Release Note

Release Date : December 2017

Product Ver. : Civil 2018 (v2.1)

DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

Analysis & Design 3

1) Plate Beam and Plate Column Design as per Eurocode
2) Accelerating, breaking and centrifugal force in Moving Load (AASHTO and PENDDOT)
3) Improvement on Traffic Lane Function
4) Addition of Legal & Permit Load as per AASHTO LRFD
5) Improvement of Moving load analysis as per Poland Standard
6) Moving Load Optimization to Poland Standard
7) Improvement on Steel Tub torsional resistance
8) Construction Stage Analysis considering material non-linearity
9) Addition of artificial earthquake generation function of dynamic analysis
10) Seismic analysis based on Base Line Correction when Multiple Support Excitation is applied
11) Implementation of Australian Time Dependent Material property standard
12) Implementation of Steel Girder Design as per IRC 24 - 2010

Pre & Post-Processing 24

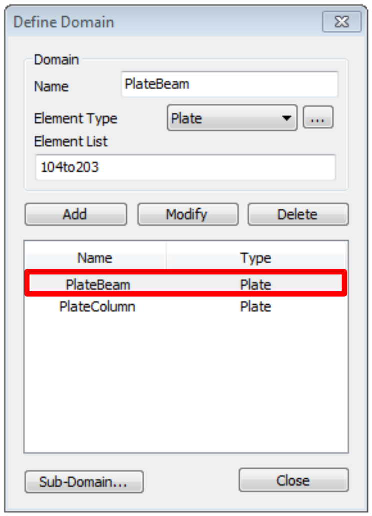
1) Revit 2018 interface
2) Reinforcement data interchange between Civil and GSD
3) Improvement on Bridge wizard function

1. Plate Beam and Plate Column (1D) Design Method

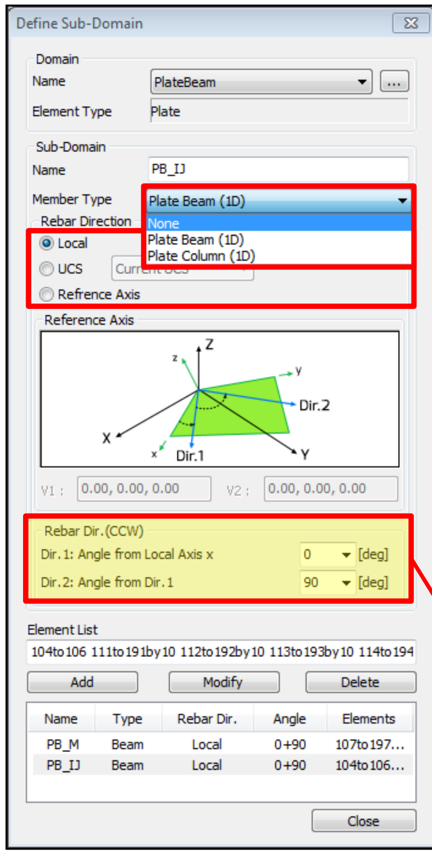
- Plate elements can now be designed with the same method of designing conventional 1D elements such as Beam or Column as per Eurocode.
- The plate design is performed for defined sub-domain. Member Type are chosen according to the purpose of the design. (e.g. Plate Beam (1D) : Slab Design and Plate Column (1D) : Abutment / Sidewall Design).
- Rebar Direction for the main rebar and distribution rebar can be defined using Local Coordinate System, UCS or Reference Axis.

- ***Node/Element > Elements > Define Sub-Domain***

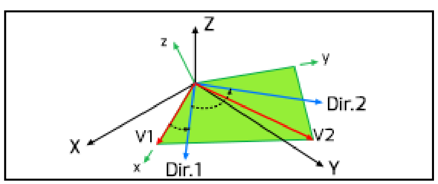
Define Domain

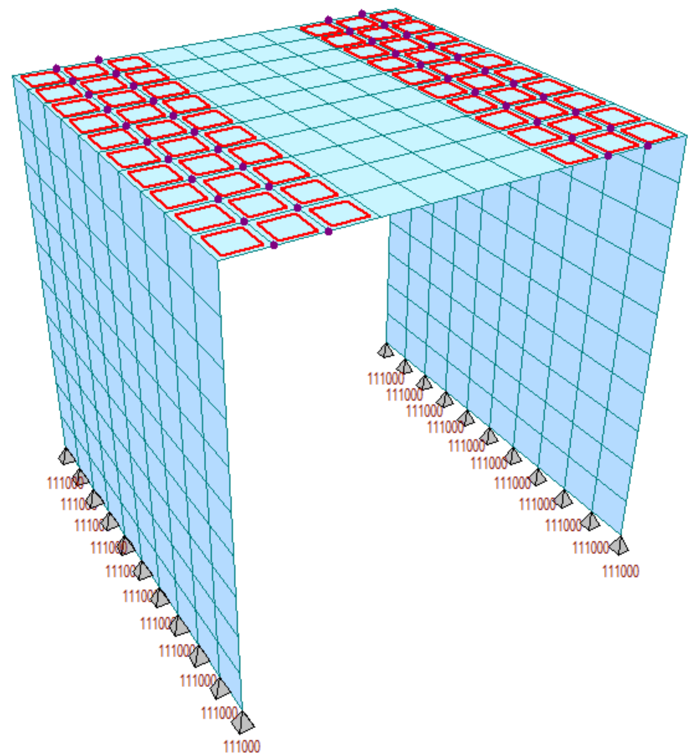


Define Sub-Domain



If Reference Axis is selected



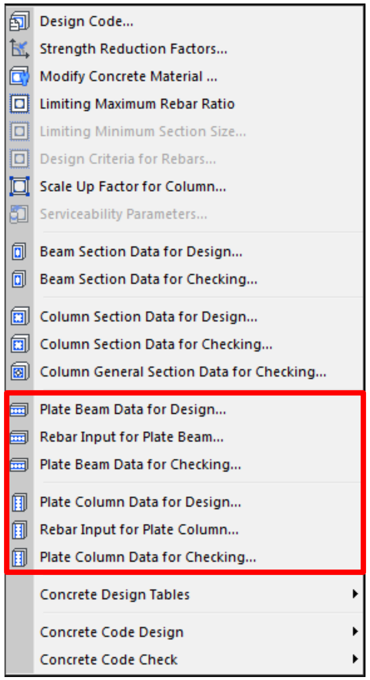


**** Note : This feature is used for the calculation of Wood-Armer moment of specific direction. This will be fixed to default for Plate Design (Dir.1 = 0 deg, Dir.2 = 90 deg).***

1. Plate Beam and Plate Column (1D) Design Method

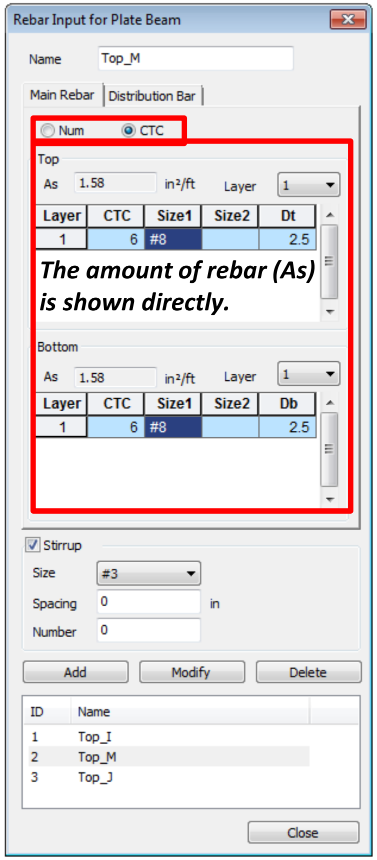
- The results of plate design can be checked in table format and also both Graphic and Detail report can be outputted.
- Positive/Negative Bending moment capacity, shear capacity and crack checks can be performed and the detail results can be obtained from this function.
- From this version, the benefit of axial force in calculation of flexural strength can be considered by considering Axial-Moment Interaction (P-M Interaction) for plate column. The Axial-Moment Diagram can be obtained from the graphic result of plate column design and checking.

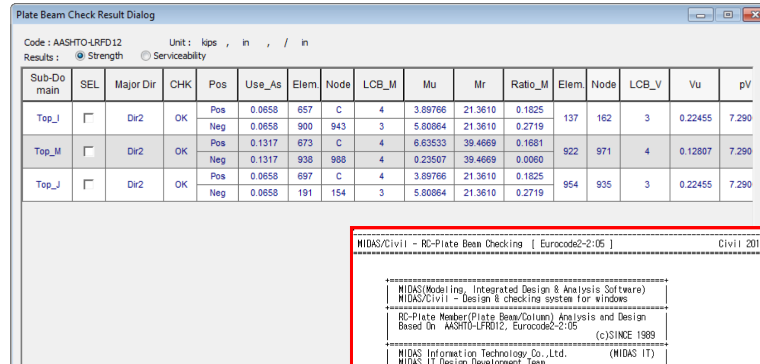
- ***Design > RC Design > Plate Beam/Column***

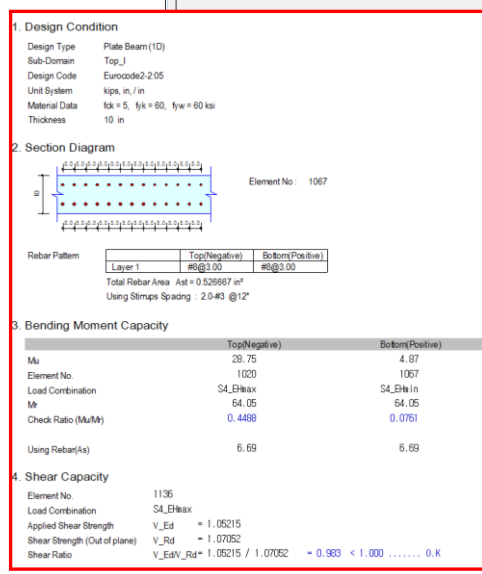


Top and Bottom rebar data can be inputted separately for multiple locations.

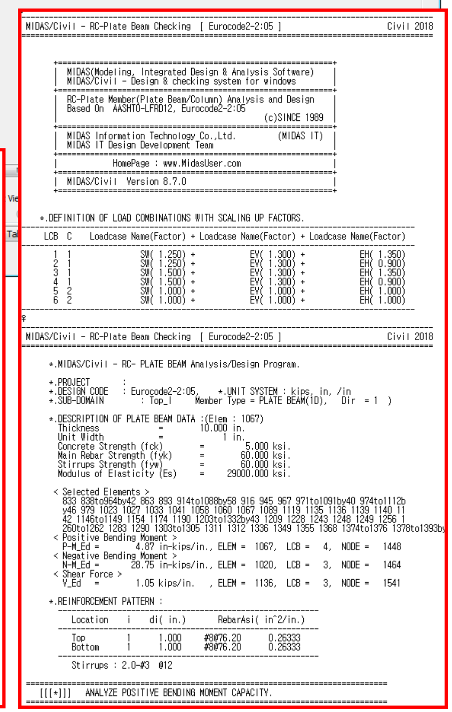
Rebar can be inputted using either Number or CTC method.







Graphic Report



Detail Report

1. Plate Beam and Plate Column (1D) Design Method

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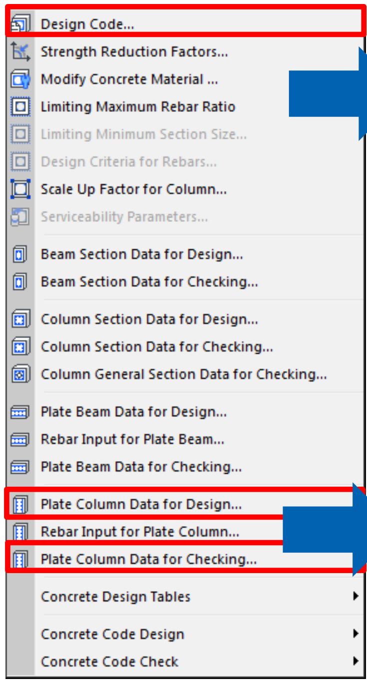
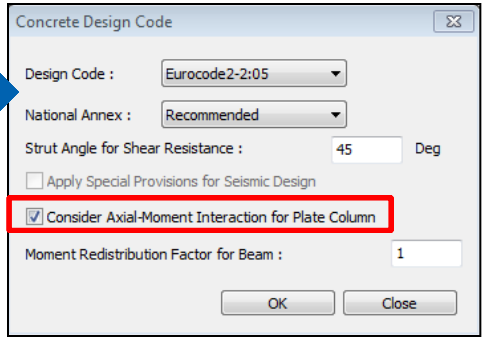
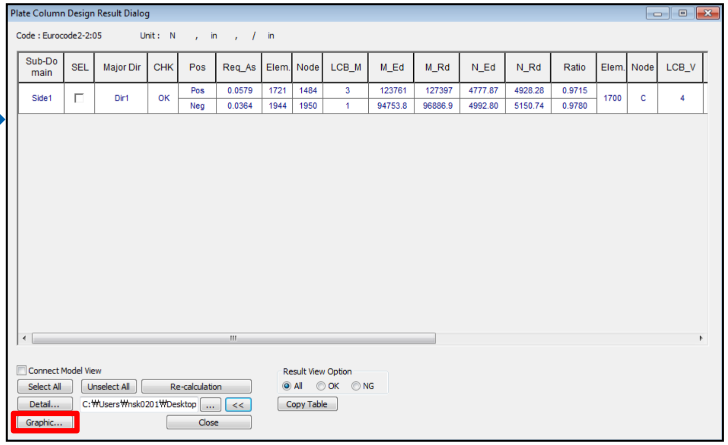
- ***Design > RC Design > Plate Column Design/Checking***



