

# Release Note

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Release Date : Oct. 2016

Product Ver. : Civil 2017 (v1.1)



# DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

# Enhancements

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- 1) Assessment Live Loading to BD 21/01
- 2) Moving Load Analysis to Polish Standard
- 3) Moving Load Optimization to Russian Standard
- 4) Auto-generation of Load Combinations to Polish Standard
- 5) PSC Composite Section Design to Indian Standard
- 6) Linear independent stage analysis
- 7) Time Dependent Materials as per New Zealand Standard
- 8) Time Dependent Materials as per Australian Standard

## ▪ Pre & Post-Processing ..... 18

- 1) Addition of PSC Super-T and I-girder Section DB
- 2) Critical stress locations due to warping for PSC section type



## 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  $40 \leq L < 50$**

$$AF = 1.$$

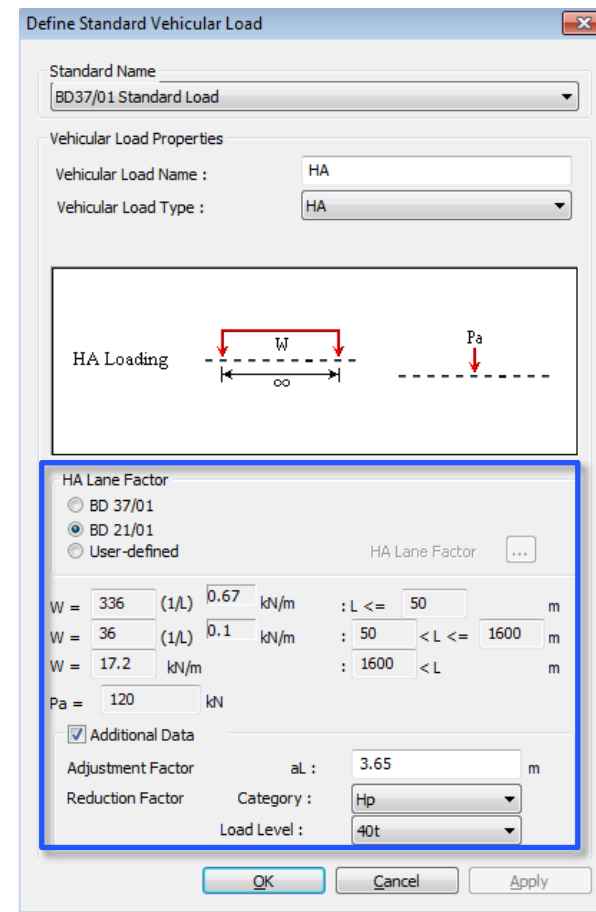
Where  $a_L = 3.65\text{m}$  and  $L$  is the loaded length (m).

- Bridge Specific Live Loading**

$$= HA / (\text{Adjustment Factor}) \times \text{Reduction Factor} \times \text{Lane Factor}$$

- Lane Factor**

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



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	1.1	1.0
HA	1.3	1.3

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

### 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.

Auto Live Load Combination  
 Type of Design Combination Factor  
 Ultimate Limit State  
 Serviceability Limit State  
 Combination of Loads  
 Combination 1  
 Combination 2 or 3  
 Load Case Data  
 Standard Load : HA  
 Special Load : None

Moving Load Case Dialog Box

Load Case Name : MV1  
 Description :  
 Select Load Model  
 Standard Load (BD 37/01, BS 5400)  
 Special Load (BD 86/11)  
 Auto Live Load Combination  
 Type of Design Combination Factor  
 Ultimate Limit State  
 Serviceability Limit State  
 Combination of Loads  
 Combination 1  
 Combination 2 or 3  
 Load Case Data  
 Standard Load : HA  
 Special Load : SOV 250  
 Assignment Lanes  

Line of Lanes	Selected Lanes	Straddling Lanes
	L1 L2 L3	L1 : L2

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**

**Define Design Traffic Line Lane**

Lane Name : Lane1

**Traffic Lane Properties**

Lane Width : 3 m

Eccentricity : 0 m

Wheel Spacing: 2.7 m

Traffic Lane Optimization

**Vehicular Load Distribution**

Lane Element  Cross Beam

Cross Beam Group

Nodes to be updated

Skew

Start 0 End 0 [deg]

**Moving Direction**

Forward  Backward  Both

**Selection by**

2 Points  Picking  Number

0, 0, 0 m

0, 0, 0 m

**Operations**

Add Insert Delete

No	Elem	Eccen. (m)	Span Start
1	203	0	<input checked="" type="checkbox"/>
2	204	0	<input type="checkbox"/>
3	205	0	<input type="checkbox"/>

OK Cancel Apply

**Define Standard Vehicular Load**

Standard Name

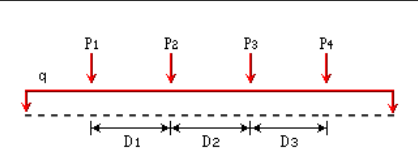
PN-85/S-10030 - RoadBridge

**Vehicular Load Properties**

Vehicular Load Name : Vehicle K

Vehicular Load Type : Vehicle K

Select Vehicle : Class A



No	Load(kN)	Spacing(m)	q
1	200	1.2	4 kN/m <sup>2</sup>
2	200	1.2	
3	200	1.2	
4	200	end	

