

Release Note

Release Date : Nov. 08, 2023

Product Ver. : Civil 2024 (v1.1)



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

Enhancements in Civil 2024 (v1.1)

- Pre & Post processing

1. Plate Thickness Temperatures
2. Equivalent Beam Stress Results for Construction Stage Analysis
3. HL-93TDM considering 100% combined effect of two tandems as per AASHTO LRFD Vehicle Load
4. Time Dependent Material as per IRC 112: 2020
5. Response Spectrum function as per SP 268.1325800.2016
6. Stress Calculation for Part2 of Composite Section with Cracked Section option

- Design

7. Design Calculation Speed
8. Steel Composite Design as per AS 5100.6:2017
9. RC, Steel, Steel Composite, and PSC Design as per AASHTO LRFD 2020
10. PSC Design as per CSA S6:19
11. Steel Composite Design as per CSA-S6-19
12. Design of Solid web girder as per IRS SBC:2017
13. Other Enhancements

Note. Some images in this document are captured from the relevant design codes.



1. Plate Thickness Temperatures

- The nonlinear temperatures in the thickness direction of plate elements can be applied for the thermal stress analysis.
- Plate Thickness Temperatures function is applicable to a composite girder which has plate elements as a slab and beam elements as a girder.

▪ Load > Temperature Loads > Plate Thickness Temperatures

Tree Menu

Node Element Boundary Mass **Load**

Plate Thickness Temperatures

Load Case Name
Temp

Load Group Name
Default

Options
 Add Replace Delete

Ref. Position
 +z (Top) -z (Bot.)

Plate Thickness Temperatures

Initial 0 [C]

H 200 mm T 15 [C]

Add Modify Delete

No.	H	T
1	0	25
2	200	15

Apply Close

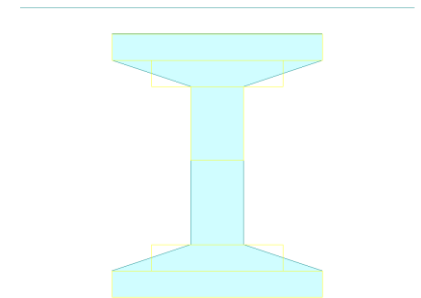
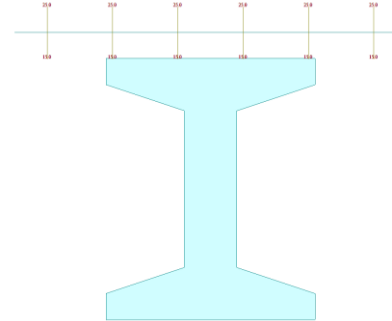
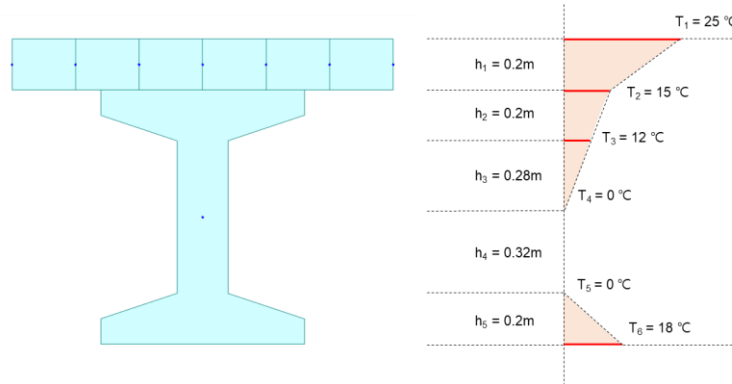
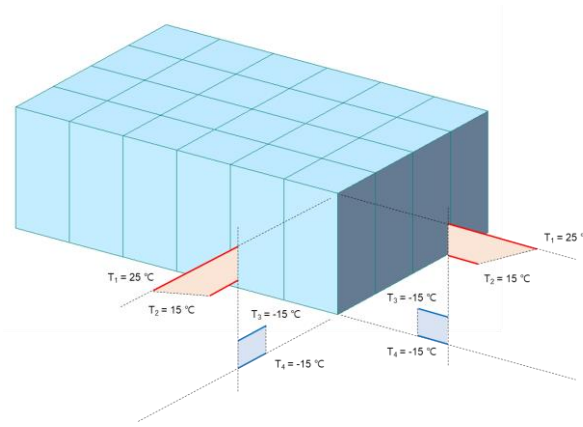
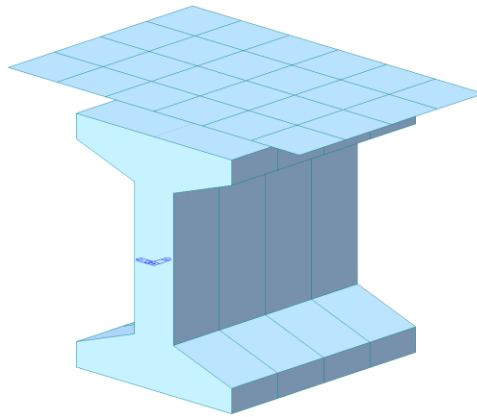


Plate Thickness Temperatures

Beam Section Temperatures

2. Equivalent Beam Stress Results for Construction Stage Analysis

- Equivalent beam stresses including Von-Mises stresses of the steel composite sections are now provided for the construction stage analysis.
- Steel-I (Type 1), Steel-Tub (Type 1), and Steel-Box (Type 1) are available.

Results > Stresses > Beam Stresses(Equivalent)

The screenshot displays the 'Main Control Data' dialog box for the 'Beam Stresses(Equivalent)' analysis. The 'Calculate Equivalent Beam Stresses (Von-Mises and Max-Shear)' option is checked and highlighted with a red box. The 'Tree Menu' shows 'Beam Stresses(Equivalent)' selected, with 'Von-Mises' chosen as the stress type. The 3D model shows the Von-Mises stress distribution on a curved steel composite section, with a legend on the right indicating stress values from 4.35687e-02 to 1.64717e+01. The legend also includes the following information:

MIDAS/Civil1	
POST-PROCESSOR	
BEAM STRESS(EQUIV.)	
Von-Mises	
1.64717e+01	
1.49793e+01	
1.34848e+01	
1.19913e+01	
1.04979e+01	
9.00439e+00	
7.51092e+00	
6.01745e+00	
4.52398e+00	
3.03051e+00	
1.53704e+00	
4.35687e-02	

Additional information from the legend:

- STAGE: CS3
- CS: SUMMATION
- FIRST
- MAX : 83
- MIN : 6
- FILE: 23 CURVED -
- UNIT: kips/in²
- DATE: 11/02/2023
- VIEW-DIRECTION
- X: -0.429
- Y: -0.891
- Z: 0.199

Von-Mises Stresses at Centroid of Steel Composite Section

3. HL-93TDM considering 100% combined effect of two tandems as per AASHTO LRFD Vehicle Load

- According to C3.6.1.3.1 AASHTO LRFD 2020, one hundred percent of the combined effect of the two design tandems and the design lane load should be used to investigate negative moment and reactions at interior supports.
- HL-93TDM vehicle load in AASHTO LRFD Load provides the option to consider the combined effect.

▪ **Load > Load Type > Moving Load > Vehicle > AASHTO LRFD Load**

Define Standard Vehicular Load

Standard Name: AASHTO LRFD Load

Vehicular Load Properties

Vehicular Load Name: HL-93TDM

Vehicular Load Type: HL-93TDM

Dynamic Load Allowance: 0 %

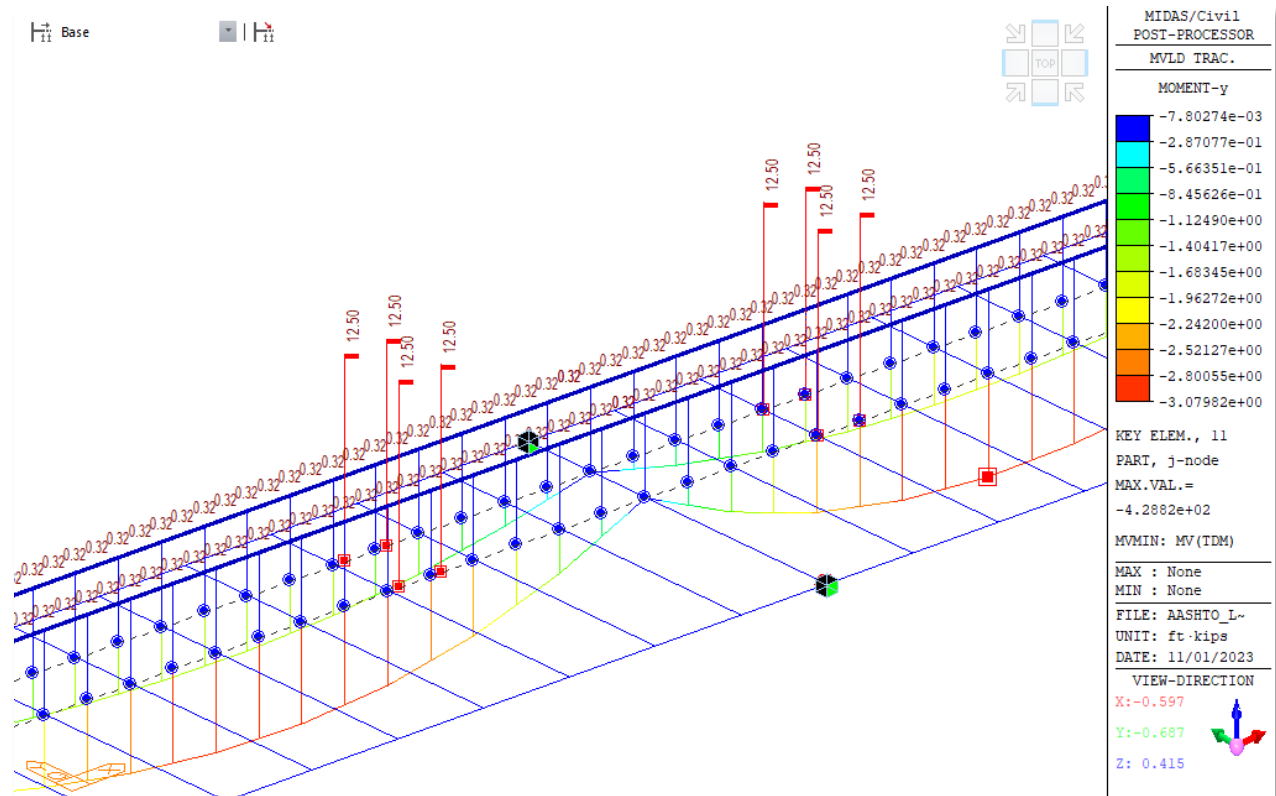
Lane Support-Neg. Moment/ Reaction	Application
Not assigned	a
Assigned	a, b