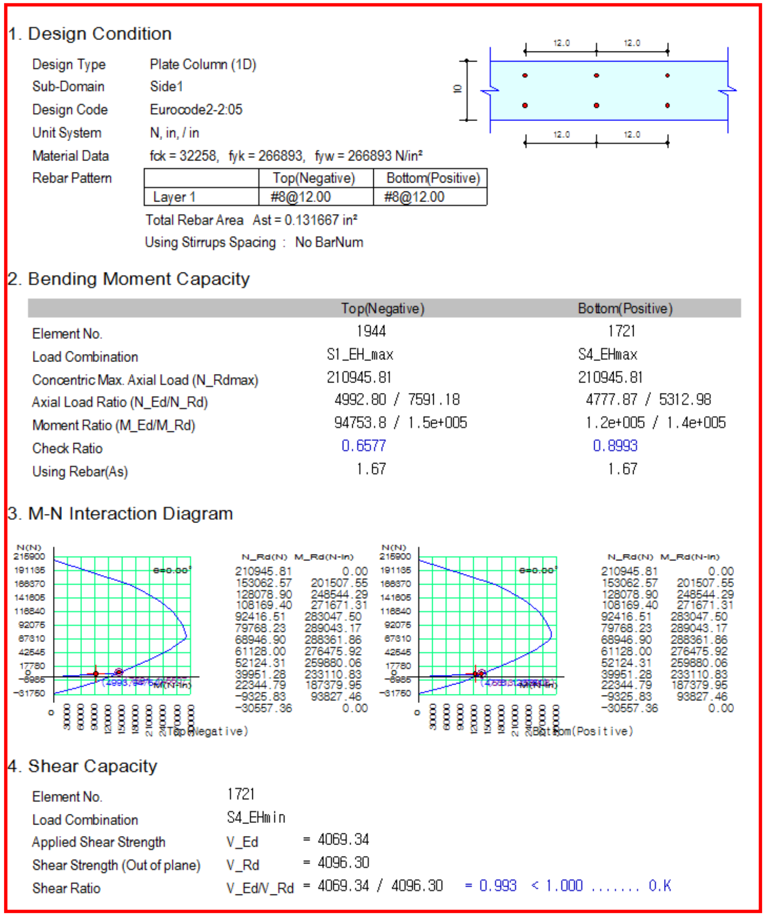
Consideration of Axial-Moment Interaction can be checked from Plate Column Design/Checking



Axial-Moment Interaction can be considered as an option



Sub-Domain	SEL	Major Dir	CHK	Pos	Req_As	Elem.	Node	LCB_M	M_Ed	M_Rd	N_Ed	N_Rd	Ratio	Elem.	Node	LCB_V
Side1		Dir1	OK	Pos	0.0579	1721	1484	3	123761	127397	4777.87	4928.28	0.9715	1700	C	4
				Neg	0.0364	1944	1950	1	94753.8	96886.9	4992.80	5150.74	0.9780			



1. Design Condition

Design Type	Plate Column (1D)
Sub-Domain	Side1
Design Code	Eurocode2-2:05
Unit System	N, in, / in
Material Data	fck = 32258, fyk = 266893, fyw = 266893 N/in²

Rebar Pattern

	Top(Negative)	Bottom(Positive)
Layer 1	#8@12.00	#8@12.00

Total Rebar Area Ast = 0.131667 in²

Using Stirrups Spacing : No BarNum

2. Bending Moment Capacity

	Top(Negative)	Bottom(Positive)
Element No.	1944	1721
Load Combination	S1_EH_max	S4_EHmax
Concentric Max. Axial Load (N_Rdmax)	210945.81	210945.81
Axial Load Ratio (N_Ed/N_Rd)	4992.80 / 7591.18	4777.87 / 5312.98
Moment Ratio (M_Ed/M_Rd)	94753.8 / 1.5e+005	1.2e+005 / 1.4e+005
Check Ratio	0.6577	0.8993
Using Rebar(As)	1.67	1.67

3. M-N Interaction Diagram

N_Rd(N)	M_Rd(N-in)
210945.81	0.00
153062.57	201507.55
128078.90	248544.29
108169.40	271671.31
92416.51	283047.50
79768.23	289043.17
68946.90	288361.86
61128.00	276475.92
52124.31	259880.06
39951.28	233110.83
22344.79	187379.95
-9325.83	93827.46
-30557.36	0.00

(Top(Negative) and Bottom(Positive) diagrams)

4. Shear Capacity

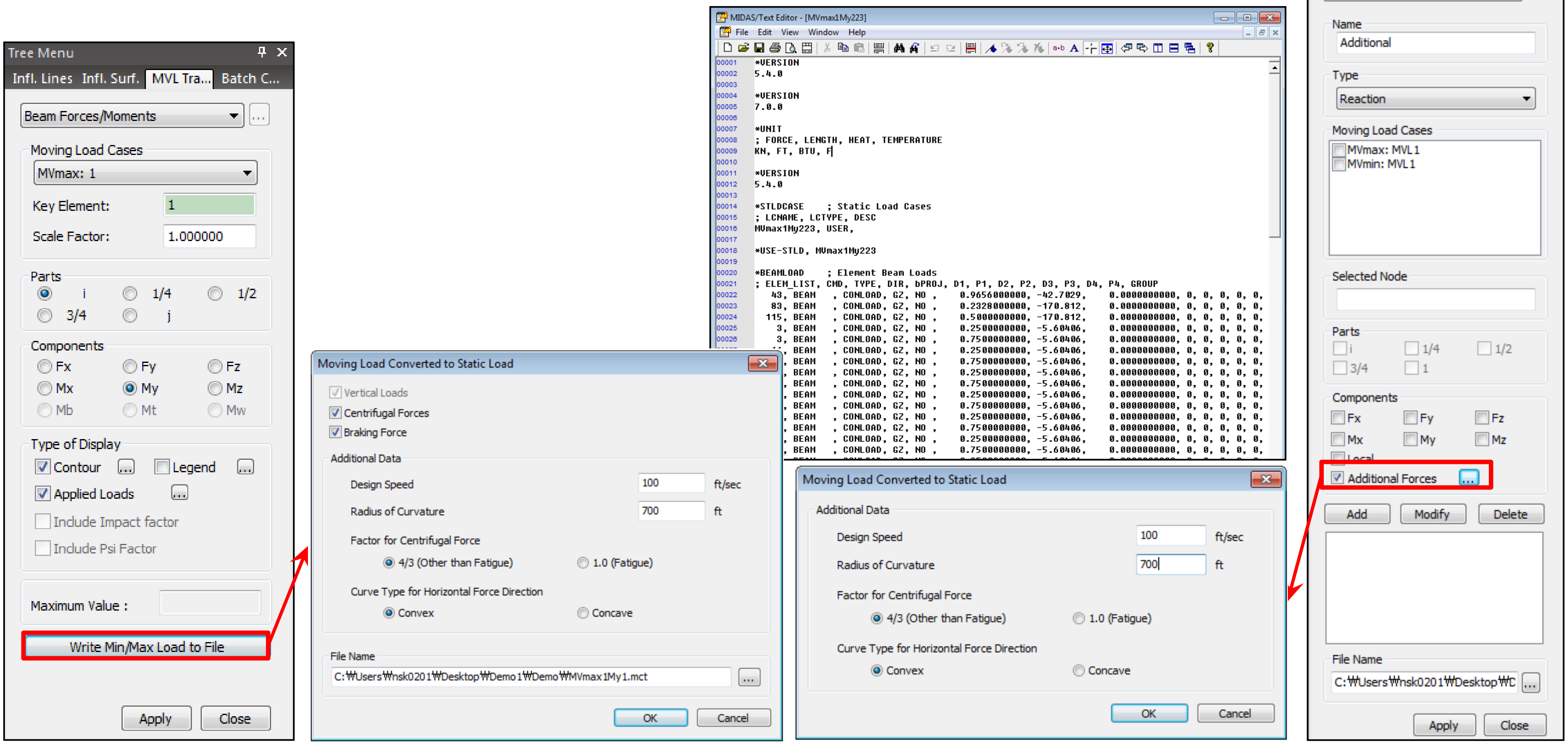
Element No.	1721	
Load Combination	S4_EHmin	
Applied Shear Strength	V_Ed	= 4069.34
Shear Strength (Out of plane)	V_Rd	= 4096.30
Shear Ratio	V_Ed/V_Rd	= 4069.34 / 4096.30 = 0.993 < 1.000 .... O.K

Graphic Report

2. Export Centrifugal, Acceleration & Braking forces (AASHTO LRFD and PennDOT)

- It is possible to export centrifugal, acceleration & braking forces as different static load cases according to the AASHTO LRFD and PennDOT.
- It is possible to import vertical centrifugal (C), longitudinal acceleration (AA) and Braking (BA) as different static load cases.

- ***Results > Moving Load > Moving Tracer > Write Min/Max Load to File***
- ***Results > Moving Load > Batch Conversion from MVLTRC to Static Load***



Export dialog for acceleration, braking and centrifugal force

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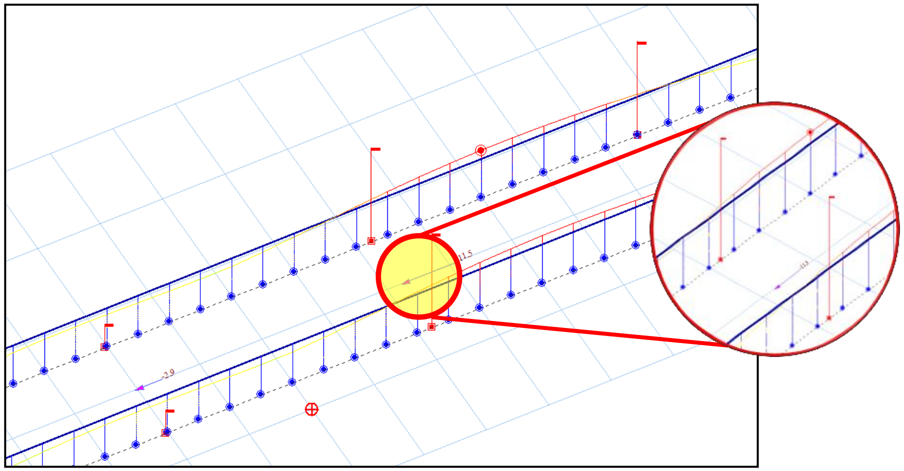


Acceleration & Braking

The braking force shall be taken as the greater of:

- ***25 % of the axle weights of the design truck or tandem.***
- ***5 % of the (design truck + lane load) or 5 % of the (design tandem + lane load).***

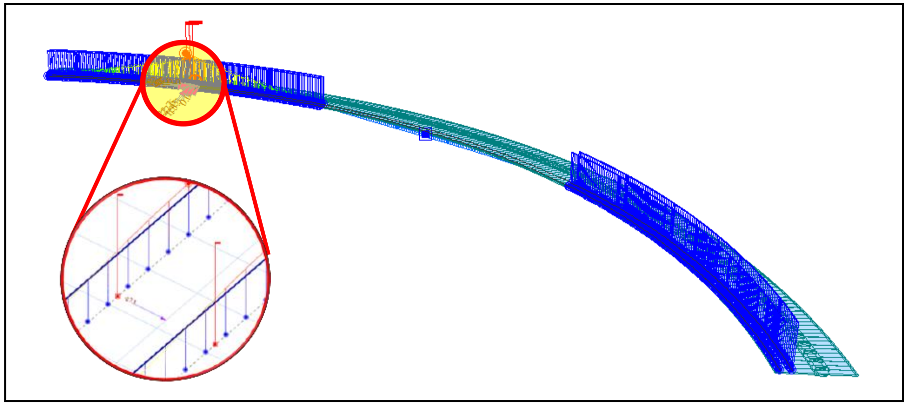
**** The multiple presence factors shall apply.***
**** Dynamic Load Allowance shall not be considered.***
**** Direction of acceleration will be the same as vehicle moving direction and direction of braking will be the opposite.***

The centrifugal force shall be calculated as per AASHTO LRFD 3.6.3:

$$C = f\frac{v^2}{gR}$$

where:
v = highway design speed (ft/s)
f = 4/3 for load combination other than fatigue and 1.0 for fatigue
g = gravitational acceleration: 32.2 (ft/s^2)
R = radius of curvature of traffic lane (ft)

C value will be applied to the axle load to calculate centrifugal force.

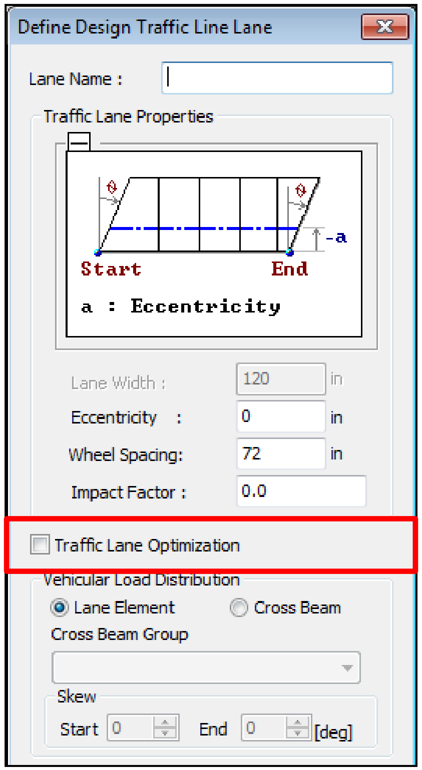


Centrifugal

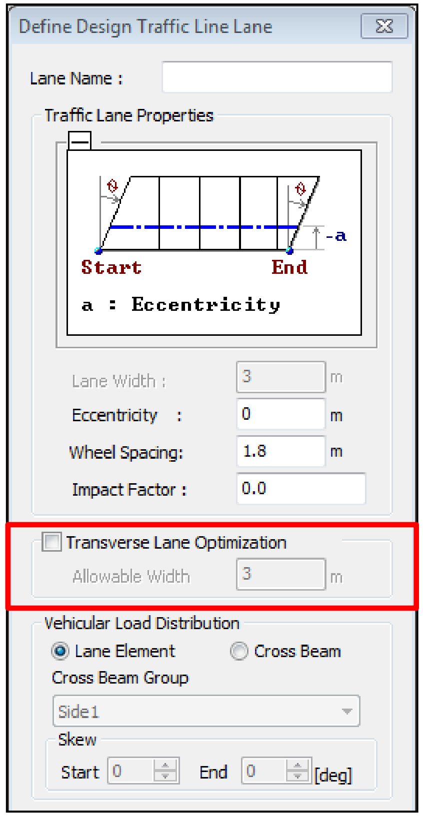
3. Improvement on traffic lane function

- Traffic Lane Optimization function has been changed to Transverse Lane Optimization.
- Previously vehicle was positioned at the middle and both left and right ends within each traffic lane to find the worst transverse effect of the moving load. The vehicle will now be positioned at the middle and left and right ends within the allowable width specified below the Transverse Lane Optimization function.

