

Release Note

Release Date : May 2020

Product Ver. : Civil 2020 (v3.1)



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

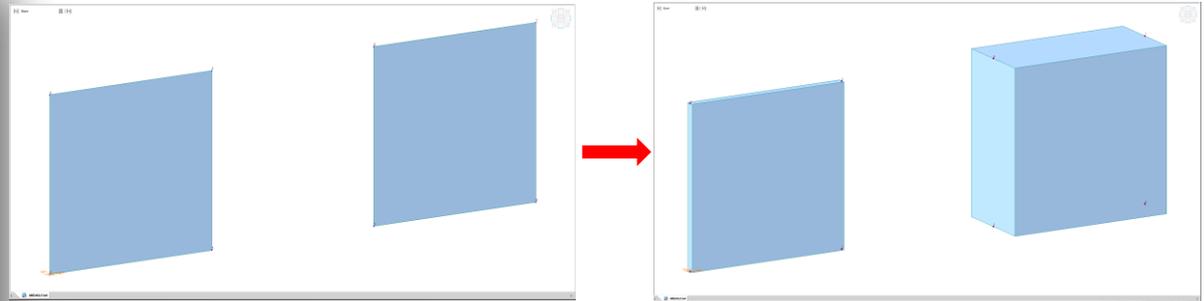
1. Batch Edit of Tendon Profile
2. Thickness Data of Plane Strain Element
3. Auto-generation of Tendon Profile – Italy Precast Section Types
4. Geometric Nonlinear Construction Stage Analysis with Plate Elements
5. Set-Back for Saddle of Suspension Bridge
6. Concurrent Forces of Beam Elements for Time History Analysis
7. Rail traffic loads to AS 5100.2
8. Heavy Load Platform to AS 5100.2
9. Rating Vehicles to AS 5100.2
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11. Rating Vehicles to CS 454
12. Prestressed Girder Design to BS 5400
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14. AASHTO LRFD 8th Design Standard – PSC/Composite Section, RC Section
15. AASHTO LRFD 8th Design Standard – Steel Composite Section
16. AASHTO LRFD 8th Load Combination – Auto Generation
17. Orthogonal effect of Seismic Load: AASHTO LRFD
18. RC Design as per IRS specifications
19. Polish Design Report



2. Thickness Data of Plane Strain Element

- In earlier versions, thickness of plane strain element is fixed as 1 m.
- Now, thickness can be defined for the plane strain element, which will be used to calculate self weight.

Node/Element > Elements > Create Elements > Plane Strain



	No	Type	Material		Section		Thickness		L/A/V		Unit Weight (kN/m ³)	Total Weight (kN)
			No	Name	No	Name	No	Name	Type	Value		
▶	1	PLANE ST	1	SS400	-	-	-	-	A	0.0000	76.9822	0.0003
	2	PLANE ST	1	SS400	-	-	-	-	A	0.0000	76.9822	0.0003

Previous Version

	No	Type	Material		Section		Thickness		L/A/V		Unit Weight (kN/m ³)	Total Weight (kN)
			No	Name	No	Name	No	Name	Type	Value		
▶	1	PLANE ST	1	SS400	-	-	1	0.1	A	4.0000	76.9800	30.7920
	2	PLANE ST	1	SS400	-	-	2	1	A	4.0000	76.9800	307.9200

Civil 2020 (v3.1)

Previous Version

Civil 2020 (v3.1)

3. Auto-generation of Tendon Profile – Italy Precast Section Types

- Italy – VH80N, VH100N, VH130N, VH140, VH150 are newly added for the auto-generation of tendon profiles.

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

Tendon Template

Use Prefix Name : strand

Assigned Elements : 1 [Add] [v] [...]

No	Name	Property
1	strand_081	Tendon
2	strand_082	Tendon
3	strand_083	Tendon
4	strand_084	Tendon
5	strand_085	Tendon
6	strand_086	Tendon
7	strand_087	Tendon
8	strand_088	Tendon
9	strand_089	Tendon
10	strand_090	Tendon
11	strand_091	Tendon
12	strand_092	Tendon
13	strand_093	Tendon
14	strand_094	Tendon
15	strand_095	Tendon
16	strand_096	Tendon
17	strand_097	Tendon
18	strand_098	Tendon
19	strand_099	Tendon

Add

Modify

Set Property

Move/Copy

Delete

Import

Export

Auto Generation

Reset Name

OK

Cancel

Apply

Tendon

Plane View

Elevation View

Section

1

Auto Generation

Name prefix : strand

Tendon Property : Tendon [v] [...]

Tendon Group : Default [v] [...]

Code : Italy [v]

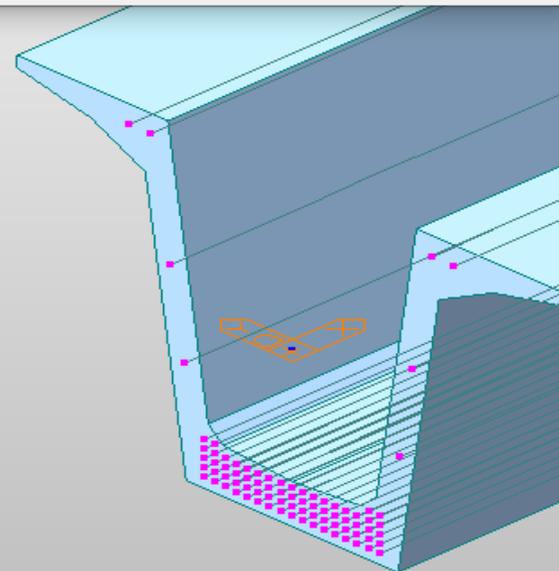
Type : Italy-VH [v]

Name : VH150 [v]

Origin Point : [v] m

Initialize Tendon Tem

OK Cancel



4. Geometric Nonlinear Construction Stage Analysis with Plate Elements

- Construction stage analysis can be performed considering geometric nonlinear effects of plate element.
- Initial tangent displacement can be applied to plate elements as well as beam elements.

▪ **Analysis > Analysis Control > Construction Stage > Initial Displacement for C.S**

Construction Stage Analysis Control Data

Final Stage
 Last Stage Other Stage CS22

Restart Construction Stage Analysis Select Stages for Restart...

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

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

No	Load Case Name	Type	Case1	Case2	...
<					>

Cable-Pretension Force Control
 Internal Force External Force Add Replace

Initial Force Control
 Convert Final Stage Member Forces to Initial Forces for Post C.S.
 Truss Beam
 Change Cable Element to Equivalent Truss Element for Post C.S.
 Apply Initial Member Force to C.S.

Initial Displacement for C.S.
 Initial Tangent Displacement for Erected Structures
 All Group SG5
 Lack-of-Fit Force Control SG6
 Apply Camber Displacement to C.S. (if Defined)

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

Beam Section Property Changes
 Constant Change with Tendon

Frame Output
 Calculate Concurrent Forces of Frame
 Calculate Output of Each Part of Composite Section
 Self-Constrained Forces & Stresses

Save Output of Current Stage(Beam/Truss)
 Remove Construction Stage Analysis Control Data

OK Cancel

Construction Stage Analysis Control

PostCS

Message Window

TANGENTIAL DISPLACEMENT RESULTS ARE SAVED.

```

CONSTRUCTION STEP NO. : 86 / 89  STAGE NO : 65  STEP NO : 1
ENTRY PHASE FOR RENUMBERING
ENTRY NUMBERING EQN
ENTRY FORM_STIFF_MASS_LOAD
THE INDIVIDUAL ELEMENT STIFFNESS AND LOAD MATRICES WILL NOW BE FORMED.
ELEMENT NO. : 2414 OF 2466
ENTRY SOLUTION PHASE
INCREMENT NO. : 1  ITERATION NO. : 1  DISPL. NORM : 0.100E+01  TOTAL ITERATION : 244
INCREMENT NO. : 1  ITERATION NO. : 2  DISPL. NORM : 0.118E-01  TOTAL ITERATION : 245
INCREMENT NO. : 1  ITERATION NO. : 3  DISPL. NORM : 0.255E-03  TOTAL ITERATION : 246
    
```

Command Message Analysis Message

5. Set-Back for Saddle of Suspension Bridge

- In a multi-span suspension bridge, top tower saddle can be shifted relative to the tower before starting the cable erection.
- Saddle can simulated using Elastic Link: saddle type.