No	Load(kips)	Spacing(ft)	W	0.64	kips/ft
1	25	4	D2	26	ft
2	25	end	D3	40	ft

Add Centrifugal Force

Consider Two Tandems in Adjacent Spans

OK Cancel Apply



Vehicular Load

4. Time Dependent Material as per IRC 112: 2020

- The time dependent materials for creep/shrinkage and compressive strength as per IRC 112:2020 can be applied.

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

Add/Modify Time Dependent Material (Creep / Shrinkage)

Name : Code :

INDIA(IRC : 112-2020)

Compressive strength of concrete at the age of 28 days : N/mm²

Relative Humidity of ambient environment (40-99) : %

Notional size of member : mm

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

Type of cement

Slow setting cement

Normal cement

Rapid hardening cement

Age of concrete at the beginning of shrinkage : day(s)

Type of aggregate

Show Result...

Time Dependent Material(Creep/Shrinkage)

Add/Modify Time Dependent Material (Comp. Strength)

Name Scale Factor Graph Options X-axis log scale Y-axis log scale

Type

Code User

Development of Strength

Code :

Mean compressive strength of concrete at the age of 28 days ($f_{ck} + \delta_{\Delta f}$) N/mm²

Cement Type(s)

Aggregate Type

Time (day)	Strength (N/mm ²)
0	0
2	10
4	18
6	23
8	26
10	28
12	29
14	30
16	31
18	32
20	32.5
22	33
24	33.5
26	34
28	35

Time Dependent Material(Compressive Strength)

5. Response Spectrum function as per SP 268.1325800.2016

- The Response Spectrum function provides the design spectrum as per SP 268.1325800.2016.

▪ **Load > Load Type > Dynamic Loads > Response Spectrum Functions**

Generate Design Spectrum ✕

Design Spectrum : SP 268.1325800.2016 ▼

Design Spectral Response Acceleration

Region Seismicity 7 ▼

Soil Category I ▼

K1 Factor 0.5

K2 Factor 1

K3 Factor 1

K4 Factor 1

KPsi Factor 1

Max. Period : 6 (Sec)

OK
Cancel

Add/Modify/Show Response Spectrum Functions ✕

Function Name SP 268.1325800.2016

Spectral Data Type
 Normalized Accel.
 Acceleration
 Velocity
 Displacement

Scaling

Scale Factor 1

Maximum Value 0 g

Gravity 32.171 ft/sec²

Damping Ratio 0.05

Graph Options

X-axis log scale

Y-axis log scale

	Period (sec)	Spectral Data (g)
1	0.0000	0.0500
2	0.0600	0.0950
3	0.1000	0.1250
4	0.1200	0.1250
5	0.1800	0.1250
6	0.2400	0.1250
7	0.3000	0.1250
8	0.3600	0.1042
9	0.4200	0.0893
10	0.4800	0.0781
11	0.5400	0.0694
12	0.6000	0.0625
13	0.6600	0.0568
14	0.7200	0.0521

Description SP 268.1325800.2016: Region=7,Soil=S1,K1=0.50,K2=1.00,K3=1.00,K4=1.00,KPsi=1.0

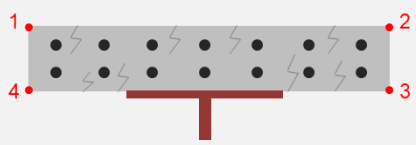
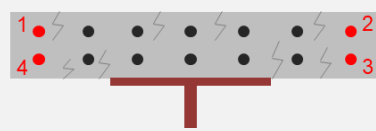
OK
Cancel
Apply

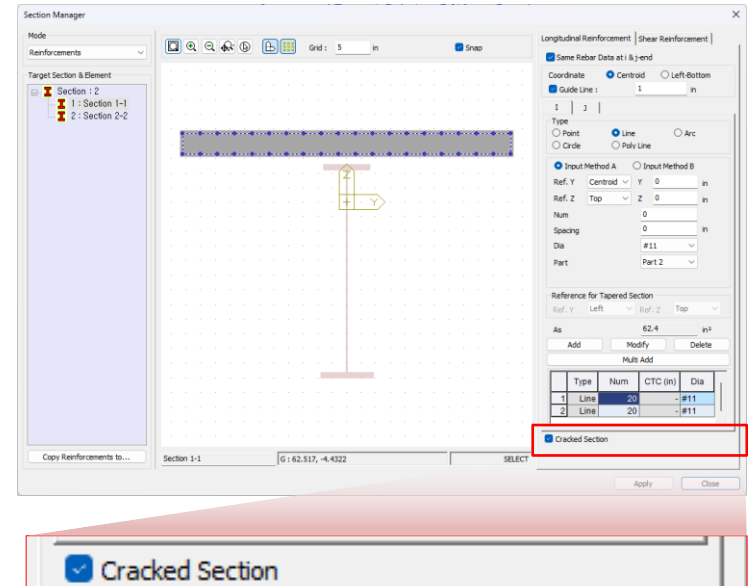
Response Spectrum Functions

6. Stress Calculation for Part2 of Composite Section with Cracked Section option

- The effect of the cracked section option has changed.

▪ Properties > Section Manager > Reinforcements > Cracked Section

Cracked Section	Previous versions	Civil 2024 (v1.1)
Stress points of Part 2	The corners of a slab section. 	Rebars placed at corners of a slab. 
Stresses of Part 2	Calculate the stresses in the concrete, and hence zero stress value.	Calculate the stresses in the rebars.



7. Steel Composite Girder Design as per AS 5100.6: 2017

- Steel plate girder and tub/box girder with composite slab can be designed for strength, service, and constructability based on AS 5100.6: 2017.
- The results of the code checks can be viewed graphically, in tables and in a detailed report.

Design > Steel Design > Design Code

Composite Steel Girder Design Parameters

Code : AS 5100.6:2017 Update by Code

Capacity reduction factor

ULS

Member subject to bending for flexure	0.9
Member subject to bending for web in shear	0.9
Member subject to bending for stiffener	0.9

