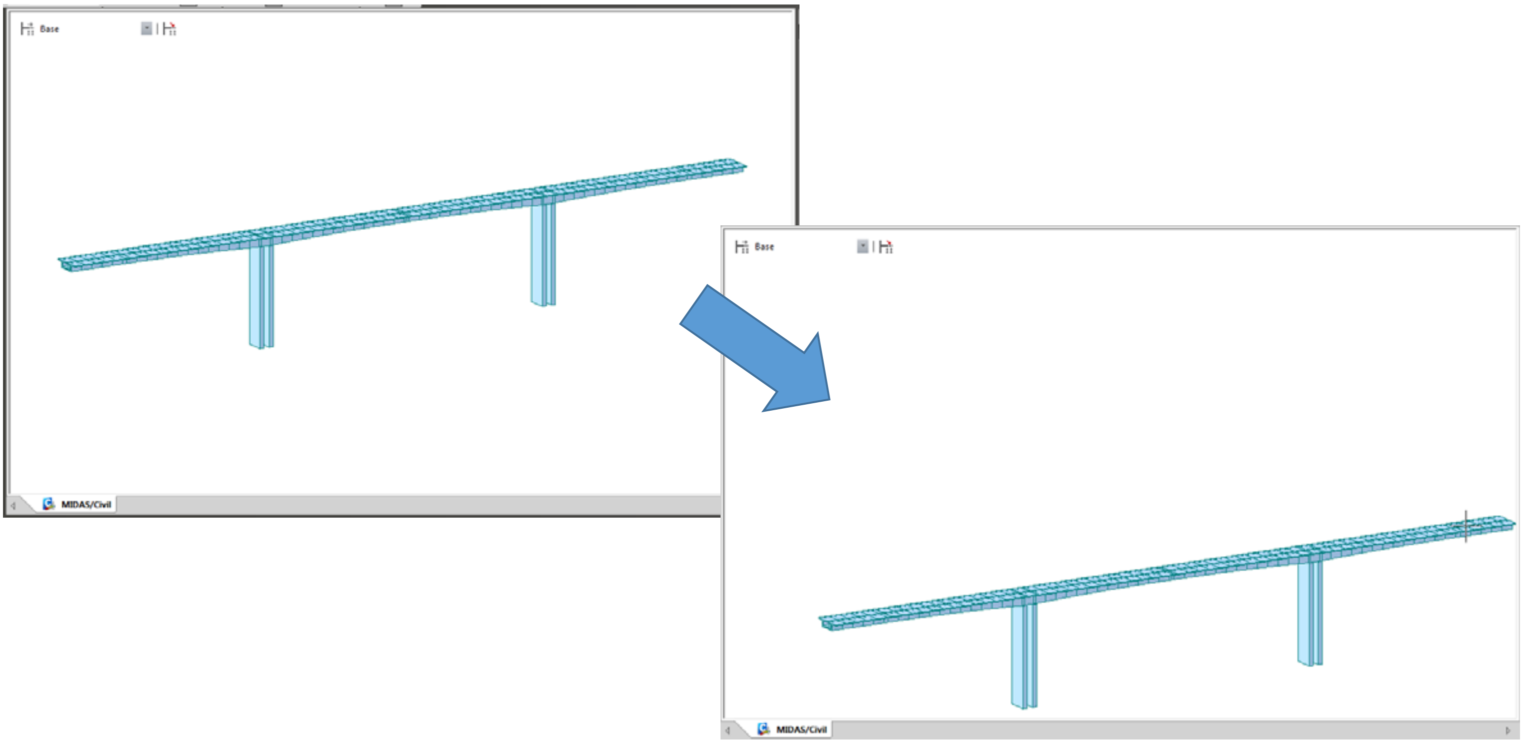
Tip

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



Tip

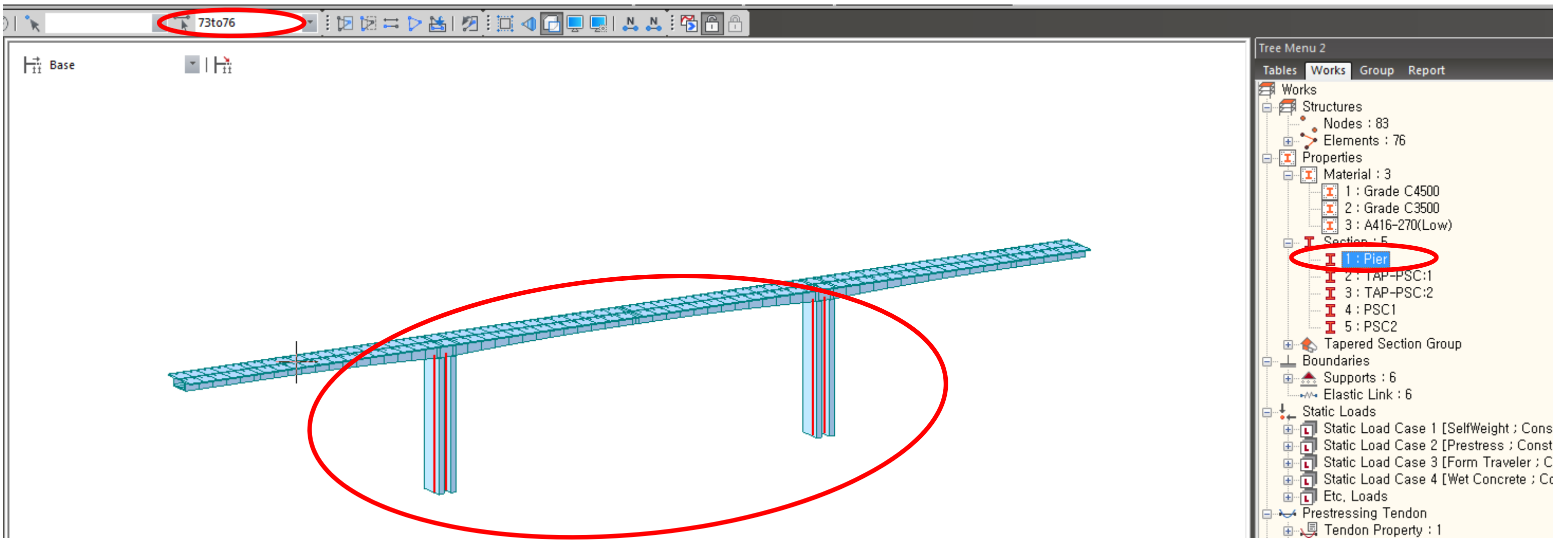
Move mouse cursor pressing mouse wheel to move the model



23 Tip

Tip

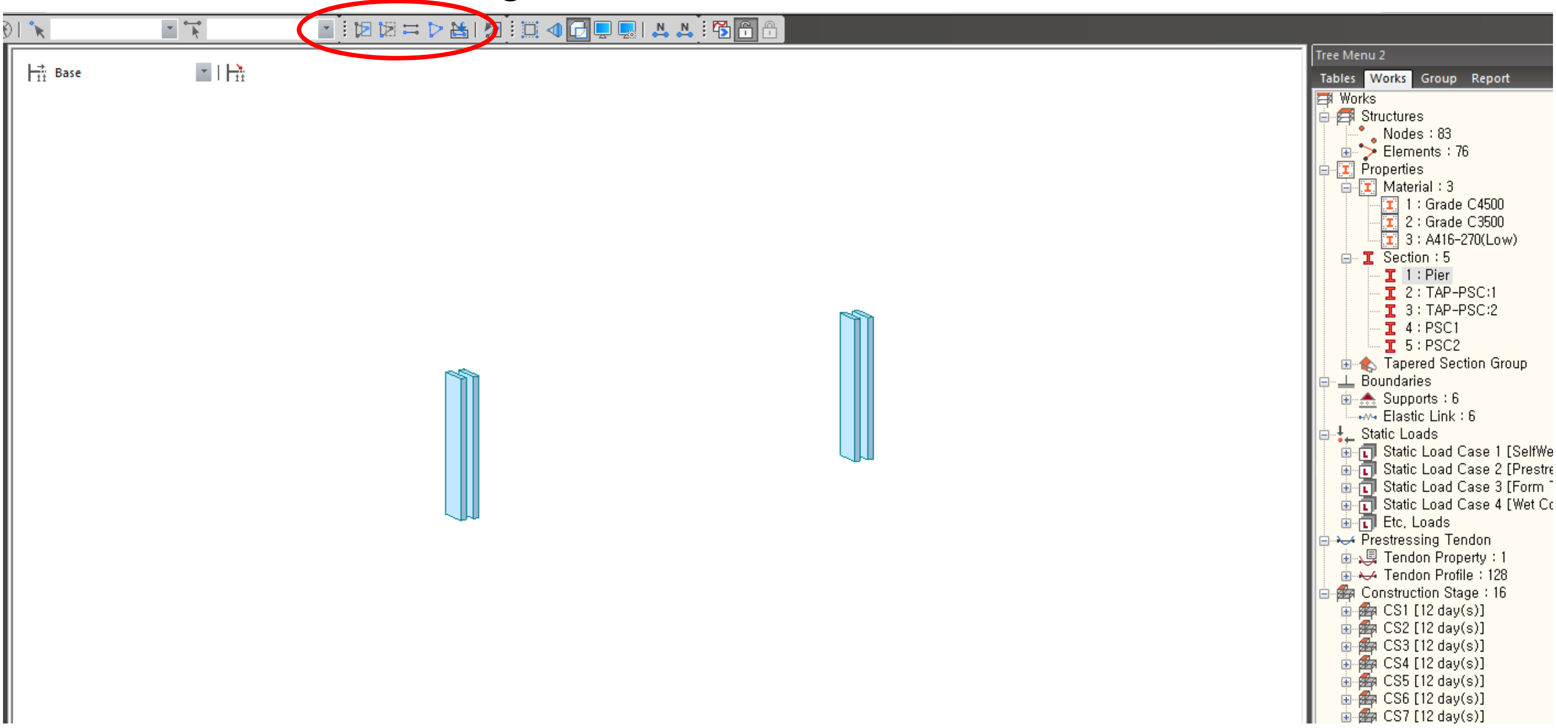
Double click any section or material, then assigned elements will be selected. And Element number will be shown.



24 Tip

Tip

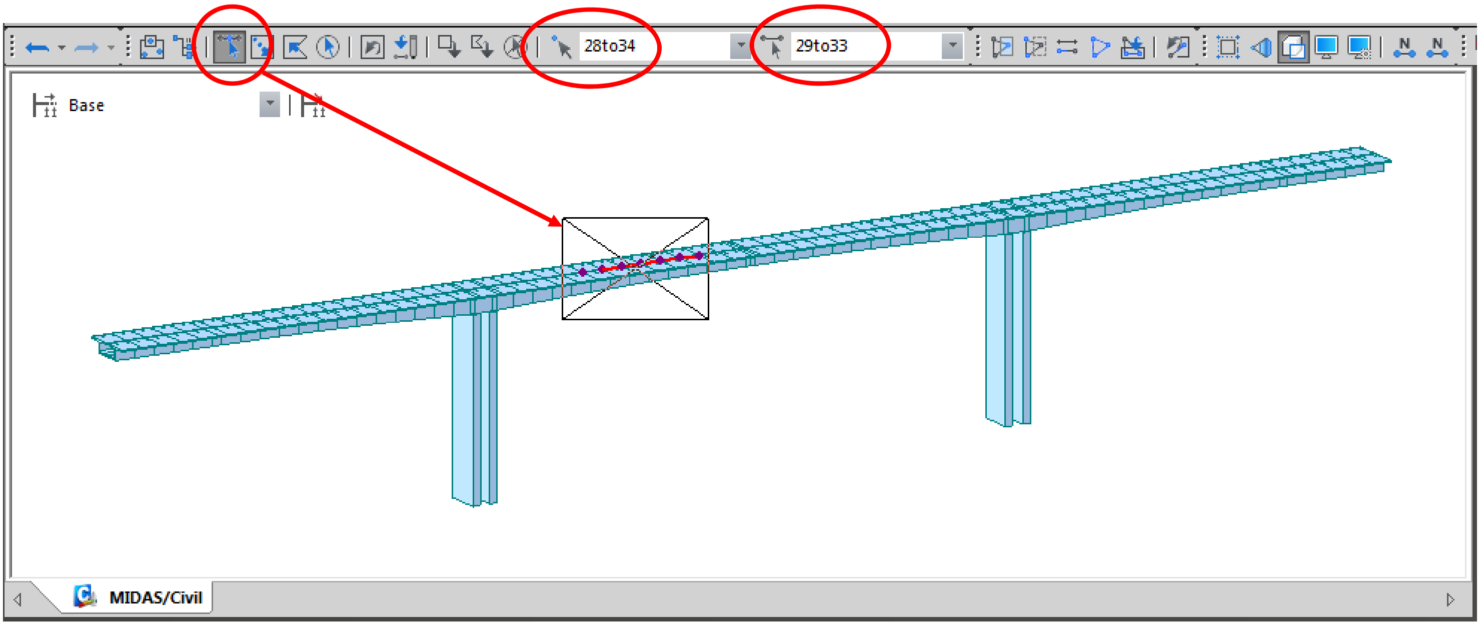
Use activation functions to activate or deactivate certain elements. It is also valid when viewing results.



25 Tip

Tip

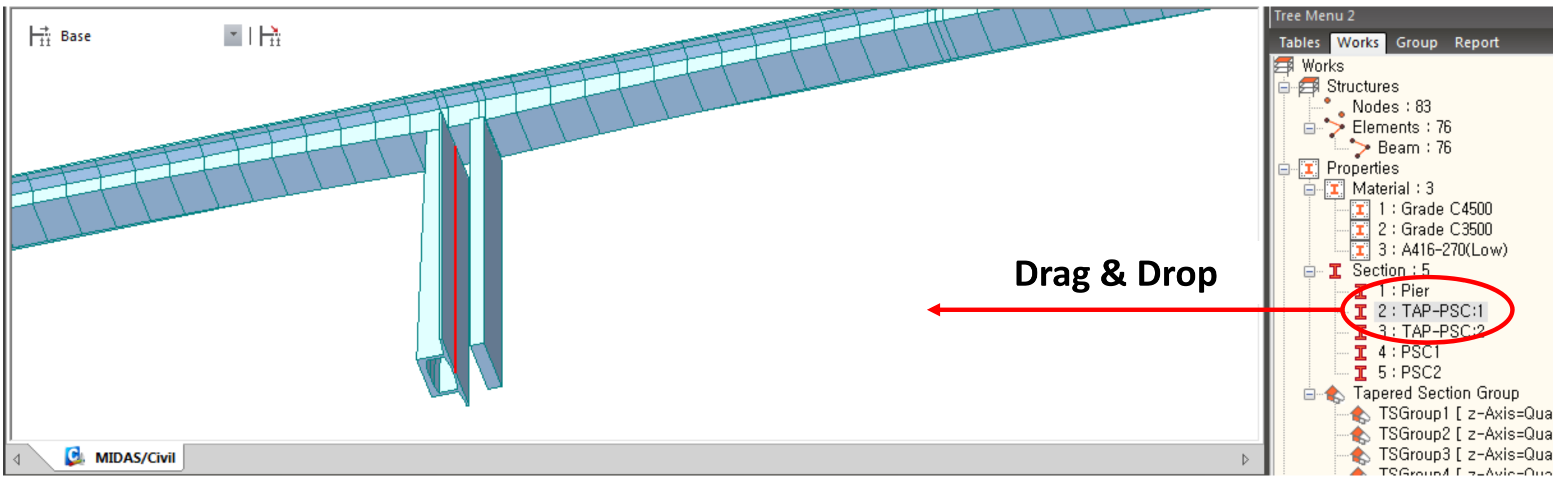
'Select Single' icon must be activated to select nodes or elements
And node number and element number will be shown



26 Tip

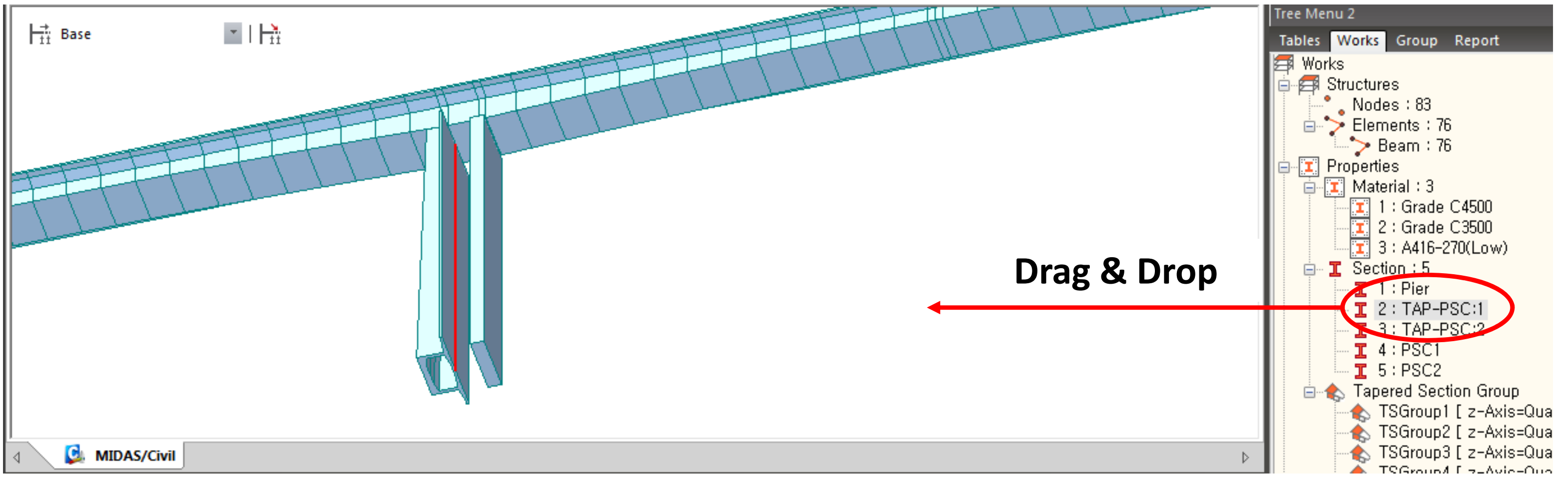
Tip

Section on the selected elements can be easily changed if you drag & drop the section from Works tree menu to model view.



Tip

Section on the selected elements can be easily changed if you drag & drop the section from Works tree menu to model view.