- **Boundary > Link > Elastic Link > Type: Saddle**
- **Load > Construction Stage > C.S Loads > Set-Back Loads for Nonlinear Construction Stage**

Set-Back Loads for Nonlinear

Load Case Name: SW

Load Group Name: Default

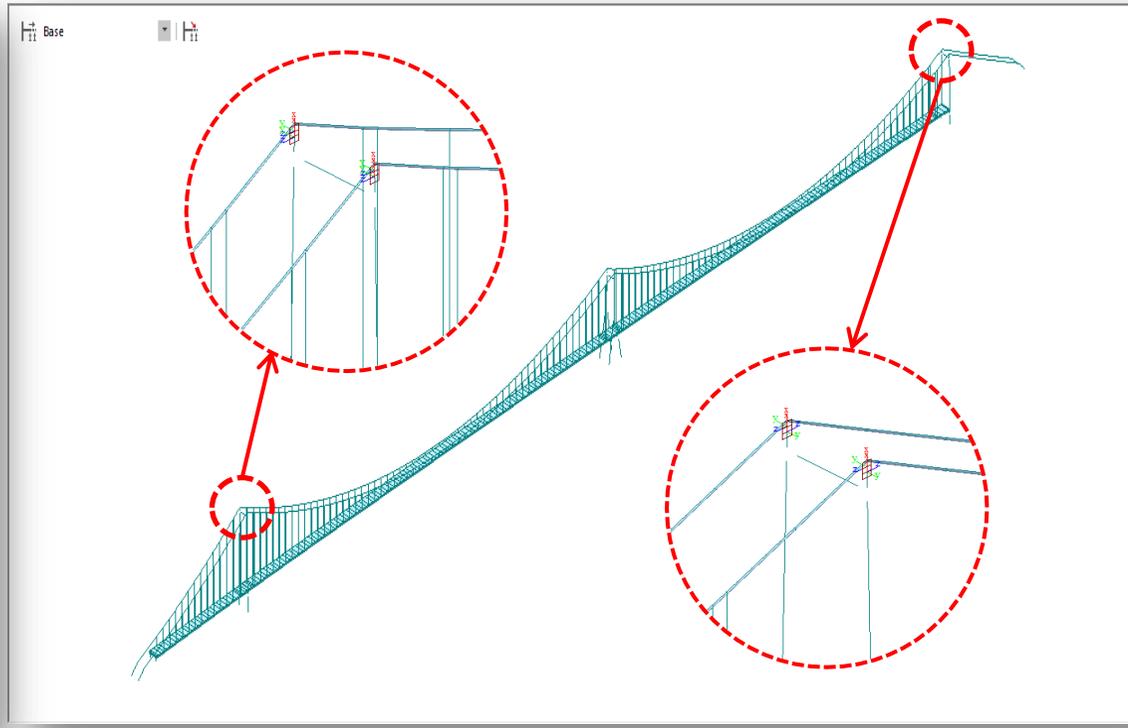
Options: Add Replace Delete

Saddle Type Elastic-Link Displacement (Local Direction)

Dx: 0 m
Dy: 0 m
Dz: 0 m

ID	Node1	Node2
15	4123	4901
16	4223	4902
17	8232	8902
18	8132	8901

Apply Close



Apply set-back to Elastic Link representing top tower saddles

Tree Menu 2

- Works
 - Analysis Control Data
 - Construction Stage Analysis [Stage=Last]
 - Structures
 - Nodes : 1465
 - Elements : 1025
 - Properties
 - Material : 11
 - Section : 244
 - Boundaries
 - Supports : 13
 - Elastic Link : 387
 - Rigid Link : 400
 - Static Loads
 - Static Load Case 1 [SW : Pylon, Main cable, Hanger
 - Static Load Case 2 [MC-wrapping ; Wrapping, Main
 - Static Load Case 3 [MC-clamp ; Cable clamps]
 - Static Load Case 4 [MC-socket ; Hanger socket on i
 - Static Load Case 5 [MC-handrail ; Hand rail, post, M
 - Static Load Case 6 [DECK-SW ; Deck, selfweight (in
 - Static Load Case 7 [DECK-DW ;]
 - Static Load Case 8 [MC Setback ; Setback]**
 - Etc. Loads
 - Set-Back for Construction Stage : 4**

Elastic Link

Boundary Group Name: Default

Options: Add Delete

Start Link Number : 1

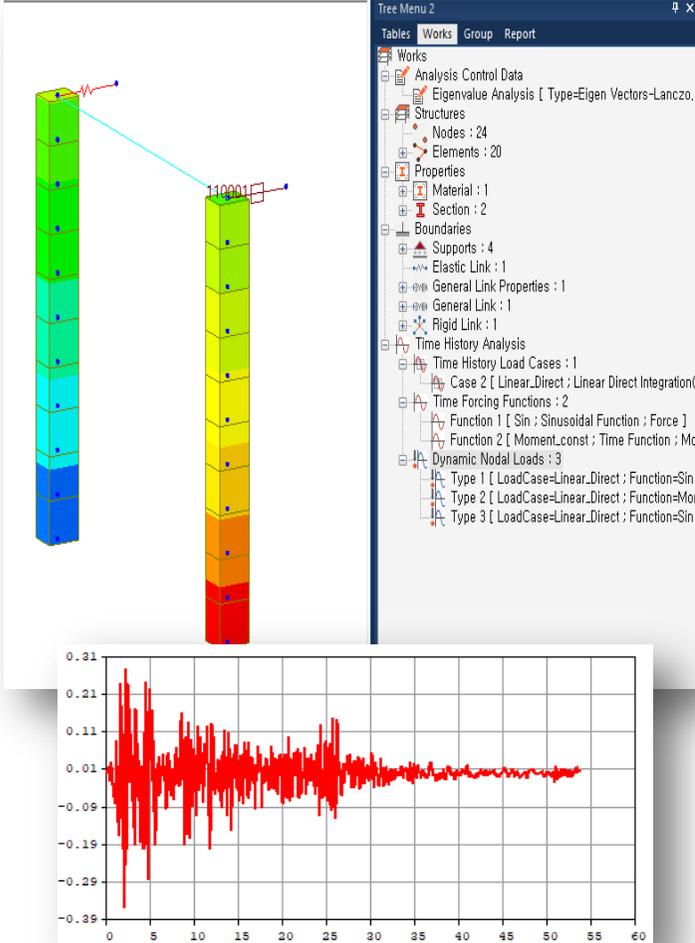
Elastic Link Data

Type: Saddle

6. Concurrent Forces of Beam Elements for Time History Analysis

- Concurrent forces for time-history analysis.
- Beam elements only.

Results > Results Tables > Beam > View by Max Value Item



Tree Menu 2

- Works
- Analysis Control Data
 - Eigenvalue Analysis [Type=Eigen Vectors-Lanczo.
- Structures
 - Nodes : 24
 - Elements : 20
- Properties
 - Material : 1
 - Section : 2
- Boundaries
 - Supports : 4
 - Elastic Link : 1
 - General Link Properties : 1
 - General Link : 1
 - Rigid Link : 1
- Time History Analysis
 - Time History Load Cases : 1
 - Case 2 [Linear_Direct ; Linear Direct Integration
 - Time Forcing Functions : 2
 - Function 1 [Sin ; Sinusoidal Function ; Force]
 - Function 2 [Moment_Const ; Time Function ; Mo
 - Dynamic Nodal Loads : 3
 - Type 1 [LoadCase=Linear_Direct ; Function=Sin
 - Type 2 [LoadCase=Linear_Direct ; Function=Mo
 - Type 3 [LoadCase=Linear_Direct ; Function=Sin

Beam Forces Table

Elem	Load	Part	Axial (kN)	Shear-y (kN)	Shear-z (kN)	Torsion (kN-m)	Moment-y (kN-m)	Moment-z (kN-m)
41	MSE(max)	J[23]	7.47	0.00	2.89	0.00	0.00	
41	MSE(max)	J[24]	7.47	0.00	2.89	0.00	9.92	
42	MSE(max)	J[24]	2173.37	0.00	310.20	0.00	9233.57	
42	MSE(max)	J[25]	2173.37	0.00	310.20	0.00	8599.10	
43	MSE(max)	J[25]	2223.34	0.00	278.02	0.00	8599.10	
43	MSE(max)	J[26]	2223.34	0.00	278.02	0.00	6128.84	
44	MSE(max)	J[26]	2140.57	0.00	253.99	0.00	6128.84	
44	MSE(max)	J[27]	2140.57	0.00	253.99	0.00	4418.04	
45	MSE(max)	J[27]	1996.63	0.00	210.71	0.00	4418.04	
45	MSE(max)	J[28]	1996.63	0.00	210.71	0.00	2750.17	
46	MSE(max)	J[28]	1841.19	0.00	170.51	0.00	2750.17	
46	MSE(max)	J[29]	1841.19	0.00	170.51	0.00	1411.97	
47	MSE(max)	J[29]	1703.47	0.00	127.41	0.00	1411.97	
47	MSE(max)	J[30]						
48	MSE(max)	J[30]						
48	MSE(max)	J[31]						
49	MSE(max)	J[31]						
49	MSE(max)	J[32]						
50	MSE(max)	J[32]						
50	MSE(max)	J[33]						
50	MSE(max)	J[33]						
51	MSE(max)	J[33]						
51	MSE(max)	J[34]						
51	MSE(max)	J[34]						
52	MSE(max)	J[34]						
52	MSE(max)	J[34]						
52	MSE(max)	J[36]						
53	MSE(max)	J[36]						
53	MSE(max)	J[36]						
53	MSE(max)	J[37]						