- ***Load > Moving Load > Traffic Line/Surface Lanes***

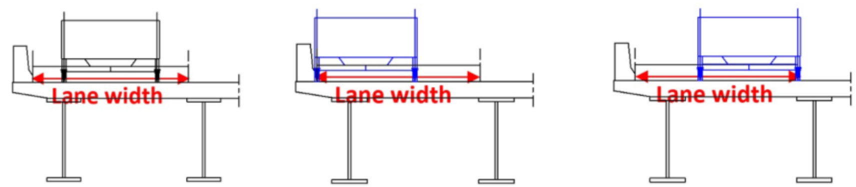


Previous version



From midas Civil 2018 v2.1

Vehicle was positioned in the multiple positions within the specified Lane width in the previous version. From midas Civil 2018 v2.1, vehicle will be positioned at the middle and additionally left and right ends of specified 'Allowable Width' if Transverse Lane Optimization function is used.

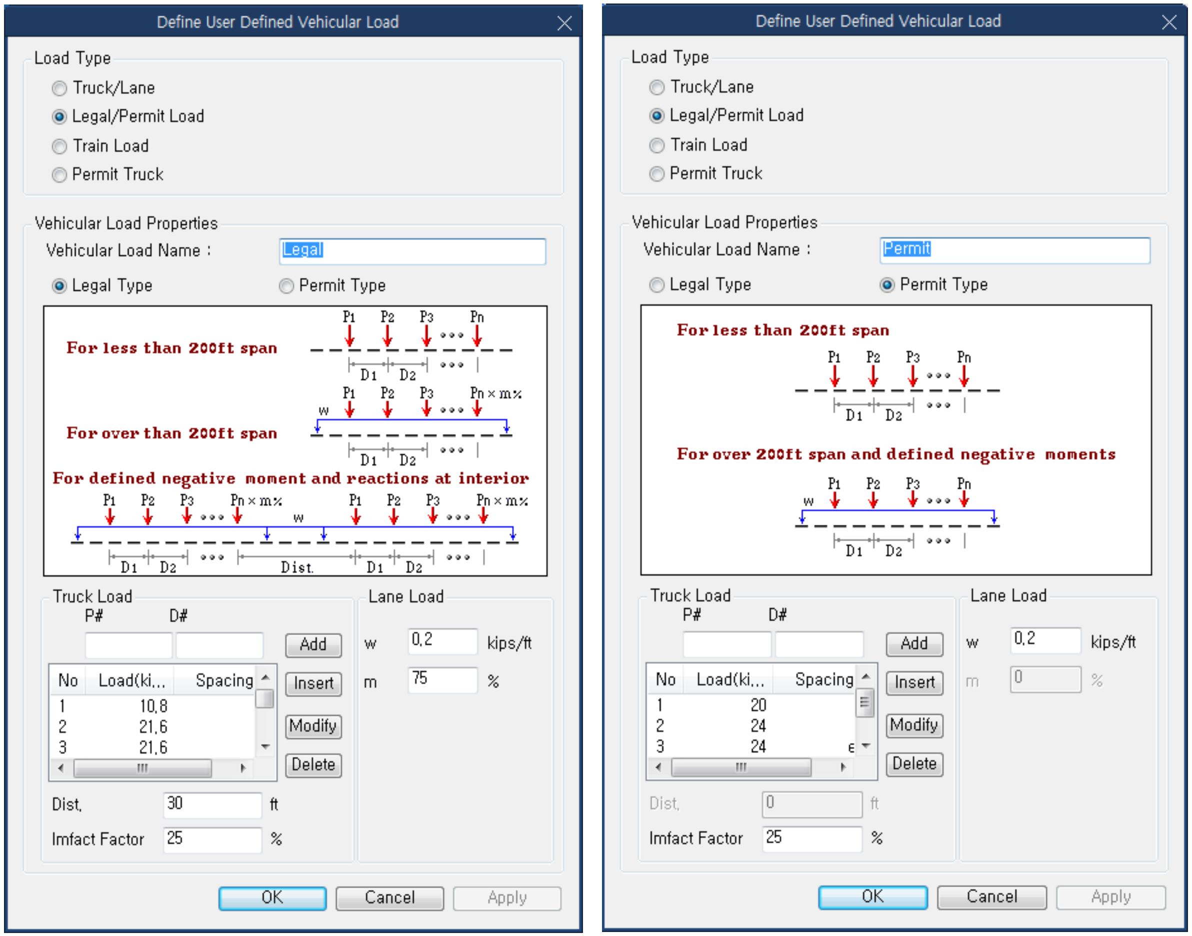


Allowable Width can be defined by checking on the Transverse Lane Optimization option and the default value of Allowable Width is taken from the Lane Width.

4. Addition of Legal & Permit Load as per AASHTO LRFD

- Addition of Legal & Permit Load in the user defined vehicle option to consider the various conditions where the span of the structure is over or under 200ft.

- ***Load > Moving Load > Vehicles (AASHTO LRFD)***



Addition of Legal/Permit Load as per AASHTO LRFD

<u>Legal Load</u>

Normal analysis result:

A. Span length of all traffic lanes are under than 200ft : Concentrated Load

B. If more than one traffic lane span is over 200ft : max/min[Concentrated Load, Concentrated Load x 0.75 + UDL(0.2 kips/ft)]

Negative moment and reaction at interior pier:

A. Span length of all traffic lanes are under 200ft : max/min[Concentrated Load, two Concentrated Loads with 30ft spacing x 0.75 + UDL(0.2kips/ft)]

B. If more than one traffic lane span is over 200ft : max/min[Concentrated Load, Concentrated Load x 0.75 + UDL(0.2 kips/ft), two Concentrated Loads with 30ft spacing x 0.75 + UDL(0.2kips/ft)]

<u>Permit Load</u>

Normal analysis result: Concentrated Load

Negative moment and reaction at interior pier:

A. Span length of all traffic lanes are under than 200ft : Concentrated Load

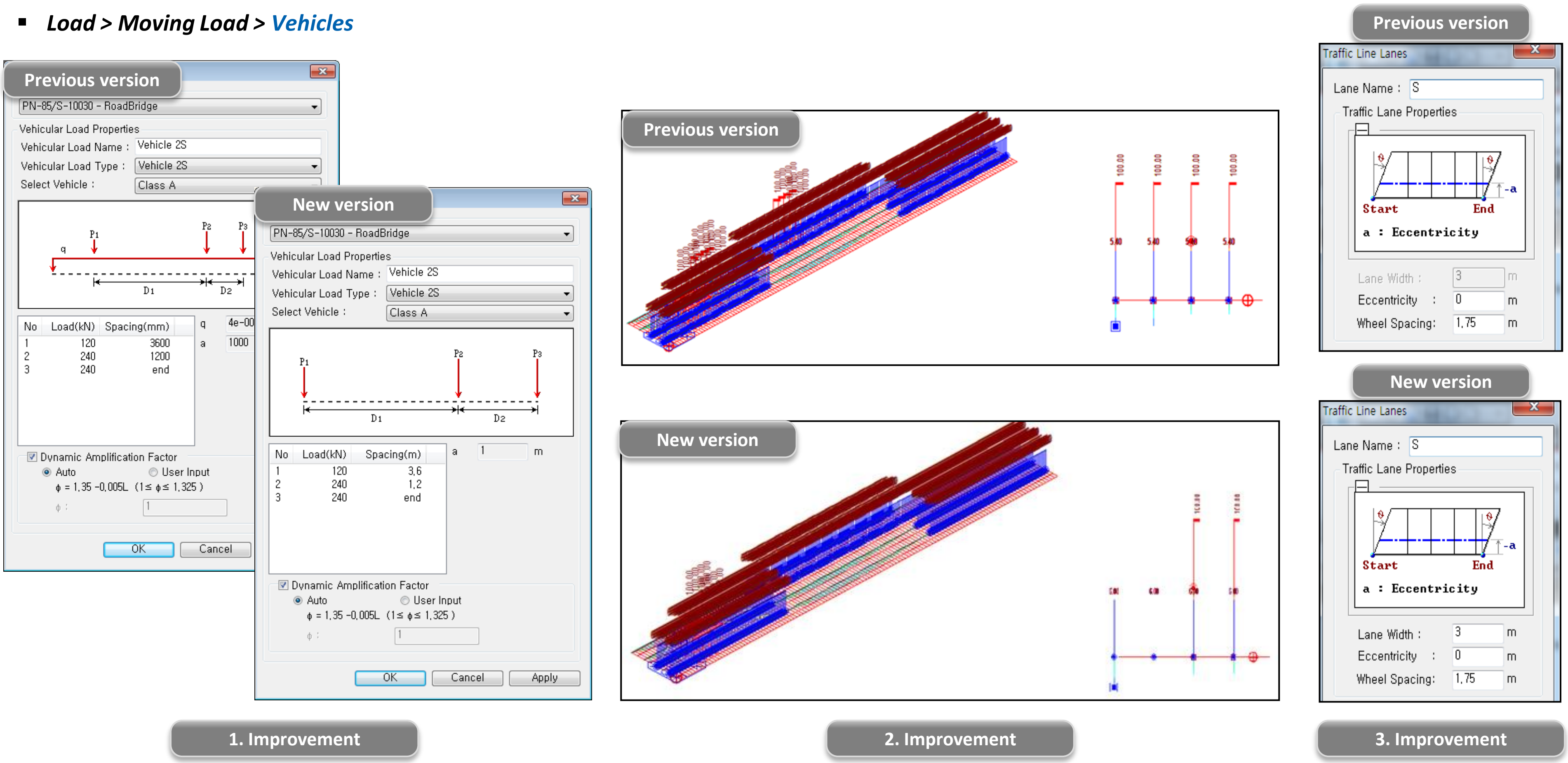
B. If more than one traffic lane span is over 200ft : max/min[Concentrated Load, Concentrated Load x 0.75 + UDL(0.2 kips/ft)]

Impact factor is only applied to concentrated load and the span length is calculated based on span start check of traffic lane

5. Moving Load analysis improvement as per Poland Standard

- In the previous versions, uniform distribution loads were included for Vehicle 2S → Now, uniform distribution loads were excluded for Vehicle 2S
- In the previous versions, concentrated forces for Vehicle K can be applied to more than 2 lanes → Now, concentrated forces for Vehicle K are applied only one critical lane.
- In the previous versions, uniform distribution loads were calculated by wheel spacing → Now, uniform distribution loads are calculated by land width.

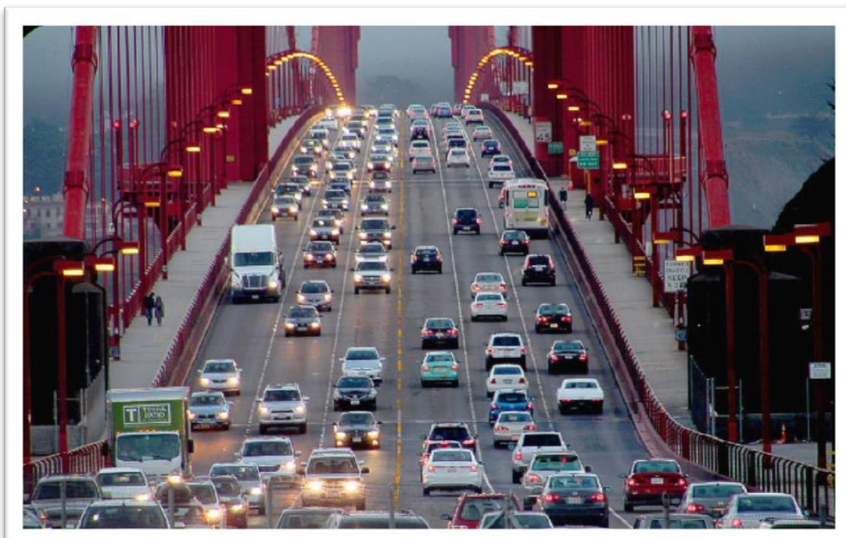
- ***Load > Moving Load > Traffic Line/Surface Lane > Traffic Line Lanes***
- ***Load > Moving Load > Vehicles***



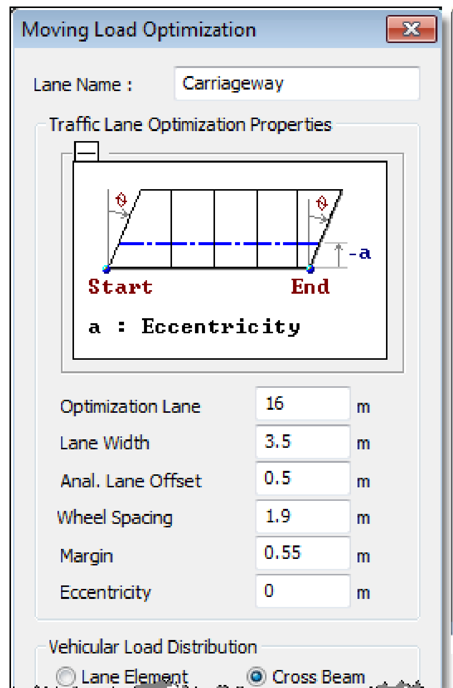
6. Moving Load Optimization to Poland Standard

- In the previous versions, moving load analysis was used to find critical vehicle locations on bridges in the longitudinal direction. The critical locations of vehicles in the transverse direction were determined by the user based on their experiences or trial-and-error approach.
- Now, Moving Load Optimization complements and extends the capabilities of moving load analysis and helps to significantly simplify the evaluation of critical vehicle locations. The critical locations of vehicles will be identified in the transverse direction as well as longitudinal direction according to the code provision.
- It reduces the amount of time spent defining lanes and leads to more economical design.
- Other regional codes will be included in the next upgrades.