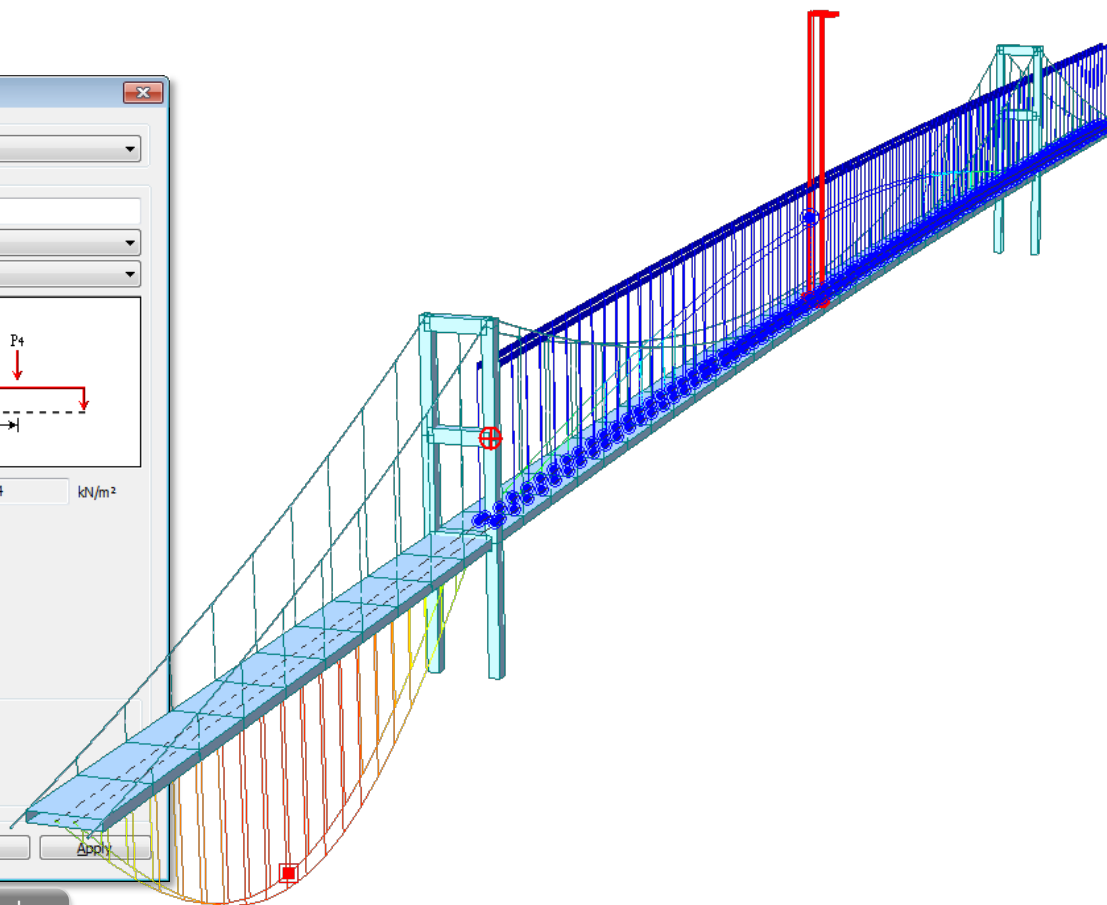
Dynamic Amplification Factor

Auto  User Input

$\phi = 1.35 - 0.005L$  ( $1 \leq \phi \leq 1.325$ )

$\phi$  : 1

OK Cancel Apply



Traffic Line Lane

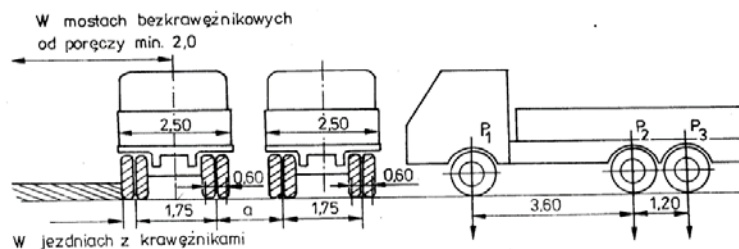
Standard Vehicular Load

## 2. Moving Load Analysis to Polish Standard (continued)

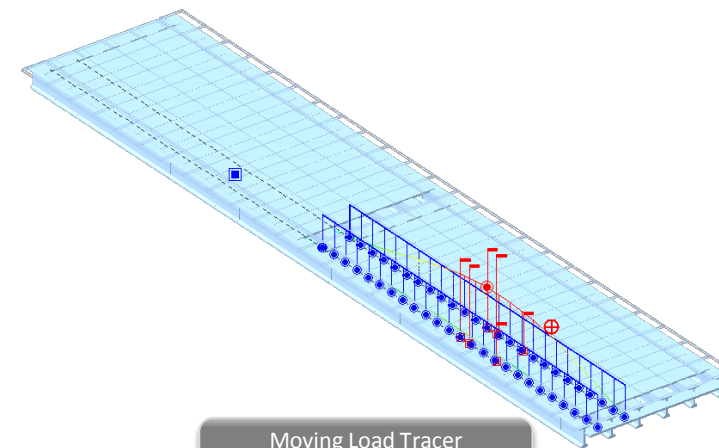
- Limitation for vehicle 2S: One axle of Vehicle 2S consists of 4 wheels. In the program, only two wheels are allowed in one axle. Therefore, the wheel spacing in Traffic Line/Surface Lane dialog box should be entered considering the distance between the centerlines of two trucks. In moving load tracer, 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 <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	
A	300	60	120	120	1,00