Concurrent Forces Table

Elem	Load	Part	Component	Axial (kN)	Shear-y (kN)	Shear-z (kN)	Torsion (kN-m)	Moment-y (kN-m)	Moment-z (kN-m)
41	MSE(max)	J[23]	Axial	7.47	0.00	2.79	-0.00	-0.00	0.00
41	MSE(max)	J[23]	Shear-y	2.92	0.00	0.17	-0.00	-0.00	0.00
41	MSE(max)	J[23]	Shear-z	7.28	0.00	2.89	-0.00	-0.00	0.00
41	MSE(max)	J[23]	Torsion	-5.74	-0.00	-1.75	0.00	-0.00	-0.00
41	MSE(max)	J[23]	Moment-y	-3.50	-0.00	-1.14	-0.00	0.00	-0.00
41	MSE(max)	J[23]	Moment-z	3.01	0.00	0.21	-0.00	-0.00	0.00
41	MSE(max)	J[24]	Axial	7.47	0.00	2.79	-0.00	-8.39	-0.00
41	MSE(max)	J[24]	Shear-y	2.92	0.00	0.17	-0.00	-0.52	-0.00
41	MSE(max)	J[24]	Shear-z	7.28	0.00	2.89	-0.00	-8.69	-0.00
41	MSE(max)	J[24]	Torsion	-5.74	-0.00	-1.75	0.00	5.25	0.00
41	MSE(max)	J[24]	Moment-y	-7.26	-0.00	-3.30	-0.00	9.92	-0.00
41	MSE(max)	J[24]	Moment-z	-5.82	-0.00	-1.82	0.00	5.48	0.00
42	MSE(max)	J[24]	Axial	2173.37	0.00	211.19	0.00	9233.39	-0.00
42	MSE(max)	J[24]	Shear-y	686.57	0.00	-125.55	0.00	2128.66	-0.00
42	MSE(max)	J[24]	Shear-z	1323.12	0.00	310.20	0.00	5925.36	-0.00
42	MSE(max)	J[24]	Torsion	613.28	0.00	-109.56	0.00	1846.23	-0.00
42	MSE(max)	J[24]	Moment-y	2173.33	0.00	211.41	0.00	9233.57	-0.00
42	MSE(max)	J[24]	Moment-z	-102.76	-0.00	-28.39	-0.00	-275.41	0.00
42	MSE(max)	J[25]	Axial	2173.37	0.00	211.19	0.00	8599.02	-0.00
42	MSE(max)	J[25]	Shear-y	686.57	0.00	-125.55	0.00	2505.79	-0.00
42	MSE(max)	J[25]	Shear-z	1323.12	0.00	310.20	0.00	4993.61	-0.00
42	MSE(max)	J[25]	Torsion	613.28	0.00	-109.56	0.00	2175.32	-0.00
42	MSE(max)	J[25]	Moment-y	2173.36	0.00	211.08	0.00	8599.10	-0.00
42	MSE(max)	J[25]	Moment-z	559.89	-0.00	227.68	-0.00	2386.86	0.00
43	MSE(max)	J[25]	Axial	2223.34	0.00	258.20	0.00	8599.10	-0.00
43	MSE(max)	J[25]	Shear-y	884.02	0.00	-18.70	0.00	2491.19	-0.00

8. Heavy Load Platform to AS 5100.2

- HLP320, HLP400, User-defined heavy load platform loads

- **Load > Moving Load > Moving Load Code > Australia**

Define Standard Vehicular Load

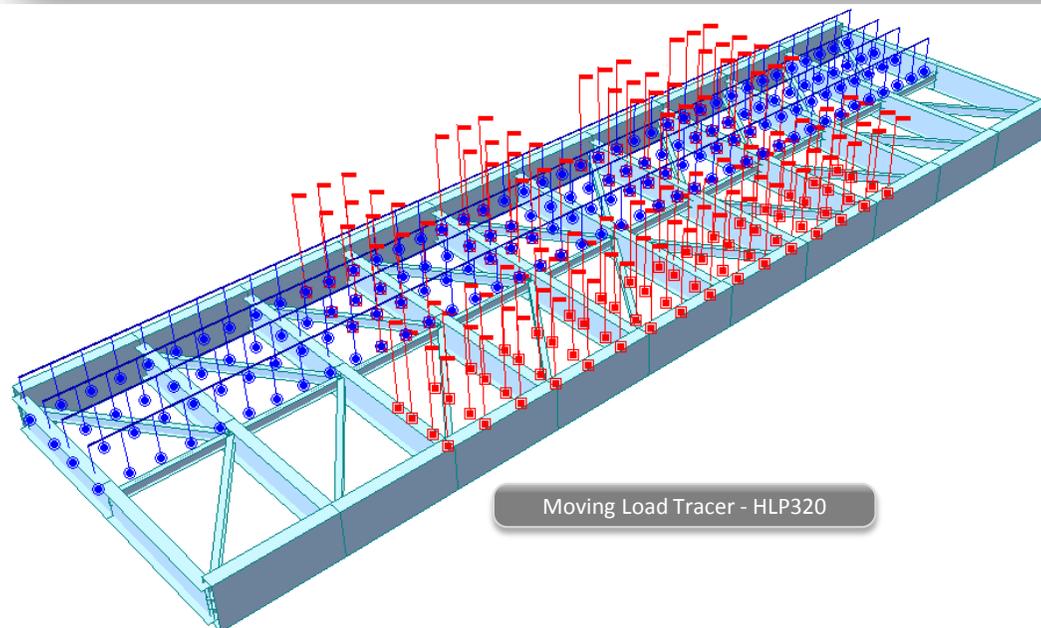
Standard Name
AS 5100.2 - Heavy Load Platform

Vehicular Load Properties
Vehicular Load Name : HLP320
Vehicular Load Type : HLP320
Dynamic Load Allowance : 0.1

P = 200 kN
D = 1.8 m
Number of Axles = 16

OK Cancel Apply

HLP320 Heavy Load Platform



9. Rating Vehicles to AS 5100.2

- T44, L44, User-defined rating vehicle loads

▪ **Load > Moving Load > Moving Load Code > Australia**

Define Standard Vehicular Load ✕

Standard Name
AS 5100.7 - Rating Vehicles

Vehicular Load Properties

Vehicular Load Name : T44

Vehicular Load Type : T44 Truck Load

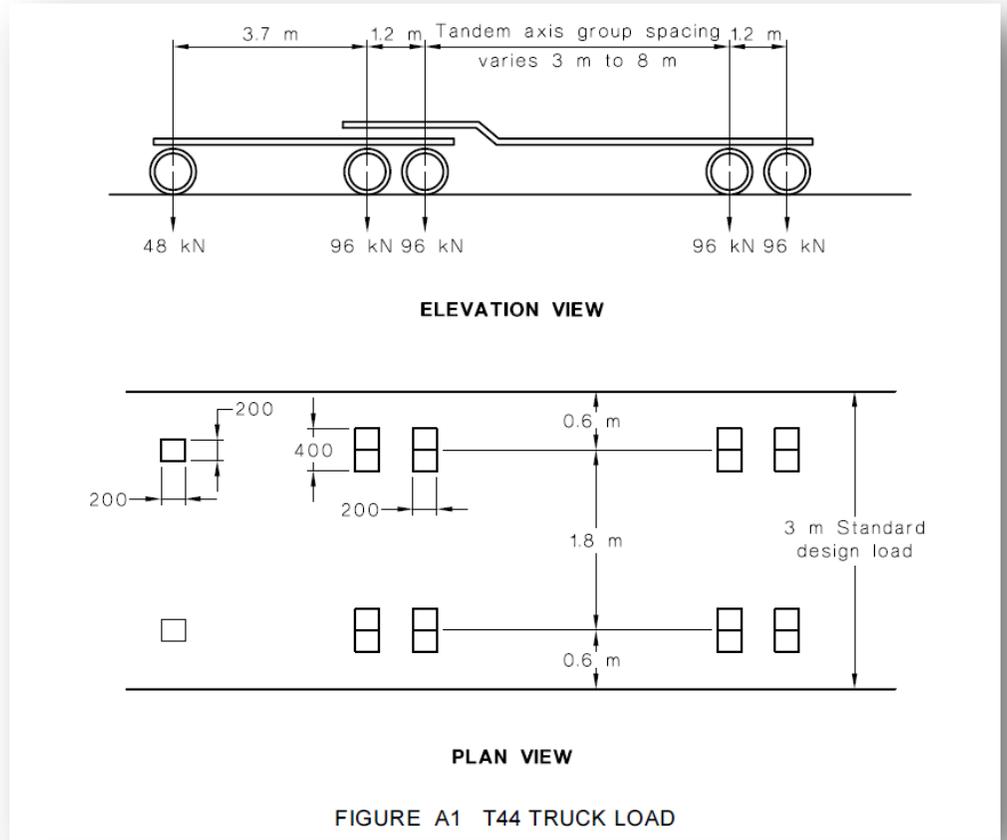
Dynamic Load Allowance : 0

P1 P2 P3 P4 P5

D1 D2 D3-D4 D5

No	Load(kN)	Spacing(m)
1	48	3.7
2	96	1.2
3	96	3
4	96	8
5	96	1.2

T44 Rating Vehicle



10. Horizontal Traffic Loads to AS 5100.2

- Centrifugal forces, traction and braking forces can be generated as static load cases.

