Release Note

Release Date : Oct. 2016

Product Ver. : Civil 2017 (v1.1)

DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

1. Assessment Live Loading to BD 21/01

- BD 21/01 is intended to be used for the assessment of highway bridges and structures in the UK. Assessment loading is generally limited to the application of dead and superimposed dead loads and the type HA live loads. For assessment purposes the HA loads are factored to give the Assessment Live Loading.
- HA loads defined to BD 21/01 can be combined with special vehicles (SV, SOV) as per BD 86/11.

- ***Load > Moving Load > Vehicles***
- ***Load > Moving Load > Moving Load Cases***

❑ Reduction Factor = Assessment Live Loading / Type HA Loading

Traffic Flow: High (H), Medium (M), Low (L)
Road Surface Categories: Good (g), Poor (p)
6 categories of bridges: Hg, Mg, Lg, Hp, Mp, Lp
Load Level: 40t, 26t, 18t, 7.5t, G1FE, G2FE, 3t

❑ Adjustment Factor (AF)

For $0 < L \leq 20$

$$AF = a_L / 2.5$$

For $20 < L < 40$

$$AF = 1 + (a_L / 2.5 - 1) \times (2 - L/20)$$

For $40 \leq L < 50$

$$AF = 1.$$

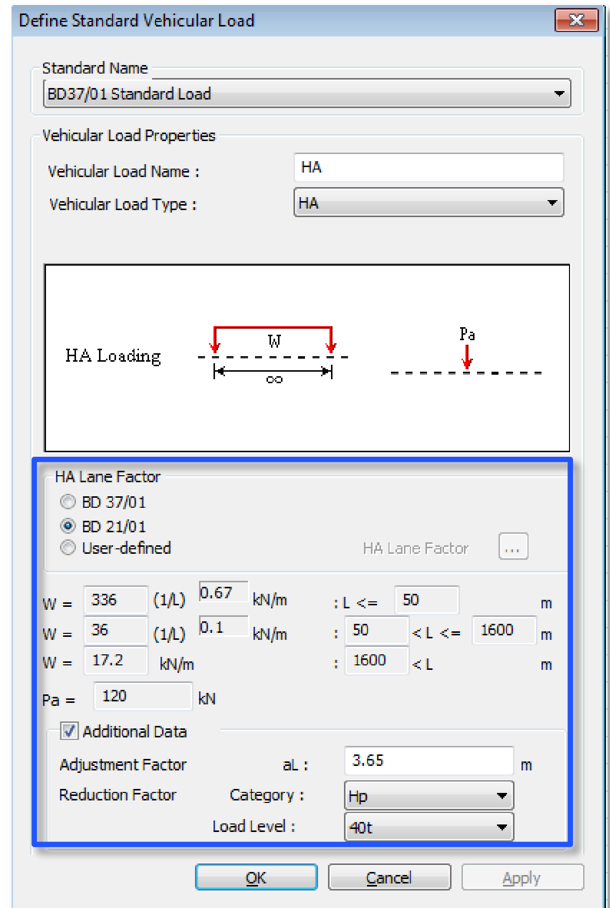
Where a_L = 3.65m and L is the loaded length (m).

❑ Lane Factor

Lane 1:	1.0
Lane 2:	1.0
Lane 3:	0.5
Lane 4 and subsequent:	0.4

❑ Bridge Specific Live Loading

= HA/(Adjustment Factor) x Reduction Factor x Lane Factor



Standard Vehicle Load for BD37/01

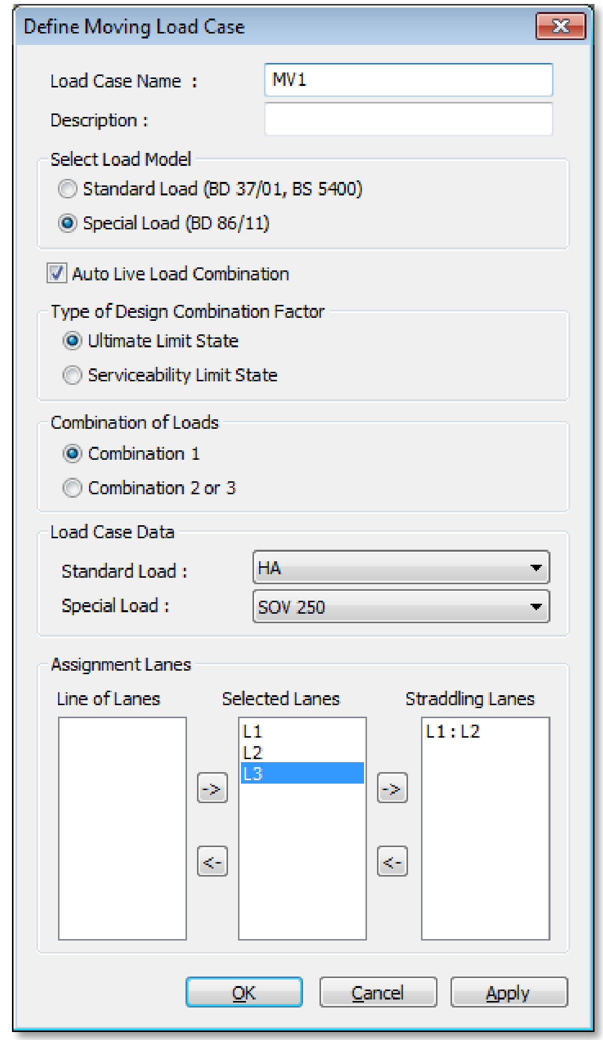
1. Assessment Live Loading to BD 21/01 (continued)

❑ Partial factor for loads

The following partial factors will be applied to each type of vehicle loads if the 'Auto Live Load Combination' option is selected.

	ULS Combination 1	ULS Combination 2 & 3
SV/SOV HA	1.1 1.3	1.0 1.3

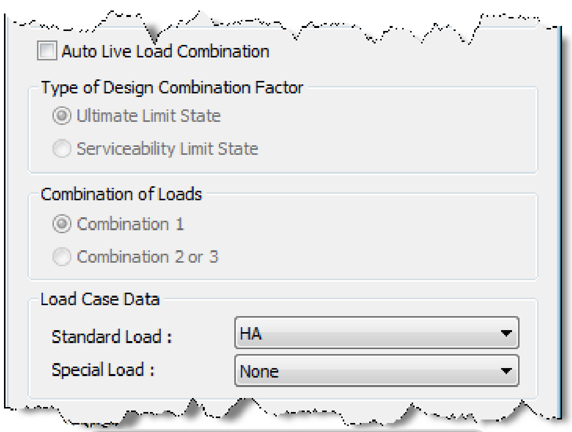
	SLS Combination 1	SLS Combination 2 & 3
SV/SOV HA	1.0 1.0	1.0 1.0



Moving Load Case Dialog Box

❑ Without partial factor

When only one type of vehicle is applied for the assessment of bridges, the 'Auto Live Load Combination' option is not supported. Thus, the partial factor for the vehicle should be applied in the load combination.

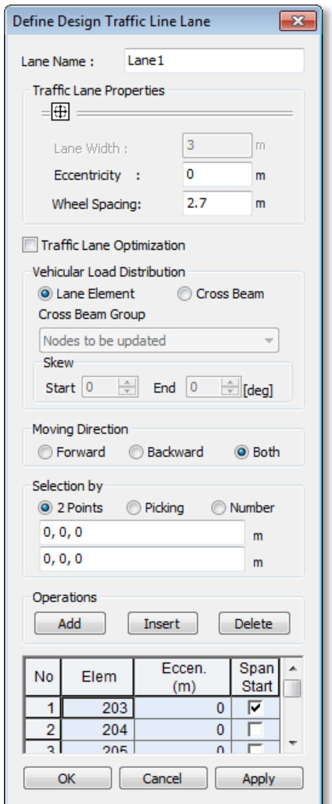


Moving Load Case Dialog Box

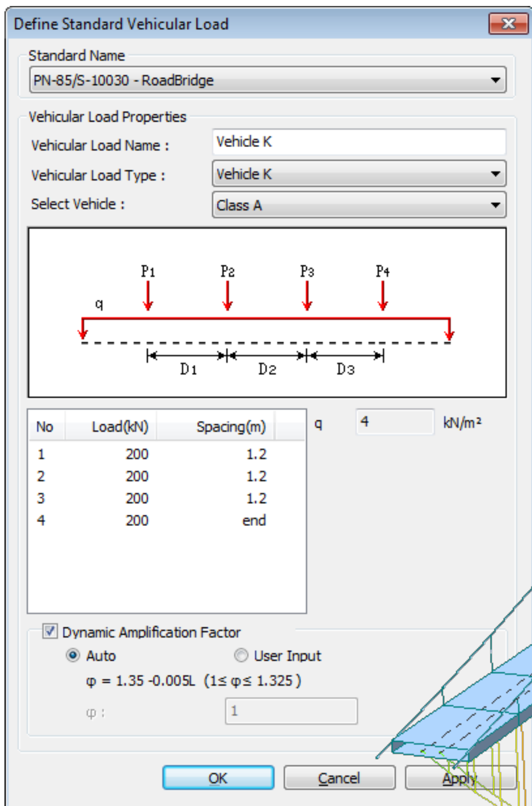
2. Moving Load Analysis to Polish Standard

- Vehicle database for road bridges and pedestrian bridges as per PN-85/S-10030 has been newly implemented. Vehicle K, Vehicle S, Vehicle 2S and user-defined vehicle can be selected.
- Dynamic amplification factor can automatically be calculated considering span length. For multi-span bridges, average span length is applied as specified in Polish Standard. Average span length can automatically be calculated using "Span Start" option in Traffic Line/Surface Lane dialog box.