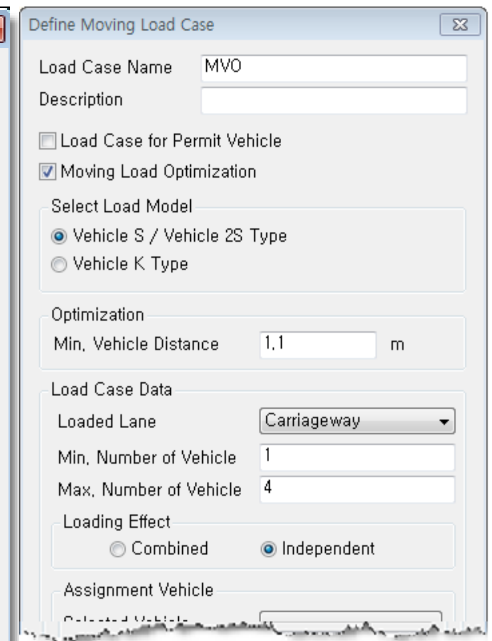
- ***Load > Moving Load > Traffic Line/Surface Lane > Moving Load Optimization***
- ***Load > Moving Load > Moving Load Cases***



Road Bridge



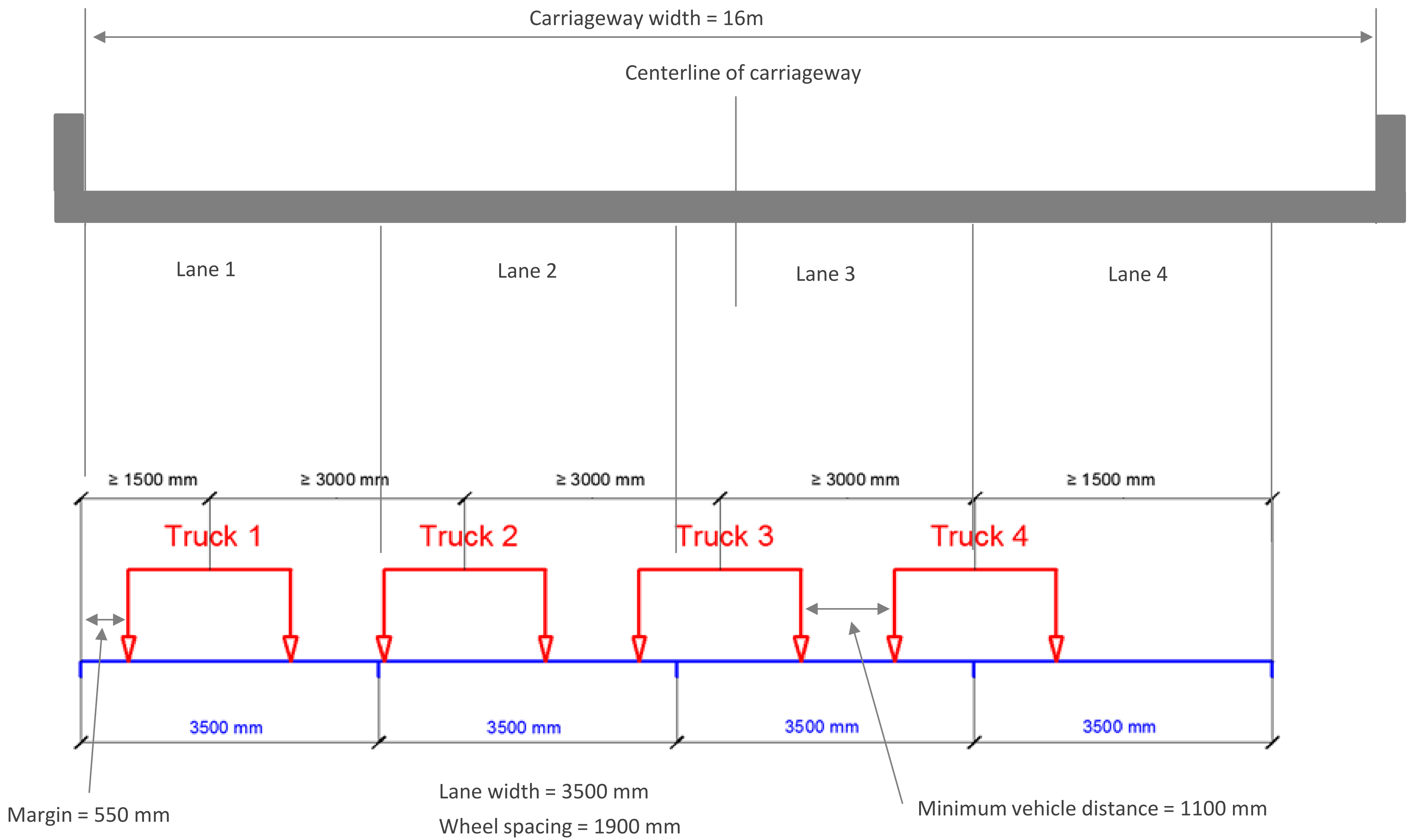
Traffic Line Lane Optimization



Moving Load Case

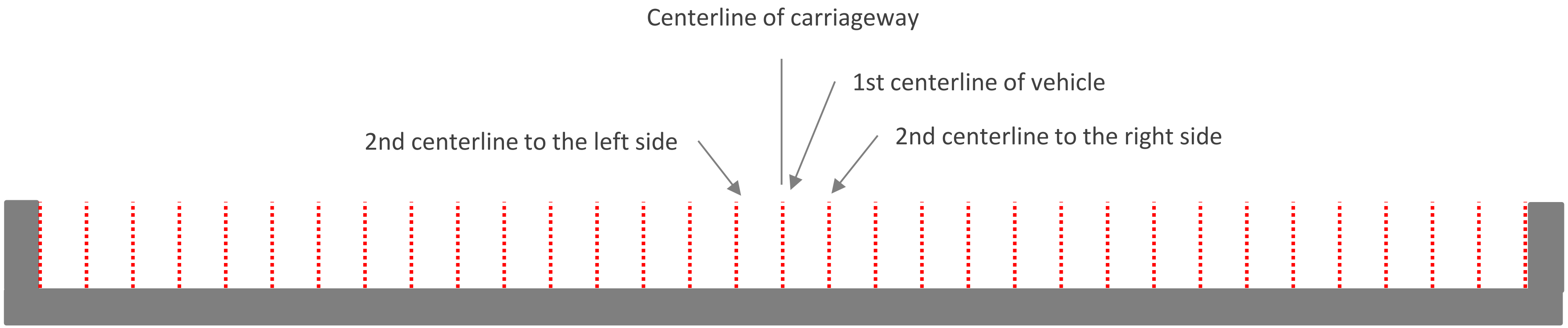
6. Moving Load Optimization to Poland Standard (continued)

❑ **An example of Moving Load Optimization to find the worst position of vehicles for the leftmost side of carriageway**



6. Moving Load Optimization to Poland Standard (continued)

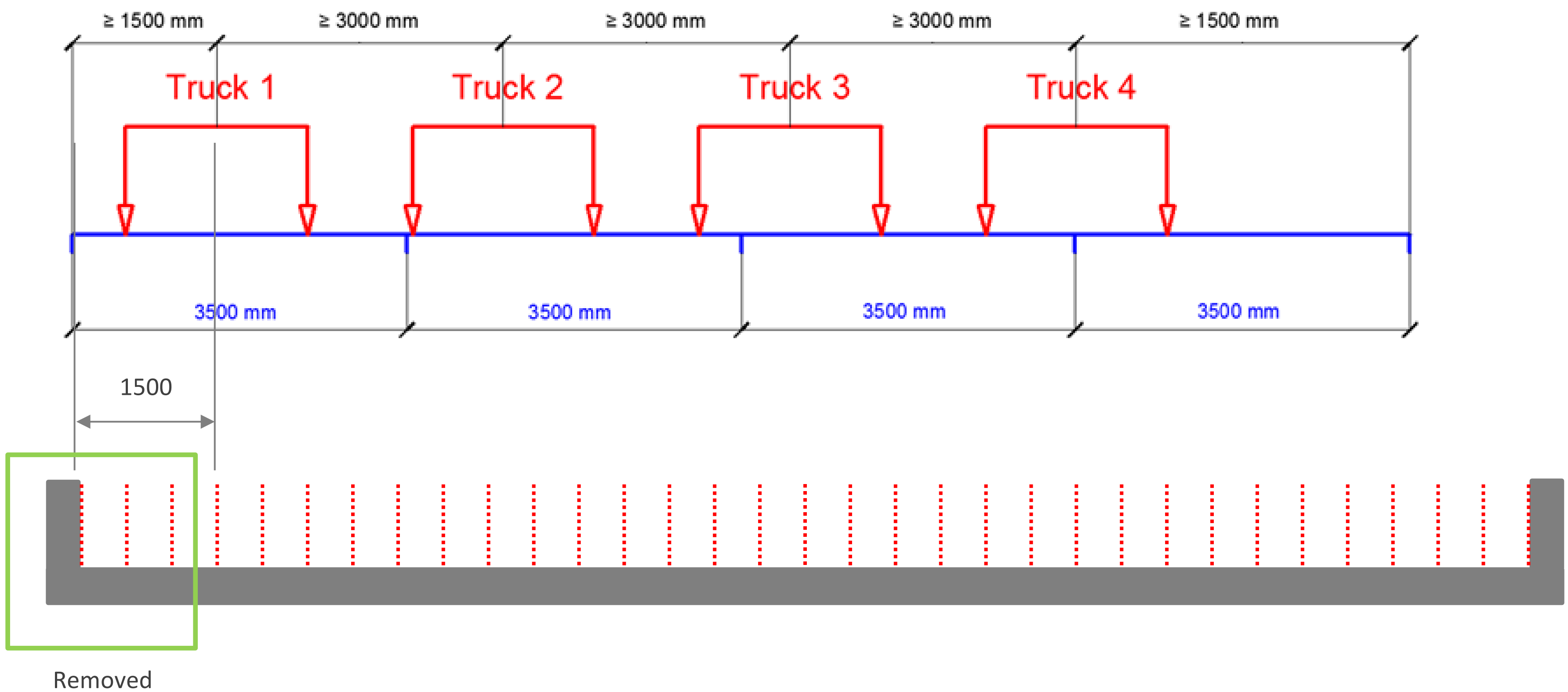
- The program will generate the centerlines of vehicles in the transverse direction within the carriageway width.
- The spacing of the centerlines is defined by the user. (Anal. Lane Offset)
- The first centerline will be generated at the centerline of carriageway.
- The second centerline will be generated away from the first centerline by the value of "Anal. Lane Offset" to the both left and right side.
- More centerlines will be generated by the user-defined spacing within the carriageway.



6. Moving Load Optimization to Poland Standard (continued)

- Vehicle centerlines which does not satisfy the requirement of minimum spacing between vehicle and boundary of carriageway and minimum s pacing between vehicles will be removed from the vehicle application.

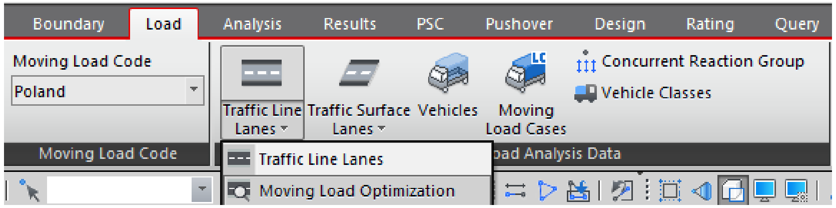
- For example, the three centerlines in the figure below will be removed from the vehicle application.



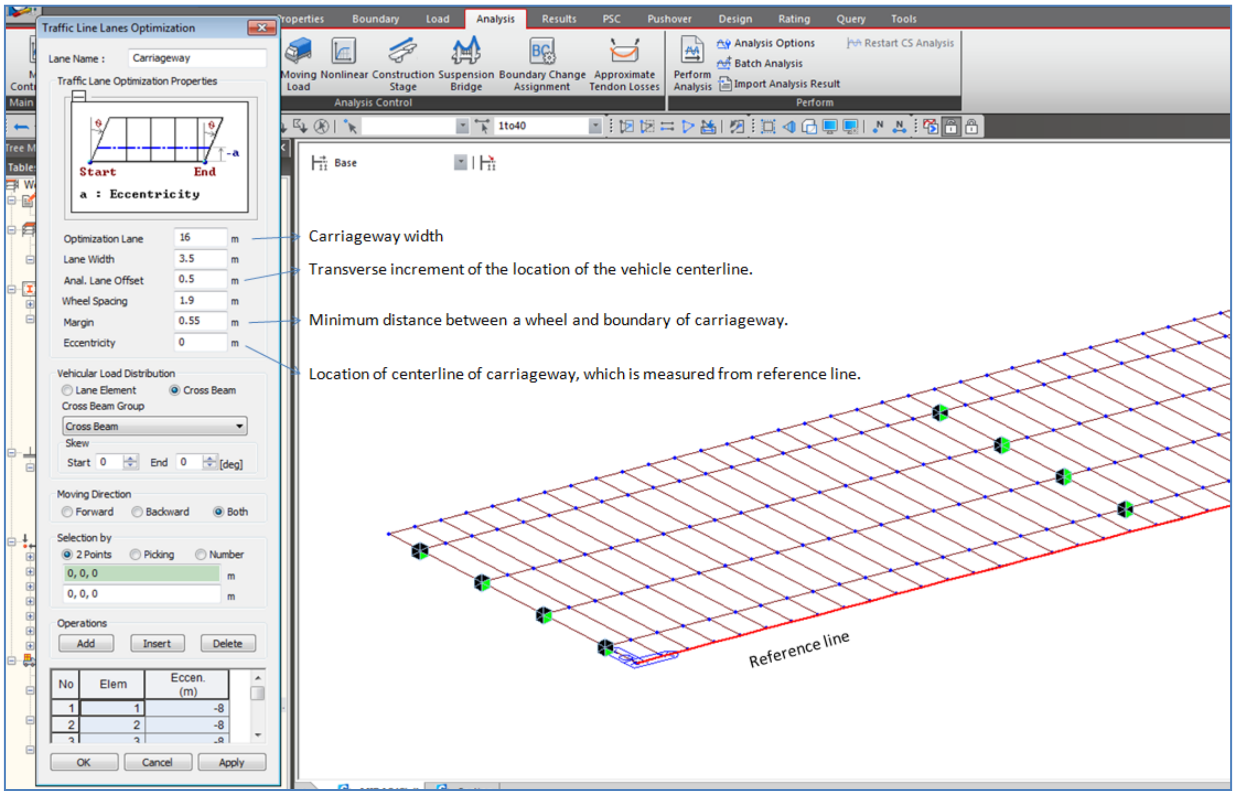
6. Moving Load Optimization to Poland Standard (continued)