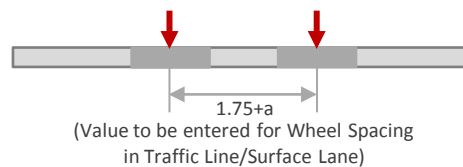


Configuration of Vehicle 2S

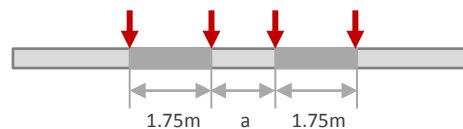


Moving Load Tracer

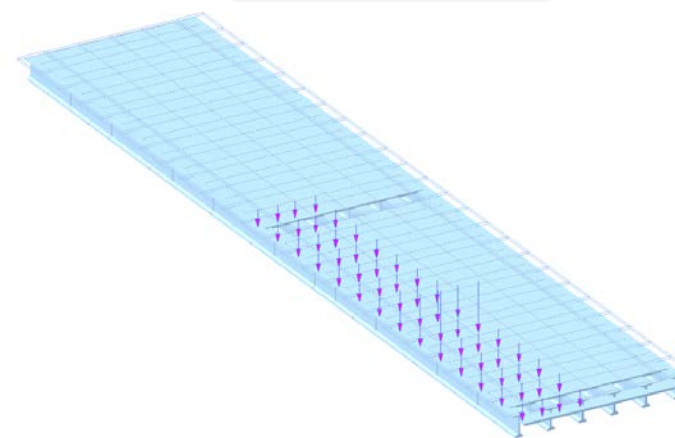
Moving Load Tracer



Convert to Static Load Case



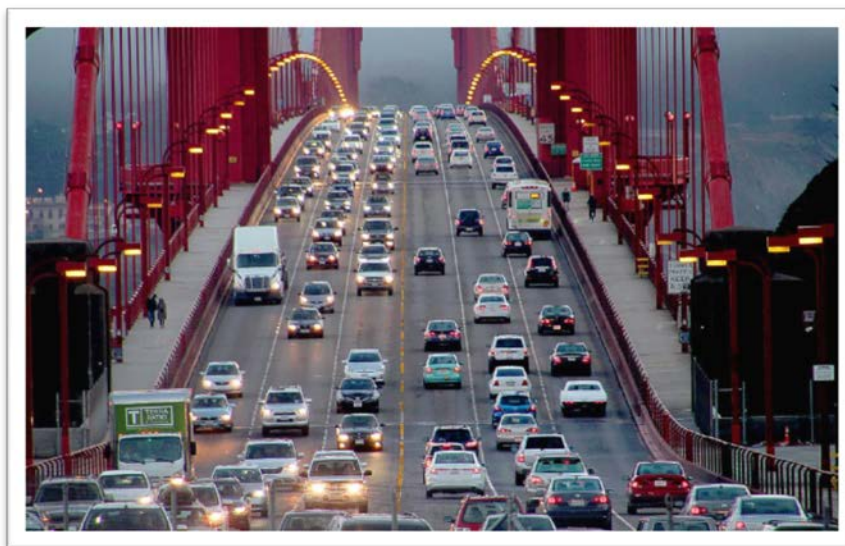
Convert to Static Load Case



### 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

**Moving Load Optimization** [Close]

Lane Name : Carriageway

Traffic Lane Optimization Properties

**a : Eccentricity**

Optimization Lane	16	m
Lane Width	3.5	m
Anal. Lane Offset	0.5	m
Wheel Spacing	1.9	m
Margin	0.55	m
Eccentricity	0	m

Vehicular Load Distribution

Lane Element  Cross Beam

Traffic Line Lane Optimization

**Define Moving Load Case** [Close]

Load Case Name : MVO

Description :