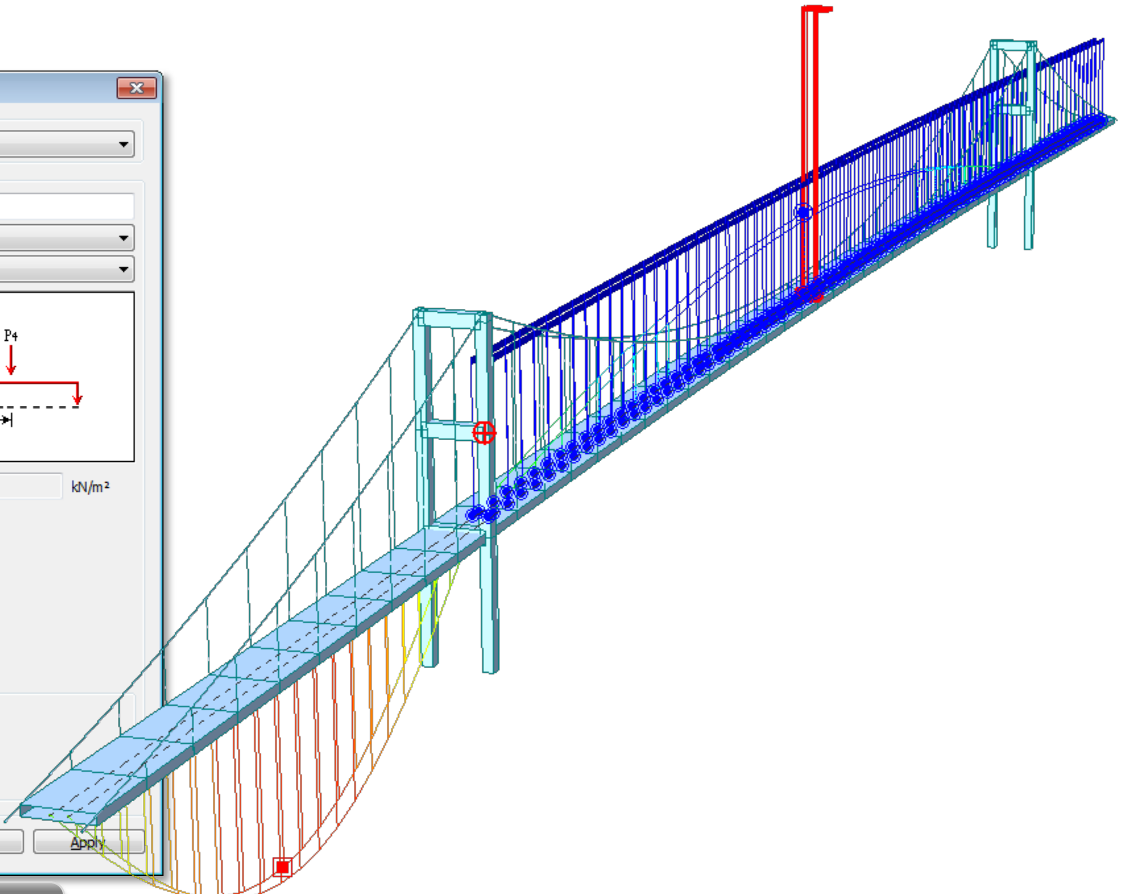
- ***Load > Moving Load > Traffic Line/Surface Lanes***
- ***Load > Moving Load > Vehicles***
- ***Load > Moving Load > Moving Load Cases***



Traffic Line Lane



Standard Vehicular Load



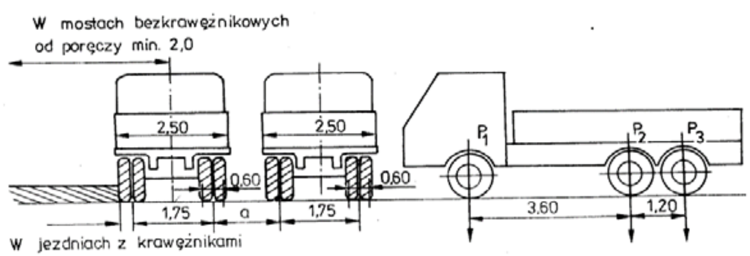
2. Moving Load Analysis to Polish Standard (continued)

- Limitation for vehicle 2S: One axle of Vehicle 2S consists of 4 wheels. In the program, only two wheels are allowed in one axle. Therefore, the wheel spacing in Traffic Line/Surface Lane dialog box should be entered considering the distance between the centerlines of two trucks. In moving load tracer, the wheel loads will be placed to the centerline of each truck for all the axles. However, the user can convert this loadings into a static load case in which actual positions of 4 wheels are taken into account.

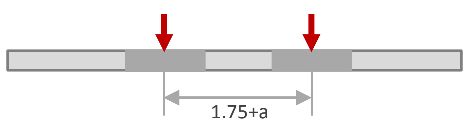
- ***Load > Moving Load > Traffic Line/Surface Lanes***
- ***Load > Moving Load > Vehicles***
- ***Load > Moving Load > Moving Load Cases***

Class of loads	Cumulative weight	Axle load (kN)			a m
		P_1	P_2	P_3	
A	300	60	120	120	1,00

Configuration of Vehicle 2S

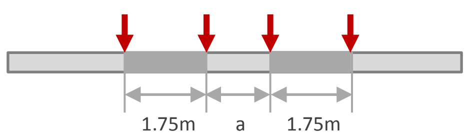


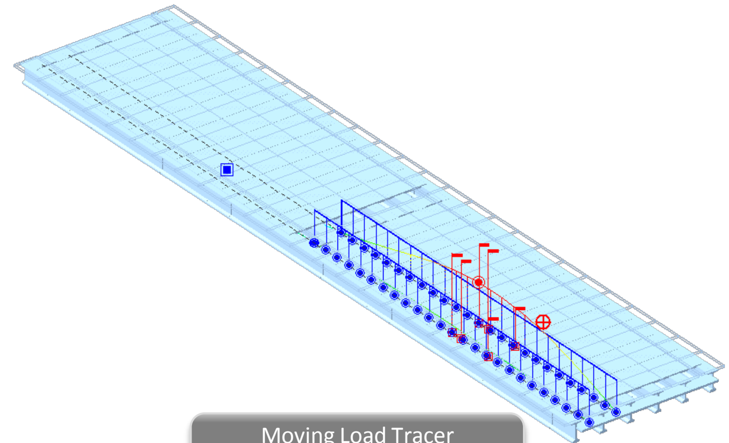
Moving Load Tracer



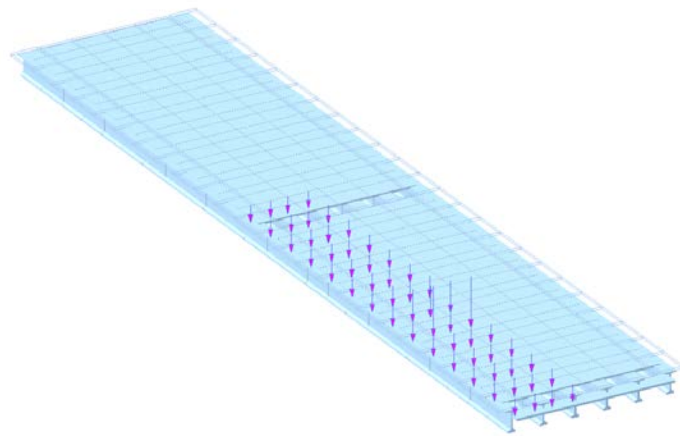
(Value to be entered for Wheel Spacing in Traffic Line/Surface Lane)

Convert to Static Load Case





Moving Load Tracer

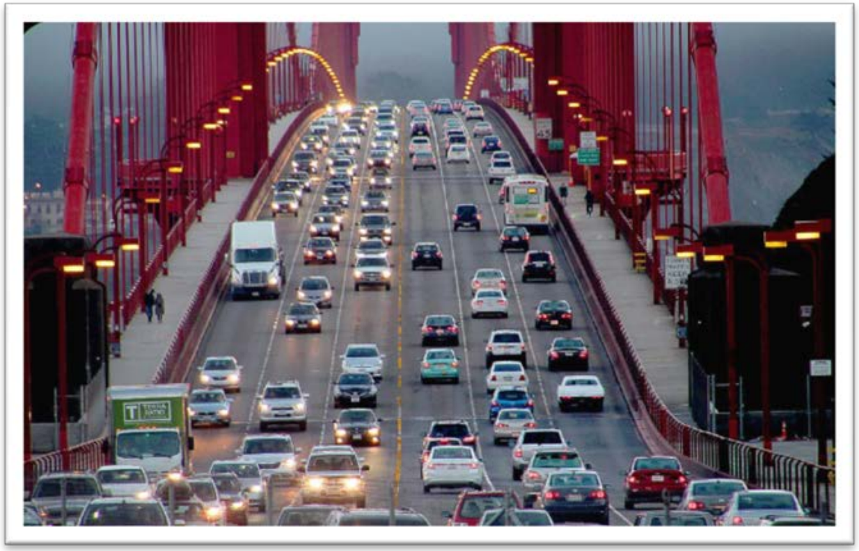


Convert to Static Load Case

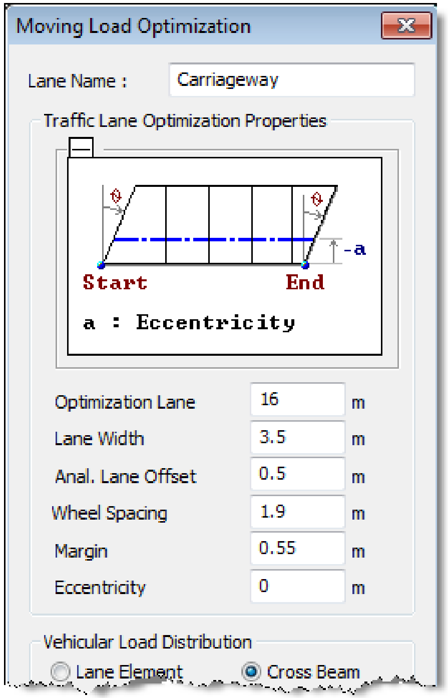
3. Moving Load Optimization to Russian Standard

- 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.