❑ Required Steps

1. Select ‘Moving Load Optimization' function.

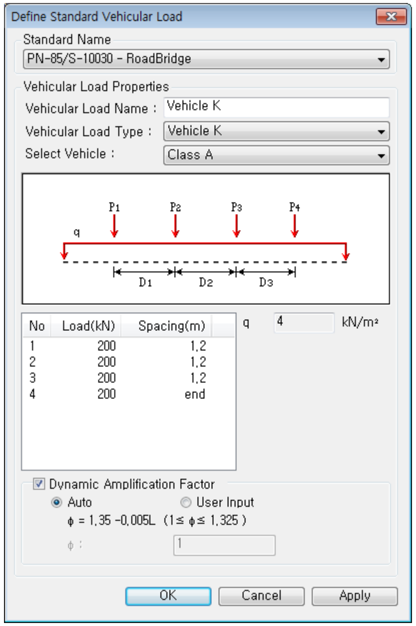


2. Define Carriageway data.



6. Moving Load Optimization to Poland Standard (continued)

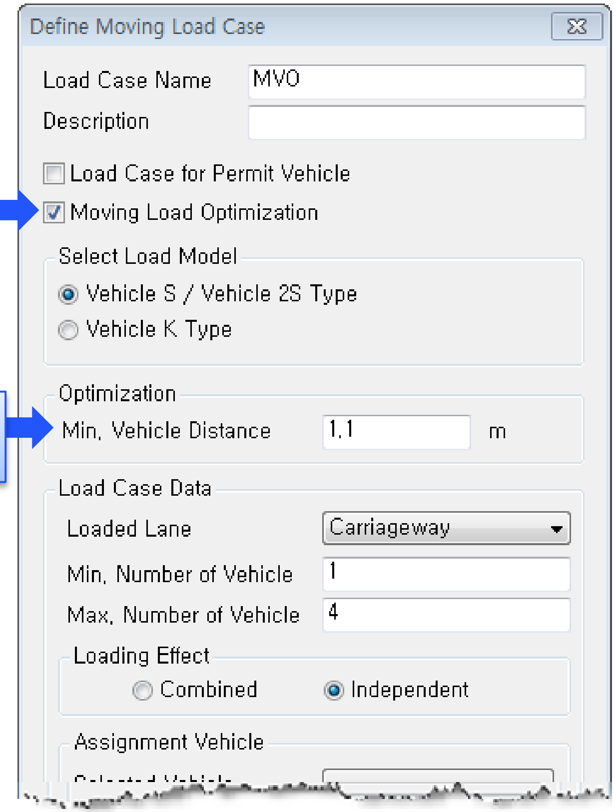
3. Define vehicle.

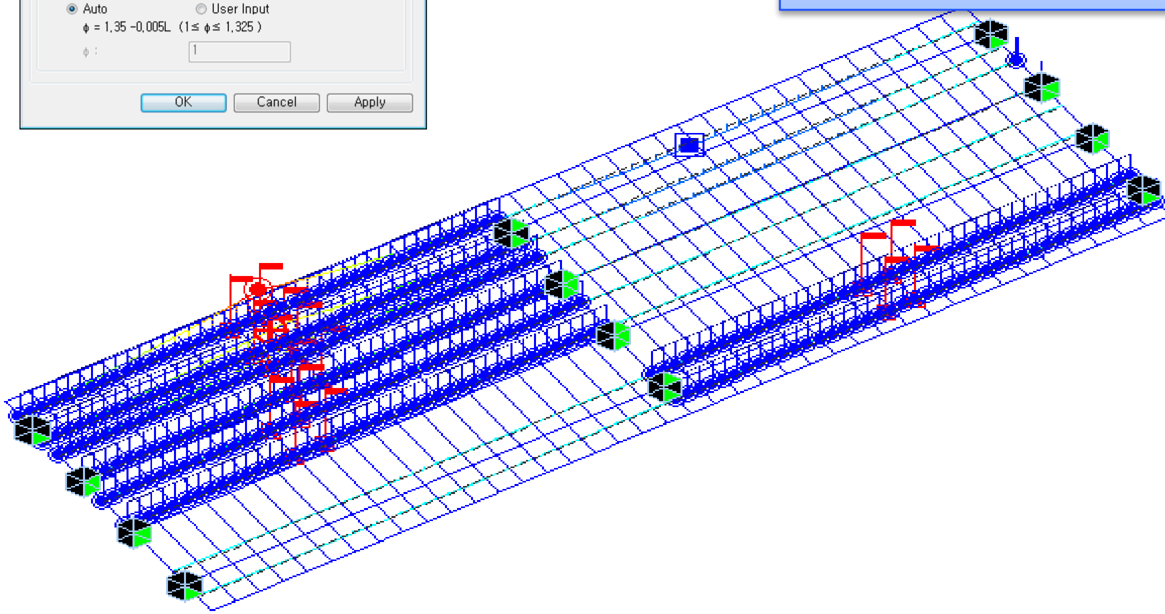


4. Define Moving Load Case.

Check on “Moving Load Optimization".

Minimum distance between two vehicles in the transverse direction.

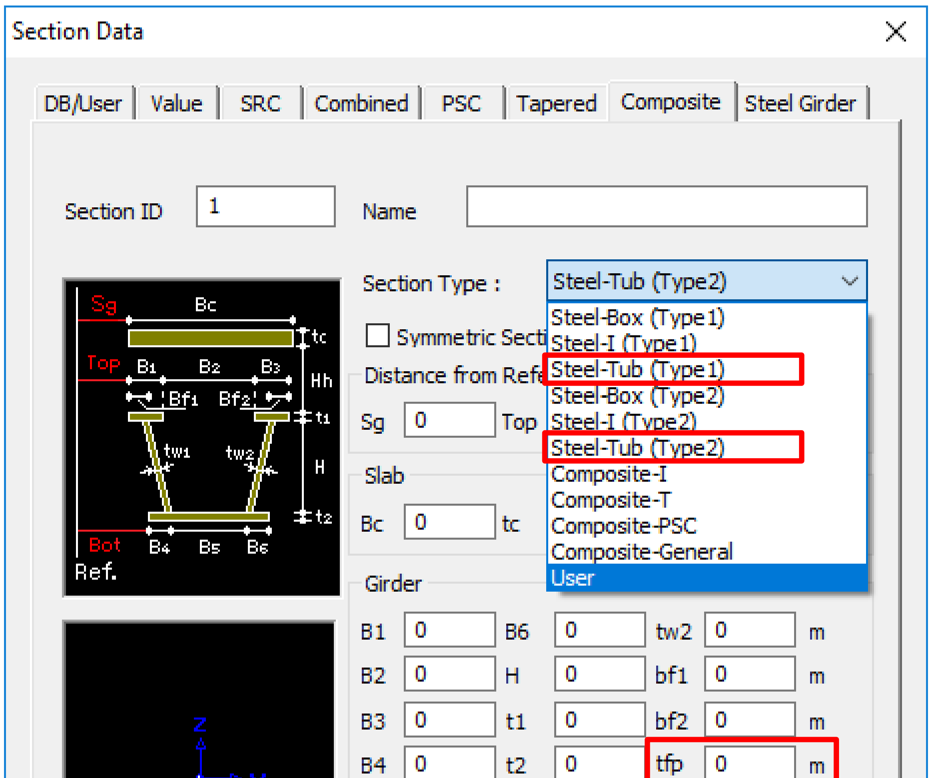


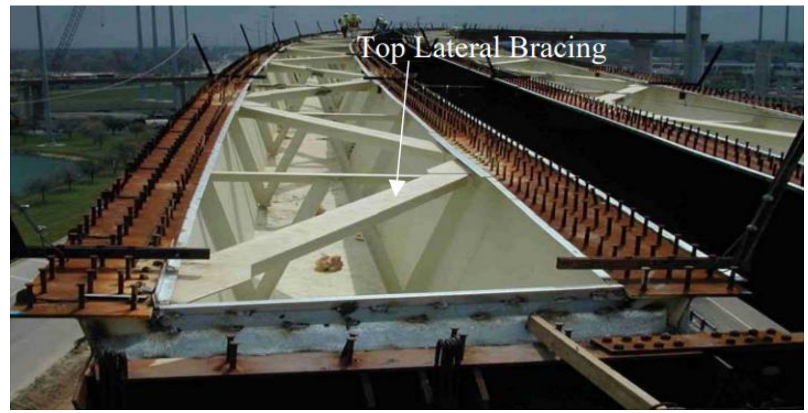


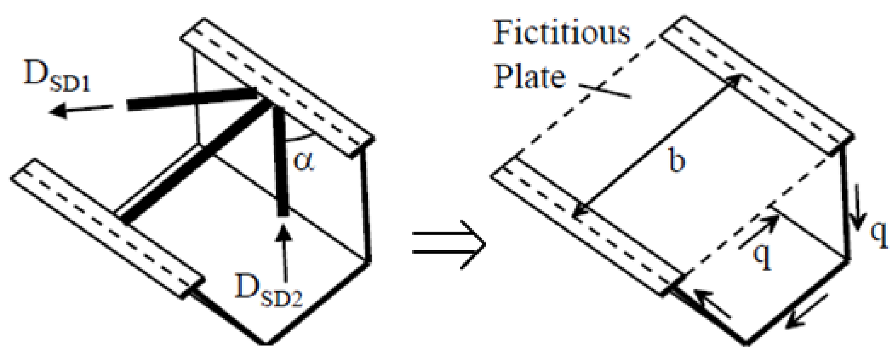
7. Improvement on Steel Tub Torsional Resistance

- Steel tub sections have very low inherent torsional resistance. Hence, practically the top flanges of a steel tub are always connected via a bracing to increase this torsional resistance.
- Ignoring this torsional resistance can lead to erroneous results in pre-composite stage, especially in cases where torsional rigidity plays important role. Example of such cases would be bridges with skew and curvature, wherein the bearing reactions would be greatly altered.
- General practice in such cases is to idealize this tub section as a box section, wherein the thickness of the top flange is calculated manually depending on the type and spacing of the bracings.
- With the latest release in midas Civil, the user can now provide this equivalent flange thickness for steel tub composite section. This thickness would only increase the torsional resistance of the steel tub in the pre-composite stage only.

- ***Properties > Section> Section Properties> Composite> Steel-Tub (Type 1)/(Type 2)***







8. Construction Stage Analysis considering Material Nonlinearity

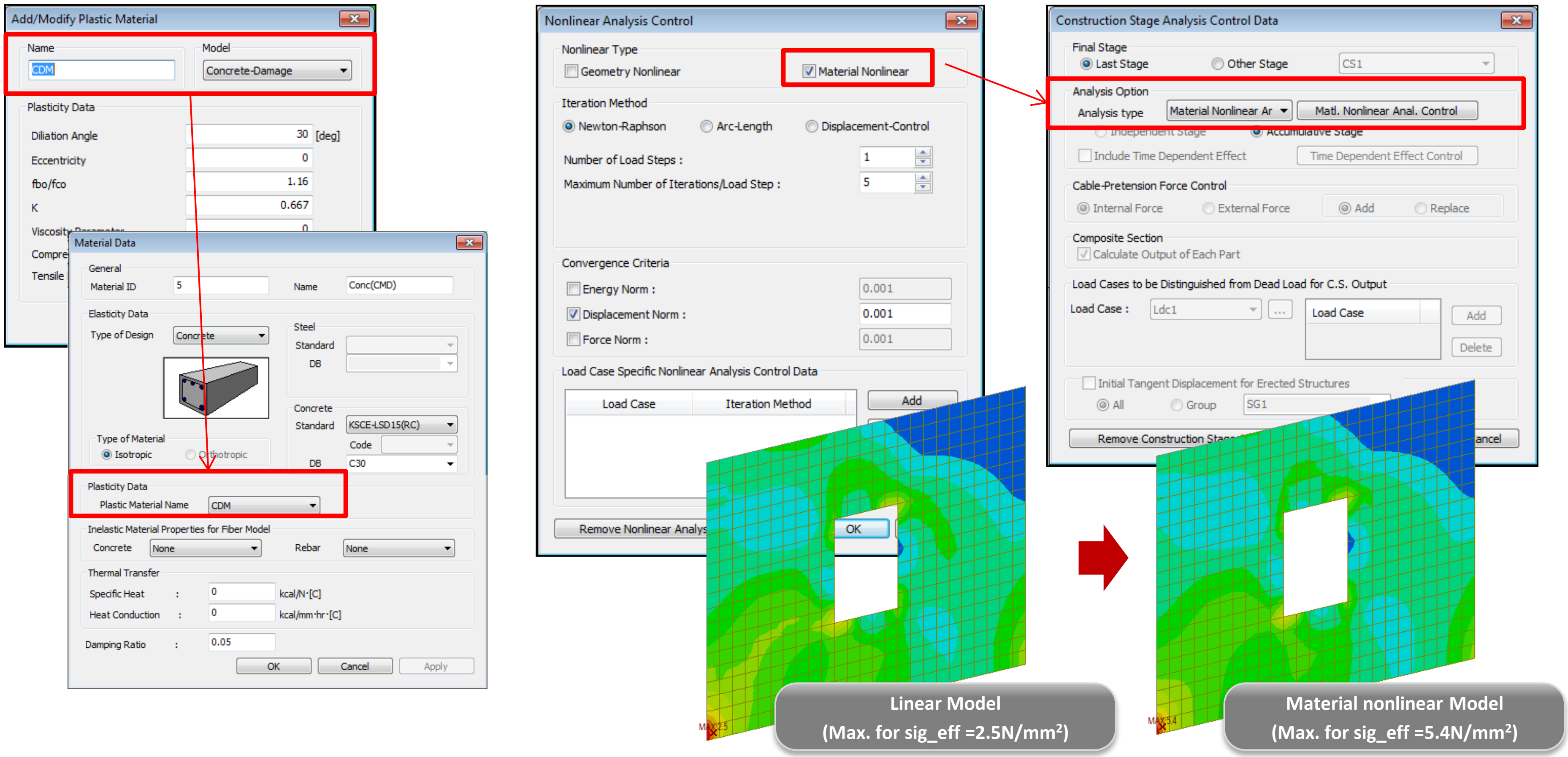
- Construction stage analysis with material nonlinear is supported.
- Plastic model for material can be defined in dialog box of 'Plastic Material' and 'Material Data'

