

Release Note

Release Date : August 2019

Product Ver. : Civil 2020 (v1.1)



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

1. Maximum Number Limit of Erection Load Cases for Construction Stage Analysis
2. Multiple Modulus of Elasticity for Composite Prestressed Girder
3. Improvement in Prestressed Composite Bridge Wizard: Non-continuous Precast Beam
4. Improvement in Prestressed Composite Bridge Wizard: Diaphragm
5. Bilinear Type Spring Stiffness for Surface Spring Support
6. Force/Stress Contouring based on Center Value of Plate Elements
7. Concurrent Reactions of Moving Load Analysis with respect to Node Local Axis
8. Concurrent Forces of Elastic Links and General Links for Moving Load Analysis
9. Analysis Filtering of Elastic Links and General Links in Moving Load Analysis
10. New Inelastic Hinge Type: Parametric P-M (multi-curve)
11. Precast Section DB: AS
12. Response Spectrum Function: AS 5100.2: 2017
13. User-Defined Drying Basic Shrinkage Strain: AS 5100.5-2017
14. Relaxation of Tendons: AS 5100.5-2017
15. User-Defined Stress Limit for Crack Check: AS 5100.5-2017
16. Dynamic Load Allowance for Expansion Joint: AASHTO LRFD
17. Standard Vehicles: Indiana Department of Transportation
18. Standard Vehicles: Colombian CCP-14
19. Auto-Generation of Load Combination: BS 5400
20. Design Report in Czech
21. Response Spectrum Function: Philippines DPWH-BSDS 2013
22. India Material Database Update
23. IRS Load Combination
24. Prestressed Concrete Design by IRS Concrete Bridge Code



1. Maximum Number Limit of Erection Load Cases for Construction Stage Analysis

- Maximum limit in the number of erection load cases is increased from 5 to 10.
- More erection loads can be applied during construction stage and the results can be viewed with different erection load cases and hence different load factors in the load combination.

▪ Analysis > Analysis Control > Construction Stage

Construction Stage Analysis Control Data

Final Stage
 Last Stage Other Stage

Restart Construction Stage Analysis Select Stages for Restart...

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

Cable-Pretension Force Control
 Internal Force External Force Add Replace

Initial Force Control
 Convert Final Stage Member Force to Initial Force
 Truss

Change Cable Element to Equivalent Truss
 Apply Initial Member Force to Cable

Initial Displacement for C.S.
 Initial Tangential Displacement for Cable
 All
 Lack-of-Fit Force Control
 Apply Camber Displacement to Cable

Consider Stress Decrease at Load Transfer
 Linear Interpolation

Beam Section Property Changes
 Constant Linear Interpolation

Frame Output
 Calculate Concurrent Forces of Members
 Calculate Output of Each Part
 Self-Constrained Forces & Moments

Save Output of Current Stage Before Next Stage

Remove Construction Stage Analysis Control Data

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

| No | Load Case Name | Type | Case 1 | |
|----|------------------|------|--------|---------------------------------------|
| 8 | Erection Load 8 | DW | LC8 | <input type="button" value="Add"/> |
| 9 | Erection Load 9 | DW | LC9 | <input type="button" value="Modify"/> |
| 10 | Erection Load 10 | DW | LC10 | <input type="button" value="Delete"/> |

Define Erection Load

Load Case Name:

Load Type for C.S.:

Assignment Load Cases

Load Case:

List of Load Case:

Selected Load Case:

Construction Stage Analysis Control Data

2. Multiple Modulus of Elasticity for Composite Prestressed Girder

- The modular ratio between slab concrete and girder concrete can be defined to determine the creep-transformed section properties of the composite section.
- The tendon and reinforcement are not taken into account to calculate the creep-transformed section properties and hence approximate stresses.

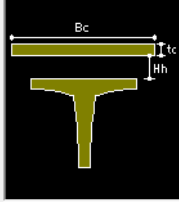
▪ Properties > Section > Composite

Section Data
✕

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

Section ID: Name:

Section Type: Composite-PSC

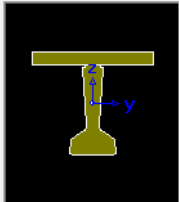


Slab

Bc: mm

tc: mm

Hh: mm



Girder

PSC Value Type:

Material

Select Material from DB ...

Egd/Esb: Dgd/Dsb:

Pgd: Psb:

Tod/Tsb:

Multiple Modulus of Elasticity
 Egd/Esb (Creep):
 Edg/Esb (Shrinkage):

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

Offset: Center-Center

Composite PSC section

Section Properties
✕

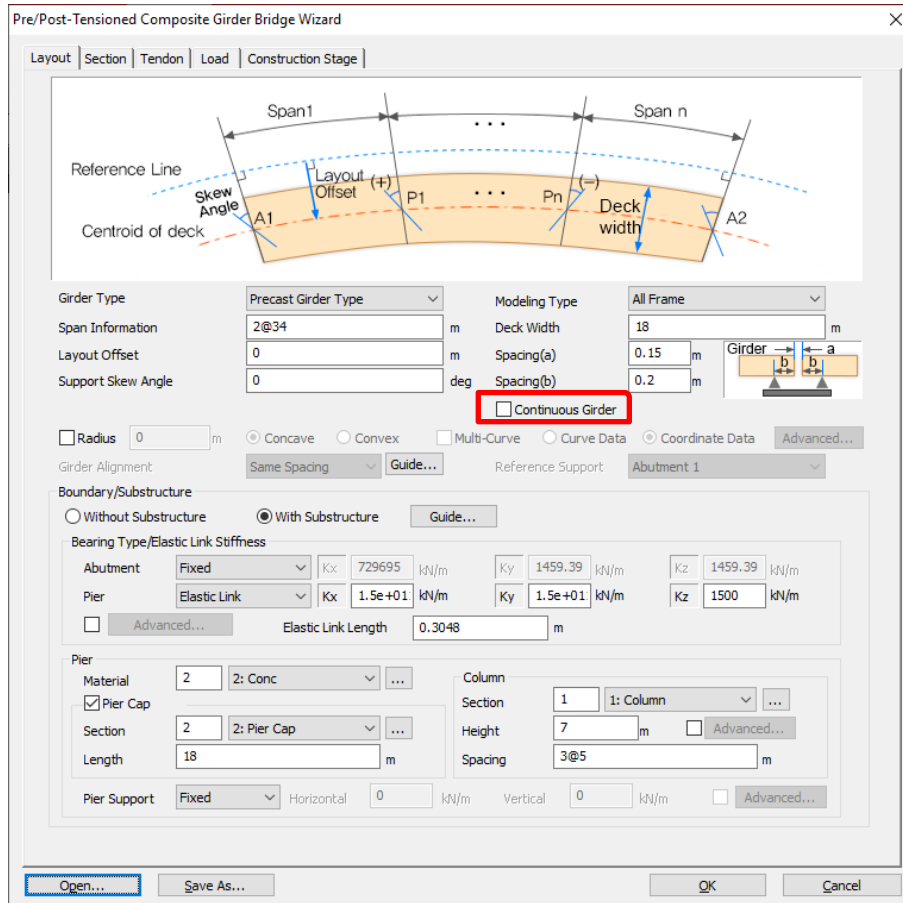
| | Value(Before) | Value(After) | Long Term | Shrinkage | Unit |
|----------|----------------|----------------|----------------|----------------|-----------------|
| Area | 5.490254e+005 | 9.013707e+005 | 6.823587e+005 | 7.490254e+005 | mm ² |
| Asy | 6.270599e+005 | 5.872924e+005 | 4.045292e+005 | 4.601618e+005 | mm ² |
| Asz | 4.422417e+005 | 3.684182e+005 | 3.279467e+005 | 3.290380e+005 | mm ² |
| Ixx | 1.659530e+010 | 1.894427e+010 | 1.748419e+010 | 1.792864e+010 | mm ⁴ |
| Iyy | 1.195447e+011 | 3.360157e+011 | 2.276104e+011 | 2.672750e+011 | mm ⁴ |
| Izz | 1.230070e+010 | 1.297491e+011 | 5.674514e+010 | 7.896736e+010 | mm ⁴ |
| Cyp | 3.750000e+002 | 3.750000e+002 | 3.750000e+002 | 3.750000e+002 | mm |
| Cym | 3.750000e+002 | 3.750000e+002 | 3.750000e+002 | 3.750000e+002 | mm |
| Czp | 9.015894e+002 | 5.100687e+002 | 7.058782e+002 | 6.341514e+002 | mm |
| Czm | 5.984106e+002 | 9.899313e+002 | 7.941218e+002 | 8.658486e+002 | mm |
| Qyb | 0.000000e+000 | 0.000000e+000 | 0.000000e+000 | 0.000000e+000 | mm ² |
| Qzb | 0.000000e+000 | 0.000000e+000 | 0.000000e+000 | 0.000000e+000 | mm ² |
| Peri:O | 4.314130e+003 | 8.714130e+003 | 8.714130e+003 | 8.714130e+003 | mm |
| Peri:l | 0.000000e+000 | 0.000000e+000 | 0.000000e+000 | 0.000000e+000 | mm |
| Center:y | 3.750000e+002 | 1.000000e+003 | 1.000000e+003 | 1.000000e+003 | mm |
| Center:z | 5.984106e+002 | 9.899313e+002 | 7.941218e+002 | 8.658486e+002 | mm |
| y1 | -1.200000e+002 | -1.200000e+002 | -1.200000e+002 | -1.200000e+002 | mm |
| z1 | 9.015894e+002 | 5.100687e+002 | 7.058782e+002 | 6.341514e+002 | mm |
| y2 | 1.200000e+002 | 1.200000e+002 | 1.200000e+002 | 1.200000e+002 | mm |
| z2 | 9.015894e+002 | 5.100687e+002 | 7.058782e+002 | 6.341514e+002 | mm |
| y3 | 3.500000e+002 | 3.500000e+002 | 3.500000e+002 | 3.500000e+002 | mm |
| z3 | -5.984106e+002 | -9.899313e+002 | -7.941218e+002 | -8.658486e+002 | mm |
| y4 | -3.500000e+002 | -3.500000e+002 | -3.500000e+002 | -3.500000e+002 | mm |
| z4 | -5.984106e+002 | -9.899313e+002 | -7.941218e+002 | -8.658486e+002 | mm |