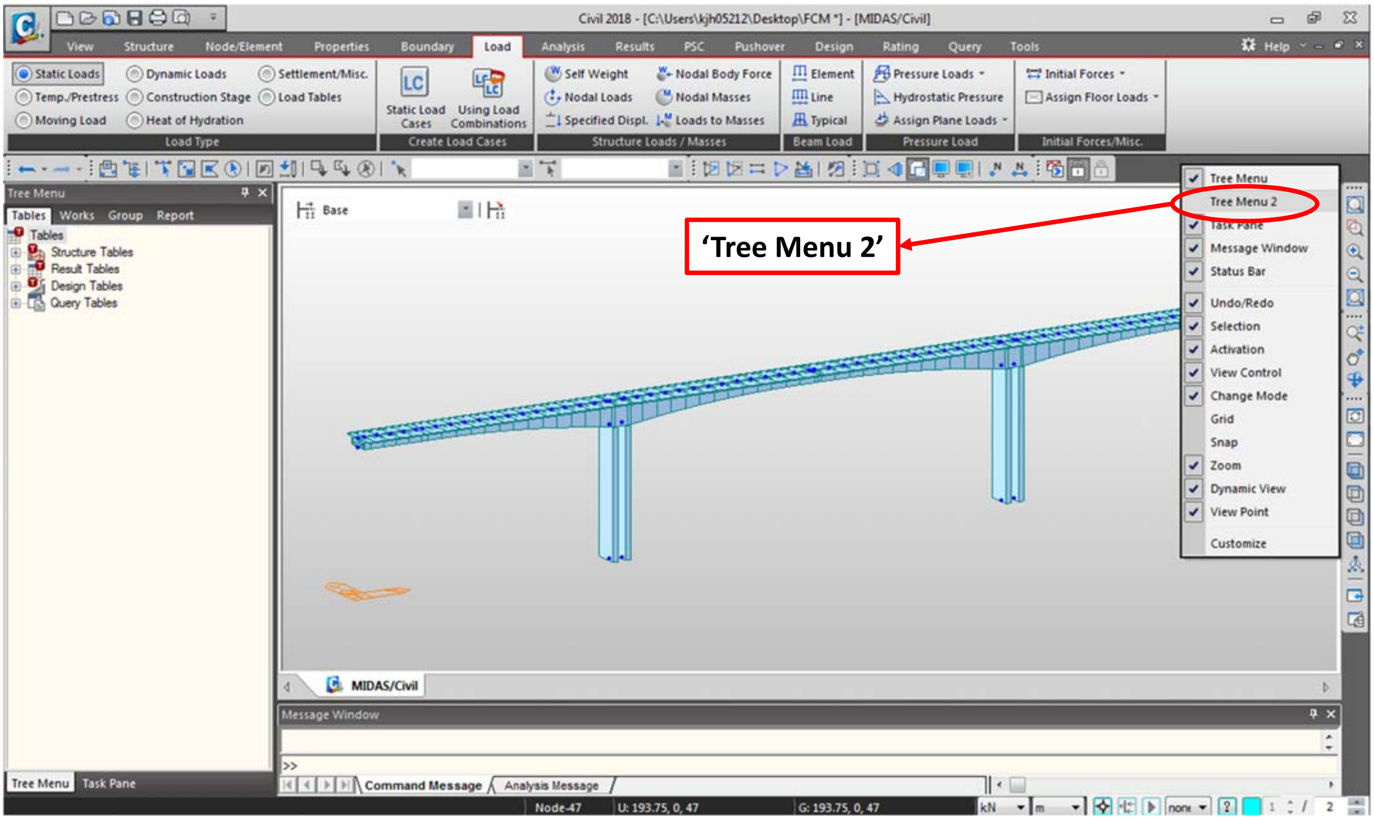


Overview

- **Properties**
  - Material / Section
- **FCM bridge wizard**
  - Model
  - Section
  - Tendon
- **Modify construction stage**
  - Add load group
- **Load**
  - Moving load
- **Analysis**
  - Moving Load
- **Results**
  - Load Combination
  - Reaction/Force/Displacement
  - Moving Tracer
  - Tendon Losses
  - Smart Report
- **Design**
  - PSC Design

Step 3. Modify construction stage

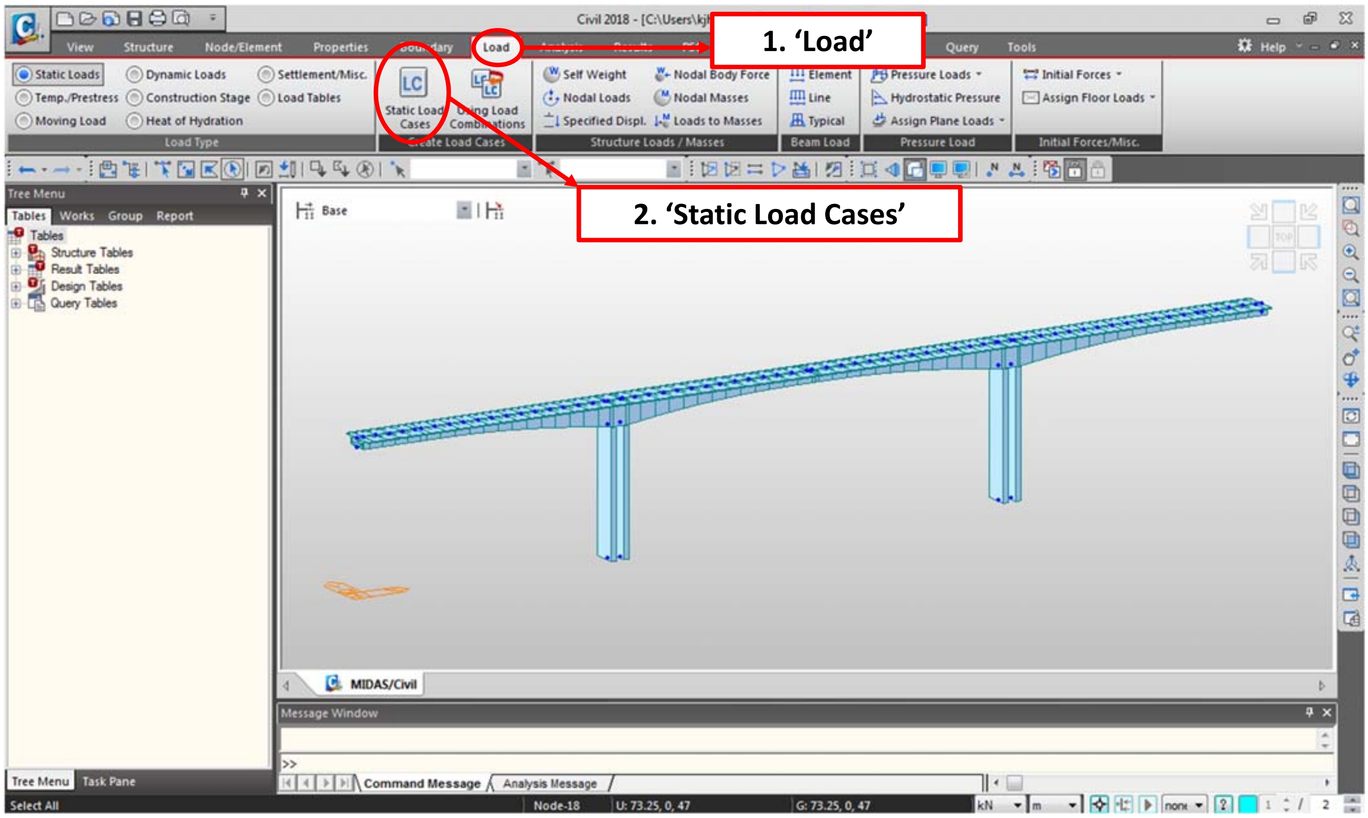
29 Modification of Construction Stage



Procedure

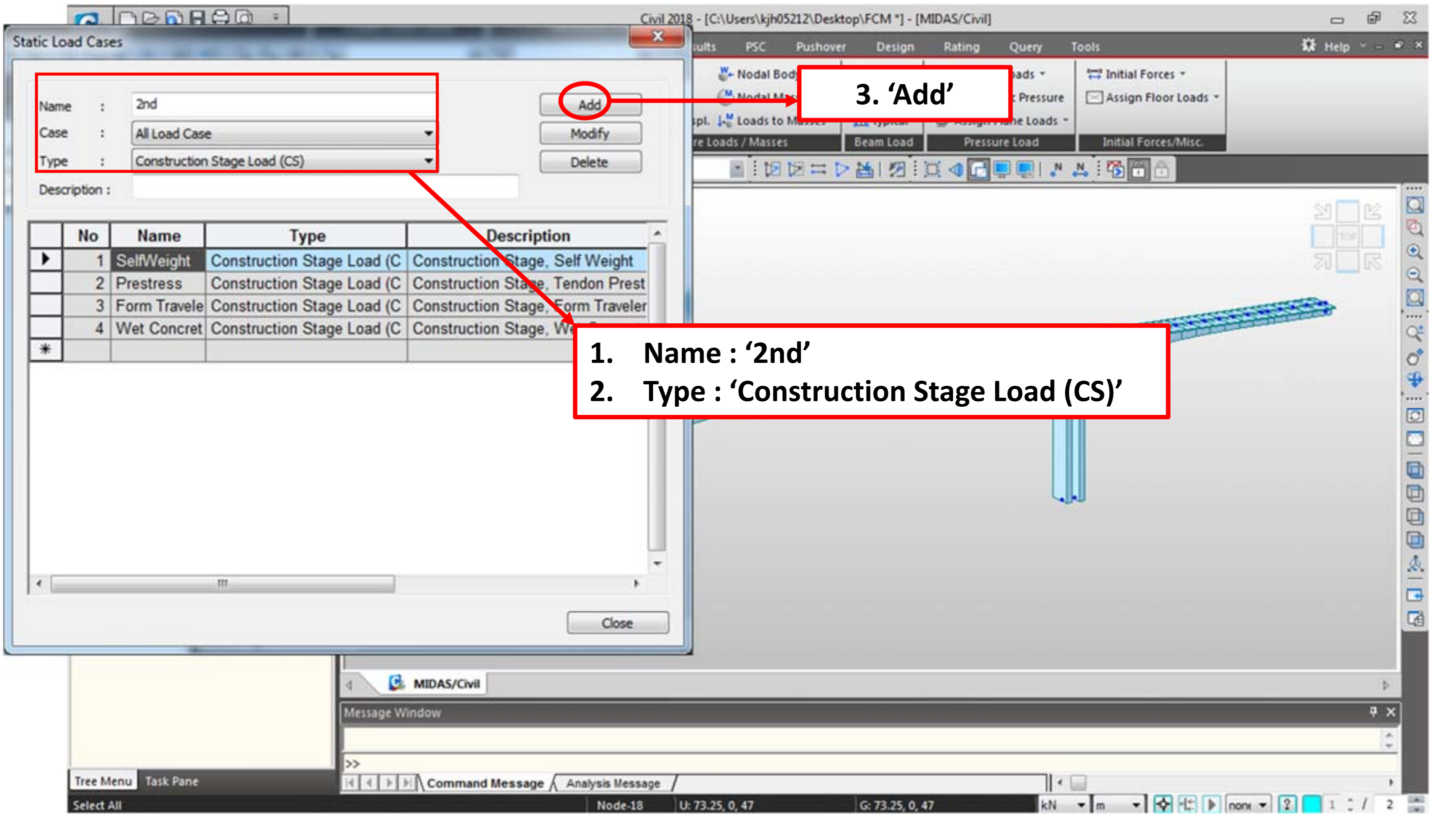
Click right button on your mouse. And check data in the model file under 'Works' menu.

30 Modification of Construction Stage



Procedure

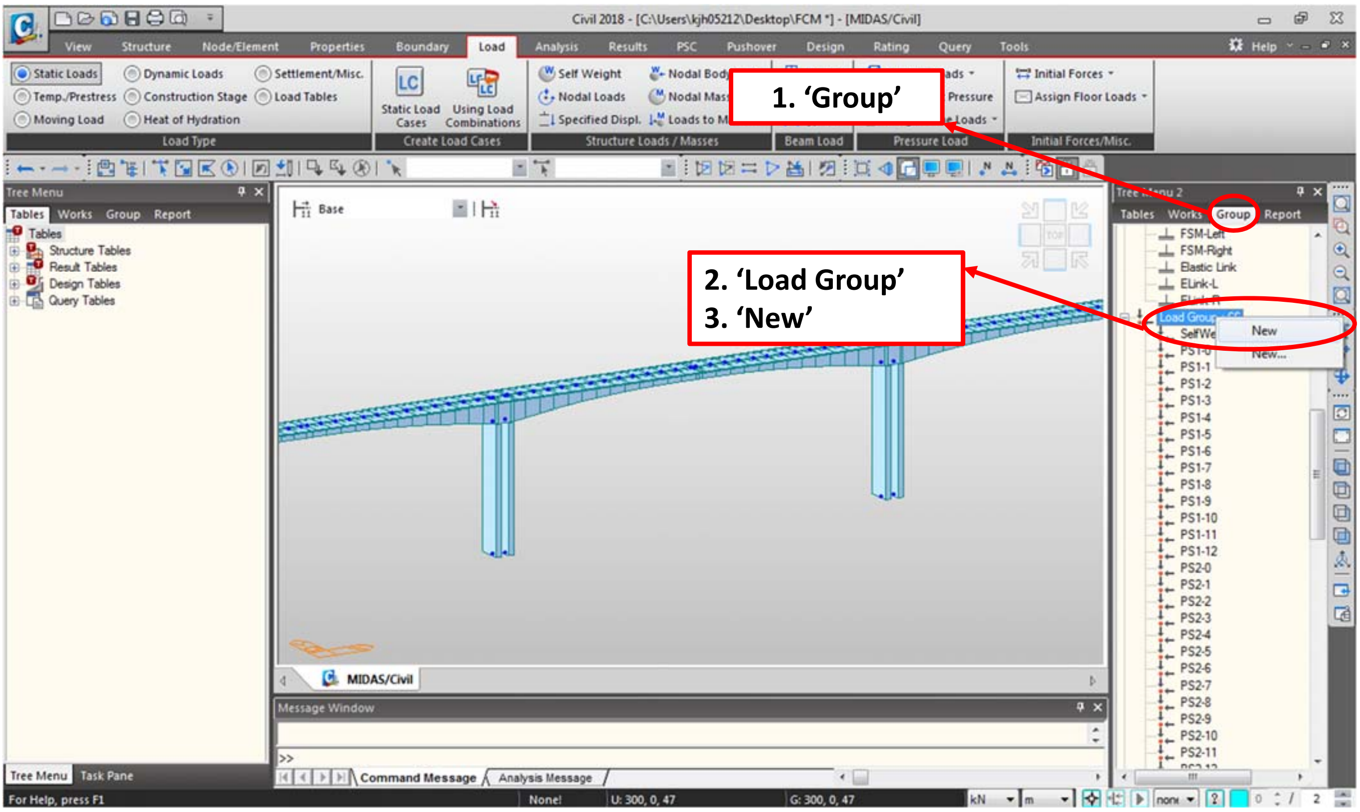
31 Modification of Construction Stage



Procedure

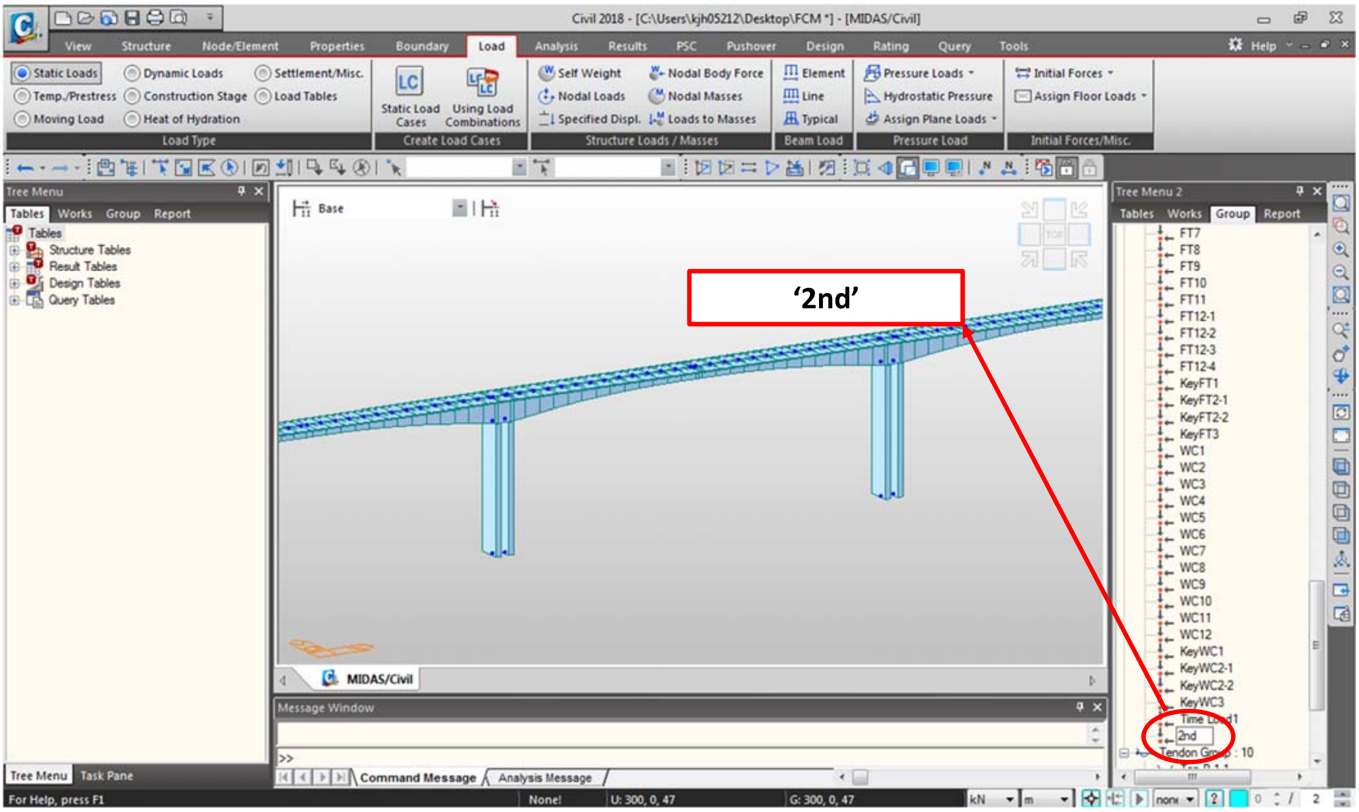
Static analysis is carried out for each static load case entered by this function. The analysis results can be interactively combined in "Load Combinations".