Moving Tracer > Moving Load Converted to Static Load

Moving Load Converted to Static Load ✕

Vertical Loads

Centrifugal Forces

Height of Forces from the top of the rail m

Design Speed m/sec

Radius of Curve m

Super Elevation (Road Traffic) %

Direction of Centrifugal Forces with reference to Vehicle Direction

Right-to-Left Direction Left-to-Right Direction

Longitudinal Force

Total Length of the Bridge (Rail Traffic) m

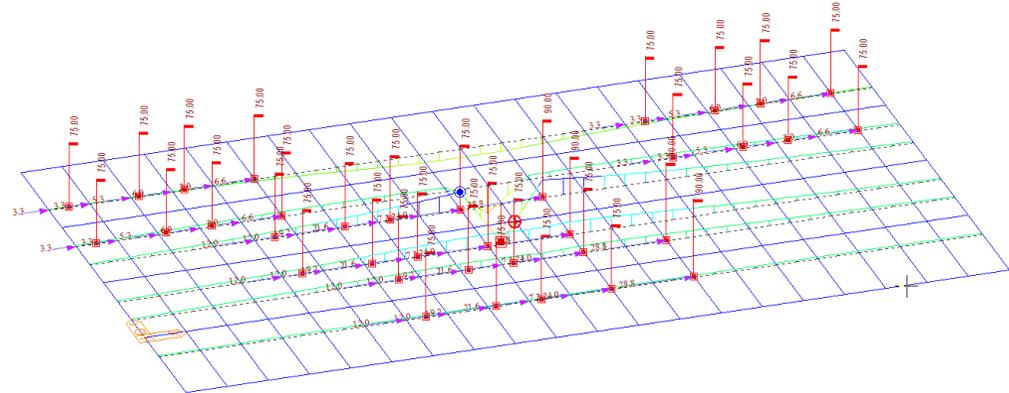
Traction Force

Braking Force

File Name

...

Conversion to Static Loads



9.7 Horizontal forces

9.7.1 Centrifugal forces

For rail bridges on horizontal curves, allowance shall be made for the centrifugal effects of rail traffic load by applying a centrifugal force (F_c) corresponding to each axle load horizontally through a point 2 m above the top of the rail.

The horizontal centrifugal force resulting from rail traffic loads shall be proportional to the design rail traffic load, and for each a (a) Braking forces:

$$F_c = \frac{V^2 A}{rg} \qquad \text{BF} = 200 + 15L_{LF} \qquad \dots 9.7.2.2(1)$$

where

BF = longitudinal braking force, in kilonewtons
 L_{LF} = total length of the bridge, in metres

where

V = design speed, in metres per second
 A = axle load, in kilonewtons
 r = radius of curve, in metres
 g = acceleration due to gravity

(b) Traction forces:

$$\begin{aligned} \text{TF} &= 200 + 25L_{LF} && \text{for } L_{LF} \leq 25 \text{ m} && \dots 9.7.2.2(2) \\ &825 + 15(L_{LF} - 25) && \text{for } 25 \text{ m} < L_{LF} \leq 50 \text{ m} && \dots 9.7.2.2(3) \\ &1200 + 7.5(L_{LF} - 50) && \text{for } 50 \text{ m} < L_{LF} \leq 250 \text{ m} && \dots 9.7.2.2(4) \\ &2700 + 5.0(L_{LF} - 250) && \text{for } 250 \text{ m} < L_{LF} && \dots 9.7.2.2(5) \end{aligned}$$

where

TF = longitudinal traction force, in kilonewtons
 L_{LF} = total length of the bridge, in metres

The specified centrifugal force shall not be used in conjunction with centrifugal and nosing forces due to rail traffic loads.

11. Rating Vehicles to CS 454

- ALL Model 1 (normal traffic, 26 tonnes, 18 tonnes, 7.5 tonnes, 3 tonnes)
- Impact factor, traffic flow factor, lane factor

▪ **Load > Moving Load > Moving Load Code > BS**

Define Standard Vehicular Load

Standard Name: CS 454 Assessment

Vehicular Load Properties

Vehicular Load Name: A-4AXLE

Vehicular Load Type: ALL MODEL 1

Sub Type: A-4AXLE

* A-4AXLE		
No	P (kN)	D (m)
1	64	1.2
2	64	3.9
3	113	1.3
4	74	end

O1 = 1 m
O2 = 1 m

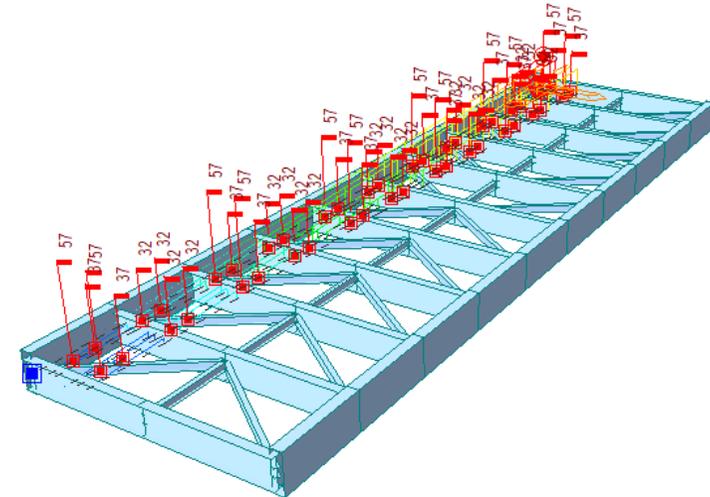
Loading Case: Single Convoy

Road Surface: Good Poor

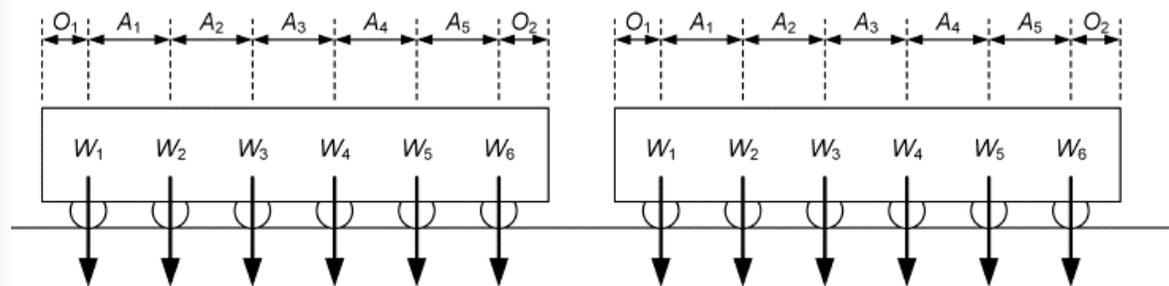
Traffic Flow Category: High Medium Low

OK Cancel Apply

- A-4AXLE
- B-4AXLE
- C-5AXLE
- D-5AXLE_1
- D-5AXLE_2
- E-5AXLE_1
- E-5AXLE_2
- F-6AXLE_1
- F-6AXLE_2
- G-6AXLE_1
- G-6AXLE_2
- H-5AXLE_1
- H-5AXLE_2
- I-3AXLE
- J-3AXLE
- K-3AXLE_1
- K-3AXLE_2
- L-3AXLE_1
- L-3AXLE_2
- M-2AXLE
- N-2AXLE
- O-2AXLE



Moving Load Tracer – ALL Model 1 A Convoy



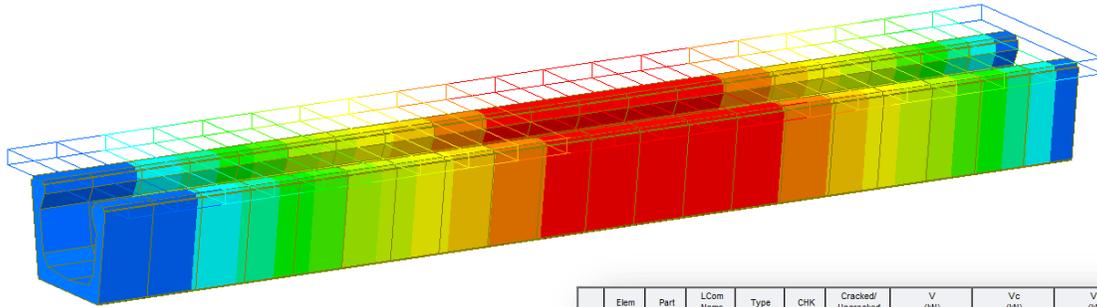
ALL Model 1 Convoy

300LA Train

12. Prestressed Girder Design to BS 5400

- Ultimate Limit State: Flexure, Shear, Torsion
- Serviceability Limit Stage: Stress, Crack

■ PSC > Design Parameter > BS 5400



PSC Design Parameters

Design Code : BS 5400-4:1990

User Input Data

Input Parameters

Principal Stress Limitation

Serviceability Limit States

Comp. 20 N/mm² Tens. 1 N/mm²

Construction Stage

Comp. 20 N/mm² Tens. 1 N/mm²

Output Parameters

Serviceability Limit States

Concrete stress limitation under service loads
 Concrete stress limitation at Construction Stage
 Principal stress under service loads
 Principal stress at Construction Stage
 Tensile stress for prestressing steel