Creep Transformed Section Properties

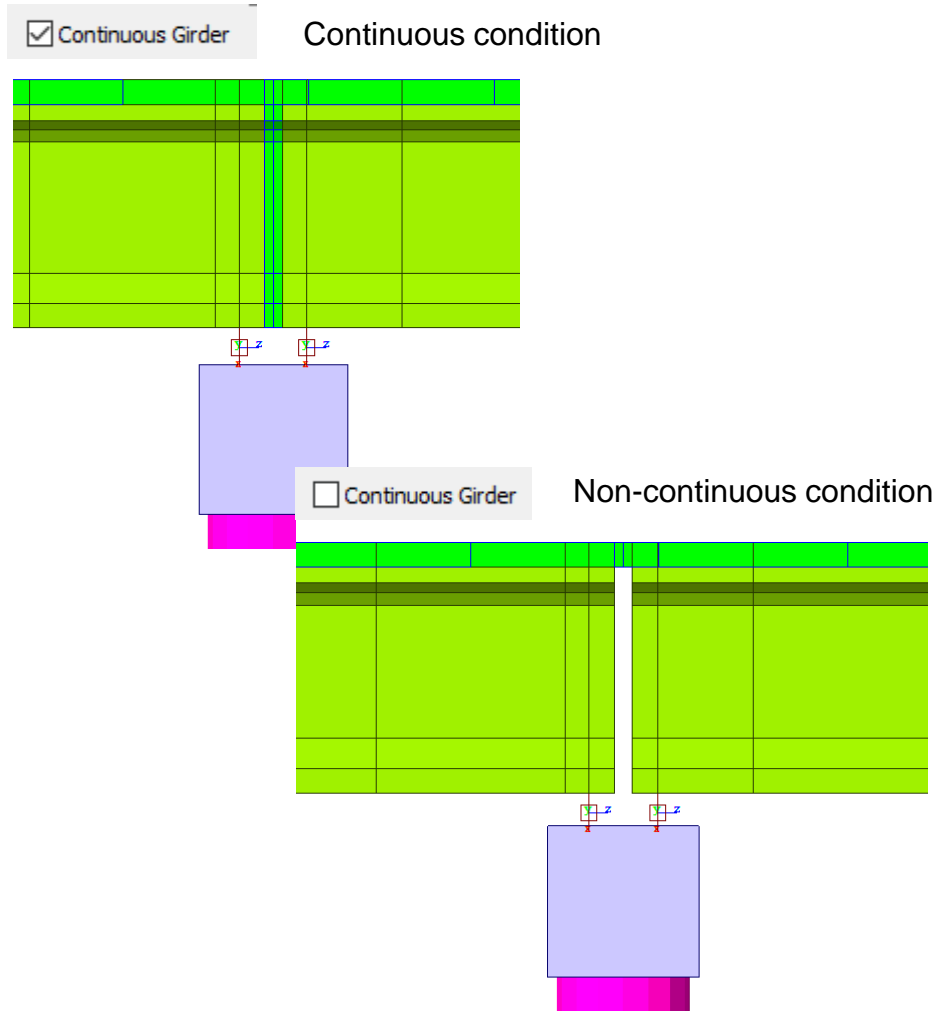
3. Improvement in Prestressed Composite Bridge Wizard: Non-continuous Precast Beam

- New option is introduced to apply non-continuous condition for the precast beams between neighboring spans.
- Bending moment is released at the slab connecting two spans.

▪ **Structure > Wizard > Prestressed Composite Bridge**



Precast Composite Girder Bridge Wizard



4. Improvement in Prestressed Composite Bridge Wizard: Diaphragm

- Individual diaphragms can be included/excluded in the modeling of prestressed composite girder bridge.

Structure > Wizard > Prestressed Composite Bridge

Pre/Post-Tensioned Composite Girder Bridge Wizard

Layout | Section | Tendon | Load | Construction Stage

Deck Thickness: 0.2 m
 Haunch Height: 0.0762 m
 Number of Girders: 6

Material:
 Deck: 2: Conc
 Girder: 1: Girder
 Diaphragm: 2: Conc

Diaphragm

Define Diaphragm Section...

Intermediate Spacing: Divisions per Span Adv...

| Diaphragm | Name | Divisions per Span |
|--------------|-------------|--------------------|
| End Support | 3:CrossBeam | |
| Pier Support | 3:CrossBeam | |
| Intermediate | 3:CrossBeam | 2 |

Transverse Deck Element
 Spacing: Distances 1.524
 Angle type: Perpendicular

Define Girder Section...

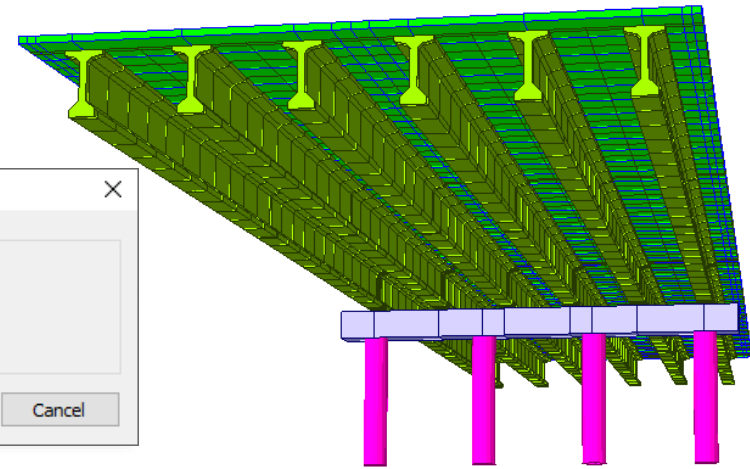
Generate 10th points elements

Girder Information

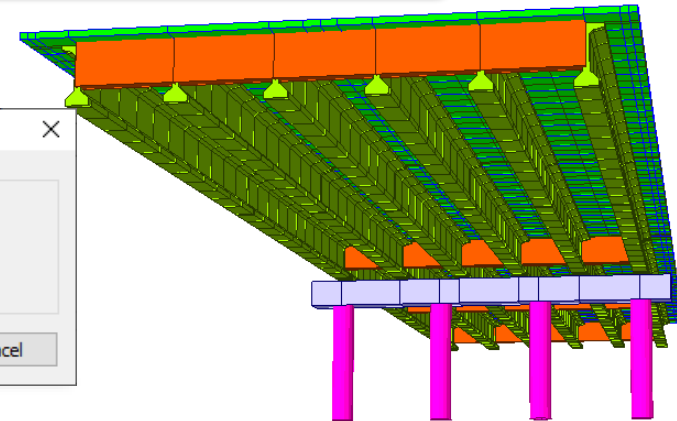
No. of Divisions: 1

| No. | Name | Start (m) | End (m) |
|-----|----------------|-----------|---------|
| 1 | 5:Comp_Precast | 0 | 33.925 |

Precast Composite Girder Bridge Wizard



No Diaphragm



No Intermediate Diaphragm

Advanced Diaphragm

Diaphragm Modeling

End Support
 Pier Support
 Intermediate

OK Cancel

Advanced Diaphragm

Diaphragm Modeling

End Support
 Pier Support
 Intermediate

OK Cancel

5. Bilinear Type Spring Stiffness for Surface Spring Support

- Bilinear spring type is added in the Surface Spring Support to simulate the strength limit of the soil. The strength limit should be defined by the user.
- Both Point Spring Support and Elastic Link are supported.

▪ Boundary > Spring Supports > Surface Spring

Node Element Boundary Mass Load

Surface Spring Supports

Boundary Group Name: Default

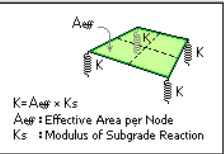
Surface Spring

Convert to Nodal Spring

Point Spring

Elastic Link

Distributed Spring



$K = A_{eff} \times K_s$
 A_{eff} : Effective Area per Node
 K_s : Modulus of Subgrade Reaction

Element Type: Frame Face #1

Width: 0.6 m

Spring Type: Multi-linear (Bi)

Modulus of Subgrade Reaction:

Node Local Axis (if defined)

Kx: 50000 kN/m³

Ky: 0 kN/m³

Kz: 0 kN/m³

PHU: 100 kN/m²

Damping Constant / Area

Cx: 0 kN*sec/m³

Cy: 0 kN*sec/m³

Cz: 0 kN*sec/m³

Apply Close

Node Element Boundary Mass Load

Surface Spring Supports

Boundary Group Name: Default

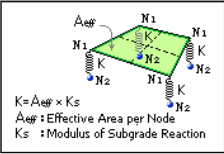
Surface Spring

Convert to Nodal Spring

Point Spring

Elastic Link

Distributed Spring



$K = A_{eff} \times K_s$
 A_{eff} : Effective Area per Node
 K_s : Modulus of Subgrade Reaction

