

Release Note

Release Date : March 2019

Product Ver. : Civil 2019 (v2.2)

* This release note includes the enhancements of Civil 2019 (v2.1).



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

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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

The Steel selection interface consists of three panels, each showing a 'Standard' dropdown, a 'DB' dropdown, and a list of available materials. Below each panel is a grey button with the standard name.

- AS/NZS 3678: 2016:** Standard: AS/NZS 3678(S), DB: 200. Available materials: 200, 250, 300, WR350, 350, 400, 450.
- AS/NZS 3679.1: 2016:** Standard: AS/NZS 3679.1(S), DB: 300. Available materials: 300, 350, HRS300, HRS350.
- AS/NZS 4672.1: 2007:** Standard: AS/NZS 4672.1(S), DB: 1030. Available materials: 1030, 1670, 1700, 1700S, 1790S, 1820S, 1830S, 1850S, 1870S.

Concrete

The Concrete selection interface shows a 'Standard' dropdown set to AS17(RC), a 'Code' dropdown, and a 'DB' dropdown. A list of concrete codes is displayed below the DB dropdown. Below the interface is a grey button with the standard name.

- AS 5100.5: 2017:** Standard: AS17(RC), Code: [blank], DB: C20. Available materials: C20, C25, C32, C40, C50, C65, C80, C100.

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

- Australia precast plank girders

▪ Properties > Section

Section Data

DB/User | Value | SRC | Combined | PSC | Tapered | Composite | Steel Girder

Section ID: 1 PSC-Value

Name: Mesh Size for Stiff. Calc.: m

Define by Coordinates... Section Data

Param. for Design

T1: m
T2: m
BT: m
HT: m

Thk. for Torsion(min.): m Auto

Calc. Section Properties		
Area	0.00000e+000	m ²
Asy	0.00000e+000	m ²
Asz	0.00000e+000	m ²
Ixx	0.00000e+000	m ⁴
Iyy	0.00000e+000	m ⁴
Izz	0.00000e+000	m ⁴
Cyp	0.0000	m
Cym	0.0000	m
Czp	0.0000	m
Czm	0.0000	m
Qyb	0.0000	m ²

Consider Shear Deformation Consider Warping Effect(7th DOF)

Warping Check: Auto User

Position	Qy	Auto	Thk. for Shear(total)	Auto
Z1: 0 m	0 m ³	<input type="checkbox"/>	0 m	<input type="checkbox"/>
Z2: Centroid	0 m ³	<input type="checkbox"/>	0 m	<input type="checkbox"/>
Z3: 0 m	0 m ³	<input type="checkbox"/>	0 m	<input type="checkbox"/>

Offset: Center-Center Change Offset ... Display Centroid

Show Calculation Results... OK Cancel Apply

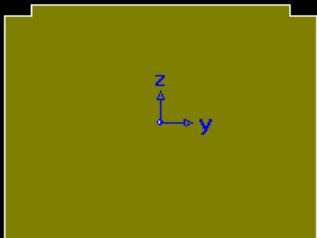
PSC Value

Select PSC DB

Code: AS Type: AS-Plank-Girder

Select DB

- 1:Span-7m
- 2:Span-8m
- 3:Span-9m
- 4:Span-10m
- 5:Span-11m
- 6:Span-12m
- 7:Void-Span-13m
- 8:Void-Span-14m
- 9:Void-Span-15m
- 10:Void-Span-16m
- 11:Void-Span-17m
- 12:Void-Span-18m



OK

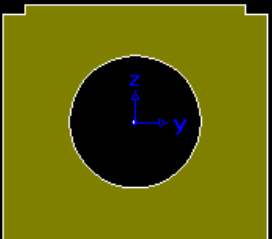
AS-Plank-Girder

Select PSC DB

Code: AS Type: AS-Plank-Girder

Select DB

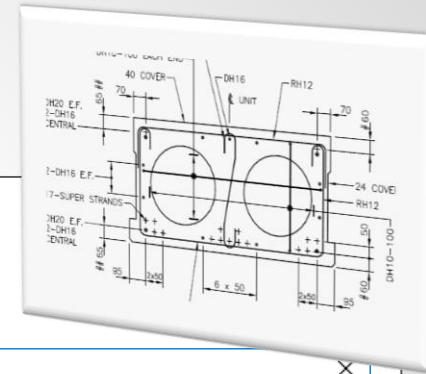
- 1:Span-7m
- 2:Span-8m
- 3:Span-9m
- 4:Span-10m
- 5:Span-11m
- 6:Span-12m
- 7:Void-Span-13m
- 8:Void-Span-14m
- 9:Void-Span-15m
- 10:Void-Span-16m
- 11:Void-Span-17m
- 12:Void-Span-18m



OK Cancel

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

- New Zealand precast hollow core sections.



Properties > Section

Section Data

DB/User | Value | SRC | Combined | PSC | Tapered | Composite | Steel Girder

Section ID: 1 PSC-Value

Name: Mesh Size for Stiff. Calc. m

Define by Coordinates... Section Data

Param. for Design

T1: m
T2: m
BT: m
HT: m

Thk. for Torsion(min.): m Auto

Consider Shear Deformation Consider Warping Effect(7th DOF)

Warping Check: Auto User

Section Properties	Calc.	Section Properties
Area	0.00000e+000	m ²
Asy	0.00000e+000	m ²
Asz	0.00000e+000	m ²
Ixx	0.00000e+000	m ⁴
Iyy	0.00000e+000	m ⁴
Izz	0.00000e+000	m ⁴
Cyp	0.0000	m
Cym	0.0000	m
Czp	0.0000	m
Czm	0.0000	m
Qyb	0.0000	m ²

Shear Check

Position	Qy	Auto	Thk. for Shear(total)	Auto
Z1: 0 m	0 m ³	<input type="checkbox"/>	0 m	<input type="checkbox"/>
Z2: Centroid	0 m ³	<input type="checkbox"/>	0 m	<input type="checkbox"/>
Z3: 0 m	0 m ³	<input type="checkbox"/>	0 m	<input type="checkbox"/>

Offset: Center-Center Change Offset ... Display Centroid

Show Calculation Results... OK Cancel Apply

PSC Value

Select PSC DB

Code: NZ Type: NZ-Hollow-Core

Select DB

- 1:SH650-Inner-16m
- 2:SH650-Outer-L-16m
- 3:SH650-Outer-R-16m
- 4:SH650-Inner-18m
- 5:SH650-Outer-L-18m
- 6:SH650-Outer-R-18m
- 7:SH900-Inner-20m
- 8:SH900-Outer-L-20m
- 9:SH900-Outer-R-20m
- 10:SH900-Inner-22.5m
- 11:SH900-Outer-L-22.5m
- 12:SH900-Outer-R-22.5m
- 13:SH900-Inner-25m

OK

NZ-Hollow-Core

Select PSC DB

Code: NZ Type: NZ-Hollow-Core

Select DB

- 9:SH900-Outer-R-20m
- 10:SH900-Inner-22.5m
- 11:SH900-Outer-L-22.5m
- 12:SH900-Outer-R-22.5m
- 13:SH900-Inner-25m
- 14:SH900-Outer-L-25m
- 15:SH900-Outer-R-25m
- 16:DH587-Inner-12m
- 17:DH587-Outer-L-12m
- 18:DH587-Outer-R-12m
- 19:DH587-Inner-14m
- 20:DH587-Outer-L-14m
- 21:DH587-Outer-R-14m

OK Cancel

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

The screenshot displays the 'Tendon Template' dialog box and the 'Auto Generation' dialog box overlaid on a 3D model of a precast girder.

Tendon Template Dialog:

- Use Prefix Name : strand
- Assigned Elements : 319to330
- Buttons: Add, Modify, Set Property, Move/Copy, Delete, Import, Export, Auto Generation, Reset Name, OK, Cancel, Apply
- Table:

No	Name	Property
1	strand_001	Tendon 001
2	strand_002	Tendon 001
3	strand_003	Tendon 001
4	strand_004	Tendon 001
5	strand_005	Tendon 001
6	strand_006	Tendon 001
7	strand_007	Tendon 001
8	strand_008	Tendon 001
9	strand_009	Tendon 001
10	strand_010	Tendon 001
11	strand_011	Tendon 001
12	strand_012	Tendon 001
13	strand_013	Tendon 001
14	strand_014	Tendon 001
15	strand_015	Tendon 001
16	strand_016	Tendon 001
17	strand_017	Tendon 001
18	strand_018	Tendon 001

Auto Generation Dialog:

- Name prefix : strand
- Tendon Property : Tendon 001
- Tendon Group : Default
- Code : AS
- Type : AS-Super-T (dropdown menu open showing AS-Super-T and AS-Plank-Girder)
- Name : AS-Super-T
- Origin Point : 0.000, 0.000 m
- Initialize Tendon Template
- Buttons: OK, Cancel

Tendon Section View:

- Plane View
- Elevation View
- Section: 319, 320, 321, 322, 323, 324
- Dimensions: 2.960 m (width), 1.680 m (height)
- Position: Pos. : i, j

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

Tendon Template

Use Prefix Name : strand

Assigned Elements : 319to330 [Add] 319to330 [v] ...