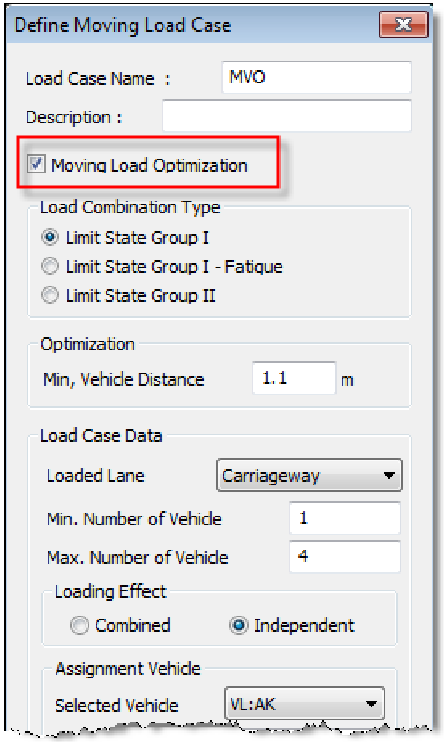
- ***Load > Moving Load > Traffic Line/Surface Lane > Moving Load Optimization***
- ***Load > Moving Load > Moving Load Cases***



Road Bridge



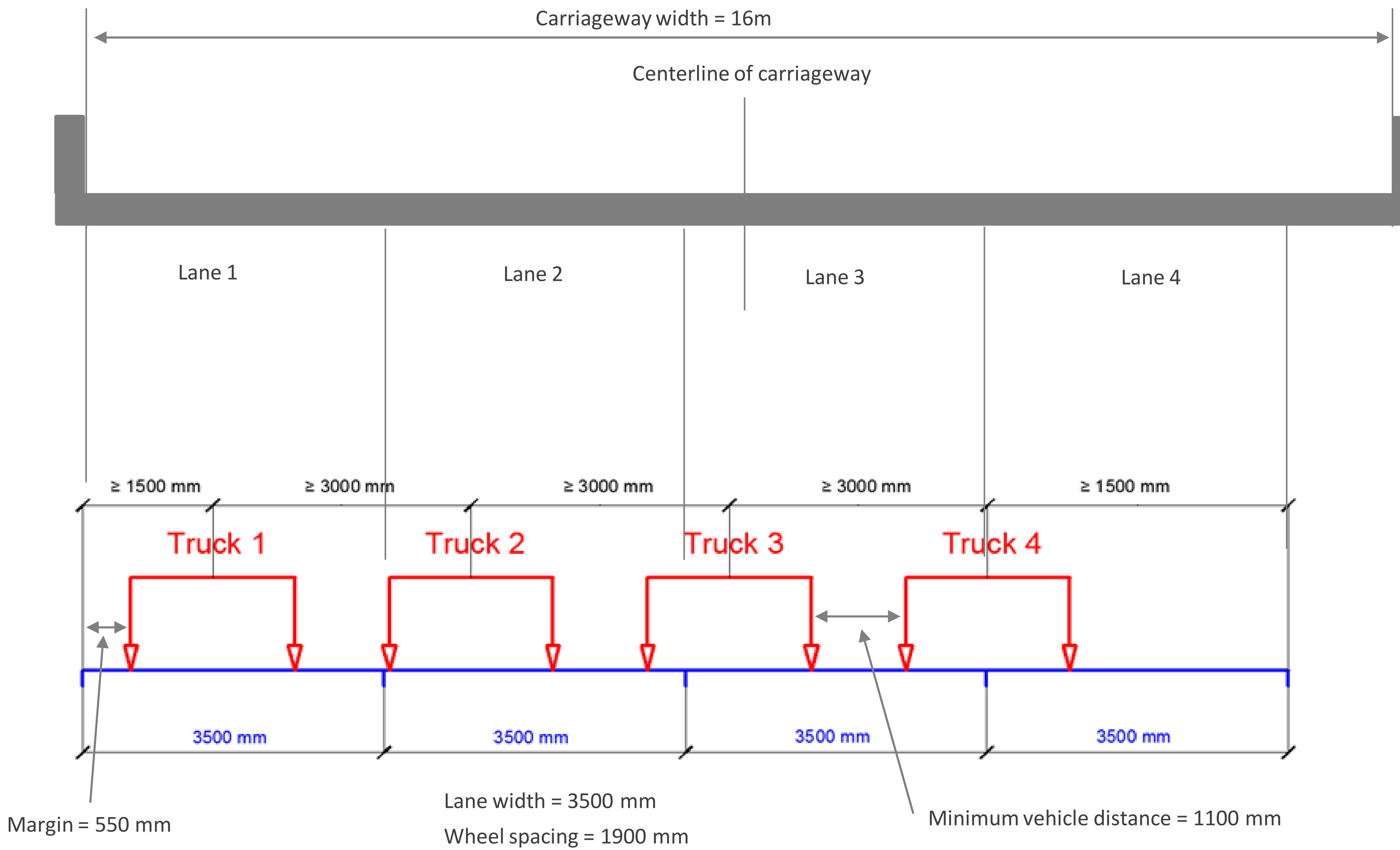
Traffic Line Lane Optimization



Moving Load Case

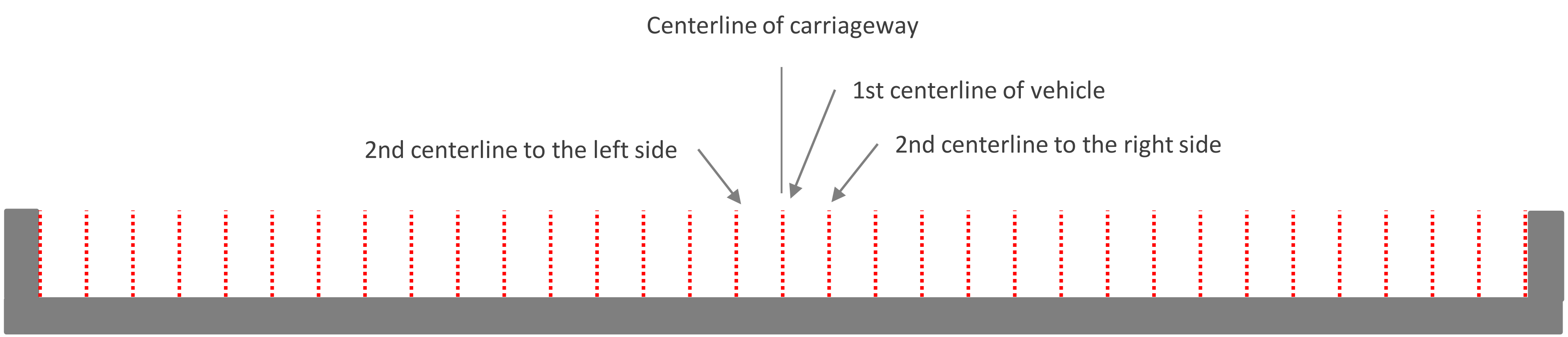
3. Moving Load Optimization to the Russian Standard (continued)

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



3. Moving Load Optimization to the Russian Standard (continued)

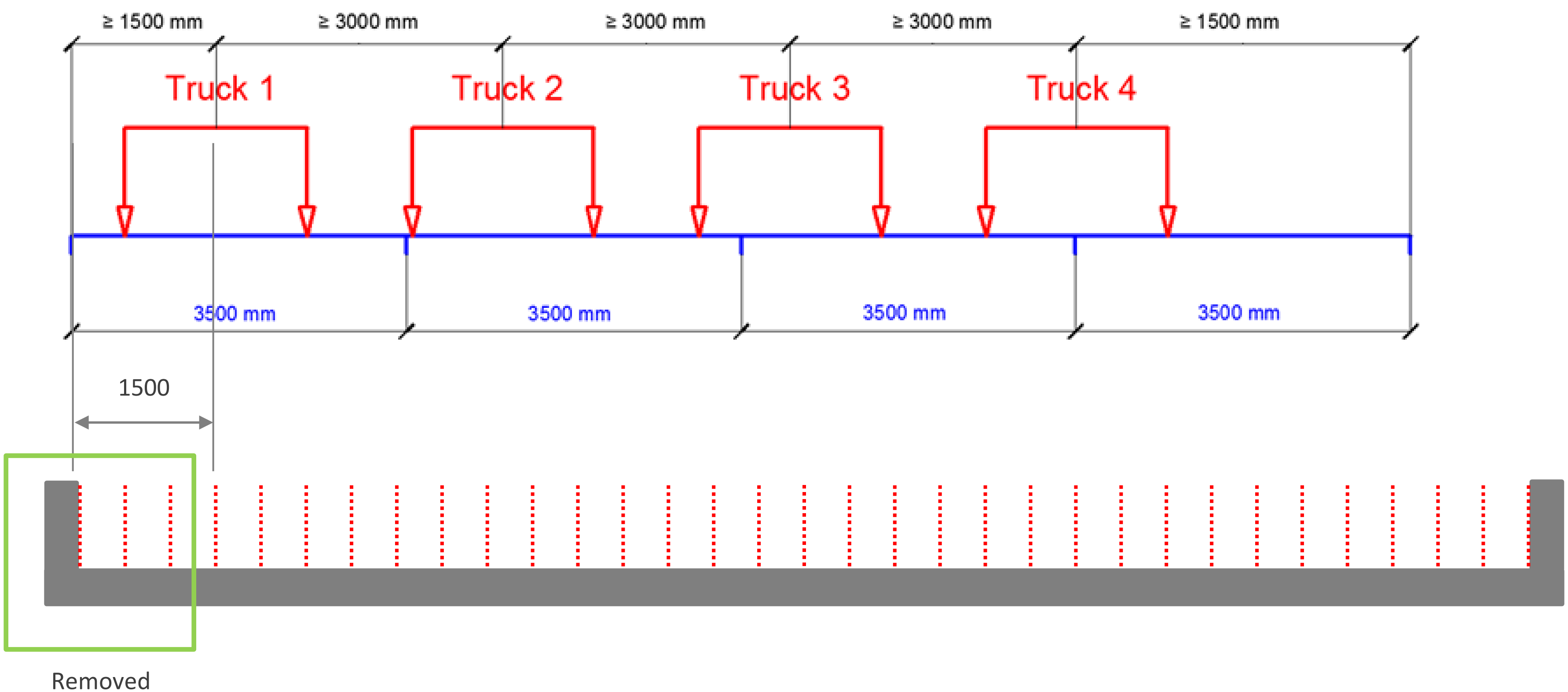
- The program will generate the centerlines of vehicles in the transverse direction within the carriageway width.
- The spacing of the centerlines is defined by the user. (Anal. Lane Offset)
- The first centerline will be generated at the centerline of carriageway.
- The second centerline will be generated 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.