SLS

Member subject to bending for shear connectors	1
--	---

Ultimate Limit State

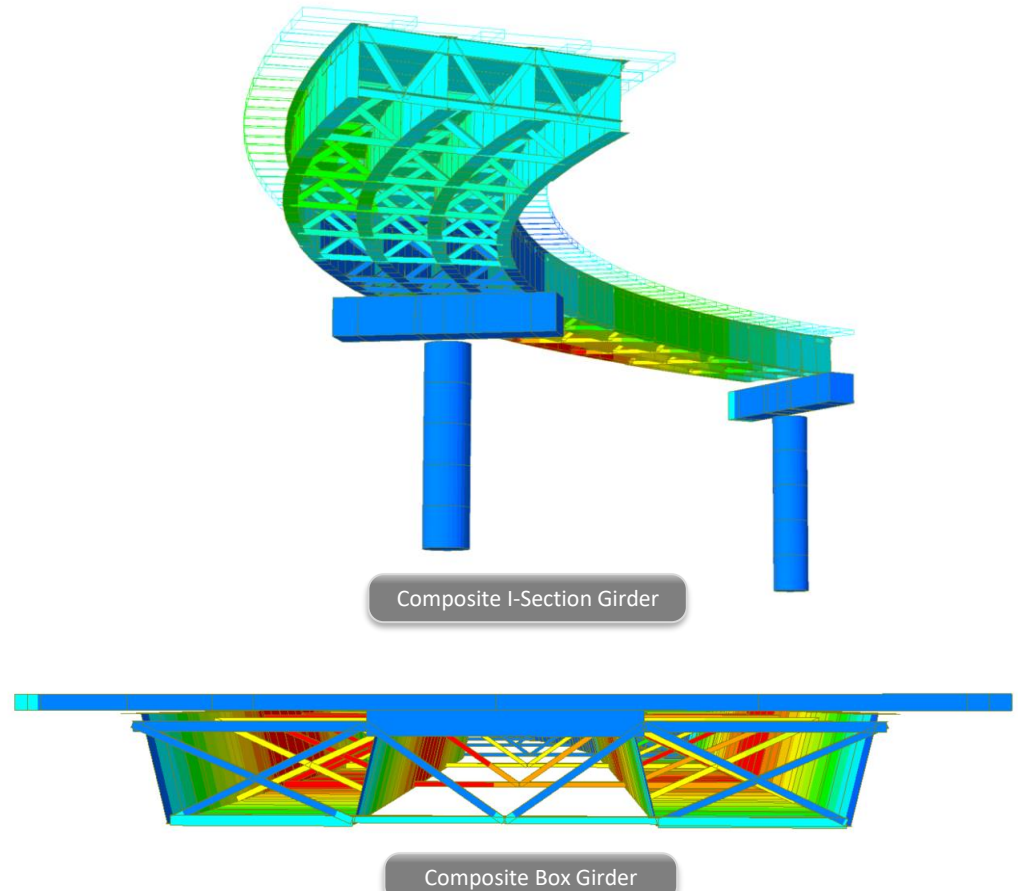
- Flexure
- Shear
- Flexure & Shear & Torsion for Box Girders with Longitudinal Stiffeners
- Constructibility

Serviceability Limit State

- Crack Control of Slab
- Longitudinal Shear

OK Cancel

Design Parameter



7. Steel Composite Girder Design as per AS 5100.6: 2017

- To enhance local buckling resistance, longitudinal stiffeners can be positioned in both the web and the box flange.

Design > Composite Design > Longitudinal Reinforcement

Section Stiffener
✕

Stiffener Properties

Name:

Type:

H

B

mm

mm

Name	Type
LS1	Flat

Stiffener

Position: Both Left Right

Reference of d: Top Bottom

N Left: N Right: N Bottom: N Top:

C	d (mm)	Stiffener
<input checked="" type="checkbox"/>	500	LS1

Section Stiffener
✕

Stiffener Properties

Name:

Type:

H

B

tw

tf

mm

mm

mm

mm

Name	Type
T	Tee
Flat	Flat

Stiffener

Position: Both Left Right

Reference of d: Top Bottom

N Left: N Right: N Bottom: N Top:

C	d (mm)	Stiffener
<input checked="" type="checkbox"/>	1862.5	T
<input checked="" type="checkbox"/>	800	T

C	d (mm)	Stiffener
<input checked="" type="checkbox"/>	390	Flat
<input checked="" type="checkbox"/>	390	Flat
<input checked="" type="checkbox"/>	390	Flat

Longitudinal Stiffener

7. Steel Composite Girder Design as per AS 5100.6: 2017

- Transverse intermediate stiffeners can be defined to increase the shear resistance of the web.

Design > Composite Design > Transverse Stiffener

The screenshot displays the 'Transverse Stiffener' configuration window. On the left, the 'Section Manager' shows the target section 'Section : 2' with two options: '1 : At splice(Hogging)&Sagging' and '2 : Not at splice'. The main workspace shows a grid with a horizontal beam and a vertical stiffener. The 'Stiffener Type' dialog box is open, showing 'Flat' as the stiffener type, 'One stiffener' selected, and properties: Fy = 360 N/mm², Pitch = 1500 mm, B = 100 mm, t = 20 mm. The main window has 'Grid : 100 mm' and 'Snap' checked. The 'Stiffener Type' dialog has 'Apply' and 'Close' buttons.

Transverse Stiffener

7. Steel Composite Girder Design as per AS 5100.6: 2017

- Longitudinal reinforcement can be entered into the concrete slab. Cracked section will be applied to calculate stresses for the negative moments.

Design > Composite Design > Longitudinal Reinforcement

The dialog box is titled "Longitudinal Reinforcement | Shear Reinforcement". It features a 3D visualization of a concrete slab with a grid of reinforcement bars. The right-hand panel contains the following settings:

- Same Rebar Data at I & J-end:**
- Coordinate:** Centroid, Left-Bottom
- Guide Line:** 0 mm
- Type:** Line, Point, Circle, Poly Line
- Input Method:** Input Method A, Input Method B
- Ref. Y:** Centroid, **Y:** 0 mm
- Ref. Z:** Top, **Z:** 0 mm
- Num:** 0
- Spacing:** 0 mm
- Dia:** P5
- Part:** [Dropdown]
- Reference for Tapered Section:** Ref. Y: Left, Ref. Z: Top
- As:** 8444.520000000 mm²
- Buttons: Add, Modify, Delete
- Multi Add table:

Type	Num	CTC (m)	Dia
1	Line	21	- P16
2	Line	21	- P16

At the bottom of the dialog, there are "Apply" and "Close" buttons. The status bar at the bottom of the window shows "At splice(Hogging)&Sagging" and "G : -1720.2, 1090.3".

Longitudinal Reinforcement

7. Steel Composite Girder Design as per AS 5100.6: 2017

- Defining the plasticity and yield limits of the flange plates relies on categorizing the residual stress type.
- Headed studs can be checked for the serviceability limit state.

Design > Composite Design > Residual Stress Type

Residual Stress Type

Option

Add/Replace Delete

Both end parts(i & j) have the same Residual Stress Type

I | J |

Residual Stress Type

SR HR

LW HW

Residual stress (see Notes)	Plasticity limit (λ_p)	Stress distribution	Yield limit (λ_{ey})	Stress distribution
SR	10	Compression	16	Compression
HR	9		16	
LW, CF	8		15	
HW	8		14	
SR	30	Compression	45	Compression
HR	30		45	
LW, CF	30		40	
HW	30		35	

Residual Stress Type

Design > Composite Design > Shear Connector

Shear Connector

Option

Add/Replace Delete

Both end parts(i & j) have the same type

I | J |

Pitch 150 mm

Height 125 mm

Dia ... 22 mm

Fu ... 420 N/mm²

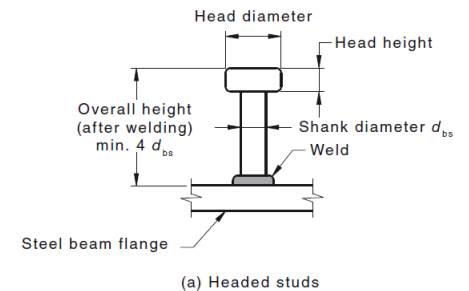
Transverse Spacing 200 mm

Num. of Shear Connectors 2 /row

Apply Close

Longitudinal Shear

$$v_L^* = \frac{V^* A_t y_c}{I_t}$$



Shear Connector

7. Steel Composite Girder Design as per AS 5100.6: 2017

- Design results and detailed calculation procedures are provided in a Word format.

Design > Composite Design > Print Result

Longitudinal shearMemb1.doc [Read-Only] [Compatibility Mode] - Word

MEMBER NAME : Steel Composite : 83 - i

1. Member Information

- Design Code
AS 5100.6:2017
- Section Property
Section 2-2
- Material
Steel
 $f_y = 320.000\text{MPa}$, $E = 200,000.000\text{MPa}$
Concrete
 $f_c = 32.000\text{MPa}$, $E_c = 30,100.000\text{MPa}$
Reinforcement
 $f_{yv} = 500.000\text{MPa}$, $E_r = 200,000.000\text{MPa}$
- Length
 $L = 1.441\text{m}$
- Section Properties

	Steel Section	Short-Term Composite Section	Long Term Composite Section
Area	86,330.473mm ²	185,951.564mm ²	114,055.580mm ²
I_y	5.686783e+10mm ⁴	1.186307e+11mm ⁴	8.481588e+10mm ⁴
I_z	1.199866e+9mm ⁴	7.080595e+10mm ⁴	2.057163e+10mm ⁴
C_y	254.000mm	254.000mm	254.000mm
C_z	905.870mm	1,522.787mm	1,185.789mm

	Short-Term Composite Section(Reinforcement)	Long Term Composite Section(Reinforcement)
Area	96,014.324mm ²	89,558.423mm ²
I_y	6.848039e+10mm ⁴	6.101762e+10mm ⁴
I_z	7.947699e+9mm ⁴	3.449057e+9mm ⁴
C_y	254.000mm	254.000mm
C_z	1,022.345mm	947.494mm

Page 1 of 4 1051 words English (United States)

Tub-Section not compactMemb1.doc [Read-Only] [Compatibility Mode] - Word

MEMBER NAME : Steel Composite : 1 - i

1. Member Information

- Design Code
AS 5100.6:2017
- Section Property
G1-3
- Material
Steel
 $f_y = 360.000\text{MPa}$, $E = 200,000.000\text{MPa}$
Concrete
 $f_c = 32.000\text{MPa}$, $E_c = 30,100.000\text{MPa}$
Reinforcement
 $f_y = 500.000\text{MPa}$, $E_r = 200,000.000\text{MPa}$
- Length
 $L = 1.000\text{m}$
- Section Properties

	Steel Section	Short-Term Composite Section	Long Term Composite Section
Area	188,163.617mm ²	386,823.617mm ²	236,046.609mm ²
I_y	7.623030e+10mm ⁴	1.610550e+11mm ⁴	1.096118e+11mm ⁴
I_z	2.857647e+11mm ⁴	8.817447e+11mm ⁴	4.294137e+11mm ⁴
C_y	1,790.000mm	1,790.000mm	1,790.000mm
C_z	635.533mm	1,114.418mm	824.688mm

	Short-Term Composite Section(Reinforcement)	Long Term Composite Section(Reinforcement)
Area	200,227.217mm ²	192,184.817mm ²
I_y	8.611792e+10mm ⁴	7.966363e+10mm ⁴
I_z	3.219155e+11mm ⁴	2.978149e+11mm ⁴
C_y	1,790.000mm	1,790.000mm
C_z	691.714mm	655.043mm

2. Moment Capacity (y-Dir., Negative)

Max. Moment: LCB LCB

Page 1 of 3 790 words English (United States)

Design Report

7. Steel Composite Girder Design as per AS 5100.6: 2017

- For all design checks, demand and capacity are represented in a table format.