No	Name	Property
1	strand_001	Tendon 001
2	strand_002	Tendon 001
3	strand_003	Tendon 001
4	strand_004	Tendon 001
5	strand_005	Tendon 001
6	strand_006	Tendon 001
7	strand_007	Tendon 001
8	strand_008	Tendon 001
9	strand_009	Tendon 001
10	strand_010	Tendon 001
11	strand_011	Tendon 001
12	strand_012	Tendon 001
13	strand_013	Tendon 001
14	strand_014	Tendon 001
15	strand_015	Tendon 001
16	strand_016	Tendon 001
17	strand_017	Tendon 001
18	strand_018	Tendon 001

[Add] [Modify] [Set Property] [Move/Copy] [Delete] [Import] [Export] [Auto Generation] [Reset Name] [OK] [Cancel] [Apply]

Tendon

Plane View [v] [^]

Elevation View [v] [^]

Section [v] [^]

319 [v] [^]

320 [v] [^]

321 [v] [^]

322 [v] [^]

323 [v] [^]

324 [v] [^]

325 [v] [^]

Pos. : i j

2 @ 0.840 m

1.138 m

0.900 m

12 @ 0.110 m

14 @ 0.660 m

Auto Generation

Name prefix : strand

Tendon Property : Tendon 001 [v] ...

Tendon Group : Default [v] ...

Code : NZ [v] ...

Type : NZ-Hollow-Core [v] ...

Name : NZ-Super-T [v] NZ-I-Girder [v] NZ-Hollow-Core [v]

Origin Point : NZ-Hollow-Core m

Initialize Tendon Template

[OK] [Cancel]

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

Define Standard Vehicular Load

Standard Name: AS 5100.2 - Road Traffic

Vehicular Load Properties

Vehicular Load Name: M1600 without UDL

Vehicular Load Type: M1600 without UDL

Dynamic Load Allowance: 0.3

No	Load(kN)	Spacing(m)
1	120	1.25
2	120	1.25
3	120	3.75
4	120	1.25
5	120	1.25
6	120	6.25
7	120	Infinite
8	120	1.25

Fatigue

OK Cancel Apply

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 (α).

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.

Define Standard Vehicular Load

Standard Name: AS 5100.2 - Road Traffic

Vehicular Load Properties

Vehicular Load Name: A160

Vehicular Load Type: A160

Dynamic Load Allowance: 0.4

No	Load(kN)	Spacing(m)
1	160	end

Fatigue

OK Cancel Apply

Fatigue Vehicle: A160

Sub - Load Case

Load Case Data

Vehicle Class: VL:M1600 without UDL

Scale Factor: 0.7

Min. Number of Loaded Lanes: 0

Max. Number of Loaded Lanes: 1

Assignment Lanes

List of Lanes: [Empty]

Selected Lanes: Lane1, Lane2, Lane3, Lane4

OK Cancel

Moving Load Case

6. Load Combination to AS 5100.2: 2017 (Not available in Civil 2019 (v2.1))

- Concrete structure only for roadway and pedestrian bridge.

Results > Combination > Load Combination

Load Combinations

General | Steel Design | Concrete Design | SRC Design | Composite Steel Girder Design

Load Combination List

No	Name	Active	Type	E	Description
22	cLCB-22	Strengt	Add	<input type="checkbox"/>	ULS4 : 1.2D+0.8E
23	cLCB-23	Strengt	Add	<input type="checkbox"/>	ULS4 : 0.85D+2.0E
24	cLCB-24	Strengt	Add	<input type="checkbox"/>	ULS4 : 0.85D+0.8E
25	cLCB-25	Strengt	Add	<input type="checkbox"/>	ULS5 : 1.2D+2.0E
26	cLCB-26	Strengt	Add	<input type="checkbox"/>	ULS5 : 1.2D+0.8E
27	cLCB-27	Strengt	Add	<input type="checkbox"/>	ULS5 : 1.2D+0.8E
28	cLCB-28	Strengt	Add	<input type="checkbox"/>	ULS5 : 1.2D+0.8E
29	cLCB-29	Strengt	Add	<input type="checkbox"/>	ULS5 : 0.85D+2.0E
30	cLCB-30	Strengt	Add	<input type="checkbox"/>	ULS5 : 0.85D+2.0E
31	cLCB-31	Strengt	Add	<input type="checkbox"/>	ULS5 : 0.85D+0.8E
32	cLCB-32	Strengt	Add	<input type="checkbox"/>	ULS5 : 0.85D+0.8E
33	cLCB-33	Strengt	Add	<input type="checkbox"/>	ULS6 : 1.2D+2.0E
34	cLCB-34	Strengt	Add	<input type="checkbox"/>	ULS6 : 1.2D+0.8E
35	cLCB-35	Strengt	Add	<input type="checkbox"/>	ULS6 : 0.85D+2.0E
36	cLCB-36	Strengt	Add	<input type="checkbox"/>	ULS6 : 0.85D+0.8E
37	cLCB-37	Strengt	Add	<input type="checkbox"/>	ULS7 : 1.2D+2.0E
38	cLCB-38	Strengt	Add	<input type="checkbox"/>	ULS7 : 1.2D+0.8E
39	cLCB-39	Strengt	Add	<input type="checkbox"/>	ULS7 : 0.85D+2.0E
40	cLCB-40	Strengt	Add	<input type="checkbox"/>	ULS7 : 0.85D+0.8E
41	cLCB-41	Strengt	Add	<input type="checkbox"/>	ULS8 : 1.2D+2.0E
42	cLCB-42	Strengt	Add	<input type="checkbox"/>	ULS8 : 1.2D+0.8E

Load Cases and Factors

LoadCase	Factor
DeadLoad(CS1)(ST)	0.9000
DeadLoad(PostSC)(ST)	0.9000
DW(ST)	1.3500
Dead Load(CS)	0.9000
*	

Copy Import... Auto Generation... Spread Sheet Form

File Name: D:\Civil Test\Temp(2018 하반기)\#5650 Civil 호 Browse Make Load Combination Sheet Close

Load Combination

Automatic Generation of Load Combinations

Option
 Add Replace

Code Selection
 Steel Concrete SRC Steel Composite
 Design Code : AS 5100.2:17

Manipulation of Construction Stage Load Case
 ST Only CS Only ST+CS
 ST : Static Load Case CS : Construction Stage

Bridge Type Roadway

Load Factors for Permanent Loads

Type of Load	Load Factor		
	R.S	I.S	Both
Dead Load	<input checked="" type="radio"/> 1.20	<input type="radio"/> 0.85	<input type="radio"/>
Superimposed Dead Load	<input checked="" type="radio"/> 2.00	<input type="radio"/> 0.80	<input type="radio"/>
Soil Load	<input checked="" type="radio"/> 1.50	<input type="radio"/> 0.70	<input type="radio"/>
Groundwater Load	<input checked="" type="radio"/> 1.00	<input type="radio"/> 1.00	<input type="radio"/>

