# Release Note

Release Date : December 2018

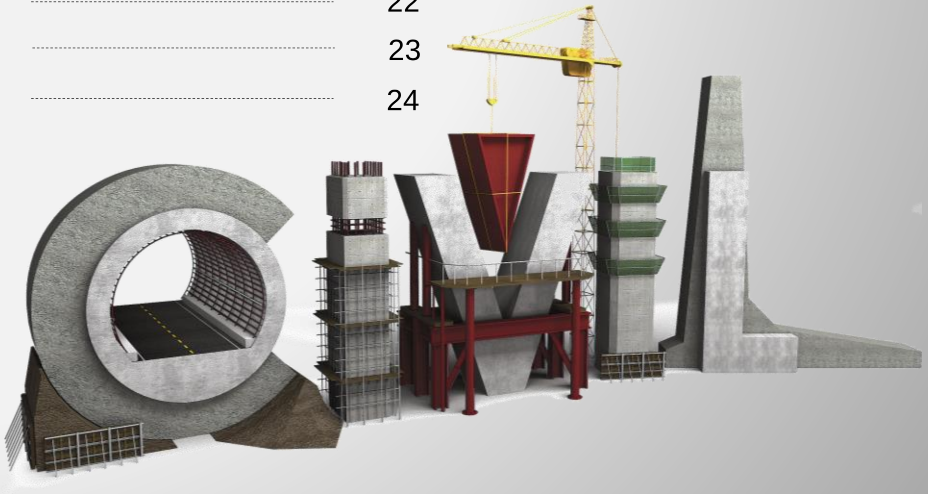
Product Ver. : Civil 2019 (v2.1)


DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

# Enhancements



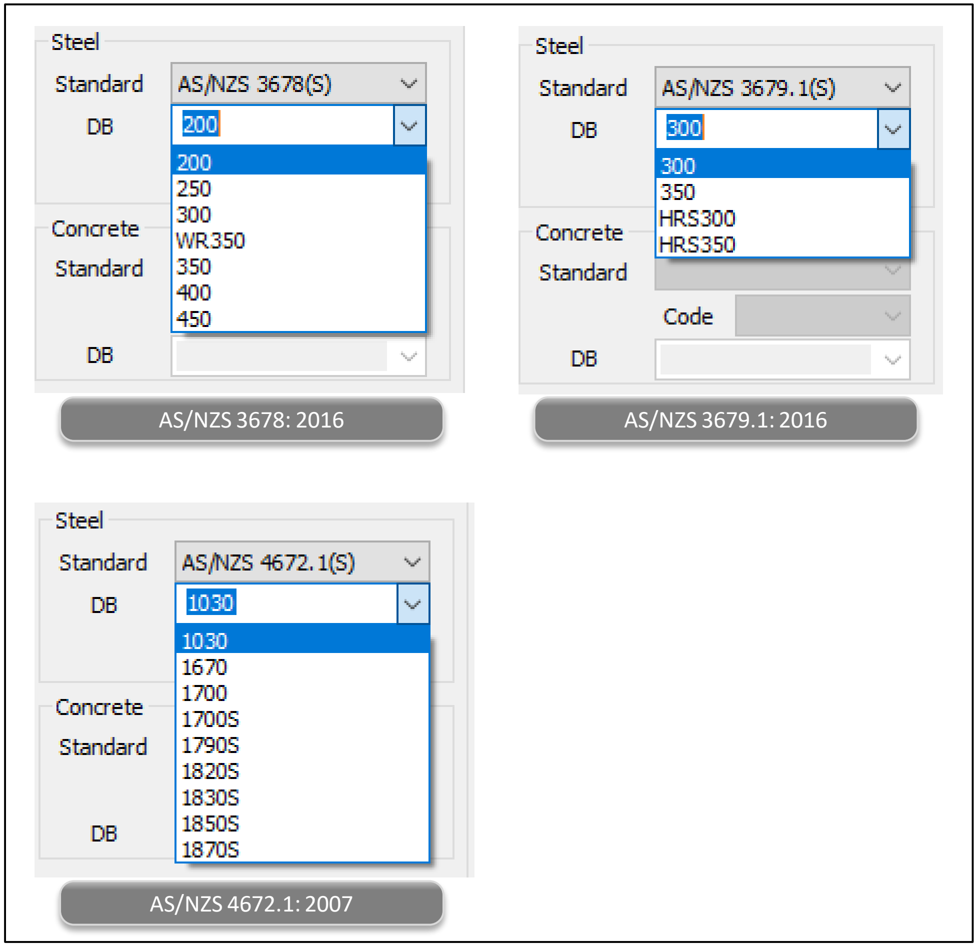


## 1. Material Database of Australia and New Zealand

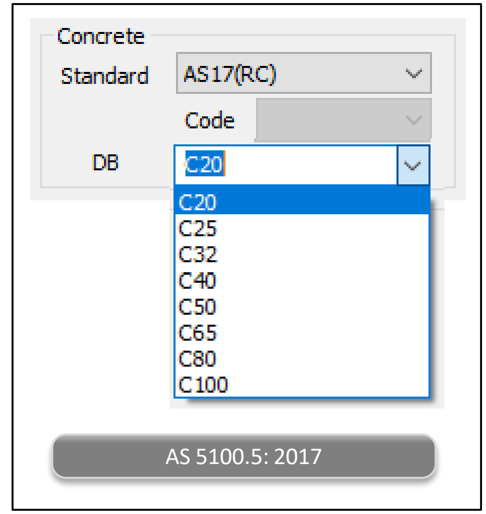
- Steel: AS/NZS 3678: 2016, AS/NZS 3679.1: 2016, AS/NZS 4672.1: 2007
- Concrete: AS 5100.5: 2017

- ***Properties > Material***

Steel



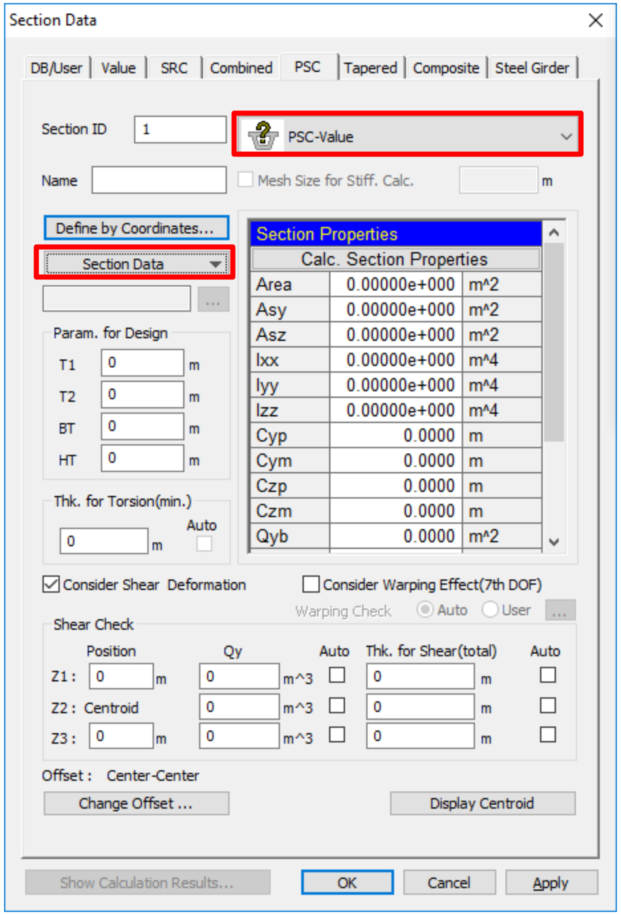

Concrete



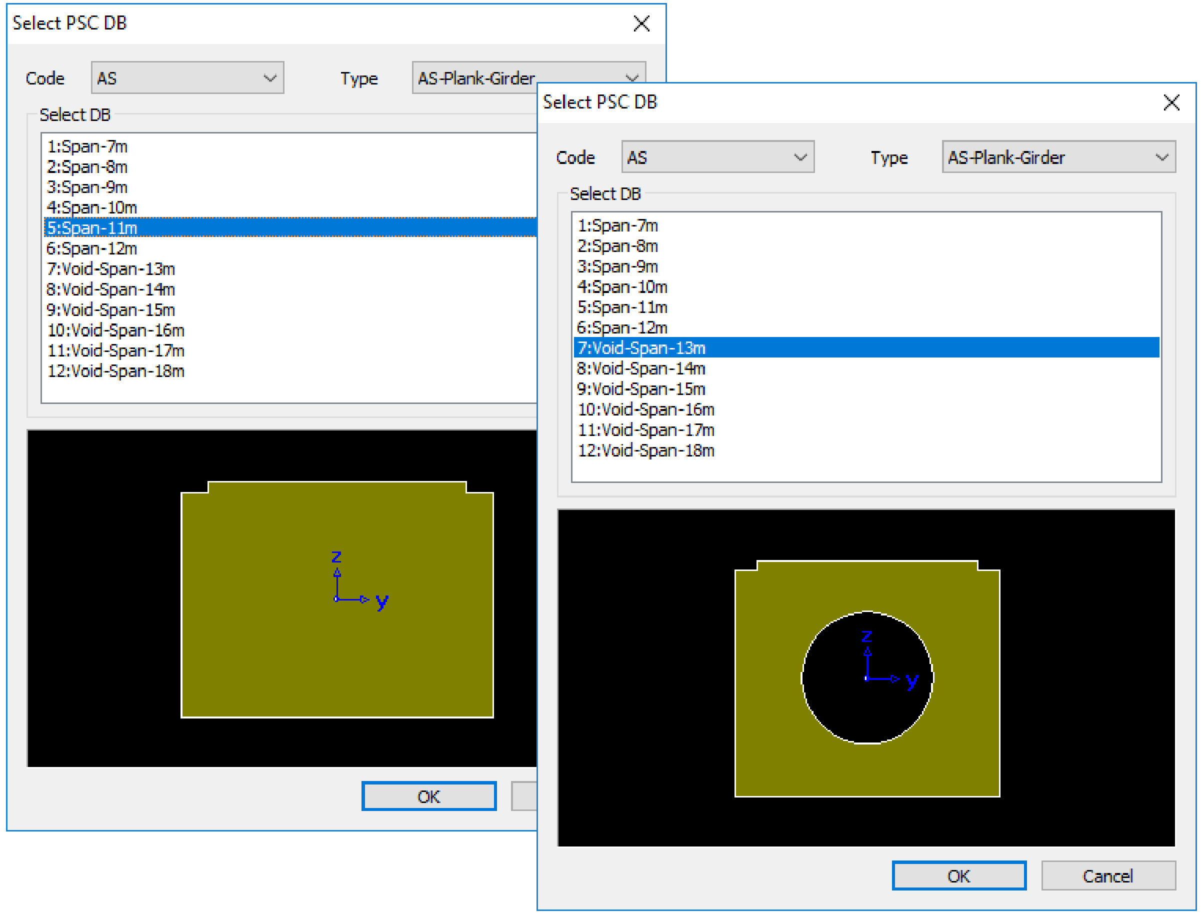
## 2. Precast Concrete Girder Section Database of Australia and New Zealand