32 Modification of Construction Stage



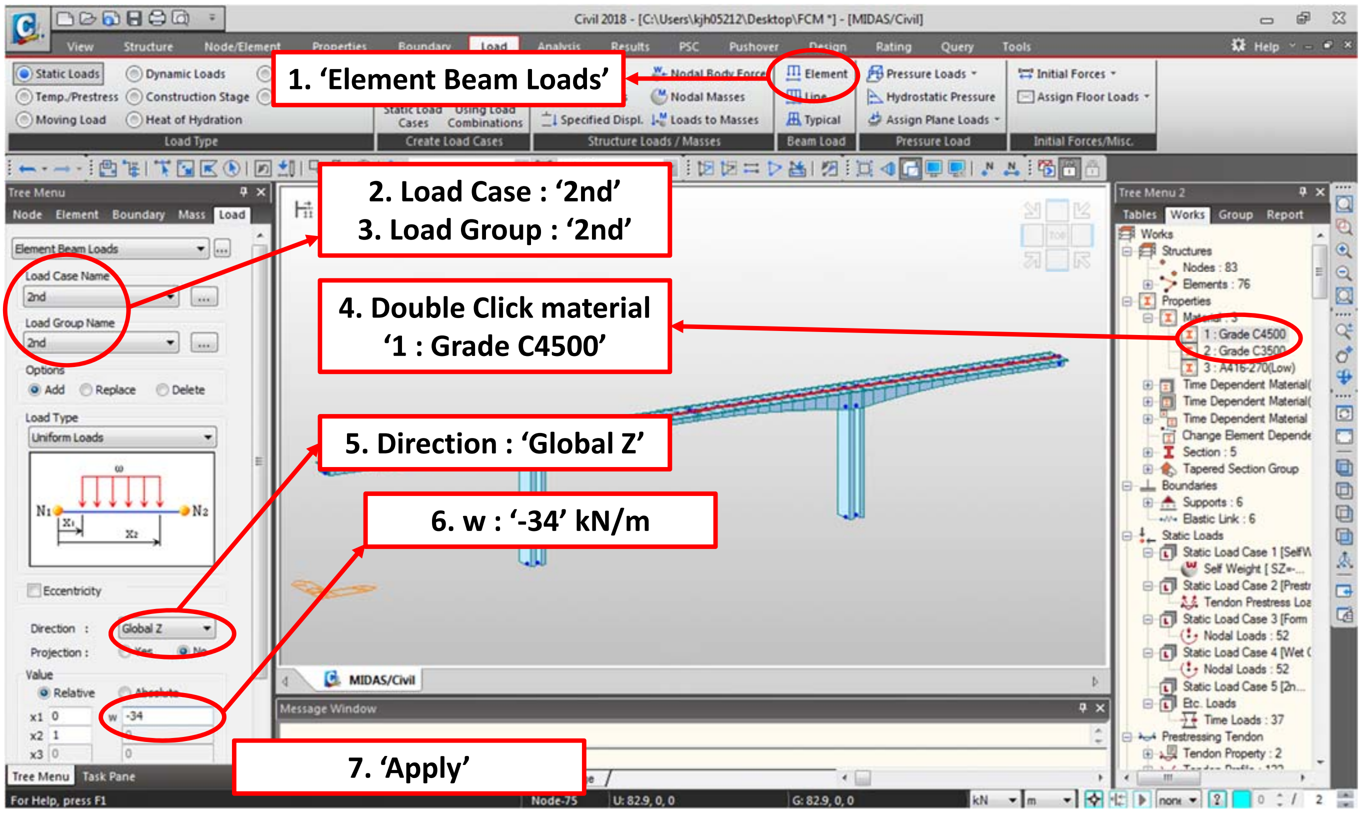
Procedure

33 Modification of Construction Stage



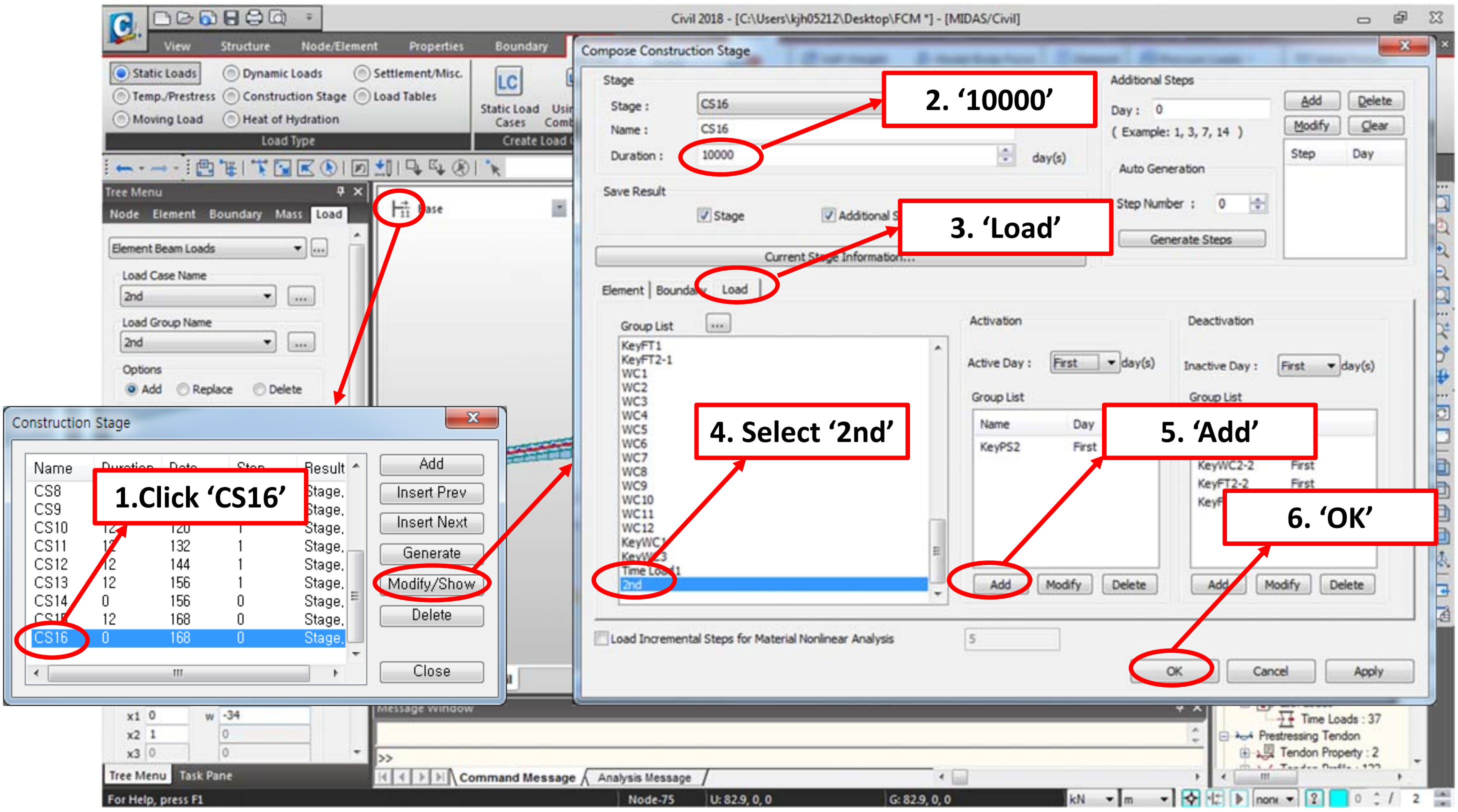
Procedure

34 Modification of Construction Stage



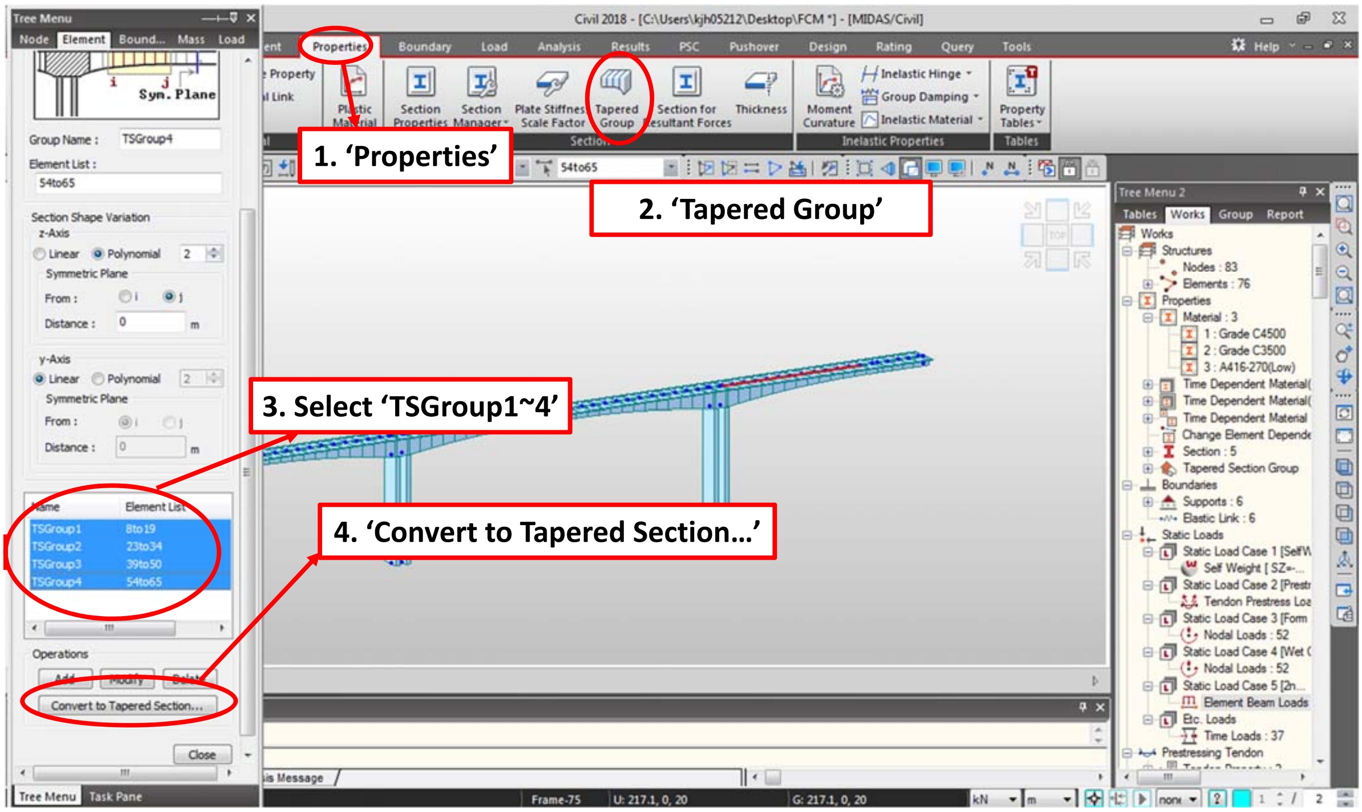
Procedure

35 Modification of Construction Stage



Procedure

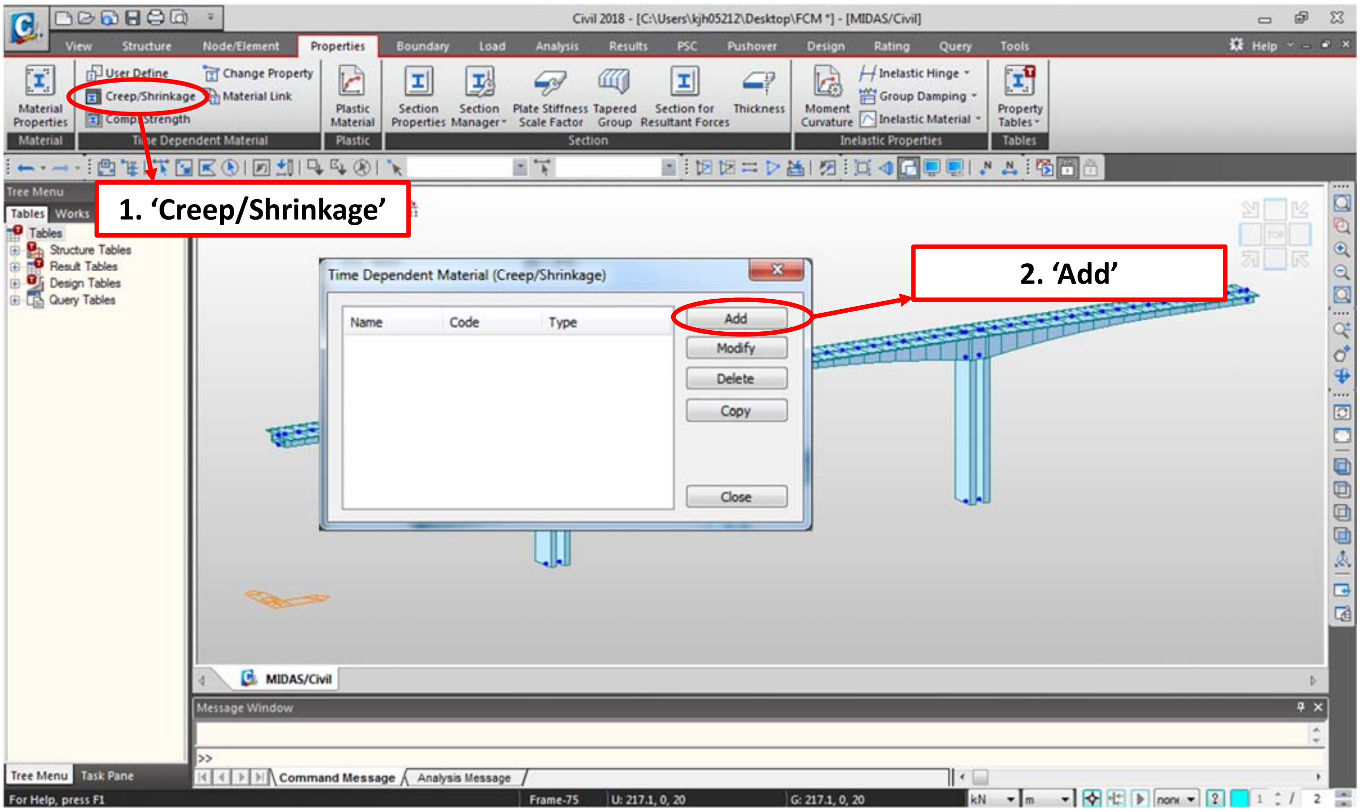
36 Tapered Section Group



Procedure

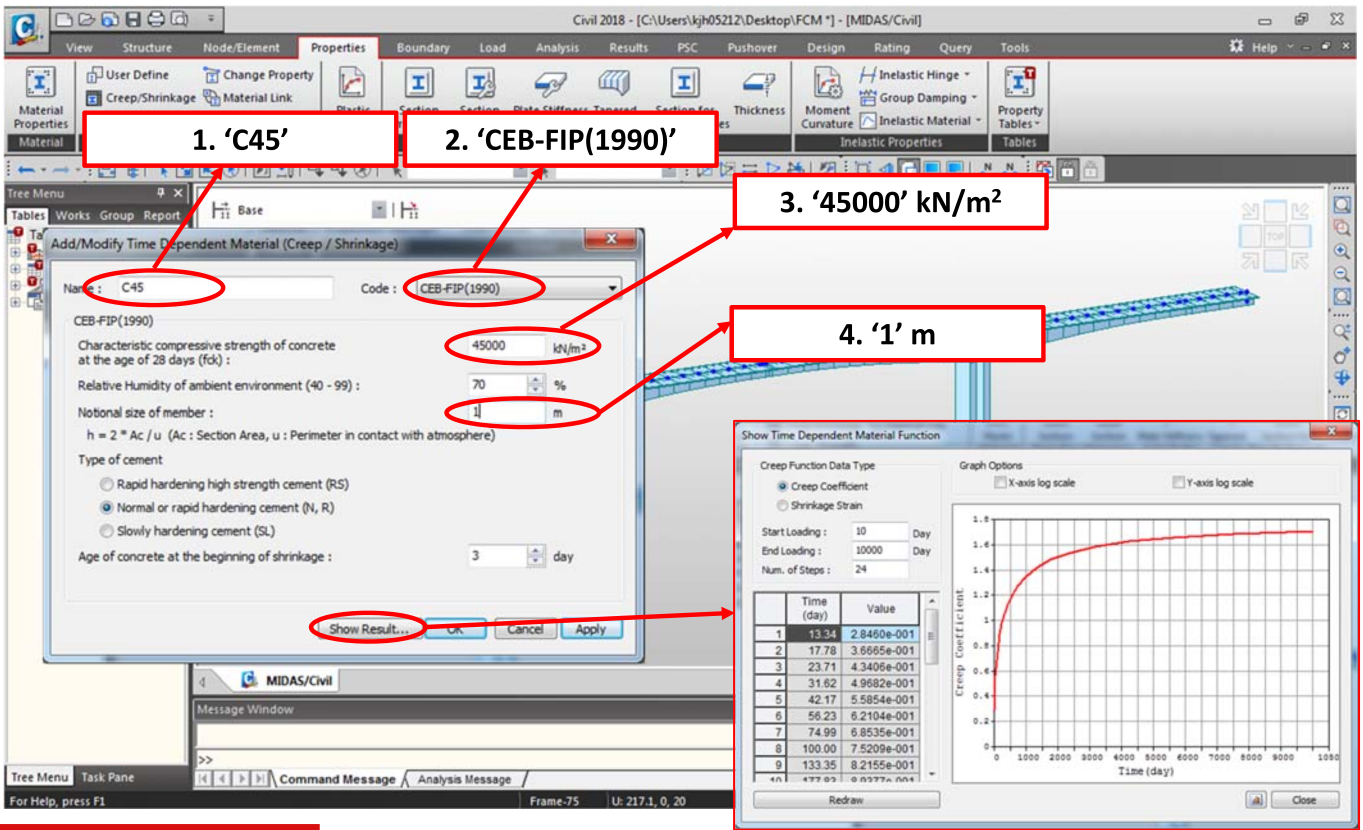
Use 'Shift' key to select multiple items