Moving Load Optimization

Load Combination Type

Limit State Group I

Limit State Group I - Fatigue

Limit State Group II

Optimization

Min, Vehicle Distance 1.1 m

Load Case Data

Loaded Lane Carriageway

Min. Number of Vehicle 1

Max. Number of Vehicle 4

Loading Effect

Combined  Independent

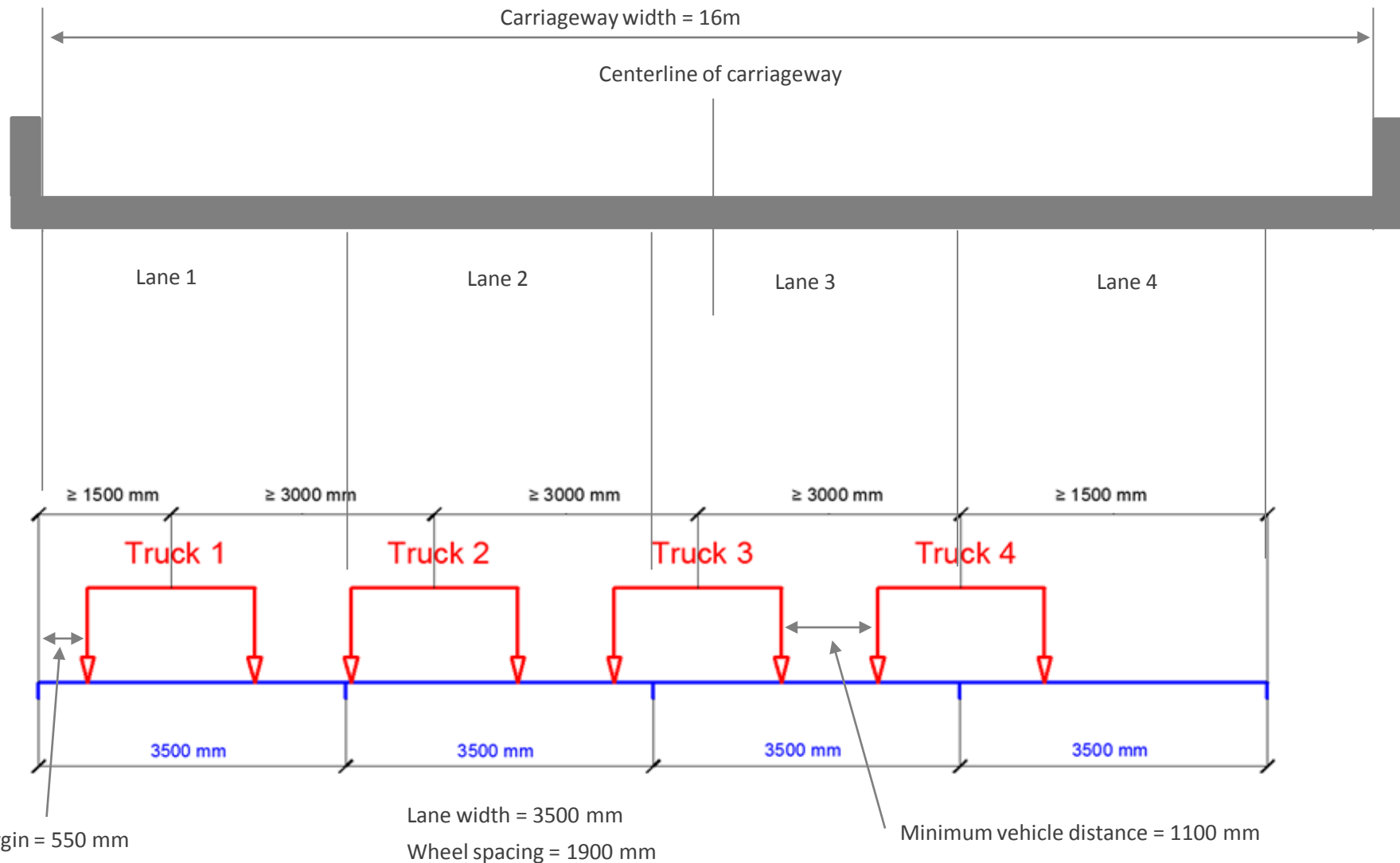
Assignment Vehicle

Selected Vehicle VL:AK

Moving Load Case

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

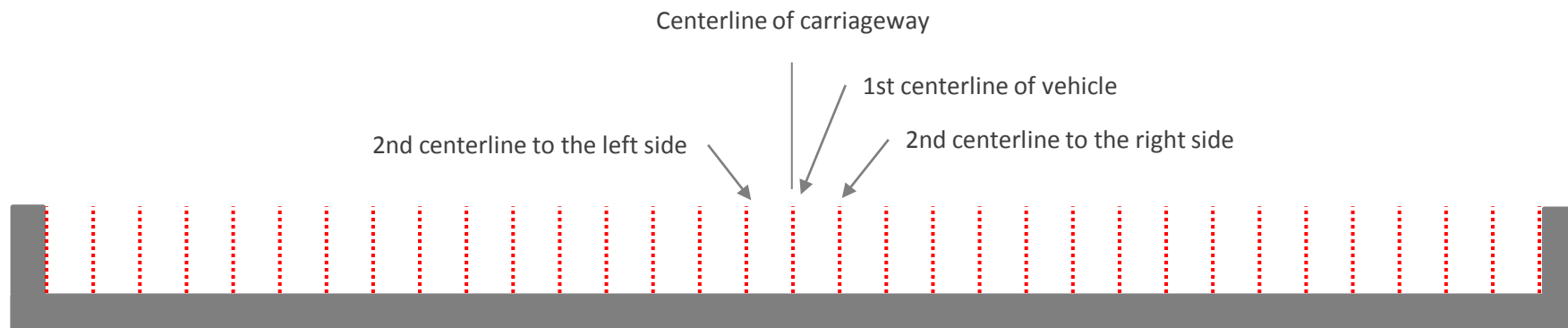
□ An example of Moving Load Optimization to find the worst position of vehicles for the leftmost side of carriageway





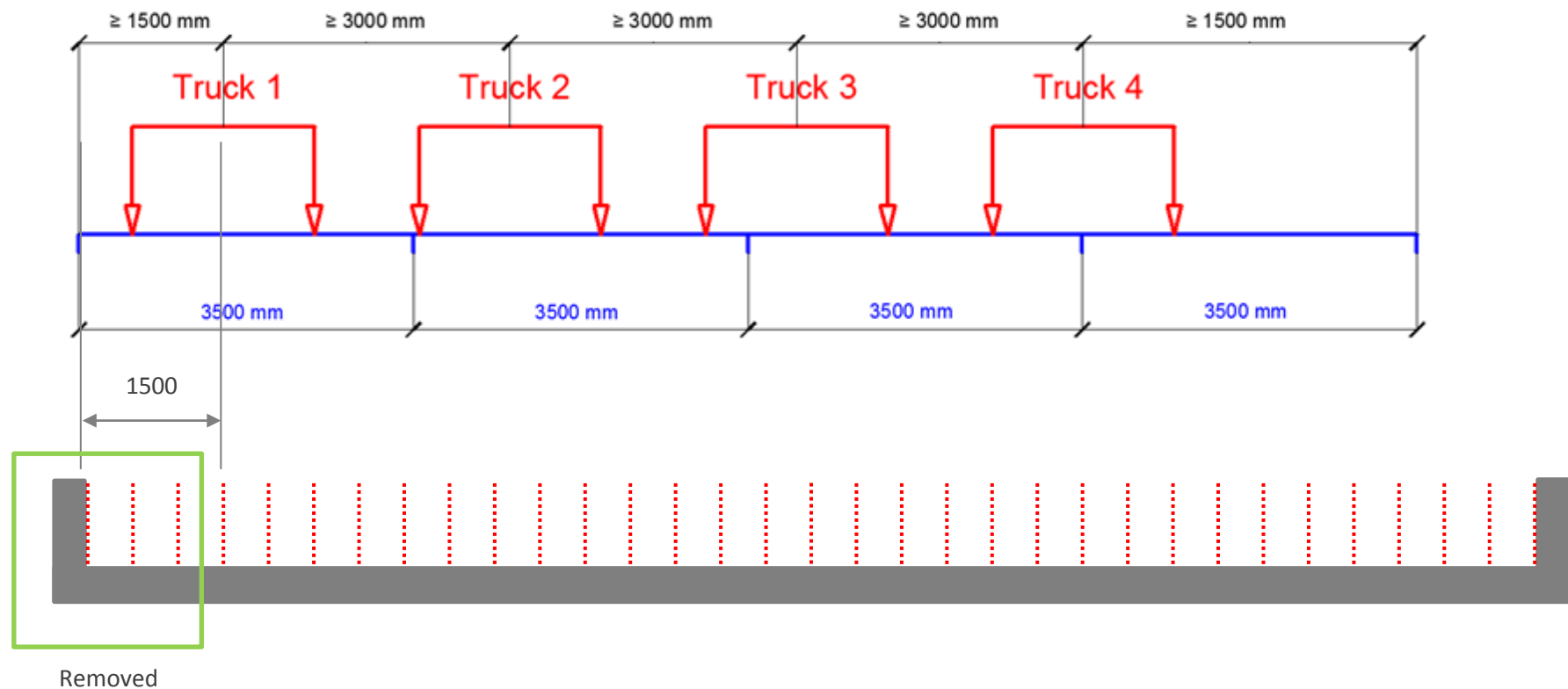
### 3. Moving Load Optimization to the Russian Standard (continued)

- 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)

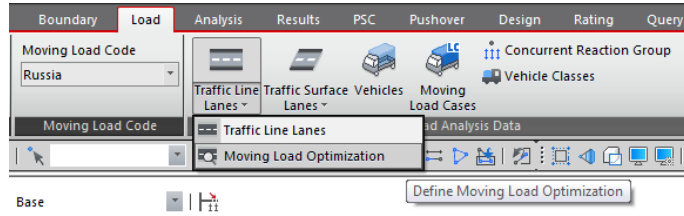
- Vehicle centerlines which do not satisfy the requirement of minimum spacing between vehicle and boundary of carriageway and minimum spacing between vehicles will be removed from the vehicle application.
- For example, the three centerlines in the figure below will be removed from the vehicle application.