R.S : Reduce Safety
 I.S : Increase Safety

Fatigue Load Combination
 Road Traffic Case : MVL1

Load Case Add Delete

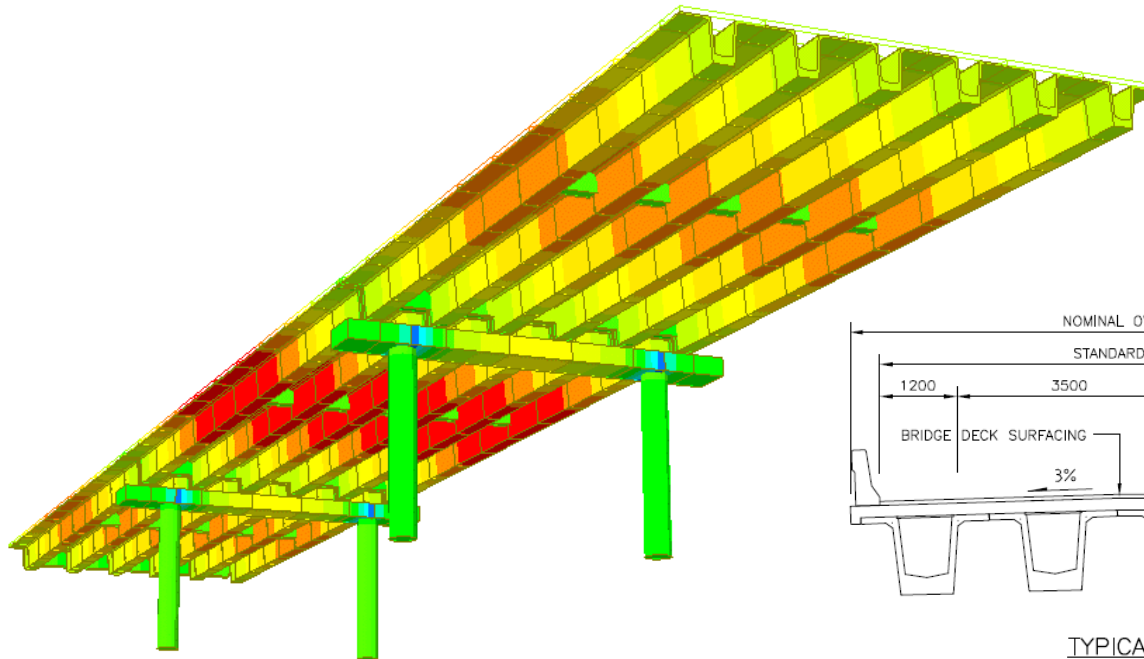
OK Cancel

Auto-Generation

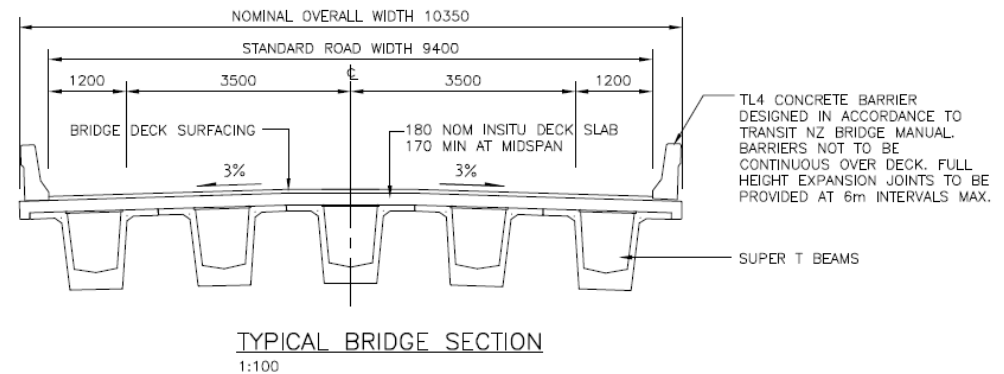
7. Prestressed Concrete Girder Design to AS 5100: 2017 (Not available in Civil 2019 (v2.1))

- 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

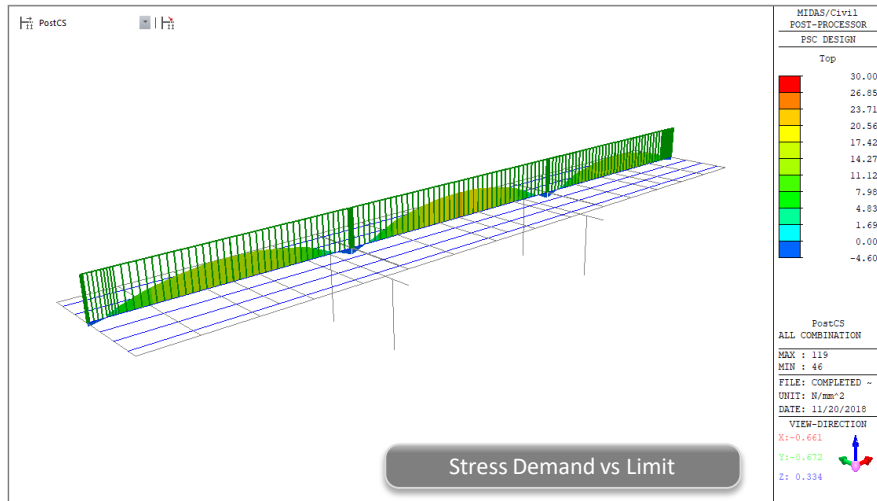


Super T Girder Bridge



7. Prestressed Concrete Girder Design to AS 5100: 2017

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



1. Design Condition										
2	Design code	Element	Node(I/J)							
3	AS5100:5-17	190	J							
5	■ Section Properties									
6	Section name		Type							
7	CPPC		Composite							
8	- Gross section				- Transformed section					
9			Before	After			Before	After		
10	H	(mm)	1500.0	1680.0	H	(mm)	1500.0	1680.0		
11	B	(mm)	2960.0	2960.0	B	(mm)	2960.0	2960.0		
12	C _{zp}	(mm)	0.0	356.1	C _{zp}	(mm)	0.0	370.8		
13	C _{zm}	(mm)	0.0	1143.9	C _{zm}	(mm)	0.0	1129.2		
14	C _{zps}	(mm)	740.6	536.1	C _{zps}	(mm)	755.0	550.8		
15	C _{zms}	(mm)	759.4	356.1	C _{zms}	(mm)	745.0	370.8		
16	A _g	(mm ²)	6.181.E+05	1.151.E+06	A _g	(mm ²)	6.332.E+05	1.166.E+06		
17	I _y	(mm ⁴)	1.947.E+11	3.936.E+11	I _y	(mm ⁴)	2.003.E+11	4.083.E+11		
18	S _t	(mm ³)	2.630.E+08	5.469.E+08	S _t	(mm ³)	2.652.E+08	5.400.E+08		
19	S _b	(mm ³)	2.564.E+08	1.702.E+08	S _b	(mm ³)	2.688.E+08	1.773.E+08		
20	S _{bs}	(mm ³)		7.342.E+08	S _{bs}	(mm ³)		7.145.E+08		
21	S _{bs}	(mm ³)		1.105.E+09	S _{bs}	(mm ³)		1.061.E+09		
23	■ Materials									
24	- Concrete									
25		f _c	f _c	f _{ctf} = 0.6√f _c	α ₂	γ				
26		(MPa)	(MPa)	(MPa)						
27	Girder	50.000	34800.000	4.243	0.85	0.70				
28	Slab	32.000	30100.000	3.394	0.85	0.83				
29	* α ₂ = 1.0 - 0.003f _c (within the limits of 0.67 ≤ α ₂ ≤ 0.85)									
30	* γ = 1.05 - 0.007f _c (within the limits of 0.67 ≤ γ ≤ 0.85)									
31	- Prestressing steel Information									
32		190_J	190_J	Bond	d	A	Strength (MPa)	E		

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

Plate Beam Check Result Dialog

Code : Eurocode2-2:05 Unit : N, mm / mm

Results : Strength Serviceability

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	<input type="checkbox"/>	Dir1	NG	Pos	500	566	1	3.7199	3.9682	24.906	400.00	521	567	1	0.4064	0.3000
				Neg	-	-	-	-	-	-	-	-	-	-	-	-
TE	<input type="checkbox"/>	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	<input type="checkbox"/>	Dir1	OK	Pos	-	-	-	-	-	-	-	-	-	-	-	-
				Neg	-	-	-	-	-	-	-	-	-	-	-	-
BE	<input type="checkbox"/>	Dir1	OK	Pos	-	-	-	-	-	-	-	-	-	-	-	-
				Neg	-	-	-	-	-	-	-	-	-	-	-	-

Connect Model View

Select All Unselect All Re-calculation

Detail... D:\My Documents\14US\1D Plz <<

Graphic... Close

Result View Option

All OK NG

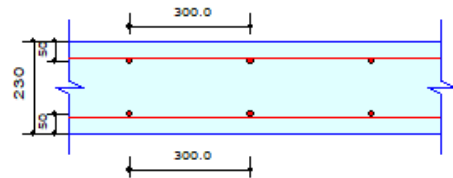
Copy Table

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 mm²/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):

