

# Release Note

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Release Date : May 2020

Product Ver. : Civil 2020 (v3.1)

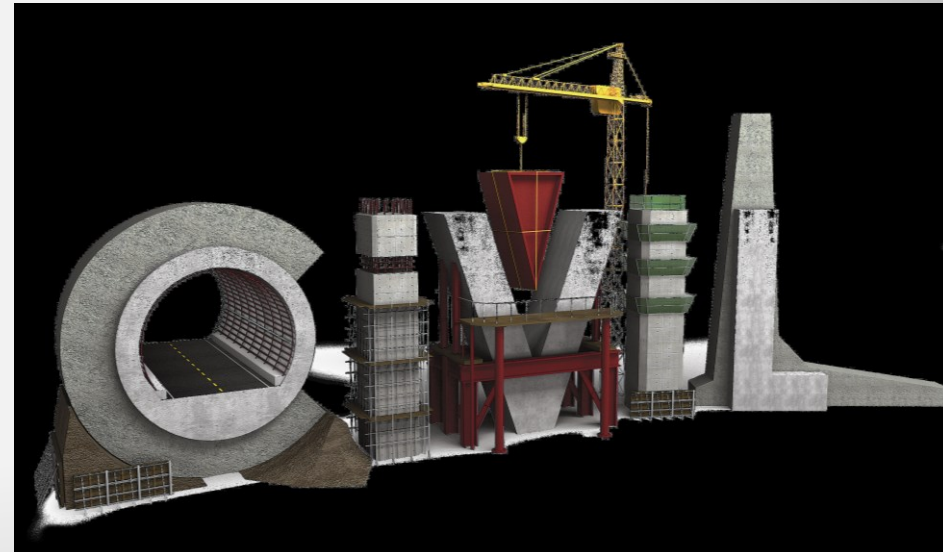


DESIGN OF CIVIL STRUCTURES

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
10. Horizontal Traffic Loads to AS 5100.2
11. Rating Vehicles to CS 454
12. Prestressed Girder Design to BS 5400
13. Improvement of Bridge Assessment to CS 454
14. AASHTO LRFD 8<sup>th</sup> Design Standard – PSC/Composite Section, RC Section
15. AASHTO LRFD 8<sup>th</sup> Design Standard – Steel Composite Section
16. AASHTO LRFD 8<sup>th</sup> Load Combination – Auto Generation
17. Orthogonal effect of Seismic Load: AASHTO LRFD
18. RC Design as per IRS specifications
19. Polish Design Report



### 1. Batch Edit of Tendon Profile

- Batch editing is possible for the multiple tendon profiles at the same time.
- Tendon Name, Tendon Property, Number of Typical Tendons, Tendon Group

▪ **Load > Temp./Prestress > Tendon Profile > Change Tendon Profile**

**Change Tendon Profile** [X]

Parameter Type

Tendon Name  
 Tendon Property  
 Tendon Property (Group)  
 Typical Tendon  
 Tendon Group

Mode

Profiles

- strand\_009
- strand\_010
- strand\_011
- strand\_012
- strand\_013
- strand\_014
- strand\_015
- strand\_016
- strand\_017
- strand\_018
- strand\_019
- strand\_020
- strand\_021
- strand\_022
- strand\_023
- strand\_024
- strand\_025
- strand\_026
- strand\_027

Selected Profiles

- strand\_001
- strand\_002
- strand\_003
- strand\_004
- strand\_005
- strand\_006
- strand\_007
- strand\_008

>>
<<

Name:

Suffix:   
 ( Example 1 3 5 6 7 to 20 by 2 )

Tree Menu 2

Tables Works Group Report

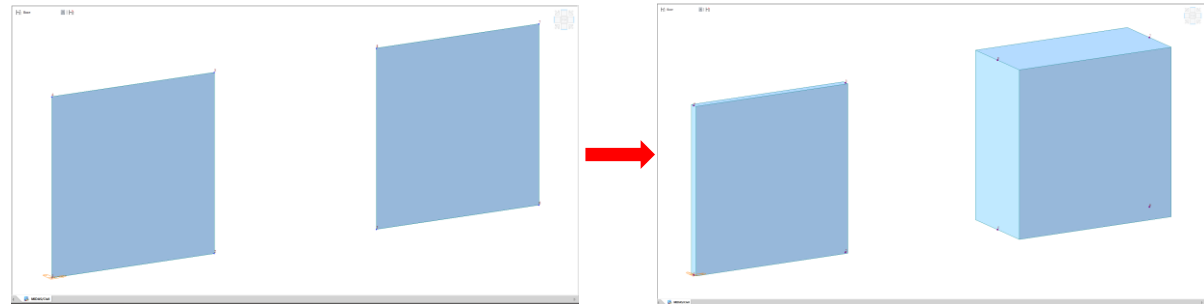
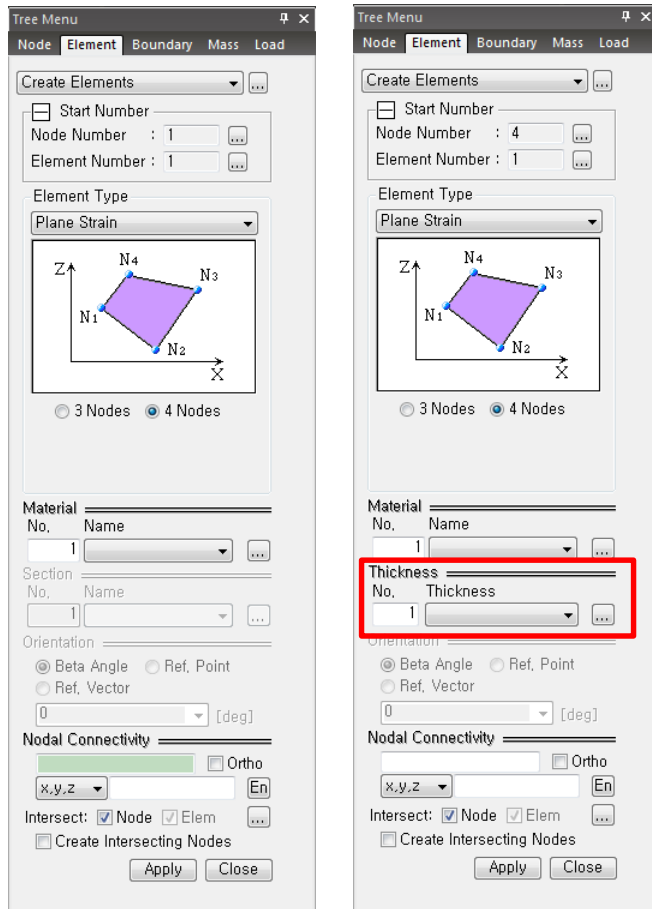
- Works
  - Structures
    - Nodes : 2
    - Elements : 1
    - Beam : 1
  - Properties
    - Material : 1
    - 1 : Tendon
    - Section : 1
    - 1 : VH150
  - Prestressing Tendon
    - Tendon Property : 1
      - Tendon [ Type=Internal ; Mat=1 ; Load=Post-tension ]
        - Tendon Profile : 80
          - Tendon\_001 [ Property=Tendon ; N=1 ; Group=Default ]
          - Tendon\_002 [ Property=Tendon ; N=1 ; Group=Default ]
          - Tendon\_003 [ Property=Tendon ; N=1 ; Group=Default ]
          - Tendon\_004 [ Property=Tendon ; N=1 ; Group=Default ]
          - Tendon\_005 [ Property=Tendon ; N=1 ; Group=Default ]
          - Tendon\_006 [ Property=Tendon ; N=1 ; Group=Default ]
          - Tendon\_007 [ Property=Tendon ; N=1 ; Group=Default ]
          - Tendon\_008 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_009 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_010 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_011 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_012 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_013 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_014 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_015 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_016 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_017 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_018 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_019 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_020 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_021 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_022 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_023 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_024 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_025 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_026 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_027 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_028 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_029 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_030 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_031 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_032 [ Property=Tendon ; N=1 ; Group=Default ]
        - strand\_033 [ Property=Tendon ; N=1 ; Group=Default ]