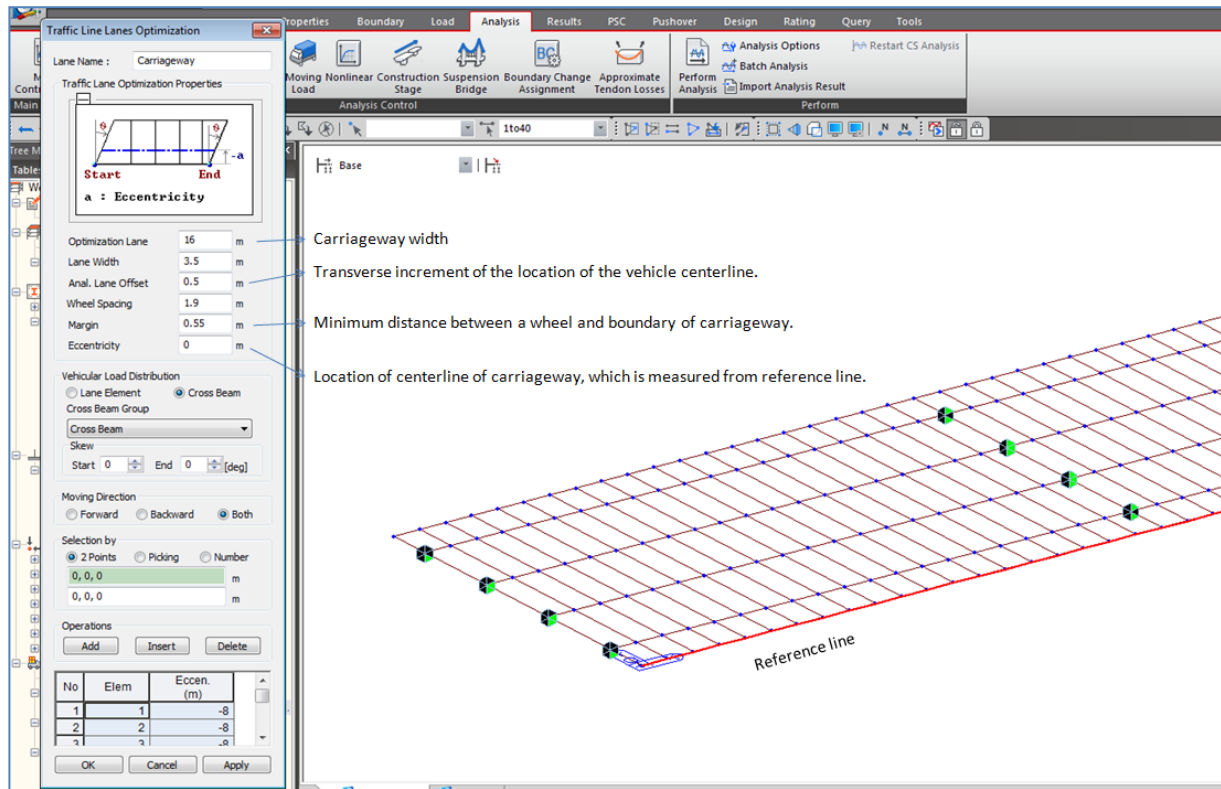
### 3. Moving Load Optimization to the Russian Standard (continued)

#### 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.

**Define Standard Vehicular Load**

Standard Name: Russia - Road Bridge and Railway Bridge

Vehicular Load Properties:  
 Vehicular Load Name: AK  
 Vehicular Load Type: AK

Dynamic Factor:  
 Auto Calculation - SNP  
 Material Type: RC  
 Bridge Type: Road and Town Bridge  
 Dynamic Factor (1+Mu):  $1+(45-\lambda)/135$

User Input  
 Dynamic Factor (1+Mu) for Bogie: 1.4  
 Dynamic Factor (1+Mu) for UDL: 1

Load Reliability Factor:  
 Auto Calculation - SNP  
 User Input  
 Load Reliability Factor (Gamma f) for Bogie: 1.5  
 Load Reliability Factor (Gamma f) for UDL: 1.15

Lane Factor (s1):  

	Lane 1	Lane 2	Lane 3 and more
Bogie	1	0.6	0.3
UDL	1	0.6	0.3

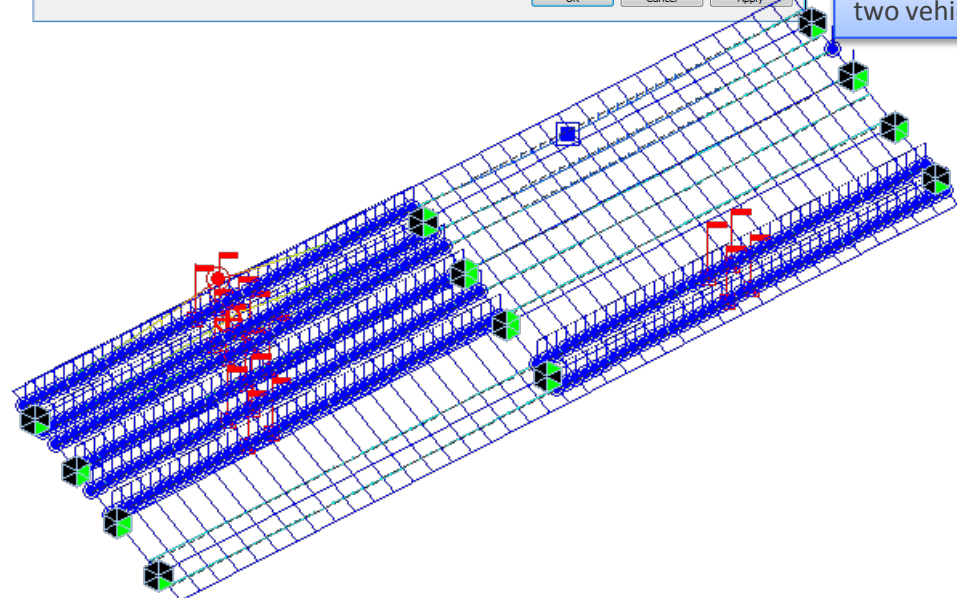
Diagram:  $P_1=10K$ ,  $P_2=10K$ ,  $W=1.0K$ ,  $D_1$ , (Unit: KN)

No	Load(kN)	Spacing(m)	K
1	10K	1.5	14
2	10K	end	

Fatigue  
 Apply same Loaded Length between Bogie and UDL

Check on "Moving Load Optimization".