Setting for Construction Stage Analysis with Material nonlinear

Step 1. Define Plastic Material Data

Step 2. Define Material Nonlinear

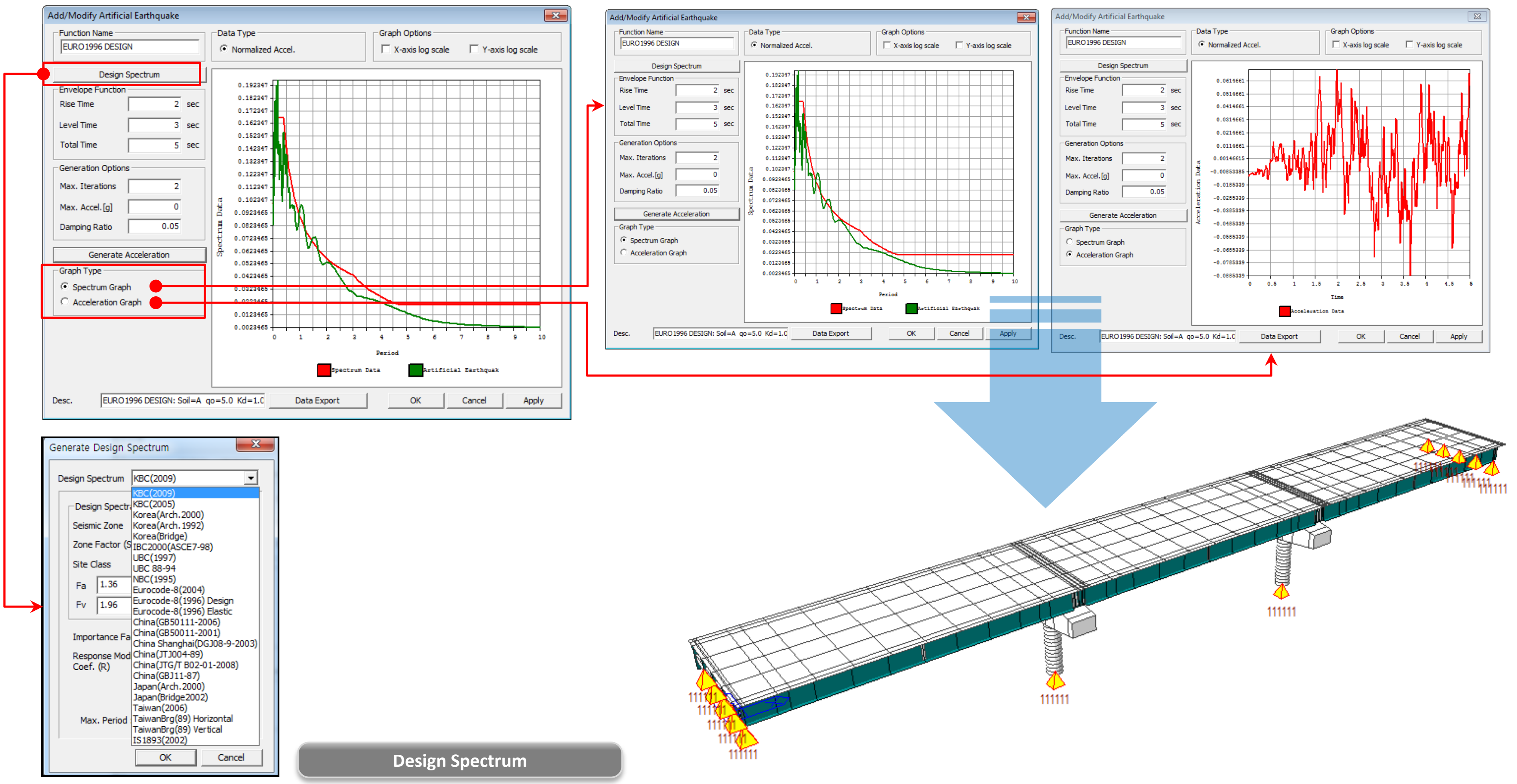
Step 3. Define Construction stage analysis Option



9. Addition of artificial earthquake generation function of dynamic analysis

- Spectral load and time history load used for dynamic analysis (Response Spectrum Analysis and Time History Analysis) can be generated as artificial seismic waves.
- It is possible to apply dynamic load with various variables through artificial earthquake generation referring to Design Spectrum according to country code.

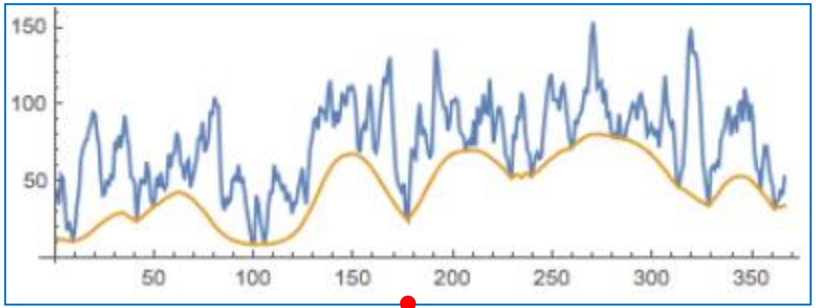
- ***Tools > Data Generator > Artificial Earthquake***

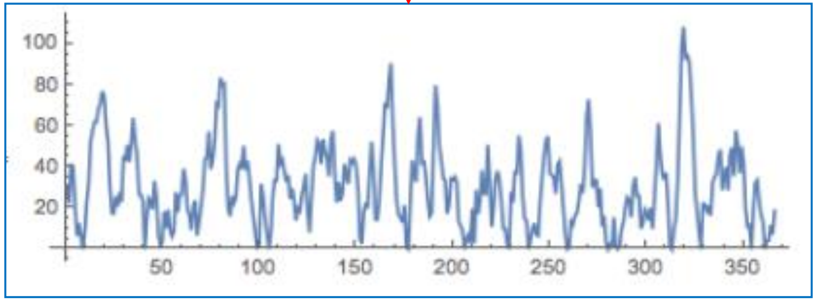


10. Seismic analysis based on Base Line Correction when Multiple Support Excitation is applied

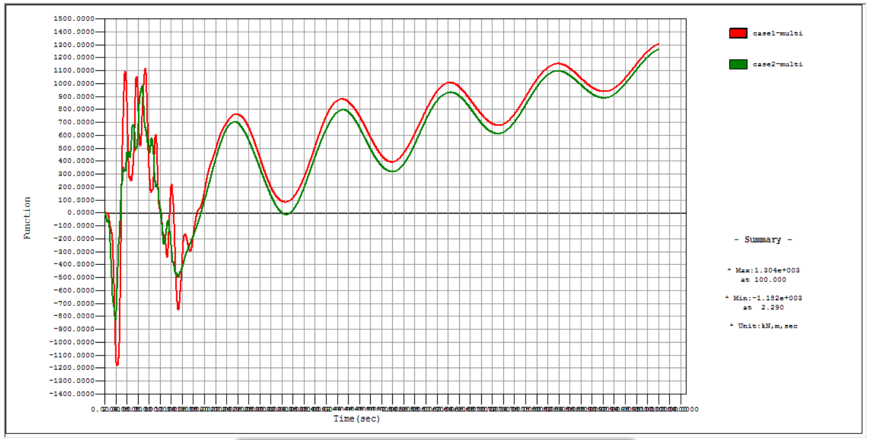
- Added the function to correct each point acceleration according to the base line which is the standard of acceleration loading with multi points.
- Displacement convergence over time using Base Line Correction method.

- ***Load > Dynamic Loads > Multiple Support Excitation***

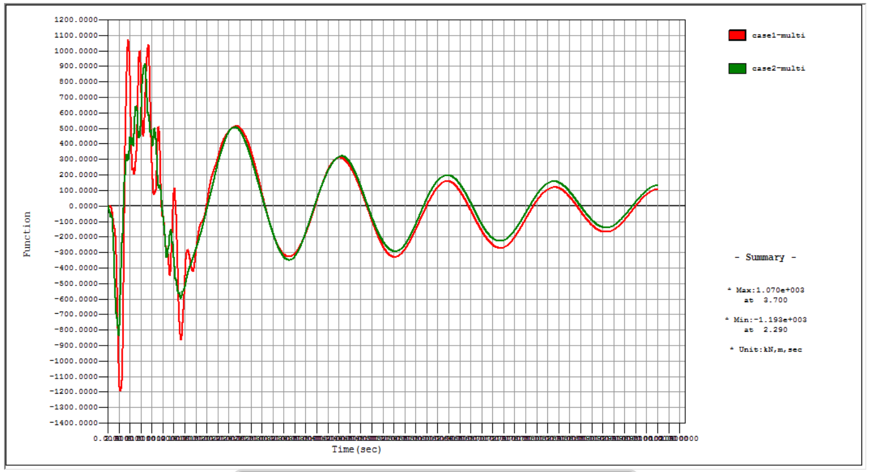




Base Line Correction Explanation



Result before Base Line Correction

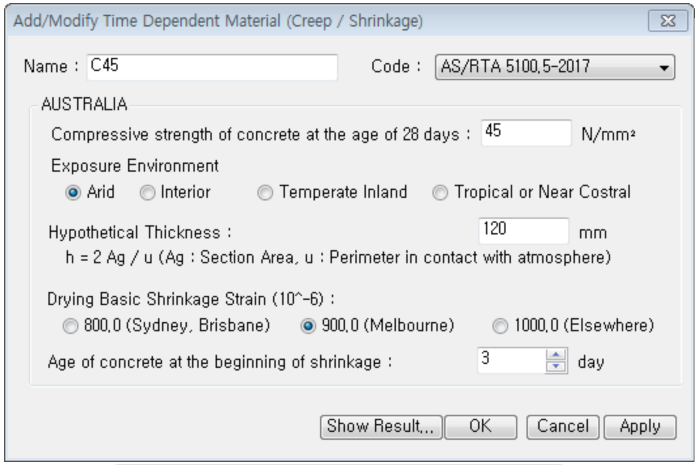


Result after Base Line Correction

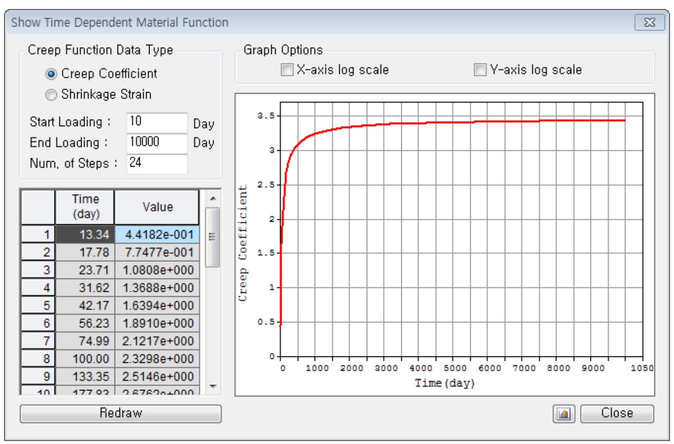
11. Time Dependent Materials as per Australian Standard (AS 5100.5 – 2017)

- Time dependent material properties: Updated Creep and Shrinkage can be defined as per AS 5100.5 – 2017.

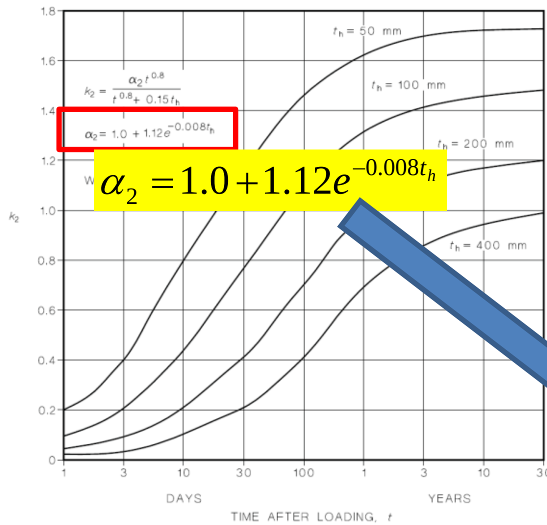
- ***Properties > Time Dependent Material > Creep/Shrinkage***



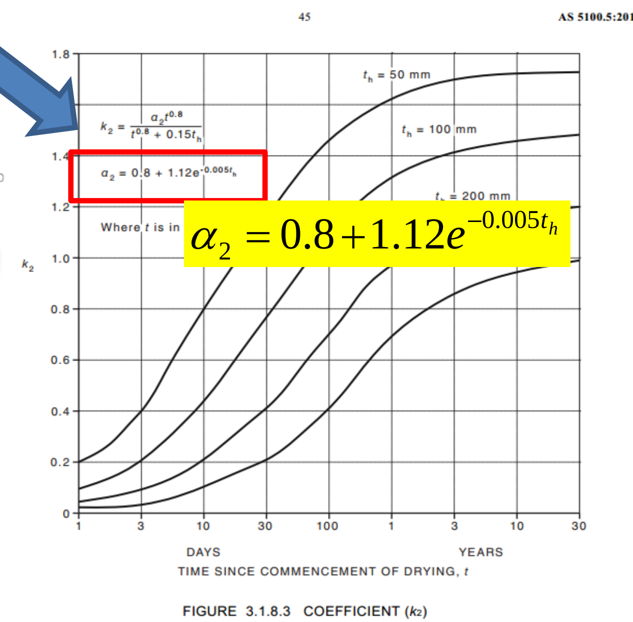
Creep/Shrinkage definition dialog box



Creep Coefficient



AS 5100.5 - 2016

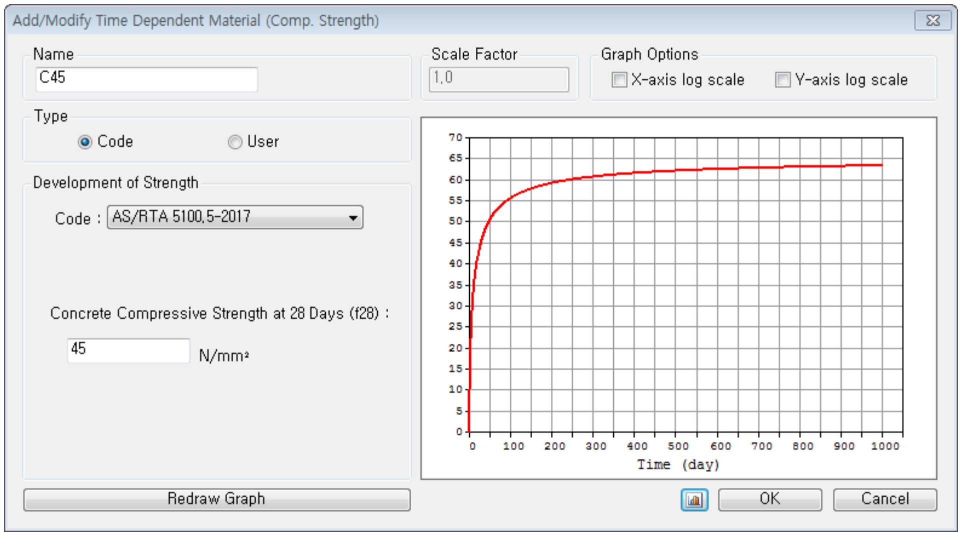


AS 5100.5 - 2017

11. Time Dependent Materials as per Australian Standard (AS 5100.5 – 2017)

- Time dependent material properties: Updated Concrete Compressive Strength can be defined as per AS 5100.5 – 2017.