Change Tendon Profile

## 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/AV		Unit Weight (kN/m <sup>3</sup> )	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/AV		Unit Weight (kN/m <sup>3</sup> )	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

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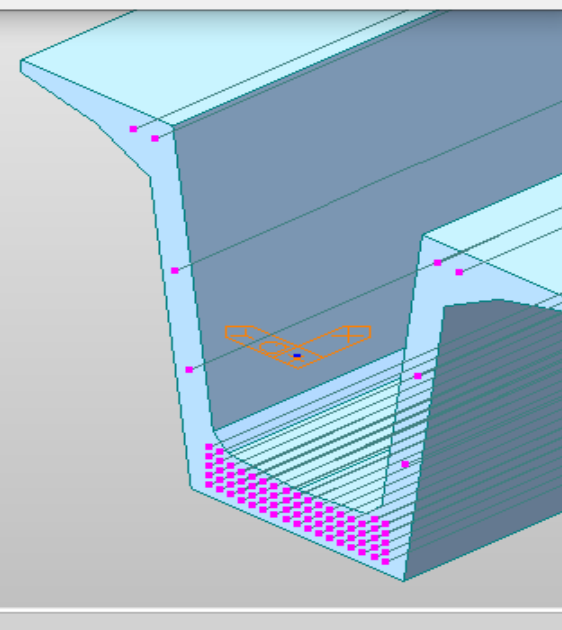
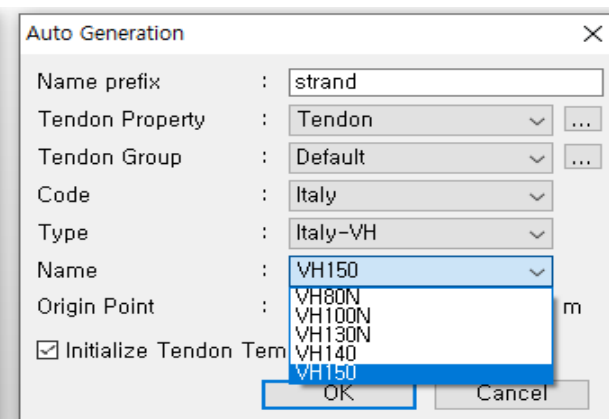
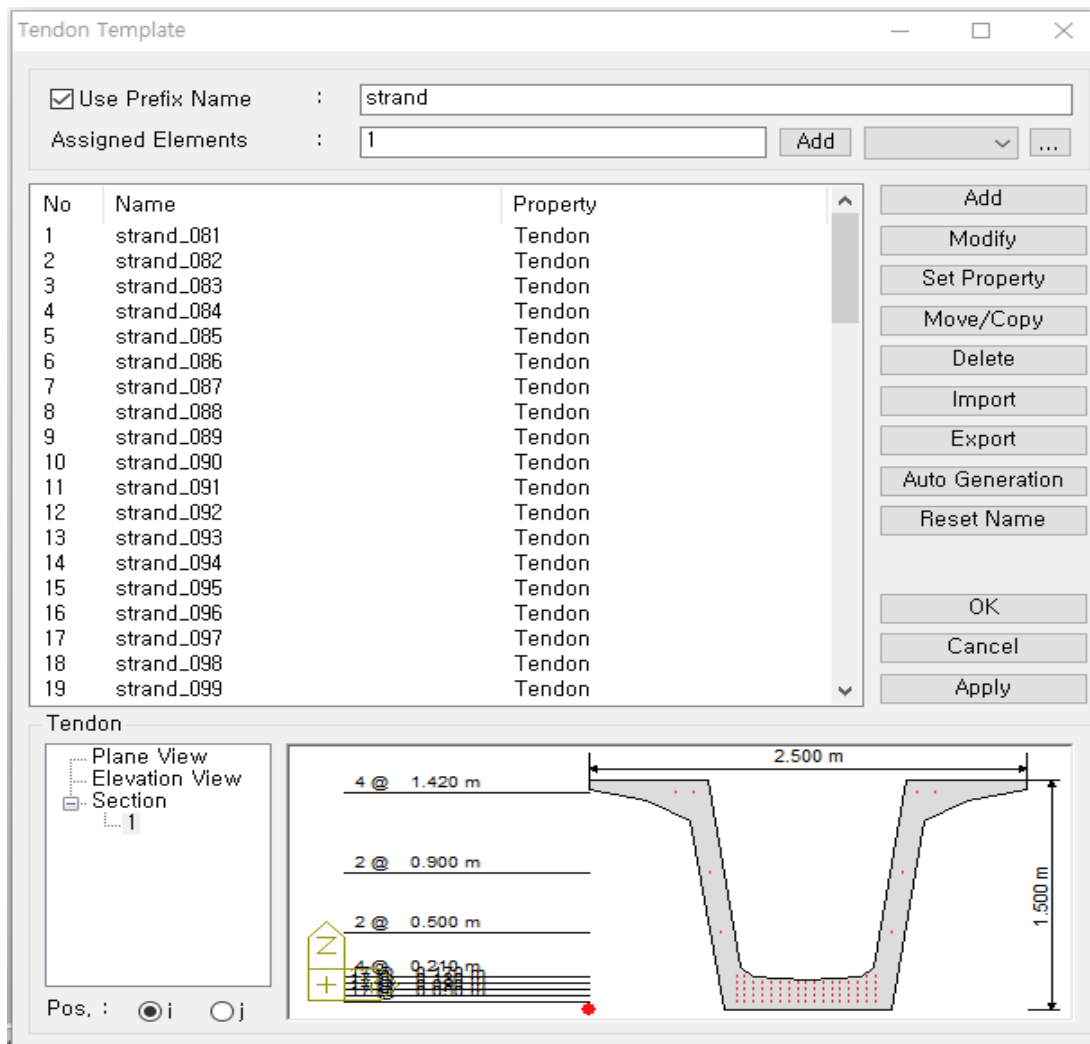
Previous Version