3. Moving Load Optimization to the Russian Standard (continued)

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

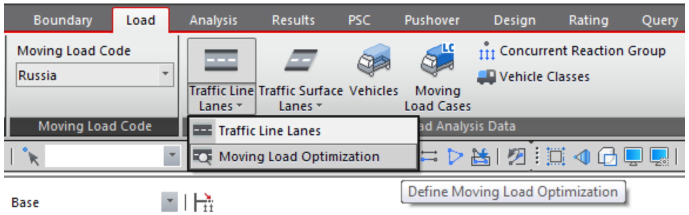
- For example, the three centerlines in the figure below will be removed from the vehicle application.



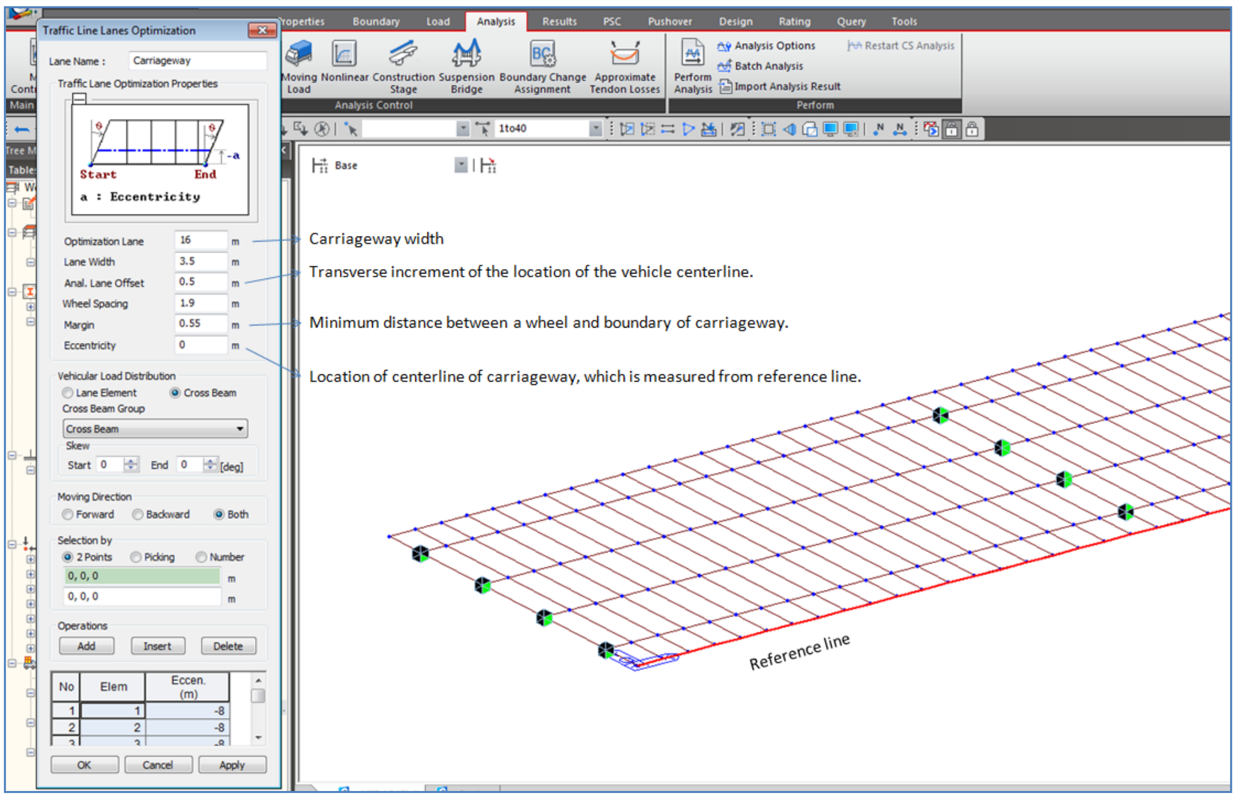
3. Moving Load Optimization to the Russian Standard (continued)

❑ Required Steps

1. Select ‘Moving Load Optimization' function.

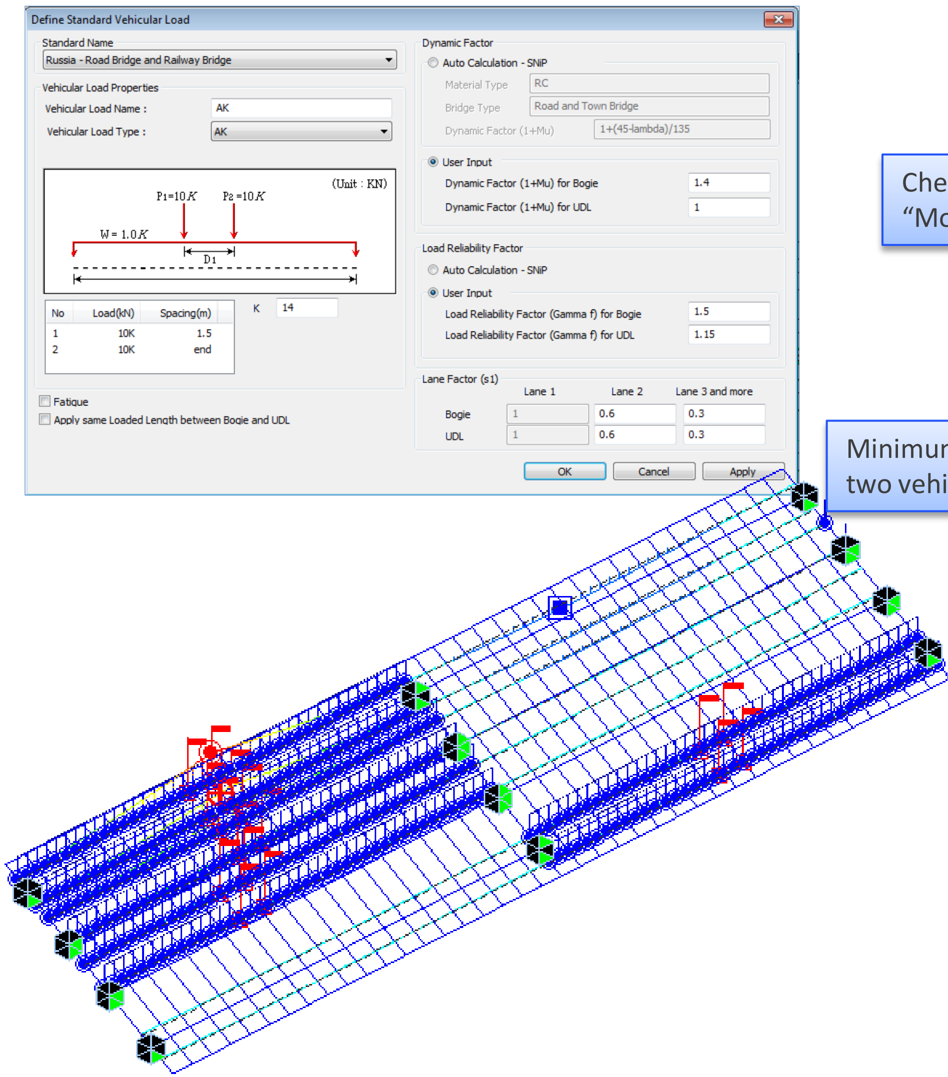


2. Define Carriageway data.



3. Moving Load Optimization to the Russian Standard (continued)

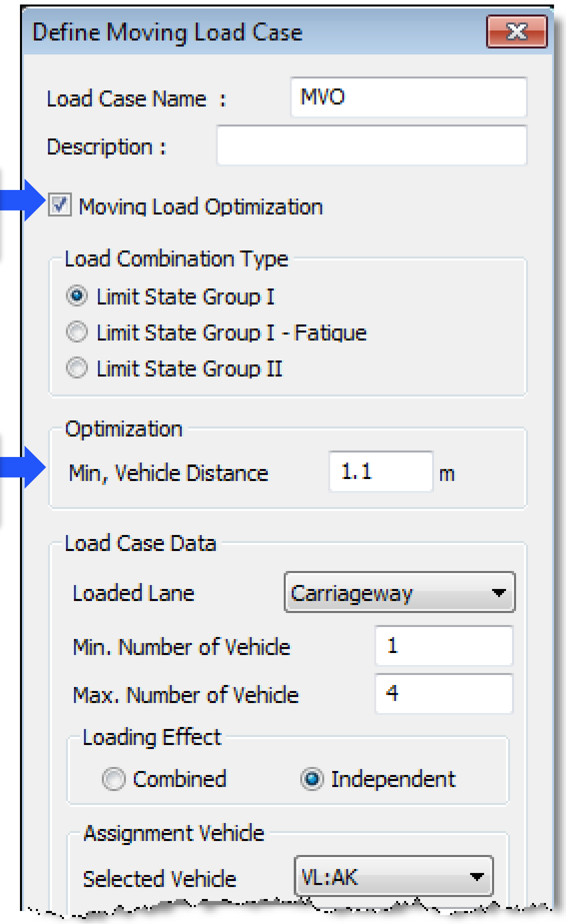
3. Define vehicle.