- ***Properties > Time Dependent Material > Comp. Strength***



Comp. Strength definition dialog box

3.1.2 Modulus of elasticity

The mean modulus of elasticity of concrete at the appropriate age (E_{cj}) shall be either—

(a) taken as equal to—

(i) $(\rho^{1.5}) \times (0.043\sqrt{f_{cmi}})$ (in megapascals) when $f_{cmi} \leq 40$ MPa; or

(ii) $(\rho^{1.5}) \times (0.024\sqrt{f_{cmi}} + 0.12)$ (in megapascals) when $f_{cmi} > 40$ MPa,

AS 5100.5 - 2016

3.1.2 Modulus of elasticity

The mean value of modulus of elasticity of concrete (E_{cj}) at the appropriate age j, in days, shall be either one of the following:

(a) Taken as equal to—

(i) $(\rho^{1.5}) \times (0.043\sqrt{f_{cmi}})$ (in megapascals) when $f_{cmi} \leq 40$ MPa; or

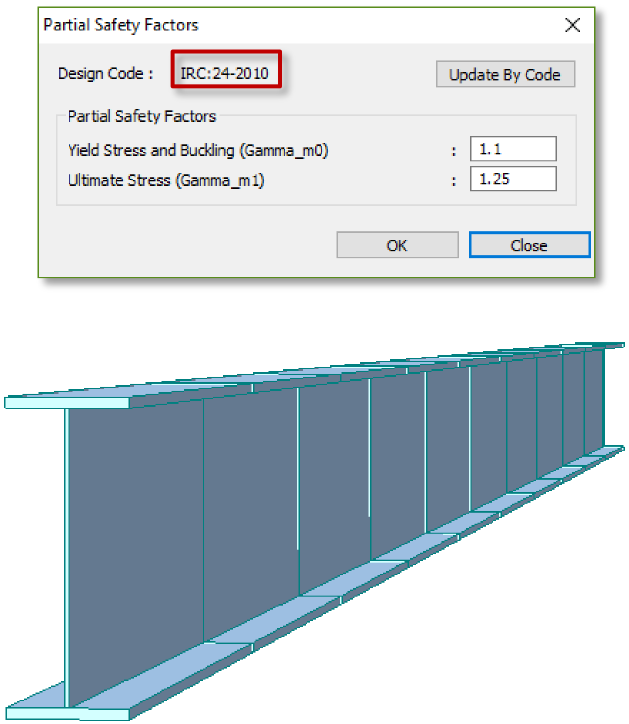
(ii) $(\rho^{1.5}) \times (0.12 + 0.024\sqrt{f_{cmi}})$ (in megapascals) when $f_{cmi} > 40$ MPa.

AS 5100.5 - 2017

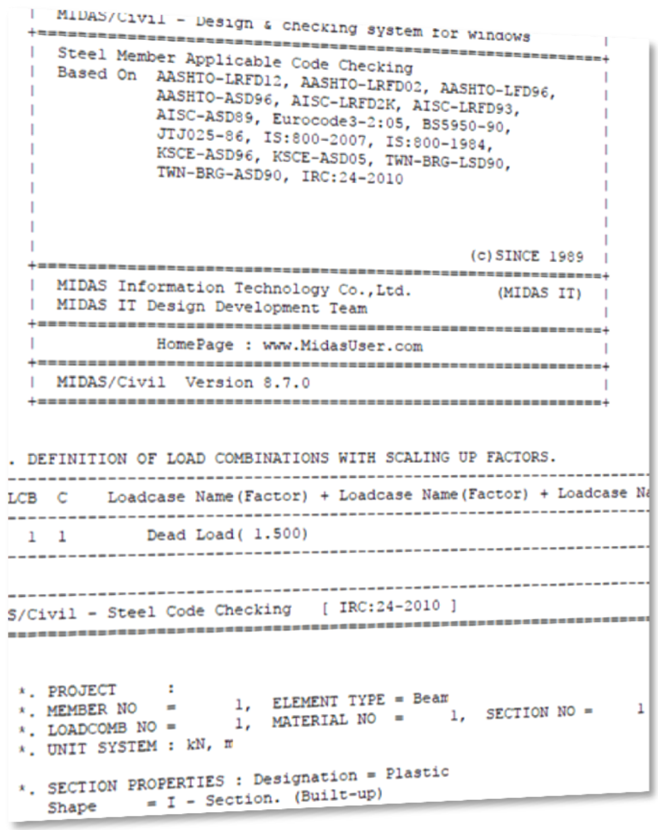
12. Implementation of Steel Girder Design as per IRC 24 -2010

- Design steel sections using IRC 24 -2010. Data base sections Angle, Channel, I, H, Box and Steel plate design are supported.
- Structural steel materials as per IS 2062 -2011.
- Graphic report and Detailed Text report for Bending Resistance, Shear Resistance, Lateral Torsional Buckling and Combined forced could be generated.

- ***Design > Steel Design > IRC 24 -2010***



Steel Design Code



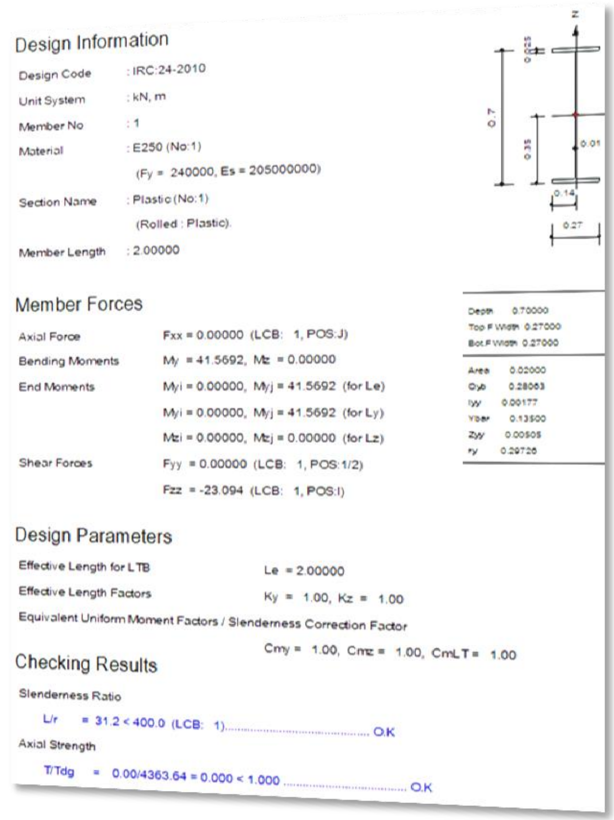
```
MIDAS/Civil - Design & checking system for windows
Steel Member Applicable Code Checking
Based On AASHTO-LRFD12, AASHTO-LRFD02, AASHTO-LFD96,
         AASHTO-ASD96, AISC-LRFD2K, AISC-LRFD93,
         AISC-ASD89, Eurocode3-2:05, BS5950-90,
         JTJ025-86, IS:800-2007, IS:800-1984,
         KSCE-ASD96, KSCE-ASD05, TWN-BRG-LSD90,
         TWN-BRG-ASD90, IRC:24-2010
                                        (c)SINCE 1989
MIDAS Information Technology Co.,Ltd.     (MIDAS IT)
MIDAS IT Design Development Team
         HomePage : www.MidasUser.com
MIDAS/Civil  Version 8.7.0

. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Na
 1   1         Dead Load( 1.500)

S/Civil - Steel Code Checking   [ IRC:24-2010 ]

*. PROJECT      :
*. MEMBER NO    =      1,  ELEMENT TYPE = Beam
*. LOADCOMB NO  =      1,  MATERIAL NO  =     1,  SECTION NO =    1
*. UNIT SYSTEM  : kN, m
*. SECTION PROPERTIES : Designation = Plastic
   Shape       = I - Section. (Built-up)
```

Text Report

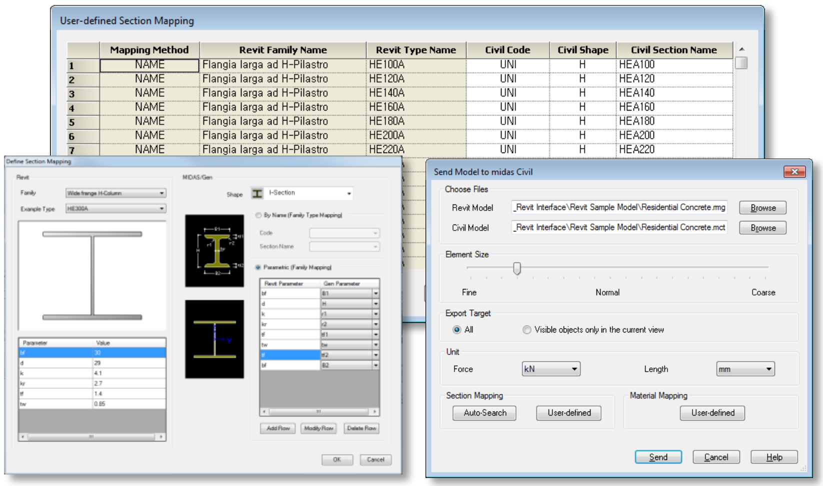


Graphic Report

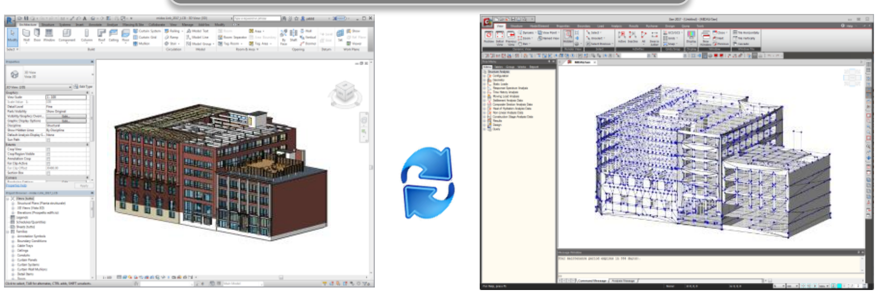
1. Revit 2018 interface

- Using Midas Link for Revit Structure, direct data transfer between midas Civil and Revit 2018 is available for Building Information Modeling (BIM) workflow. Midas Link for Revit Structure enables us to directly transfer a Revit model data to midas Civil, and deliver it back to the Revit model file. This feature is provided as an Add-In module in Revit Structure and midas Civil text file (*.mct) is used for the roundtrip.

- ***File > Import > midas Civil MCT File***
- ***File > Export > midas Civil MCT File***



Send Model to midas Civil



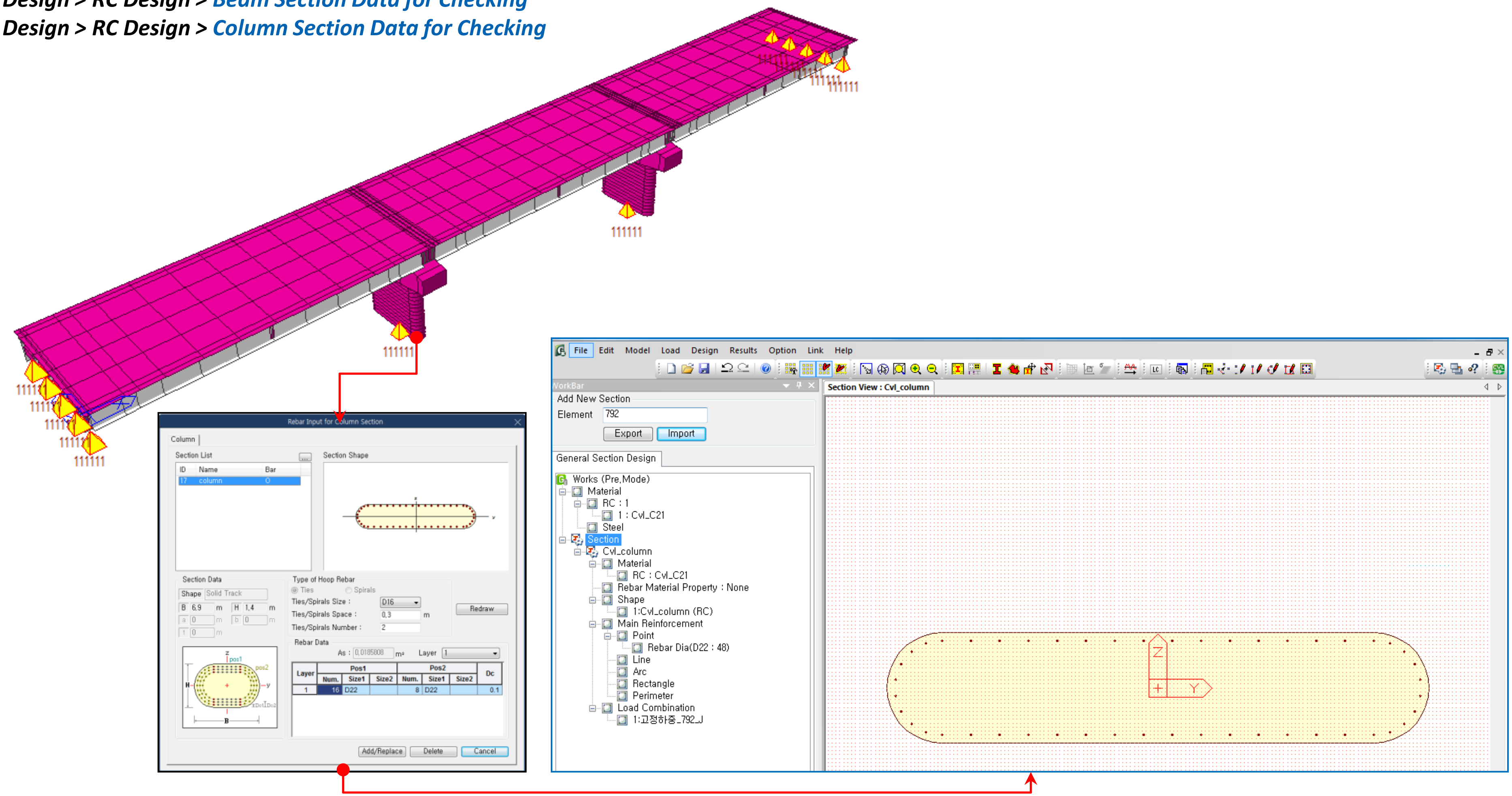
Revit 2018 Civil 2018

	Functions	Revit <> Gen
Linear Elements	Structural Column	<>
	Beam	<>
	Brace	<>
	Curved Beam	>
	Beam System	>
	Truss	>
Planar Elements	Foundation Slab	<>
	Structural Floor	<>
	Structural Wall	<>
	Wall Opening & Window	>
	Door	>
	Vertical or Shaft Opening	>
Boundary	Offset	>
	Rigid Link	>
	Cross-Section Rotation	>
	End Release	>
	Isolated Foundation Support	>
	Point Boundary Condition	>
	Line Boundary Condition	>
	Wall Foundation	>
	Area Boundary Condition	>
Load	Load Nature	>
	Load Case	>
	Load Combination	>
	Hosted Point Load	>
	Hosted Line Load	>
	Hosted Area Load	>
Other Parameters	Material	<>
	Level	>