37 Time dependent Material



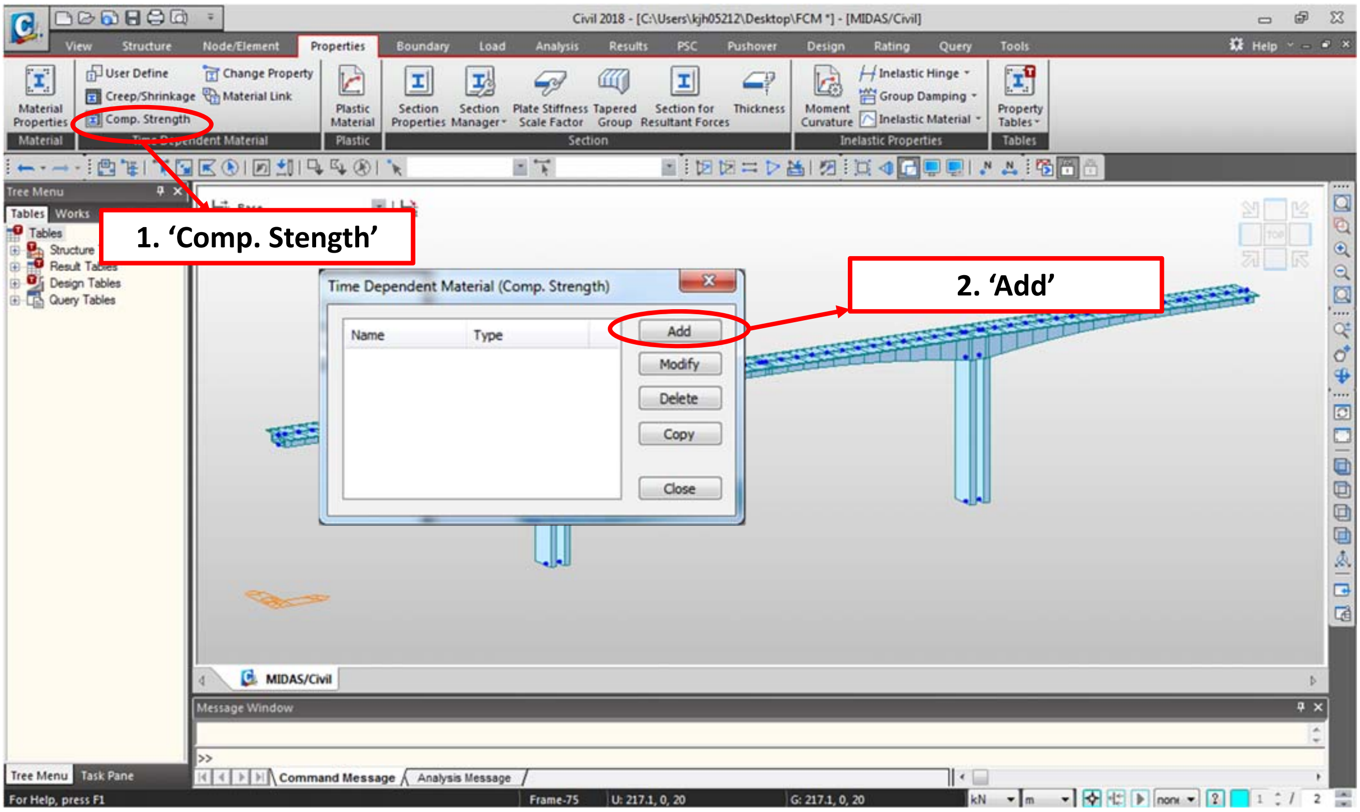
Procedure

38 Time dependent Material



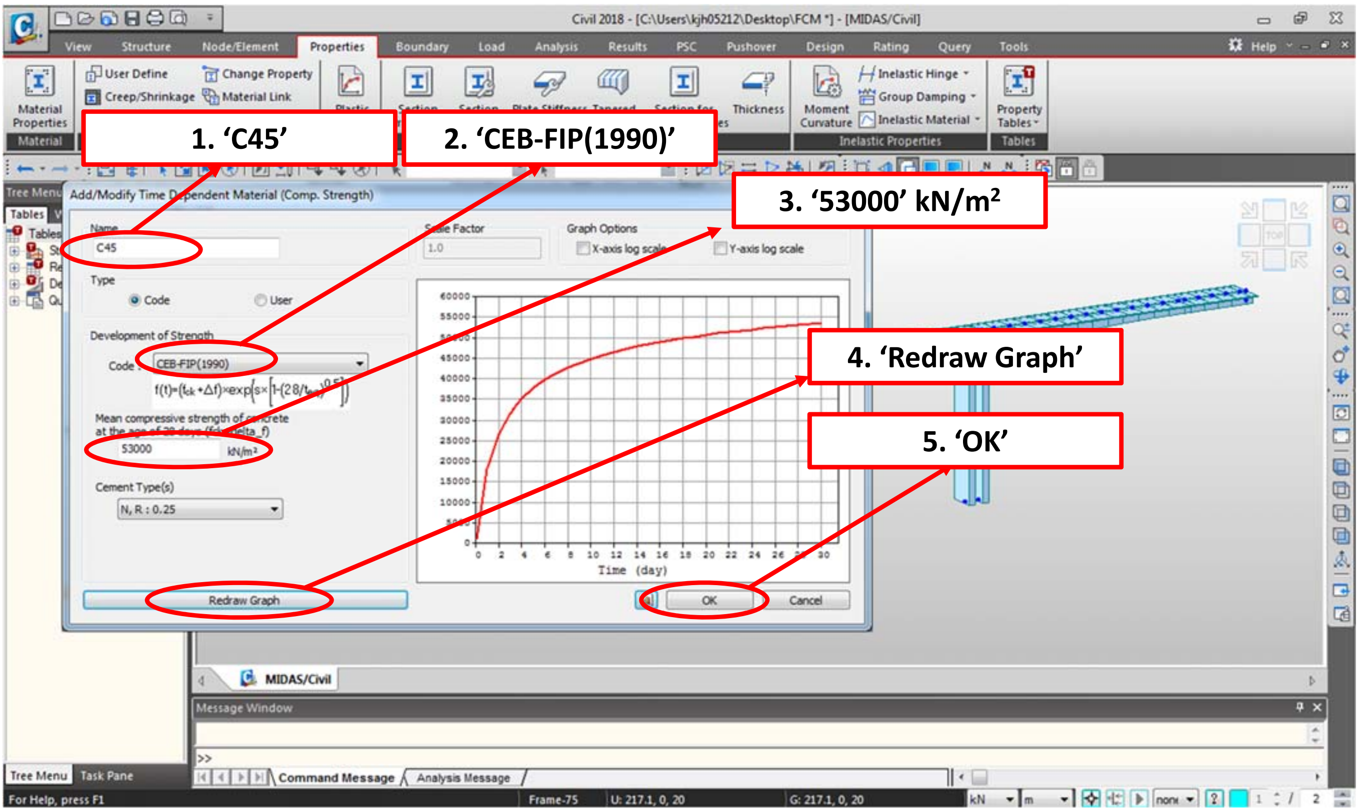
Procedure

39 Time dependent Material



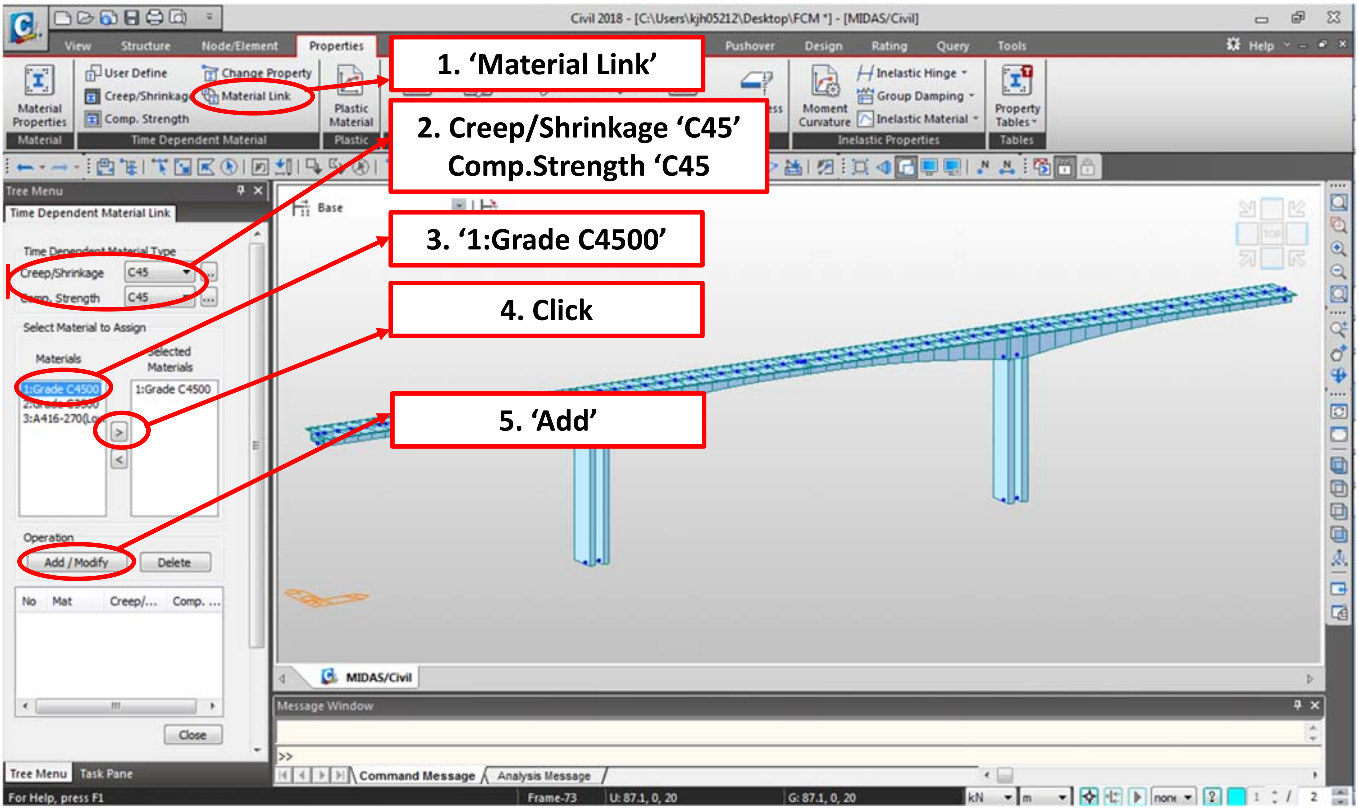
Procedure

40 Time dependent Material



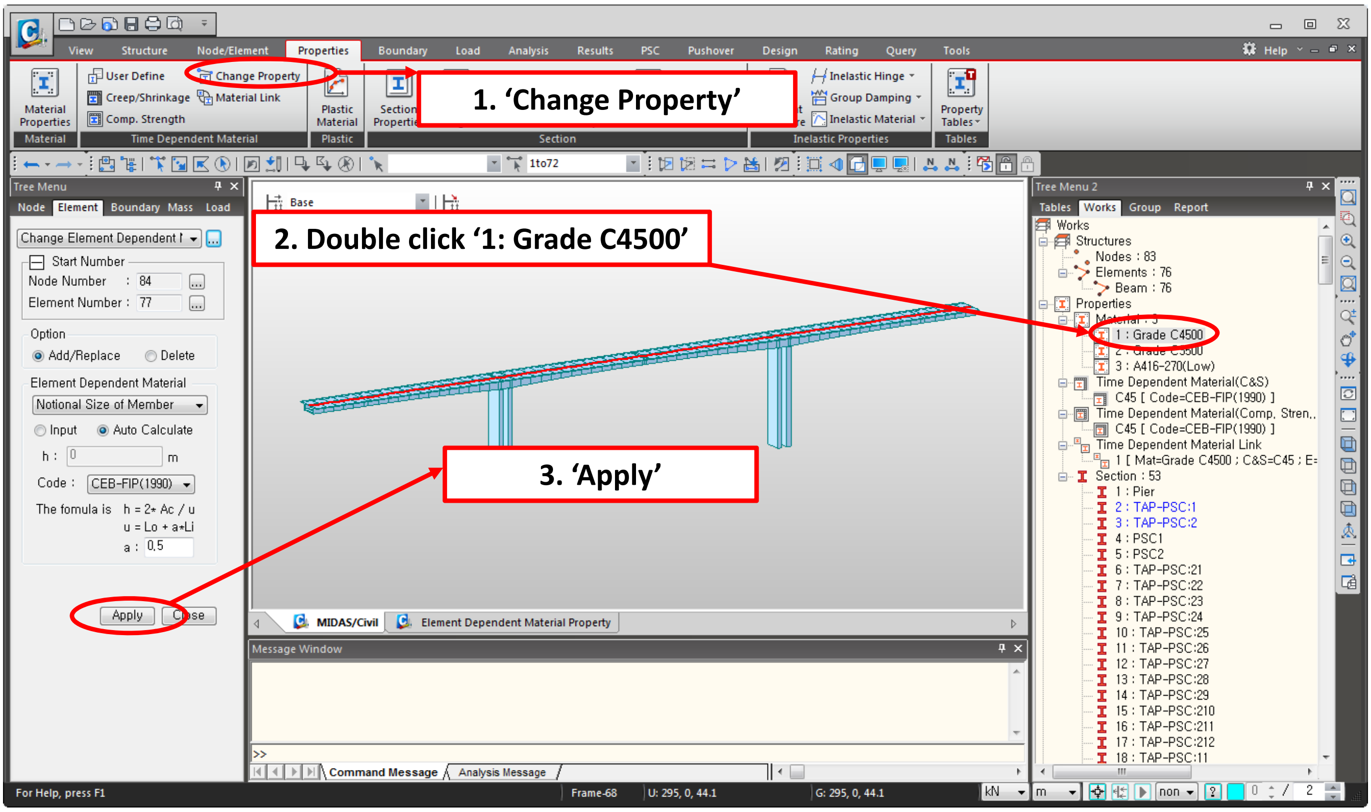
Procedure

41 Time dependent Material



Procedure

42 Time dependent Material



Procedure

Overview

- **Properties**
  - Material / Section
- **FCM bridge wizard**
  - Model
  - Section
  - Tendon
- **Modify construction stage**
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  - Moving load
- **Analysis**
  - Moving Load
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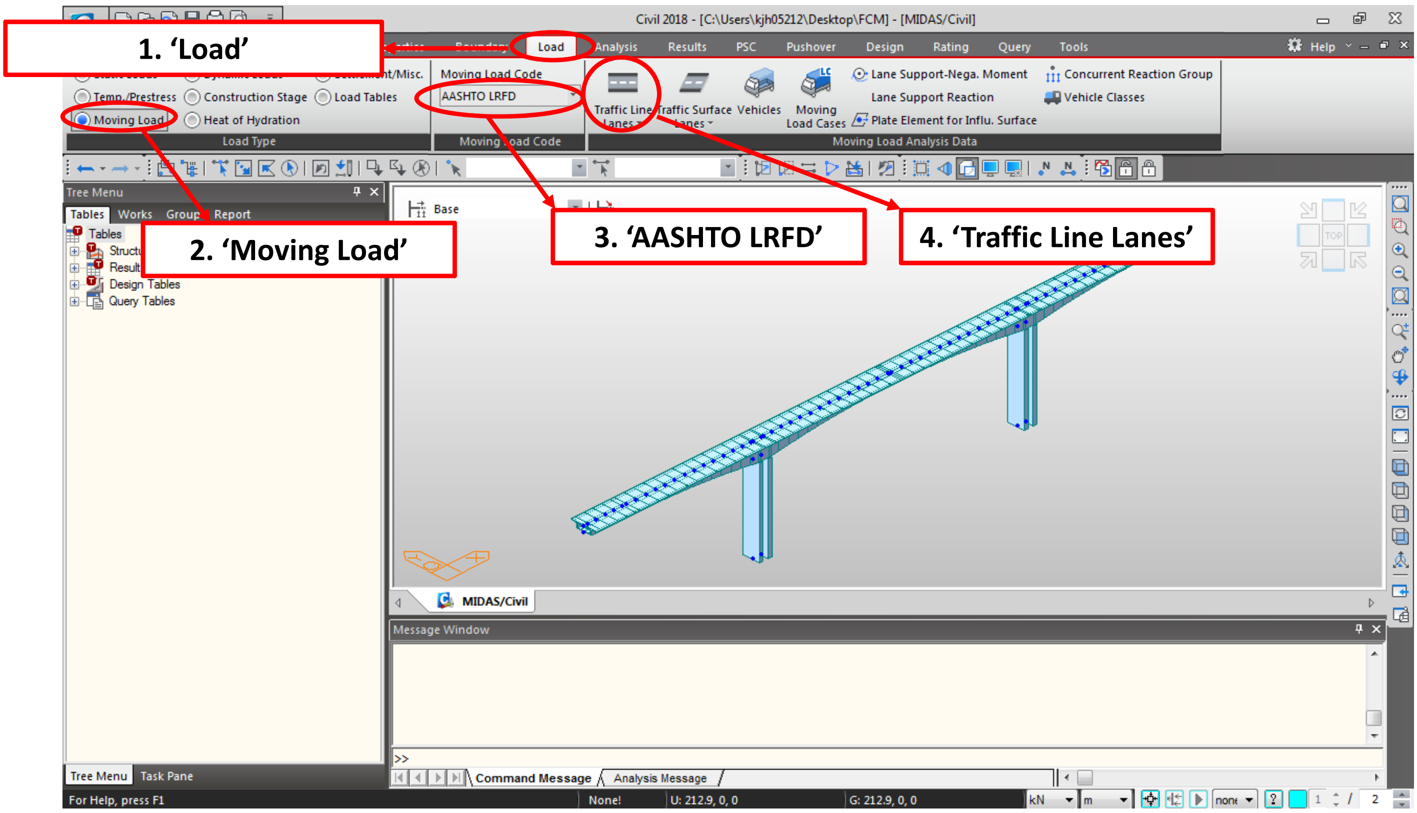
  - Reaction/Force/Displacement
  - Moving Tracer
  - Tendon Losses
  - Smart Report
- **Design**
  - PSC Design