4. Define Moving Load Case.

Check on
"Moving Load Optimization".

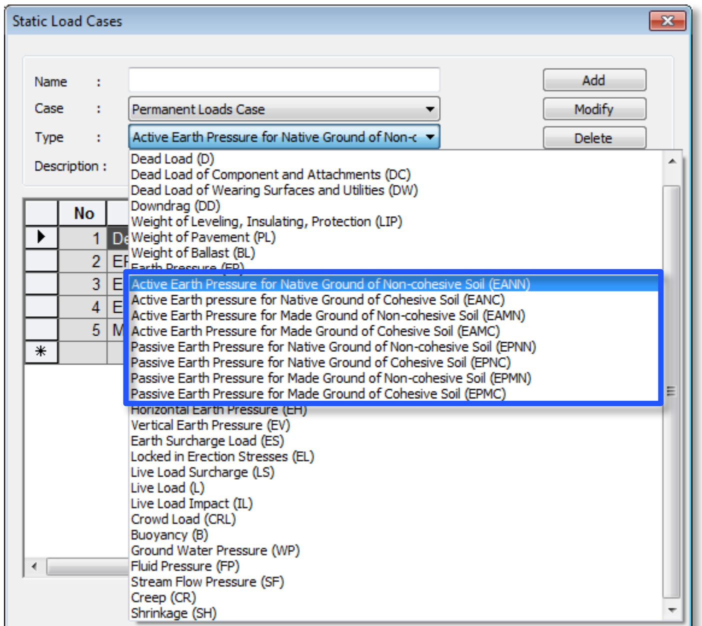
Minimum distance between
two vehicles in the transverse direction.



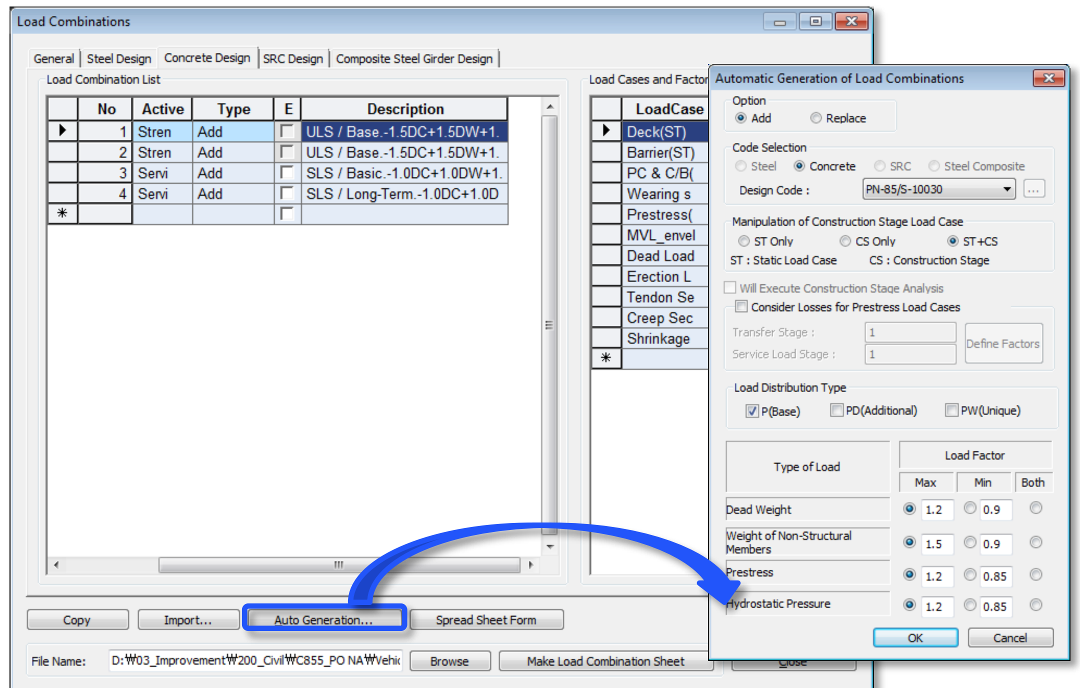
4. Auto-generation of Load Combinations to Polish Standard

- Load combinations can automatically be generated as per PN-85/S-10030. P (basic combination), PD (additional combination) and PW (unique combination) can be considered by selecting the desired load distribution type.
- For dead loads, prestress and hydrostatic pressure loads, both favorable and unfavorable case can ben considered and different load factors will be applied in the load combinations.
- New static load case types were added such as Active/Passive Earth Pressure for Native/Made Ground of Cohesive/Non-cohesive Soil.
- Following load types are considered in the auto-generation of load combinations:
  - ✓ Static Load Cases (DL, DC, DW, PS, EP, EANN, EANC, EAMN, EAMC, EPNN, EPNC, EPMN, EPMC, WP, CF, BRK, CRL, T, W, IP)
  - ✓ Construction Stage Load Cases (Dead Load, Erection Load, Creep Secondary, Shrinkage Secondary, Tendon Secondary)
  - ✓ Settlement Load Cases
  - ✓ Moving Load Cases

- ***Load > Load Type > Static Loads***
- ***Results > Load Combination***



Static Load Cases

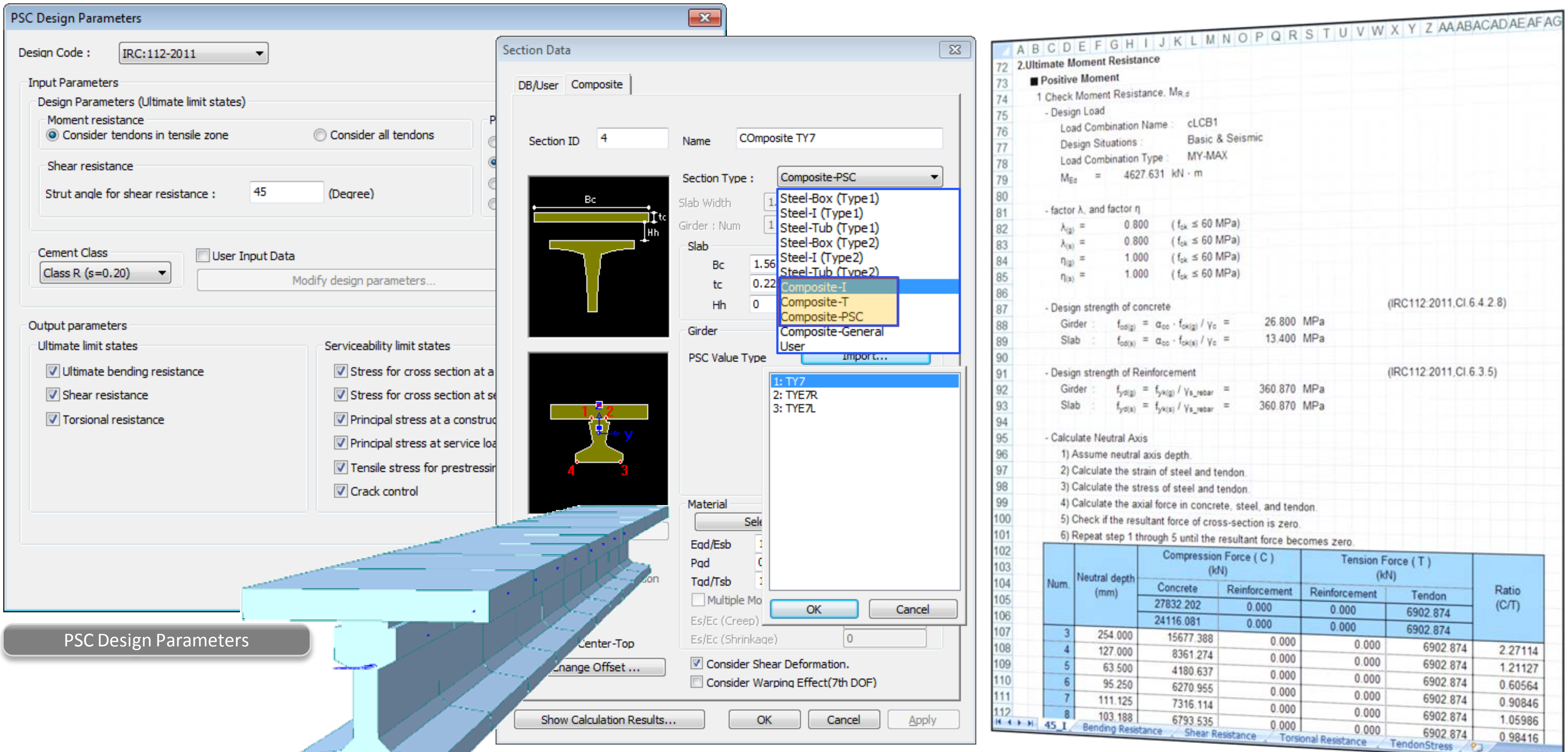


Auto generation of load combinations

5. PSC Composite Section Design to Indian Standard

- In the previous version, only composite general section defined using SPC can be designed to IRC:112-2011. In the new version, sections defined in the Section dialog in midas Civil can also be designed. Modeling to define / modify a typical shape of composite I, T and PSC sections are much faster and easier.
- Applicable section type for design: Composite-I, Composite-T, Composite-PSC and User type