- Australia precast plank girders

- ***Properties > Section***



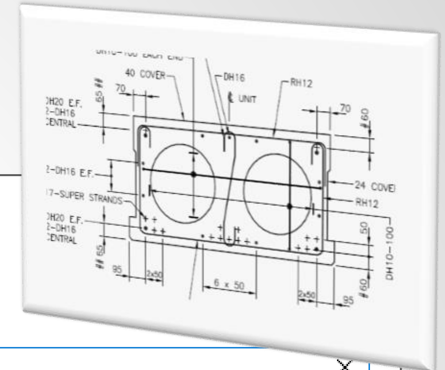

PSC Value



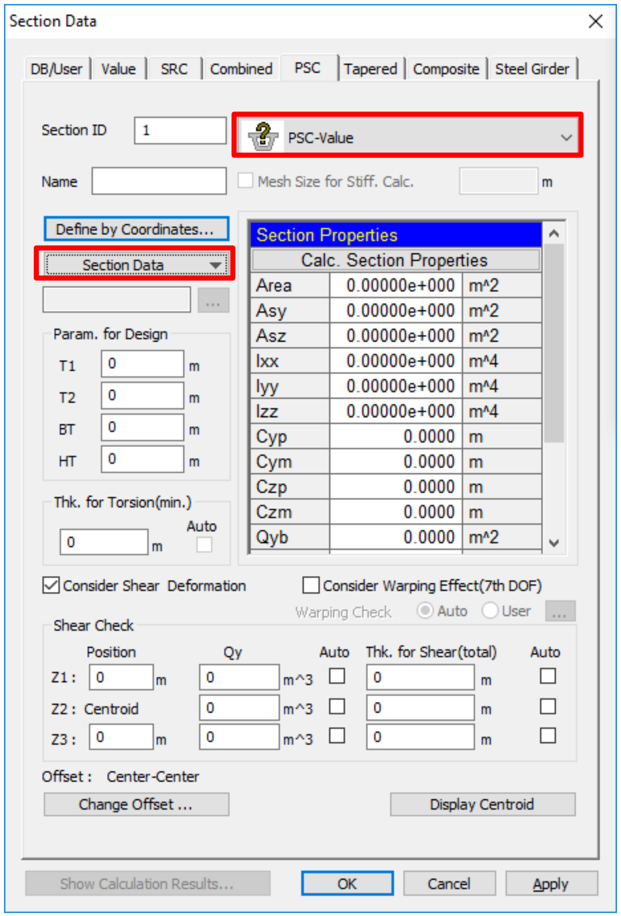

AS-Plank-Girder

# 2. Precast Concrete Girder Section Database of Australia and New Zealand

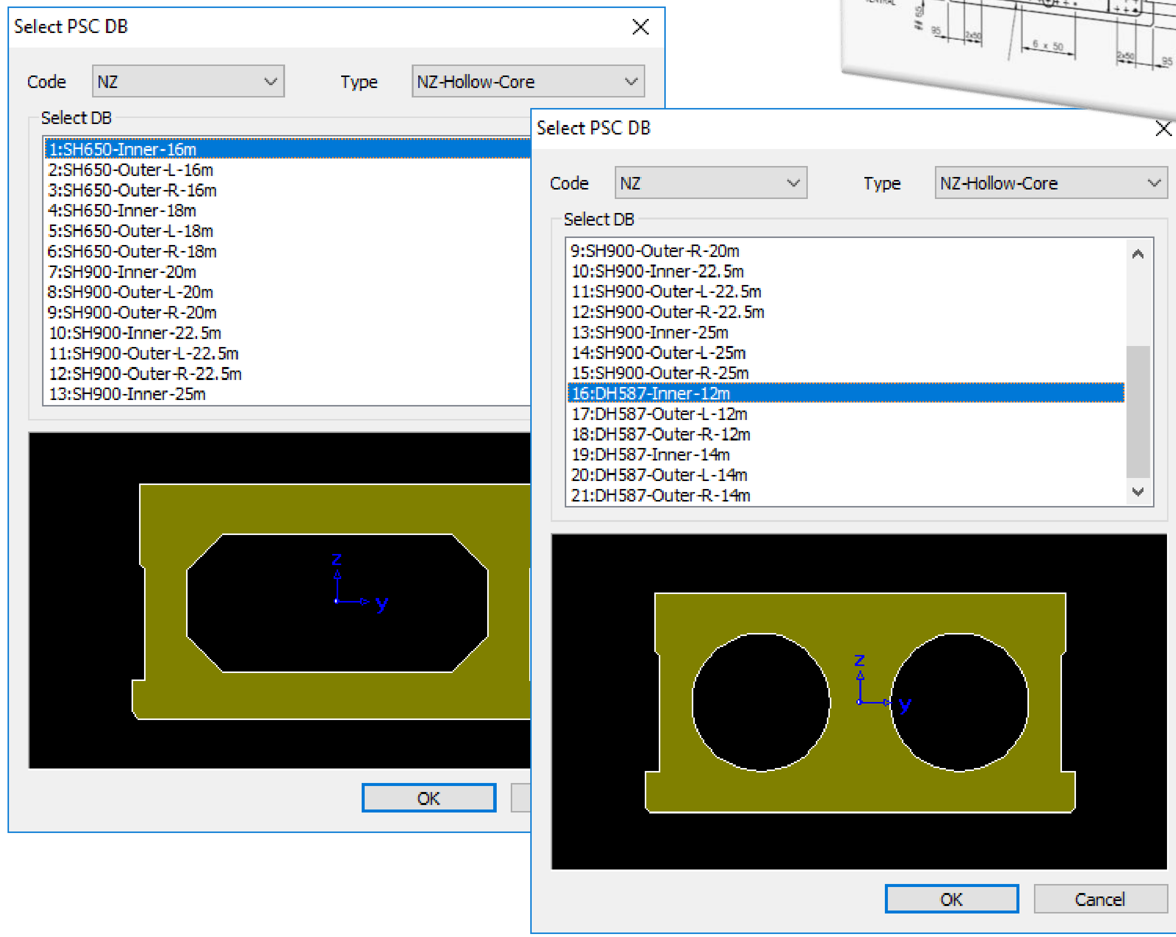
- New Zealand precast hollow core sections.



- ***Properties > Section***




PSC Value

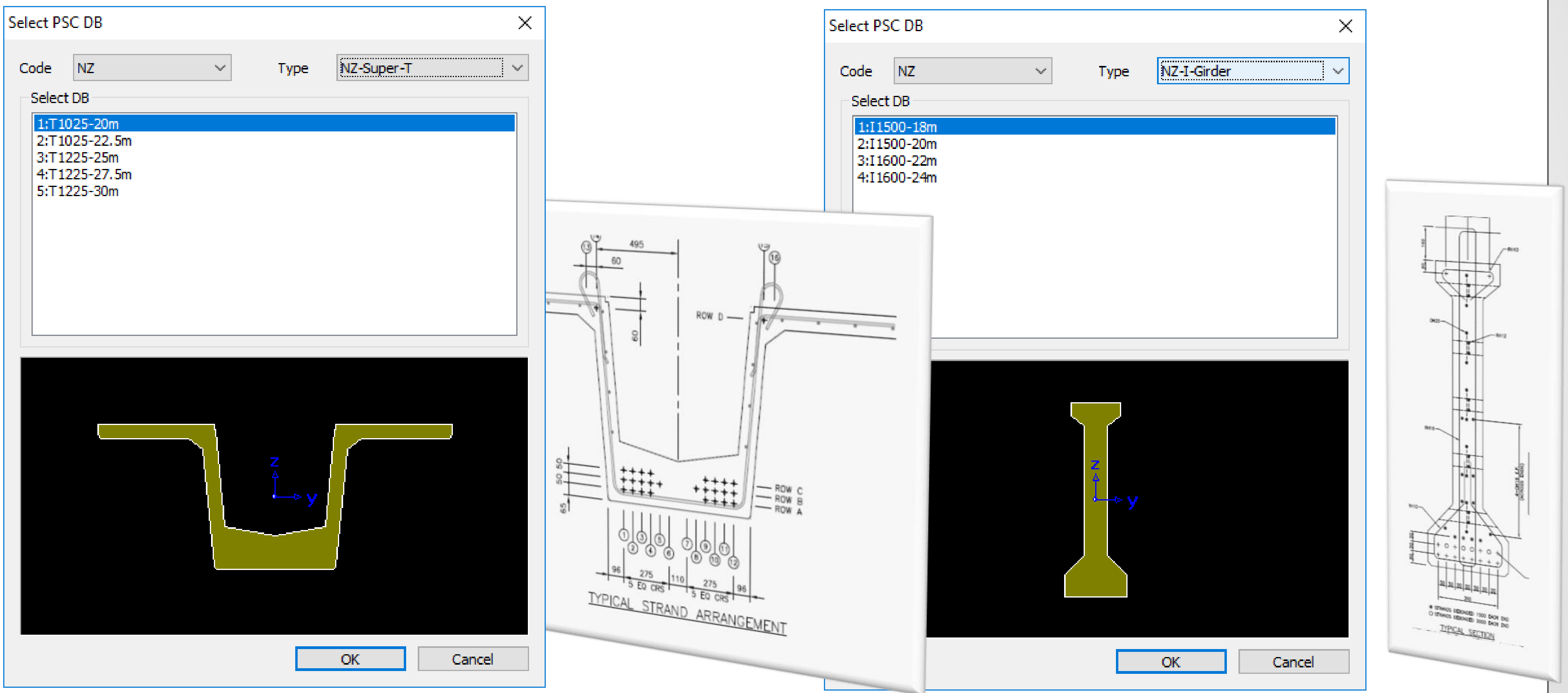



NZ-Hollow-Core

## 2. Precast Concrete Girder Section Database of Australia and New Zealand

- Section 2: **T1025-22.5m** and 4: **T1225-27.5m** are added in the database of NZ-Super-T.
- Section **I 1500** is separated into **I 1500-18m** and **I 1500-20m** which have the same section properties but different arrangement of strands. Similarly, **I 1600** into **I 1600-22m** and **I 1600-24m**.

- ***Properties > Section***



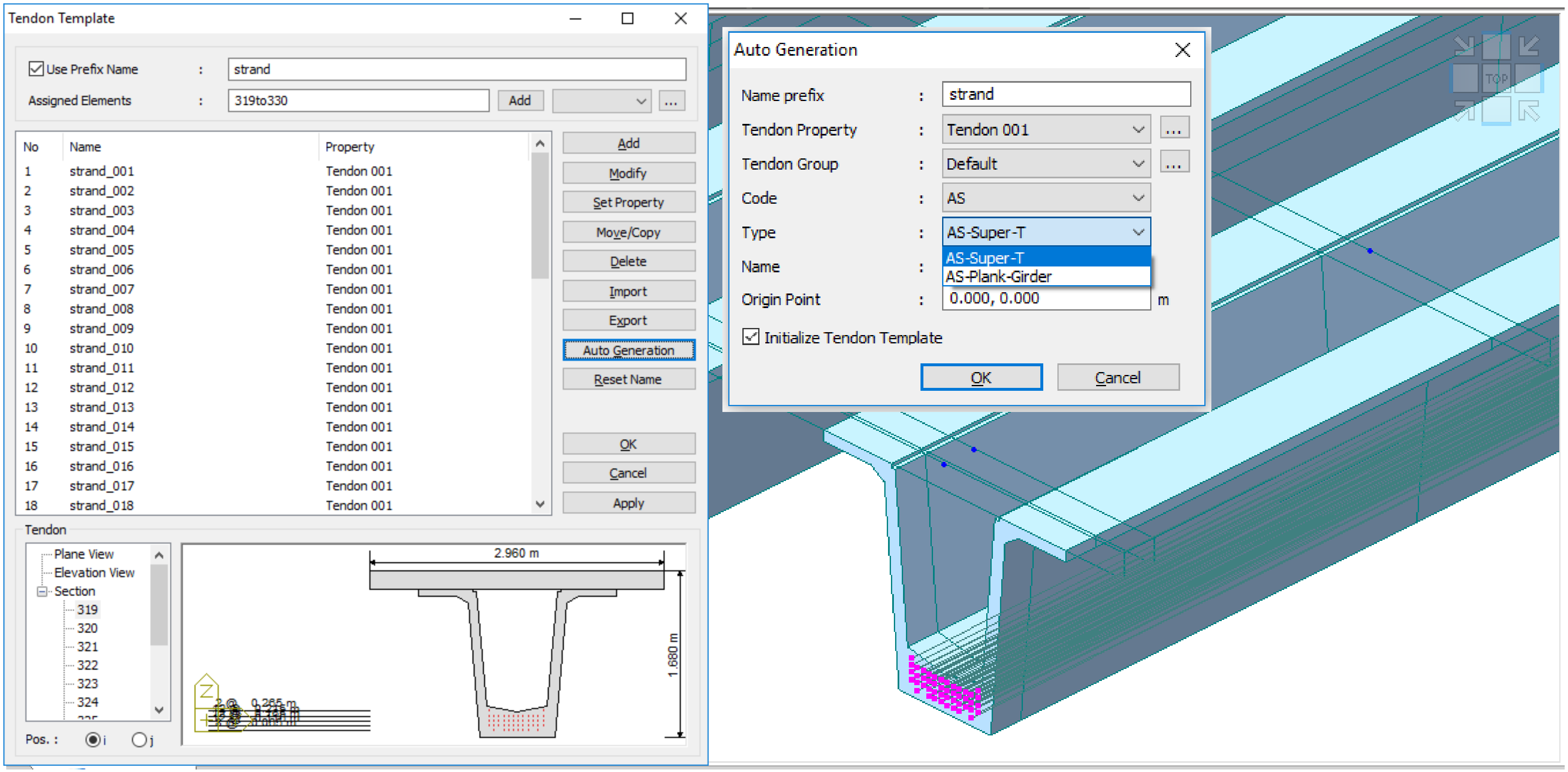

NZ-Super-T

NZ-I-Girder

# 3. Tendon Template for Australian Precast Girder

- AS-Super-T and AS-Plank-Girder are newly added for the auto-generation of tendon profiles.

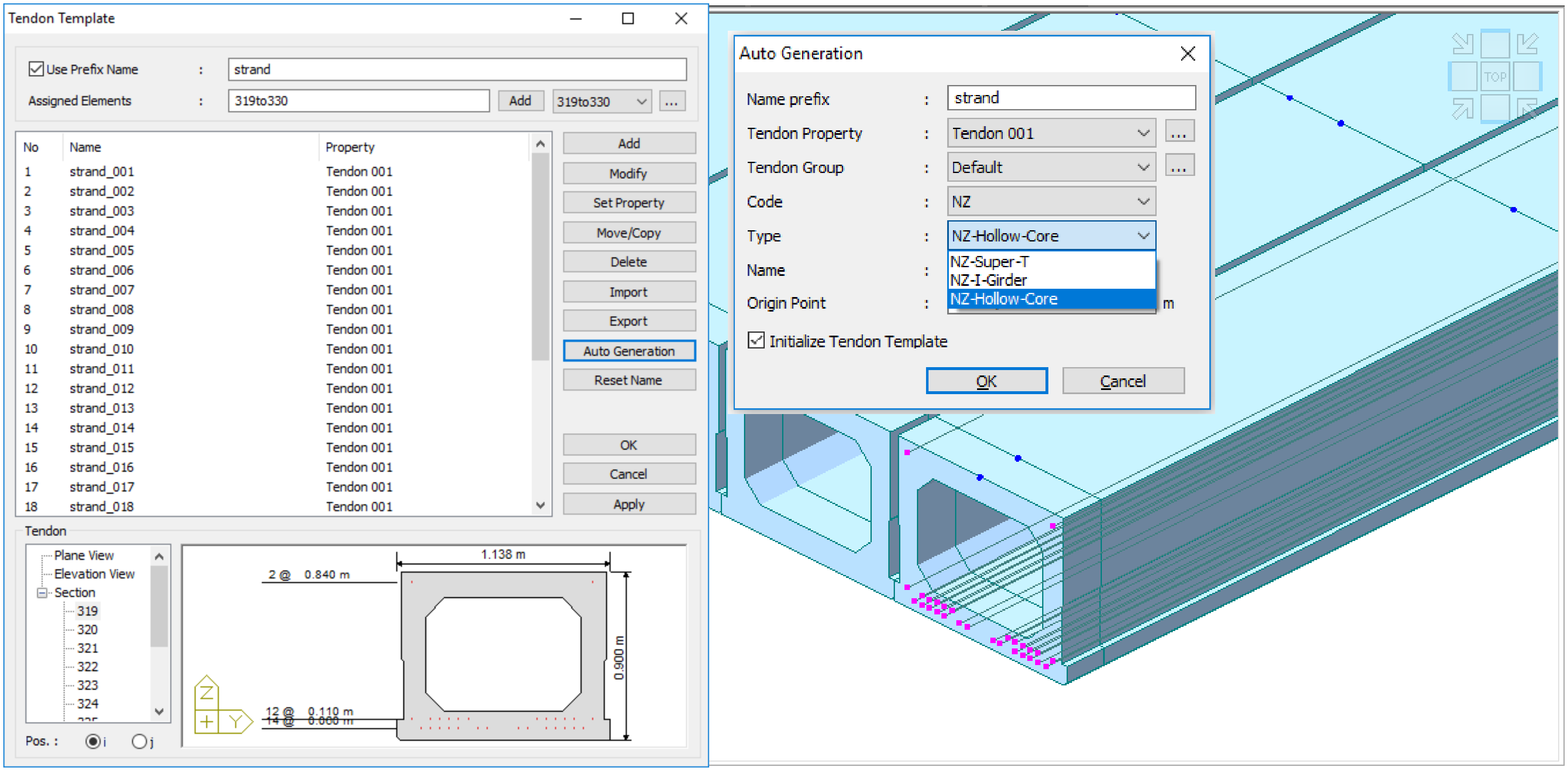
***Structure > Wizard > PSC Bridge > Tendon Template***



# 4. Tendon Template for New Zealand Precast Girder

- NZ-Super-T, NZ-I-Girder and NZ-Hollow-Core are newly added for the auto-generation of tendon profiles.