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



### 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	Add	Modify	Delete
<							>

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

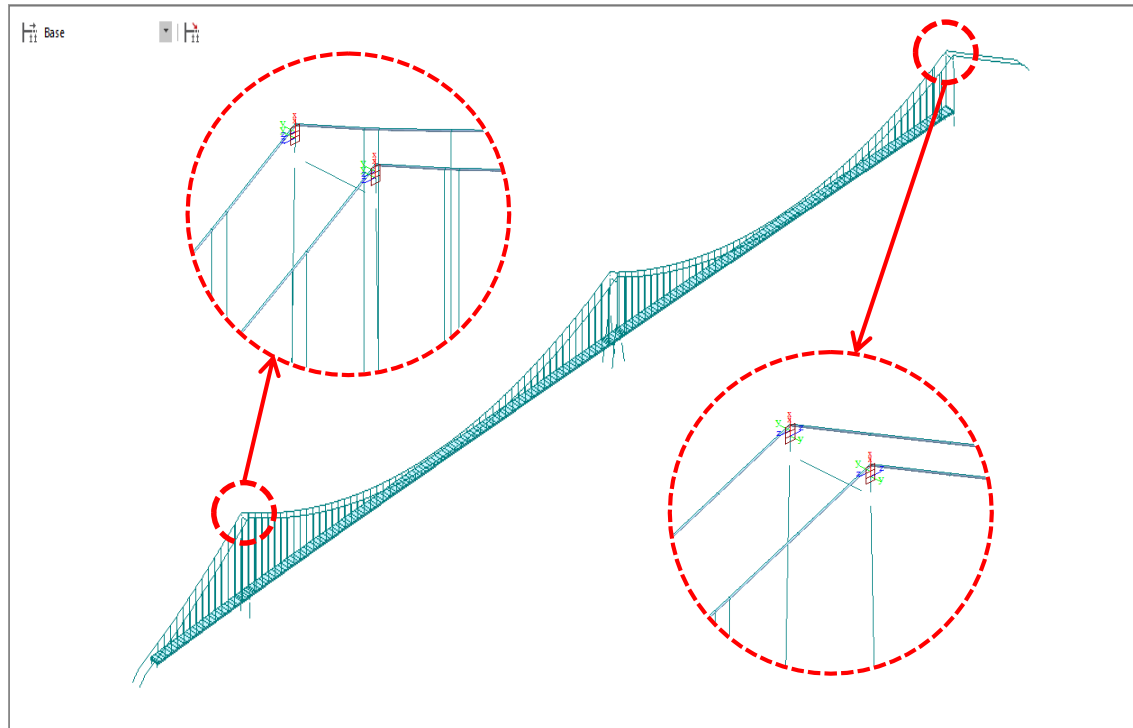
Options:  Add  Replace  Delete

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 ]
      - 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 ; Set-back]
    - 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**

**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(ma)	J[23]	7.47	0.00	2.89	0.00	0.00	
41	MSE(ma)	J[24]	7.47	0.00	2.89	0.00	9.92	
42	MSE(ma)	J[24]	2173.37	0.00	310.20	0.00	9233.57	
42	MSE(ma)	J[25]	2173.37	0.00	310.20	0.00	8599.10	
43	MSE(ma)	J[25]	2223.34	0.00	278.02	0.00	8599.10	
43	MSE(ma)	J[26]	2223.34	0.00	278.02	0.00	6128.84	
44	MSE(ma)	J[26]	2140.57	0.00	253.99	0.00	6128.84	
44	MSE(ma)	J[27]	2140.57	0.00	253.99	0.00	4418.04	
45	MSE(ma)	J[27]	1996.63	0.00	210.71	0.00	4418.04	
45	MSE(ma)	J[28]	1996.63	0.00	210.71	0.00	2750.17	
46	MSE(ma)	J[28]	1841.19	0.00	170.51	0.00	2750.17	
46	MSE(ma)	J[29]	1841.19	0.00	170.51	0.00	1411.97	
47	MSE(ma)	J[29]	1703.47	0.00	127.41	0.00	1411.97	
47	MSE(ma)	J[30]						
48	MSE(ma)	J[30]						
48	MSE(ma)	J[31]						
49	MSE(ma)	J[31]						
49	MSE(ma)	J[32]						
50	MSE(ma)	J[32]						
50	MSE(ma)	J[33]						
50	MSE(ma)	J[33]						
51	MSE(ma)	J[33]						
51	MSE(ma)	J[34]						
51	MSE(ma)	J[34]						
52	MSE(ma)	J[34]						
52	MSE(ma)	J[34]						
52	MSE(ma)	J[36]						
53	MSE(ma)	J[36]						
53	MSE(ma)	J[36]						
53	MSE(ma)	J[37]						
53	MSE(ma)	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



## 7. Rail traffic loads to AS 5100.2

- 300 LA, 150 LA, User-defined rail traffic loads
- Different dynamic load allowances for bending moment and all other effects

### ▪ Load > Moving Load > Moving Load Code > Australia

Define Standard Vehicular Load

Standard Name: AS 5100.2 - Rail Traffic Load

Vehicular Load Properties

Vehicular Load Name: 300LA

Vehicular Load Type: 300LA

Dynamic Load Allowance: 0 Bending Moment, 0 All Other Effects

No	Load(kN)	Spacing(m)
1	360	2
2	300	1.7
3	300	1.1
4	300	1.7
5	300	end

Distance Between Group

Dmin = 12m

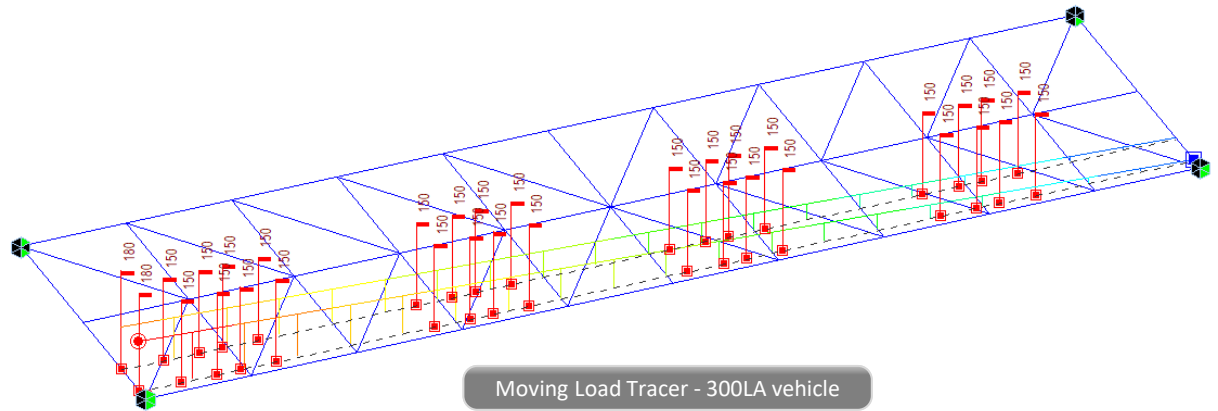
Dmax = 20m

Increment of Dist(Dinc)