Element Type: Frame Face #1

Width: 0.6 m

Type: Multi-linear (Bi)

Direction: Normal(+)

Modulus of Subgrade Reaction:

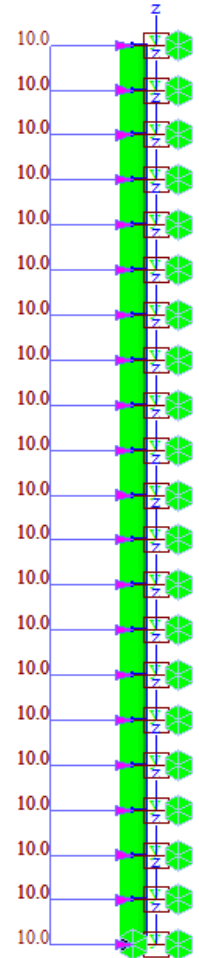
50000 kN/m³

Limit Strength: 100 kN/m²

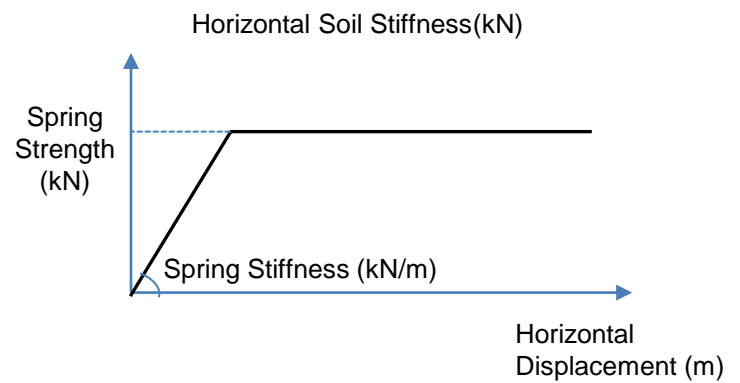
Length of Elastic Link: 1 m

Apply Close

Surface Spring Support



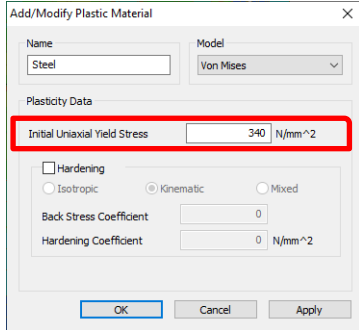
Spring Strength [kN]
 = Section Width [m] × Element Length [m] × PHU [kN/m²]



6. Force/Stress Contouring based on Center Value of Plate Elements

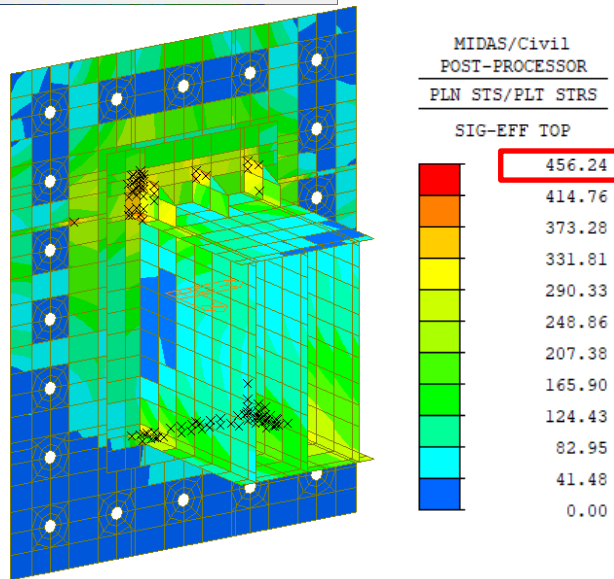
- Stresses at the node are determined by the linear interpolation of Gauss points, which often leads to stress exceeding yield stress in the material nonlinear analysis.
- Plate stress contour can now be displayed using the value at the element center instead of element nodes. The center values will not exceed the yield stress.

Results > Results > Stresses > Plane-Stress/Plate Stresses

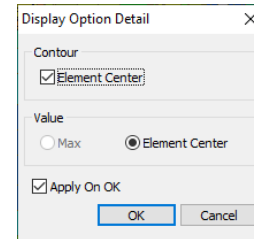
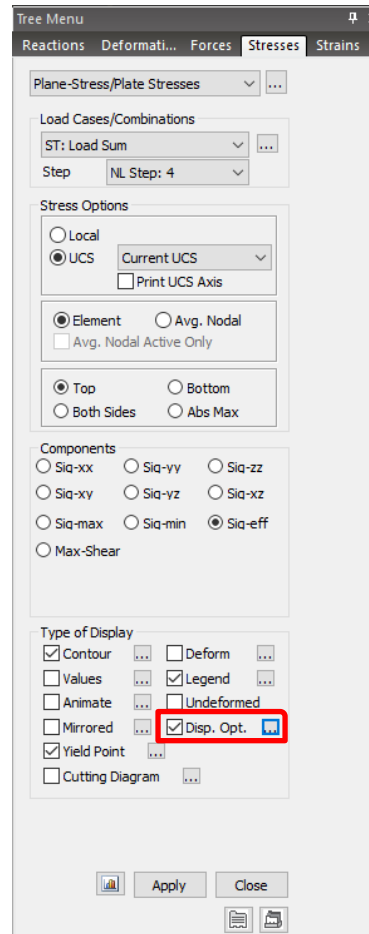


Yield Stress=340MPa

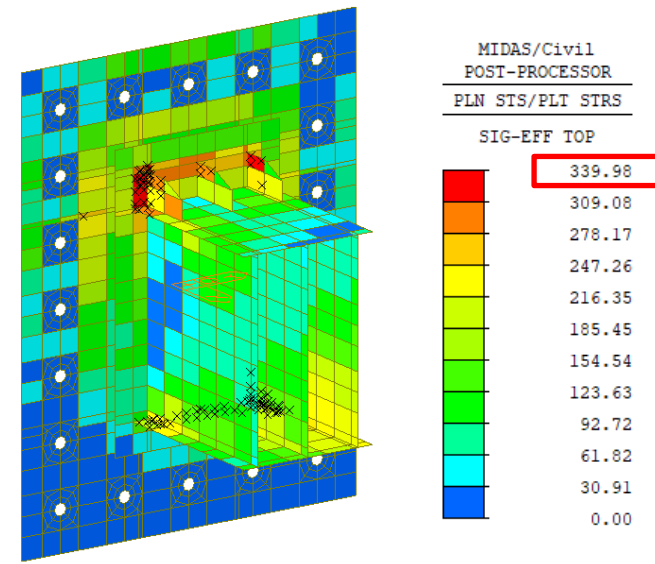
Larger than yield stress



Without Center Contour option



Less than yield stress



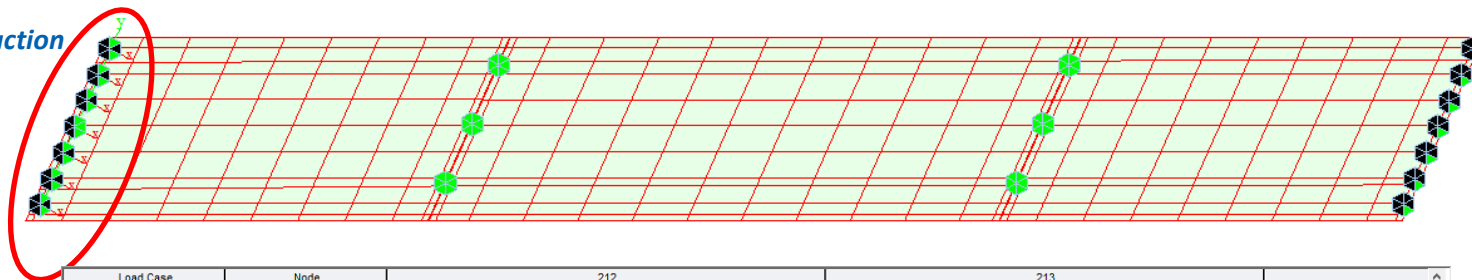
With Center Contour option

7. Concurrent Reactions of Moving Load Analysis with respect to Node Local Axis

- Concurrent reactions due to moving load case can be viewed with respect to node local axis as well as global axis.
- This is useful to check concurrent reactions in the skewed bridges or horizontally curved bridges.