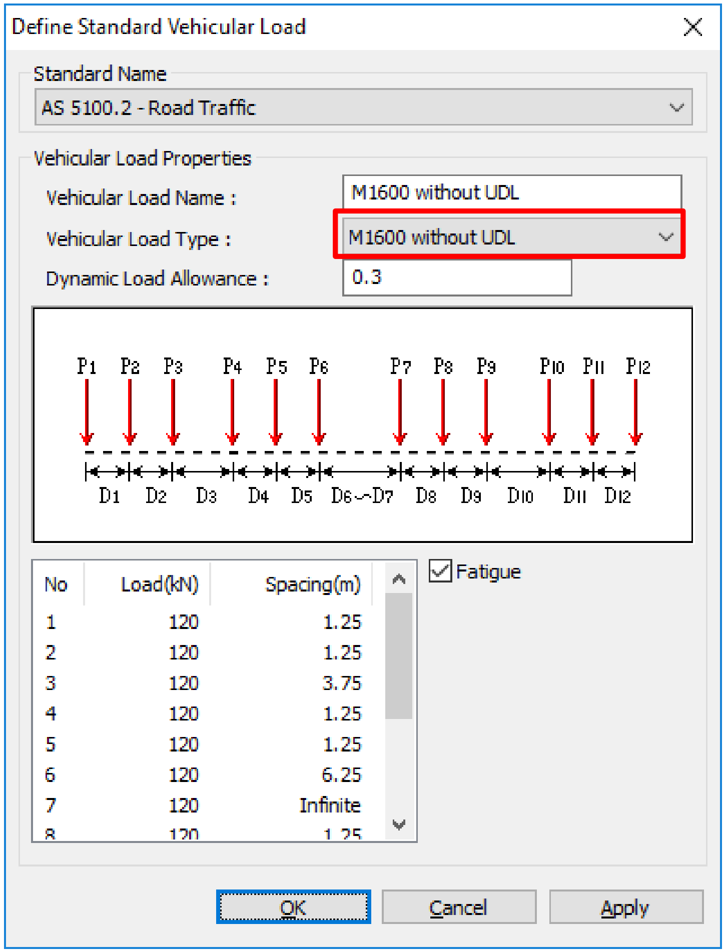
***Structure > Wizard > PSC Bridge > Tendon Template***



# 5. Fatigue Vehicle to AS 5100.2

- Check on the **Fatigue** option after selecting the **M1600 without UDL** or **A160** vehicle.
- The reduction of the load effects to 70% can be done when defining Moving Load Case using the scale factor.

***Load > Moving Load > Moving Load Analysis Data > Vehicles***

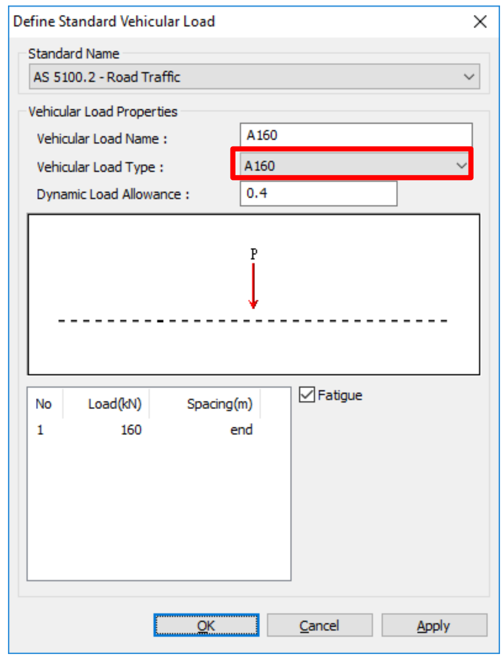



Fatigue Vehicle: M1600

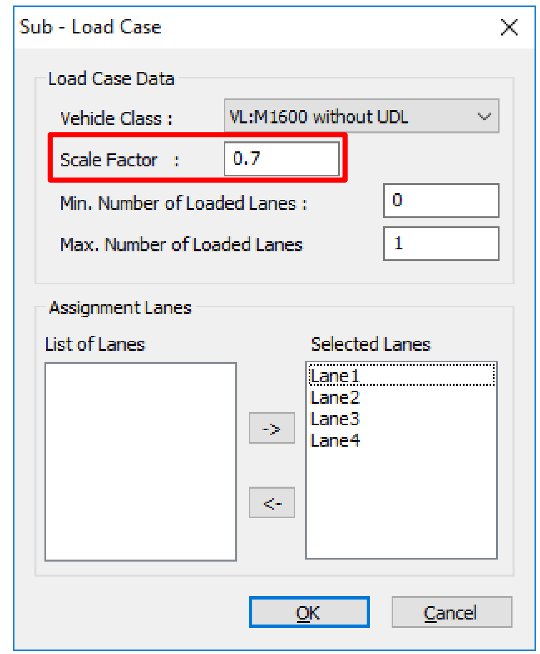
### 7.9 Fatigue load effects

The fatigue design traffic load effects shall be determined from 70% of the effects of a single A160 axle or 70% of a single M1600 moving traffic load, without UDL, whichever is more severe. In both cases, a load factor of 1.0 shall be used and the load effects shall be increased by the dynamic load allowance ($\alpha$).

The single A160 axle load or M1600 moving traffic load, without UDL, shall be placed within any design traffic lane to maximize the fatigue effects for the component under consideration.




Fatigue Vehicle: A160

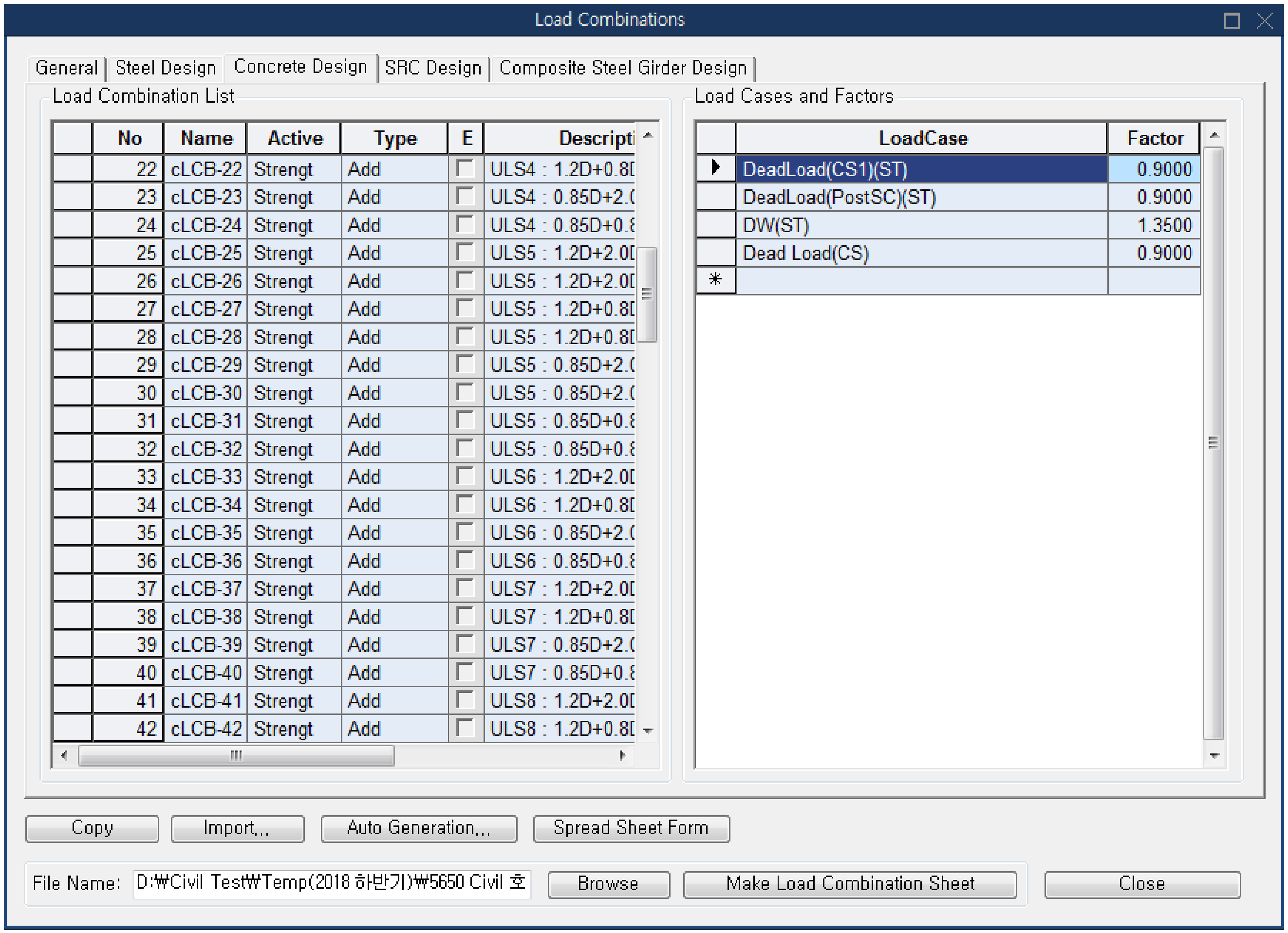



Moving Load Case

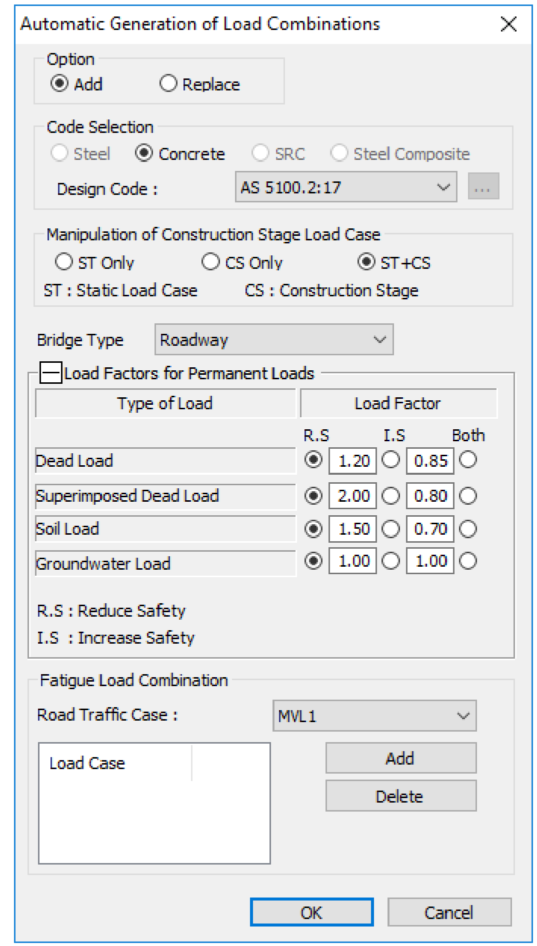
# 6. Load Combination to AS 5100.2: 2017

- Concrete structure only for roadway and pedestrian bridge.