Design > Composite Design > Design Result Tables

Elem	part	Positive/ Negative	Lcom	Type	CHK	M_demand (N-mm)	φMb (N-mm)	fs (N/mm ²)	φfy (N/mm ²)
35	[50]	Pos	scLCB1	FX-MAX	OK	785552117	3019476	-	-
35	J[287]	Neg	-	-	-	-	-	-	-
▶ 35	J[287]	Pos	scLCB1	MY-MIN	OK	-450953350	-	-	-
36	[51]	Neg	scLCB1	MY-MIN	OK	-176618382	-	-	-
36	[51]	Pos	-	-	-	-	-	-	-
36	J[288]	Neg	scLCB1	MY-MIN	OK	-325816309	-	-	-
36	J[288]	Pos	-	-	-	-	-	-	-
37	[52]	Neg	scLCB1	MY-MIN	OK	-489278107	-	-	-
37	[52]	Pos	-	-	-	-	-	-	-
37	J[289]	Neg	scLCB1	MY-MIN	OK	-660255514	-	-	-
37	J[289]	Pos	-	-	-	-	-	-	-
38	[53]	Neg	scLCB1	MY-MIN	OK	-840656031	-	-	-
38	[53]	Pos	-	-	-	-	-	-	-
38	J[290]	Neg	scLCB1	MY-MIN	OK	-107131001	-	-	-
38	J[290]	Pos	-	-	-	-	-	-	-
39	[54]	Neg	scLCB1	MY-MIN	OK	-132240146	-	-	-
39	[54]	Pos	-	-	-	-	-	-	-
39	J[291]	Neg	scLCB1	MY-MIN	OK	-159944309	-	-	-
39	J[291]	Pos	-	-	-	-	-	-	-
83	[10]	Neg	scLCB1	MY-MIN	NG	-225504069	-	-	-
83	[10]	Pos	-	-	-	-	-	-	-
83	J[332]	Neg	scLCB1	MY-MIN	NG	-190746000	-	-	-
83	J[332]	Pos	-	-	-	-	-	-	-
84	[95]	Neg	scLCB1	MY-MIN	OK	-158914050	-	-	-
84	[95]	Pos	-	-	-	-	-	-	-
84	J[333]	Neg	scLCB1	MY-MIN	OK	-129141403	-	-	-
84	J[333]	Pos	-	-	-	-	-	-	-
85	[96]	Neg	scLCB1	MY-MIN	OK	-101631624	-	-	-
85	[96]	Pos	-	-	-	-	-	-	-
85	J[334]	Neg	scLCB1	MY-MIN	OK	-765269486	-	-	-
85	J[334]	Pos	-	-	-	-	-	-	-
86	[97]	Neg	scLCB1	MY-MIN	OK	-538011914	-	-	-
86	[97]	Pos	-	-	-	-	-	-	-
86	J[335]	Neg	scLCB1	MY-MIN	OK	-324642625	-	-	-

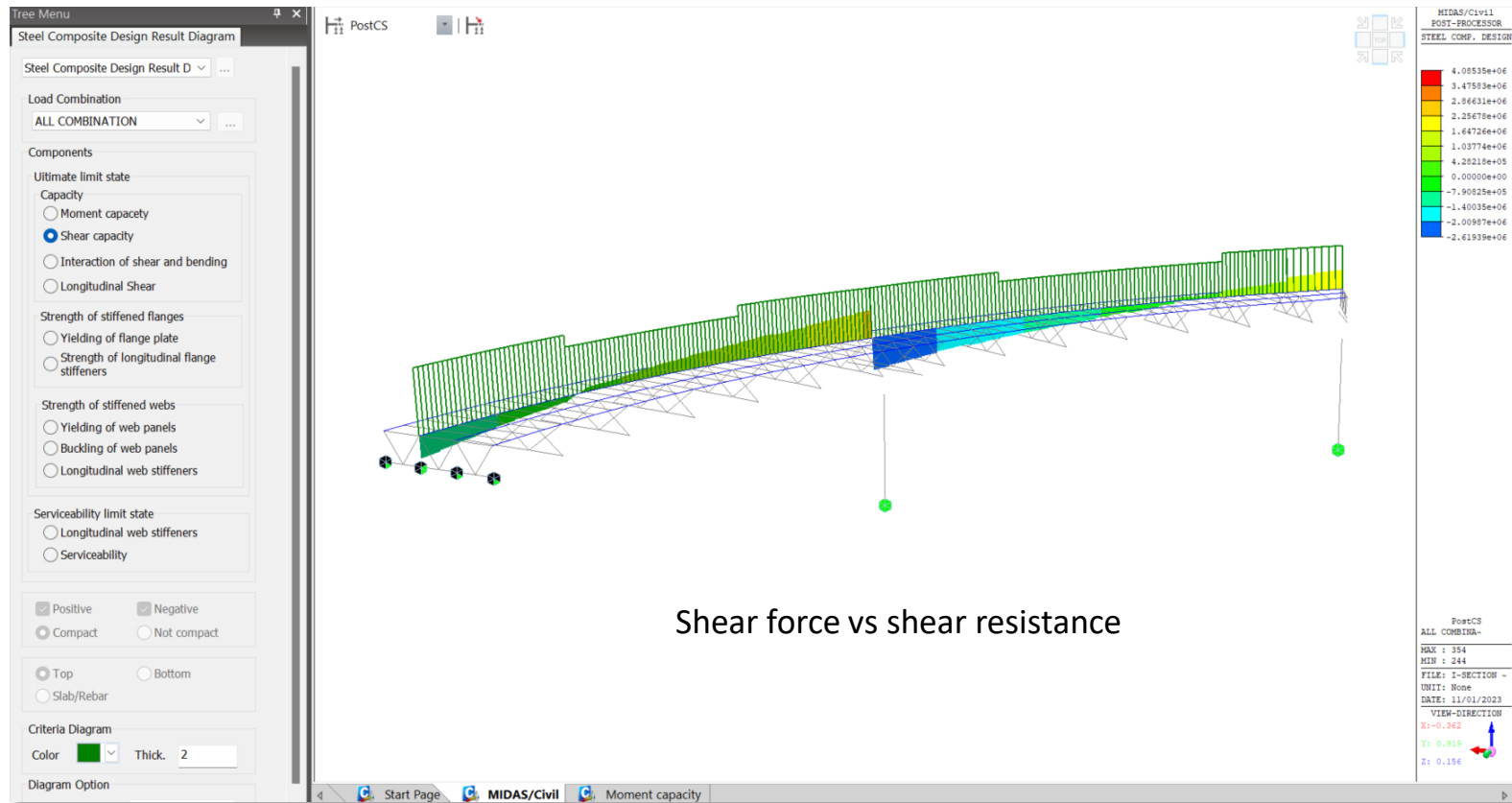
Elem	part	Lcom	Type	CHK	V*/web (kN)	V* (kN)	φVv (kN)
▶ 27	[6]	scLCB1	FZ-MIN	OK	-1373.7	-1373.7	4085.3
27	J[279]	scLCB1	FZ-MIN	OK	-1293.6	-1293.6	4085.3
28	[43]	scLCB1	FZ-MIN	OK	-1098.1	-1098.1	4085.3
28	J[280]	scLCB1	FZ-MIN	OK	-1018.1	-1018.1	4085.3
29	[44]	scLCB1	FZ-MIN	OK	-800.2	-800.2	4085.3
29	J[281]	scLCB1	FZ-MIN	OK	-720.2	-720.2	4085.3
30	[45]	scLCB1	FZ-MIN	OK	-567.0	-567.0	4085.3
30	J[282]	scLCB1	FZ-MIN	OK	-487.0	-487.0	4085.3
31	[46]	scLCB1	FZ-MIN	OK	-282.7	-282.7	3287.7
31	J[283]	scLCB1	FZ-MA	OK	245.8	245.8	3287.7
32	[47]	scLCB1	FZ-MA	OK	339.1	339.1	3287.7
32	J[284]	scLCB1	FZ-MA	OK	416.7	416.7	3287.7
33	[48]	scLCB1	FZ-MA	OK	656.3	656.3	3287.7
33	J[285]	scLCB1	FZ-MA	OK	733.9	733.9	3287.7
34	[49]	scLCB1	FZ-MA	OK	863.2	863.2	3287.7
34	J[286]	scLCB1	FZ-MA	OK	940.8	940.8	3287.7
35	[50]	scLCB1	FZ-MA	OK	1077.0	1077.0	3287.7
35	J[287]	scLCB1	FZ-MA	OK	1154.6	1154.6	3287.7
36	[51]	scLCB1	FZ-MA	OK	1325.0	1325.0	4085.3
36	J[288]	scLCB1	FZ-MA	OK	1405.1	1405.1	4085.3
37	[52]	scLCB1	FZ-MA	OK	1440.3	1440.3	4085.3
37	J[289]	scLCB1	FZ-MA	OK	1520.4	1520.4	4085.3
38	[53]	scLCB1	FZ-MA	OK	1758.0	1758.0	4085.3
38	J[290]	scLCB1	FZ-MA	OK	1838.1	1838.1	4085.3
39	[54]	scLCB1	FZ-MA	OK	2020.8	2020.8	4085.3
39	J[291]	scLCB1	FZ-MA	OK	2100.9	2100.9	4085.3
83	[10]	scLCB1	FZ-MIN	OK	-2619.4	-2619.4	4085.3
83	J[332]	scLCB1	FZ-MIN	OK	-2539.1	-2539.1	4085.3
84	[95]	scLCB1	FZ-MIN	OK	-2300.2	-2300.2	4085.3
84	J[333]	scLCB1	FZ-MIN	OK	-2219.9	-2219.9	4085.3
85	[96]	scLCB1	FZ-MIN	OK	-1937.2	-1937.2	4085.3
85	J[334]	scLCB1	FZ-MIN	OK	-1857.0	-1857.0	4085.3
86	[97]	scLCB1	FZ-MIN	OK	-1832.2	-1832.2	4085.3
86	J[335]	scLCB1	FZ-MIN	OK	-1751.9	-1751.9	4085.3
87	[98]	scLCB1	FZ-MIN	OK	-1559.5	-1559.5	3287.7