Result Tables > Concurrent Reaction

Support and Node Local axis not parallel to global axis in the skewed bridge



| Load Case | Node | Reaction | 212 | | | | | | | 213 | | | | | | | |
|-----------|------|--------------------|----------|---------|---------|-----------|-----------|-----------|-----------|---------|----------|-----------|-----------|-----------|-----------|-----------|--------|
| Node | | | FX (kN) | FY (kN) | FZ (kN) | MX (kN*m) | MY (kN*m) | MZ (kN*m) | FX (kN) | FY (kN) | FZ (kN) | MX (kN*m) | MY (kN*m) | MZ (kN*m) | FX (kN) | FY (kN) | |
| 111111 | A1 | ULS1(MV-max) Apply | 193.3470 | 0.0000 | 44.4303 | 0.0000 | 0.0000 | 0.0000 | 19.9739 | 0.0000 | 39.2917 | 0.0000 | 0.0000 | 0.0000 | -178.7430 | 0.0000 | |
| 212 | | FX(kN) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | |
| | | FY(kN) | 165.6590 | 0.0000 | 50.8902 | 0.0000 | 0.0000 | 0.0000 | -97.8688 | 0.0000 | 154.4990 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -227.4120 | 0.0000 |
| | | FZ(kN) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | MX(kN*m) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 213 | | FX(kN) | 135.4230 | 0.0000 | 40.8514 | 0.0000 | 0.0000 | 0.0000 | 83.3519 | 0.0000 | -15.4524 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 39.3949 | 0.0000 |
| | | FY(kN) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | FZ(kN) | 134.1910 | 0.0000 | 35.0469 | 0.0000 | 0.0000 | 0.0000 | -85.2902 | 0.0000 | 261.3780 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -169.0720 | 0.0000 |
| | | MX(kN*m) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 214 | | FX(kN) | 129.5600 | 0.0000 | 39.1016 | 0.0000 | 0.0000 | 0.0000 | 80.0568 | 0.0000 | -14.9024 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 40.5398 | 0.0000 |
| | | FY(kN) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | FZ(kN) | 141.4410 | 0.0000 | 36.7324 | 0.0000 | 0.0000 | 0.0000 | -96.2584 | 0.0000 | 249.9700 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -179.9540 | 0.0000 |
| | | MX(kN*m) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 215 | | FX(kN) | 28.8074 | 0.0000 | 5.1753 | 0.0000 | 0.0000 | 0.0000 | 4.3606 | 0.0000 | 44.9575 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -3.5035 | 0.0000 |
| | | FY(kN) | 111.9200 | 0.0000 | 33.9288 | 0.0000 | 0.0000 | 0.0000 | 65.6059 | 0.0000 | -10.8590 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 17.8776 | 0.0000 |
| | | FZ(kN) | 151.1740 | 0.0000 | 33.6825 | 0.0000 | 0.0000 | 0.0000 | 13.3552 | 0.0000 | 48.5736 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -155.3090 | 0.0000 |
| | | MX(kN*m) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 216 | | FX(kN) | 136.5600 | 0.0000 | 28.7323 | 0.0000 | 0.0000 | 0.0000 | -84.6647 | 0.0000 | 202.9450 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -160.8580 | 0.0000 |
| | | FY(kN) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | FZ(kN) | 121.2110 | 0.0000 | 32.9305 | 0.0000 | 0.0000 | 0.0000 | 62.8156 | 0.0000 | -11.6060 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -3.8166 | 0.0000 |
| | | MX(kN*m) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 217 | | FX(kN) | 160.8810 | 0.0000 | 49.8977 | 0.0000 | 0.0000 | 0.0000 | -100.2810 | 0.0000 | 155.0940 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | -228.7280 | 0.0000 |
| | | FY(kN) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | FZ(kN) | 125.6970 | 0.0000 | 38.4487 | 0.0000 | 0.0000 | 0.0000 | 78.2017 | 0.0000 | -14.4885 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 39.7617 | 0.0000 |
| | | MX(kN*m) | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Define Concurrent Reaction Group

Node Group

- EXISTING Deck
- South Bridge
- North Bridge
- Northwest deck
- Southwest deck
- Southeast deck
- Centre-South deck
- Northeast deck
- Centre - North deck
- NW Deck LBs
- SW Deck LBs
- Centre-south deck
- Southeast deck diap
- SE Deck LBs
- NW Deck diaphragm

Selected Group

A1

Remove Concurrent Reaction Group
OK
Cancel

Concurrent Reaction Group

Concurrent Reaction (Local)

Concurrent Reaction Table

8. Concurrent Forces of Elastic Links and General Links for Moving Load Analysis

- Concurrent forces of Elastic Links and General Links are provided for the moving load analysis.
- This is useful when the bearings of the bridge are simulated using Elastic links.

▪ **Analysis > Analysis Control > Moving Load,**

Result Tables > Elastic Link,

Result Tables > General Link

Moving Load Analysis Control Data [X]

Truck/Train Load Control Option

Analysis Method
 Exact Pivot Quick

Load Point Selection
 Influence Line Dependent Point All Points

Influence Generating Points
 Number/Line Element : [v]
 Distance between Points : ft

Analysis Results

Plate
 Center
 Center + Nodal
 Stress
 Concurrent Force

Frame
 Normal
 Normal + Concurrent Force/Stress
 Combined Stress

Concurrent Force of Elastic/General Links

Calculation Filters

Reactions
 All Group : [v]

Displacements
 All Group : [v]

Forces/Moments
 All Group : [v]

Elastic/General Links
 All Group : EL [v]

[OK] [Cancel]

Moving Load Analysis Control

| No. | Load | Node | Axial (kips) | Shear-y (kips) | Shear-z (kips) | Torsion (ft*kips) | Moment-y (ft*kips) | Moment-z |
|-----|----------|------|--------------|----------------|----------------|-------------------|--------------------|----------|
| 1 | MVL(max) | 57 | 0.74 | 13.19 | 49.60 | 0.00 | 0.00 | |
| 1 | MVL(max) | 1 | 0.74 | 13.19 | 49.60 | 0.00 | 0.00 | |
| 2 | MVL(max) | 59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 2 | MVL(max) | 21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 3 | MVL(max) | 58 | 0.00 | 13.89 | 0.00 | 0.00 | 0.00 | |
| 3 | MVL(max) | 11 | 0.00 | 13.89 | 0.00 | 0.00 | 0.00 | |
| 4 | MVL(max) | 60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 4 | MVL(max) | 31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 1 | MVL(min) | 57 | -140.97 | -13.89 | -47.10 | 0.00 | 0.00 | |
| 1 | MVL(min) | 1 | -140.97 | -13.89 | -47.10 | 0.00 | 0.00 | |
| 2 | MVL(min) | 59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 2 | MVL(min) | 21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 3 | MVL(min) | 58 | -141.97 | -13.19 | 0.00 | 0.00 | 0.00 | |
| 3 | MVL(min) | 11 | -141.97 | -13.19 | 0.00 | 0.00 | 0.00 | |
| 4 | MVL(min) | 60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |
| 4 | MVL(min) | 31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |

Elastic Link Force Table

| No. | Load | Node | Component | Axial (kips) | Shear-y (kips) | Shear-z (kips) | Torsion (ft*kips) | Moment-y (ft*kips) | Moment-z (ft*kips) |
|-----|----------|------|-----------|--------------|----------------|----------------|-------------------|--------------------|--------------------|
| 1 | MVL(max) | 57 | Axial | 0.74 | -0.45 | 1.60 | 0.00 | 0.00 | 0.00 |
| 1 | MVL(max) | 1 | Axial | 0.74 | -0.45 | 1.60 | 0.00 | 0.00 | 0.00 |
| 2 | MVL(max) | 59 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MVL(max) | 21 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | MVL(max) | 58 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | MVL(max) | 11 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | MVL(max) | 60 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | MVL(max) | 31 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | MVL(min) | 57 | Axial | -140.97 | -0.32 | 1.14 | 0.00 | 0.00 | 0.00 |
| 1 | MVL(min) | 1 | Axial | -140.97 | -0.32 | 1.14 | 0.00 | 0.00 | 0.00 |
| 2 | MVL(min) | 59 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | MVL(min) | 21 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | MVL(min) | 58 | Axial | -141.97 | 0.82 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | MVL(min) | 11 | Axial | -141.97 | 0.82 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | MVL(min) | 60 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | MVL(min) | 31 | Axial | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Concurrent Forces of Elastic Links

Result View Items

Copy

Find...

Sorting Dialog...

Style Dialog...

Show Graph...

Activate Records...

Export to Excel...

View by Max Value Item...

Dynamic Report Table...

Result View Items

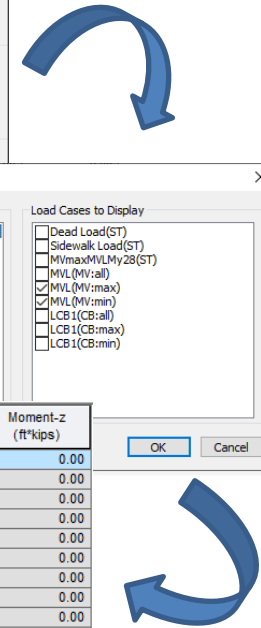
Items to Display

Axial
 Shear-y
 Shear-z
 Torsion
 Moment-y
 Moment-z

Load Cases to Display

Dead Load(ST)
 Sidewalk Load(ST)
 WlmaxMVLMy28(ST)
 MVL(MV:all)
 MVL(MV:max)
 MVL(MV:min)
 LCB1(CB:all)
 LCB1(CB:max)
 LCB1(CB:min)

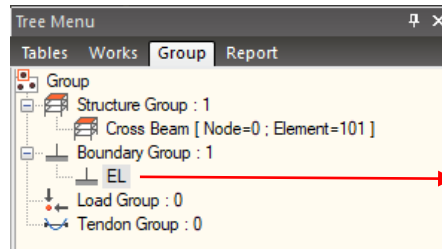
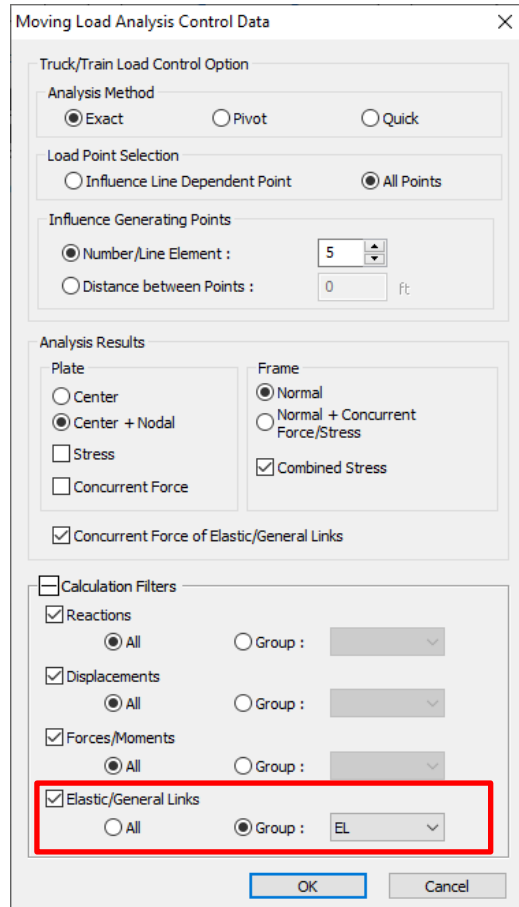
[OK] [Cancel]