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

where

$s_{r,max}$ is the maximum crack spacing

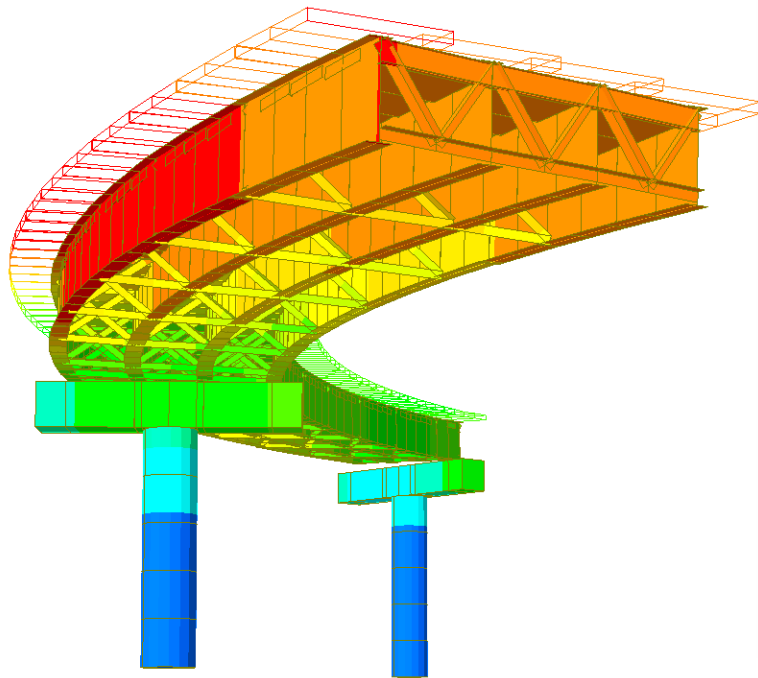
ϵ_{sm} is the mean strain in the reinforcement under the relevant combination of loads, including the effect of imposed deformations and taking into account the effects of tension stiffening. Only the additional tensile strain beyond the state of zero strain of the concrete at the same level is considered

ϵ_{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

Load Combination Type

Steel Design

Load Combination List

sLCB1	Fatigue Load Combination
	sLCB5

7 Resistance to Fatigue	
- Design load	
Load combination name :	sLCB5
F_z	= 244.651 kN
- Shear stress range for the connector	
$\Delta\tau = F_{sc} / A_{sc}$	= 33.854 MPa
where, F_{sc}	= $V_{L,Ed} \cdot \text{space of stud} / \text{number of stud}$ = 9.599 kN
A_{sc}	= 283.529 mm ²
- Damage equivalent factor	
$\lambda_v = \lambda_{v,1} \cdot \lambda_{v,2} \cdot \lambda_{v,3} \cdot \lambda_{v,4}$	= 1.586
where, $\lambda_{v,1}$	= 1.550
$\lambda_{v,2}$	= 1.000
$\lambda_{v,3}$	= 1.023
$\lambda_{v,4}$	= 1.000
- Equivalent constant amplitude range of shear stress related to 2 million cycles	
$\Delta\tau_{E,2} = \lambda_v \cdot \Delta\tau$	= 53.684 MPa
- Verification	
$\gamma_{Ff} \cdot \Delta\tau_{E,2} / (\Delta\tau_c / \gamma_{Mf,s})$	= 0.596 < 1

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

Define Standard Vehicular Load

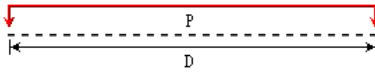
Standard Name: Military Load Class

Vehicular Load Properties

Vehicular Load Name: Tracked Vehicle

Vehicular Load Type: Tracked Vehicle

Select Vehicle: Class 12



Total Load (P): 10.88 tonf

Tracked Length (D): 2.74 m

Wheel Spacing: 1.73 m

Nose to Tail Distance:

Num of Vehicle:

Dynamic Amplification Factor

Auto

$\phi = 1.35 - 0.005L$ (1 = p

ϕ



Tracked Vehicle

Define Standard Vehicular Load

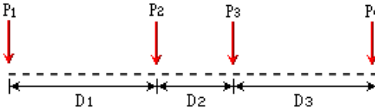
Standard Name: Military Load Class

Vehicular Load Properties

Vehicular Load Name: Wheeled Vehicle

Vehicular Load Type: Wheeled Vehicle

Select Vehicle: Class 40



No	Load(tonf)	Spacing(m)
1	6.35	3.66
2	11.79	1.22
3	11.79	4.88
4	12.7	end

Wheel Spacing: 2.1 m

Nose to Tail Dist.: 30.5 m

Num of Vehicle: 1

Dynamic Amplification Factor

Auto

$\phi = 1.35 - 0.005L$ (1 = p

ϕ

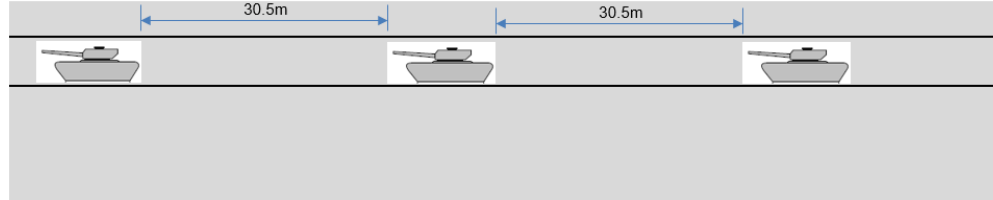


Wheeled Vehicle

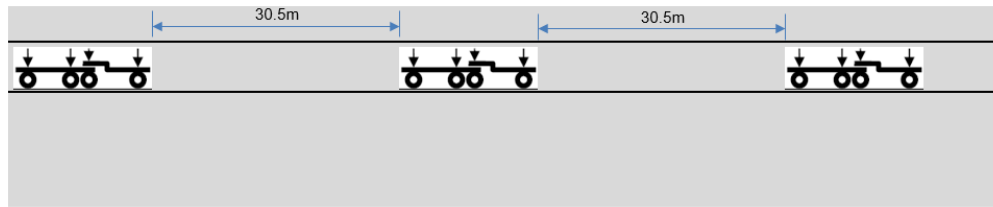
- Class 4
- Class 8
- Class 12
- Class 16
- Class 20
- Class 24
- Class 30
- Class 40
- Class 50
- Class 60
- Class 70
- Class 80
- Class 90
- Class 100
- Class 120
- Class 150

10. Military Load Class

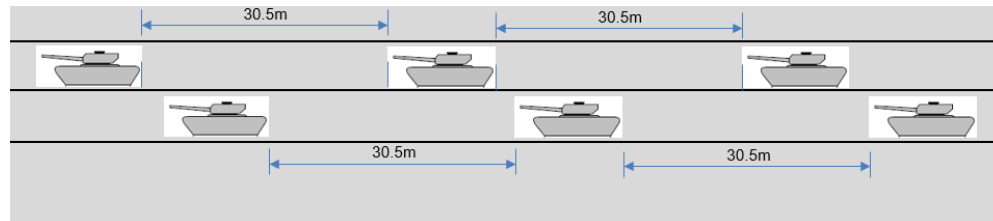
Case 1) Tracked Vehicles are applied to one lane.



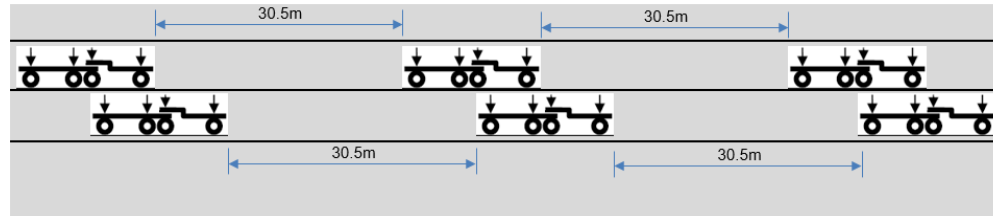
Case 2) Wheeled Vehicles are applied to one lane.