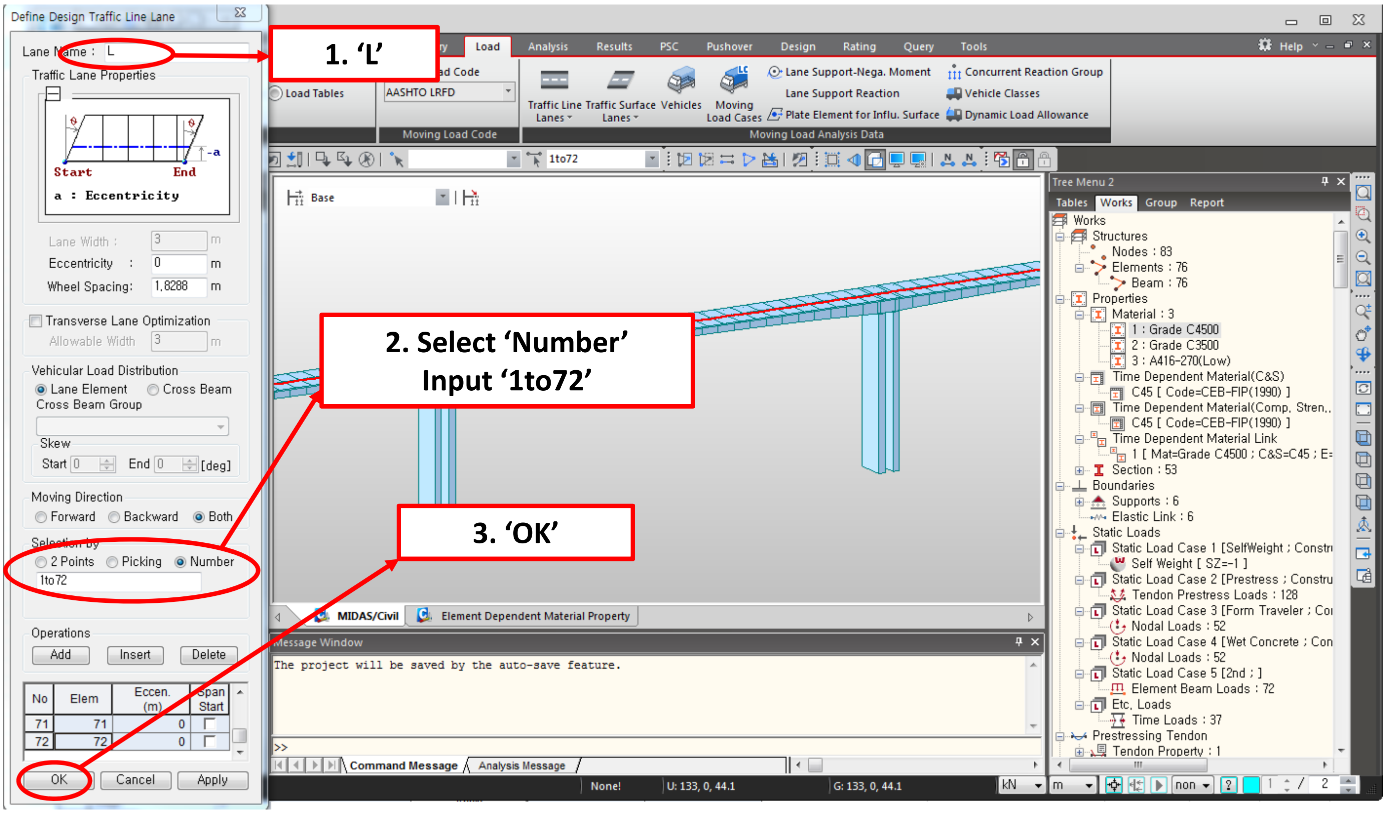
Step 4. Load

44 Moving Load



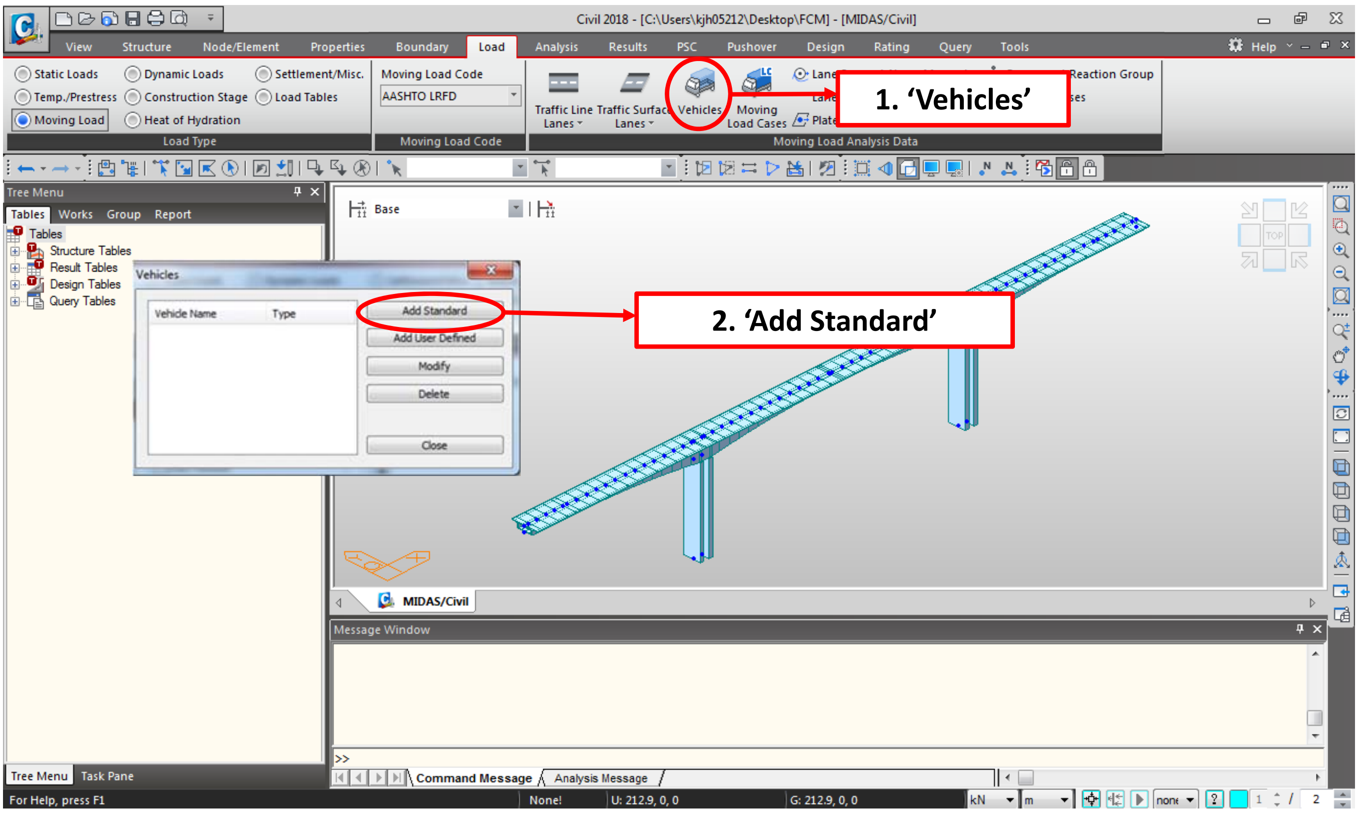
Procedure

45 Moving Load



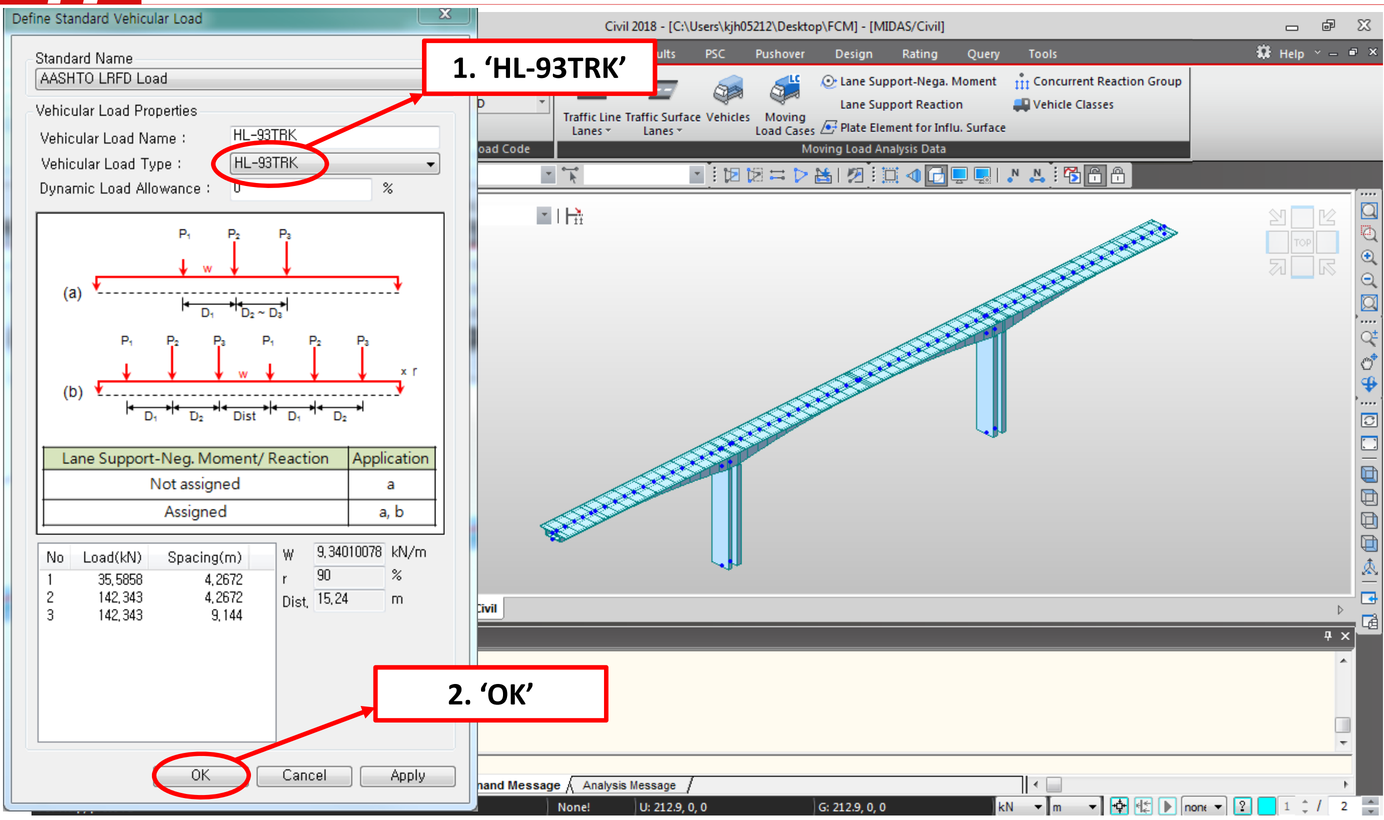
Procedure

46 Moving Load



Procedure

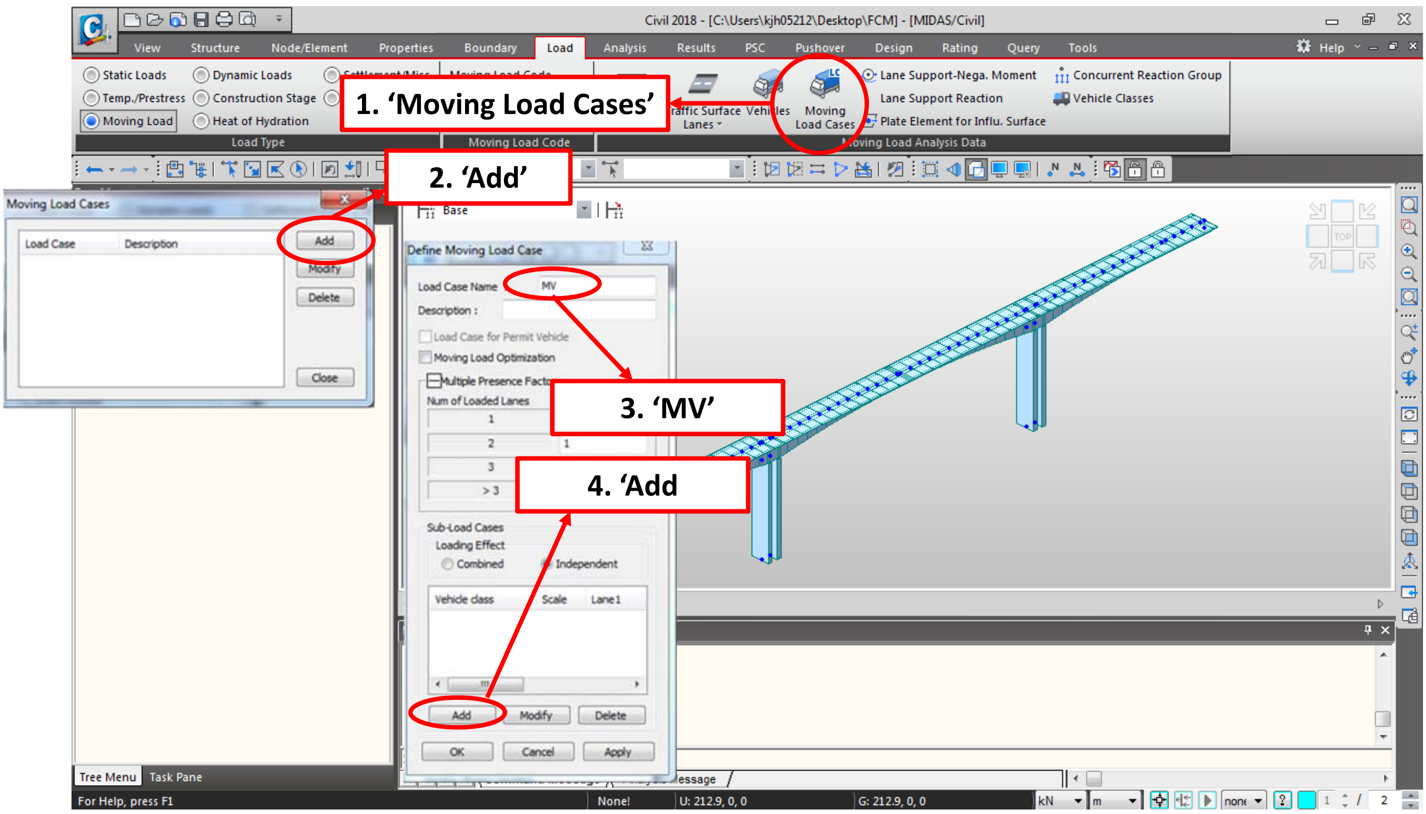
47 Moving Load



Procedure

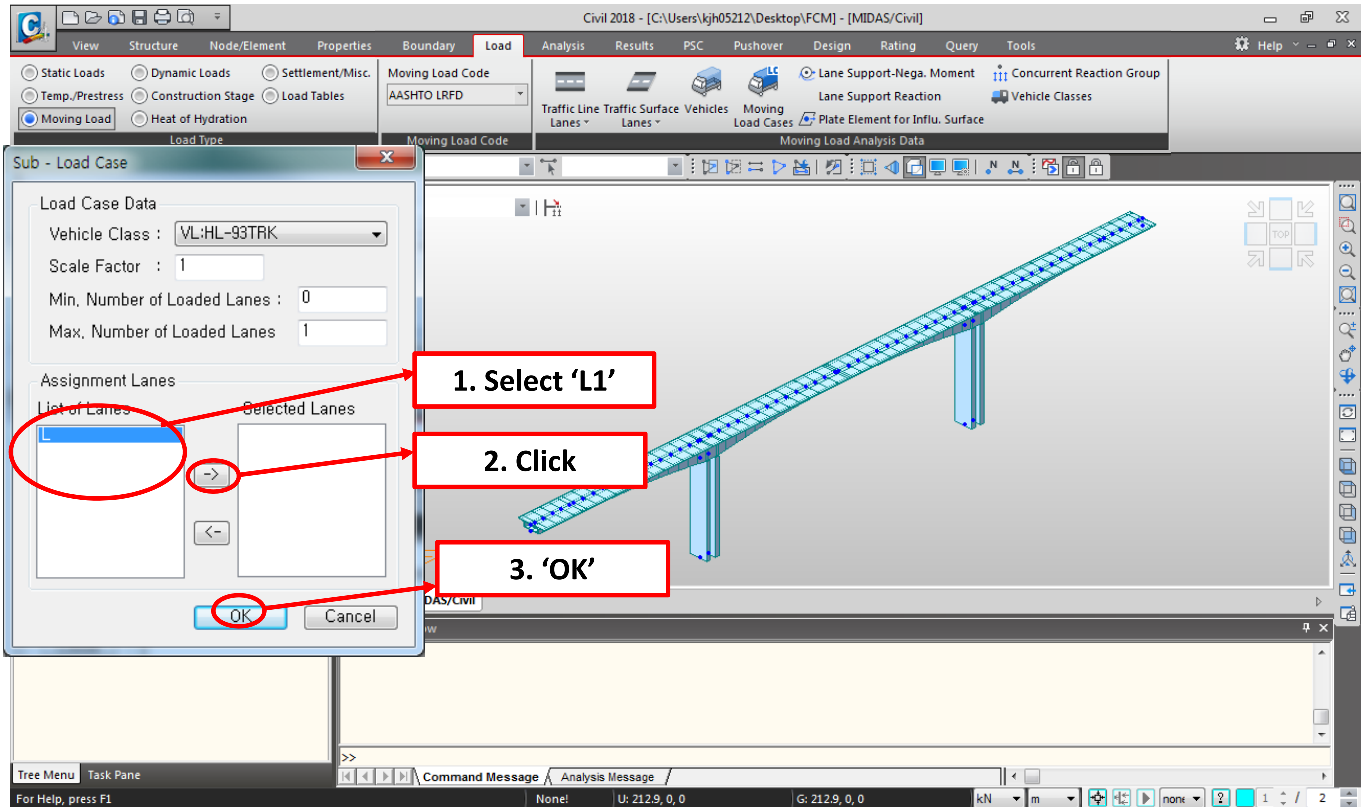
Dynamic Load Allowance will be applied to wheel loads.

48 Moving Load



Procedure

49 Moving Load



Procedure

Overview

- **Properties**
  - Material / Section
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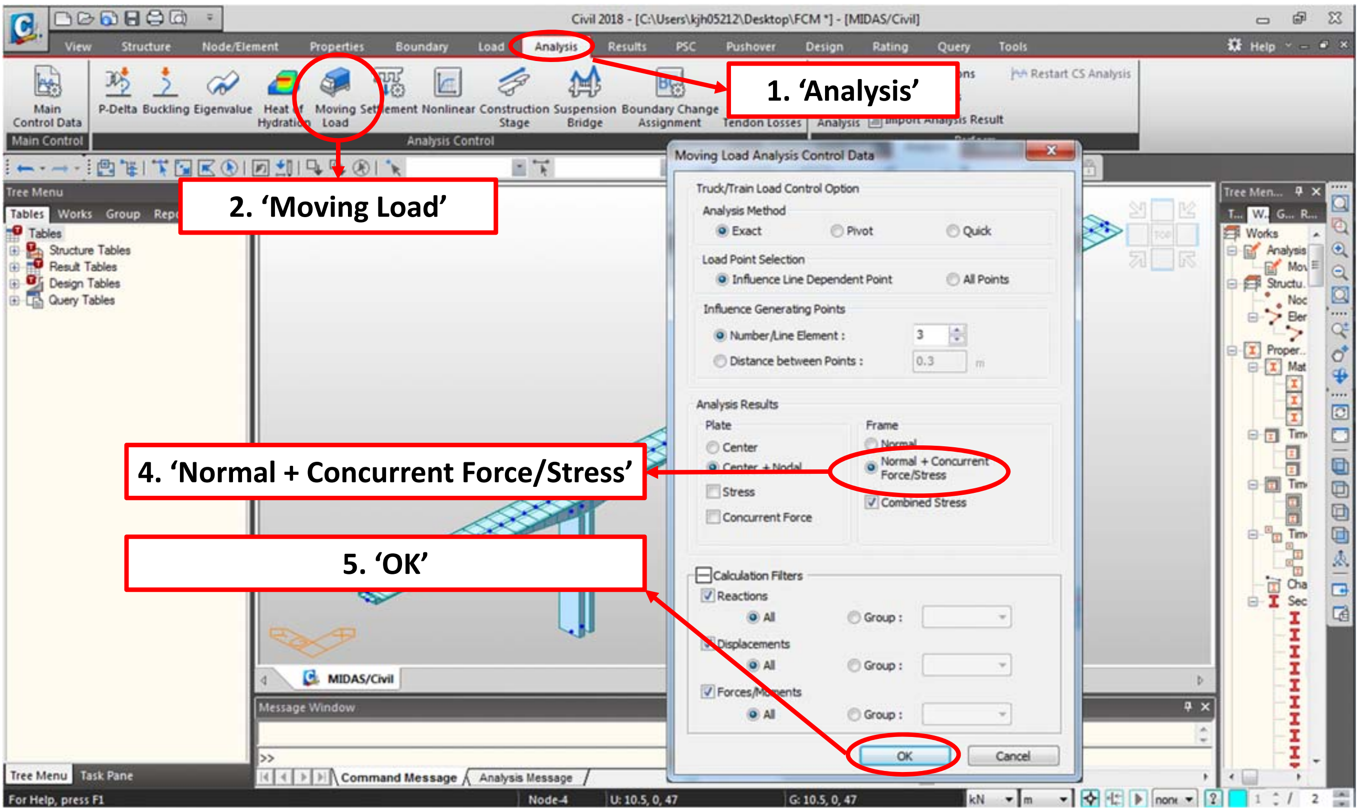
  - Smart Report
- **Design**
  - PSC Design

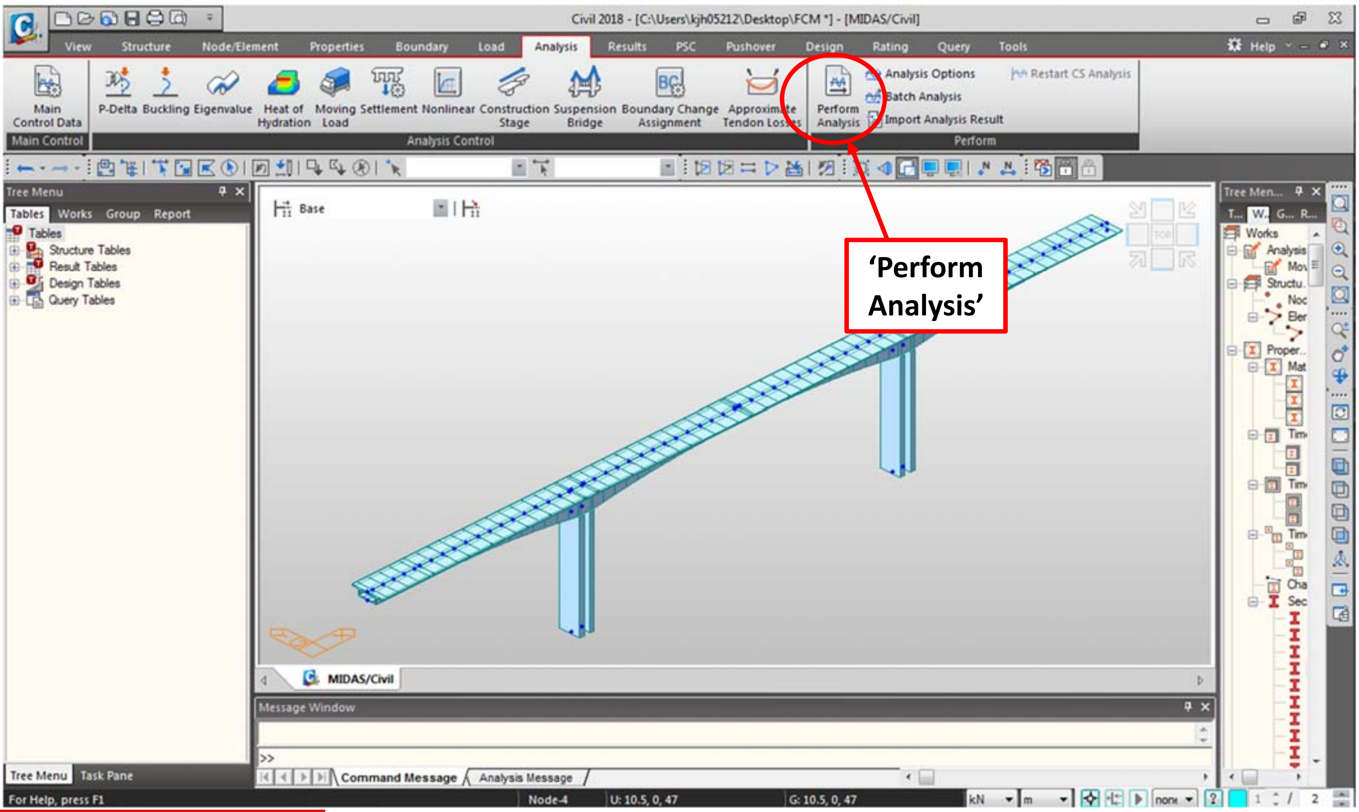
Step 5. Analysis

51 Perform Analysis



Procedure

52 Perform Analysis



Procedure

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

Overview

- **Properties**
  - Material / Section
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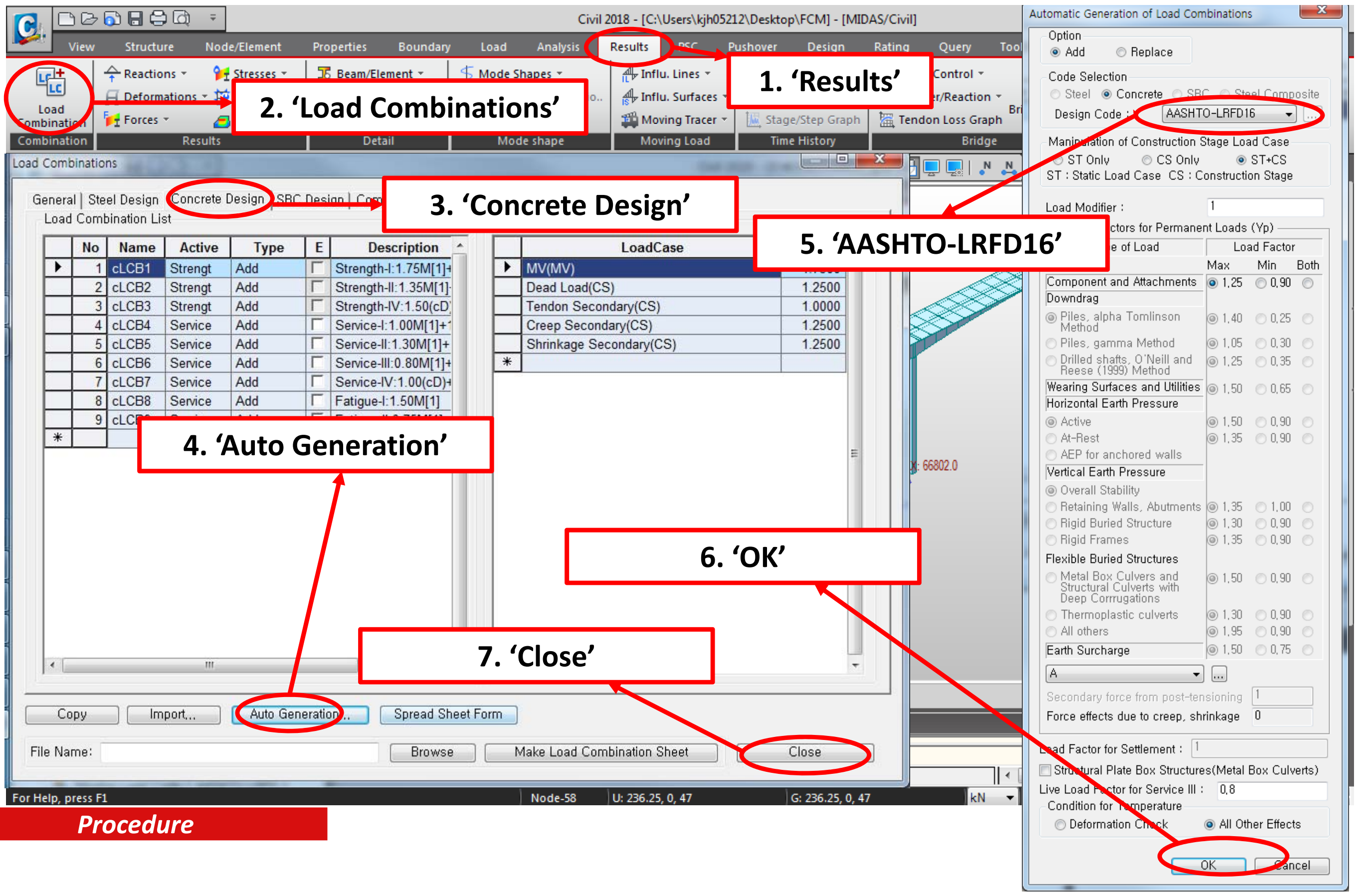
  - Smart Report
- **Design**
  - PSC Design