Ultimate limit states

Bending resistance
 Shear resistance
 Torsional resistance

Elem	Part	LCom Name	Type	CHK	Cracked/UnCracked	V (kN)	Vc (kN)	Vp (kN)
31	[31]	clCB1	FX-MAX	OK	UnCracked	3697.7653	5600.6276	1089.4979
31	[32]	clCB1	FX-MAX	OK	UnCracked	4300.0696	6718.8185	2089.7983
32	[32]	clCB1	FX-MAX	OK	UnCracked	4367.9569	6718.6466	2089.7048
32	[33]	clCB1	FX-MAX	OK	UnCracked	4994.0555	7756.5974	3043.3164
33	[33]	clCB1	FX-MAX	OK	UnCracked	5096.0264	7756.3981	3043.1926
33	[34]	clCB1	FX-MAX	OK	UnCracked	5719.3801	8677.3702	3899.5325
34	[34]	clCB1	FX-MAX	OK	UnCracked	5783.4813	8676.4566	3898.9226
34	[35]	clCB8	FZ-MAX	OK	UnCracked	6480.1368	6486.1565	2029.9368
35	[35]	clCB8	FZ-MAX	OK	UnCracked	6489.9510	6495.9617	2029.8209
35	[36]	clCB8	FZ-MAX	OK	UnCracked	7429.1805	4429.1410	291.5115
36	[36]	clCB9	FZ-MN	OK	UnCracked	-7798.3355	4428.9546	291.4776
36	[37]	clCB9	FZ-MN	OK	UnCracked	-6862.3546	5153.2858	963.5172
37	[37]	clCB9	FZ-MN	OK	UnCracked	-6862.4360	5152.5049	963.1935
37	[38]	clCB1	FX-MAX	OK	UnCracked	-5996.8881	6486.6041	2181.7369
38	[38]	clCB1	FX-MAX	OK	UnCracked	-6306.8062	8359.5716	3162.6951
38	[39]	clCB1	FX-MAX	OK	UnCracked	-5283.1650	8926.0487	3678.6855
39	[39]	clCB1	FX-MAX	OK	UnCracked	-5587.7388	8925.3904	3678.2591
39	[40]	clCB1	FX-MAX	OK	UnCracked	-4564.0556	8883.8478	3652.2015
40	[40]	clCB1	FX-MAX	OK	UnCracked	-4887.5397	7726.5373	2895.2502
40	[41]	clCB1	FX-MAX	OK	UnCracked	-3865.8775	7147.4793	2354.1593
41	[41]	clCB1	FX-MAX	OK	UnCracked	-4186.7548	7146.7462	2353.7685
41	[42]	clCB1	FX-MAX	OK	UnCracked	-3177.8515	5622.5204	968.4353
42	[42]	clCB1	FX-MAX	OK	UnCracked	-2272.7099	5622.1340	968.2604
42	[43]	clCB1	FX-MAX	OK	UnCracked	-1725.7445	4611.5058	59.1826
43	[43]	clCB1	FX-MAX	OK	UnCracked	-1725.7620	4611.4441	59.1790
43	[44]	clCB1	FX-MAX	OK	UnCracked	-1178.9167	4548.8947	11.5920
44	[44]	clCB1	FX-MAX	OK	UnCracked	-1178.8348	4548.8953	11.5920
44	[45]	clCB1	FX-MAX	OK	UnCracked	-631.8694	4521.4062	2.0371
45	[45]	clCB1	FX-MAX	OK	UnCracked	-631.8804	4521.3875	2.0371
45	[46]	clCB1	FX-MAX	OK	UnCracked	-84.9151	4502.6167	2.7656
46	[46]	clCB1	FX-MAX	OK	UnCracked	-84.9273	4502.5904	2.7656
46	[47]	clCB1	FX-MAX	OK	UnCracked	462.0381	4500.9874	21.8337
47	[47]	clCB1	FX-MAX	OK	UnCracked	462.0311	4500.7999	21.8327
47	[48]	clCB1	FX-MAX	OK	UnCracked	1008.9965	4652.9981	356.1016
48	[48]	clCB1	FX-MAX	OK	UnCracked	1009.0100	4852.8649	356.0749

PSC Design Result Table

Design code	Element	Node(I/J)
BS 5400-4:1990	16	J

Section Properties

Section Type: Non-Composite

Gross section

H	3000.000 (mm)	A _g	6.209E+06 (mm ²)	S _x	6.505E+09 (mm ³)
B	8500.000 (mm)	I _y	7.867E+12 (mm ⁴)	S _y	4.399E+09 (mm ³)
C _{ip}	1209.410 (mm)				
C _{em}	1790.590 (mm)				

Transformed section

H	3000.000 (mm)	A _e	6.439E+06 (mm ²)	S _x	6.790E+09 (mm ³)
B	8500.000 (mm)	I _e	8.116E+12 (mm ⁴)	S _y	4.497E+09 (mm ³)
C _{ip}	1195.243 (mm)				
C _{em}	1804.757 (mm)				

Partial Safety Factors

Partial Safety Factors for Ultimate Limit State

γ _{mc} for Concrete	Characteristic
γ _{mc} for Concrete	1.5
γ _{ms} for Reinforce/Prestress	1.15

Partial Safety Factors for Serviceability Limit State

Type of Stress	γ _{mc} for concrete
Triangular Compressive	1.25
Uniform Compressive	1.67
Pre-tension	1.25
Post-tension	1.55

Material

- Concrete

PSC Design Detail Report

13. Improvement of Bridge Assessment to CS 454

- Serviceability limit state check for Class 3 type section
- Ultimate limit state check and serviceability limit state check for unbonded tendons

Rating > Bridge Rating Design > CS 454/19

Section for Assessment Check ...

Option

Add/Replace Delete

Position

I J I & J

Class Category

Class 1

Class 2

Class 3

Tendon Type for Class 3

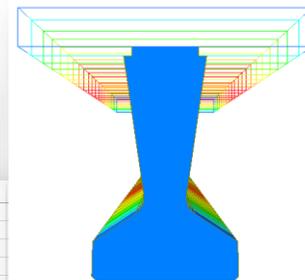
Type C : Pre-tensioned tendons distributed close to the tension faces

Apply Close

Class Category

Element	Part	Class	Rating Case	Load Effect	sig_c (N/mm ²)	sig_c_lim (N/mm ²)	sig_t (N/mm ²)	sig_t_lim (N/mm ²)	A	Check
12	J[14]	Class 3	SLS1_Fzz(Min)	Positive	15.2245	25.0000	-7.9229	-11.5705	1.4604	OK
12	J[14]	Class 3	SLS1_Mxx(Max)	Positive	15.2245	25.0000	-7.9229	-11.5705	1.4604	OK
12	J[14]	Class 3	SLS1_Mxx(Min)	Positive	15.2245	25.0000	-7.9229	-11.5705	1.4604	OK
12	J[14]	Class 3	SLS1_Myy(Max)	Positive	17.2856					
12	J[14]	Class 3	SLS1_Myy(Min)	Positive	8.1046					
12	J[14]	Class 3	SLS1_Mzz(Max)	Positive	8.1046					
12	J[14]	Class 3	SLS1_Mzz(Min)	Positive	8.1046					
13	I[14]	Class 3	SLS1_Fxx(Max)	Positive	15.6500					
13	I[14]	Class 3	SLS1_Fxx(Min)	Positive	8.1046					
13	I[14]	Class 3	SLS1_Fyy(Max)	Positive	8.1046					
13	I[14]	Class 3	SLS1_Fyy(Min)	Positive	8.1046					
13	I[14]	Class 3	SLS1_Fzz(Max)	Positive	16.5127					
13	I[14]	Class 3	SLS1_Fzz(Min)	Positive	15.2245					
13	I[14]	Class 3	SLS1_Mxx(Max)	Positive	15.2245					
13	I[14]	Class 3	SLS1_Mxx(Min)	Positive	15.2245					
13	I[14]	Class 3	SLS1_Myy(Max)	Positive	17.2856					
13	I[14]	Class 3	SLS1_Myy(Min)	Positive	8.1046					
13	I[14]	Class 3	SLS1_Mzz(Max)	Positive	8.1046					
13	I[14]	Class 3	SLS1_Mzz(Min)	Positive	8.1046					
13	J[15]	Class 3	SLS1_Fxx(Max)	Positive	14.2445					
13	J[15]	Class 3	SLS1_Fxx(Min)	Positive	7.6422					
13	J[15]	Class 3	SLS1_Fyy(Max)	Positive	7.6422					
13	J[15]	Class 3	SLS1_Fyy(Min)	Positive	7.6422					
13	J[15]	Class 3	SLS1_Fzz(Max)	Positive	15.8003					
13	J[15]	Class 3	SLS1_Fzz(Min)	Positive	13.8680					
13	J[15]	Class 3	SLS1_Mxx(Max)	Positive	12.8885					
13	J[15]	Class 3	SLS1_Mxx(Min)	Positive	12.8885					
13	J[15]	Class 3	SLS1_Myy(Max)	Positive	16.3155					
13	J[15]	Class 3	SLS1_Myy(Min)	Positive	7.6422					
13	J[15]	Class 3	SLS1_Mzz(Max)	Positive	7.6422					
13	J[15]	Class 3	SLS1_Mzz(Min)	Positive	7.6422					
14	I[15]	Class 3	SLS1_Fxx(Max)	Positive	15.1026					
14	I[15]	Class 3	SLS1_Fxx(Min)	Positive	7.6422					
14	I[15]	Class 3	SLS1_Fyy(Max)	Positive	7.6422					
14	I[15]	Class 3	SLS1_Fyy(Min)	Positive	7.6422					

SLS Reserve Factor Table



5. Serviceability Limit State for a Section

Class 3 Limit Check

• Check If Stresses are Within Class 3 Limits

* For Bonded Tendons

■ Compression

- Service limit load combination : SLS1

- Service limit load combination type : MY-MAX

$$\sigma_{c,min} \leq 0.625 \frac{f_{cu}}{\gamma_{mc}} = \sigma_{c,limit} = 25.00 \text{ (MPa)}$$