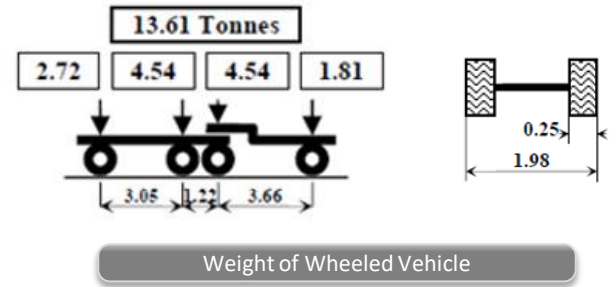
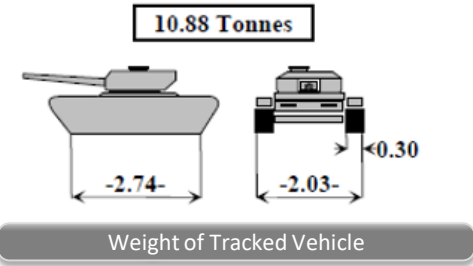
Case 3) Tracked Vehicles are applied to two lanes.



Case 4) Wheeled Vehicles are applied to two lanes.



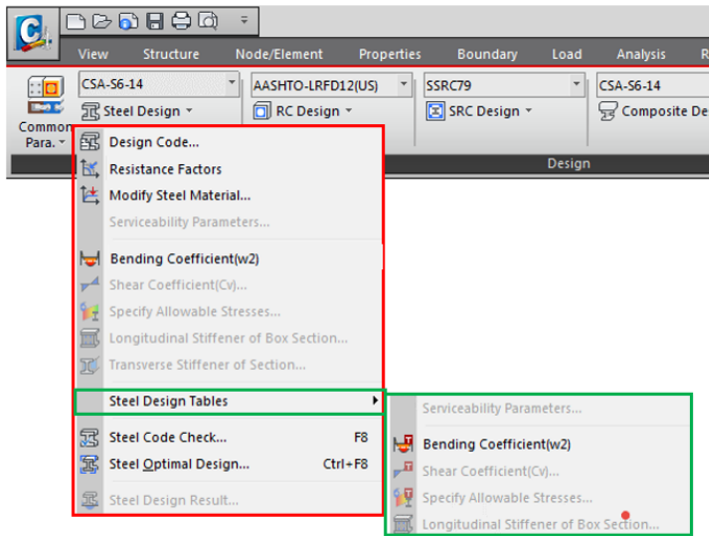
Application Rule



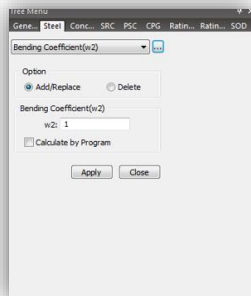
11. Steel Design to CSA-S6-14

- 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)



CSA-S6-14 Code Checking Result Dialog

Code: CSA-S6-14 Unit: kN , m Primary Sorting Option

Sorted by: Member Property Change... Update...

CH	MEMB	SECT	SE	Section	LCB	Len	Om1	Om2y	Pf	Mfy	Mfz	Vfy	Vfz
K	COM	SHR	L	Material Fy	WTR	Lb			Pr	Mry	Mrz	Vry	Vrz
OK	1	3		Beam, ISMB 300	4	8.00000	1.000	1.000	0.00000	-205.94	0.00000	0.00000	109.274
	0.870	0.199		Fe540 410000	-	8.00000		1.000	2075.99	236.631	46.2689	0.00000	547.965
OK	2	3		Beam, ISMB 300	5	8.00000	1.000	1.000	0.00000	-206.37	0.00000	0.00000	-108.32
	0.872	0.198		Fe540 410000	-	8.00000		1.000	2075.99	236.631	46.2689	0.00000	547.965
OK	3	3		Beam, ISMB 300									
	0.860	0.196		Fe540 410000									
OK	4	1		edge columns, ISMB 400									
	0.582	0.138		Fe540 410000									
OK	5	1		edge columns, ISMB 400									
	0.568	0.136		Fe540 410000									
OK	6	1		edge columns, ISMB 400									
	0.578	0.138		Fe540 410000									
OK	7	1		edge columns, ISMB 400									
	0.580	0.141		Fe540 410000									
OK	8	3		Beam, ISMB 300									
	0.516	0.163		Fe540 410000									
OK	9	3		Beam, ISMB 300									
	0.489	0.138		Fe540 410000									
OK	10	3		Beam, ISMB 300									
	0.516	0.163		Fe540 410000									

Connect Model View

Design Information

Design Code : CSA-S6-14

Unit System : N, mm

Member No : 324

Material : A409(C) (No:1)
(Fy = 400.000, Es = 200000)

Section Name : HP12x84* (No:1)
(Rolled: HP12x84*)

Member Length : 6000.00

Member Forces

Axial Force: Foc = 58815.1725 N

Bending Moments: Mxi = 205.94 kNm, Myi = 236.631 kNm, Mzi = 46.2689 kNm

Shear Forces: Fyy = 2075.99 kN, Fzz = 206.37 kN

Design Parameters

Unbraced Lengths: Lx = 6000.00 mm, Ly = 6000.00 mm, Lz = 6000.00 mm

Effective Length Factors: Kx = 1.0, Ky = 1.0, Kz = 1.0

Moment Factor / Bending Coefficient: C1 = 1.0, C2 = 1.0, C3 = 1.0

Checking Results

Slenderness Ratio: $KL/r = 80.5 < 120.0$ (Member Class 3)

Axial Strength: $C\phi C_r = 209396.2939574$ N

Bending Strength: $M_f/\phi_b = 442762377.9587$ Nmm

Combined Resistance (Compression): $R_{max} = R_{max1} = 0.836$ N

Shear Resistance: $V_r = 2939573.95$ N

Check axial tension/compression resistance: $KL/r = 80.5 < 120.0$ ---> O.K.

Check slenderness ratio of axial compression member (KL/r): $KL/r = 80.5 < 120.0$ ---> O.K.

Check width-thickness ratio of element in flexural compression (BTR): $BTR = bf/(2*tf) = 8.97 < \text{Limit3}$ ---> Class 3

Check depth-thickness ratio of element in flexural compression (DTR): $DTR = d/tw = 15.95 < \text{Limit1}$ ---> Class 1

Calculate flexural buckling resistance at axial compression (Crb): $Crb = \phi_b A_g F_y (1 - \lambda^2)^{-1/n} = 2939573.95$ N

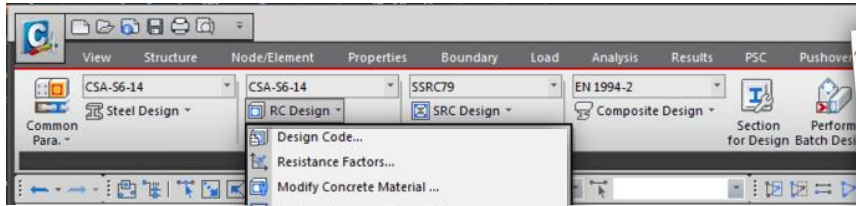
Check ratio of flexural buckling resistance (Cf/Crb): $Cf/Crb = 0.020 < 1.000$ ---> O.K.

Calculate euler buckling stress about major(y) and minor(z) axis.

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



CSA-S6-14 RC-Column Design Result Di...

Code: CSA-S6-14 Unit: kN, m

Sorted by: Member Section

MEMB	SEL	Section	fc'	fy	CHK
0		40000.0	413686		
1	<input type="checkbox"/>	akshay_u	3.0000	413686	OK
0	<input type="checkbox"/>	Tablet_sh	40000.0	413686	PM*
2	<input type="checkbox"/>	3.0000	413686		

Buttons: Connect Model View, Select All, Unselect All, Re-calculation, Graphic..., Summary..., Summary By LCB, Detail..., C:\Users\midas\Desktop\MIDAS_DATA, Draw PM Curve..., Close

ANALYZE NEGATIVE BENDING MOMENT CAPACITY

(-) Compute parameter:
 - $\rho_{min} = 0.75$
 - $\rho_{max} = 0.90$
 - $\alpha = 0.79$
 - $\beta = 0.87$
 - $\rho_{req} = 0.4375 \%$

(-) Compute maximum and minimum reinforcement: [S6-14: 8.9.4, 3.8, 8.4.5]
 - $\rho_{min1} = (1/2) \rho_{min} (\rho_{min} + \rho_{min}^2) = 0.0018$
 - $\rho_{min2} = (4/3) \rho_{min} (\rho_{min} + \rho_{min}^2) = 0.0024$
 - $\rho_{min} = \max(\rho_{min1}, \rho_{min2}) = 0.0024$
 - $\rho_{max} = 0.90$
 - $\rho_{req} = 0.4375 \%$
 - $\rho_{min} = 0.0024$
 - $\rho_{max} = 0.90$

(-) Search for required reinforcement: Unit: kN, m
 Trial Assumed As Ratio Status
 1 5.263e-005 0.53 0.660 0.X