1 m

D = Dmin+Dinc, Dmin+2Dinc, Dmin+3Dinc, ... Dmax

OK Cancel Apply



Moving Load Tracer - 300LA vehicle

300LA Train

### 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

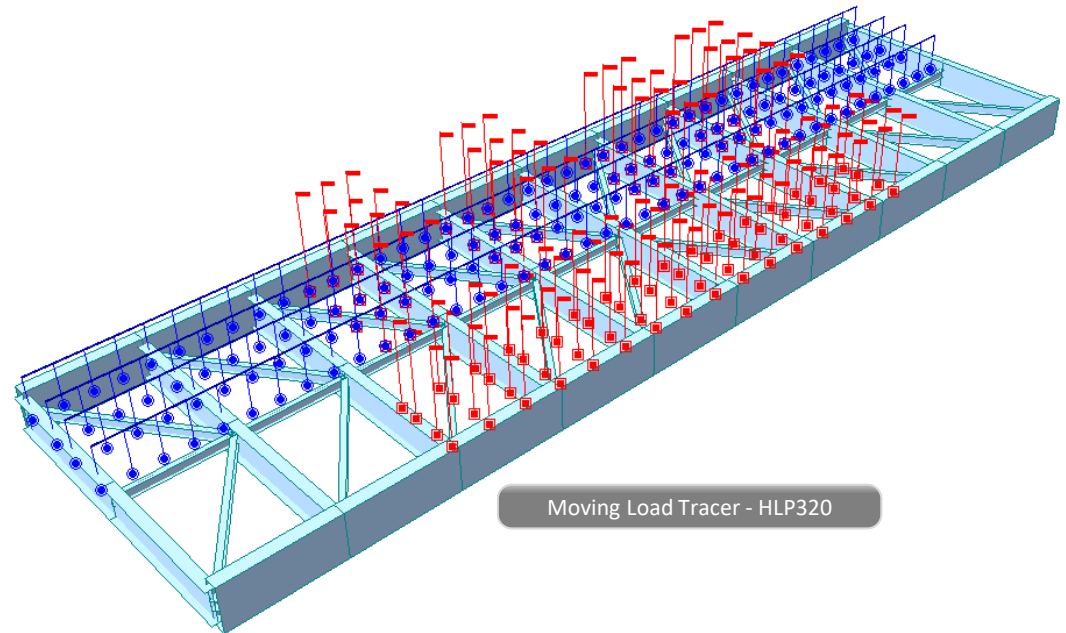
Standard Name  
AS 5100.2 - Heavy Load Platform

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



Moving Load Tracer - HLP320

## 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

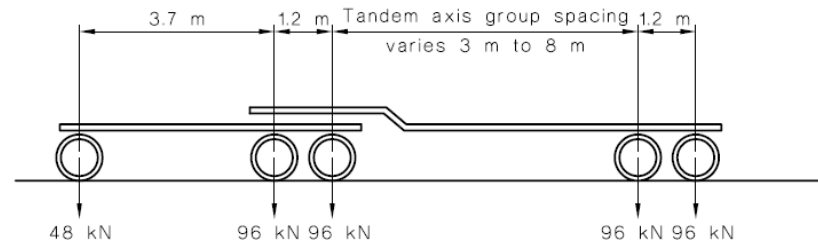
Dynamic Load Allowance : 0

P1 P2 P3 P4 P5

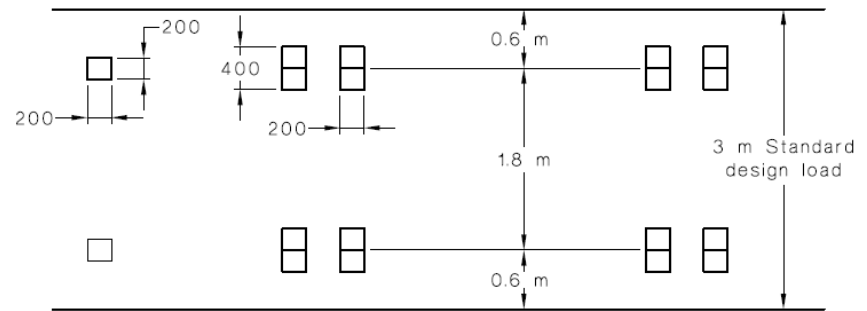
D1 D2 D3-D4 D5

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



**ELEVATION VIEW**



**PLAN VIEW**

FIGURE A1 T44 TRUCK LOAD

## 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

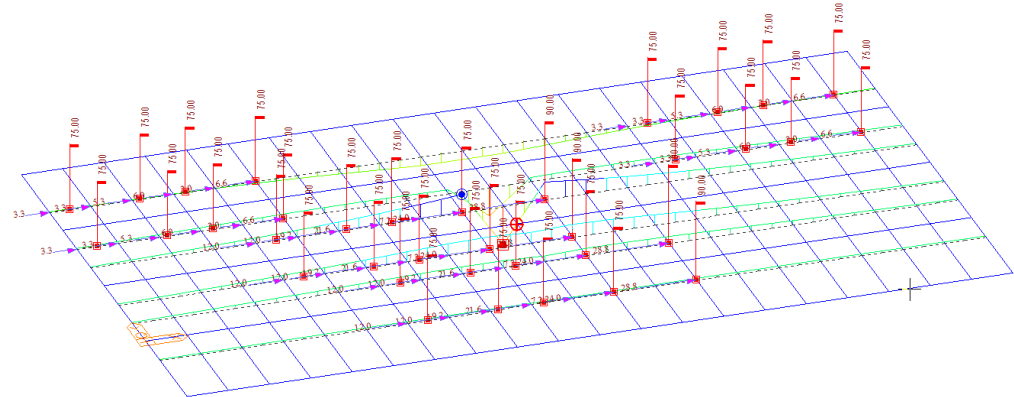
Total Length of the Bridge (Rail Traffic)  m

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

$A$  = axle load, in kilonewtons (b)

$r$  = radius of curve, in metres

$g$  = acceleration due to gravit;