■ Tension

- Service limit load combination : SLS1

- Service limit load combination type : MY-MAX

$$\sigma_{c,max} \leq \sigma_{limit} * DF + \sigma_{rebar} = \sigma_{c,limit} = -11.31 \text{ (MPa)}$$

where,

- $\sigma_{c,max}$: Tensile stress on the prestressed concrete = -11.29 (MPa)
- $\sigma_{c,min}$: Compressive stress on the prestressed concrete = 18.12 (MPa)
- σ_{limit} : Flexural tensile stresses for class 3 members (Table 25) = -7.80 (MPa)
- DF : Depth factor for class 3 members based on the depth of member = 0.70
- $A_{conc,T}$: Area of concrete in tensile section = 251932.18 (mm²)
- $A_{rebar,T}$: Area of rebar in tensile section = 4909.00 (mm²)
- σ_{rebar} : Increase in the tensile stress limit due to the presence of additional reinforcement = -5.85 (MPa)
- $\sigma_{c,limit}$: Flexural tensile stress limit
- $\sigma_{t,limit}$: Flexural compressive stress limit

Since

$\sigma_{c,max} \leq \sigma_{c,limit}$ ∴ OK

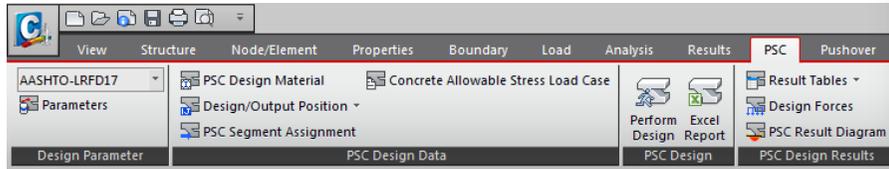
$\sigma_{c,min} \leq \sigma_{c,limit}$ ∴ OK

Serviceability Limit State Check Report

14. AASHTO LRFD 8th Design Standard – PSC/Composite Section, RC Section

- New AASHTO LRFD design standard can be applied to various design functions.
- RC, PSC Box, PSC Composite.

▪ **PSC > Design > AASHTO LRFD 17**



Torsional effects shall be investigated where:

$$T_u > 0.25\phi T_{cr} \quad (5.7.2.1-3)$$

- For solid shapes:

$$T_{cr} = 0.126K\lambda\sqrt{f'_c} \frac{A_{cp}^2}{P_c}$$

- For hollow shapes:

$$T_{cr} = 0.126K\lambda\sqrt{f'_c} 2A_o b_o$$

in which:

$$K = \sqrt{1 + \frac{f_{pc}}{0.126\lambda\sqrt{f'_c}}} \leq 2.0$$

5.7.2.6—Maximum Spacing of Transverse Reinforcement

The spacing of the transverse reinforcement shall not exceed the maximum permitted spacing, s_{max} , determined as:

- If $v_u < 0.125 f'_c$, then:

$$s_{max} = 0.8d_v \leq 24.0 \text{ in.} \quad (5.7.2.6-1)$$

- If $v_u \geq 0.125 f'_c$, then:

$$s_{max} = 0.4d_v \leq 12.0 \text{ in.} \quad (5.7.2.6-2)$$

where:

v_u = shear stress calculated in accordance with Article 5.7.2.8 (ksi)

d_v = effective shear depth as defined in Article 5.7.2.8 (in.)

1. Design Condition

Design Code	Element	Node(I/J)
AASHTO-LRFD2017	16	I

Section Properties

- Gross section	
H	117.992 (in)
B	492.126 (in)
C_{22}	42.858 (in)
C_{21}	75.134 (in)
- Transformed section	
H	117.992 (in)
B	492.126 (in)
C_{22}	43.709 (in)
C_{21}	74.283 (in)

Materials

- Concrete	
f'_c (ksi)	7.000
* β_1 : 0.85 if f'_c is lower	

- Prestressing steel information

No.	Tendon	B
1	S_L8_CS1	B
2	S_L2_CS1	B
3	S_L1_CS1	B
4	S_R3_CS1	B
5	S_L6_CS1	B
6	S_R4_CS1	B
7	S_L5_CS1	B
8	S_R1_CS1	B
9	S_R2_CS1	B
10	S_L7_CS1	B
11	S_R7_CS1	B
12	S_L4_CS1	B
13	S_L3_CS1	B
14	S_R8_CS1	B
15	S_R6_CS1	B
16	S_R5_CS1	B

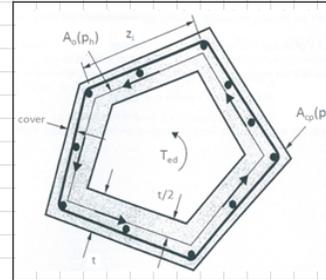
* d_p : Distance from extr

4. Torsional design for a section

Case of V_{max}

- Section type	: Segmental-Box
- The Strength Limit Load Combination	: cLCB1
- Factored torsional moment	: $T_u = -111236.26$ (kips-in)
- Factored shear force	: $V_u = 1809.62$ (kips)
- Factored moment	: $M_u = 1012397.15$ (kips-in)
- Factored axial force	: $N_u = -12515.30$ (kips)
- Resistance factor for shear	: $\Phi = 0.90$
- Component of prestressing force in direction of the shear force	: $V_p = \Sigma A_{ps} f_{pe} \sin \alpha = 413.49$ (kips)

1) Notation



A_o = Area enclosed by the shear flow path, including any area of holes therein.	= 35799.879 (in ²)
p_h = Perimeter of the centerline of the closed transverse torsion reinforcement.	= 1113.426 (in)
A_{cp} = Total area enclosed by outside perimeter of the concrete section.	= 35799.879 (in ²)
p_c = The length of the outside perimeter of concrete section.	= 1113.426 (in)

2) Checking Torsional Effects

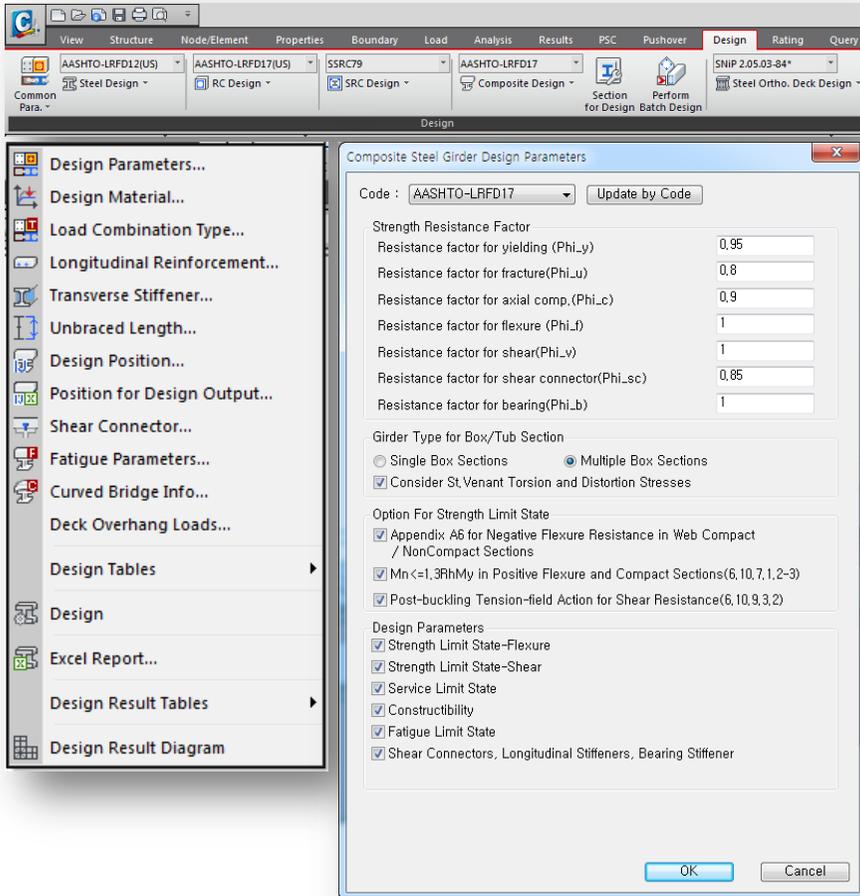
• Torsional cracking moment (T_{cr})	
$b_e = 16.375$ (in) : The effective thickness of shear flow path of elements	
$T_{cr} = 0.126 K \sqrt{f'_c} 2A_o b_e = 781714.14$ (kips-in)	(Eq. 5.7.2.1-5)
$T_u = -111236.262 $ (kips-in) $\leq 0.25\Phi T_{cr} = 175885.68$ (kips-in)	(Eq. 5.7.2.1-3)
$\therefore T_u \leq 0.25\Phi T_{cr}$ Ignore Torsional Effects.	
• Check combined torsional and shear	(Eq. 5.12.5.3.8c-6)

$\frac{V_u}{b_v d_v} + \frac{T_u}{2A_o b_e} = 0.00$ (ksi) $\geq 0.474 \sqrt{f'_c} = 0.00$ (ksi)	OK
---	----

15. AASHTO LRFD 8th Design Standard – Steel Composite Section

- New AASHTO LRFD design standard can be applied to various design functions.
- Steel Composite

Design > Composite Design > AASHTO - LRFD 17



Design Parameters

Code	AASHTO-LRFD 2017
Element	3
Position	1
Moment Type	Beam

I. Design Condition (Positive Flexure)

1. Section Properties

1) Slab Properties

B_s = 240.000 in
t_s = 10.000 in
t_e = 5.000 in
f_c' = 3.000 ksi
E_c = 3155.924 ksi
A_c = 0.000 in²
F_{yr} = 40.000 ksi

2) Girder Properties

[Section]

b_{tc} = 130.000 in b_{ft} = 106.000 in
t_{tc} = 3.000 in t_{ft} = 1.300 in
D = 130.384 in t_w = 1.500 in
H = 134.300 in

Position	Material	Thick(in)	f _y (ksi)	f _u (ksi)	Note
Compression Flange	A36	3.000	36.000	58.000	
Tension Flange	A36	1.300	36.000	58.000	less than 2 in.
Web	A36	1.500	36.000	58.000	less than 2 in.