(-) Search for neutral axis: Unit: kN, m
 Trial Assumed As Ratio Status
 1 5.263e-005 0.53 0.660 0.X

(-) Check moment capacity:
 - $C = 0.0022 \text{ m}$
 - $T = 19.83 \text{ mm}$
 - $M_r = 0.53 \text{ MNm}$
 - $M_r/M_c = 0.660 \rightarrow 0.X$

ANALYZE POSITIVE BENDING MOMENT CAPACITY

(+) Compute parameter:
 - $\rho_{min} = 0.75$
 - $\rho_{max} = 0.90$
 - $\alpha = 0.79$
 - $\beta = 0.87$
 - $\rho_{req} = 0.4375 \%$

(+) Compute maximum and minimum reinforcement: [S6-14: 8.9.4, 3.8, 8.4.5]
 - $\rho_{min1} = (1/2) \rho_{min} (\rho_{min} + \rho_{min}^2) = 0.0018$
 - $\rho_{min2} = (4/3) \rho_{min} (\rho_{min} + \rho_{min}^2) = 0.0024$
 - $\rho_{min} = \max(\rho_{min1}, \rho_{min2}) = 0.0024$
 - $\rho_{max} = 0.90$
 - $\rho_{req} = 0.4375 \%$
 - $\rho_{min} = 0.0024$
 - $\rho_{max} = 0.90$

(+) Search for required reinforcement: Unit: kN, m
 Trial Assumed As Ratio Status
 1 6.507e-006 1.00 0.660 0.X

(+) Search for neutral axis: Unit: kN, m
 Trial Assumed As Ratio Status
 1 6.507e-006 1.00 0.660 0.X

1. Design Information

Member Number: 1
 Design Code: CSA-S6-00
 Unit System: kN, m
 Material Data: $f_c = 40000$, $f_y = 413686$, $f_{ys} = 413686 \text{ kPa}$
 Beam Span: 6.71 m
 Section Property: akshay_ultra_beam (No. 1)

2. Section Diagram

3. Bending Moment Capacity

	END-1	MD	END-2
Negative Moment (kNm)	5.63	0.00	5.63
(-) Load Combination No.	1	1	1
Factored Strength (kNm)	0.6601	2.81	0.70
Check Ratio (M/M _r)	8.53	0.0000	0.6601
Positive Moment (kNm)	1	1	1
(+) Load Combination No.	1	1	1
Factored Strength (kNm)	0.6614	4.27	0.6614
Check Ratio (M/M _r)	1.06	0.6994	0.0001
Required Top As	0.0001	0.0000	0.0000
Required Bot As	1	2.52	1
Load Combination No.	5.03	100.72	100.80
Factored Shear Force (kN)	82.90	83.00	82.90
Shear Strength by Conc (V _c)	0.0004	0.0004	0.0004
Shear Strength by Rebar (V _s)	2.043 @320	2.043 @320	2.043 @320
Required Shear Rein. (A _{st})	0.0274	0.0137	0.0274
Required Stirrup Spacing			
Check Ratio			

1. Design Condition

Design Code: CSA-S6-00
 Unit System: kN, m
 Member Number: 3
 Material Data: $f_c = 40000$, $f_y = 413686$, $f_{ys} = 413686 \text{ kPa}$
 Column Height: 3 m
 Section Property: akshay_ultra_beam (No. 1)
 Rebar Pattern: Total Rebar Area $A_{st} = 0.00195801 \text{ m}^2$ ($\rho_{req} = 0.0131$)

2. Applied Loads

Load Combination 1 AT(J) Point
 PF = 15.0000 kN, $M_{oy} = 3.0000$, $M_{oz} = 1.50000$, $M_c = 3.35410 \text{ MNm}$

3. Axial Forces and Moments Capacity Check

Concentric Max. Axial Load $P_{r-max} = 3178.20 \text{ kN}$
 Axial Load Ratio $P/F_r = 15.0000 / 1028.24 = 0.015 < 1.000 \dots \text{OK}$
 Moment Ratio $M_{oz}/M_z = 1.50000 / 207.391 = 0.014 < 1.000 \dots \text{OK}$
 $M_{oy}/M_y = 3.00000 / 104.303 = 0.014 < 1.000 \dots \text{OK}$
 $M_o/M_r = 3.35410 / 232.142 = 0.014 < 1.000 \dots \text{OK}$

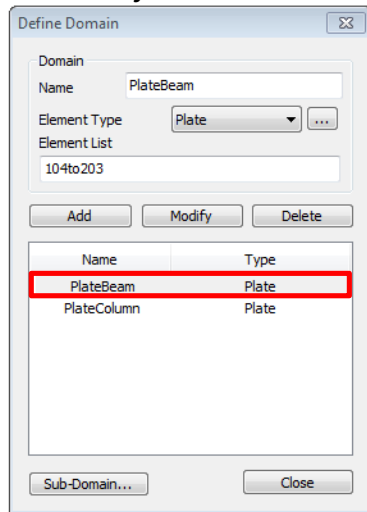
4. P-M Interaction Diagram

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

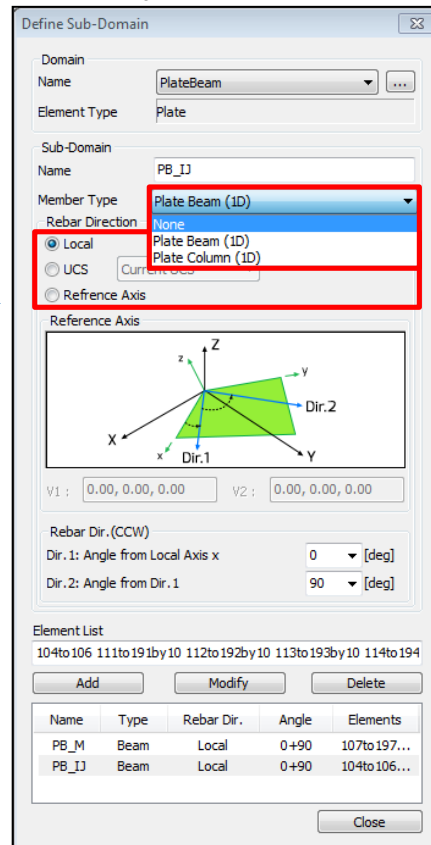
- Plate elements can now be designed with the same method of designing conventional 1D elements such as Beam or Column as per SNIp 2.05.03-84* and SP 35.13330.2011. The plate design is performed for defined sub-domain. Member Type is chosen according to the purpose of the design. (e.g. Plate Beam (1D)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

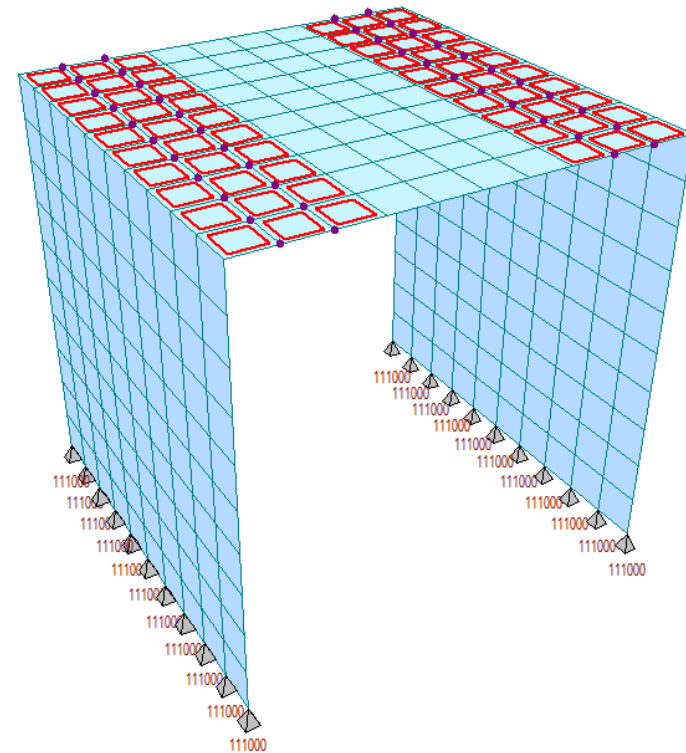
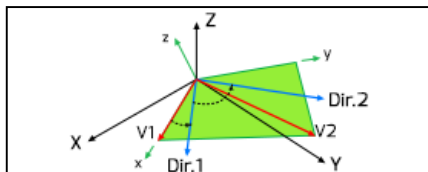
Define Domain