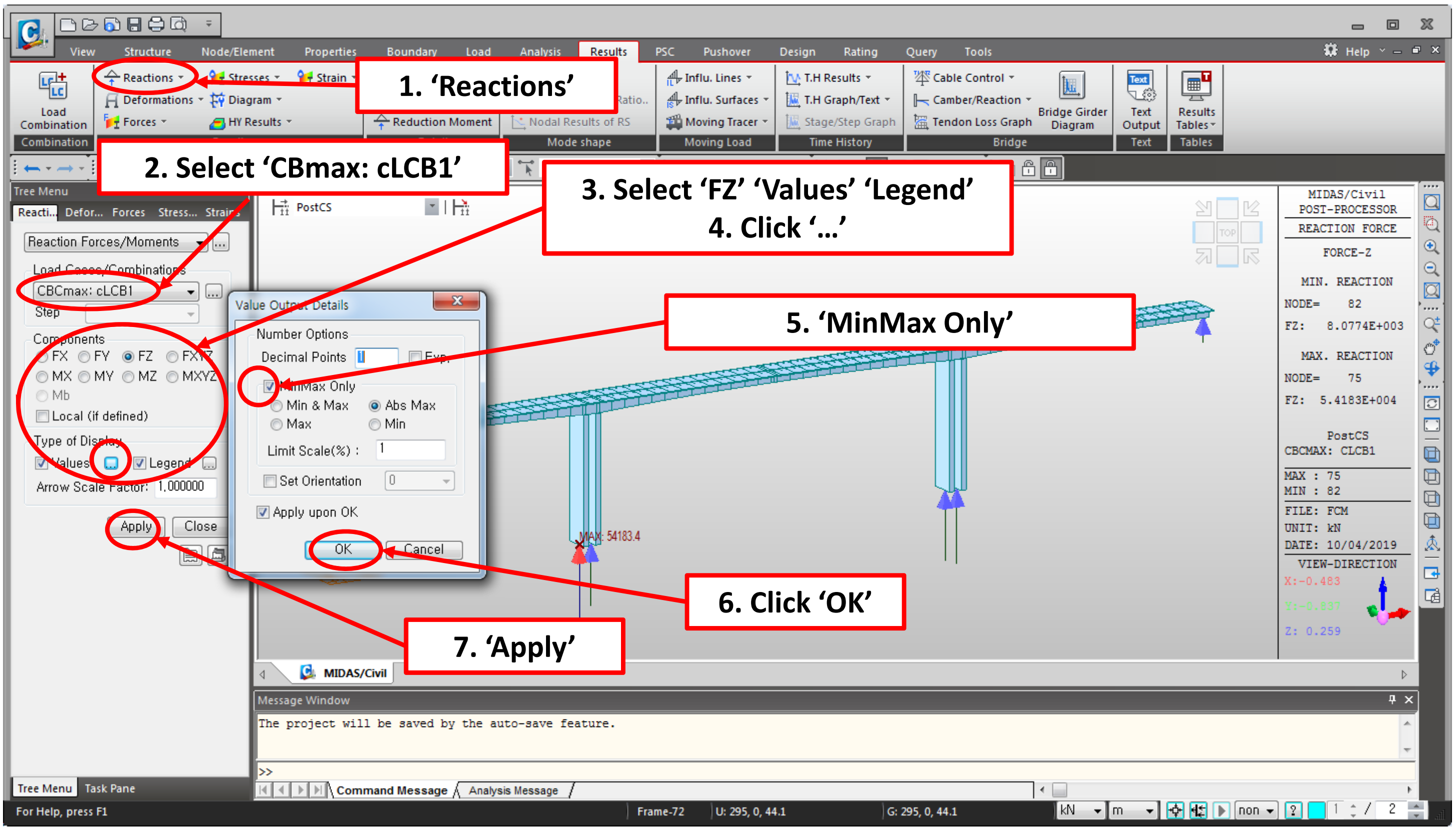
Step 6. Results

Load Combination



Procedure

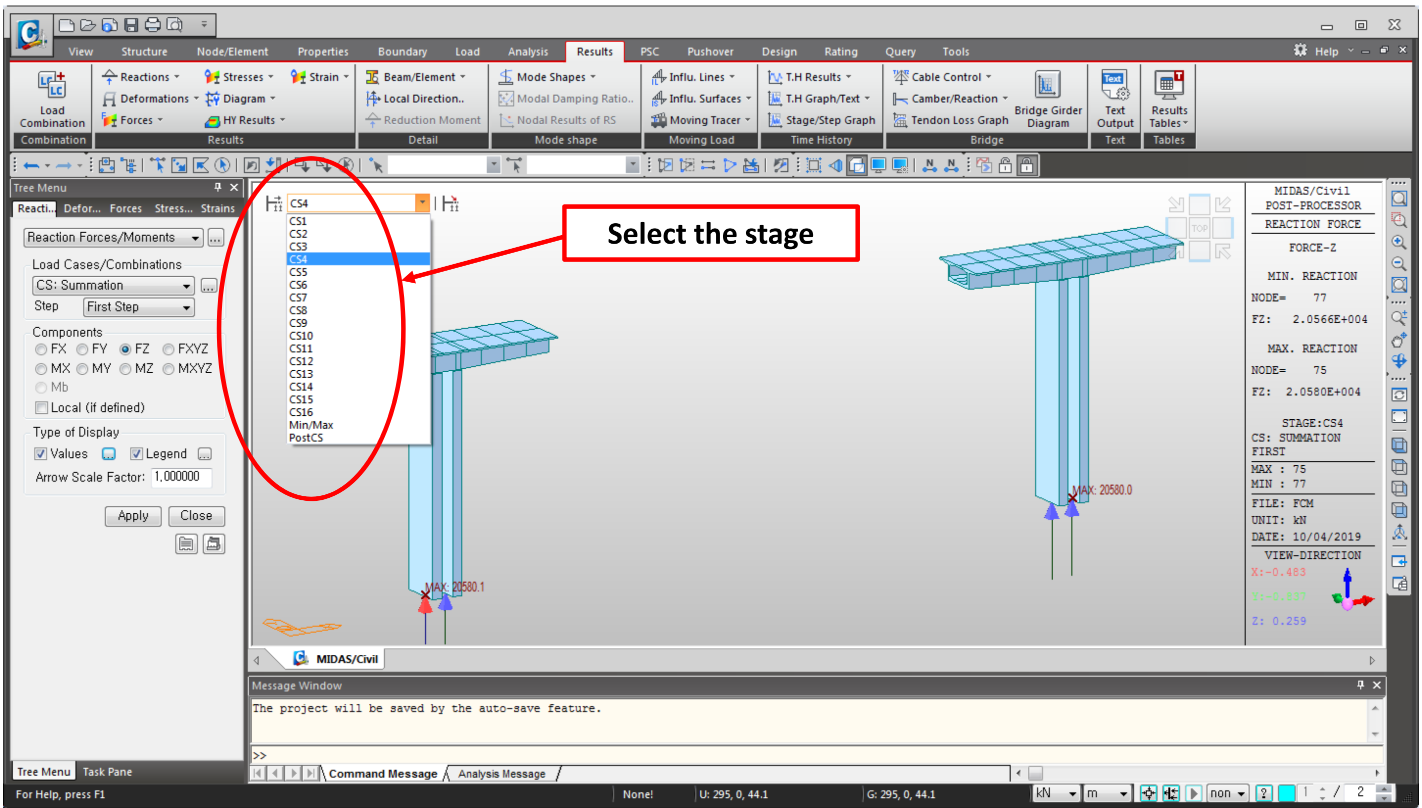
55 Reaction / Force / Displacement



Procedure

Check reactions under the load combination

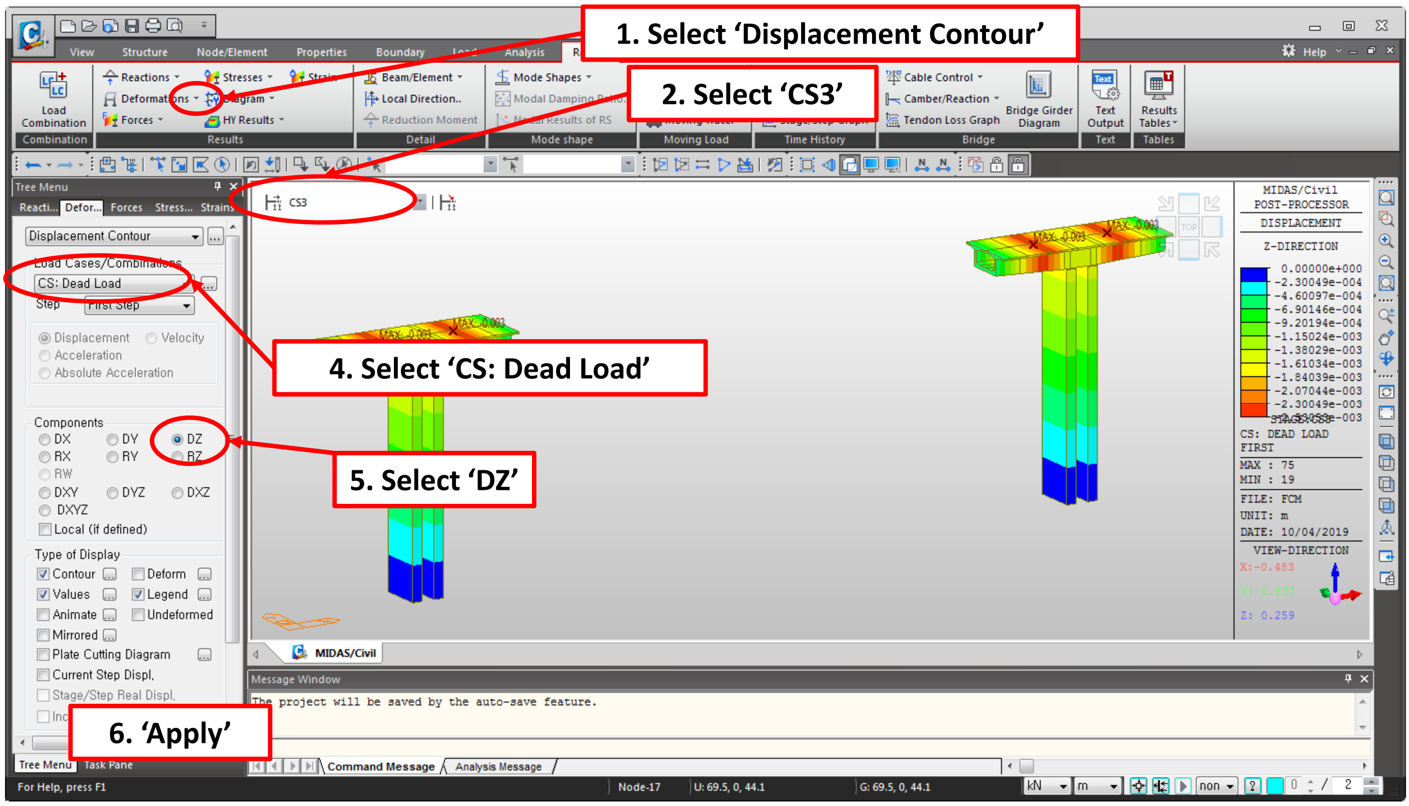
56 Reaction / Force / Displacement



Procedure

Check the results along the stages.

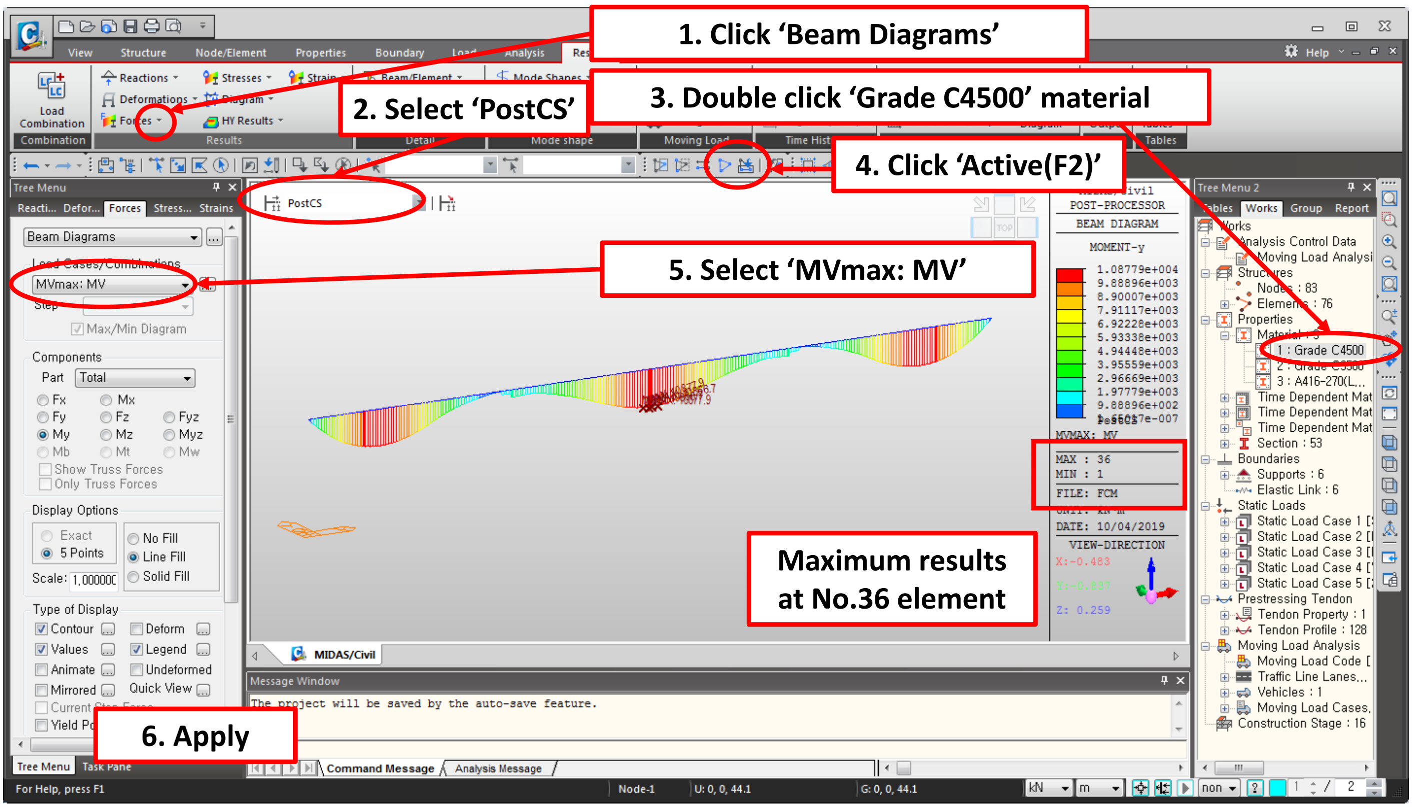
57 Reaction / Force / Displacement



Procedure

Check the results under dead load along the stages.

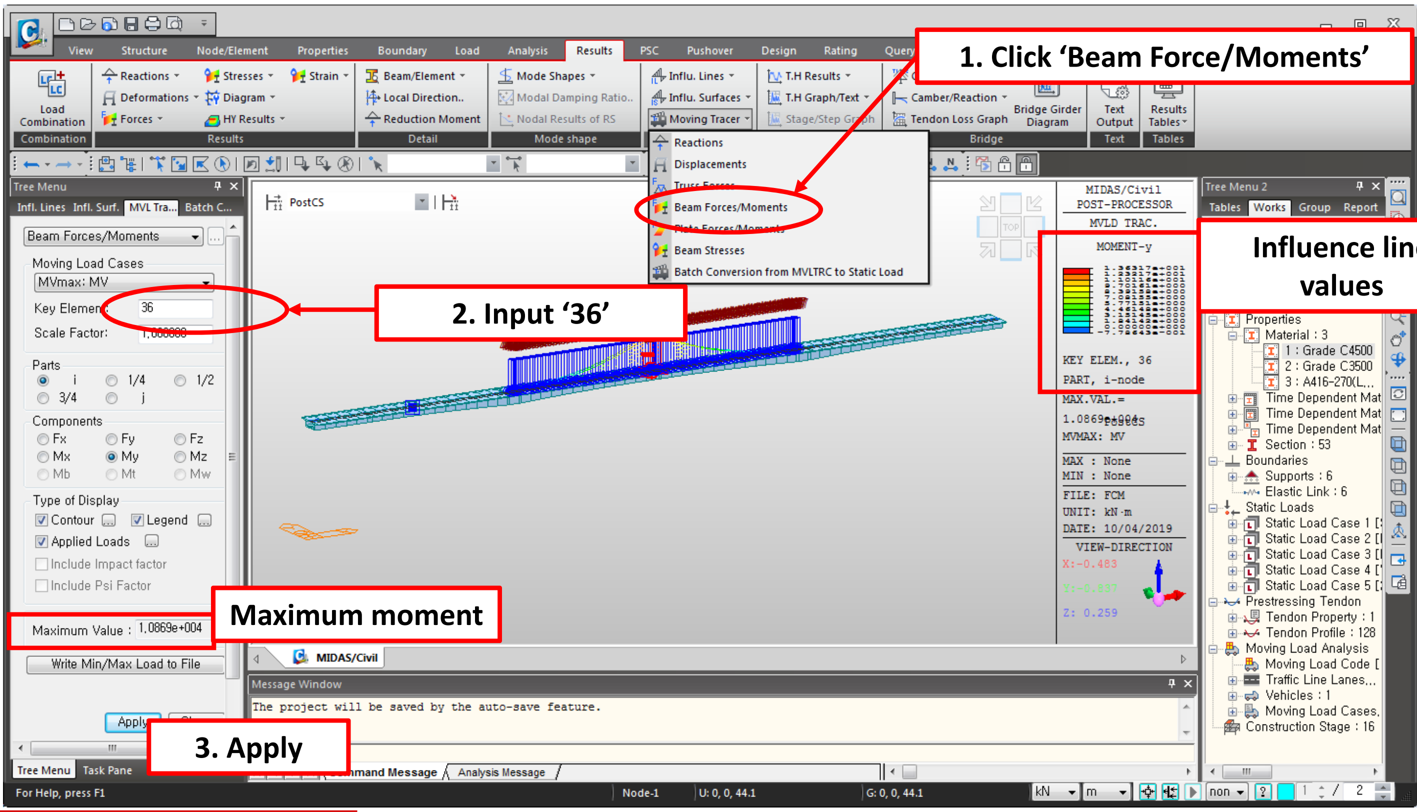
58 Reaction / Force / Displacement



Procedure

Check the beam moment diagram under moving load on Par 1(Girder).

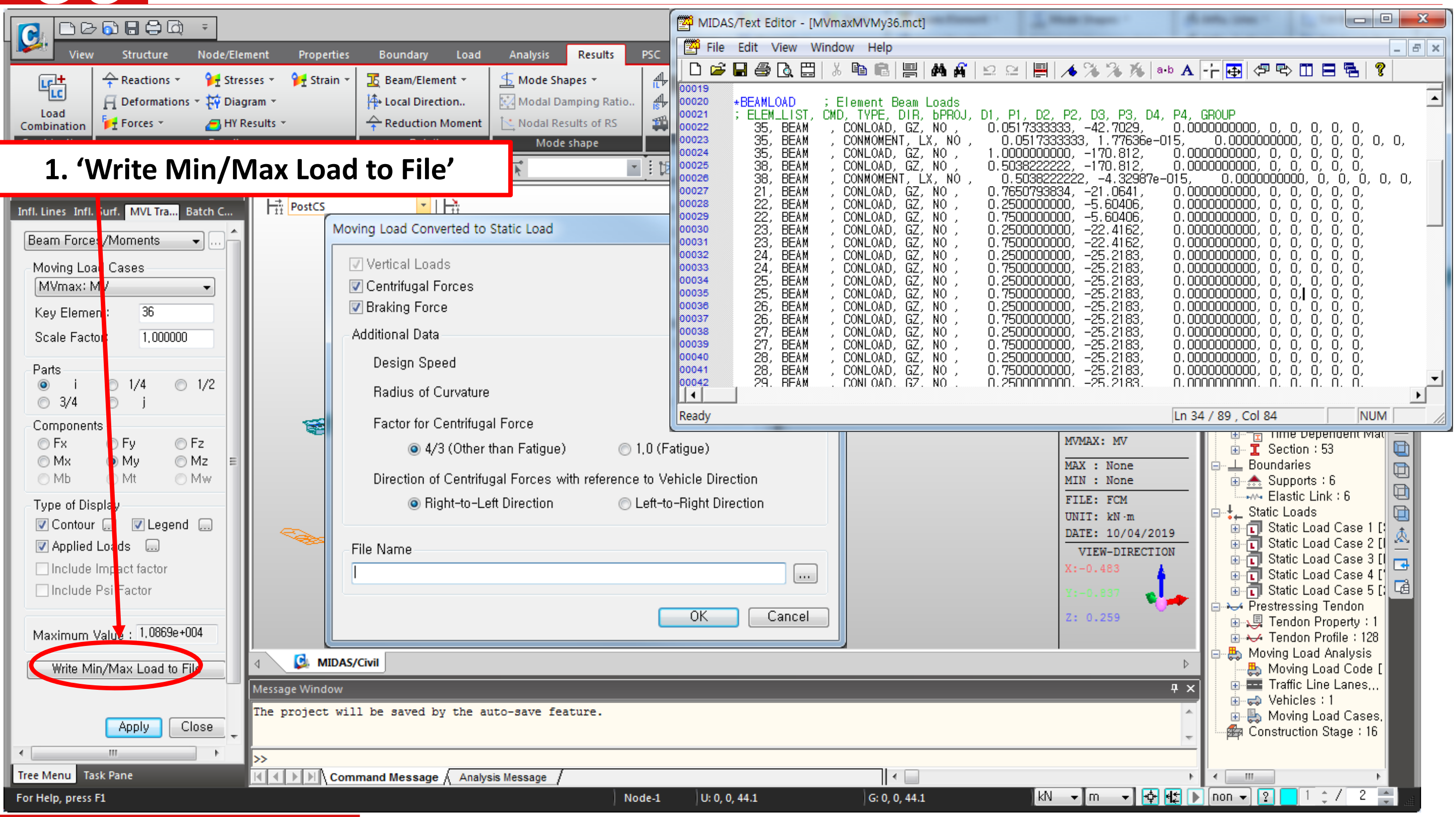
59 Moving Tracer



Procedure

Check the ciritical location of the vehicles.