***Results > Combination > Load Combination***




Load Combination

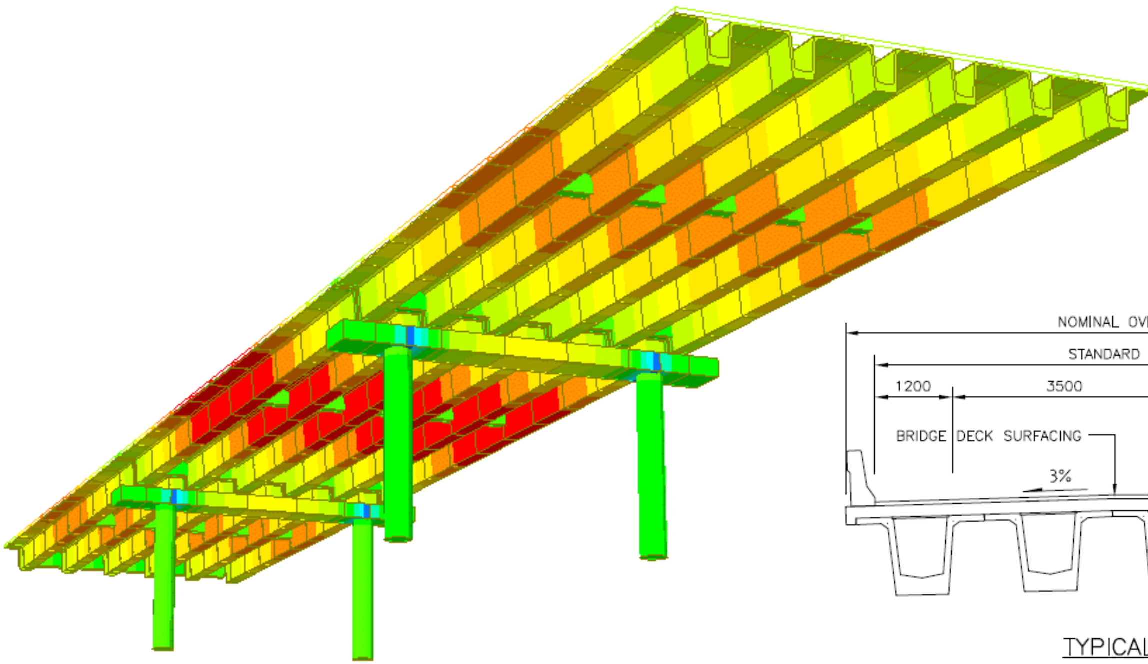



Auto-Generation

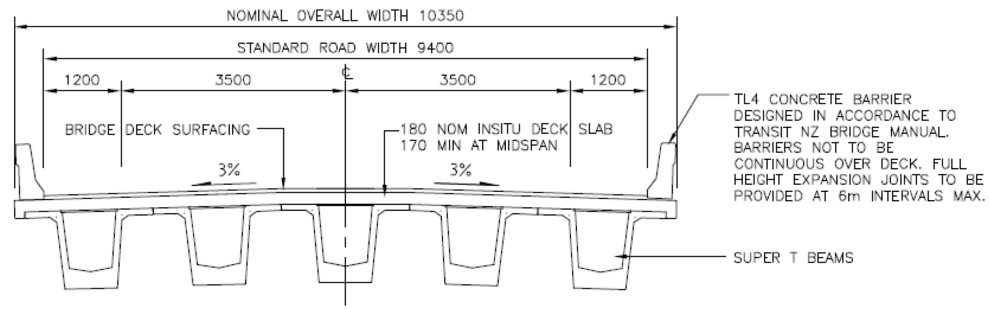
## 7. Prestressed Concrete Girder Design to AS 5100: 2017

- Prestressed concrete section design is now available as per AS 5100: 2017.
- Composite section for construction stages considering time dependent material can be considered with consideration of tendons and reinforcement in each stage (before and after composite effect).
- Ultimate Limit State (bending, shear and torsion resistance) and Service Limit State (crack, stress check) design are provided. All checks can be viewed in the Excel calculation report.
- Design results can be checked in the result tables for strength (bending, shear, torsion) and stress under construction and service loads, and tendons. PSC result diagram for forces and stress is also provided.

- ***PSC > Design Parameters > AS 5100: 2017***



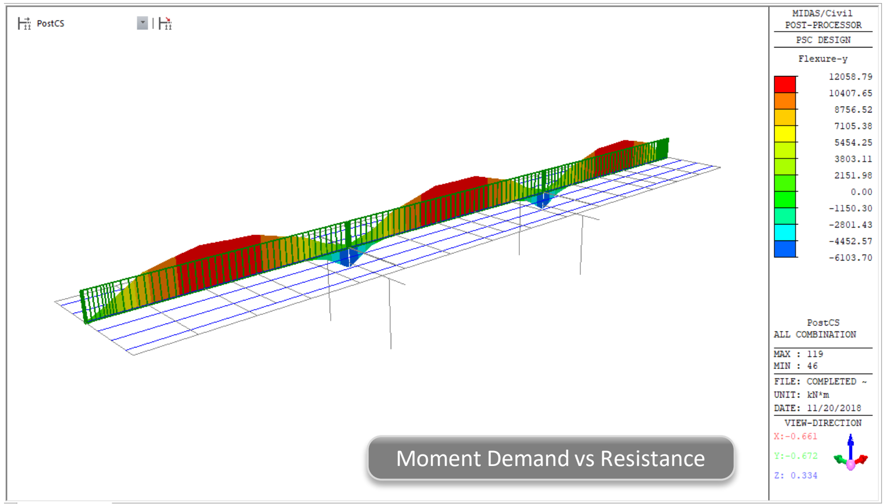
Super T Girder Bridge




TYPICAL BRIDGE SECTION
1:100

# 7. Prestressed Concrete Girder Design to AS 5100: 2017

- ***PSC > Design Parameters > AS 5100: 2017***




Moment Demand vs Resistance


Stress Demand vs Limit

**1. Design Condition**

| Design code | Element | Node(I/J) |
|---|---|---|
| AS5100:5-17 | 190 | J |

**■ Section Properties**

| Section name | Type |
|---|---|
| CPPC | Composite |

- Gross section

| | | Before | After |
|---|---|---|---|
| H | (mm) | 1500.0 | 1680.0 |
| B | (mm) | 2960.0 | 2960.0 |
| $C_{zp}$ | (mm) | 0.0 | 356.1 |
| $C_{zm}$ | (mm) | 0.0 | 1143.9 |
| $C_{zps}$ | (mm) | 740.6 | 536.1 |
| $C_{zms}$ | (mm) | 759.4 | 356.1 |
| $A_g$ | ($mm^2$) | 6.181.E+05 | 1.151.E+06 |
| $I_y$ | ($mm^4$) | 1.947.E+11 | 3.936.E+11 |
| $S_t$ | ($mm^3$) | 2.630.E+08 | 5.469.E+08 |
| $S_b$ | ($mm^3$) | 2.564.E+08 | 1.702.E+08 |
| $S_{ts}$ | ($mm^3$) | | 7.342.E+08 |
| $S_{bs}$ | ($mm^3$) | | 1.105.E+09 |

- Transformed section

| | | Before | After |
|---|---|---|---|
| H | (mm) | 1500.0 | 1680.0 |
| B | (mm) | 2960.0 | 2960.0 |
| $C_{zp}$ | (mm) | 0.0 | 370.8 |
| $C_{zm}$ | (mm) | 0.0 | 1129.2 |
| $C_{zps}$ | (mm) | 755.0 | 550.8 |
| $C_{zms}$ | (mm) | 745.0 | 370.8 |
| $A_g$ | ($mm^2$) | 6.332.E+05 | 1.166.E+06 |
| $I_y$ | ($mm^4$) | 2.003.E+11 | 4.083.E+11 |
| $S_t$ | ($mm^3$) | 2.652.E+08 | 5.400.E+08 |
| $S_b$ | ($mm^3$) | 2.688.E+08 | 1.773.E+08 |
| $S_{ts}$ | ($mm^3$) | | 7.145.E+08 |
| $S_{bs}$ | ($mm^3$) | | 1.061.E+09 |

**■ Materials**

- Concrete

| | $f'_c$ (MPa) | $f'_c$ (MPa) | $f'_{ct.f} = 0.6\sqrt{f'_c}$ (MPa) | $\alpha_2$ | $\gamma$ |
|---|---|---|---|---|---|
| Girder | 50.000 | 34800.000 | 4.243 | 0.85 | 0.70 |
| Slab | 32.000 | 30100.000 | 3.394 | 0.85 | 0.83 |

* $\alpha_2 = 1.0 - 0.003f'_c$ (within the limits of $0.67 \le \alpha_2 \le 0.85$)

* $\gamma = 1.05 - 0.007f'_c$ (within the limits of $0.67 \le \gamma \le 0.85$)

- Prestressing steel Information

| | Bond | d | A | Strength (MPa) | E |
|---|---|---|---|---|---|

190_I | 190_J

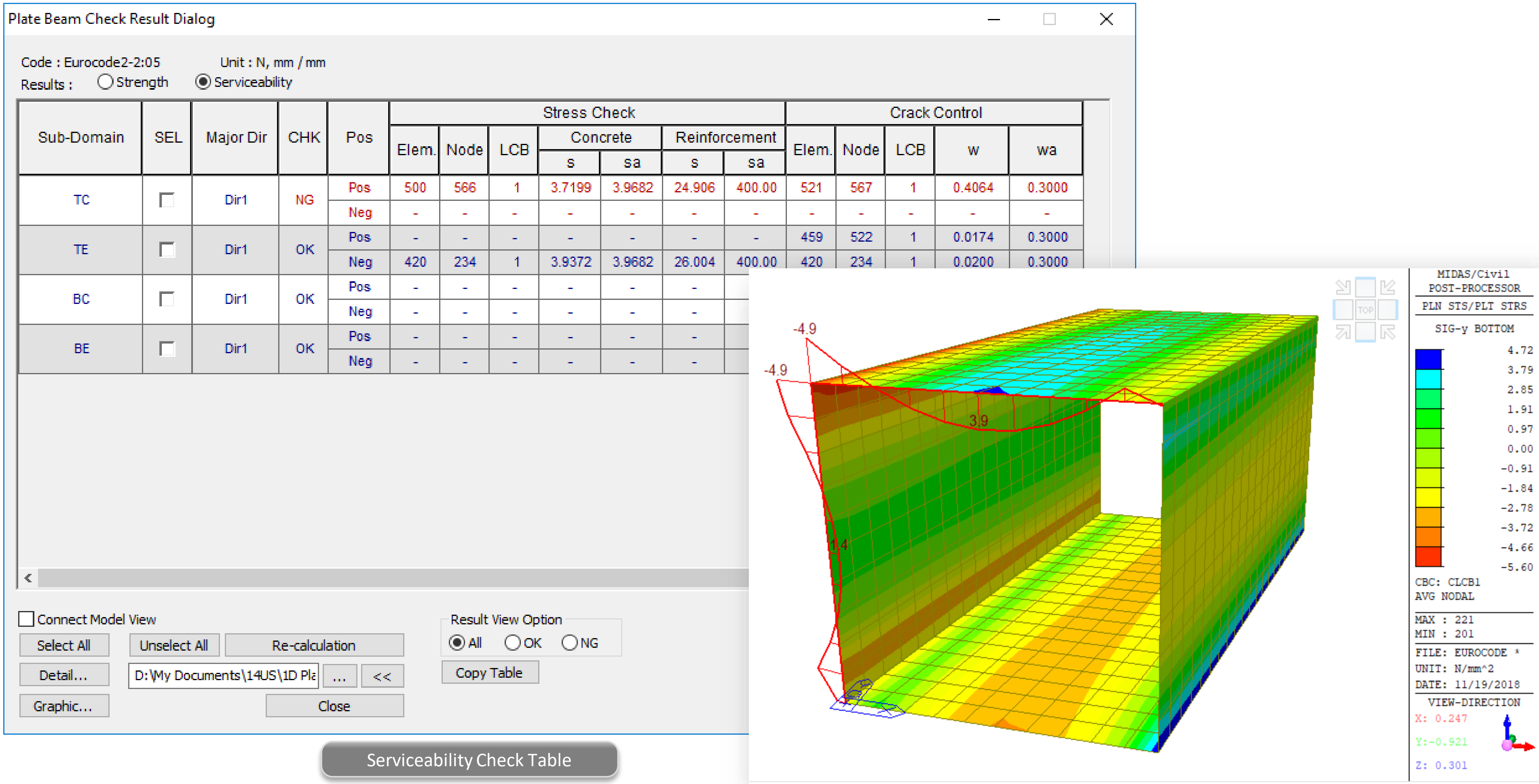
READY

Excel Report

# 8. Serviceability Limit State Check for Plate Beam/Column Design to EN 1992-2

- In the previous versions, only the ultimate limit state check was provided. Now, the serviceability limit state check is added for the stress limit in the concrete and reinforcement and the crack width check.

***Design > RC Design > Concrete Code Check > Plate Beam Checking / Plate Column Checking***



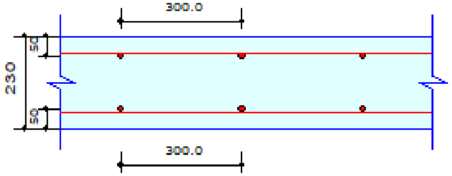

| Sub-Domain | SEL | Major Dir | CHK | Pos | Stress Check | | | | | | | Crack Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Elem. | Node | LCB | Concrete | | Reinforcement | | Elem. | Node | LCB | w | wa |
| | | | | | | | | s | sa | s | sa | | | | | |
| TC | ☐ | Dir1 | NG | Pos | 500 | 566 | 1 | 3.7199 | 3.9682 | 24.906 | 400.00 | 521 | 567 | 1 | 0.4064 | 0.3000 |
| | | | | Neg | - | - | - | - | - | - | - | - | - | - | - | - |
| TE | ☐ | Dir1 | OK | Pos | - | - | - | - | - | - | - | 459 | 522 | 1 | 0.0174 | 0.3000 |
| | | | | Neg | 420 | 234 | 1 | 3.9372 | 3.9682 | 26.004 | 400.00 | 420 | 234 | 1 | 0.0200 | 0.3000 |
| BC | ☐ | Dir1 | OK | Pos | - | - | - | - | - | - | | | | | | |
| | | | | Neg | - | - | - | - | - | - | | | | | | |
| BE | ☐ | Dir1 | OK | Pos | - | - | - | - | - | - | | | | | | |
| | | | | Neg | - | - | - | - | - | - | | | | | | |

Serviceability Check Table

# 8. Serviceability Limit State Check for Plate Beam/Column Design to EN 1992-2

***Design > RC Design > Concrete Code Check > Plate Beam Checking / Plate Column Checking***

## 2. Section Diagram




Element No : 521

| Rebar Pattern | | Top(Negative) | Bottom(Positive) |
|---|---|---|---|
| | Layer 1 | P16@300.00 | P16@300.00 |

Total Rebar Area Ast = 1.3404 mm^2/mm

Using Stirrups Spacing : No Stirrup

## 5. Stress Check

| | Concrete | Rebar |
|---|---|---|
| Element No. | - | - |
| (-) Load Combination | - | - |
| Stress(s) | 0.00 | 0.00 |
| Allowable Stress(sa) | 0.00 | 0.00 |
| Stress Ratio(s/sa) | 0.0000 | 0.0000 |
| Element No. | 500 | 500 |
| (+) Load Combination | cLCB1 | cLCB1 |
| Stress(s) | 3.72 | 24.91 |
| Allowable Stress(sa) | 3.97 | 400.00 |
| Stress Ratio(s/sa) | 0.9374 | 0.0623 |