[Design Strength]

F_{yc} = 36.000 ksi (Compression Flange Yield Strength)
F_{yw} = 36.000 ksi (Web Yield Strength)
F_{yt} = 36.000 ksi (Tension Flange Yield Strength)
E_s = 29000.000 ksi (Elastic Modulus of Steel)

3) Transverse Stiffener Properties

Position	Type	f _y (ksi)	H(in)	B(in)	t _w (in)	t _f (in)	d ₀ (in)
Web	1Side	35.000	10.000	10.000	2.000	2.000	100.000

Excel Design Report

16. AASHTO LRFD 8th Load Combination – Auto Generation

- Load factors of extreme event.
- Load factors of fatigue .

▪ Result > Load Combinations > AASHTO LRFD 17

Table 3.4.1-1—Load Combinations and Load Factors

Load Combination Limit State	DC DD DW EH EV ES EL PS CR SH	LL IM CE BR PL LS	Use One of These at a Time												
			WA	WS	WL	FR	TU	TG	SE	EQ	BL	IC	CT	CY	
Strength I (unless noted)	γ_p	1.75	1.00	—	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—	—
Strength II	γ_p	1.35	1.00	—	—	1.00	0.50/1.20	γ_{TG}	γ_{SE}	—	—	—	—	—	—
Strength III	γ_p	—	1.00	1.4	0	—	—	—	—	—	—	—	—	—	—
Strength IV	γ_p	—	1.00	—	—	1.00	0.50/1.20	—	—	—	—	—	—	—	—
Strength V	γ_p	1.35	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 3.4.1-1—Load Combinations and Load Factors

Load Combination Limit State	DC DD DW EH EV ES EL PS CR SH	LL IM CE BR PL LS	Use One of These at a Time												
			WA	WS	WL	FR	TU	TG	SE	EQ	BL	IC	CT	CY	
Extreme Event I	γ_p	γ_{EQ}	—	—	—	—	—	—	—	—	—	—	—	—	—
Extreme Event II	γ_p	0.50	—	—	—	—	—	—	—	—	—	—	—	—	—
Service I	1.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—
Service II	1.00	1.30	—	—	—	—	—	—	—	—	—	—	—	—	—
Service III	1.00	0.80	—	—	—	—	—	—	—	—	—	—	—	—	—
Service IV	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fatigue I—LL, IM & CE only	—	1.50	—	—	—	—	—	—	—	—	—	—	—	—	—
Fatigue II—LL, IM & CE only	—	0.75	—	—	—	—	—	—	—	—	—	—	—	—	—

Changes of Load Factors

Load Combinations

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

Load Combination List

No	Name	Active	Type	Description
1	scLCB1	Strengt	Add	Strength-I:1.75M[1].0.5
2	scLCB2	Strengt	Add	Strength-I:1.75M[1].0.5
3	scLCB3	Strengt	Add	Strength-I:1.75M[2].0.5
4	scLCB4	Strengt	Add	Strength-I:1.75M[2].0.5
5	scLCB5	Strengt	Add	Strength-II:1.35M[1].0.5
6	scLCB6	Strengt	Add	Strength-II:1.35M[1].0.5
7	scLCB7	Strengt	Add	Strength-II:1.35M[2].0.5
8	scLCB8	Strengt	Add	Strength-II:1.35M[2].0.5
9	scLCB9	Strengt	Add	Strength-III:1.0W[1].0.5
10	scLCB1	Strengt	Add	Strength-III:1.0W[1].0.5
11	scLCB1	Strengt	Add	Strength-III:-1.0W[1].0.5
12	scLCB1	Strengt	Add	Strength-III:-1.0W[1].0.5
13	scLCB1	Strengt	Add	Strength-III:1.0W[2].0.5
14	scLCB1	Strengt	Add	Strength-III:1.0W[2].0.5
15	scLCB1	Strengt	Add	Strength-III:-1.0W[2].0.5
16	scLCB1	Strengt	Add	Strength-III:-1.0W[2].0.5
17	scLCB1	Strengt	Add	Strength-III:1.0W[3].0.5
18	scLCB1	Strengt	Add	Strength-III:1.0W[3].0.5
19	scLCB1	Strengt	Add	Strength-III:-1.0W[3].0.5
20	scLCB2	Strengt	Add	Strength-III:-1.0W[3].0.5
21	scLCB2	Strengt	Add	Strength-III:1.0W[4].0.5
22	scLCB2	Strengt	Add	Strength-III:1.0W[4].0.5

Load Cases and Factors

LoadCase	Factor
Strength(MV)	1.7500
Temperature Fall(ST)	0.5000
Dead Load(CS)	1.2500
DC(CS)	1.2500

Automatic Generation of Load Combinations

Option

Add Replace

Code Selection

Steel Concrete SRC Steel Composite

Design Code : AASHTO-LRFD17

Manipulation of Construction Stage Load Case

ST Only CS Only ST+CS

ST : Static Load Case CS : Construction Stage

Load Modifier :

Load Factors for Permanent Loads (Yp)

Seismic Load Combination

Load Factor for Settlement :

Structural Plate Box Structures(Metal Box Culverts)

Live Load Factor for Service III :

Condition for Temperature

Deformation Check All Other Effects

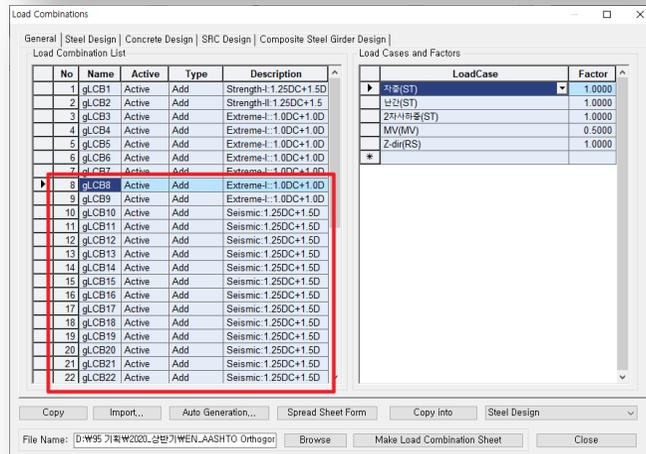
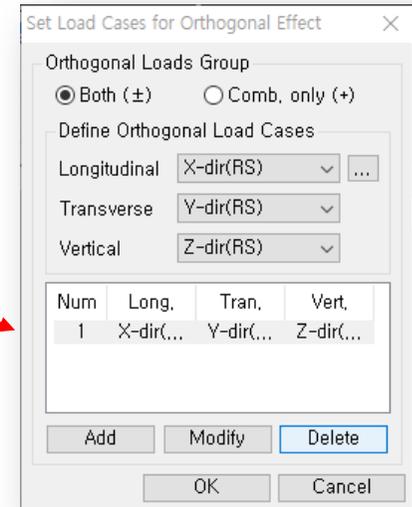
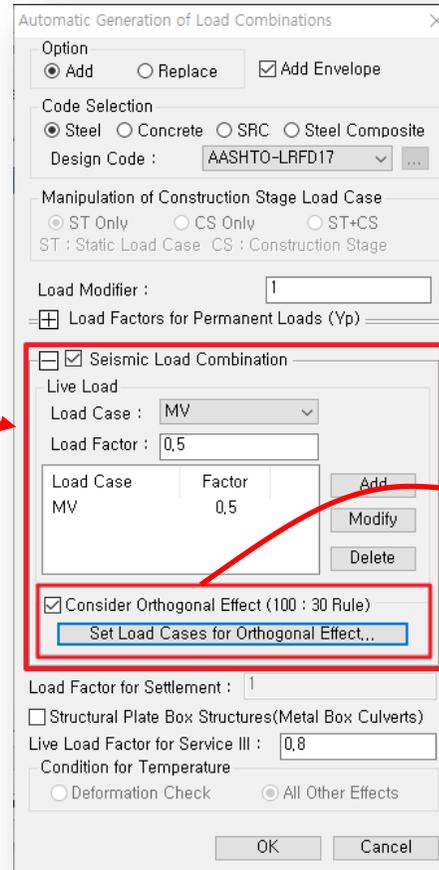
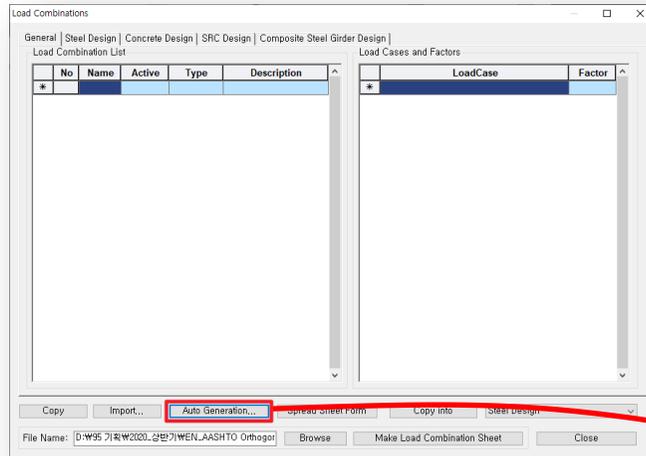
OK Cancel

Automatic Generation of Load Combination

17. Orthogonal effect of Seismic Load: AASHTO LRFD

- Orthogonal effect of seismic loads can be included in the auto-generation of load combination to AASHTO-LRFD 16 & 17.