Design Result Tables

7. Steel Composite Girder Design as per AS 5100.6: 2017

- For all design checks, demand and capacity can be represented in a diagram format.

Design > Composite Design > Steel Composite Design Result Diagram



8. RC, Steel, Steel Composite, and PSC Design as per AASHTO LRFD 2020

- RC, Steel, Steel Composite, and PSC Design function as per AASHTO LRFD 2020 has been updated.
- The design report provides SI and US unit options.
- The design report of RC is now generated in Word format, which is faster than text format and enables the user to change the report style with ease.

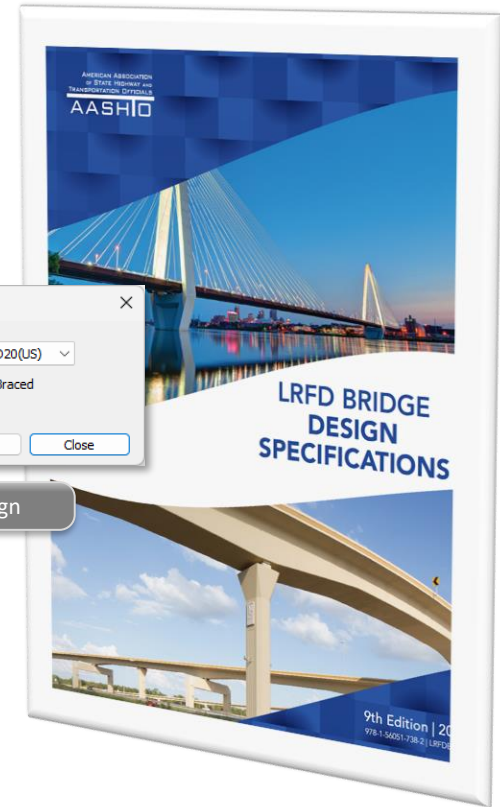
Design > RC, Steel, and Composite Design

PSC > PSC Design

The image displays several overlapping dialog boxes from a design software interface:

- Automatic Generation of Load Combinations:** Includes options for 'Add Envelope', 'Code Selection' (Steel, Concrete, SRC, Steel Composite), 'Design Code' (AASHTO-LRFD20), and 'Manipulation of Construction Stage Load Case' (ST+CS).
- Composite Steel Girder Design Parameters:** Shows 'Code' (AASHTO-LRFD20) and various resistance factors for yielding, fracture, axial comp., flexure, shear, and bearing.
- PSC Design Parameters:** Includes 'Design Code' (AASHTO-LRFD20), 'Tendon Type' (Low Relaxation Tendons, Stress Relieved Tendons, Prestressing Bars), 'Exposure Factor for Crack Width' (Class I, II, User), and 'Corrosive Condition' (Severe, Moderate/Mild).
- Concrete Design Code:** Features 'Design Code' (AASHTO-LRFD20(US)) and checkboxes for 'All Beams/Girders are Laterally Braced' and 'Check Beam/Column Deflection'.
- Steel Design Code:** Similar to the concrete code, with 'Design Code' (AASHTO-LRFD20(US)) and checkboxes for lateral bracing and deflection checks.

Overlaid on the bottom of the dialog boxes are labels for the design types: **Auto Load Combination**, **Composite Steel Girder Design**, **Prestressed Girder Design**, **Concrete Design**, and **Steel Design**.

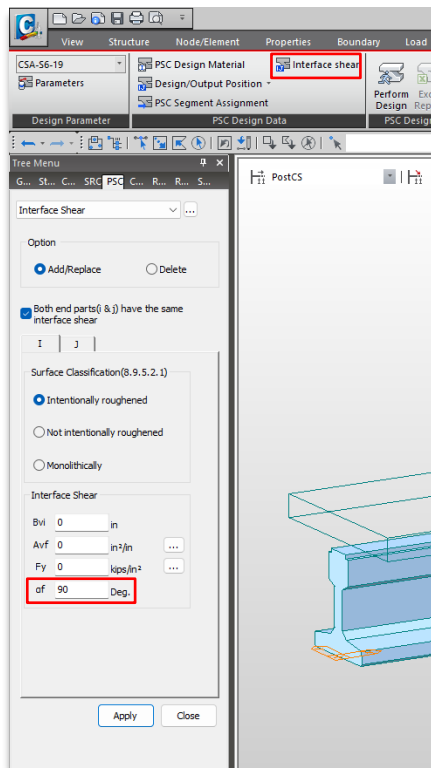


9. PSC Design as per CSA S6:19

- The reinforcement angle α_f is considered in the Interface Shear Transfer function as per 8.9.5.1 and 8.9.5.4, CSA S6:19.

■ PSC > Design Parameter > CSA-S6-19

CSA S6:14



Interface Shear

8.9.5 Interface shear transfer

8.9.5.1 General

A crack shall be assumed to occur along the shear plane and the relative displacement shall be considered to be resisted by cohesion and friction maintained by the shear-friction reinforcement crossing the crack. In lieu of more detailed calculations, the shear resistance of the plane, v_r may be calculated as $\phi_c (c + \mu\sigma)$, but v shall not exceed $0.25\phi_c f'_c$ or 6.5 MPa. c and μ shall be as specified in Clause 8.9.5.2 and σ shall be as specified in Clause 8.9.5.3.

8.9.5.3 Value of σ

The value of σ in Clause 8.9.5.1 shall be calculated as follows:

$$\sigma = \rho_v f_y + \frac{N}{A_v}$$

where

$$\rho_v = \frac{A_{vf}}{A_{cv}}$$

9) Interface Shear

• Factored interface shear stress (V_f)	
$V_f = V_i / (b_v d_v) =$	3.323 (MPa)
where,	
$V_i =$	2039.154 (kN)
$b_v =$	300.00 (mm)
$d_v =$	2045.59 (mm)
• Interface shear resistance without shear-friction reinforcement ($V_{i,concrete}$)	
$V_{i1} = \Phi_c (c + \mu N/A_{cv}) =$	0.375 (MPa)
Interface shear resistance shall not exceed $0.25 \Phi_c f'_c$ or 6.5 MPa.	
$V_{i2} = 0.25 \Phi_c f'_c =$	3.878 (MPa)
$V_{i3} =$	6.500 (MPa)
Therefore, $V_{i,concrete} =$	0.375 (MPa)
$V_{i,concrete} =$	0.375 (MPa) < $V_f =$ 3.323 (MPa) NG
\therefore Shear-friction reinforcement is required.	
• Interface shear resistance with shear-friction reinforcement ($V_{i,reinforcement}$)	
$V_{i1} = \Phi_c (c + \mu (\rho_v f_y + N/A_{cv})) =$	7.65 (MPa)
Interface shear resistance shall not exceed $0.25 \Phi_c f'_c$ or 6.5 MPa.	
$V_{i2} = 0.25 \Phi_c f'_c =$	3.878 (MPa)
$V_{i3} =$	6.500 (MPa)
Therefore, $V_{i,reinforcement} =$	3.878 (MPa)
$V_{i,reinforcement} =$	3.878 (MPa) $\geq V_f =$ 3.323 (MPa) OK

CSA S6:19

8.9.5 Interface shear transfer

8.9.5.1 General

A crack shall be assumed to occur along the shear plane and the relative displacement shall be considered to be resisted by cohesion and friction maintained by the shear-friction reinforcement crossing the crack. In lieu of more detailed calculations, the factored shear resistance of the plane shall be computed from

$$v_r = \lambda_1 \phi_c (c + \mu\sigma) + \phi_s \rho_v f_y \cos \alpha_f$$

where the expression $\lambda_1 \phi_c (c + \mu\sigma)$ shall not exceed $0.25\phi_c f'_c$ or 6.5 MPa.