## 6. Crack Control

| | Top(Negative) | Bottom(Positive) |
|---|---|---|
| Element No. | - | 521 |
| Load Combination | - | cLCB1 |
| Crack Width(w) | 0.0000 | 0.4064 |
| Allowable Crack Width(wa) | 0.3000 | 0.3000 |
| Check Ratio | 0.0000 | 1.3547 |

```
===============================================================================
   [[[*]]]   ANALYZE CRACK.
===============================================================================

     ( ). Calculate crack width of bottom reinforcement.
          [ EN 1992-1-1:2004 Clause 7.3.4 , Appendix B. ]
          -. fcm       = fck+8(MPa)     =    38.00000 MPa.
          -. fctm      = 0.30*fck^(2/3)=     2.89647 MPa.(fck<=C50/60)
          -. fct.eff   = fctm (by 28 days).
          -. Sigma_s   =      347.163 MPa.( LCB    1 )
          -. kt        = 0.6 (for short term loading.).
          -. X         =    47.10938 mm.
          -. hc,ef     = MIN[ 2.5*(h-d), (h-X)/3, h/2 ] =    60.96354 mm.
          -. Ac.eff    = Bc*hc,ef            =    60.96354 mm^2.
          -. Rho_p.eff= As/Ac.eff            =   0.0110
          -. Ecm       = 22[fcm/10]^0.3 *1000 =   32836.568 MPa. (by Table 3.1)
          -. Alpha_e   = Es/Ecm              =     6.09077
          -. (Eps_sm-Eps_cm) = (Sigma_s-kt*fct.eff/Rho_p.eff*(1+Alpha_e*Rho_p.eff))/Es
                             =   0.001041
                               >= 0.6*Sigma_s/Es =  0.001041

          -. Bond coefficient(k1)                =   0.8000
          -. Strain distribution coefficient(k2) =   0.5000
          -. NAD Value (k3)                      =   3.4000
          -. NAD Value (k4)                      =   0.4250
          -. c         =    42.00000 mm.
          -. Phi       =    16.00000 mm.
          -. S_r.max   = k3*c + k1*k2*k4*Phi/Rho_p.eff =   390.21992 mm.

          -. wk        = S_r.max * ( Eps_sm-Eps_cm)    =     0.40641 mm.
             wk >  0.300 mm.   --->  Not Acceptable !!!
```

**7.3.4 Calculation of crack widths**

(1) The crack width, $w_k$, may be calculated from Expression (7.8):

$$w_k = s_{r,max}\,(\varepsilon_{sm} - \varepsilon_{cm}) \qquad (7.8)$$

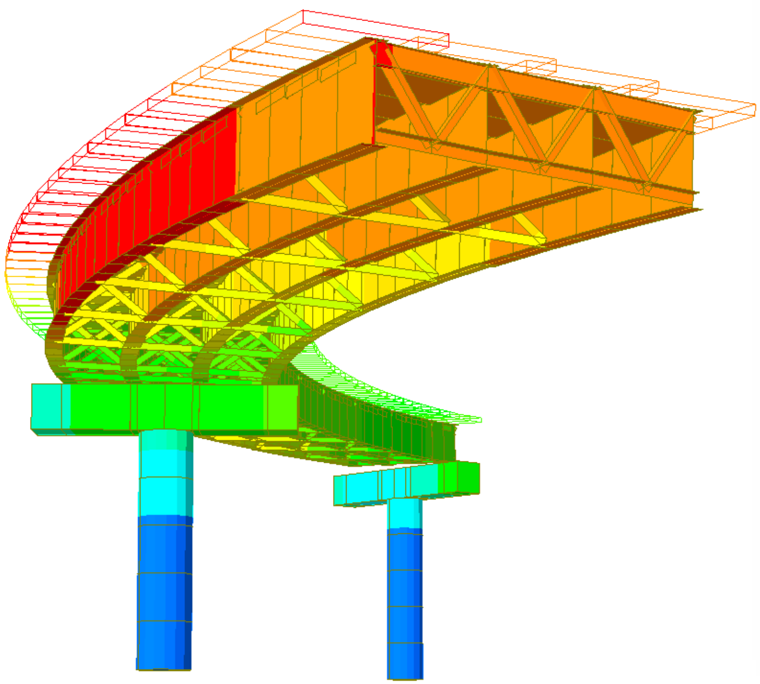
where

- $s_{r,max}$ is the maximum crack spacing
- $\varepsilon_{sm}$ is the mean strain in the reinforcement under the relevant combination of loads, including the effect of imposed deformations and taking into account the effects of tension stiffening. Only the additional tensile strain beyond the state of zero strain of the concrete at the same level is considered
- $\varepsilon_{cm}$ is the mean strain in the concrete between cracks

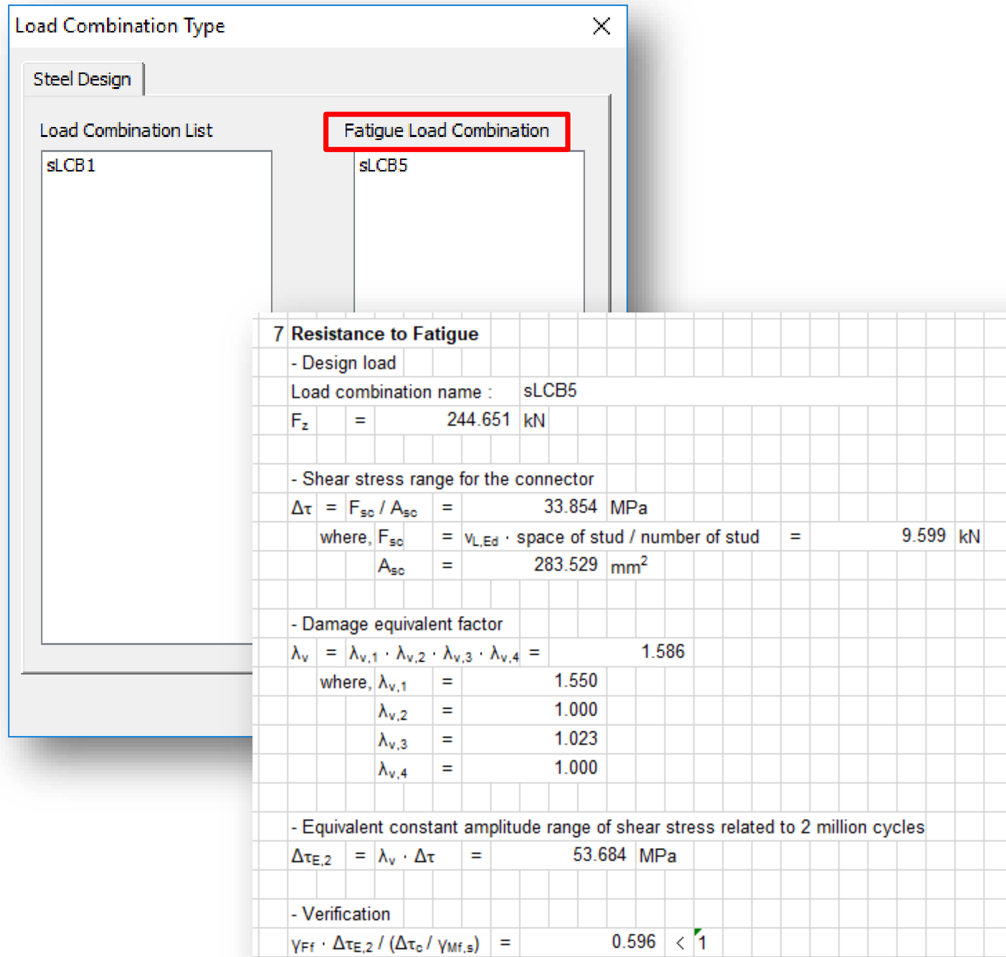
# 9. Fatigue Load Combination for Steel Composite Girder Design to Eurocode

- In the previous versions, the fatigue check for the shear connector was performed for all the ULS load combinations. Now, it is performed only for the load combination selected as **Fatigue Load Combination**.

***Design > Composite Design > Fatigue Load Combination Type***



Steel Composite Girder Bridge

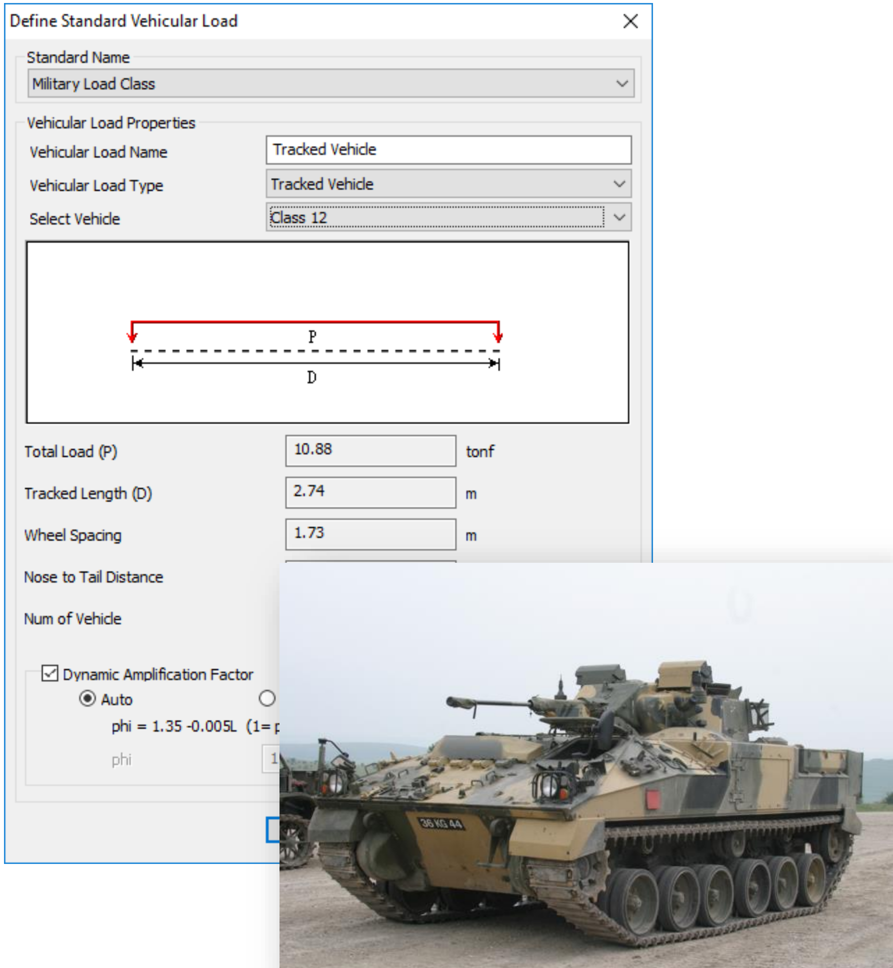



Fatigue Load Combination and Report

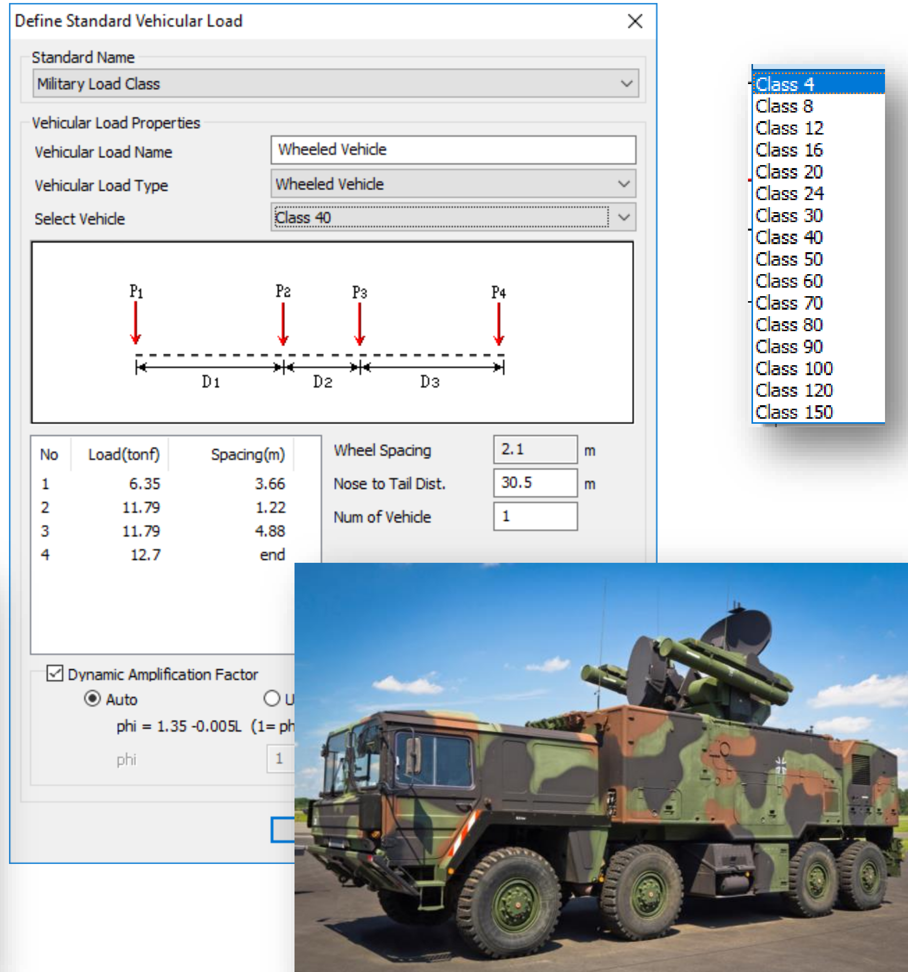
## 10. Military Load Classes

- Military load classes and application are implemented as per **TRILATERAL DESIGN AND TEST CODE FOR MILITARY BRIDGING AND GAP-CROSSING EQUIPMENT (2005).**
- These vehicles can only be found when the ‘Poland’ code is selected for the moving load code.