Minimum distance between two vehicles in the transverse direction.



**Define Moving Load Case**

Load Case Name: MVO

Description:

Moving Load Optimization

Load Combination Type:  
 Limit State Group I  
 Limit State Group I - Fatigue  
 Limit State Group II

Optimization:  
 Min, Vehicle Distance: 1.1 m

Load Case Data:  
 Loaded Lane: Carriageway  
 Min. Number of Vehicle: 1  
 Max. Number of Vehicle: 4

Loading Effect:  
 Combined  
 Independent

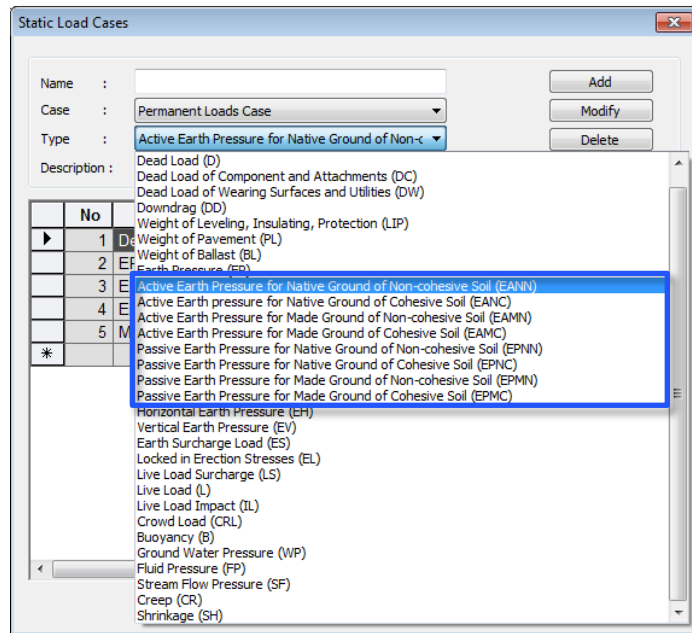
Assignment Vehicle:  
 Selected Vehicle: VL:AK

### 4. Auto-generation of Load Combinations to Polish Standard

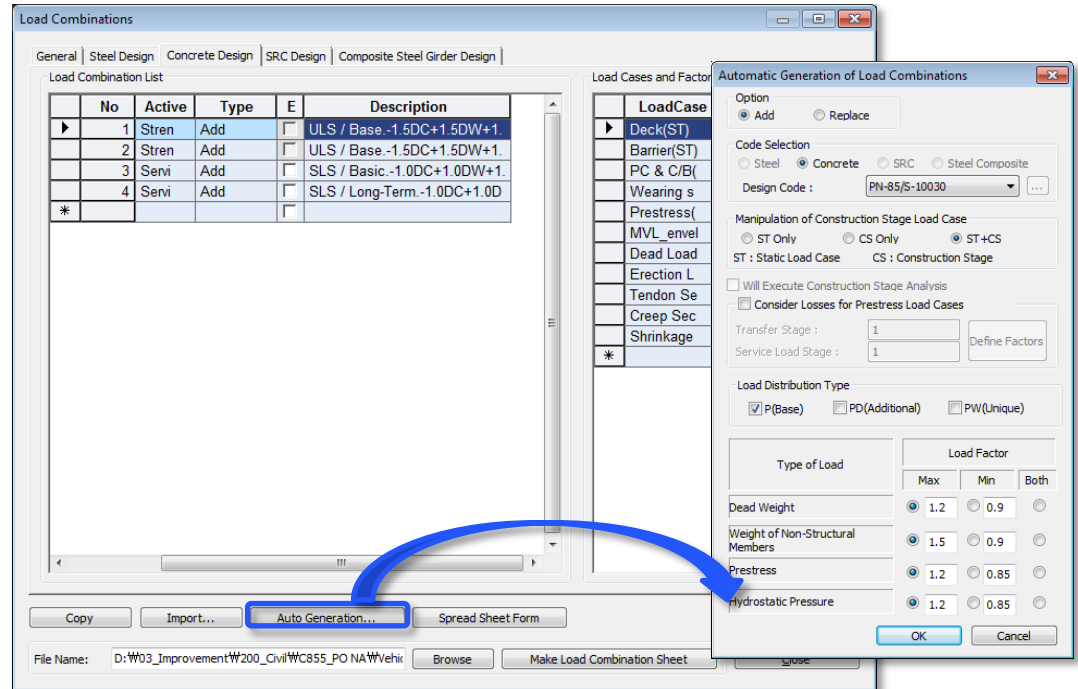
- Load combinations can automatically be generated as per PN-85/S-10030. P (basic combination), PD (additional combination) and PW (unique combination) can be considered by selecting the desired load distribution type.
- For dead loads, prestress and hydrostatic pressure loads, both favorable and unfavorable case can be 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**

Design Code : IRC:112-2011

**Input Parameters**

Design Parameters (Ultimate limit states)

Moment resistance  
 Consider tendons in tensile zone     Consider all tendons

Shear resistance  
 Strut angle for shear resistance : 45 (Degree)

Cement Class  
 Class R (s=0.20)     User Input Data

**Output parameters**

Ultimate limit states  
 Ultimate bending resistance  
 Shear resistance  
 Torsional resistance

Serviceability limit states  
 Stress for cross section at a...  
 Principal stress at a construc...  
 Principal stress at service loa...  
 Tensile stress for prestressin...  
 Crack control