The specified centrifugal force shall n

Centrifugal and nosing forces due to r

(b) Traction forces:

$$\text{TF} = 200 + 25L_{LF} \qquad \text{for} \qquad L_{LF} \leq 25 \text{ m} \qquad \dots 9.7.2.2(2)$$

$$825 + 15(L_{LF} - 25) \qquad \text{for} \qquad 25 \text{ m} < L_{LF} \leq 50 \text{ m} \qquad \dots 9.7.2.2(3)$$

$$1200 + 7.5(L_{LF} - 50) \qquad \text{for} \qquad 50 \text{ m} < L_{LF} \leq 250 \text{ m} \qquad \dots 9.7.2.2(4)$$

$$2700 + 5.0(L_{LF} - 250) \qquad \text{for} \qquad 250 \text{ m} < L_{LF} \qquad \dots 9.7.2.2(5)$$

where

TF = longitudinal traction force, in kilonewtons

$L_{LF}$  = total length of the bridge, in metres

## 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

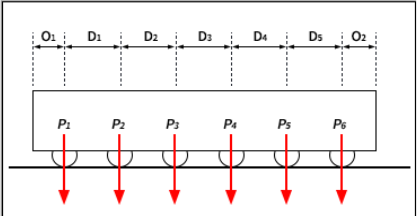
Standard Name: CS 454 Assessment

Vehicular Load Properties

Vehicular Load Name: A-4AXLE

Vehicular Load Type: ALL MODEL 1

Sub Type: A-4AXLE



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

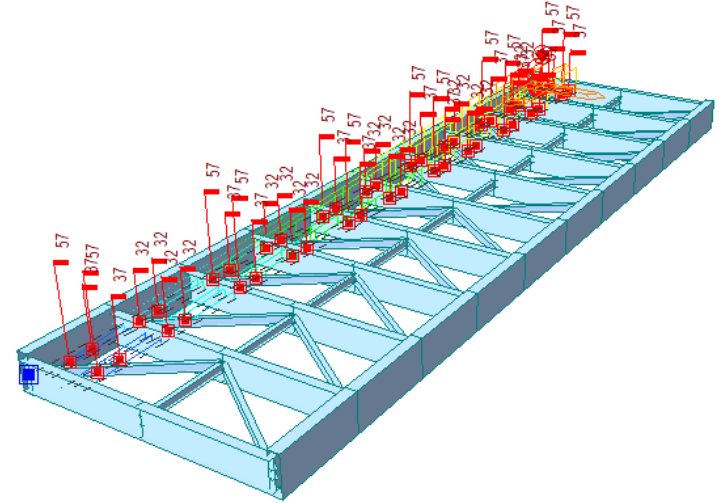
Road Surface:  Good  Poor

Traffic Flow Category:  High  Medium  Low

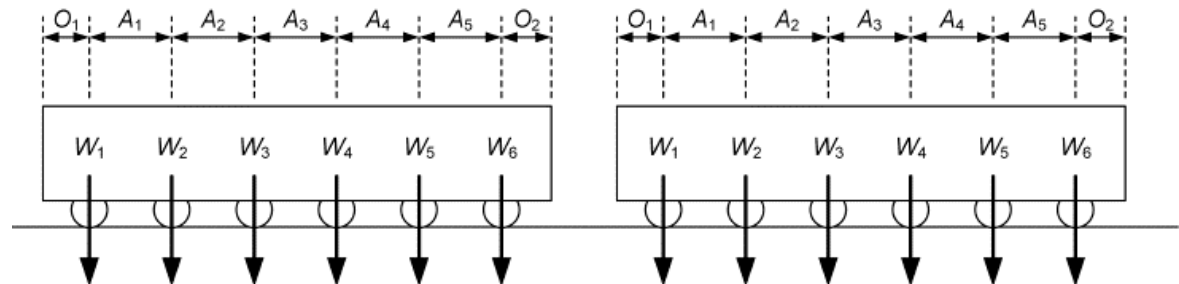
OK Cancel Apply

300LA Train

- 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

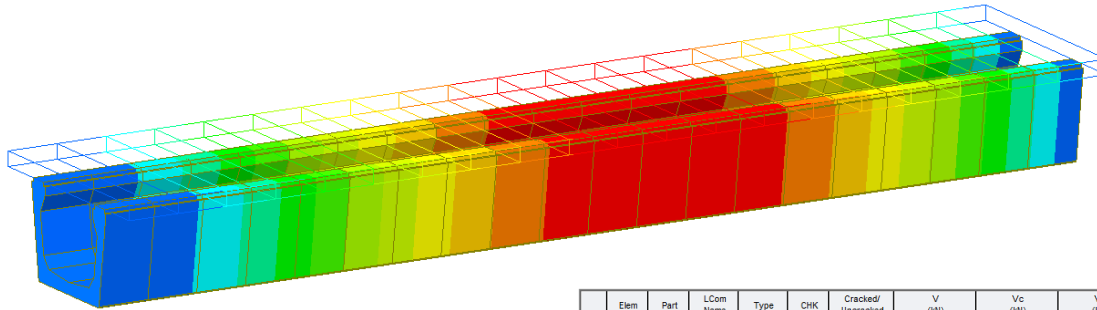


ALL Model 1 Convoy

## 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    Modify Design Parameters...

**Principal Stress Limitation**

Serviceability Limit States

Comp. 20 N/mm<sup>2</sup>    Tens. 1 N/mm<sup>2</sup>

Construction Stage

Comp. 20 N/mm<sup>2</sup>    Tens. 1 N/mm<sup>2</sup>

**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

Select All    Unselect All

OK    Cancel

PSC Design Parameter

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	1069.4979
31	J[32]	clCB1	FX-MAX	OK	UnCracked	4300.0696	6718.8185	2089.7983
32	[32]	clCB1	FX-MAX	OK	UnCracked	4307.9589	6718.6466	2089.7048
32	J[33]	clCB1	FX-MAX	OK	UnCracked	4994.0855	7756.5974	3043.3164
33	[33]	clCB1	FX-MAX	OK	UnCracked	5096.0264	7756.3981	3043.1926
33	J[34]	clCB1	FX-MAX	OK	UnCracked	5719.3801	8677.3702	3899.5326
34	[34]	clCB1	FX-MAX	OK	UnCracked	5783.4813	8676.4566	3898.9226
34	J[35]	clCB8	FZ-MAX	OK	UnCracked	6490.1368	6486.1565	2029.9368
35	[35]	clCB8	FZ-MAX	OK	UnCracked	6489.9510	6485.9617	2029.8289
35	J[36]	clCB8	FZ-MAX	OK	UnCracked	7429.1905	4429.1410	291.5115
36	[36]	clCB9	FZ-MIN	OK	UnCracked	-7790.3355	4428.9545	291.4776
36	J[37]	clCB9	FZ-MIN	OK	UnCracked	-6962.3546	5153.2856	963.5172
37	[37]	clCB9	FZ-MIN	OK	UnCracked	-6962.4360	5152.5049	963.1935
37	J[38]	clCB1	FX-MAX	OK	UnCracked	-5996.8881	6486.6041	2181.7369
38	[38]	clCB1	FX-MAX	OK	UnCracked	-6306.8902	8359.3716	3162.8951
38	J[39]	clCB1	FX-MAX	OK	UnCracked	-5283.1850	8926.0487	3678.6665
39	[39]	clCB1	FX-MAX	OK	UnCracked	-5587.7388	8925.3904	3678.2591
39	J[40]	clCB1	FX-MAX	OK	UnCracked	-4564.0558	8883.8478	3652.2015
40	[40]	clCB1	FX-MAX	OK	UnCracked	-4887.5397	7726.5373	2895.2502
40	J[41]	clCB1	FX-MAX	OK	UnCracked	-3865.8775	7147.4793	2354.1593
41	[41]	clCB1	FX-MAX	OK	UnCracked	-4186.7548	7146.7462	2353.7085
41	J[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	J[43]	clCB1	FX-MAX	OK	UnCracked	-1725.7445	4611.5058	59.1826
43	[43]	clCB1	FX-MAX	OK	UnCracked	-1725.7820	4611.4441	59.1790
43	J[44]	clCB1	FX-MAX	OK	UnCracked	-1178.9167	4548.8947	11.5620
44	[44]	clCB1	FX-MAX	OK	UnCracked	-1178.8348	4548.8863	11.5620
44	J[45]	clCB1	FX-MAX	OK	UnCracked	-831.8694	4521.4062	2.0371
45	[45]	clCB1	FX-MAX	OK	UnCracked	-631.8804	4521.3875	2.0371
45	J[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	J[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	J[48]	clCB1	FX-MAX	OK	UnCracked	1008.9965	4652.9981	356.1016
48	[48]	clCB1	FX-MAX	OK	UnCracked	1009.0100	4652.8649	356.0749

PSC Design Result Table