***Load > Moving Load > Moving Load Analysis Data > Vehicles***



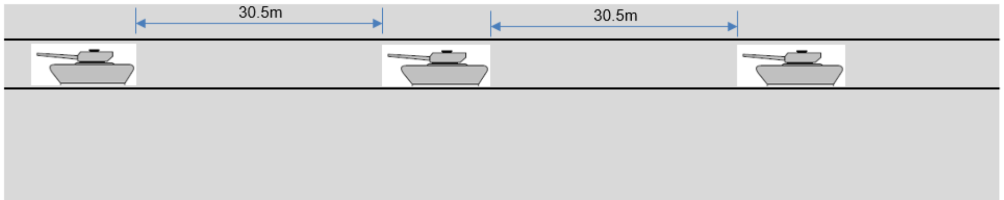

Tracked Vehicle



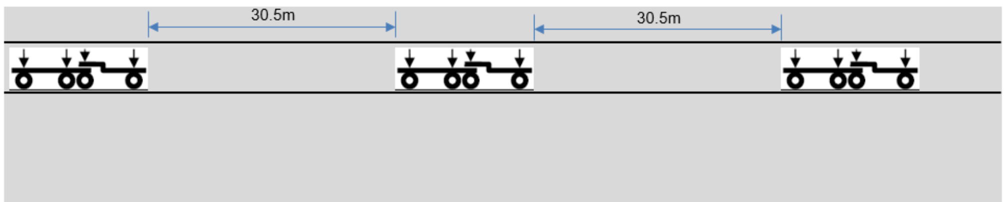

Wheeled Vehicle

# 10. Military Load Class

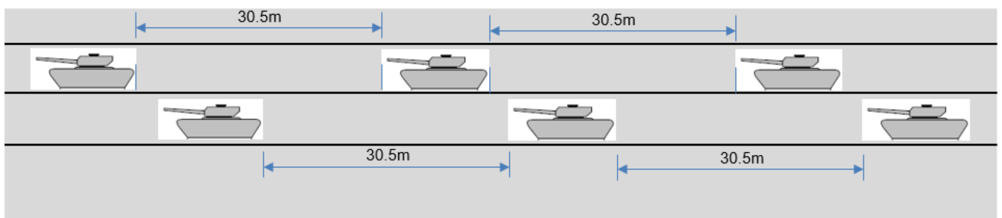
Case 1) Tracked Vehicles are applied to one lane.



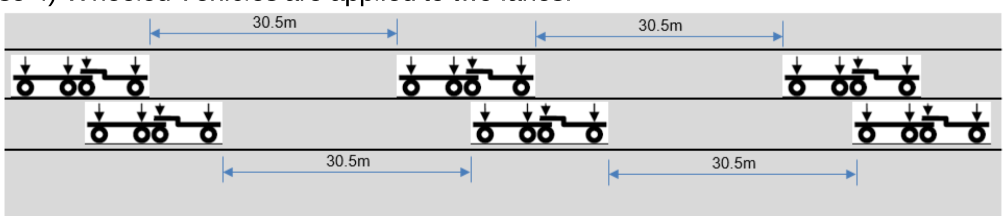

Case 2) Wheeled Vehicles are applied to one lane.



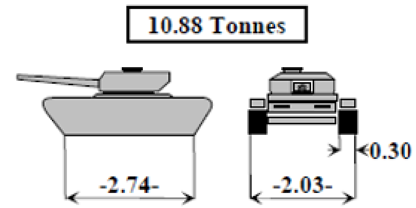

Case 3) Tracked Vehicles are applied to two lanes.



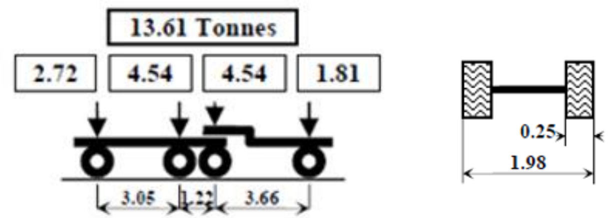

Case 4) Wheeled Vehicles are applied to two lanes.




Application Rule



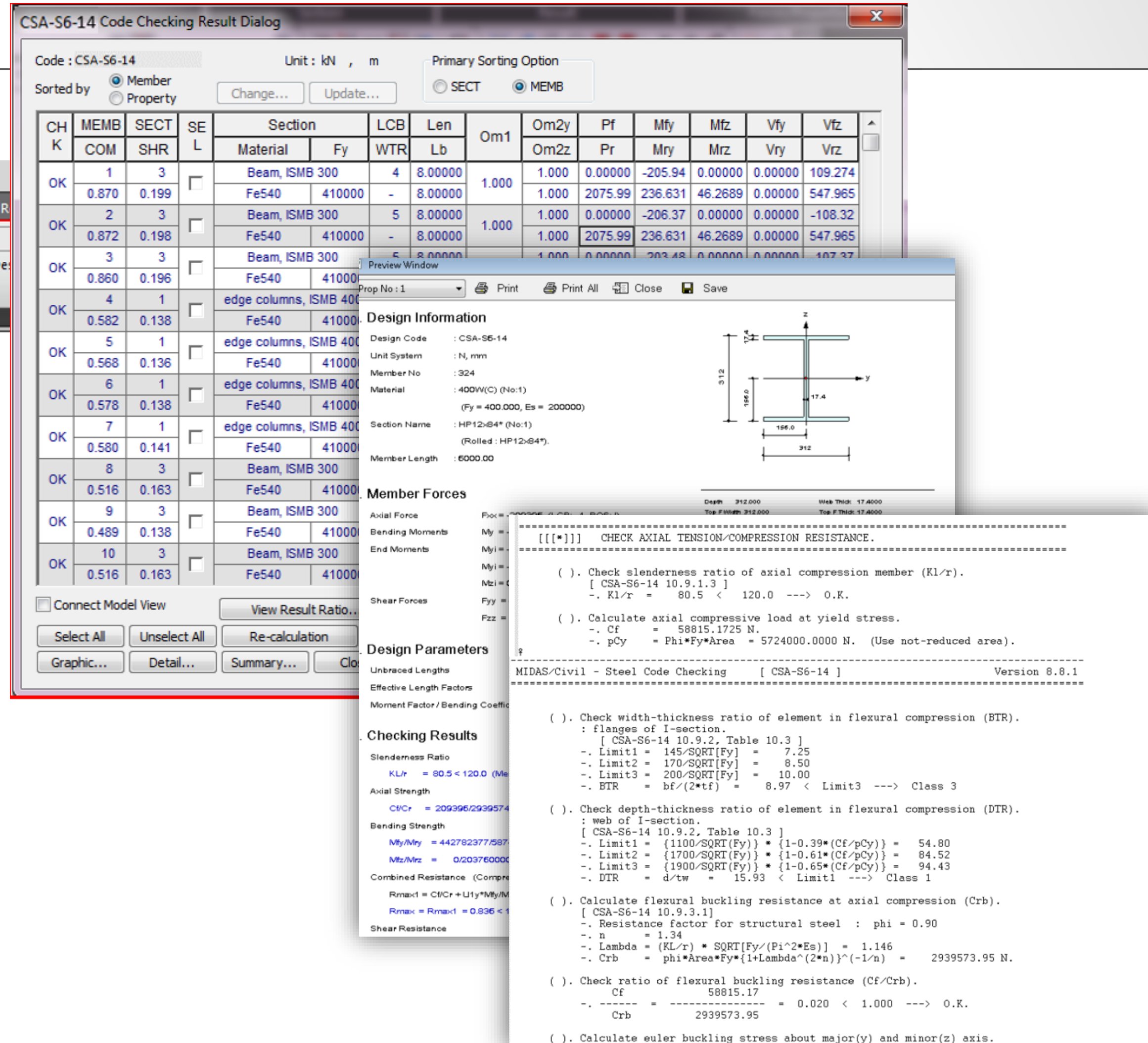

Weight of Tracked Vehicle



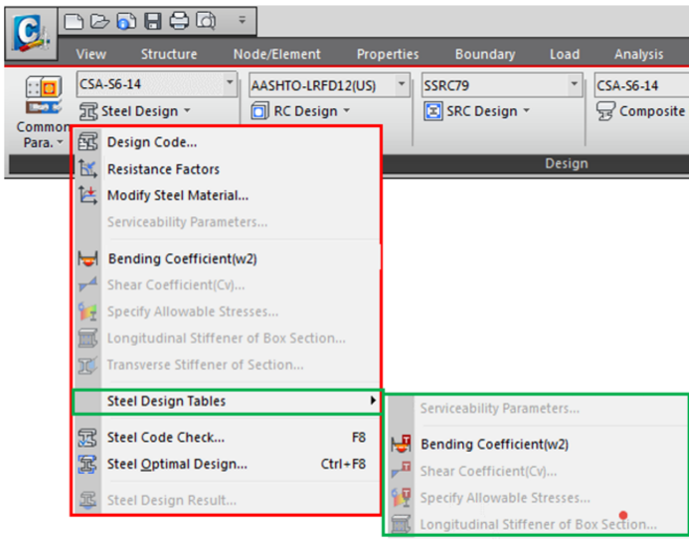

Weight of Wheeled Vehicle

## 11. Steel Design to CSA-S6-14

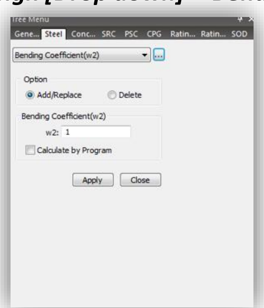
- Now steel design of beam and column can be performed as per Canadian CSA-S6-14 code.
- The results of steel design can be viewed in table format, detail report format and summary report format .
- Steel optimal design can be performed.




- ***Design > Steel Design > CSA-S6-14***



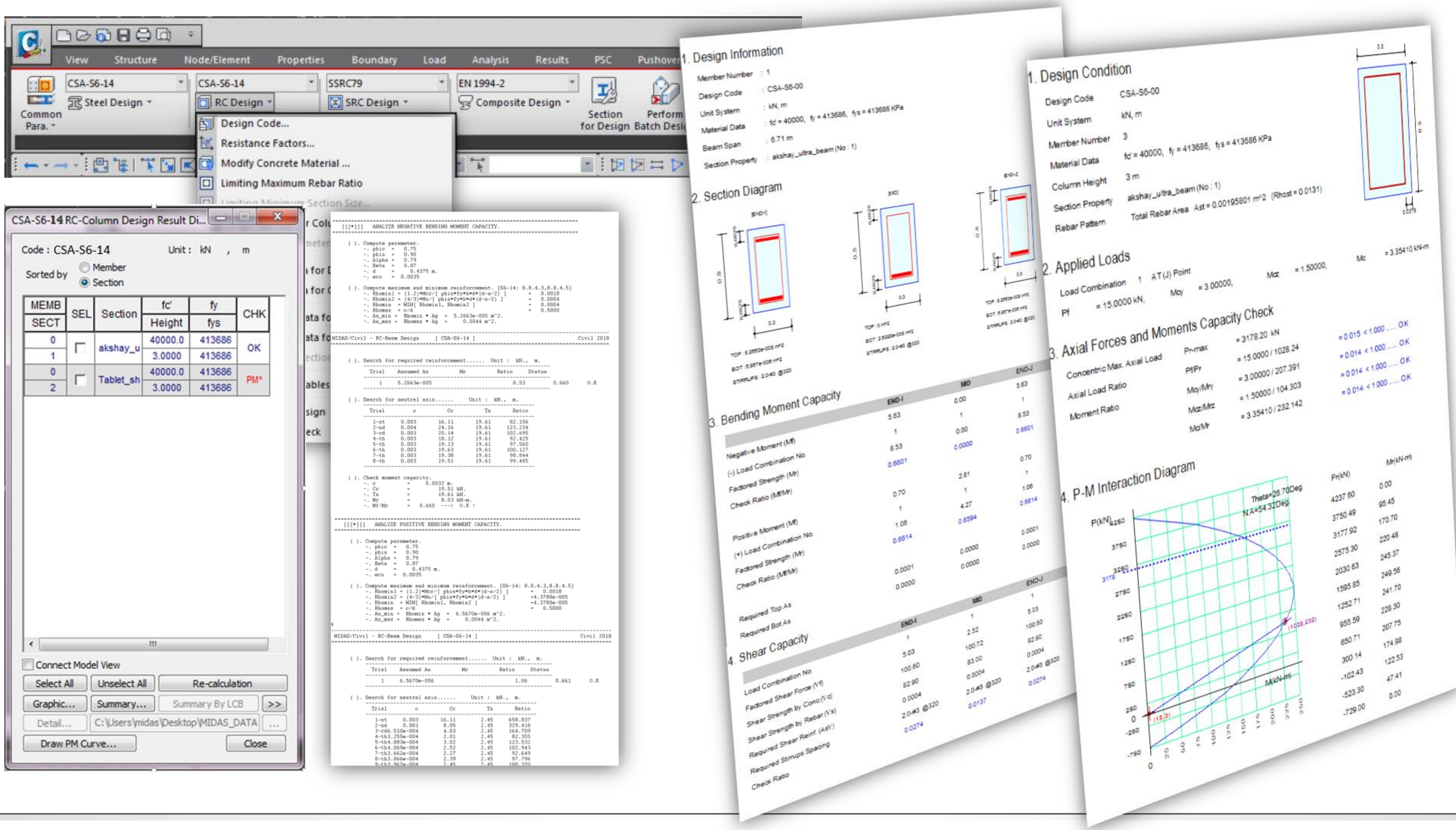

- ***Design->Steel Design [Drop down] ->Bending Coefficient (w2)***



## 12. Reinforced Concrete Design to CSA-S6-14

- Now RC design can be performed as per the latest Canadian CSA-S6-14 code.
- The results of RC design can be viewed in table format, detail report format and summary report format .