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**

Plate Beam Check Result Dialog

Code : SP 35.13330.2011 Unit : N, mm / mm
Results : Strength Serviceability

Sub-Domain	SEL	Major Dir	CHK	Pos	Use_As	Elem	Node	LCB_M	M	Mr	Ratio_M	Elem	Node	LCB_Q	Q
TC	<input checked="" type="checkbox"/>	Dir1	OK	Pos	0.6702	521	567	2	52676.2	56986.1	0.9244	541	588	2	69.0177
				Neg	0.6702	479	522	2	30.0						
TE	<input type="checkbox"/>	Dir1	OK	Pos	1.3404	420	234	2	53.0						
				Neg	0.6702	678	777	2	0.0						
BC	<input type="checkbox"/>	Dir1	OK	Pos	1.3404	620	1	2	58.0						
				Neg	0.6702	660	714	2	34.0						

Preview Window

Name: TC(Dir1) Print Print All Close Save

1. Design Condition

Design Type : Plate Beam (1D)
Sub-Domain : TC
Design Code : SP 35.13330.2011
Unit System : N, mm / mm
Material Data : Rb = 30, Rsn = 500, Rswn = 500 MPa
Thickness : 230 mm

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 mm²/mm
Using Stirrups Spacing : No Stirrup

3. Bending Resistance

	Top(Negative)	Bottom(Positive)
Mu	0.00	52676.25
Element No.	479	521
Load Combination	d.LCB2	d.LCB2
Mr	56986.15	56986.15
Check Ratio (Mu/Mr)	0.0000	0.9244
Using Rebar(As)	0.6702	0.6702

4. Shear Resistance

Element No. : 541
Load Combination : d.LCB2

Applied Shear Force	Q	= 69.0177	
Shear Strength (Out of plane)	Qrc	= 181.554	Qrs = 0.00000
	Qr	= 181.554	
Shear Ratio	Q/Qr	= 69.0177 / 181.554	= 0.380 < 1.000 OK

Russia - Excel

2. First Group Limiting State

2.1 Positive Bending Resistance

[SP 35.13330.2011 : 7.62]

$$\xi = \frac{x}{h_0} = 0.080 \leq \xi_y = 0.422$$

Where, $x = 14.368$ mm
 $h_0 = 180.000$ mm

$$\xi_y = \frac{\omega}{1 + \frac{\sigma_s}{\sigma_2} (1 - \frac{\omega}{1.1})} = 0.422$$

$\omega = 0.85 - 0.008 \cdot R_s = 0.610$
 $\sigma_2 = R_s = 500.000$ MPa
 $\sigma_s = 500.000$ MPa
 $m_{sd} R_s A_s = 329.759$ kN

*. Check Bending Resistance

[SP 35.13330.2011 : 7.62]

$x_1 = \frac{R_s A_s}{R_s \cdot b} = 14.368$ mm

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.

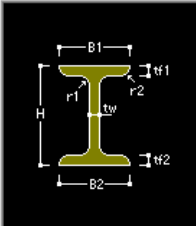
▪ Properties > Section Properties

Section Data

DB/User | Value | SRC | Combined | PSC | Tapered | Composite | Steel Girder

Section ID: 1 I-Section

Name: NPB 330x160x57 User DB IS



Sect. Name: NPB 330x160x57 Built-Up Section

Get Data from Single Angle

DB Name: AISC10(US)

Sect. Name:

H	0.334	m
B1	0.162	m
tw	0.0085	m
tf1	0.0135	m
B2	0	m
tf2	0	m
r1	0.018	m
r2	0	m

Consider Shear Deformation.
 Consider Warping Effect(7th DOF)

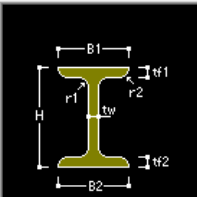
Offset: Center-Center

Section Data

DB/User | Value | SRC | Combined | PSC | Tapered | Composite | Steel Girder

Section ID: 1 I-Section

Name: PBP 320x117.32 User DB IS



Sect. Name: PBP 320x117.32 Built-Up Section

Get Data from Single Angle

DB Name: AISC10(US)

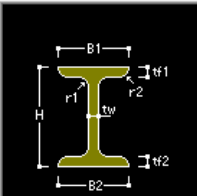
Sect. Name:

Section Data

DB/User | Value | SRC | Combined | PSC | Tapered | Composite | Steel Girder

Section ID: 1 I-Section

Name: WPB 200x200x74.C User DB IS



Sect. Name: WPB 200x200x74.01 Built-Up Section

Get Data from Single Angle

DB Name: AISC10(US)

Sect. Name:

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:l	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

Composite Steel Girder Design Parameters

Code : IRC:22-2015 Update by Code

Partial Factor

Concrete Basic And Seismic(Gamma_c)	<input type="text" value="1.5"/>
Concrete Accidental(Gamma_c)	<input type="text" value="1.2"/>
Structural Steel For Yielding and Buckling(Gamma_M0)	<input type="text" value="1.1"/>
Structural Steel For Ultimate Stress(Gamma_M1)	<input type="text" value="1.25"/>
Reinforcing Steel (Gamma_s)	<input type="text" value="1.15"/>
Shear Connectors for Yield(Gamma_v)	<input type="text" value="1.25"/>
Fatigue Load(Gamma_fft)	<input type="text" value="1"/>
Fatigue Strength(Gamma_Mf,t)	<input type="text" value="1.35"/>

Resistance to fatigue

Number of Load Cycles

Stress Limitation

k1 : k3 : k4 : k6 :

Deflection Control

Limit : L / m

Crack Width

k3 : k4 : Exposure : Moderate

Option For Strength Limit State

Post-buckling Tension Field Action for Shear Resistance

Ultimate Limit States	Serviceability Limit State
<input checked="" type="checkbox"/> Bending Resistance	<input checked="" type="checkbox"/> Stress Limitation
<input checked="" type="checkbox"/> Resistance to Vertical Shear	<input checked="" type="checkbox"/> Longitudinal Shear (SLS)
<input checked="" type="checkbox"/> Resistance to Lateral-torsional Buckling	<input checked="" type="checkbox"/> Deflection Control
<input checked="" type="checkbox"/> Resistance to Transverse force	<input checked="" type="checkbox"/> Crack Width Check
<input checked="" type="checkbox"/> Resistance to Longitudinal Shear	
<input checked="" type="checkbox"/> Resistance to Fatigue	

OK Cancel

Design Parameters

I. Partial Safety Factors (Table 1.3 IRC 22 : 2015)

γ_c for concrete (Basic & Seismic)	1.50	γ_s for reinforcing steel	1.15
γ_c for concrete (Accidental)	1.20	γ_v for Shear Connectors (Yield)	1.25
γ_{M0} for structural steel (Yield & Buckling)	1.10	γ_{ff} for fatigue load	1.00
γ_{M1} for structural steel (Ultimate)	1.25	γ_{mf} for fatigue strength	1.35

II. Section Properties

1) Slab Properties

[Section]

B_c	=	2000.000	mm
t_c	=	300.000	mm
H_n	=	0.000	mm
d_c	=	515.000	mm
f_{ck}	=	35.000	MPa
E_c	=	32308.25	MPa
F_{yk}	=	500.000	MPa

[Effective Width of Concrete Slab] (Clause 603.2.1, IRC 22 : 2015)

$B_{eff} = L_o/4 \leq (B1+B2)/2 + X$

= 2000.000 mm

[Reinforcement Details]

Position	Dia (mm)	c/c spacing (mm)	No.	No. of layers	Cover (mm)	Total Area(mm ²)
Top Layer	20	100.000	18.0	1.000	50.000	5654.867
Bottom Layer	0	0.000	0.00	0.000	0.000	0.000

[Design Strength] (Annex I.1.1, IRC 22 : 2015)

Concrete Slab : $\eta = 1.0$; $\lambda = 0.8$; $\alpha = 0.67$

$f_{cd(s)} = \alpha \cdot \lambda \cdot f_{ck(s)} / \gamma_c = 15.633$ MPa (Concrete Design Strength for Basic & Seismic)

$f_{cd(a)} = \alpha \cdot \lambda \cdot f_{ck(s)} / \gamma_c = 19.542$ MPa (Concrete Design Strength for Accidental)

Steel Design : $f = f_y / \gamma_s = 424.782$ MPa (Reinforcement Design Strength)

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

Domain Name:

Element Type:

Element List:

Add Modify Delete

Name	Type
beam	Plate
column	Plate

Sub-Domain... Close

Define Sub-Domain

Domain Name:

Element Type:

Sub-Domain Name:

Member Type:

Rebar Direction: Local UCS Reference Axis

Reference Axis

V1: V2:

Rebar Dir.(CCW)

Dir.1: Angle from Local Axis x: [deg]

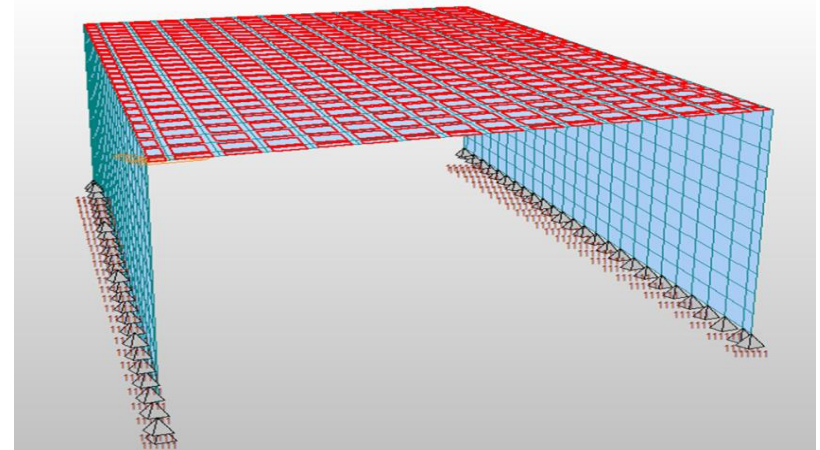
Dir.2: Angle from Dir.1: [deg]

Element List:

Add Modify Delete

Name	Type	Rebar Dir.	Angle	Elements
L	Beam	Local	0+90	132 133...
R	Beam	Local	0+90	138to14...
1	Beam	Local	0+90	231to24...
2	Beam	Local	0+90	273to28...

Close



*** 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

IRC:112-2011 SSRC79

RC Design SRC Design

- Design Code...
- Partial Safety Factors for Material Properties...
- Modify Concrete Material ...
- Limiting Maximum Rebar Ratio
- Limiting Minimum Section Size...
- Scale Up Factor for Column...
- Serviceability Parameters...
- Serviceability Load Combination Type...
- Beam Section Data for Design...
- Beam Section Data for Checking...
- Column Section Data for Design...
- Column Section Data for Checking...
- Column General Section Data for Checking...
- Plate Beam Data for Design...
- Rebar Input for Plate Beam...
- Plate Beam Data for Checking...
- Plate Column Data for Design...
- Rebar Input for Plate Column...
- Plate Column Data for Checking...
- Concrete Design Tables
- Concrete Code Design
- Concrete Code Check

Rebar Input for Plate Beam

Name: B1

Main Rebar: Distribution Bar

Top: Num CTC

As: 0.003142 m²/m Layer: 1

Layer	Num	Size1	Size2	Dt
1	10	P20		0.03

Bottom: Num CTC

As: 0.003142 m²/m Layer: 1

Layer	Num	Size1	Size2	Db
1	10	P20		0.03

Stirrup: Size: P6 Spacing: 0 m Number: 0

Add Modify Delete

ID	Name
1	B1

Close

Plate Beam Check Result Dialog

Code: IRC:112-2011 Unit: kN, m / m

Results: Strength Serviceability

Sub-Domain	SEL	Major Dir	CHK	Pos	Use_As	Ele m.	Nod e	LCB_M	M_Ed	M_Rd	Ratio_M	Ele m.	Nod e	LCB_V	V_Ed
L	<input type="checkbox"/>	Dir1	NG	Pos	0.0031	199	204	13	77.3405	316.341	0.2445	177	12	13	304.138
L	<input type="checkbox"/>	Dir2		Neg	0.0031	166	116	13	128.029	316.341	0.4047				

Plate Beam Check Result Dialog

Code: IRC:112-2011 Unit: kN, m / m

Results: Strength Serviceability

Sub-Domain	SEL	Major Dir	CHK	Pos	Stress Check				Crack Control							
					Ele m.	Nod e	LCB	Reinforcemen sa	Ele m.	Nod e	LCB	w	wa			
L	<input type="checkbox"/>	Dir1	OK	Pos	199	204	40	2296.9	3938.1	21072	400000	199	204	52	0.0000	0.0003
L	<input type="checkbox"/>	Dir1		Neg	166	116	40	3674.3	3938.1	33707	400000	214	216	52	0.0000	0.0003
L	<input type="checkbox"/>	Dir2	OK	Pos	177	12	40	2403.6	3938.1	22051	400000	177	12	52	0.0000	0.0003
L	<input type="checkbox"/>	Dir2		Neg	166	116	40	1635.5	3938.1	15004	400000	176	126	52	0.0000	0.0003

Graphic Report

1. Design Condition

Design Type: Plate Beam (1D)

Sub-Domain: L

Design Code: IRC:112:2011

Unit System: kN, m / m

Material Data: f_{ck} = 40000, f_y = 500000, f_{yk} = 500000 kPa

Thickness: 0.3 m

2. Section Diagram

Element No.: 132

Rebar Pattern:

Layer	Top(Negative)	Bottom(Positive)
1	P20@10	P20@10

Total Rebar Area: Ast = 0.006284 m²/m

Using Stirrups Spacing: No Stirrup

3. Bending Moment Capacity

	Top(Negative)	Bottom(Positive)
Mu	57.22	83.29
Element No.	188	132
Load Combination	dLCB13	dLCB14
M	916.34	916.34
Check Ratio (Mu/Md)	0.1626	0.2933
Using Reinforce	0.0031	0.0031

4. Shear Capacity

Element No.: 132

Load Combination: dLCB14

Applied Shear Force: V_{Ed} = 196.665

Shear Strength (Out of plane): V_{u,Rd} = 279.076

Shear Ratio: V_{u,Rd} / V_{Ed} = 196.665 / 279.076 = 0.705 < 1.000 OK

5. Stress Check

Element No.	Concrete	Rebar
155	155	155
(+) Load Combination	dLCB40	dLCB40
Stress	1635.47	15003.50
Allowable Stress(s)	3938.07	400000.00
Stress Ratio(s)	0.4153	0.0375

MIDAS/Civil - RC-Plate Beam Checking [IRC:112-2011]

MIDAS (Modeling, Integrated Design & Analysis Software)

MIDAS/Civil - Design & checking system for windows

RC-Plate Member (Plate Beam/Column) Analysis and Design

Based On AASHTO-LFRD12, Eurocode2-2:05, IRC:112-2011 (G)TYPE 1919

MIDAS Information Technology Co., Ltd. (MIDAS IT)

MIDAS IT Design Development Team

HomePage : www.MidasUser.com

DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.

LCB	C	Loadcase Name (Factor)	+	Loadcase Name (Factor)	+	Loadcase Name (Factor)
1	1	DL (1.350) +		LL (1.500) +		WX (0.900)
2	1	DL (1.350) +		LL (1.500) +		WX (-0.900)
3	1	DL (1.350) +		LL (1.500) +		WY (0.900)
4	1	DL (1.350) +		LL (1.500) +		WY (-0.900)
5	1	DL (1.000) +		LL (1.500) +		WX (0.900)
6	1	DL (1.000) +		LL (1.500) +		WX (-0.900)
7	1	DL (1.000) +		LL (1.500) +		WY (0.900)
8	1	DL (1.000) +		LL (1.500) +		WY (-0.900)
9	1	DL (1.350) +		LL (1.500)		
10	1	DL (1.000) +		LL (1.500)		
11	1	DL (1.350) +		LL (1.900)		
12	1	DL (1.000) +		LL (1.500)		
13	1	DL (1.350) +		LL (1.150) +		WX (1.500)
14	1	DL (1.350) +		LL (1.150) +		WX (-1.500)
15	1	DL (1.350) +		LL (1.150) +		WY (1.500)
16	1	DL (1.350) +		LL (1.150) +		WY (-1.500)
17	1	DL (1.000) +		LL (1.150) +		WX (1.500)
18	1	DL (1.000) +		LL (1.150) +		WX (-1.500)
19	1	DL (1.000) +		LL (1.150) +		WY (1.500)
20	1	DL (1.000) +		LL (1.150) +		WY (-1.500)
21	1	DL (1.350) +		WX (1.500)		

Plate Design Inputs

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