1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
<b>1. Design Condition</b>																																	
2	Design code		Element		Node(I/J)																												
3	BS 5400-4:1990		16		J																												
<b>Section Properties</b>																																	
Section Type																																	
Non-Composite																																	
<b>Gross section</b>																																	
9	H	3000.000 (mm)	A <sub>g</sub>	6.209E+06 (mm <sup>2</sup> )	S <sub>x</sub>	6.505E+09 (mm <sup>3</sup> )																											
10	B	8500.000 (mm)	I <sub>y</sub>	7.867E+12 (mm <sup>4</sup> )	S <sub>y</sub>	4.399E+09 (mm <sup>3</sup> )																											
11	C <sub>cp</sub>	1209.410 (mm)																															
12	C <sub>cm</sub>	1790.590 (mm)																															
<b>Transformed section</b>																																	
14	H	3000.000 (mm)	A <sub>g</sub>	6.439E+06 (mm <sup>2</sup> )	S <sub>x</sub>	6.790E+09 (mm <sup>3</sup> )																											
15	B	8500.000 (mm)	I <sub>y</sub>	8.116E+12 (mm <sup>4</sup> )	S <sub>y</sub>	4.497E+09 (mm <sup>3</sup> )																											
16	C <sub>cp</sub>	1195.243 (mm)																															
17	C <sub>cm</sub>	1804.757 (mm)																															
<b>Partial Safety Factors</b>																																	
<b>Partial Safety Factors for Ultimate Limit State</b>																																	
Characteristic																																	
21	γ <sub>mc</sub> for Concrete		1.5																														
22	γ <sub>ms</sub> for Reinforce/Prestress		1.15																														
<b>Partial Safety Factors for Serviceability Limit State</b>																																	
Type of Stress    γ <sub>mc</sub> for concrete																																	
26	Triangular Compressive		1.25																														
27	Uniform Compressive		1.67																														
28	Pre-tension		1.25																														
29	Post-tension		1.55																														
<b>Material</b>																																	
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

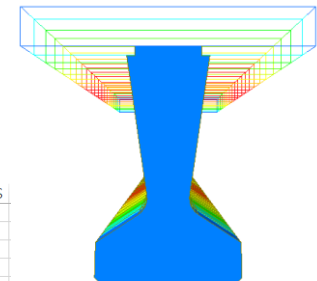
Type C : Pre-tensioned tendons distributed close to the tension faces

Apply    Close

Class Category

Element	Part	Class	Rating Case	Load Effect	sig_c (N/mm <sup>2</sup> )	sig_c_lim (N/mm <sup>2</sup> )	sig_t (N/mm <sup>2</sup> )	sig_t_lim (N/mm <sup>2</sup> )	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_Mzz(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)

$\sigma_{limit}$  : 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 (mm<sup>2</sup>)

$A_{rebar,T}$  : Area of rebar in tensile section = 4909.00 (mm<sup>2</sup>)

$\sigma_{rebar}$  : 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

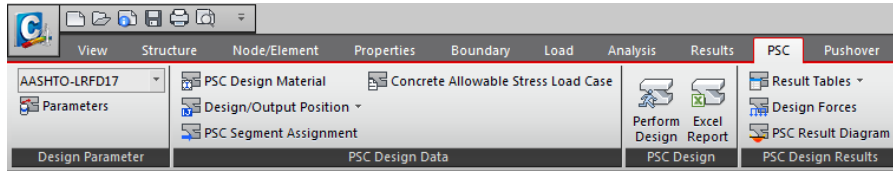
$\sigma_{c,min} \leq \sigma_{t,limit}$  ∴ OK

Serviceability Limit State Check Report

### 14. AASHTO LRFD 8<sup>th</sup> 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 <sub>22</sub>	42.858 (in)
C <sub>21</sub>	75.134 (in)

- Transformed section

H	117.992 (in)
B	492.126 (in)
C <sub>22</sub>	43.709 (in)
C <sub>21</sub>	74.283 (in)

**Materials**

- Concrete

$f'_c$ (ksi)	7.000
--------------	-------

\*  $\beta_1$  : 0.85 if  $f'_c$  is lower t

- Prestressing steel information

No.	Tendon	B	T
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)

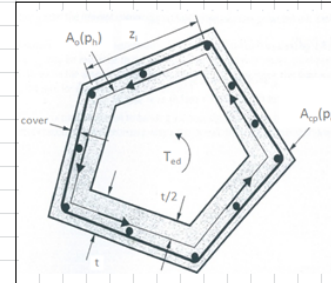
- Factored moment :  $M_u = 1012397.15$  (kips-in)

- 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<sup>2</sup>)

$p_h$  = 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<sup>2</sup>)

$p_c$  = 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.