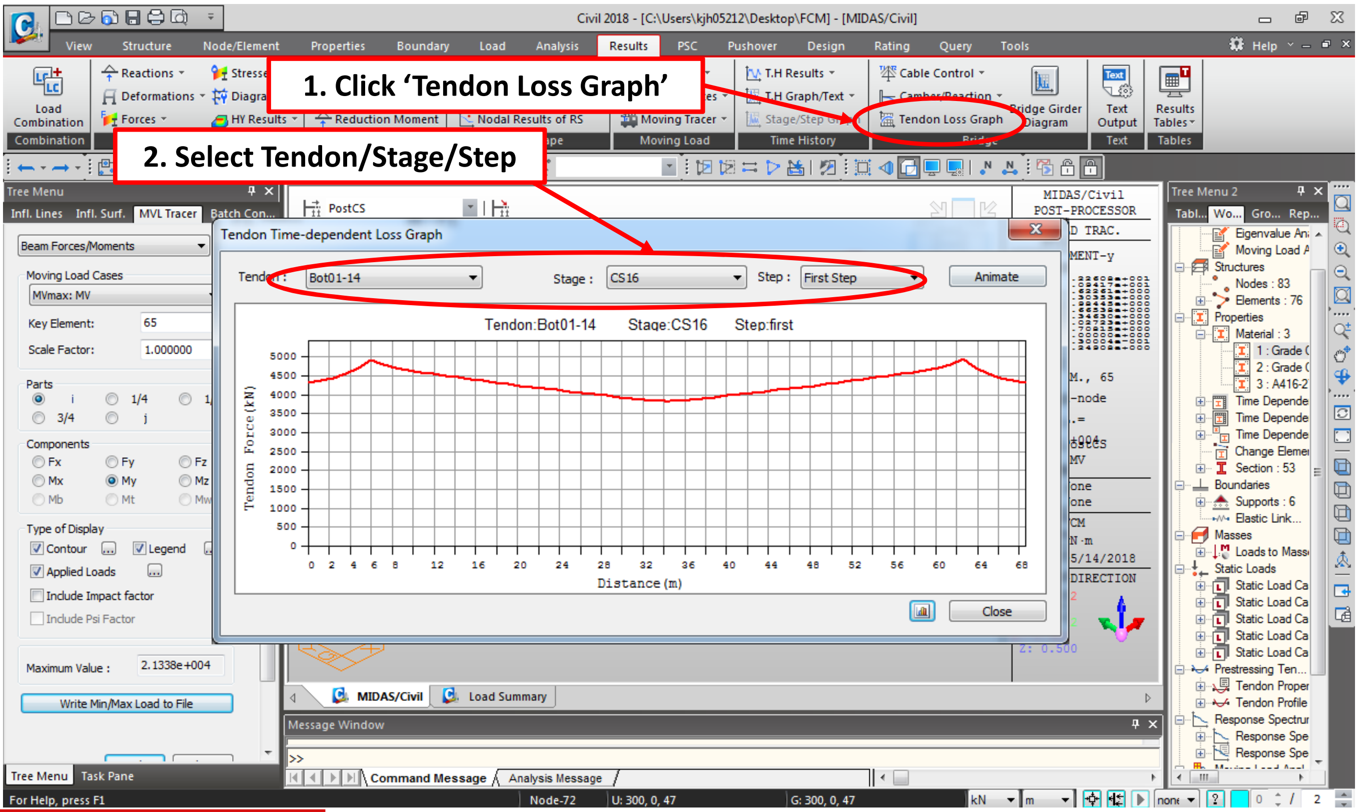
60 Moving Tracer



Procedure

Create static load case to consider Centrifugal/Braking/Acceleration forces. Copy and paste the text into MCT Command Shell under Tools menu.

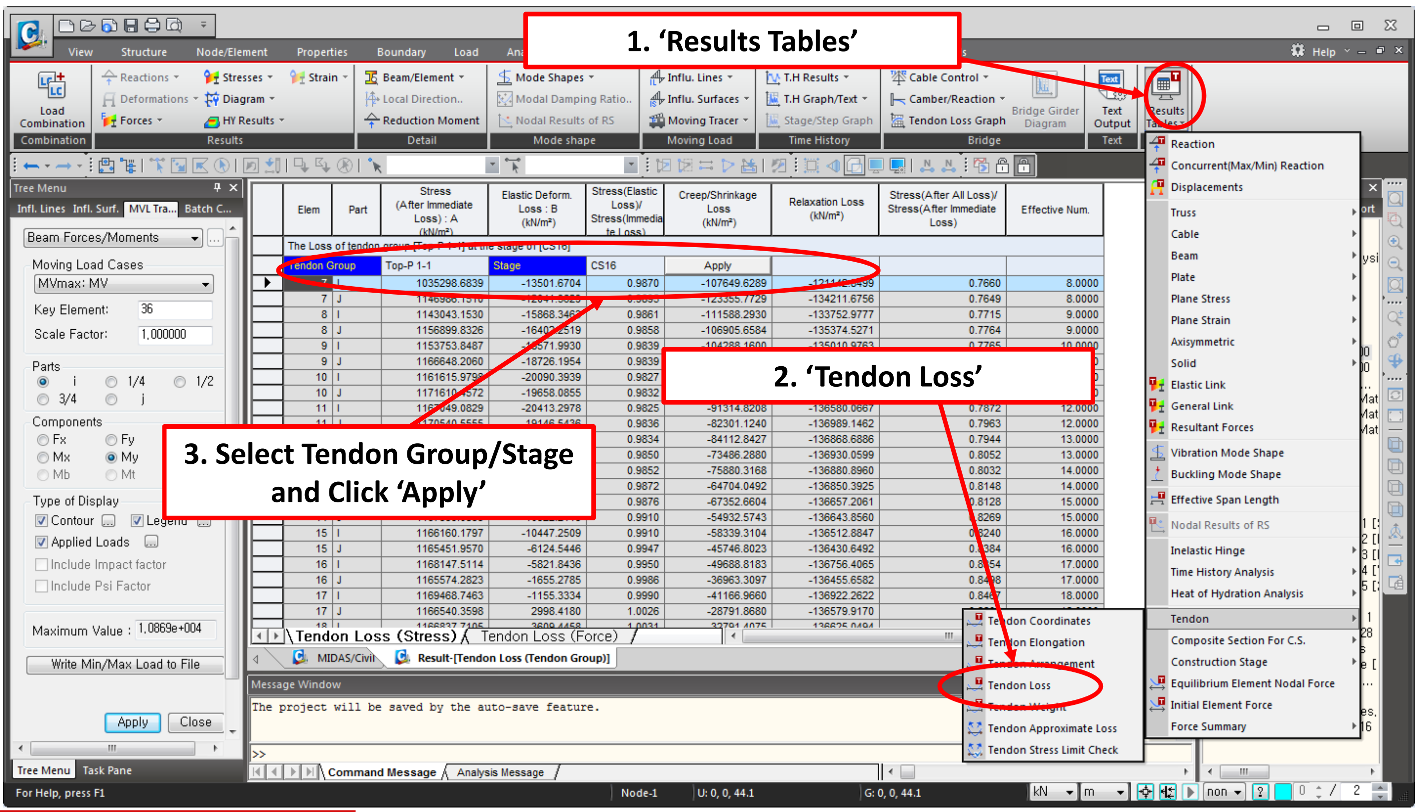
61 Tendon Losses



Procedure

Check tendon losses with graph format.

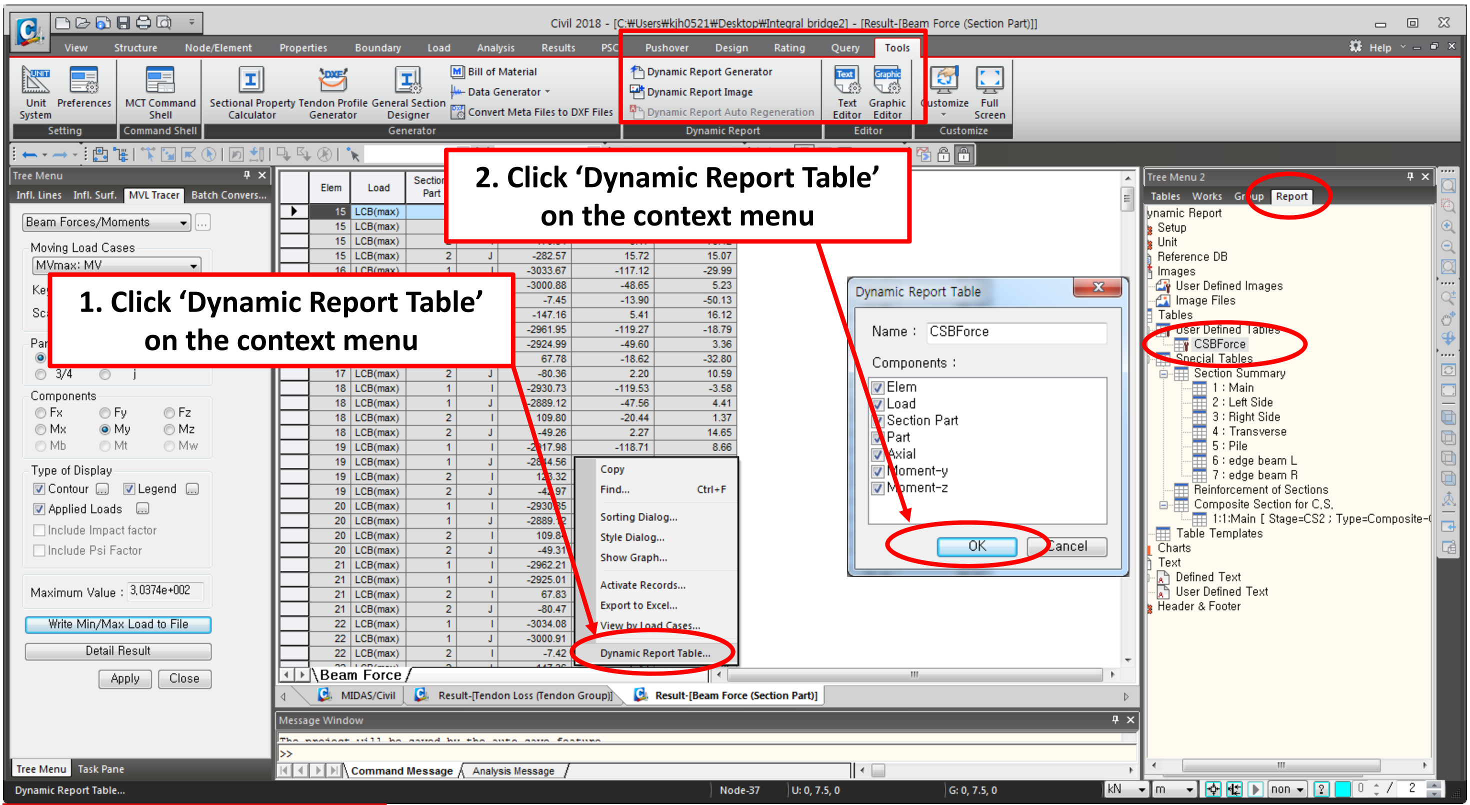
62 Tendon Losses



Procedure

Check tendon losses.

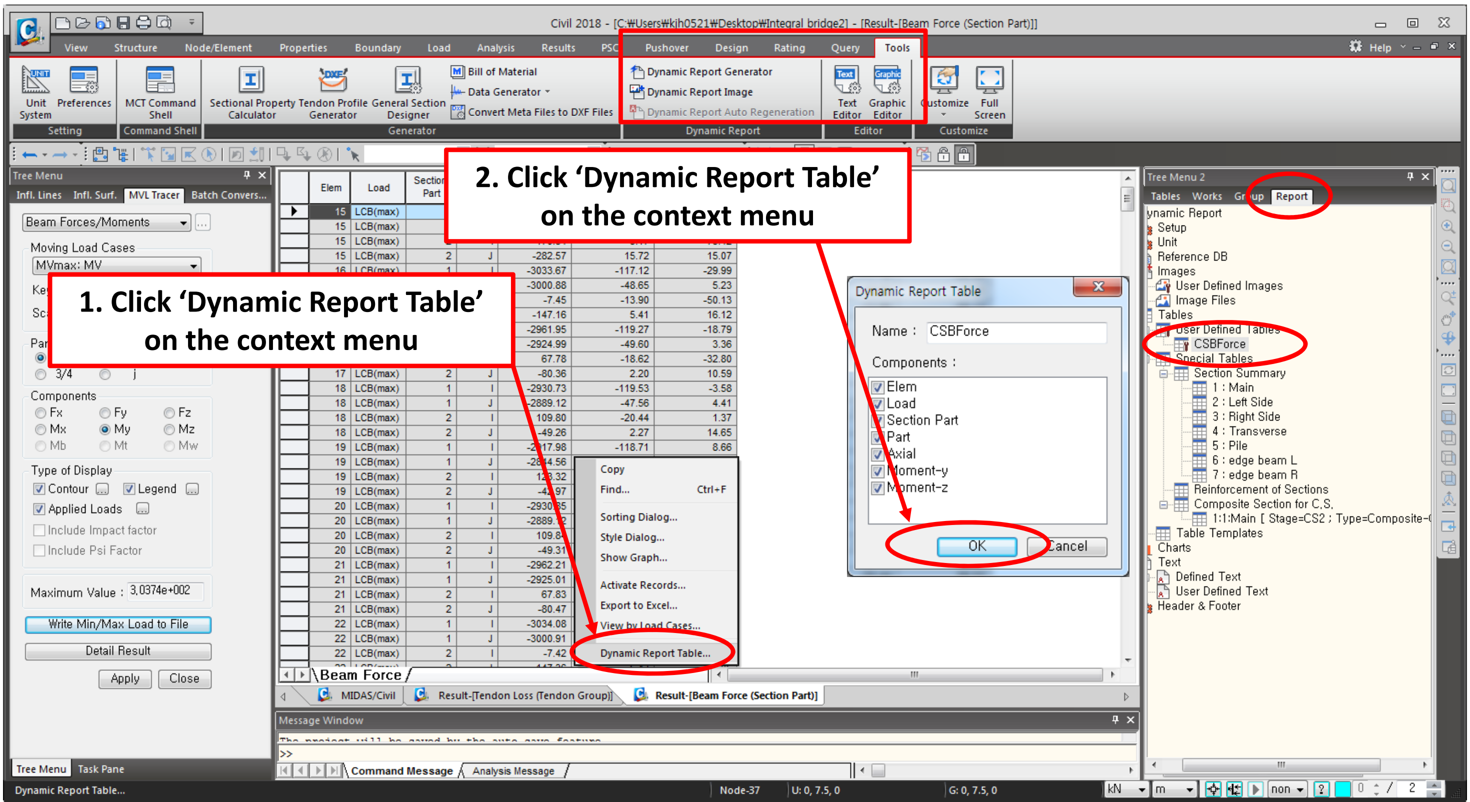
63 Smart Report



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.

64 Smart Report



Procedure

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Add all input & output figures & tables to Tree Menu by clicking on 'Dynamic Report Table' on the context menu.

Overview

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  - Moving Tracer
  - Tendon Losses
  - Smart Report
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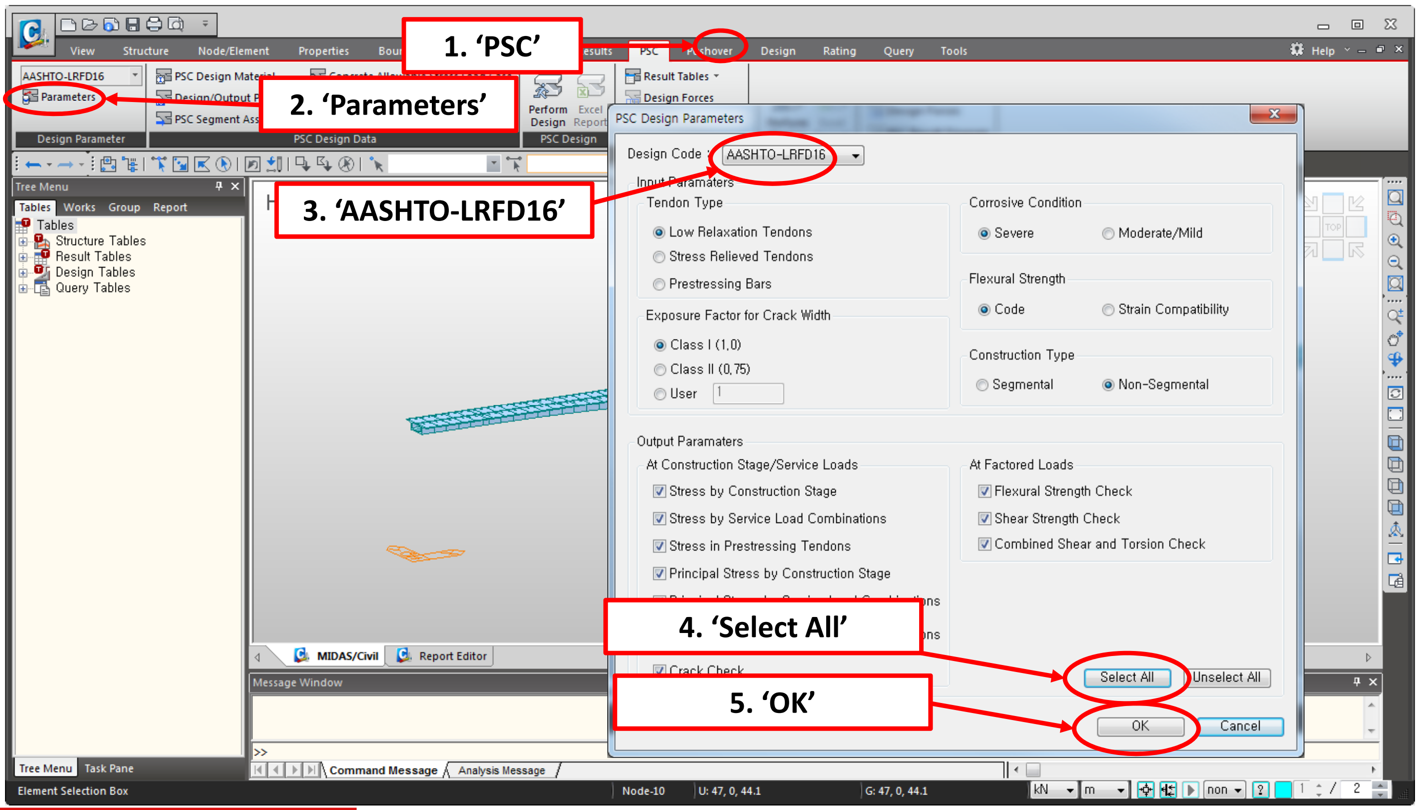
  - PSC Design