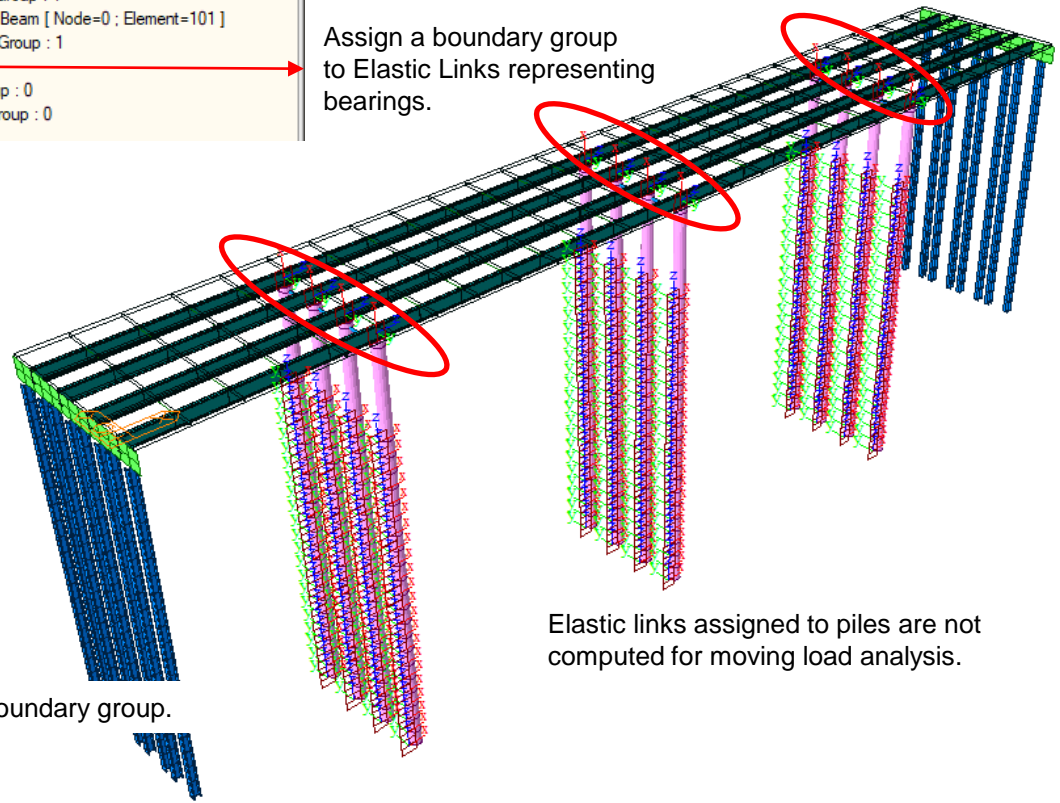
9. Analysis Filtering of Elastic Links and General Links in Moving Load Analysis

- The user can choose a group of Elastic Links and General Links to be analyzed for the moving load cases.
- This filter option makes the analysis time much shorter when there are a lot of Elastic Links / General Links in the model.

Analysis > Analysis Control > Moving Load



Assign a boundary group to Elastic Links representing bearings.



Select the boundary group.

Elastic links assigned to piles are not computed for moving load analysis.

Moving Load Analysis Control

10. New Inelastic Hinge Type: Parametric P-M (multi-curve)

- Parametric P-M (multi-curve) is a new inelastic hinge type described by bending moment vs. curvature relationship which is a function of the axial force.
- Unlike the other types of hinge, the moment vs. curvature relationship can be defined by the user depending on the axial forces.

▪ Properties > Inelastic Properties > Inelastic Hinge

Add/Modify Inelastic Hinge Properties

Name :

Description :

Element Type

Beam-Column Truss General Link

Material Type

RC/SRC(encased) Steel/SRC(filled)

Definition

Moment - Rotation(M-Theta) Moment - Curvature (M-Phi Distributed) ...

Hinge Type

Skeleton Model Fiber Model

Interaction Type

None P-M in Strength Calculation P-M-M in Status Determination Parametric P-M (Multi-Curve)

Fiber Section

Auto Generation User Defined

Section :

Fiber Name : ...

Component Properties

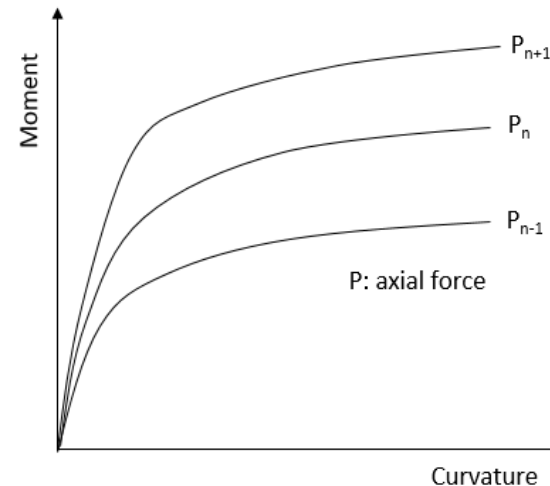
| Component | No. of Sections | Hysteresis Model | |
|--|--------------------------------|----------------------|---------------|
| <input type="checkbox"/> Fx | <input type="text" value="3"/> | Kinematic Hardening | Properties... |
| <input type="checkbox"/> Fy | <input type="text" value="3"/> | Kinematic Hardening | Properties... |
| <input type="checkbox"/> Fz | <input type="text" value="3"/> | Kinematic Hardening | Properties... |
| <input type="checkbox"/> Mx | <input type="text" value="3"/> | Kinematic Hardening | Properties... |
| <input checked="" type="checkbox"/> My | <input type="text" value="3"/> | P-M Multi-Curve Type | Properties... |
| <input checked="" type="checkbox"/> Mz | <input type="text" value="3"/> | P-M Multi-Curve Type | Properties... |

Yield Surface Properties...

OK Cancel Apply

Inelastic Hinge Properties

- The flexural behavior of the beam element is described by bending moment vs. curvature relationship. This relationship is input in the form of multilinear functions. The moment vs. curvature relationship is a function of the axial force.
- The flexural behavior of the beam element is defined by two bending vs. curvature relationships, one for each principal plane of inertia. Interaction between the two bending moments (M_y and M_z) are not taken into account.



10. New Inelastic Hinge Type: Parametric P-M (multi-curve) continued

- Ultimate positive and negative curvature can be specified.
- This hinge type can be applied to nonlinear static or nonlinear time history analysis.

▪ *Properties > Inelastic Properties > Inelastic Hinge*

Directional Hinge Properties : P-M Multi-Curve Type

Multi-Curve Data

Multi-Curve: Define Axial Force

Axial Force (P): 0,000 kN

Multi-Linear Force & Deformation

| | Curvature (rad/m) | Moment (kN*m) |
|---|-------------------|---------------|
| 1 | -5.000e-001 | -1.001e+003 |
| 2 | -1.000e-001 | -1.000e+003 |
| 3 | 0.000e+000 | 0.000e+000 |
| 4 | 1.000e-001 | 1.000e+003 |
| 5 | 5.000e-001 | 1.001e+003 |
| 6 | | |

Primary Curve

Deformation Indexes

Strain Hardening Type

Isotropic Kinematic

Mixed β 0

Initial Stiffness

(+) 10000 kN*m²

(-) 10000 kN*m²

OK Cancel

P-M Multi-Curve Type

- P-M Multi-Curve Type allows for bilinear and multilinear plasticity.
- The first data point corresponds to negative rupture and the last data point corresponds to positive rupture. One data point – the zero point – must be at the origin. A different number of data points can be used for the positive and negative sections of the curve.
- Moment and curvature relationship can depend on the axial force and the dependence can be different in tension and in compression. The number of axial forces must be two at least.
- To obtain the bending moment-curvature curve for a level of axial force not input, interpolation is used. This interpolation is performed, not on the bending moment-curvature curves, but on the moment-plastic curvature curves. The moment-plastic curvature curves are automatically calculated from the bending moment-curvature curves.
- Strain hardening can be isotropic, kinematic or mixed. The moment-curvature relationship can either be symmetric or non-symmetric. Whether it is symmetric or non-symmetric, entire moment-curvature curve should be entered.

11. Precast Concrete Girder Section Database Update: AS-Super T RMS 2019

- AS-Super T RMS 2019 T1, T2, T3, T4, T5
- This section database is also updated in the Tendon Template.