8.9.5.4 Values of σ and ρ_v

The value of σ in Clause 8.9.5.1 shall be calculated as follows:

$$\sigma = \rho_v f_y \sin \alpha_f + \frac{N}{A_{cv}}$$

where

$$\rho_v = \frac{A_{vf}}{A_{cv}}$$

9) Interface Shear

• Factored interface shear stress (V_f)	
$V_f = V_i / (b_v d_v) =$	3.323 (MPa)
where,	
$b_v =$	300.000 (mm)
$d_v =$	2045.592 (mm)
• Factored interface shear resistance without shear-friction reinforcement ($V_{i,concrete}$)	
$V_{i1} = \lambda_1 \Phi_c (c + \mu N/A_{cv}) =$	0.375 (MPa)
Interface shear resistance shall not exceed $0.25 \Phi_c f'_c$ or 6.5 MPa.	
$V_{i2} = 0.25 \Phi_c f'_c =$	3.878 (MPa)
$V_{i3} =$	6.500 (MPa)
Therefore, $V_{i,concrete} =$	0.375 (MPa)
$V_{i,concrete} =$	0.375 (MPa) < $V_f =$ 3.323 (MPa) NG
\therefore Shear-friction reinforcement is required.	
• Factored interface shear resistance of the plane (V_{ri})	
$V_{ri} = \lambda_1 \Phi_c (c + \mu\sigma) + \Phi_s \rho_v f_y \cos \alpha_f =$	7.653 (MPa)
$\lambda_1 \Phi_c (c + \mu\sigma)$ shall not exceed $0.25 \Phi_c f'_c$ or 6.5 MPa.	
$V_{i2} = 0.25 \Phi_c f'_c + \Phi_s \rho_v f_y \cos \alpha_f =$	3.878 (MPa)
$V_{i3} = 6.5 + \Phi_s \rho_v f_y \cos \alpha_f =$	6.500 (MPa)
Therefore, $V_{ri} =$	3.878 (MPa)
$V_{ri} =$	3.878 (MPa) $\geq V_f =$ 3.323 (MPa) OK

9. PSC Design as per CSA S6:19

- The Environmental Exposure option in PSC Design Parameters function has changed as per 8.12.3.4, CSA S6:19.
- The tensile stress of reinforcing steel is now checked along the environmental exposure class.

■ PSC > Design Parameter > CSA-S6-19

PSC Design Parameters ✕

Design Code : CSA-S6-19

Input Parameters

Tendon Type

Low-relaxation Strand

Smooth High-strength Bar

Deformed High-strength Bar

Flexural Strength

Code Strain Compatibility

Reinforcing Rebar

Epoxy-coated bars

Uncoated bars

Environmental Exposure

Category A exposure

Category B exposure

Construction Type

Segmental

Non-Segmental

Output Parameters

Serviceability Limit State

Stress for Cross Section at a Construction Stage

Stress for Cross Section at Service Load

Stress in Prestressing Tendons

Principal Stress by Construction Stage

Principal Stress by Service Load Combinations (Max Shear)

Principal Stress by Service Load Combinations (Max Torsion)

Control of Cracking

Ultimate Limit State

Flexural resistance

Shear resistance

Torsional resistance

CSA S6:19

8.12.3.4 Tensile stress limits for reinforcing steel

Tensile stress in reinforcing steel produced by the governing cases defined in Clause 8.12.3.3 shall not exceed the following limits:

- a) For Category A exposure:

The lesser of

$$\sqrt{\frac{2.8f_{cr}E_s}{\alpha_b d_b}}$$

or

$$300 \text{ MPa.}$$

For deck surfaces of slab on girder bridges built with unshored construction that are subject to predominantly live loads, the factor 2.8 shall be replaced by 1.6.

- b) For Category B exposure:

The lesser of

$$\sqrt{\frac{3.9f_{cr}E_s}{\alpha_b d_b}}$$

or

$$300 \text{ MPa.}$$

5. Crack check

(see 8.12.3.2)

In both cases, α_b shall be taken as 1.0. When bars of a different diameter are used, the area shall be taken as the total area of bars with an area equal to the total area of the reinforcement.

■ Top

- The maximum Service Limit Load Combination : cLCB90
- Factored moment : $M_f = -20460.854 \text{ (kN-m)}$
- Factored axial force : $N_f = 5.403 \text{ (kN)}$

- Parameters for Control of cracking

$$\alpha_b = 1.20 \text{ for Epoxy-coated bars}$$

- Tensile stress limits for reinforcing steel

For Category B exposure:

$$\sigma_{max} = \min \left[\sqrt{\left(\frac{3.9 f_{cr} E_s}{\alpha_b d_b} \right)}, 300 \text{ MPa} \right] = 300.000 \text{ (MPa)}$$

where, $d_b = 12.70 \text{ (mm)}$: the nominal diameter of a bar or prestressing strand

- Tensile stress in reinforcing steel

In tensile rebar

$$\sigma_s = \left(\frac{N_f}{A_{cr}} - \frac{M_f}{I_{cr}} d_s \right) n_s = 1292.153 \text{ (MPa)}$$

In prestressing steel

$$\sigma_p = \left(\frac{N_f}{A_{cr}} - \frac{M_f}{I_{cr}} d_p \right) n_p = 420.653 \text{ (MPa)}$$

9. PSC Design as per CSA S6:19

- The coefficient of allowable stress based on the tendon types has changed.

▪ PSC > Design Parameter > CSA-S6-19

CSA S6:14

Table 8.2
Prestressing tendon stress limits
(See Clause 8.7.1.)

	Tendon type		
	Low-relaxation strand	High-strength bar	
		Smooth	Deformed
At jacking			
Pretensioning	$0.78f_{pu}$	—	—
Post-tensioning	$0.80f_{pu}$	$0.76f_{pu}$	$0.75f_{pu}$
At transfer			
Pretensioning	$0.74f_{pu}$	—	—
Post-tensioning			
At anchorage and couplers	$0.70f_{pu}$	$0.70f_{pu}$	$0.66f_{pu}$
Elsewhere	$0.74f_{pu}$	$0.70f_{pu}$	$0.66f_{pu}$

CSA S6:19

Table 8.2
Prestressing tendon stress limits
(See Clause 8.7.1.)

	Tendon type		
	Low-relaxation strand	High-strength bar	
		Smooth	Deformed
Pretensioning			
Immediately prior to transfer	$0.75f_{pu}$	—	—
Post-tensioning			
At jacking	$0.80f_{pu}$	$0.76f_{pu}$	$0.75f_{pu}$
Immediately after transfer			
At anchorage and couplers	$0.70f_{pu}$	$0.70f_{pu}$	$0.66f_{pu}$
Elsewhere	$0.74f_{pu}$	$0.70f_{pu}$	$0.66f_{pu}$

9. PSC Design as per CSA S6:19

- The formula for the review of shear resistance by transverse reinforcement has changed as per 8.9.1.2, CSA S6:19.

▪ PSC > Design Parameter > CSA-S6-19

CSA S6:14

8.9.1.2 Regions requiring transverse reinforcement

Except for solid slabs, walls, and footings, transverse reinforcement shall be provided in all regions where V_f is greater than $(0.20\phi_c f_{cr} b_v d_v + 0.5\phi_p V_p)$ and T_f is greater than $0.25T_{cr}$.

6) Factored shear resistance by transverse reinforcement (V_s).

- Judgement (see 8.9.1.2)

$$0.2\phi_c f_{cr} b_v d_v + 0.5\phi_p V_p = 2493.152 \text{ (kN)} < V_f = 5522.327 \text{ (kN)}$$

∴ Need shear reinforcing

- shear resistance by transverse reinforcement (V_s) (see 8.9.3.5)

$$V_s = \frac{\Phi_s \cdot A_v \cdot f_y \cdot d_v (\cot\theta + \cot\alpha) \sin\alpha}{s} = 20425.169 \text{ (kN)}$$

where, $s = 150.000 \text{ (mm)}$

$\alpha = 90.000 \text{ (deg.)}$

- Maximum spacing of reinforcement for shear. (see 8.14.6)

$$0.1\phi_c f_{cr} b_v d_v + V_p = 9703.873 \text{ (kN)} > V_f = 5522.327 \text{ (kN)}$$

$$s_{\max} = \text{Min}[0.75d_v, 600(\text{mm})] = 600.000 \text{ (mm)}$$

∴ $s = 150.000 \text{ (mm)} \leq s_{\max}$ OK

CSA S6:19

8.9.1.2 Regions requiring transverse reinforcement

Except for footings and walls, transverse reinforcement shall be provided in regions where T_f is greater than $0.25T_{cr}$ and in regions where V_f is greater than $k_v V_c + V_p$. The value of k_v shall be taken as 1.0 for d less than or equal to 300 mm, as 0.5 for d greater than or equal to 600 mm, and as $-0.00167d + 1.5$ for values of d between 300 mm and 600 mm. Quantity d shall be as defined in Clause 8.9.1.5.