▪ ***Design > RC Design > CSA-S6-14***

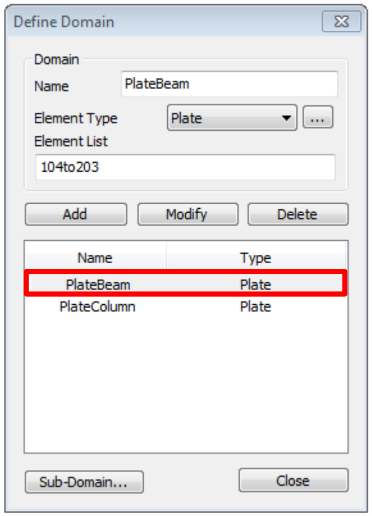


## 13. Plate Beam and Plate Column (1D) Checking to Russian SNiP and SP

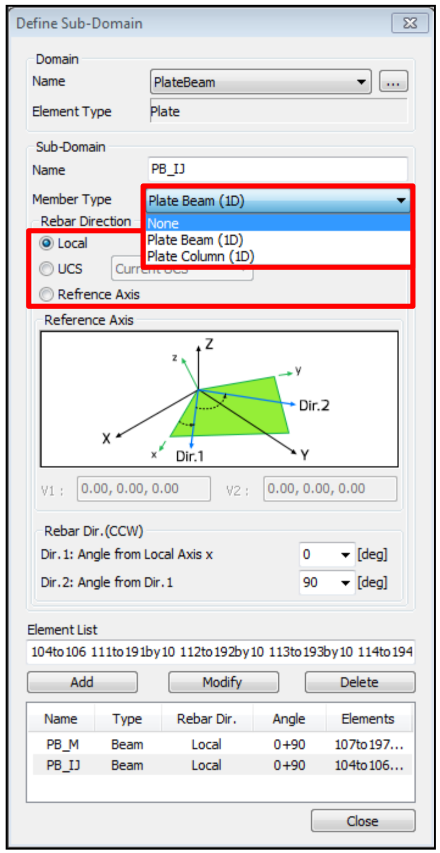
- Plate elements can now be designed with the same method of designing conventional 1D elements such as Beam or Column as per SNiP 2.05.03-84* and SP 35.13330.2011. The plate design is performed for defined sub-domain. Member Type is chosen according to the purpose of the design. (e.g. Plate Beam (1D) : 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***

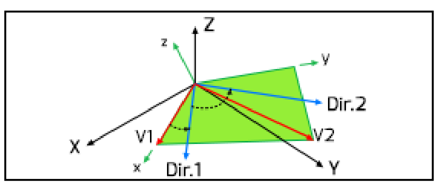
***Define Domain***

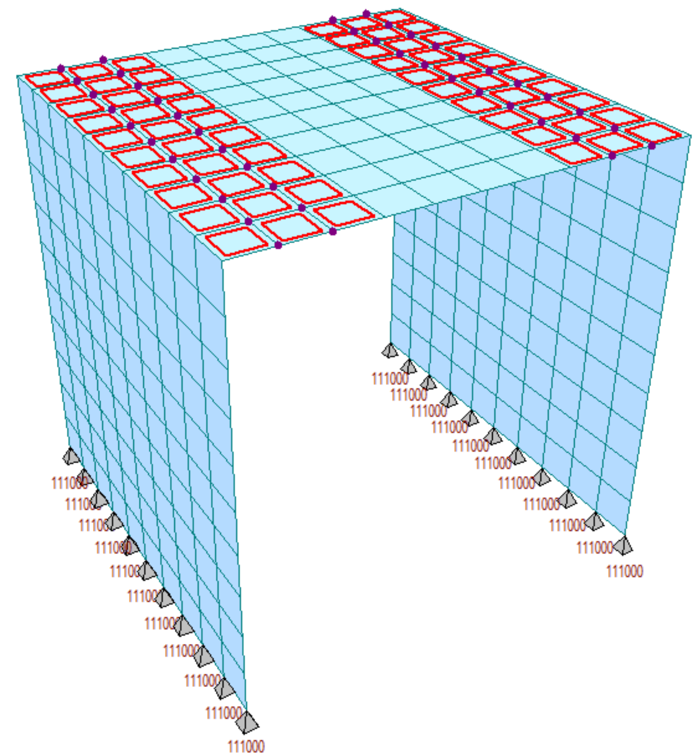



***Define Sub-Domain***




***If Reference Axis is selected***

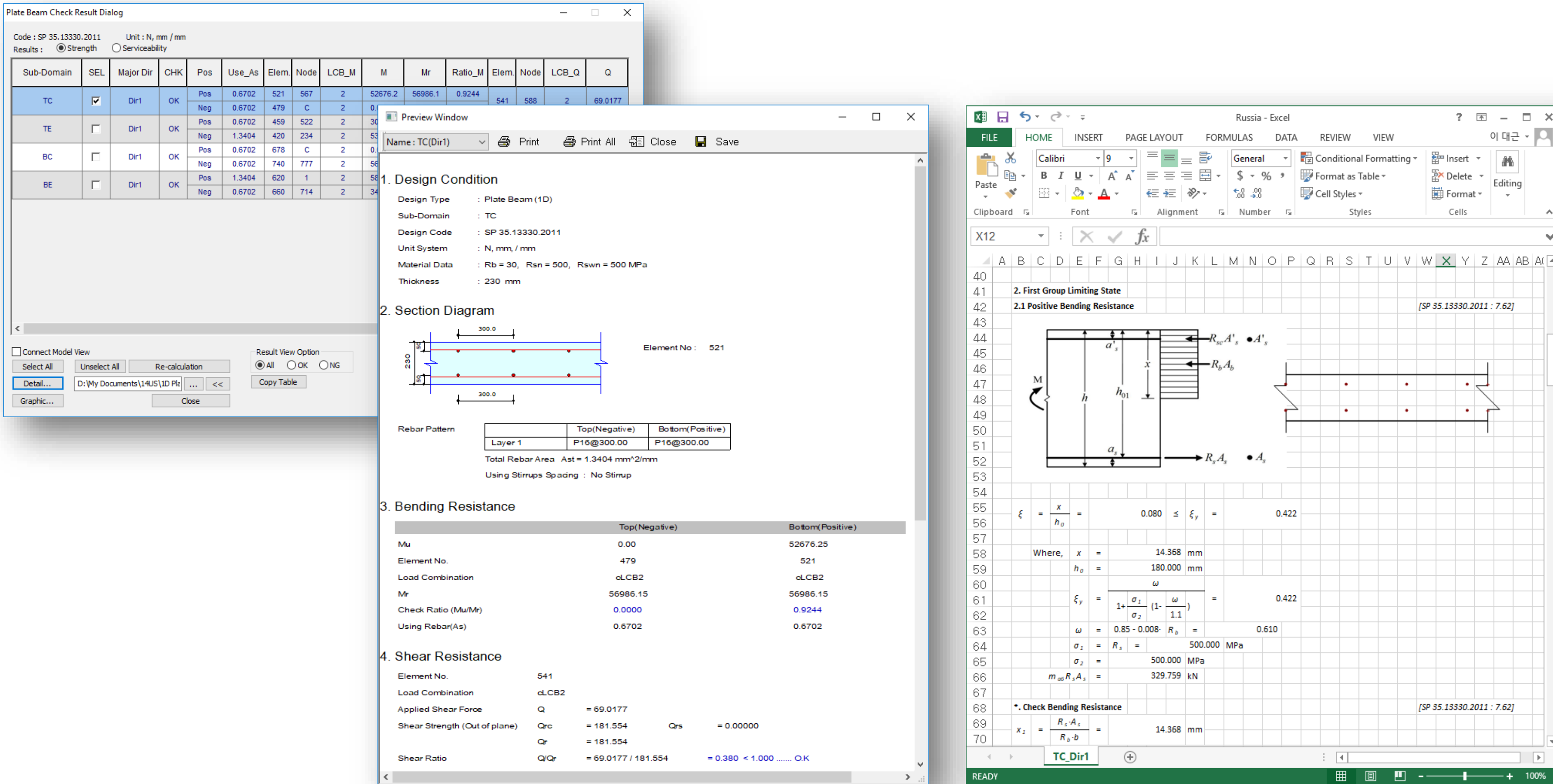


# 13. Plate Beam and Plate Column (1D) Checking to Russian SNiP and SP

- The results of plate beam checking/plate column checking can be viewed in table format and also both summary report and excel 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.

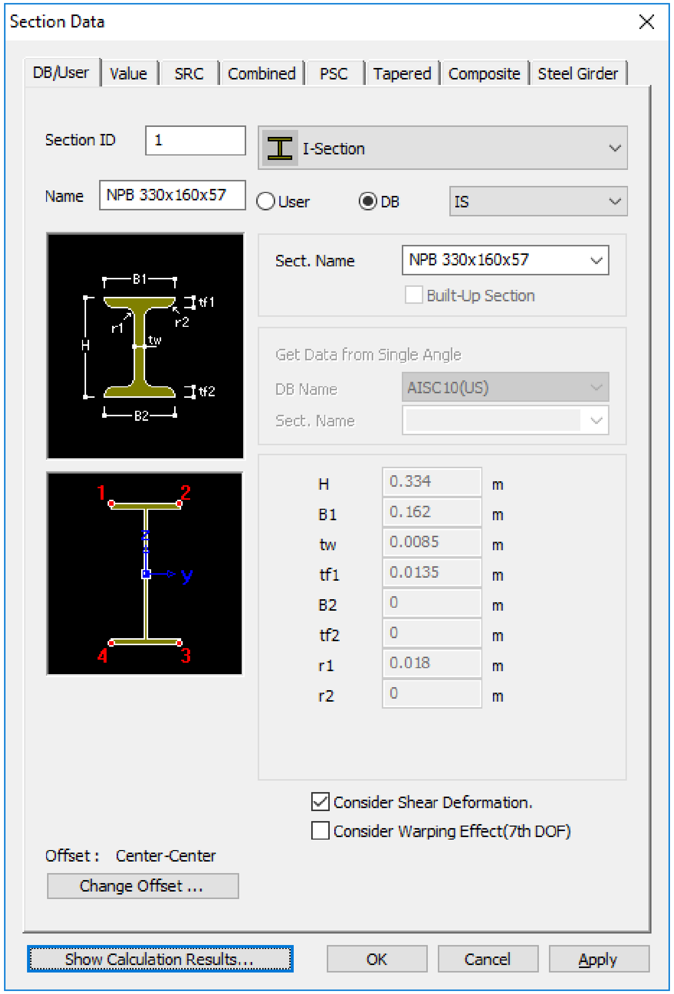
- ***Design > RC Design > Plate Beam/Column Checking***

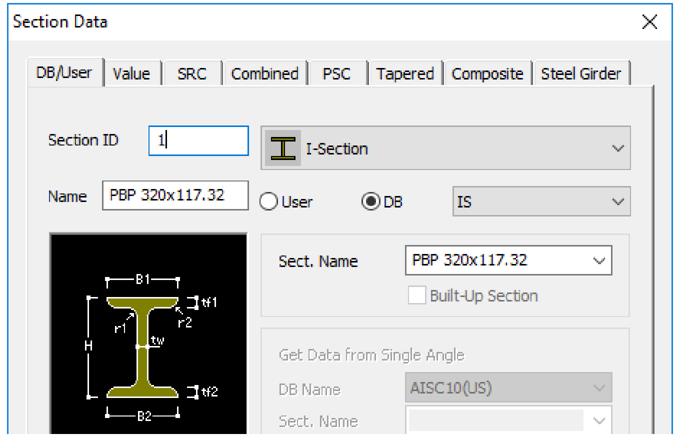


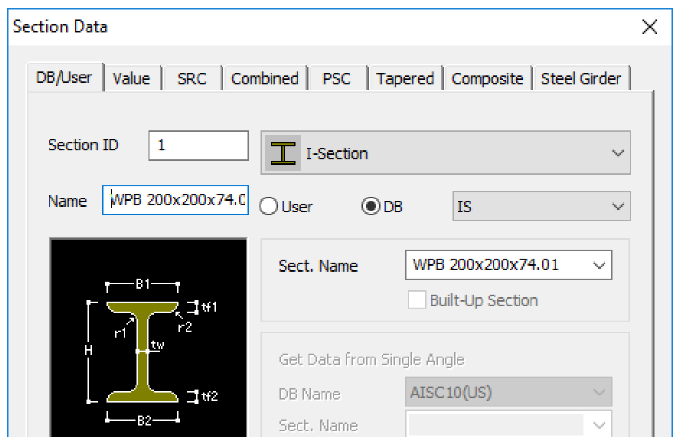
# 14. Steel Section Database Update to IS-12778:2004

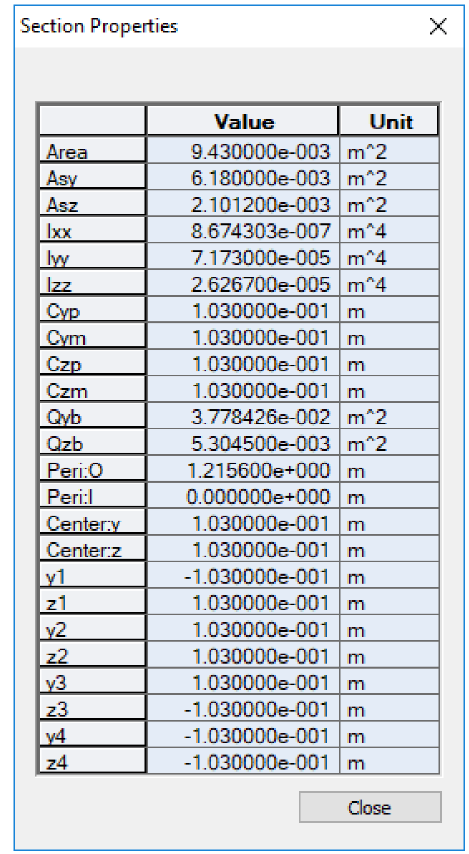
- Authorities have issued permission to allow sections from IS-12778:2004 for railway bridge design.
- Additional I sections (NPB, PBP, WPB) is now available for steel design and optimization.