Results > Load Combination > Auto Generation...



Automatic Generation of Load combination

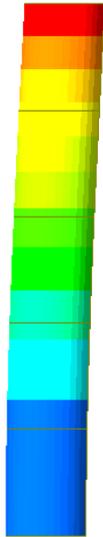
Define Seismic Load Combination

Define Orthogonal RS Loads

18. RC Design as per IRS specifications

- Reinforced Concrete Design as per IRS is now available. RC Beam Design, Beam Checking, Column Design and Column Checking can now be performed for IRS.
- The Graphic/Detailed reports which include both Ultimate Limit State and Serviceability Limit State checks as per IRS Specifications can be generated.

Design > RC Design > IRS



No: 160

1. Design Information

Member Number : 160
 Design Code : IRS
 Unit System : kN, m
 Material Data : fck = 30000, fy = 500000, fyw = 500000 KPa
 Beam Span : 0.472727 m
 Section Property : mid (No: 1)

2. Section Diagram

No: 187

1. Design Condition

Design Code : IRS
 Unit System : kN, m
 Member Number : 187
 Material Data : fck = 30000, fy = 500000, fyw = 500000 KPa
 Column Height : 4.75 m
 Section Property : PIER (No: 12)
 Rebar Pattern : Total Rebar Area Ast = 0.0113097 m² (RhoSt = 0.0100)

2. Applied Loads

Load Combination 36+ AT (J) Point
 N_{Ed} = 2035.00 kN, M_{Edy} = 246.587, M_{Edz} = 1862.67, M_{Ed} = 1878.92 kN-m

3. Axial Forces and Moments Capacity Check

Concentric Max. Axial Load N_{Rdmax} = 39244.8 kN
 Axial Load Ratio N_{Ed}/N_{Rd} = 2035.00 / 4765.59 = 0.427 < 1.000OK
 M_{Edy}/M_{Rdy} = 246.587 / 578.278 = 0.426 < 1.000OK
 Moment Ratio M_{Edz}/M_{Rdz} = 1862.67 / 4361.91 = 0.427 < 1.000OK
 M_{Ed}/M_{Rd} = 1878.92 / 4400.07 = 0.427 < 1.000OK

4. P-M Interaction Diagram

N(kN)	M _{Rd} (kN-m)	N _{Rd} (kN)	M _{Rd} (kN-m)
39244.78	0.00	39244.78	0.00
35689.30	1608.83	35689.30	1608.83
30608.49	3591.27	30608.49	3591.27
25788.21	4874.66	25788.21	4874.66
21810.48	5579.97	21810.48	5579.97
18652.82	5931.38	18652.82	5931.38
16185.09	6013.27	16185.09	6013.27
13940.09	5952.35	13940.09	5952.35
11488.38	5744.15	11488.38	5744.15
8463.42	5280.91	8463.42	5280.91

MIDAS/Text Editor - [RCCT girder IRS RC design.rcs]

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.MIDAS/Civil - RC-BEAM Analysis/Design Program.
*.PROJECT :
*.DESIGN CODE : IRS, *.UNIT SYSTEM : kN, m
*.MEMBER : Member Type = BEAM, MEMB = 160

*.DESCRIPTION OF BEAM DATA (ISEC = 1) : mid
Section Type : Tee-Section (TEE)
Beam Length (Span) = 0.473 m.
Section Depth (Hc) = 1.450 m.
Section Width (Bc) = 0.300 m.
Width of Flange (bf) = 2.800 m.
Depth of Flange (hf) = 0.250 m.
    
```

MIDAS/Text Editor - [RCCT girder IRS RC design.rcs]

```

.MIDAS/Civil - RC-COLUMN Design [ IRS ]
*.MIDAS/Civil - RC-COLUMN Analysis/Design Program.
*.PROJECT :
*.DESIGN CODE : IRS, *.UNIT SYSTEM : kN, m
*.MEMBER : Member Type = COLUMN, MEMB = 187, LCB = 36+, POS = J

*.DESCRIPTION OF COLUMN DATA (ISEC = 12) : PIER
Column Height (L) = 4.750 m.

Section Type : SOLID ROUND (SR)
Section Diameter (D) = 1.200 m.
Concrete Strength (fck) = 30000.000 KPa.
Main Rebar Strength (fy) = 500000.000 KPa.
Ties/Spirals Strength (fyw) = 500000.000 KPa.
Modulus of Elasticity (Es) = 200000000.000 KPa.

*.REINFORCEMENT PATTERN :
Concrete Cover to C.O.R. (do) = 0.065 m.
Total Rebar Area = 0.01131 m^2.

*.Ties : Failure
    
```

[[[*]]] CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.

() . Factored forces/moments caused by unit load case. Unit : kN, m.
 *.Load combination ID = 36+

Load Case	N _{Ed_max}	Myi	Myj	Mzi	Mzj
DL	2070.96	-1.03	-5.29	0.00	0.00
LL	-6.43	0.00	0.00	1120.50	1109.33
DL+LL	2064.53	-1.03	-5.29	1120.50	1109.33
Others	-29.52	48.47	251.88	304.79	753.34
DL+LL+Others	2035.00	47.44	246.59	1425.29	1862.67

() . Check slenderness ratios of BRACED/UNBRACED frame.
 -. End Moments (My1) = 1.03 kN-m.

Concrete Design Code

Design Code : IRS

Apply Special Provisions for Seismic Design

Moment Redistribution Factor for Beam : 1

Torsion Design

OK Close

Code option for IRS RC Design

Graphic report for Beam and Column design

Detailed report for Beam and Column Design

19. Polish Design Report

- Poland Design Report applied in PSC Box&Composite, Steel Composite in Eurocode

▪ PSC Box&Composite > Design > Report

Select Print Language

Select the language for print.

Language : English

English
Czech
Polish

OK

Numer elementu	1075
Position Information	I

1.Przypadek wymiarowania

1.1 Parametry wymiarowania

- Współczynniki częściowe dla SGU (EN 1992-1-1:2004, 2.4.2.4)

Przypadki wymiarowania	γ_c dla betonu	γ_s dla stali zbrojeniowej	γ_s dla stali sprężającej
Staly i zmienny	1.500	1.150	1.150
Wyjątkowy	1.200	1.000	1.000

- Współczynnik α_{cc} , α_{ct} : współczynnik długoterminowych wpływów na wytrzymałość na ściskanie i zginanie.

α_{cc} = 0.850 (dla wytrzymałości na ściskanie)

α_{ct} = 1.000 (dla wytrzymałości na rozciąganie)

1.2 Informacje o przekroju

Informacje o przekroju	Przechr. zast.(ciąg., zbroj.) (Dźwigar)	Przechr. zas (Po ścisł.) (Dźwigar + Płyta)
A (mm ²)	515465.603	952336.200
I_y (mm ⁴)	137162101892.318	224570272776.134
y_{st} (mm)	-	512.636
y_{sp} (mm)	-	212.636
y_1 (mm)	543.286	212.636
y_2 (mm)	806.714	1137.364
Z_{st} (mm ³)	-	438069976.161
Z_{sp} (mm ³)	-	1056127262.797
Z_1 (mm ³)	46047196.375	1056127262.797
Z_2 (mm ³)	189305140.655	197447956.212

1.3 Dane materiałowe

▪ Dźwigar (EN 1992-1-1:2004, Table 3.1)

- Informacje o betonie

PSC Design Report

▪ Steel Composite > Design > Report

Select Print Language

Select the language for print.

Language : English

English
Czech
Polish

OK

Numer elementu	2
Położenie elementu	I

1 Przypadek wymiarowania

1.1 Parametry do wymiarowania

▪ Współczynniki częściowe

γ_c dla betonu	0.60	γ_s dla sworzni z łbem	1.10
γ_s dla stali zbrojeniowej	0.70	γ_{Ft} dla równow. zakresu zmienności naprężeń o st	0.90
γ_{M2} dla stali konstrukcyjnej	0.80	γ_{M2} dla wytrzymałości zmęczeniowej	0.80
γ_{M1} dla stali konstrukcyjnej	0.90	γ_{M1} dla wytrzymałości zmęczeniowej przy ścianiu	0.70

1.2 Dane materiałowe

▪ Stal konstrukcyjna

f_{sk} = 440.000 MPa E_s = 210000.000 MPa

▪ Beton

f_{ck} = 40.000 MPa E_{cm} = 35000.000 MPa

▪ Zbrojenie

f_{yk} = 400.000 MPa E_r = 210000.000 MPa

1.3 Informacje o przekroju

Steel Composite Design Report