6) Factored shear resistance by transverse reinforcement (V_s).

- Judgement (see 8.9.1.2)

$$k_v V_c + V_p = 4091.979 \text{ (kN)} \geq V_f = 3009.777 \text{ (kN)}$$

where, $k_v = 0.500$: effective depth, $d \geq 600\text{mm}$

∴ No-need shear reinforcing

- shear resistance by transverse reinforcement (V_s) (see 8.9.3.5)

$$V_s = \frac{\Phi_s \cdot A_v \cdot f_y \cdot d_v (\cot\theta + \cot\alpha) \sin\alpha}{s} = 9872.751 \text{ (kN)}$$

where, $s = 150.000 \text{ (mm)}$

$\alpha = 90.000 \text{ (deg.)}$

9. PSC Design as per CSA S6:19

- The formula for the angle of inclination(θ) has changed as per 8.9.3.7, CSA S6:19

▪ PSC > Design Parameter > CSA-S6-19

CSA S6:14

8.9.3.7 Determination of β and θ (general method)

The value of β shall be calculated as follows:

$$\beta = \left[\frac{0.4}{(1 + 1500\epsilon_x)} \right] \left[\frac{1300}{(1000 + s_{ze})} \right]$$

For sections containing at least the minimum transverse reinforcement required by Clause 8.9.1.3, s_{ze} shall be taken as 300 mm; otherwise, s_{ze} shall be calculated in accordance with Clause 8.9.3.6. The value of a_g in Clause 8.9.3.6 shall be taken as zero if f'_c is greater than 70 MPa and shall be linearly equal to zero as f'_c goes from 60 to 70 MPa. The angle of inclination, θ , shall be calculated as $(29 + 7000\epsilon_x)(0.88 + s_{ze}/2500)$.

4) Values of β and θ

- Parameter that account for influence of aggregate size (see 8.9.3.7)

$$S_{ze} = 300.000 \text{ (mm)} \quad \because A_v \geq A_{v,min}$$

- Values of β and θ

$$\beta = \left[\frac{0.4}{(1 + 1500 \epsilon_x)} \right] \cdot \left[\frac{1300}{(1000 + S_{ze})} \right] = 0.400$$

$$\theta = (29 + 7000 \epsilon_x) \cdot (0.88 + S_{ze} / 2500) = 29.000 \text{ (deg.)}$$

CSA S6:19

8.9.3.7 Determination of β and θ (general method)

The value of β shall be calculated as follows:

$$\beta = \left[\frac{0.4}{(1 + 1500\epsilon_x)} \right] \left[\frac{1300}{(1000 + s_{ze})} \right]$$

For sections containing at least the minimum transverse reinforcement required by Clause 8.9.1.3, s_{ze} shall be taken as 300 mm; otherwise, s_{ze} shall be calculated in accordance with Clause 8.9.3.6. The value of a_g in Clause 8.9.3.6 shall be taken as zero if f'_c is greater than 70 MPa and shall be linearly reduced to zero as f'_c goes from 60 to 70 MPa. The angle of inclination, θ , shall be calculated as $(29 + 7000\epsilon_x)$.

4) Values of β and θ

- Parameter that account for influence of aggregate size (see 8.9.3.7)

$$S_{ze} = 300.000 \text{ (mm)} \quad \because A_v \geq A_{v,min}$$

- Values of β and θ

$$\beta = \left[\frac{0.4}{(1 + 1500 \epsilon_x)} \right] \cdot \left[\frac{1300}{(1000 + S_{ze})} \right] = 0.076$$

$$\theta = (29 + 7000 \epsilon_x) = 48.911 \text{ (deg.)}$$

10. Steel Composite Design as per CSA-S6-19

- Bearing stiffeners can now be designed based on the latest code provisions. Summary report as well as a detailed excel report can be obtained.
- Load combinations and fatigue category details for shear stud connectors have been updated to reflect the latest code provisions. Now shear studs are considered in Category S for fatigue.

- **Results > Load Combination > Composite Steel Girder Design**
- **Design > Composite Design > Composite Steel Girder Design Parameters**
- **Design > Composite Design > Transverse Stiffener**

Automatic Generation of Load Combinations

Option
 Add Replace

Code Selection
 Steel Concrete SRC Steel Composite

Design Code :

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

Load Factors for Permanent Loads

Type of Load	Max	Min	Both
Dead Load	<input type="radio"/> 1.20	<input type="radio"/> 0.90	<input checked="" type="radio"/>
Wearing Surfaces	<input checked="" type="radio"/> 1.50	<input type="radio"/> 0.65	<input type="radio"/>
Earth Pressure	Define Earth Pressure LoadType		
Passive Earth Pressure	<input checked="" type="radio"/> 1.25	<input type="radio"/> 0.50	<input type="radio"/>
At-rest Earth Pressure	<input checked="" type="radio"/> 1.25	<input type="radio"/> 0.80	<input type="radio"/>
Active Earth Pressure	<input checked="" type="radio"/> 1.25	<input type="radio"/> 0.80	<input type="radio"/>
Backfill Pressure	<input checked="" type="radio"/> 1.25	<input type="radio"/> 0.80	<input type="radio"/>
Hydrostatic Pressure	<input checked="" type="radio"/> 1.10	<input type="radio"/> 0.90	<input type="radio"/>
Secondary Prestress Effects	<input checked="" type="radio"/> 1.05	<input type="radio"/> 0.95	<input type="radio"/>

OK Cancel

Auto-generation of Load Combinations

Composite Steel Girder Design Parameters

Code : Update by Code

Strength Resistance Factor

Resistance factor for flexure (Phi_s)	0.95
Resistance factor for shear (Phi_s)	0.95
Resistance factor for compression (Phi_s)	0.9
Resistance factor for tension (Phi_s)	0.95
Resistance factor for torsion (Phi_s)	0.9
Resistance factor for reinforcement (Phi_r)	0.9
Resistance factor for shear connector (Phi_sc)	0.85
Resistance factor for concrete (Phi_c)	0.75
Resistance factor for bearing, end (Phi_u)	0.75

Girder Type for Box/Tub Section
 Single Box Sections Multiple Box Sections
 Consider St. Venant Torsion and Distortion Stresses

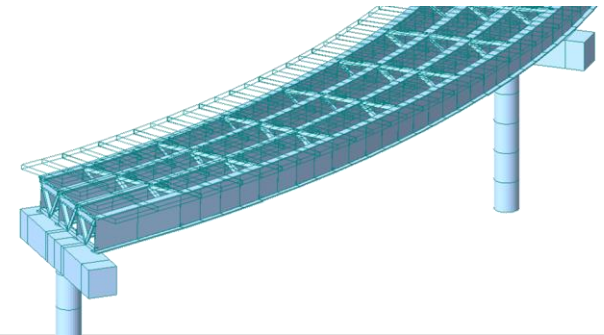
Option For Construction Stage
 Check Construction Stage Resistance

Design Parameters

- Ultimate Limit State-Flexure
- Ultimate Limit State-Shear
- Service Limit State
- Transverse Stiffeners, Longitudinal Stiffeners, Shear Connectors
- Fatigue Limit State

OK Cancel

Design code & Parameter input



4. Bearing Stiffener

Width-to-thickness ratio of plate bearing stiffeners		[10.10.8]
b = 75.00 mm : width of stiffener		[10.10.8.2]
t = 20.00 mm : thickness of stiffener		
b/t = 3.75	≤ 200√F _y = 10.00	OK
Factored bearing resistance of the bearing stiffeners		[10.10.8.2]
Φ _s = 0.90	: resistance factor for steel	
A _s = 6000.00 mm ²	: area of stiffener in contact with the flange	
F _y = 400.00 MPa	: yield stress of the stiffener of flange, whichever is less	
B _r = 209.88 kN	< B _r = 1.50Φ _s A _s F _y = 3240.00 kN	OK
Compressive resistance of bearing section		[10.10.8.3, 10.9.3.1]
Φ _s = 0.90	: resistance factor for steel	
A = 7876.00 mm ²		
F _y = 400.00 MPa	: yield stress of the stiffener of flange, whichever is less	
n = 1.34	: coefficient for axial buckling resistance	
KL = 547.50 mm	: effective column length (not less than 0.75 times the depth of the girder)	
I = 6.46E+06 mm ⁴		
r = √I/A = 28.634 mm		
E _s = 200000.00 MPa	: modulus of elastic of steel	
λ = $\frac{KL}{r} \sqrt{\frac{F_y}{\pi^2 E_s}}$ = 0.272		
C _r = 209.88 kN	< C _r = Φ _s A _s F _y (1+λ ²ⁿ) ^{-1m} = 2899.82 kN	OK

Detailed excel report – Bearing Stiffener

11. Design of Solid web girder as per IRS SBC:2017

- Detailed calculation report as well as a graphical report can now be generated for solid web steel beam sections based on IRS SBC:2017
- Design checks for I, C, L and T sections based on stress limits provided in IRS are supported.