PSC > Design Parameter > ***IRC 112-2012***



PSC Design Parameters

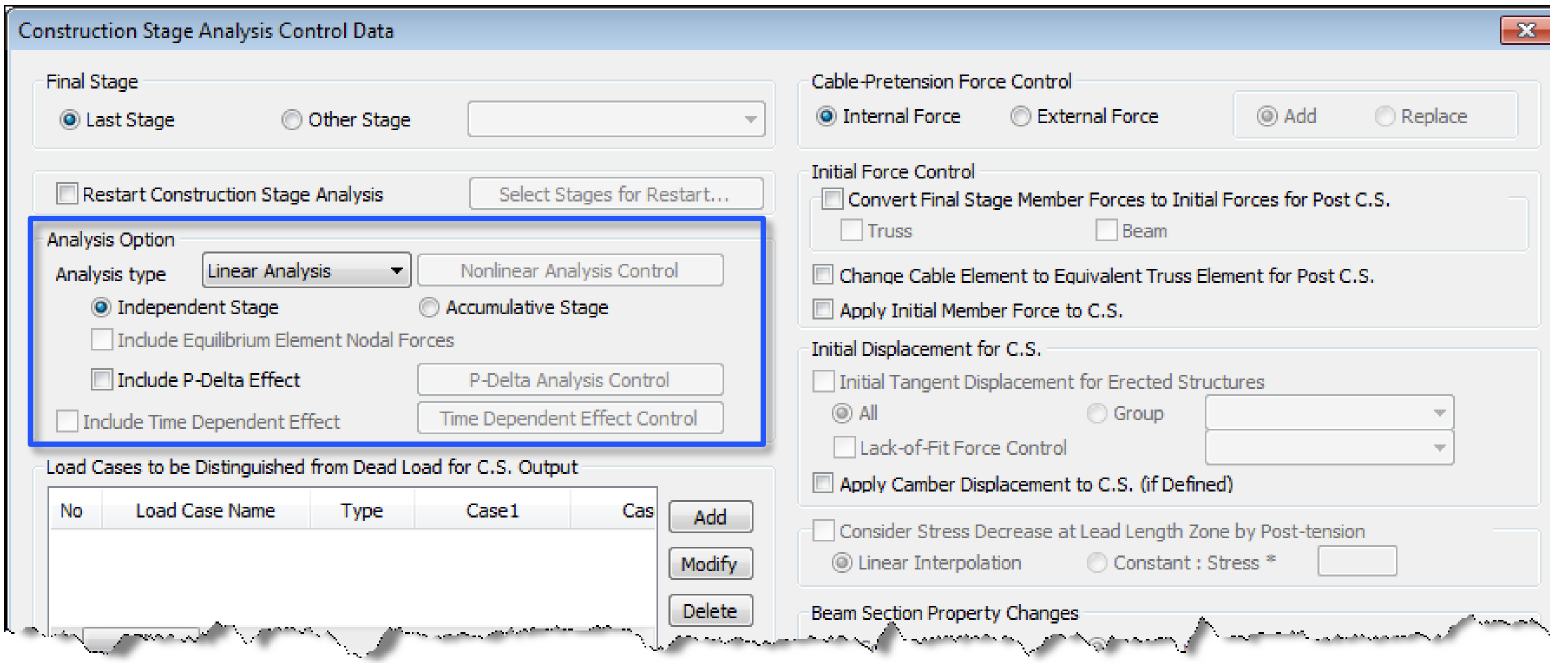
PSC Composite Section

Design Report

6. Linear independent stage analysis

- In the previous versions, the 'Independent Stage' option was only activated in the nonlinear analysis and mostly used for the backward analysis of a suspension bridge considering large displacement. Geometric nonlinear analysis was carried out independently in models of each construction stage.
- Now, linear analysis is also supported for the independent stage analysis.

▪ ***Analysis > Analysis Control > Construction Stage Analysis Control***

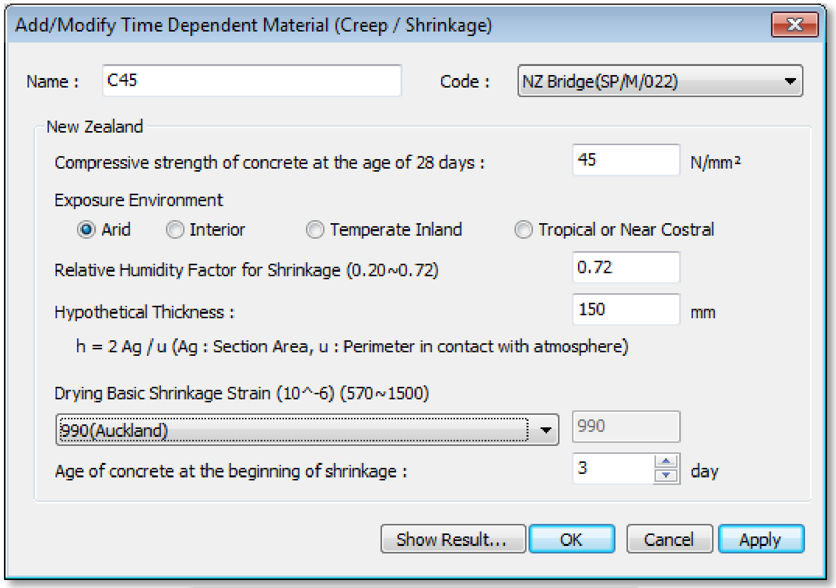


Construction Stage Analysis Control

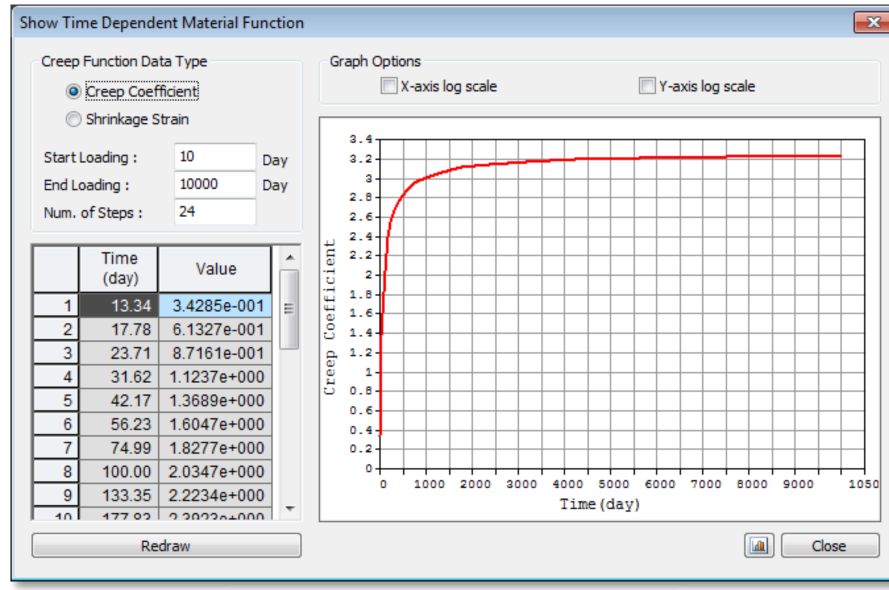
7. Time Dependent Materials as per New Zealand Standard

- Time dependent material properties: Creep and Shrinkage can be defined as per New Zealand Bridge Design Manual (SP/M/022).
- Final drying basic shrinkage table is added as per Table 4.4 of the bridge design manual.