**Section Data**

DB/User Composite

Section ID 4    Name COMposite TY7

Section Type : Composite-PSC

Slab Width 1  
 Girder : Num 1  
 Slab Bc 1.56  
 tc 0.22  
 Hh 0  
 Girder PSC Value Type  
 Multiple Mo  
 Es/Ec (Creep) 0  
 Es/Ec (Shrinkage) 0  
 Consider Shear Deformation.  
 Consider Warping Effect(7th DOF)

Material  
 Eqd/Esb :  
 Pad :  
 Tad/Tsb :  
 Multiple Mo  
 Es/Ec (Creep) :  
 Es/Ec (Shrinkage) :  
 Consider Shear Deformation.  
 Consider Warping Effect(7th DOF)

**2.Ultimate Moment Resistance**

1 Check Moment Resistance,  $M_{Rd}$

- Design Load  
 Load Combination Name : cLCB1  
 Design Situations : Basic & Seismic  
 Load Combination Type : MY-MAX  
 $M_{Ed} = 4627.631 \text{ kN} \cdot \text{m}$

- factor  $\lambda$ , and factor  $\eta$   
 $\lambda_{(g)} = 0.800$  ( $f_{ck} \leq 60 \text{ MPa}$ )  
 $\lambda_{(s)} = 0.800$  ( $f_{ck} \leq 60 \text{ MPa}$ )  
 $\eta_{(g)} = 1.000$  ( $f_{ck} \leq 60 \text{ MPa}$ )  
 $\eta_{(s)} = 1.000$  ( $f_{ck} \leq 60 \text{ MPa}$ )

- Design strength of concrete (IRC112.2011.CI.6.4.2.8)  
 Girder :  $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 26.800 \text{ MPa}$   
 Slab :  $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 13.400 \text{ MPa}$

- Design strength of Reinforcement (IRC112.2011.CI.6.3.5)  
 Girder :  $f_{yd(g)} = f_{yk(g)} / \gamma_{s,reqar} = 360.870 \text{ MPa}$   
 Slab :  $f_{yd(s)} = f_{yk(s)} / \gamma_{s,reqar} = 360.870 \text{ MPa}$

- Calculate Neutral Axis  
 1) Assume neutral axis depth.  
 2) Calculate the strain of steel and tendon.  
 3) Calculate the stress of steel and tendon.  
 4) Calculate the axial force in concrete, steel, and tendon.  
 5) Check if the resultant force of cross-section is zero.  
 6) Repeat step 1 through 5 until the resultant force becomes zero.

Num.	Neutral depth (mm)	Compression Force (C) (kN)		Tension Force (T) (kN)		Ratio (C/T)
		Concrete	Reinforcement	Reinforcement	Tendon	
		27832.202	0.000	0.000	6902.874	
		24116.081	0.000	0.000	6902.874	
3	254.000	15677.388	0.000	0.000	6902.874	2.27114
4	127.000	8361.274	0.000	0.000	6902.874	1.21127
5	63.500	4180.637	0.000	0.000	6902.874	0.60564
6	95.250	6270.955	0.000	0.000	6902.874	0.90846
7	111.125	7316.114	0.000	0.000	6902.874	1.05986
8	103.188	6793.535	0.000	0.000	6902.874	0.98416

## 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 Data**

Final Stage  
 Last Stage     Other Stage   

Restart Construction Stage Analysis   

**Analysis Option**  
 Analysis type:       
 Independent Stage     Accumulative Stage  
 Include Equilibrium Element Nodal Forces  
 Include P-Delta Effect      
 Include Time Dependent Effect   

Load Cases to be Distinguished from Dead Load for C.S. Output

No	Load Case Name	Type	Case 1	Cas

Cable-Pretension Force Control  
 Internal Force     External Force     Add     Replace

Initial Force Control  
 Convert Final Stage Member Forces to Initial Forces for Post C.S.  
 Truss     Beam

Change Cable Element to Equivalent Truss Element for Post C.S.  
 Apply Initial Member Force to C.S.

Initial Displacement for C.S.  
 Initial Tangent Displacement for Erected Structures  
 All     Group      
 Lack-of-Fit Force Control      
 Apply Camber Displacement to C.S. (if Defined)

Consider Stress Decrease at Lead Length Zone by Post-tension  
 Linear Interpolation     Constant : Stress \*   

Beam Section Property Changes

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

**Add/Modify Time Dependent Material (Creep / Shrinkage)**

Name : C45 Code : NZ Bridge(SP/M/022)

New Zealand

Compressive strength of concrete at the age of 28 days : 45 N/mm<sup>2</sup>

Exposure Environment

Arid  Interior  Temperate Inland  Tropical or Near Coastal

Relative Humidity Factor for Shrinkage (0.20~0.72) : 0.72

Hypothetical Thickness : 150 mm

$h = 2 A_g / u$  ( $A_g$  : Section Area,  $u$  : Perimeter in contact with atmosphere)

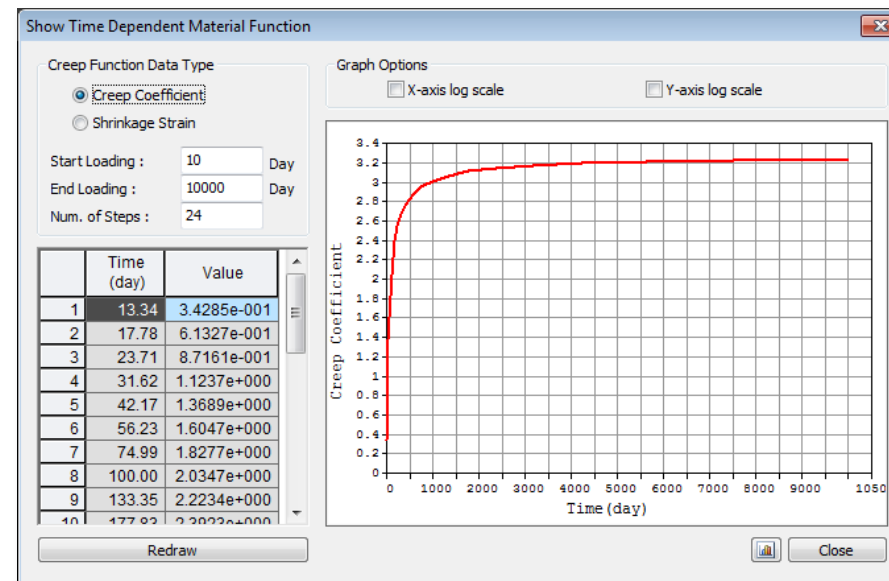
Drying Basic Shrinkage Strain ( $10^{-6}$ ) (570~1500)