2. Reinforcement data interchange between Civil and GSD

- Addition of the function to link rebar input data to Civil column with GSD.
- Improvement of GSD design process (Interaction Curve and Moment Curvature Curve) through convenient reinforcement input function of Civil.
- The process of creating reinforcing bars in Line and Arc Type for track type and arbitrary cross section in GSD can be conveniently placed using Rebar Input function in Civil.

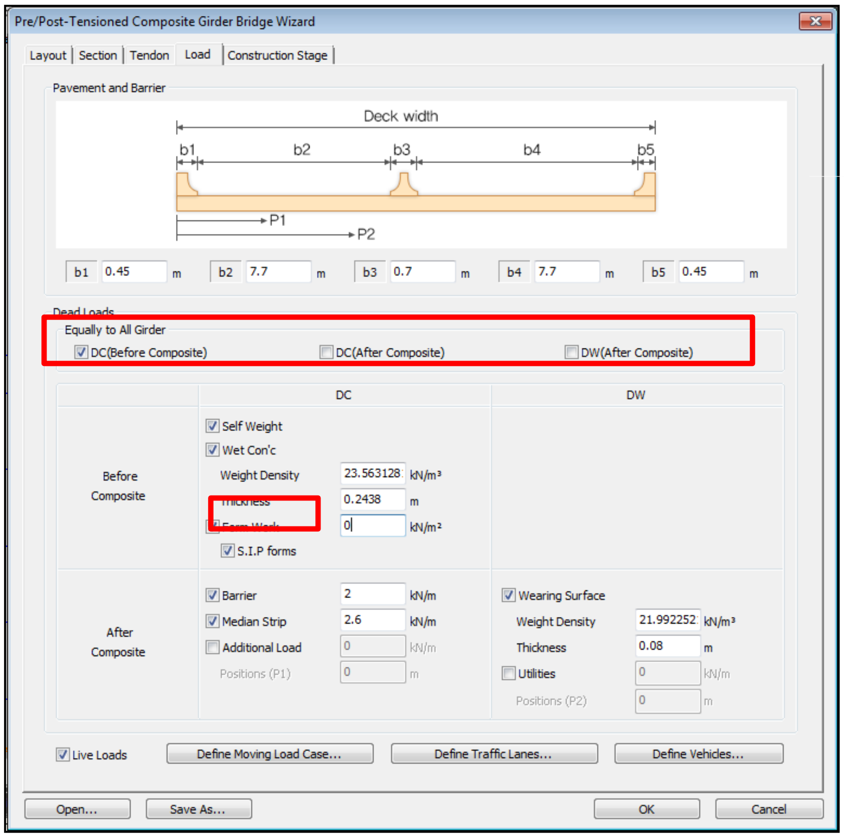
- ***Design > RC Design > Beam Section Data for Checking***
- ***Design > RC Design > Column Section Data for Checking***



3. Improvement on Steel/Prestressed Composite Bridge Wizard

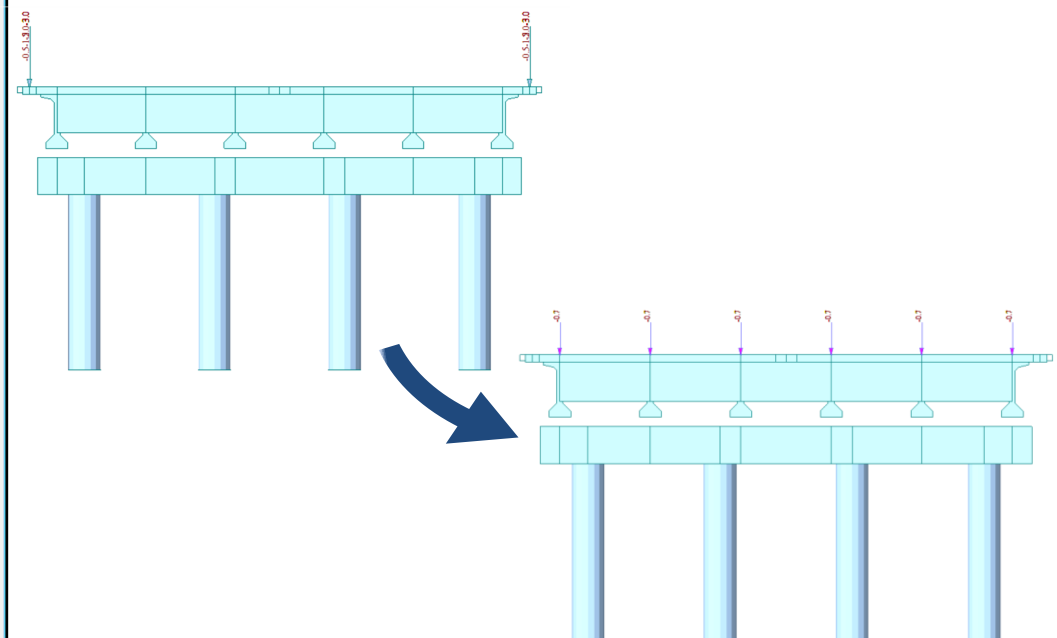
- Form work load can now also consider S.I.P forms (Stay in place forms). If S.I.P forms is selected, the loading on the girder will be activated after the composite action as well.
- Loading data across the girders can now be distributed equally using 'Equally to All Girder' option.

- ***Structure > Wizard > Steel/Prestressed Composite Bridge wizards***



Changes in Load tab of Steel/Prestressed Composite Bridge Wizard

Example of 1.5" Form Deck (Stay in Place forms)

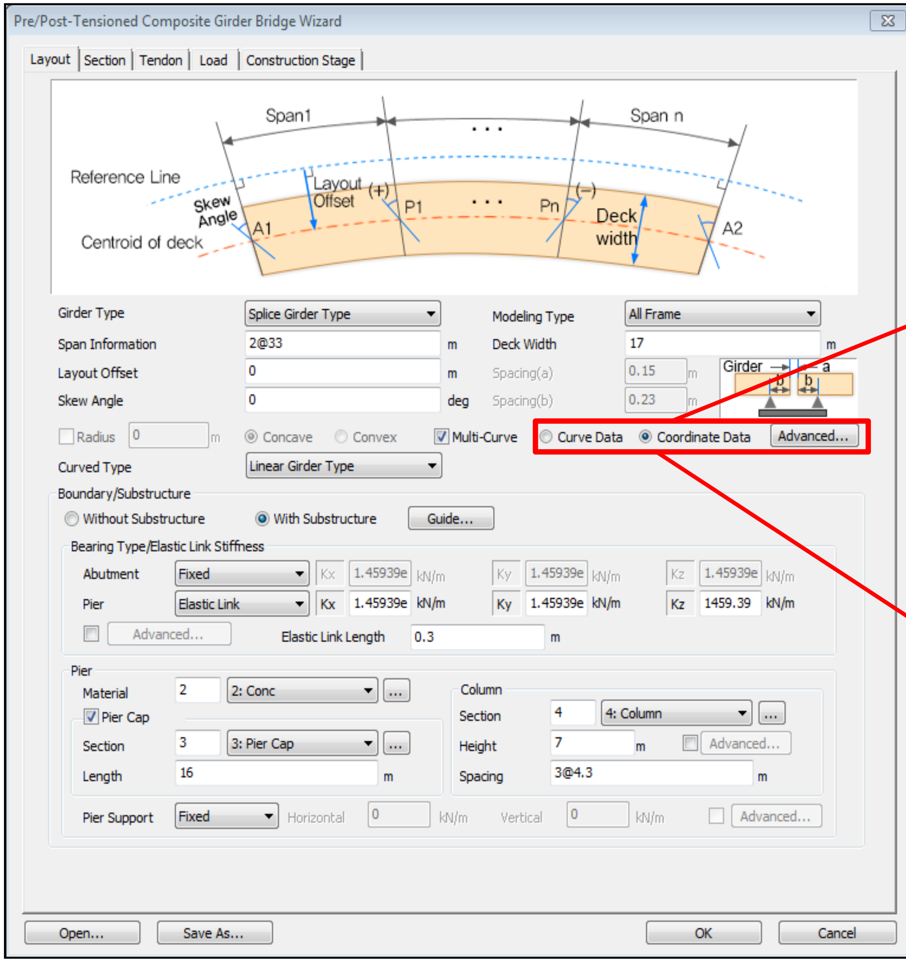


Applying 'Equally to All Girder' function

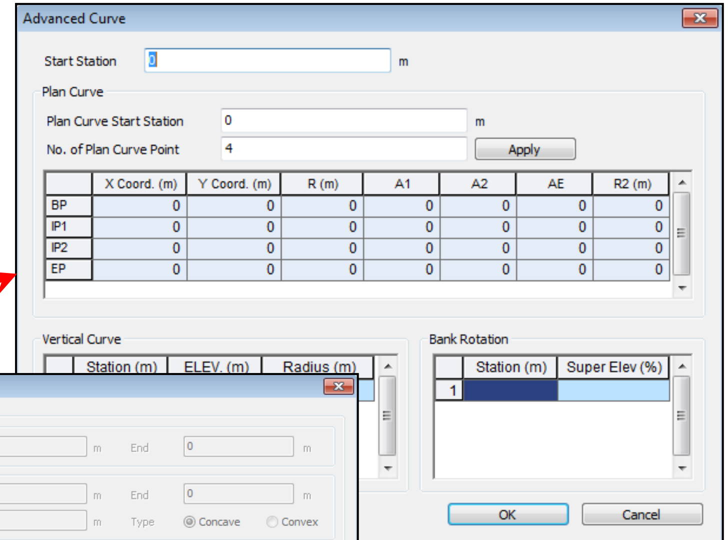
3. Improvement on Steel/Prestressed Composite Bridge Wizard

- Multi-curve was inputted by entering the coordinate data of the steel/prestressed composite girder. New input option is implemented in the case where there is no coordinate data for the curvature of the structure. This is the same multi-curve input method of that of the Grillage Model Wizard.

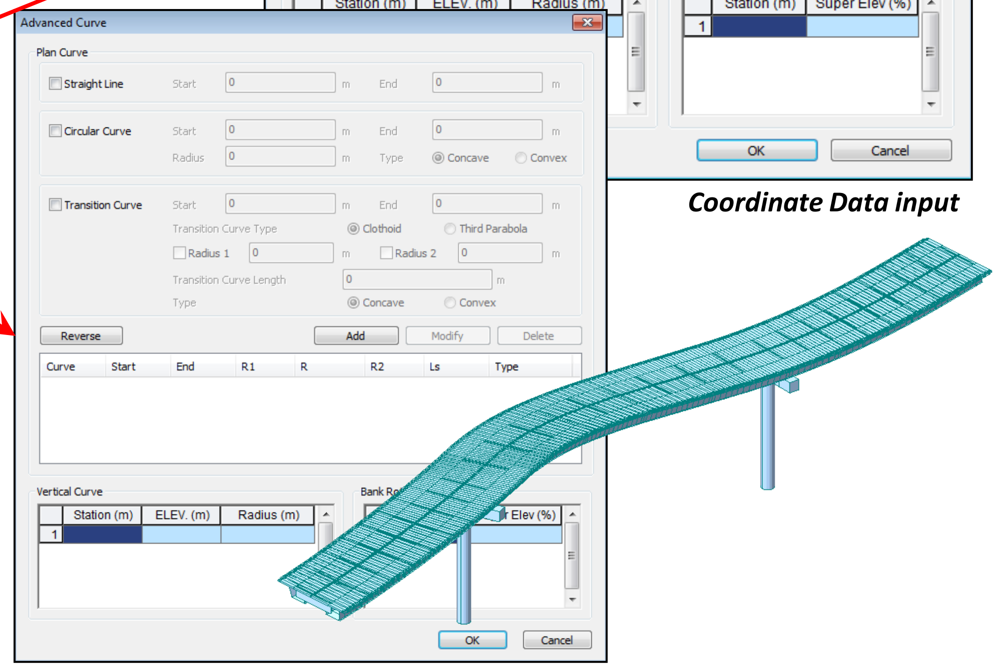
- ***Structure > Wizard > Steel/Prestressed Composite Bridge wizards***



Changes in Layout tab of Steel/Prestressed Composite Bridge Wizard



Coordinate Data input



Curve Data input