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

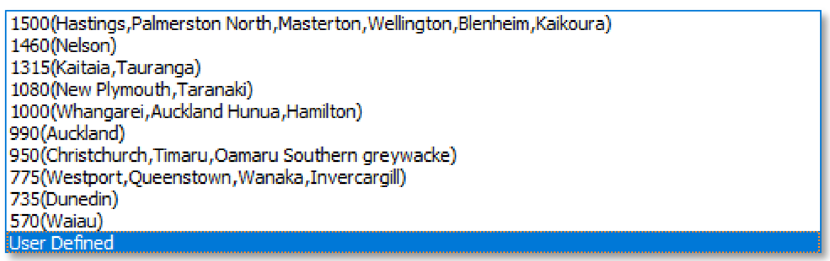


Creep/Shrinkage definition dialog box



Creep Curve

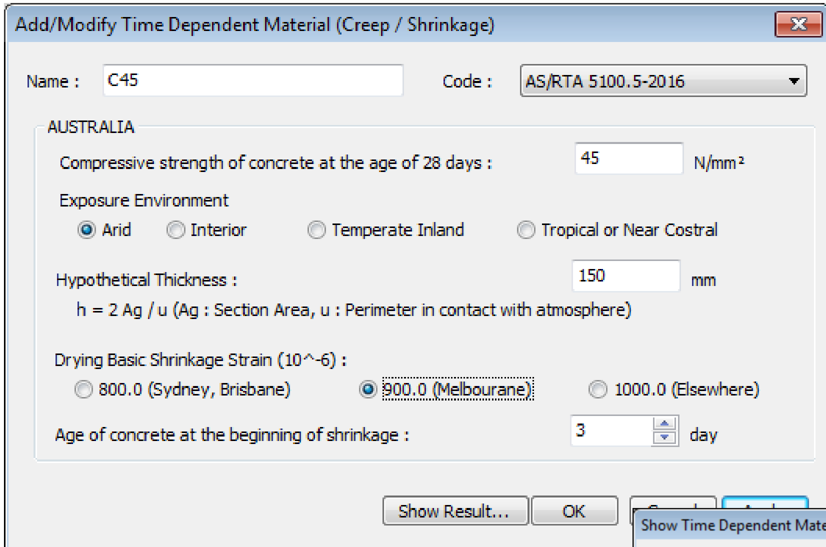
Final Drying Shrinkage Data



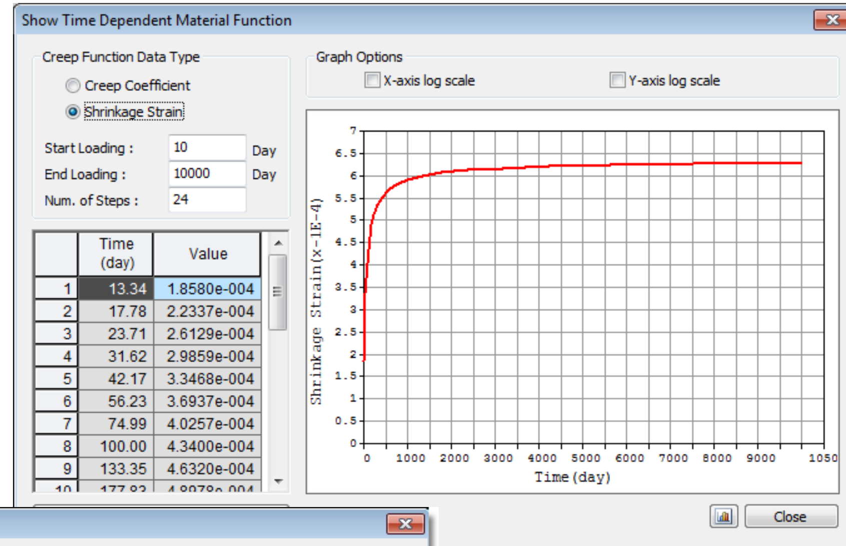
8. Time Dependent Materials as per Australian Standard

- Time dependent material properties: Creep and Shrinkage can be defined as per AS 5100.5 – 2016.

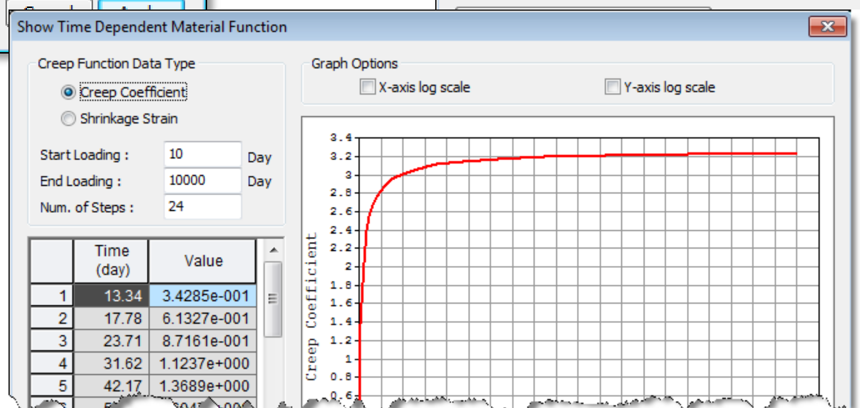
▪ ***Properties > Time Dependent Material> Creep/Shrinkage***



Creep/Shrinkage definition dialog box



Shrinkage Strain



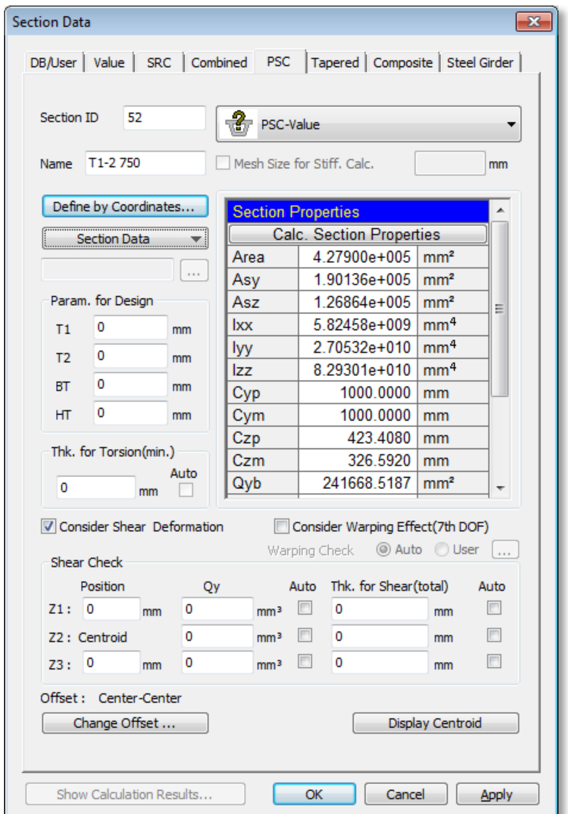
Creep Curve

1. Addition of PSC Super-T and I-girder Section DB

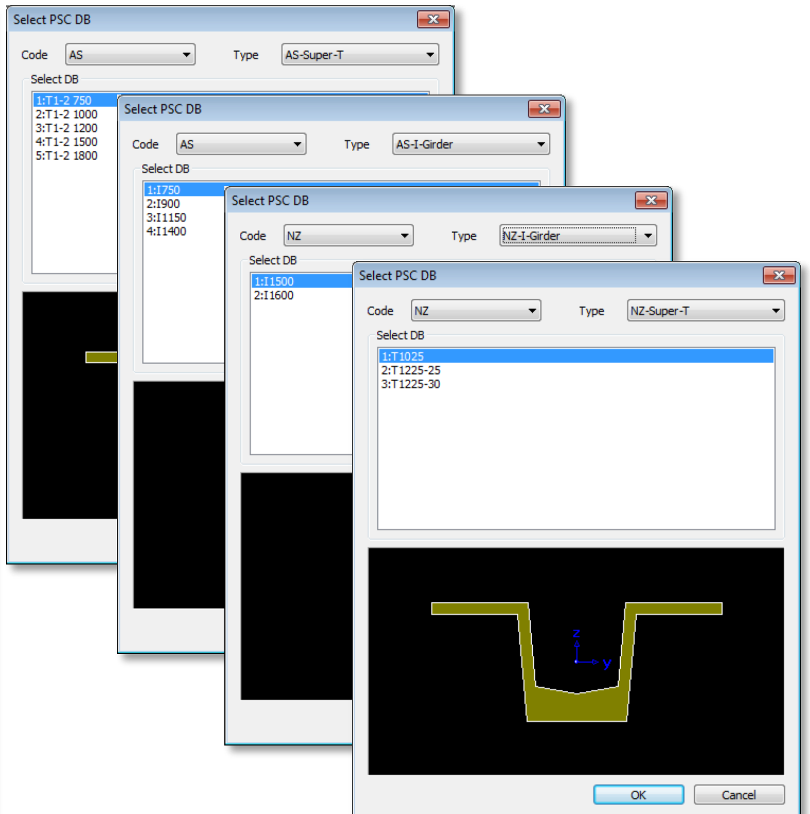
- PSC section database as per AS 5100.5 and NZ Transport Agency is newly added for PSC super-T and I-girder bridges.

- Following sections are available:
  ✓ AS 5100.5 Super-T: Type T1-2 750 mm Deep, T1-2 1000 mm Deep, T1-2 1200 mm Deep, T1-2 1500 mm Deep, T1-2 1800 mm Deep
  ✓ AS 5100.5 I-girder: Type-1 750mm Deep, Type-2 900mm Deep, Type-3 1150mm Deep, Type-4 1400mm Deep
  ✓ NZ Transport Agency Super-T: 1225mm Deep Super-T beam 30m Span, 1225mm Deep Super-T beam 25m & 27.5m Span, 1025mm Deep Super-T beam 25m & 27.5m Span
  ✓ NZ Transport Agency I-girder: 1600mm Deep I-beam, 1500mm Deep I-beam