Properties > Section > PSC

Section Data

DB/User Value SRC Combined PSC Tapered Composite Steel Girder

Section ID: 1 PSC-Value

Name: T1 Mesh Size for Stiff. Calc. mm

Define by Coordinates...
Section Data

Param. for Design

T1: 200 mm
T2: 300 mm
BT: 1000 mm
HT: 1000 mm

Thk. for Torsion(min.)
200 mm Auto

Section Properties

| Calc. Section Properties | |
|--------------------------|------------------------------|
| Area | 4.59271e+005 mm ² |
| Asy | 1.98204e+005 mm ² |
| Asz | 1.28248e+005 mm ² |
| Ixx | 6.24376e+009 mm ⁴ |
| Iyy | 3.14046e+010 mm ⁴ |
| Izz | 1.02028e+011 mm ⁴ |
| Cyp | 1050.0000 mm |
| Cym | 1050.0000 mm |
| Czp | 414.9670 mm |
| Czm | 350.0340 mm |
| Qyb | 270791.5445 mm ² |

Warping Check: Auto User

Shear Check

| Position | Qy | Auto | Thk. for Shear(total) | Auto |
|--------------|-------------------|-------------------------------------|-----------------------|-------------------------------------|
| Z1: 300 mm | 0 mm ³ | <input checked="" type="checkbox"/> | 0 mm | <input checked="" type="checkbox"/> |
| Z2: Centroid | 0 mm ³ | <input checked="" type="checkbox"/> | 0 mm | <input checked="" type="checkbox"/> |
| Z3: 600 mm | 0 mm ³ | <input checked="" type="checkbox"/> | 0 mm | <input checked="" type="checkbox"/> |

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

Show Calculation Results... OK Cancel Apply

Section Data

Select PSC DB

Code: AS Type: AS-Super-T_RMS_2019

Select DB

- 1:T1
- 2:T2
- 3:T3
- 4:T4
- 5:T5

OK

AS-Super-T RMS 2019 DB

Auto Generation

Name prefix: strand

Tendon Property: Tendon

Tendon Group: Default

Code: AS

Type: AS-Super-T_RMS_2019

Name: T1

Origin Point: 0.970, 0.000 m

Initialize Tendon Template

OK Cancel

Tendon Template

12. Response Spectrum Function: AS 5100.2: 2017

- Response spectrum function as per AS 5100.2: 2017

▪ Load > Response Spectrum Data > RS Functions

Add/Modify/Show Response Spectrum Functions

Function Name: AS 5100.2(2017)

Spectral Data Type: Normalized Accel. Acceleration Velocity Displacement

Scaling: Scale Factor Maximum Value

Scale Factor: 1

Gravity: 9806 mm/sec²

Damping Ratio: 0.05

Graph Options: X-axis log scale Y-axis log scale

| | Period (sec) | Spectral Data (g) |
|----|--------------|-------------------|
| 1 | 0.0000 | 0.0901 |
| 2 | 0.0600 | 0.1891 |
| 3 | 0.1000 | 0.2551 |
| 4 | 0.1200 | 0.2551 |
| 5 | 0.1800 | 0.2551 |
| 6 | 0.2400 | 0.2551 |
| 7 | 0.3000 | 0.2551 |
| 8 | 0.3600 | 0.2407 |
| 9 | 0.4200 | 0.2063 |
| 10 | 0.4800 | 0.1806 |
| 11 | 0.5400 | 0.1605 |
| 12 | 0.6000 | 0.1444 |
| 13 | 0.6600 | 0.1313 |
| 14 | 0.7200 | 0.1204 |

Description: AS 5100.2(2017): SC=Ce, kp=1.30, Z=0.08, μ=1.50

Buttons: OK, Cancel, Apply

Response Spectrum Functions

Generate Design Spectrum

Design Spectrum : AS 5100.2(2017)

Site Sub Soil Class: Ae Be Ce De Ee

Probability Factor (kp): 1.3

Hazard Factor (Z): 0.08

Design Ductility Factor (μ): 1.5

Max. Period : 6 (Sec)

Buttons: OK, Cancel

Design Spectrum

13. User-Defined Drying Basic Shrinkage Strain: AS 5100.5-2017

- The development of shrinkage strain can be defined using user-defined drying basic shrinkage strain as well as recommended values for each cities when applying AS 5100.5-2017.

▪ **Properties > Time Dependent Material > Creep/Shrinkage**

Add/Modify Time Dependent Material (Creep / Shrinkage)

Name : Code : AS 5100.5-2017

AUSTRALIA

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

Exposure Environment
 Arid Interior Temperate Inland Tropical or Near Coastal

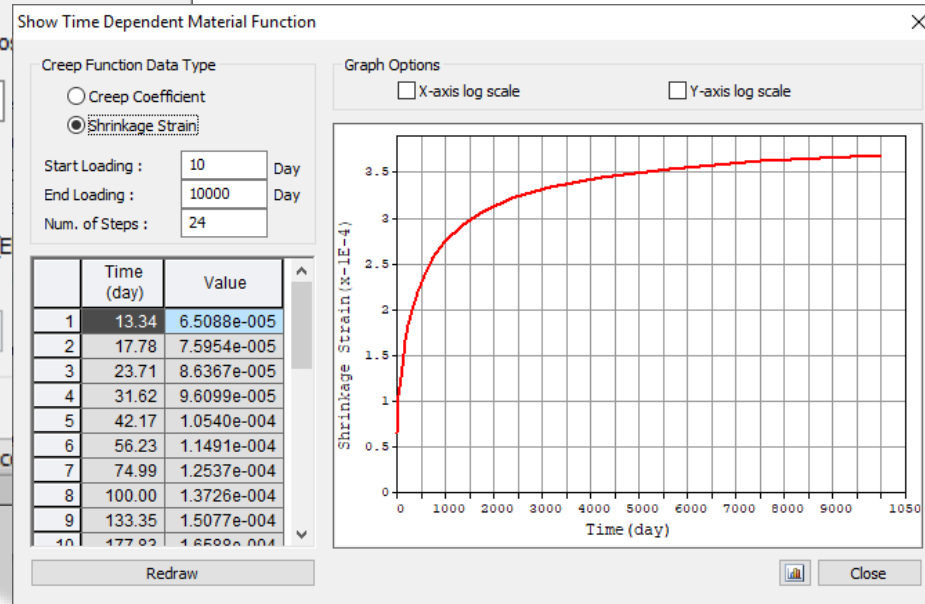
Hypothetical Thickness :
 $h = 2 A_g / u$ (A_g : Section Area, u : Perimeter in contact with atmosphere)

Drying Basic Shrinkage Strain (10^{-6}) :
 800.0 (Sydney, Brisbane) 900.0 (Melbourne) 1000.0 (Especially Arid)
 User Define

Age of concrete at the beginning of shrinkage :

Show Result... OK Cancel

Time Dependent Material (Creep/Shrinkage)



Shrinkage development

14. Relaxation of Tendons: AS 5100.5-2017

- Prestress loss due to the relaxation of tendon is calculated as per equation 3.3.4.3 of AS 5100.5-2017 using user-defined basic relaxation, R_b .
- $R_b(\%)$ is the basic % relaxation of a tendon at 1,000 hour.

- **Load > Load Type > Temp./Prestress**
- **Load > Prestress Loads > Tendon Property**

Add/Modify Tendon Property ✕

Tendon Type

Tendon Name:

Tendon Type:

Material:

Total Tendon Area: mm²

Duct Diameter: mm

Relaxation Coefficient:

Characteristic Value of Strength (f_{pb}): N/mm²

Curvature Friction Factor:

Wobble Friction Factor: 1/mm

External Cable Moment Magnifier: N/mm²

Anchorage Slip(Draw in)

Begin: mm

End: mm

Bond Type

Bonded

Unbonded

Tendon Property

3.3.4.2 Basic relaxation

The basic relaxation of a tendon (R_b) after one thousand hours at 20°C and $0.8f_{pb}$ shall be determined in accordance with AS/NZS 4672.1.

3.3.4.3 Design relaxation

Subject to Clause 3.3.4.4, the design relaxation of a tendon (R) shall be determined from the following equation:

$$R = k_6 k_7 k_8 R_b \quad \dots 3.3.4.3$$

where

$$k_6 = \text{a coefficient, dependent on the duration of the prestressing force} \\ = \log [5.4(j)^{1/6}]$$

$$j = \text{time after prestressing, in days}$$

$$k_7 = \text{a coefficient, dependent on the stress in the tendon as a proportion of } f_{pb}, \\ \text{determined from Figure 3.3.4.3}$$

$$k_8 = \text{a coefficient, dependent on the average annual temperature } (T) \text{ in degrees} \\ \text{Celsius, taken as } T/20 \text{ but not less than 1.0}$$

$$R_b = \text{basic relaxation of a tendon after one thousand hours at 20°C, as specified in} \\ \text{Clause 3.3.4.2}$$

AS 5100.5-2017 Specification

15. User-Defined Stress Limit for Crack Check: AS 5100.5-2017

- For the crack control for flexure in prestressed beams, the maximum increment of steel stress was fixed as 160 MPa in the previous version.
- Now, it can be defined by the user.