Design > Steel Design > Design Code

1. Design Information

Design Code	IRS SBC
Unit System	kN, m
Member No	1
Material	E250 (No:1) (Fy = 240000, Es = 205000000)
Section Name	ISWB 600 (No:1) (Rolled : ISWB 600).
Member Length	: 8.00000

2. Member Forces

Axial Force	Fxx = 5.00000 (LCB: 1, POS:J)
Bending Moments	M _{yi} = -160.00, M _z = 0.00000
End Moments	M _{yi} = 0.00000, M _{yj} = -160.00 (for Lb) M _{zi} = 0.00000, M _{zj} = -160.00 (for Lz) M _{zi} = 0.00000, M _{zj} = 0.00000 (for Lz)
Shear Forces	F _{yy} = 0.00000 (LCB: 1, POS:I) F _{zz} = 40.00000 (LCB: 1, POS:J)

3. Design Parameters

Unbraced Lengths	L _y = 8.00000, L _z = 8.00000, L _b = 8.00000
Effective Length Factors	K _y = 1.00, K _z = 1.00
Moment Factor / Bending Coefficient	C _{my} = 1.00, C _{mz} = 1.00

4. Checking Results

Slenderness Ratio	L/r = 152.4 < 300.0 (Memb:1, LCB: 1)..... OK
Axial Stress	fat_cal/fat = 293/142056 = 0.002 < 1.000..... OK
Bending Stresses	f _{by_cal} /f _{by} = 45198/150000 = 0.301 < 1.000..... OK
Combined Stress (Tension+Bending)	R _{max} = fat_cal/fat + f _{by_cal} /f _{by} = 0.582 < 1.000..... OK

Steel Design Code

Design Code : IRS SBC

All Beams/Girders are Laterally Braced

Check Beam/Column Deflection

OK Close

MIDAS/Text Editor - [Combined_Axial_C_bendingnShear.acs]

```

[[[*]]] CHECK AXIAL STRESS.
-----
( ). Check slenderness ratio of axial tension member (l/r).
[ IRS:SBC-2017 Specification 3.7 TABLE 3.1 ]
-. Lambda = l/r = 152.4 < 300.0 ----> O.K.
( ). Permissible tensile stress (fat).
[ IRS:SBC-2017 TABLE II AND CL.3.7 ]
-. fat = 142056.098 KPa.
( ). Calculate axial tensile stress of member (fat_cal).
-. fat_cal = Fxx/Area = 293.462 KPa.
-----
MIDAS/Civil - Steel Code Checking [ IRS SBC ] Version 9.4.5
-----
( ). Check ratio of axial stress (fat_cal/fat).
fat_cal = 293.462
-. ----- = 0.002 < 1.000 ----> O.K.
fat = 142056.098
-----
[[[*]]] CHECK BENDING STRESSES ABOUT MAJOR AXIS.
-----
( ). Calculate condition for Ix and Iy.
[ IRS:SBC-2017 Cl.-3.9.1 ]
-. Ixx = 0.001 m4.
-. Iyy = 4.702e-05 m4.
Calculation Procedure is Applicable according to Code.
( ). Check Requirement of Web Stiffener.
d1 = 0.557
-. ----- = 49.8 < 175.00 ----> O.K.Web Stiffener Not Required
t1 = 0.011
    
```

Steel Design Code

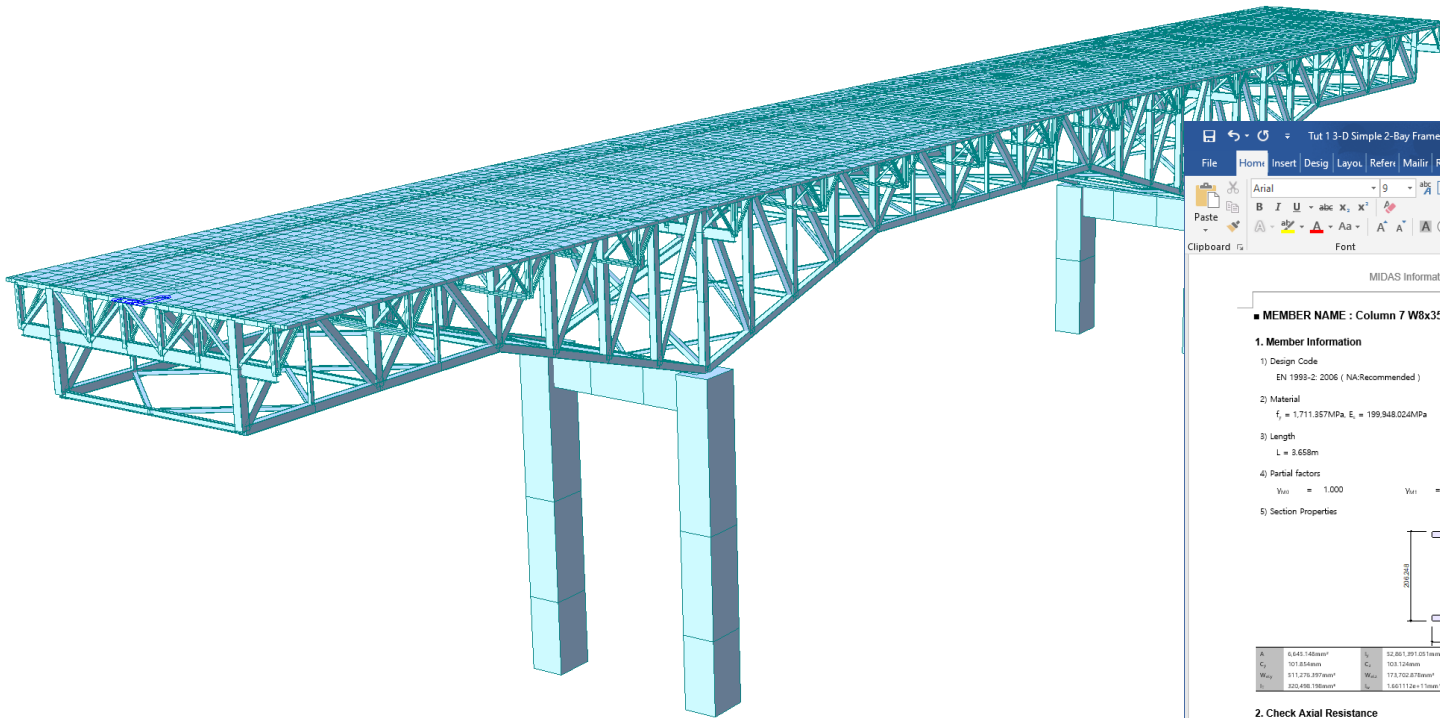
Graphical Report

Text Report

12. Design Calculation Speed

- The multithreading is now applied to the design calculation.
- The calculation time has been reduced to around 40% (40 mins. -> 16 mins.) for a test model.
 - Test model condition: 2844 beam elements, steel code check as per AASHTO LRFD 2017

Design



Tut 13-D Simple 2-Bay Frame_Sl [Compatib... DK 이대근

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Font Paragraph Styles Editing

MIDAS Information Technology Co., Ltd. Civil 2024 (v1.1) / Checking

MEMBER NAME : Column 7 W8x35 (ID : 1)

1. Member Information

- Design Code
EN 1993-2:2006 (NA:Recommended)
- Material
 $f_y = 1,711.357\text{MPa}$, $E_s = 199,948.024\text{MPa}$
- Length
 $L = 3.658\text{m}$
- Partial factors
 $\gamma_{M0} = 1.000$ $\gamma_{M1} = 1.000$ $\gamma_{M2} = 1.250$
- Section Properties

A	6,643,146mm ²	I _y	32,861,291.031mm ⁴	I _z	17,731,453.711mm ⁴	I _{xy}	0.000mm ⁴
C _y	101.845mm	C _z	103.124mm	I _{yc}	89.154mm ⁴	I _{zc}	51.562mm ⁴
W _{pl,y}	511,279,397mm ³	W _{pl,z}	173,702,878mm ³	W _{pl,yc}	558,631,127mm ³	W _{pl,zc}	261,831,730mm ³
I _{xx}	320,338,158mm ⁴	I _{yy}	1,601,116mm ⁴				

2. Check Axial Resistance

Axis LCB sLCB1

Axis N_{Ed} / N_{Rd} $287,283\text{kN} / 2,325,666\text{kN} = 0.124$ [OK](#)

*sLCB1 = Strength/17.8400

1) Check slenderness ratio of compressive member

$\frac{K_1 L}{i} = 79,936 < 200,000 \Rightarrow \text{O.K.}$

Page 1 of 9 2471 words English (United States) 80%

13. Other Enhancements

- Update Interface with BIM software
 - Revit 2024 Interface
 - Tekla 2023 Interface