▪ ***Properties > Section Properties***



PSC Value Type Section Properties



AS and NZ PSC Section DB

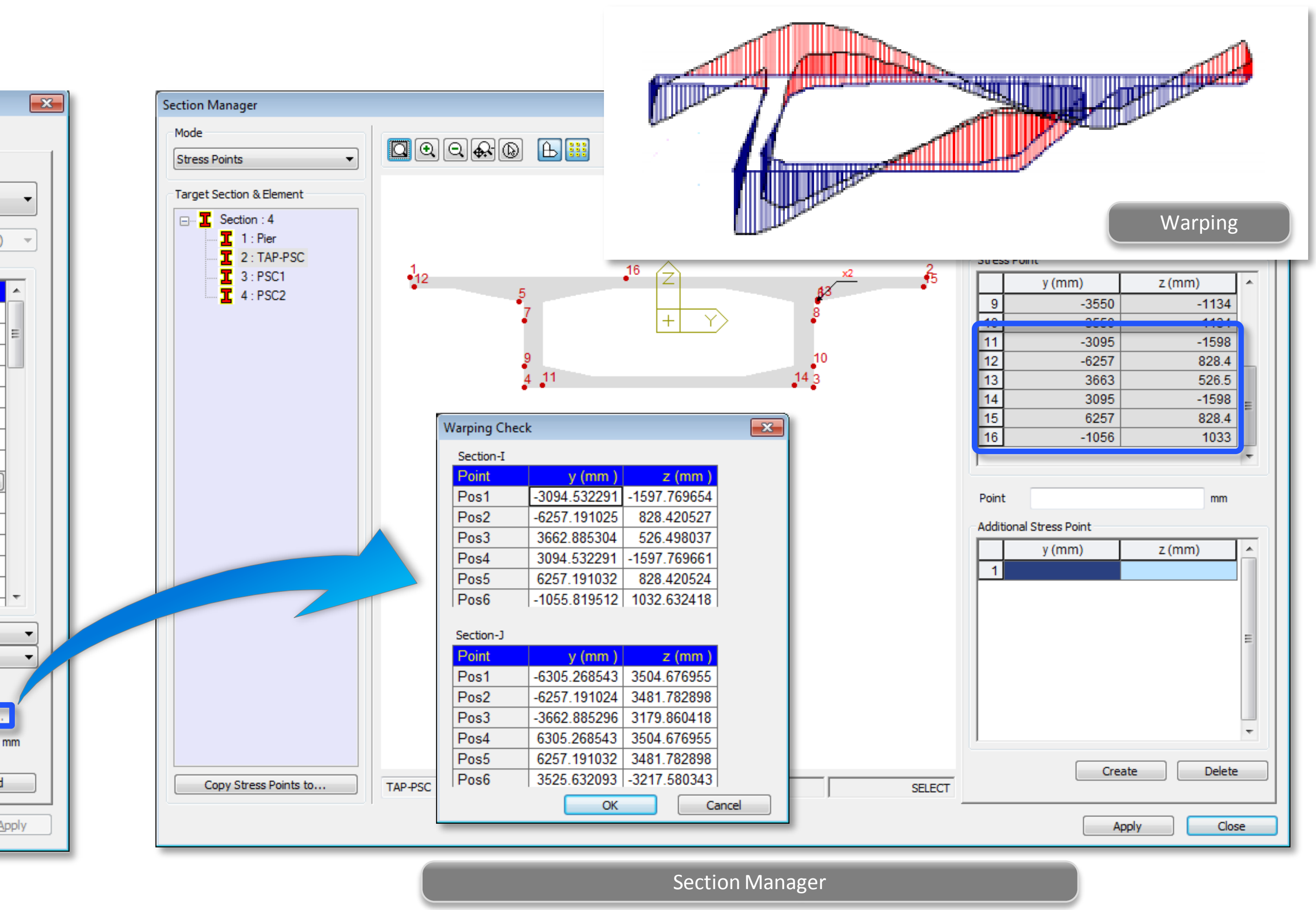
Super-T and I-girder Bridge

2. Critical stress locations due to warping for PSC section type

- The locations for the critical normal stresses and shear stresses due to warping are automatically identified for the PSC section type including tapered PSC section.
- The locations can be viewed from the Section Manager dialog.
- Two points for the maximum/minimum normal stresses and four points for the maximum/minimum shear stresses in the xy and xz plane due to warping.

Properties > Section > Section Properties

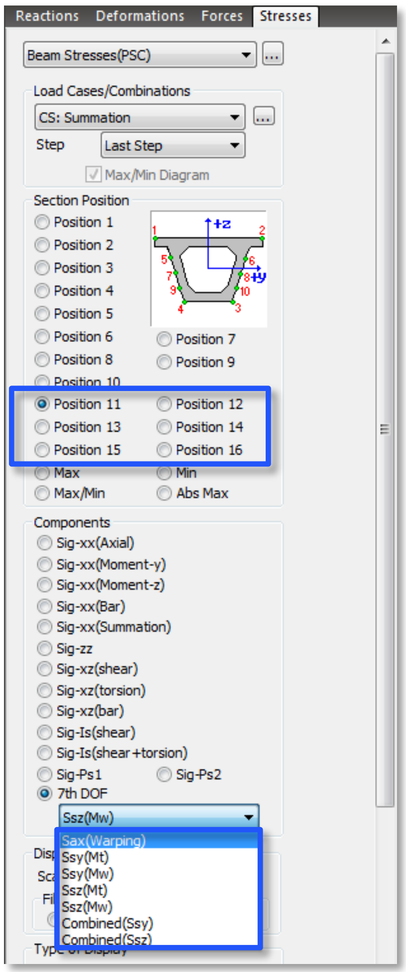
Properties > Section > Section Manager



2. Maximum stress locations due to warping for PSC section type (continued)

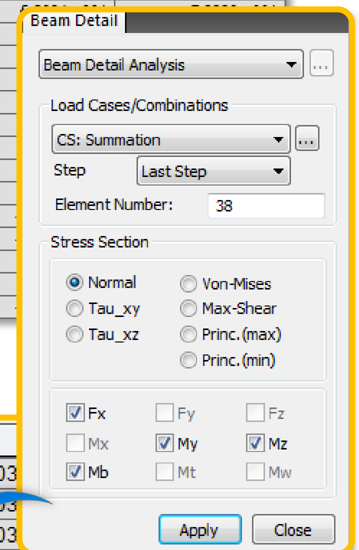
- Normal stresses and shear stresses due to bending, torsion and warping can be checked for the added six points in the Beam Stresses (PSC) menu and the 'Beam Detail Analysis' menu.

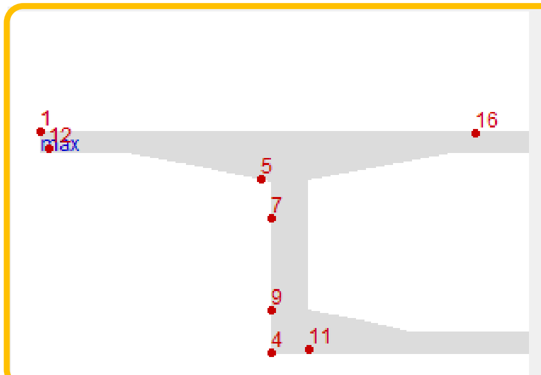
Results > Stresses > Beam Stresses (PSC)
Results > Detail > Beam Element > Beam Detail Analysis



Section Position	Sax(Warping) (N/mm^2)	Ssy(Mt) (N/mm^2)	Ssy(Mw) (N/mm^2)	Ssz(Mt) (N/mm^2)	Ssz(Mw) (N/mm^2)	Combined(Ssy) (N/mm^2)	Combined(Ssz) (N/mm^2)
Pos-1	-6.5295e-001	-3.0337e-001	-1.0655e-001	-1.5527e-001	2.9205e+000	-4.0993e-001	2.7652e+000
Pos-2	6.5295e-001	-3.0337e-001	-1.0655e-001	1.5527e-001	7.3458e-001	-4.0993e-001	8.8985e-001
Pos-3	5.6977e+000	4.0068e-001	1.5966e-001	4.1280e-001	3.8710e-001		
Pos-4	-5.6977e+000	4.0068e-001	1.5966e-001	-4.1280e-001	-3.8710e-001		
Pos-5	1.3134e+000	1.2787e+000	-1.5339e-001	-7.6233e-001	-3.7651e-001		
Pos-6	-1.3134e+000	1.2787e+000	-1.5339e-001	7.6233e-001	3.7651e-001		
Pos-7	-2.6894e-001	1.4324e-001	-1.0355e-002	-3.0023e+000	-1.9989e-001		
Pos-8	3.3342e-001	1.4324e-001	-1.0355e-002	3.0023e+000	1.9989e-001		
Pos-9	-3.4205e+000	-7.1397e-003	1.2924e-001	-2.6449e+000	-2.2573e-001		
Pos-10	3.4205e+000	-7.1397e-003	1.2924e-001	2.6449e+000	2.2573e-001		
Pos-11	-5.9537e+000	2.6888e+000	-6.7300e-003	5.5147e+000	-7.6213e-001		
Pos-12	-2.9028e+000	-1.4263e-001	-8.6986e-002	2.2041e+000	-8.9425e-001		
Pos-13	-1.3134e+000	-3.0040e-002	-5.9665e-002	2.2712e+000	2.6601e-001		
Pos-14	5.9537e+000	7.6233e-001	1.3254e-001	2.5654e-001	3.4490e-001		
Pos-15	2.9028e+000	1.4262e-001	-1.0761e-001	1.2787e+000	6.4246e-001		
Pos-16	2.3796e+000	3.0040e-002	-1.2345e-001	2.2712e+000	-2.8820e-001		

Beam Stresses (PSC)





Position	Stress	y coordi.	
Pos-6	-5.06222e+000	3.67500e+003	
Pos-7	-6.55928e+000	-3.55000[illegible]	
Pos-8	-6.62856e+000	3.55[illegible]e+003	
Pos-9	-1.02601e+001	-3.55[illegible]e+003	-1.13447e+003
Pos-10	-1.03294e+001	3.55000e+003	-1.13447e+003
Pos-11	-1.17985e+001	-3.09453e+003	-1.60469e+003
Pos-12	-3.80360e+000	-6.25719e+003	8.36639e+002
Pos-13	-4.88532e+000	3.66289e+003	5.34716e+002
Pos-14	-1.18589e+001	3.09453e+003	-1.60469e+003
Pos-15	-3.92571e+000	6.25719e+003	8.36639e+002
Pos-16	-3.18818e+000	-1.05582e+003	1.04085e+003

Beam Detail Analysis