▪ PSC > Design Parameter > AS 5100.5: 17

PSC Design Parameters

Design Code : AS 5100.5:17

Input Parameters

Maximum nominal aggregate size (8.2.4.2)

d_g : 16 mm

Crack Control

Maximum Increment of Steel Stress

160 N/mm²

Output Parameters

Ultimate limit states

Flexural resistance

Shear resistance

Torsional resistance

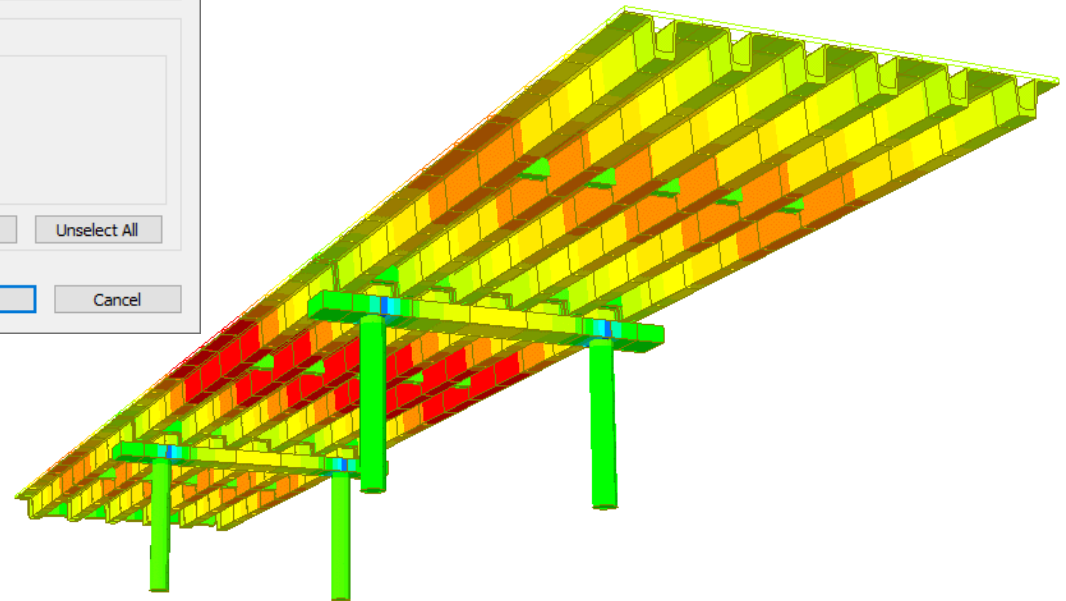
Serviceability limit state

Control of Cracking

Select All Unselect All

OK Cancel

PSC Design parameter

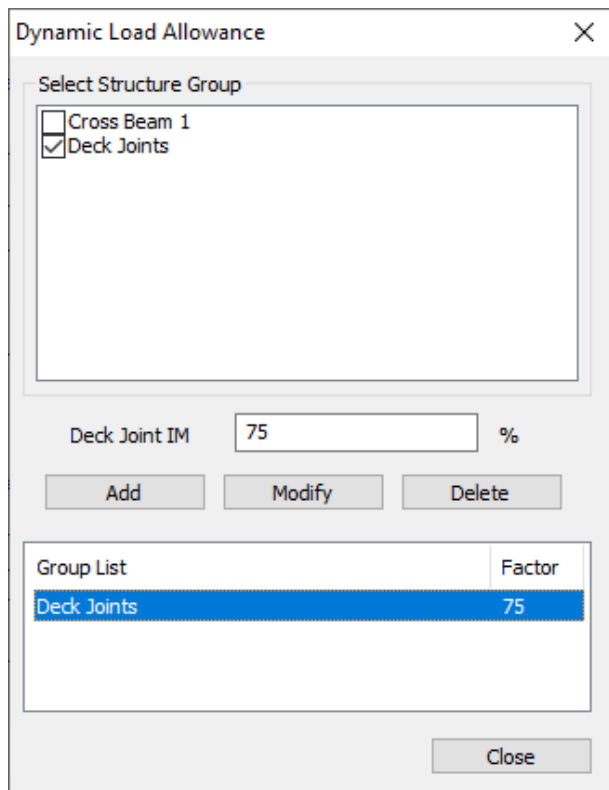


Super T Girder Bridge

16. Dynamic Load Allowance for Expansion Joint: AASHTO LRFD

- Dynamic load allowance is defined in the Vehicle dialog in the moving load analysis by AASHTO LRFD.
- Different dynamic load allowance can now be applied to a separate structure group using this new feature.

- **Load > Load Type > Moving Load > Moving Load Code > AASHTO LRFD**
- **Load > Moving Load Analysis Data > Dynamic Load Allowance**

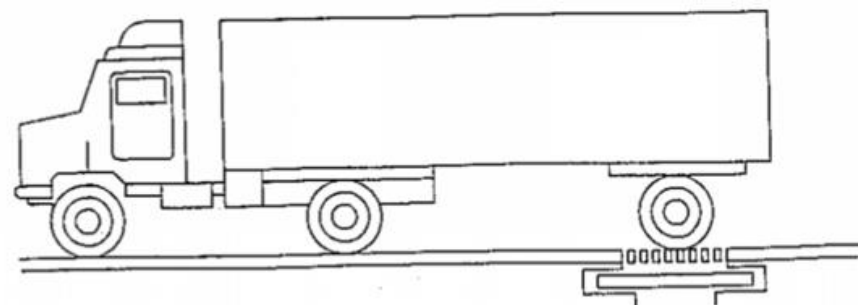


Dynamic Load Allowance

Table 3.6.2.1-1—Dynamic Load Allowance, *IM*

| Component | IM |
|------------------------------------|-----|
| Deck Joints—All Limit States | 75% |
| All Other Components: | |
| • Fatigue and Fracture Limit State | 15% |
| • All Other Limit States | 33% |

AASHTO LRFD Specification



Truck loads on the deck joint

17. Standard Vehicles: Indiana Department of Transportation

- Toll Road Loading No.1, Toll Road Loading No.2, Special Toll Road Truck, Michigan Train Truck No.5, Michigan Train Truck No.8
- SUPERLOAD - 11 Axles Loading, SUPERLOAD - 13 Axles Loading, SUPERLOAD - 14 Axles Loading, SUPERLOAD - 19 Axles Loading 1, SUPERLOAD - 19 Axles Loading 2

- **Load > Load Type > Moving Load > Moving Load Code > AASHTO LRFD**
- **Load > Moving Load Analysis Data > Vehicles**

Define Standard Vehicular Load ✕

Standard Name:

Vehicular Load Properties

Vehicular Load Name :

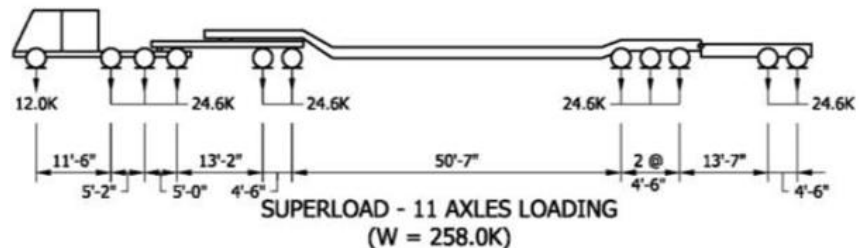
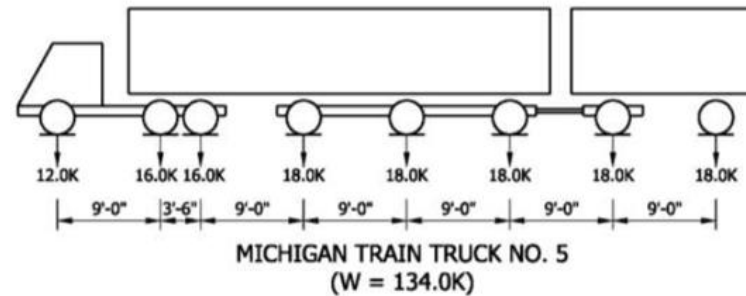
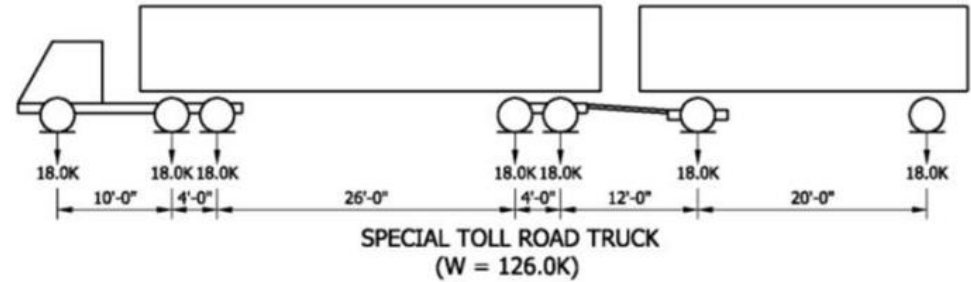
Vehicular Load Type :

Dynamic Load Allowance :

P1 P2 P3 P4

D1 D2 D3 D4 D5 D6 D7

| No | Load(kips) | Spacing(ft) | W | | |
|----|------------|-------------|-----|---|---------|
| 1 | 12 | 9 | 0 | | kips/ft |
| 2 | 16 | 3.5 | Ps | 0 | kips |
| 3 | 16 | 9 | Pm | 0 | kips |
| 4 | 18 | 9 | dW1 | 0 | kips/ft |
| 5 | 18 | 9 | dD1 | 0 | ft |
| 6 | 18 | 9 | dW2 | 0 | kips/ft |
| 7 | 18 | 9 | dD2 | 0 | ft |
| 8 | 18 | end | | | |



INDOT Load Rating Vehicles

18. Standard Vehicles: Colombian CCP-14

- CCP-14 Truck, CCP-14 Tandem

▪ **Load > Load Type > Moving Load > Moving Load Code > AASHTO LRFD, Load > Moving Load Analysis Data > Vehicles**

Define Standard Vehicular Load

Standard Name: Colombia

Vehicular Load Properties

Vehicular Load Name: CCP-14 Truck

Vehicular Load Type: CCP-14 Truck

Dynamic Load Allowance: 0 %

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

| No | Load(kN) | Spacing(m) | W | 10.3 | kN/m |
|----|----------|------------|-------|------|------|
| 1 | 40 | 4.3 | r | 100 | % |
| 2 | 160 | 4.3 | Dist. | 15 | m |
| 3 | 160 | 9 | | | |