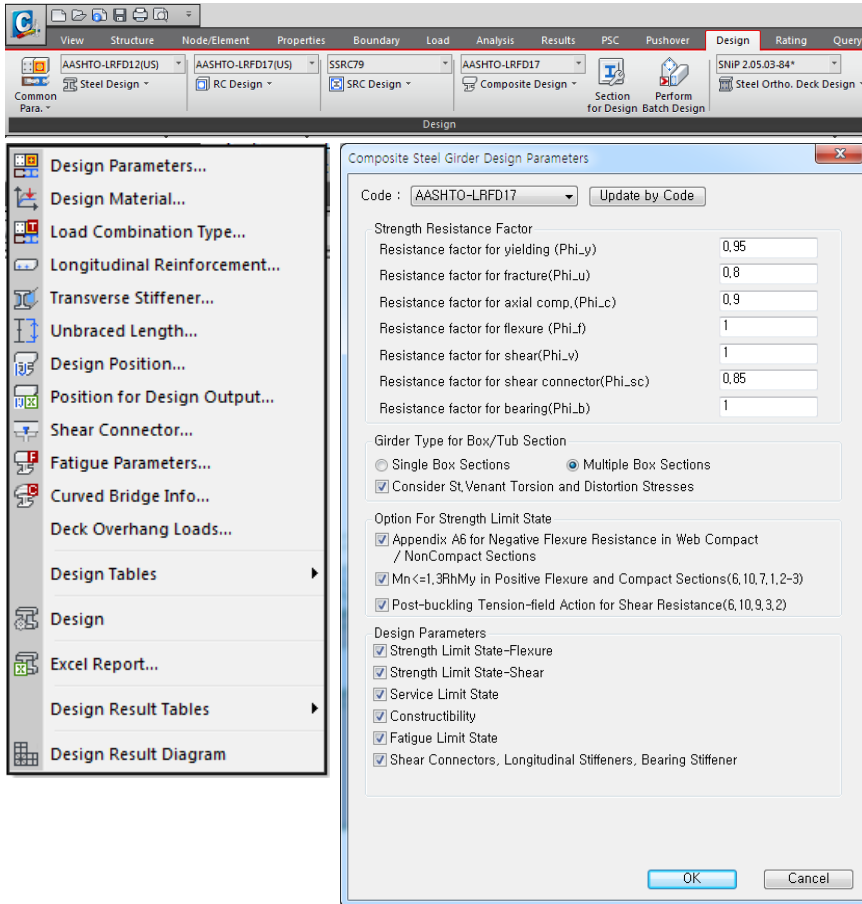
- Check combined torsional and shear (Eq. 5.12.5.3.8c-6)

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

## 15. AASHTO LRFD 8<sup>th</sup> 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

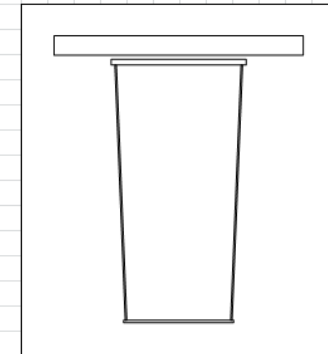
###### 1) Slab Properties

$B_s = 240.000$  in  
 $t_s = 10.000$  in  
 $t_b = 5.000$  in  
 $f'_c = 3.000$  ksi  
 $E_c = 3155.924$  ksi  
 $A_c = 0.000$  in<sup>2</sup>  
 $F_{yr} = 40.000$  ksi

###### 2) Girder Properties

[Section]

$b_{tc} = 130.000$  in     $b_{tt} = 106.000$  in  
 $t_{tc} = 3.000$  in     $t_{tt} = 1.300$  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)	$d_o$ (in)
Web	1Side	35.000	10.000	10.000	2.000	2.000	100.000

Excel Design Report

## 16. AASHTO LRFD 8<sup>th</sup> 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)	$\gamma_p$	1.75	1.00	—	—	1.00	0.50/1.20	$\gamma_{TC}$	$\gamma_{SE}$	—	—	—	—	—	—	
Strength II	$\gamma_p$	1.35	1.00	—	—	1.00	0.50/1.20	$\gamma_{TC}$	$\gamma_{SE}$	—	—	—	—	—	—	
Strength III	$\gamma_p$	—	1.00	1.4	0	—	—	—	—	—	—	—	—	—	—	
Strength IV	$\gamma_p$	—	1.00	—	—	1.00	0.50/1.20	—	—	—	—	—	—	—	—	
Strength V	$\gamma_p$	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	$\gamma_p$	$\gamma_{EQ}$	—	—	—	—	—	—	—	—	—	—	—	—	—	
Extreme Event II	$\gamma_p$	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

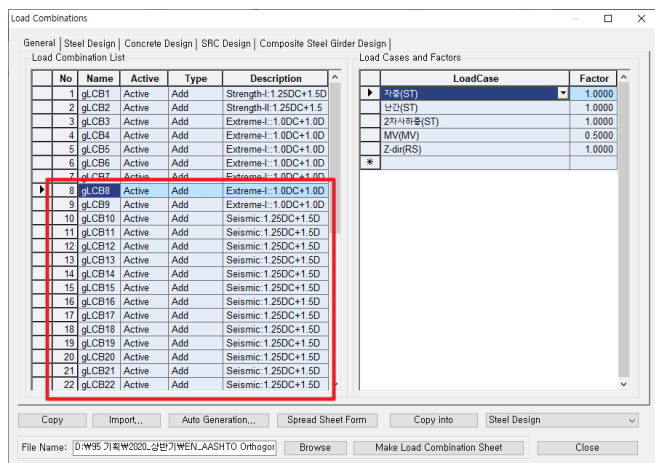
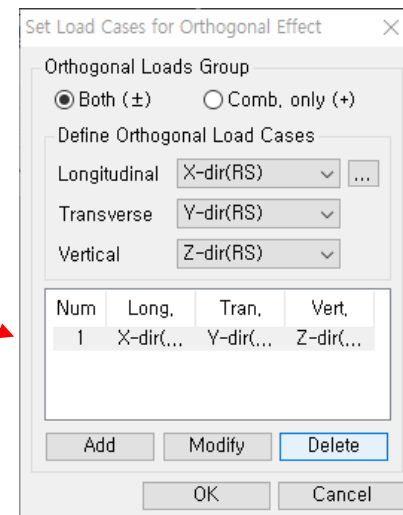
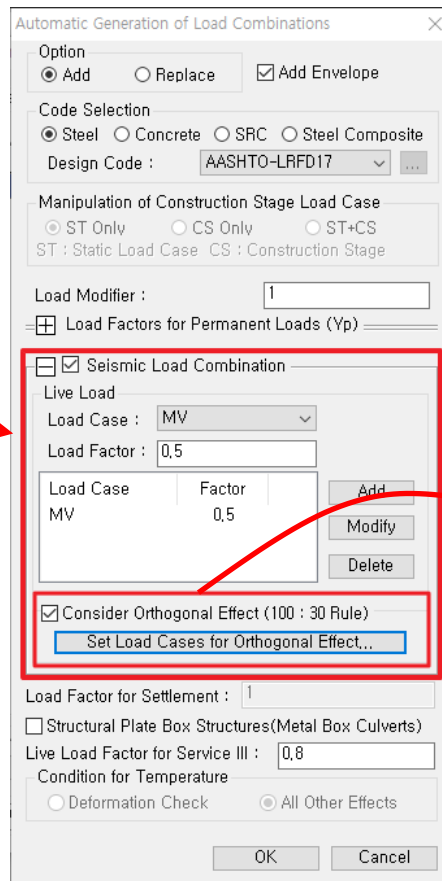
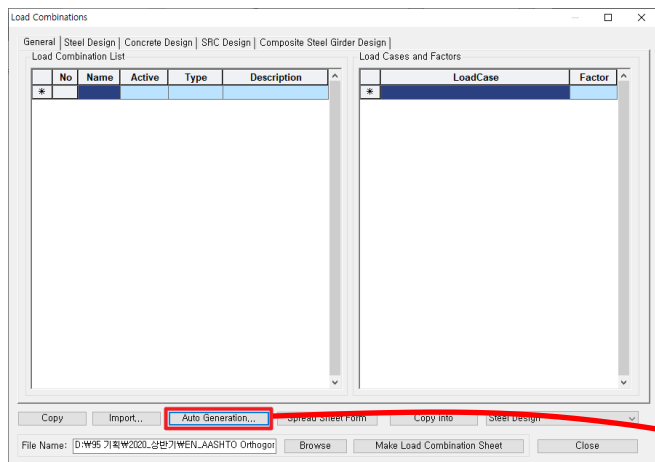
OK Cancel