▪ ***Properties > Section Properties***



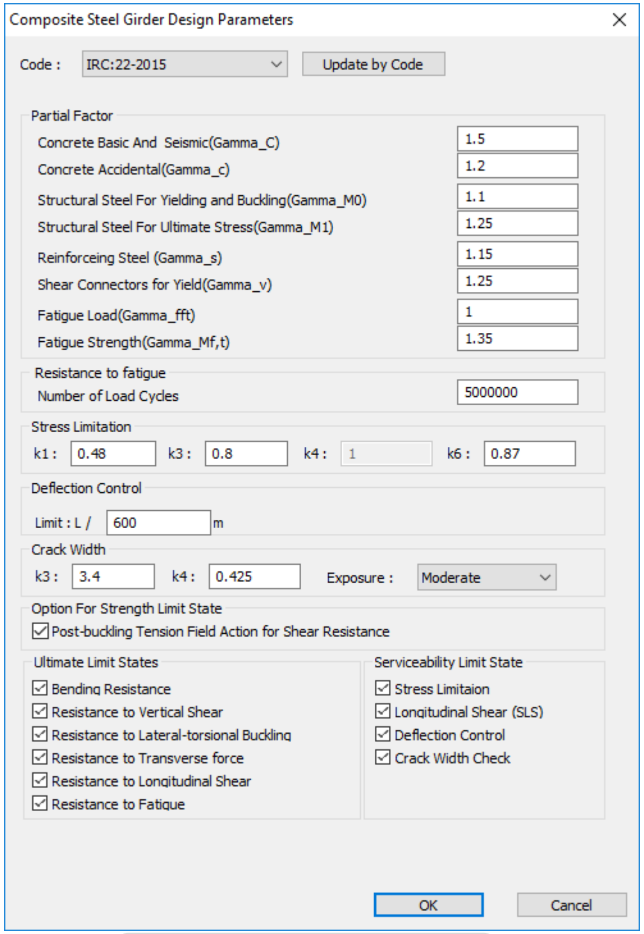




| | Value | Unit |
|---|---|---|
| Area | 9.430000e-003 | m^2 |
| Asy | 6.180000e-003 | m^2 |
| Asz | 2.101200e-003 | m^2 |
| Ixx | 8.674303e-007 | m^4 |
| Iyy | 7.173000e-005 | m^4 |
| Izz | 2.626700e-005 | m^4 |
| Cyp | 1.030000e-001 | m |
| Cym | 1.030000e-001 | m |
| Czp | 1.030000e-001 | m |
| Czm | 1.030000e-001 | m |
| Qyb | 3.778426e-002 | m^2 |
| Qzb | 5.304500e-003 | m^2 |
| Peri:O | 1.215600e+000 | m |
| Peri:I | 0.000000e+000 | m |
| Center:y | 1.030000e-001 | m |
| Center:z | 1.030000e-001 | m |
| y1 | -1.030000e-001 | m |
| z1 | 1.030000e-001 | m |
| y2 | 1.030000e-001 | m |
| z2 | 1.030000e-001 | m |
| y3 | 1.030000e-001 | m |
| z3 | -1.030000e-001 | m |
| y4 | -1.030000e-001 | m |
| z4 | -1.030000e-001 | m |

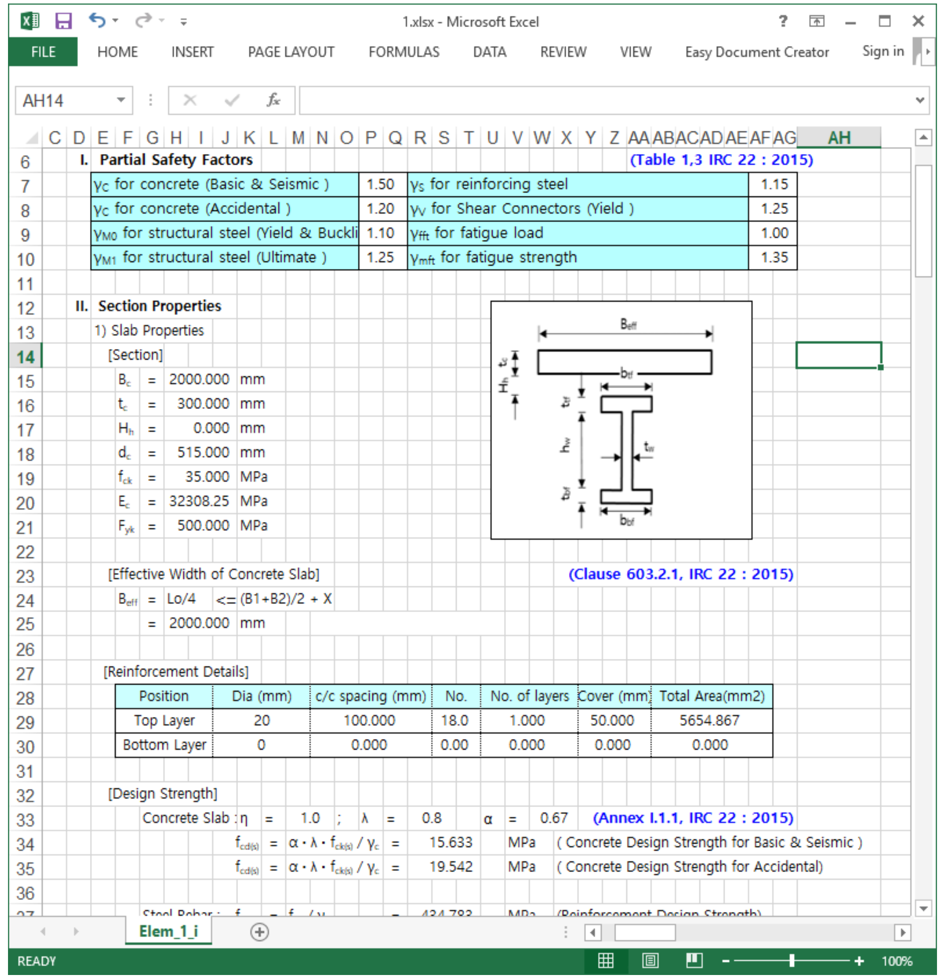
# 15. Steel Composite Girder Design to IRC-22:2015

- Steel composite girder design is now possible with the latest IRC code. This feature is applicable for beam type of elements.
- Section checks for ultimate limit state as well as serviceability limit state are available.
- Results are available in tabular format and the details calculations could be referred in the excel file.

- ***Design > Composite Design***




Design Parameters

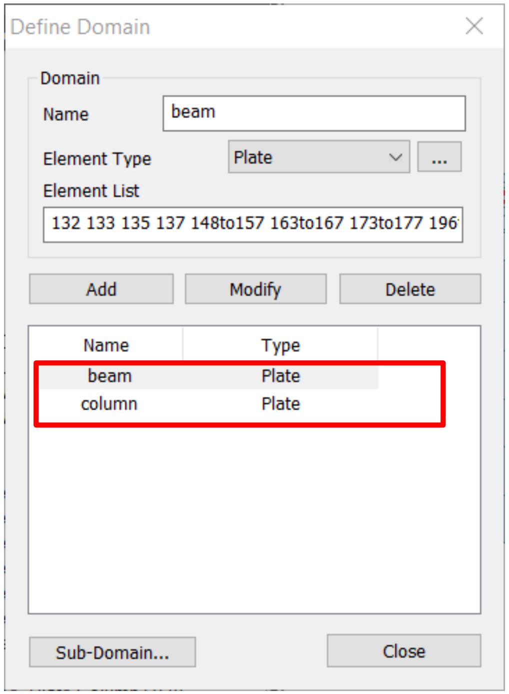



Excel Design Report

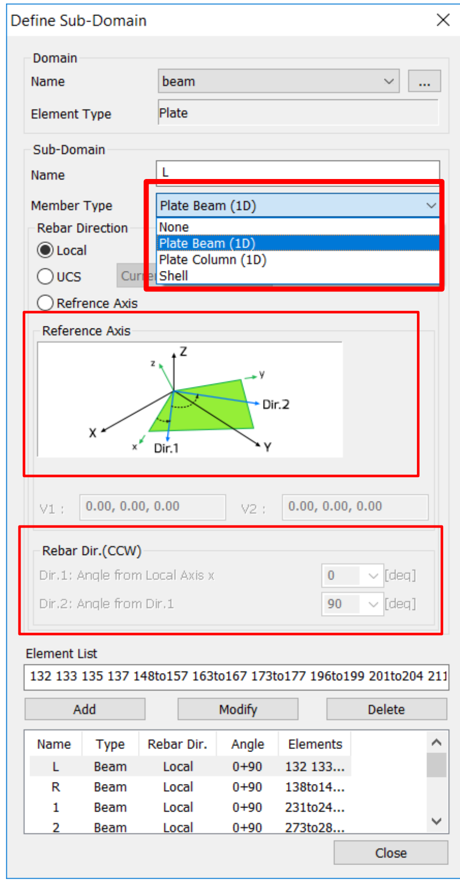
# 16. Plate Beam and Plate Column (1D) Design to IRC 112:2011 Code

- Plate elements can now be designed with the same method of designing conventional 1D elements such as beam or column as per IRC 112: 2011.
- The plate design is performed for defined sub-domain. Member Type is 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.

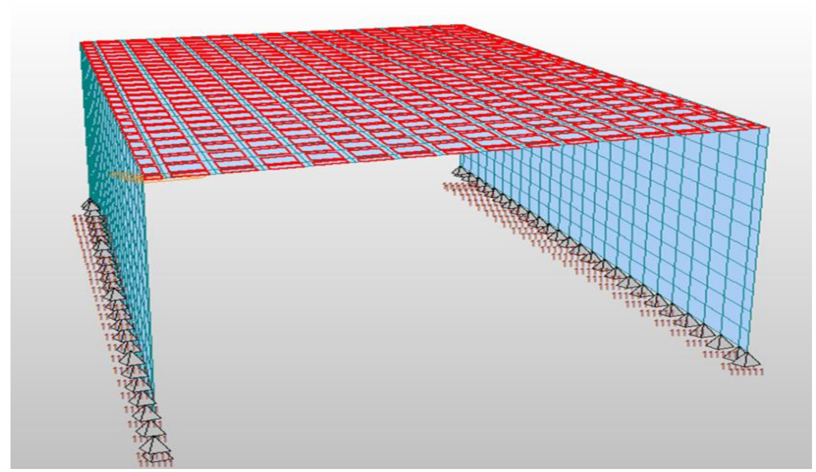
▪ ***Node/Element > Elements > Define Sub-Domain***




Define Domain




Define Sub-Domain

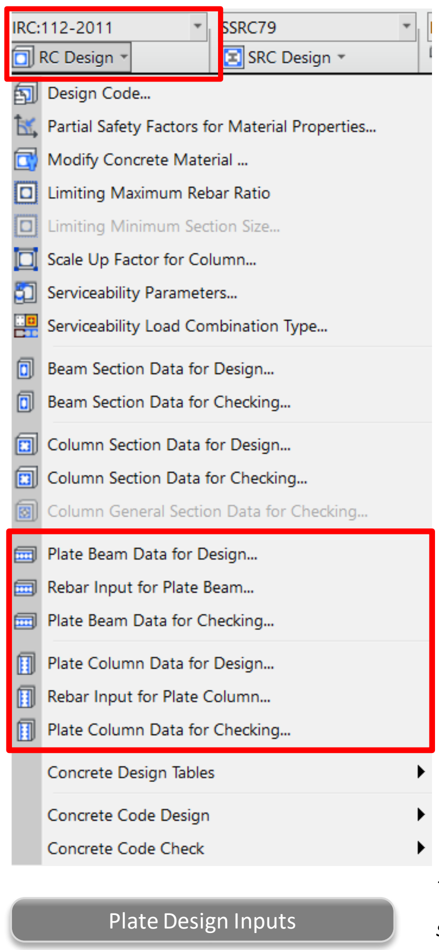


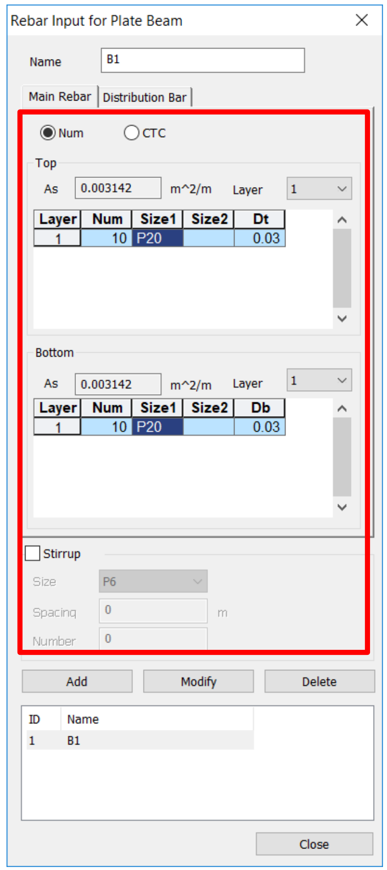
**** Note : This feature is used for the calculation of Wood-Armer moment of specific direction. This will be fixed to default for Plate Design (Dir.1 = 0 deg, Dir.2 = 90 deg).***

# 16. Plate Beam and Plate Column (1D) Design to IRC 112:2011 Code

- 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.
- The main target of this function is culvert and abutment. Axial force is not critical when we are designing culvert or abutment. Therefore this feature does not consider the benefit of axial force in calculation of flexural strength. However the calculation of axial resistance is provided in checking mode.

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




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