990(Auckland) 990

Age of concrete at the beginning of shrinkage : 3 day

Show Result... OK Cancel Apply

Creep/Shrinkage definition dialog box



Creep Curve

Final  
Drying  
Shrinkage  
Data

1500(Hastings,Palmerston North,Masterton,Wellington,Blenheim,Kaikoura)  
1460(Nelson)  
1315(Kaitaia,Tauranga)  
1080(New Plymouth,Taranaki)  
1000(Whangarei,Auckland Hunua,Hamilton)  
990(Auckland)  
950(Christchurch,Timaru,Oamaru Southern greywacke)  
775(Westport,Queenstown,Wanaka,Invercargill)  
735(Dunedin)  
570(Waiiau)  
User Defined



## 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

**Add/Modify Time Dependent Material (Creep / Shrinkage)**

Name : C45 Code : AS/RTA 5100.5-2016

**AUSTRALIA**

Compressive strength of concrete at the age of 28 days : 45 N/mm<sup>2</sup>

Exposure Environment  
 Arid  Interior  Temperate Inland  Tropical or Near Coastal

Hypothetical Thickness : 150 mm  
 $h = 2 A_g / u$  ( $A_g$  : Section Area,  $u$  : Perimeter in contact with atmosphere)

Drying Basic Shrinkage Strain ( $10^{-6}$ ) :  
 800.0 (Sydney, Brisbane)  900.0 (Melbourne)  1000.0 (Elsewhere)

Age of concrete at the beginning of shrinkage : 3 day

Show Result... OK

Creep/Shrinkage definition dialog box

**Show Time Dependent Material Function**

Creep Function Data Type  
 Creep Coefficient  
 Shrinkage Strain

Start Loading : 10 Day  
 End Loading : 10000 Day  
 Num. of Steps : 24

	Time (day)	Value
1	13.34	1.8580e-004
2	17.78	2.2337e-004
3	23.71	2.6129e-004
4	31.62	2.9859e-004
5	42.17	3.3468e-004
6	56.23	3.6937e-004
7	74.99	4.0257e-004
8	100.00	4.3400e-004
9	133.35	4.6320e-004
10	177.83	4.9070e-004

Graph Options  
 X-axis log scale  Y-axis log scale

Close

Shrinkage Strain

**Show Time Dependent Material Function**

Creep Function Data Type  
 Creep Coefficient  
 Shrinkage Strain

Start Loading : 10 Day  
 End Loading : 10000 Day  
 Num. of Steps : 24

	Time (day)	Value
1	13.34	3.4285e-001
2	17.78	6.1327e-001
3	23.71	8.7161e-001
4	31.62	1.1237e+000
5	42.17	1.3689e+000
6	56.23	1.5447e+000
7	74.99	1.6777e+000
8	100.00	1.7677e+000
9	133.35	1.8177e+000
10	177.83	1.8500e+000

Graph Options  
 X-axis log scale  Y-axis log scale

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

Calc. Section Properties		
Area	4.27900e+005	mm <sup>2</sup>
Asy	1.90136e+005	mm <sup>2</sup>
Asz	1.26864e+005	mm <sup>2</sup>
Ixx	5.82458e+009	mm <sup>4</sup>
Iyy	2.70532e+010	mm <sup>4</sup>
Izz	8.29301e+010	mm <sup>4</sup>
Cyp	1000.0000	mm
Cym	1000.0000	mm
Czp	423.4080	mm
Czm	326.5920	mm
Qyb	241668.5187	mm <sup>2</sup>



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

Warping Check

Point	y (mm)	z (mm)
Section-I		
Pos1	-3094.532291	-1597.769654
Pos2	-6257.191025	828.420527
Pos3	3662.885304	526.498037
Pos4	3094.532291	-1597.769661
Pos5	6257.191032	828.420524
Pos6	-1055.819512	1032.632418
Section-J		
Pos1	-6305.268543	3504.676955
Pos2	-6257.191024	3481.782898
Pos3	-3662.885296	3179.860418
Pos4	6305.268543	3504.676955
Pos5	6257.191032	3481.782898
Pos6	3525.632093	-3217.580343

	y (mm)	z (mm)
9	-3550	-1134
10	3550	-1134
11	-3095	-1598
12	-6257	828.4
13	3663	526.5
14	3095	-1598
15	6257	828.4
16	-1056	1033

Section Manager

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

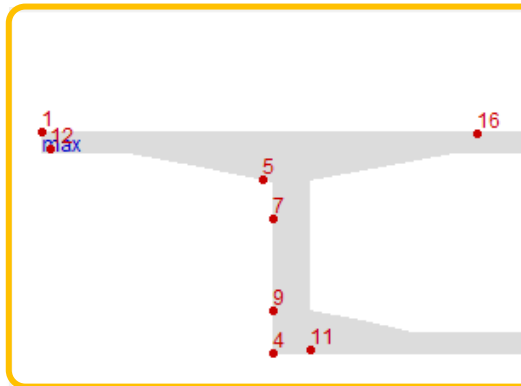
- Normal stresses and shear stresses due to bending, torsion and warping can be checked for the added six points in the Beam Stresses (PSC) menu and the 'Beam Detail Analysis' menu.

Results > Stresses > Beam Stresses (PSC)

Results > Detail > Beam Element > Beam Detail Analysis

Section Position	Sax(Warping) (N/mm <sup>2</sup> )	Ssy(Mt) (N/mm <sup>2</sup> )	Ssy(Mw) (N/mm <sup>2</sup> )	Ssz(Mt) (N/mm <sup>2</sup> )	Ssz(Mw) (N/mm <sup>2</sup> )	Combined(Ssy) (N/mm <sup>2</sup> )	Combined(Ssz) (N/mm <sup>2</sup> )
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	-3.55000e+003	
Pos-8	-6.62856e+000	3.55000e+003	-1.13447e+003
Pos-9	-1.02601e+001	-3.55000e+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