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

3. Bending Moment Capacity

Negative Moment (M<sub>Ed</sub>)  
 (-) Load Combination No.  
 Factored Strength (M<sub>Rd</sub>)  
 Check Ratio (M<sub>Ed</sub>/M<sub>Rd</sub>)

Positive Moment (M<sub>Ed</sub>)  
 (+) Load Combination No.  
 Factored Strength (M<sub>Rd</sub>)  
 Check Ratio (M<sub>Ed</sub>/M<sub>Rd</sub>)

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 m<sup>2</sup> (RhoSt = 0.0100)

2. Applied Loads

Load Combination 36+ AT (J) Point  
 N<sub>Ed</sub> = 2035.00 kN, M<sub>Edy</sub> = 246.587, M<sub>Edz</sub> = 1862.67, M<sub>Ed</sub> = 1878.92 kN-m

3. Axial Forces and Moments Capacity Check

Concentric Max. Axial Load N<sub>Rdmax</sub> = 39244.8 kN  
 Axial Load Ratio N<sub>Ed</sub>/N<sub>Rd</sub> = 2035.00 / 4765.59 = 0.427 < 1.000 .....OK  
 M<sub>Edy</sub>/M<sub>Rdy</sub> = 246.587 / 578.278 = 0.426 < 1.000 .....OK  
 Moment Ratio M<sub>Edz</sub>/M<sub>Rdz</sub> = 1862.67 / 4361.91 = 0.427 < 1.000 .....OK  
 M<sub>Ed</sub>/M<sub>Rd</sub> = 1878.92 / 4400.07 = 0.427 < 1.000 .....OK

4. P-M Interaction Diagram

N(kN)	M <sub>Rd</sub> (kN-m)	N <sub>Rd</sub> (kN)	M <sub>Rd</sub> (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 - [RCC T girder IRS RC design.rcs]

```

.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 - [RCC T 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 <sub>Ed_max</sub>	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

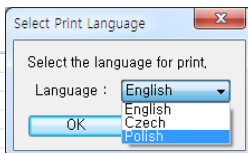


## 19. Polish Design Report

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

### ▪ PSC Box&Composite > Design > Report

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)

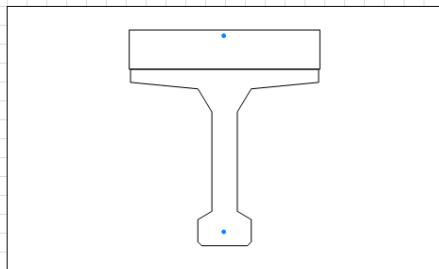
Przypadki wymiarowania	$\gamma_c$ dla betonu	$\gamma_s$ dla stali zbrojeniowej	$\gamma_s$ dla stali sprężającej
Staly i zmienny	1.500	1.150	1.150
Wyjątkowy	1.200	1.000	1.000

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

$\alpha_{cc}$  = 0.850 (dla wytrzymałości na ściskanie)  
 $\alpha_{ct}$  = 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 <sup>2</sup> )	515465.603	952336.200
$I_y$ (mm <sup>4</sup> )	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 <sup>3</sup> )	-	438069976.161
$Z_{sp}$ (mm <sup>3</sup> )	-	1056127262.797
$Z_1$ (mm <sup>3</sup> )	46047196.375	1056127262.797
$Z_2$ (mm <sup>3</sup> )	189305140.655	197447956.212



##### 1.3 Dane materiałowe

###### ▪ Dźwigar

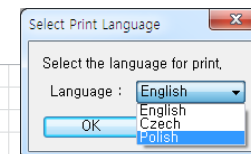
- Informacje o betonie

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

PSC Design Report

### ▪ Steel Composite > Design > Report

Numer elementu	2
Położenie elementu	I



#### 1 Przypadek wymiarowania

##### 1.1 Parametry do wymiarowania

###### ■ Współczynniki częściowe

$\gamma_c$ dla betonu	0.60	$\gamma_v$ dla sworzni z łbem	1.10
$\gamma_s$ dla stali zbrojeniowej	0.70	$\gamma_{F1}$ dla równow. zakresu zmienności naprężeń o st	0.90
$\gamma_{M2}$ dla stali konstrukcyjnej	0.80	$\gamma_{M2}$ dla wytrzymałości zmęczeniowej	0.80
$\gamma_{M1}$ dla stali konstrukcyjnej	0.90	$\gamma_{M1,s}$ dla wytrzymałości zmęczeniowej przy ścianii	0.70

##### 1.2 Dane materiałowe

###### ■ Stal konstrukcyjna

$f_{sk}$  = 440.000 MPa  $E_s$  = 210000.000 MPa

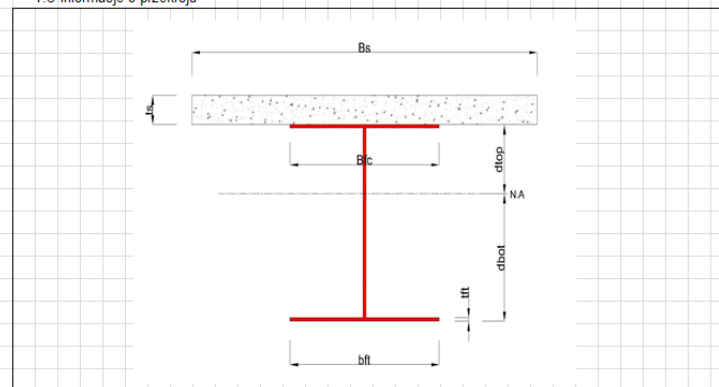
###### ■ Beton

$f_{ck}$  = 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