Step 7. Design

66

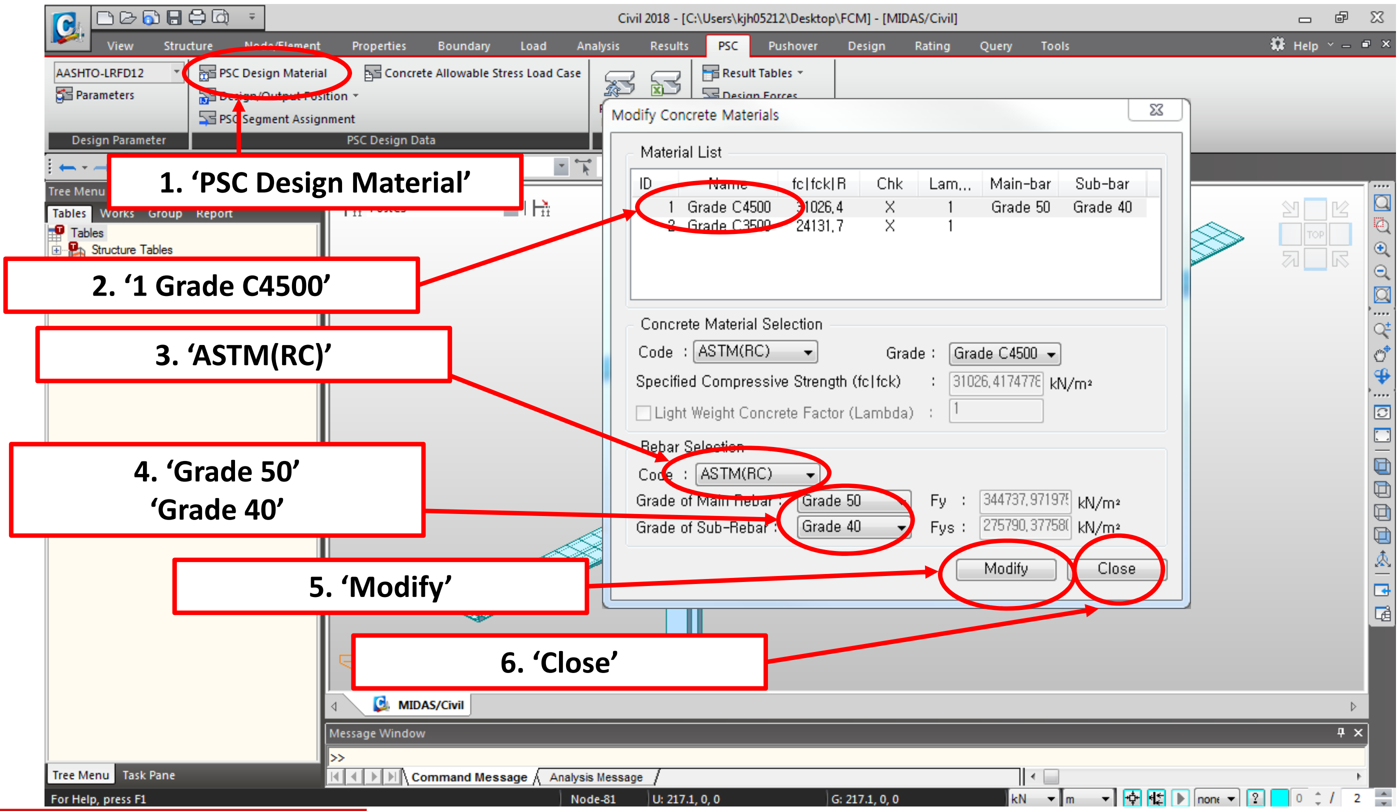
PSC Design



Procedure

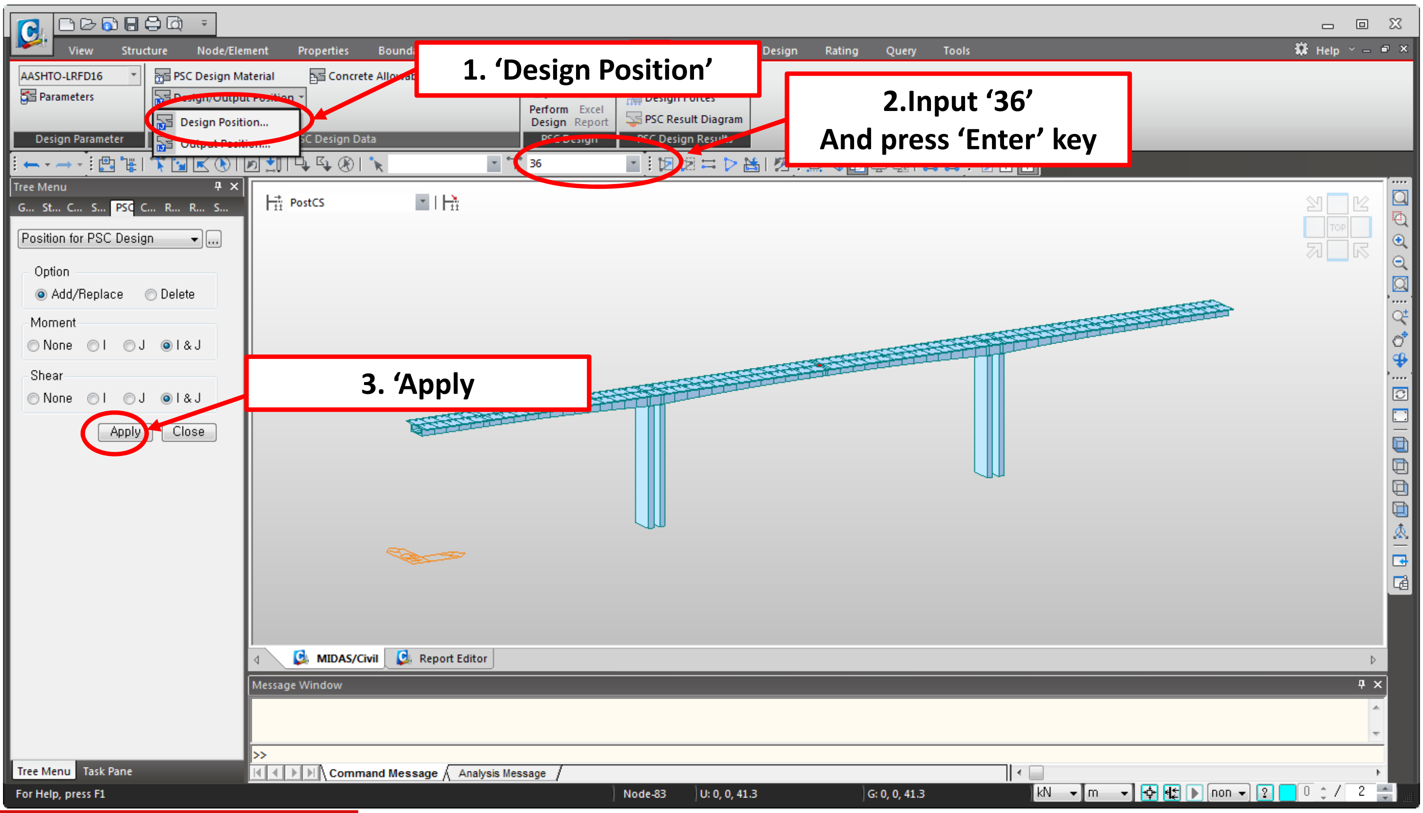
Decide output parameters

67 PSC Design



Procedure

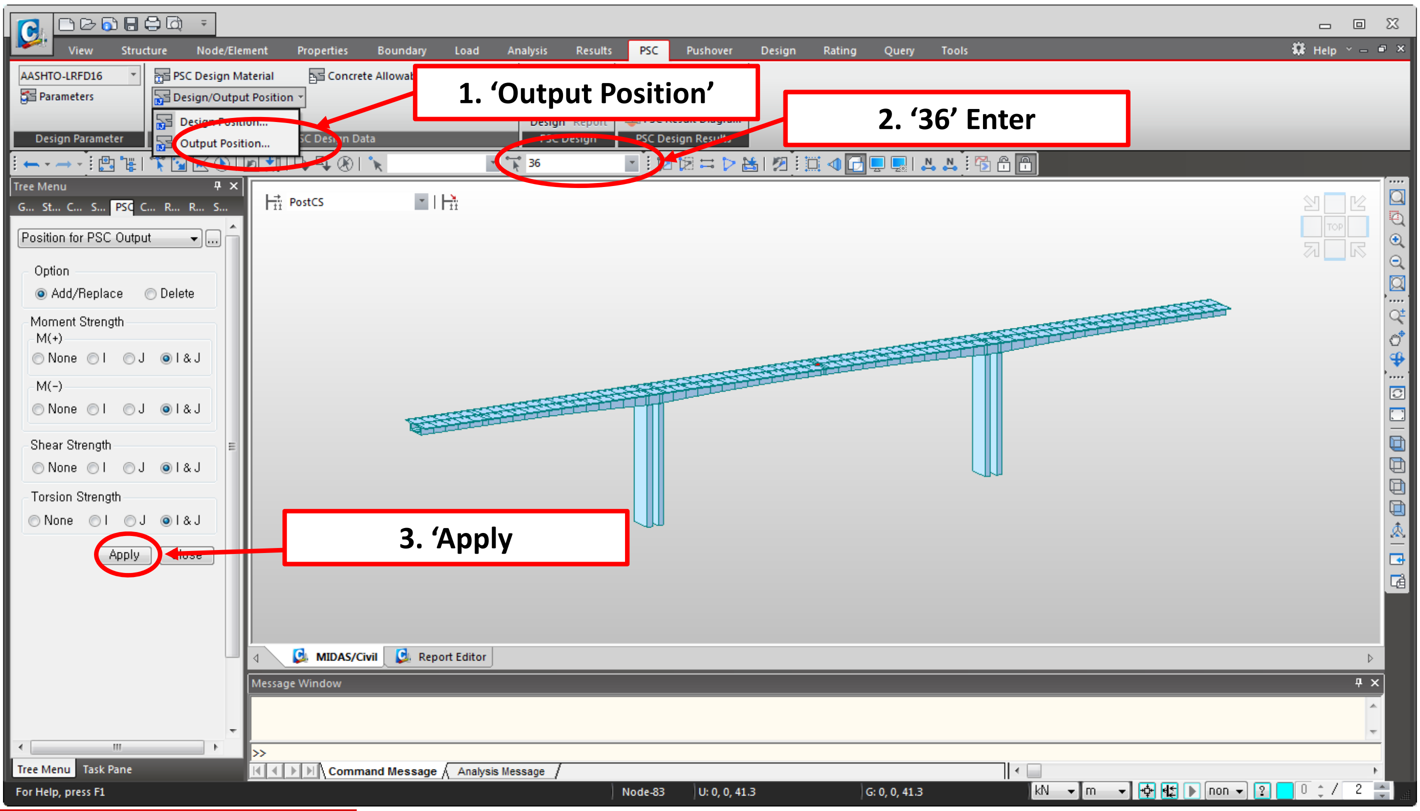
68 PSC Design



Procedure

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

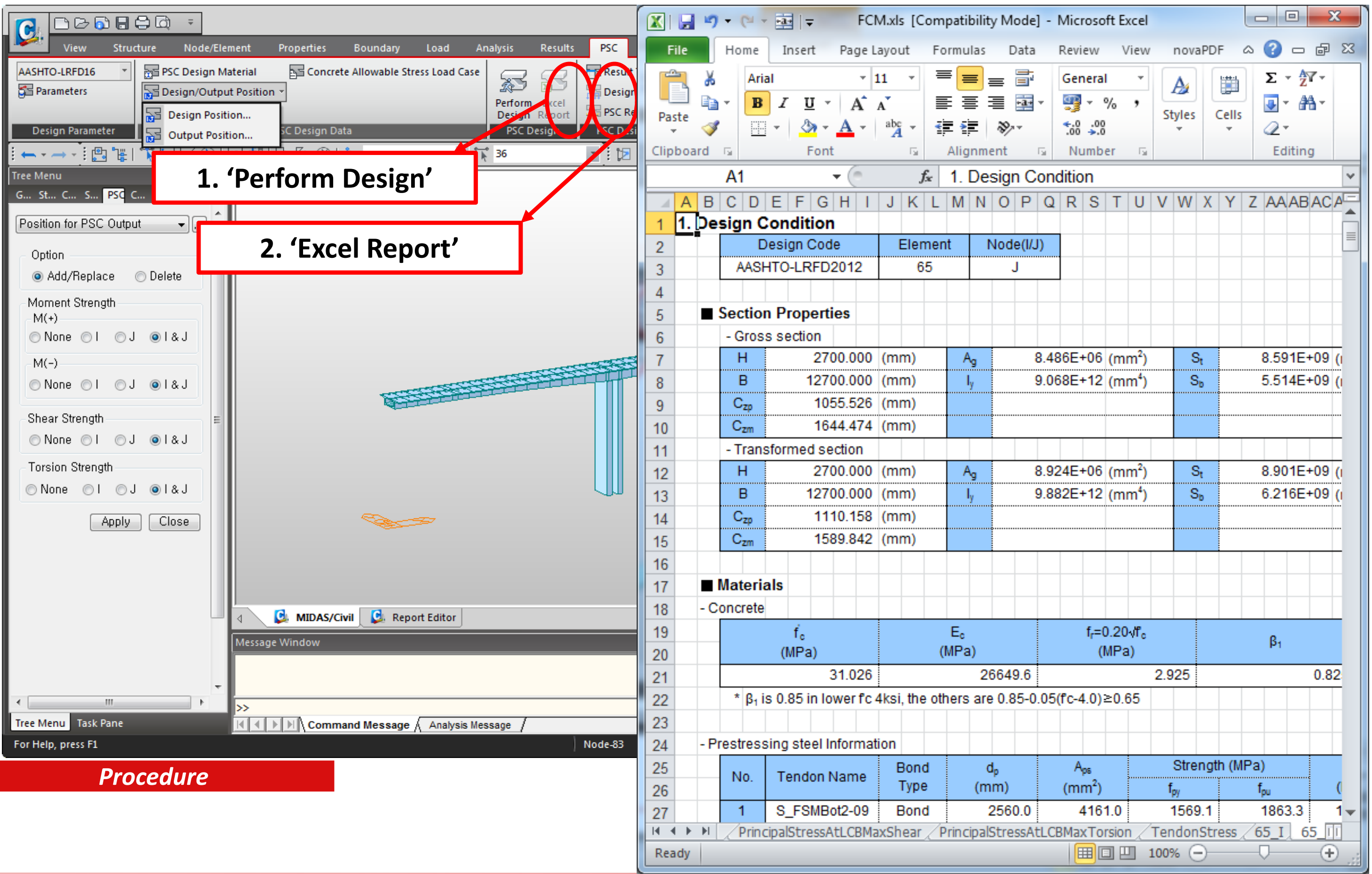
69 PSC Design



Procedure

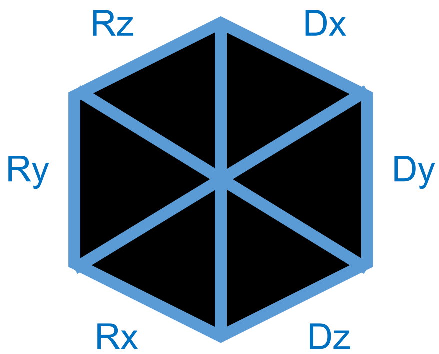
Decide the position to export Excel report

70 PSC Design

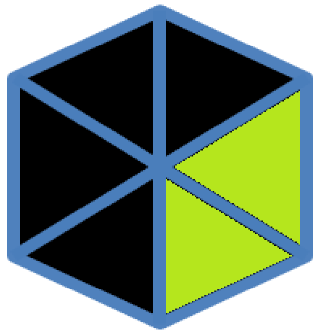


Procedure

Support Boundary

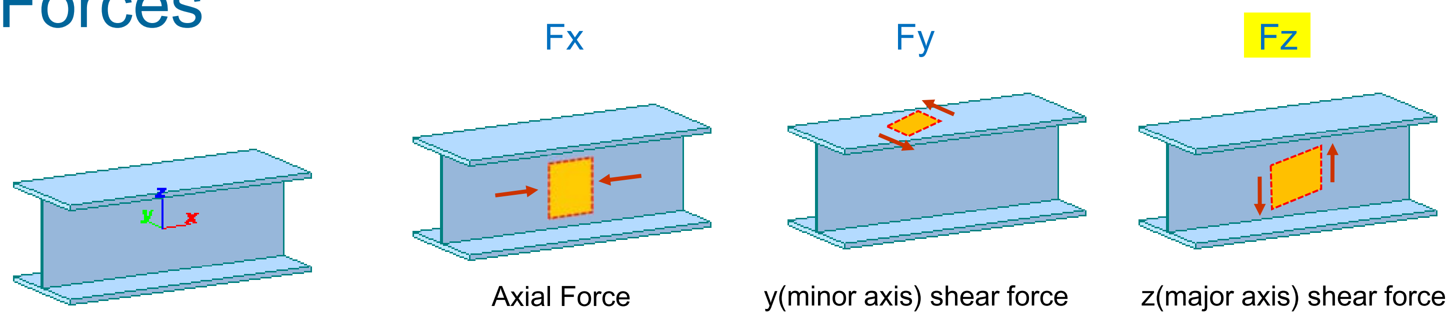


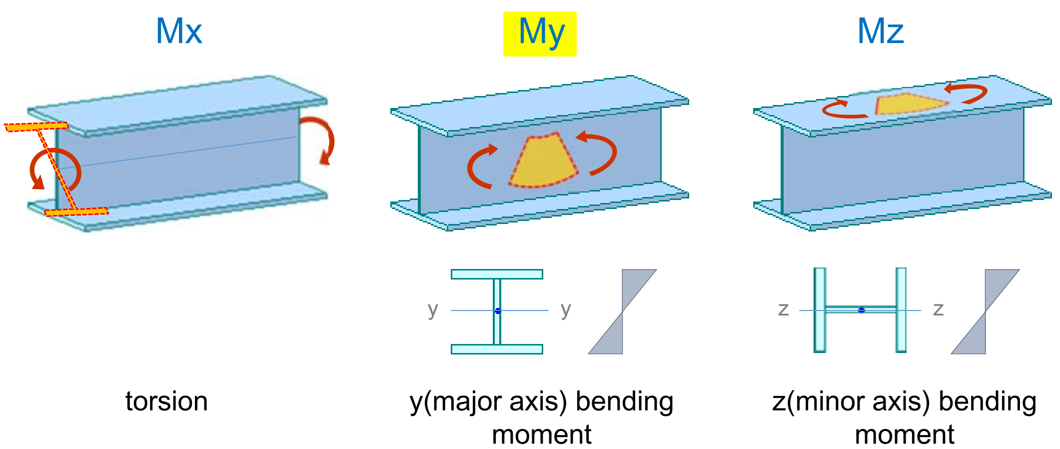
Example:



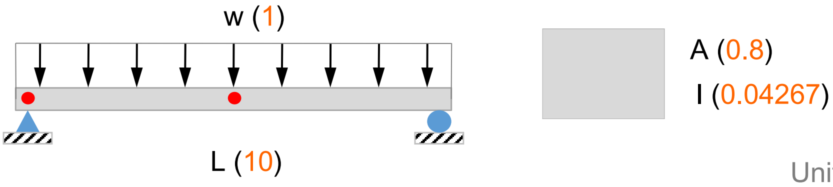
Dy, Dz are fixed

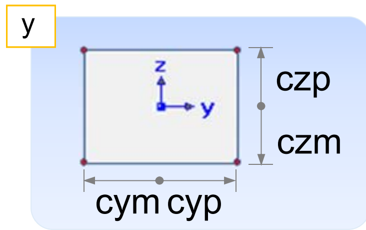
Forces





Stress





Unit : kN, m

Section Properties

	Value	Unit
Area	8.000000e-001	m^2
Ixx	8.758668e-002	m^4
Iyy	4.266667e-002	m^4
Izz	6.666667e-002	m^4
Cyp	5.000000e-001	m
Cym	5.000000e-001	m
Czp	4.000000e-001	m
Czm	4.000000e-001	m
Qyb	8.000000e-002	m^2
Qzb	1.250000e-001	m^2
Peri:O	3.600000e+000	m
Peri:I	0.000000e+000	m
Center:y	5.000000e-001	m
Center:z	4.000000e-001	m
y1	-5.000000e-001	m
z1	4.000000e-001	m
y2	5.000000e-001	m
z2	4.000000e-001	m
y3	5.000000e-001	m
z3	-4.000000e-001	m
y4	-5.000000e-001	m
z4	-4.000000e-001	m

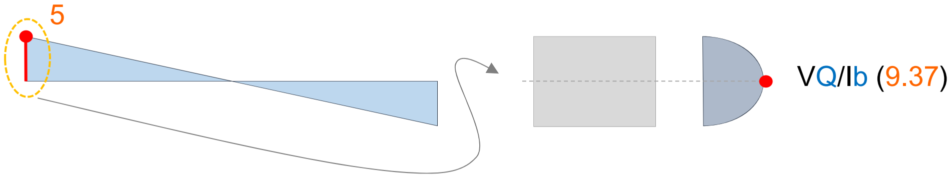
Close

y

Q/b

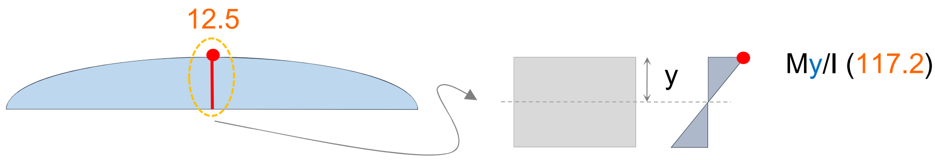
SFD

Shear Stress

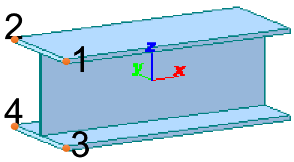


BMD

Bending Stress



Stress



Section Properties

	Value	Unit
Area	8.000000e-001	m^2
Ixx	8.758668e-002	m^4
Iyy	4.266667e-002	m^4
Izz	6.666667e-002	m^4
Cyp	5.000000e-001	m
Cym	5.000000e-001	m
Czp	4.000000e-001	m
Czm	4.000000e-001	m
Qyb	8.000000e-002	m^2
Qzb	1.250000e-001	m^2
Peri:O	3.600000e+000	m
Peri:I	0.000000e+000	m
Center:y	5.000000e-001	m
Center:z	4.000000e-001	m
y1	-5.000000e-001	m
z1	4.000000e-001	m
y2	5.000000e-001	m
z2	4.000000e-001	m
y3	5.000000e-001	m
z3	-4.000000e-001	m
y4	-5.000000e-001	m
z4	-4.000000e-001	m

Close

Sax (σ axial)	axial stress	$\frac{P}{A}$	$\frac{Fx}{Area}$
Ssy (σ shear)	minor axis shear stress	$\frac{VQ}{Ib}$	$\frac{Fy}{Izz} \cdot Qzb$
Ssz	major axis shear stress		$\frac{Fz}{Iyy} \cdot Qyb$
Sby (σ bending)	minor axis bending stress	$\frac{My}{I}$	$\frac{Mz}{Izz} \cdot Cy$ (max(Cyp, Cym))
Sbz	major axis bending stress		$\frac{My}{Iyy} \cdot Cz$
Combined		$\frac{P}{A} + \frac{My}{I}$	$\frac{Fx}{Area} + \frac{Mz}{Izz} \cdot y + \frac{My}{Iyy} \cdot z$ (y1, y2, y3, y4)