OK Cancel Apply

Define Standard Vehicular Load

Standard Name: Colombia

Vehicular Load Properties

Vehicular Load Name: CCP-14 Tandem

Vehicular Load Type: CCP-14 Tandem

Dynamic Load Allowance: 0 %

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

| No | Load(kN) | Spacing(m) | W | 10.3 | kN/m |
|----|----------|------------|-------|------|------|
| 1 | 125 | 1.2 | r | 100 | % |
| 2 | 125 | end | Dist. | 8~12 | m |

OK Cancel Apply

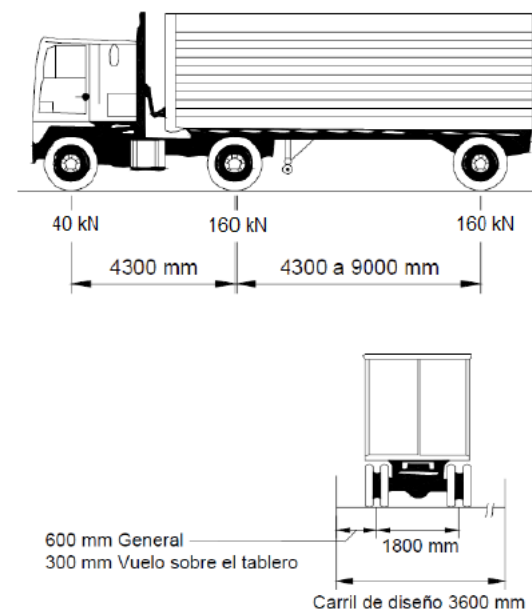


Figura 3.6.1.2.2-1 — Características del Camión de Diseño

19. Auto-Generation of Load Combination: BS 5400

- Auto-generation of load combinations with respect to BS 5400 is now available for concrete structures.

Results > Load Combination

Load Combinations

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

Load Combination List

| No | Name | Active | Type | Description |
|----|--------|--------|------|----------------------|
| 1 | gLCB1 | Active | Add | ULS Comb 1: 1.32D+1. |
| 2 | gLCB2 | Active | Add | ULS Comb 1: 1.32D+1. |
| 3 | gLCB3 | Active | Add | ULS Comb 1: 1.32D+1. |
| 4 | gLCB4 | Active | Add | ULS Comb 1: 1.32D+1. |
| 5 | gLCB5 | Active | Add | ULS Comb 2: 1.32D+1. |
| 6 | gLCB6 | Active | Add | ULS Comb 2: 1.32D+1. |
| 7 | gLCB7 | Active | Add | ULS Comb 2: 1.32D+1. |
| 8 | gLCB8 | Active | Add | ULS Comb 2: 1.32D+1. |
| 9 | gLCB9 | Active | Add | ULS Comb 2: 1.32D+1. |
| 10 | gLCB10 | Active | Add | ULS Comb 2: 1.32D+1. |
| 11 | gLCB11 | Active | Add | ULS Comb 2: 1.32D+1. |
| 12 | gLCB12 | Active | Add | ULS Comb 2: 1.32D+1. |
| 13 | gLCB13 | Active | Add | ULS Comb 2: 1.32D+1. |
| 14 | gLCB14 | Active | Add | ULS Comb 2: 1.32D+1. |
| 15 | gLCB15 | Active | Add | ULS Comb 2: 1.32D+1. |
| 16 | gLCB16 | Active | Add | ULS Comb 2: 1.32D+1. |
| 17 | gLCB17 | Active | Add | ULS Comb 2: 1.32D+1. |
| 18 | gLCB18 | Active | Add | ULS Comb 2: 1.32D+1. |
| 19 | gLCB19 | Active | Add | ULS Comb 2: 1.32D+1. |
| 20 | gLCB20 | Active | Add | ULS Comb 2: 1.32D+1. |
| 21 | gLCB21 | Active | Add | ULS Comb 2: 1.32D+1. |
| 22 | gLCB22 | Active | Add | ULS Comb 2: 1.32D+1. |

Load Cases and Factors

| LoadCase | Factor |
|----------------------|--------|
| D(ST) | 1.3200 |
| DW(ST) | 1.9250 |
| DC(ST) | 1.3200 |
| EV(ST) | 1.3200 |
| EP(ST) | 1.6500 |
| EH(ST) | 1.6500 |
| STL(ST) | 1.3200 |
| Settlement(SM) | 1.3200 |
| PS(ST) | 1.1000 |
| CR(ST) | 1.3200 |
| SH(ST) | 1.3200 |
| Dead Load(CS) | 1.3200 |
| Tendon Secondary(CS) | 1.1000 |
| * | |

Copy Import... Auto Generation... Spread Sheet Form Copy into Steel Design

File Name: C:\Users\nsk0201\Desktop\BS Assessment\LCB\LCB.lcp Browse Make Load Combination Sheet Close

ULS and SLS combinations

Automatic Generation of Load Combinations

Option
 Add Replace Add Envelope

Code Selection
 Steel Concrete SRC Steel Composite

Design Code : BS 5400

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

Bridge Type Roadway

Load Factors for Permanent Loads

| Type of Load | Load Factor | | |
|-----------------------------|---------------------------------------|----------------------------|-----------------------|
| | Max | Min | Both |
| Dead Load | <input checked="" type="radio"/> 1.20 | <input type="radio"/> 1.15 | <input type="radio"/> |
| Deck Surfacing(DW) | <input checked="" type="radio"/> 1.75 | <input type="radio"/> 1.20 | <input type="radio"/> |
| Other Loads(DC) | <input checked="" type="radio"/> 1.20 | <input type="radio"/> 1.20 | <input type="radio"/> |
| Vertical Earth Pressure | <input type="radio"/> 1.20 | <input type="radio"/> 1.00 | <input type="radio"/> |
| Non-vertical Earth Pressure | <input checked="" type="radio"/> 1.50 | <input type="radio"/> 1.00 | <input type="radio"/> |

Partial Safety Factor for Moving Load
 Road Traffic Case : HB
 BS Vehicle Type : HB alone

BS Vehicle Partial Factor Table

| Load Case | Vehicle Name |
|-----------|--------------|
| HA | HA alone |
| HA&HB | HA with HB |
| HB | HB alone |

Add Delete

Partial Load Factor for Inaccurate Load Effect
 For Ultimate Limit State 1.10
 For Service Limit State 1.00

OK Cancel

Selecting BS 5400 for Auto Load Combinations

20. Design Report in Czech

- The design reports are provided in Czech for the composite steel girder design and prestressed concrete girder design as per Eurocode.

Design > Composite Design > Excel Report, PSC > PSC Design > Excel Report

AI13 : X ✓ f_x

| 1 Podmínky návrhu | | | |
|------------------------------------|---------------|--|------------------|
| 1.1 Návrhové parametry | | | |
| ■ Dílčí součinitele | | | |
| γ_c pro beton | 1.50 | γ_{Vf} pro spřahovací trny | 1.25 |
| γ_s pro betonářskou výztuž | 1.15 | γ_{Ft} pro ekvivalentní konstantní rozkmit napětí | 1.00 |
| γ_{M0} pro konstrukční ocel | 1.00 | γ_{Mf} pro únavovou pevnost | 1.00 |
| γ_{M1} pro konstrukční ocel | 1.10 | $\gamma_{Mf,s}$ pro únavovou pevnost trnů ve smyku | 1.00 |
| 1.2 Materiálové informace | | | |
| ■ Konstrukční ocel | | | |
| f_{sk} | = 355.000 MPa | E_s | = 205000.000 MPa |
| ■ Beton | | | |
| f_{ck} | = 40.000 MPa | E_{cm} | = 35220.462 MPa |
| ■ Výztuž | | | |
| f_{yk} | = 400.000 MPa | E_r | = 205000.000 MPa |
| 1.3 Informace o průřezu | | | |

Design Report – EN 1994-2

A1 : X ✓ f_x

| 1.1.1 Návrhové parametry | | | |
|---|----------------------------------|---|-----------------------------|
| - Dílčí součinitele pro mezní stav únosnosti (EN 1992-1-1:2004, 2.4.2.4) | | | |
| Návrhové situace | γ_c beton | γ_s betonářská výztuž | γ_s předpjatá výztuž |
| Trvalé & Dočasné | 1.500 | 1.150 | 1.150 |
| Mimořádné | 1.200 | 1.000 | 1.000 |
| - součinitel α_{cc} , α_{ct} : Součinitel pro dlouhodobé účinky únosnosti v tlaku a tahu. | | | |
| α_{cc} | = 0.850 | (pro únosnost betonu v tlaku) | |
| α_{ct} | = 1.000 | (pro únosnost betonu v tahu) | |
| 1.2 Průřezy | | | |
| Průřezové charakteristiky | Ekv. průř. (kab., výt.) (Nosník) | Ekv. průř. (Po spřahení) (Nosník + Deska) | |
| A (mm ²) | 301674.143 | 663314.768 | |
| I_y (mm ⁴) | 19347928584.907 | 45420636187.532 | |
| y_{st} (mm) | - | 460.290 | |
| y_{sp} (mm) | - | 414.710 | |
| y_t (mm) | 469.682 | 310.261 | |
| y_b (mm) | 280.318 | 439.739 | |
| Z_{st} (mm ³) | - | 98678220.689 | |
| Z_{sp} (mm ³) | - | 109523952.519 | |
| Z_t (mm ³) | 39392059.949 | 146394744.529 | |
| Z_b (mm ³) | 20227260.040 | 103290078.773 | |

Design Report – EN 1992-2

21. Response Spectrum Function: Philippines DPWH-BSDS 2013

- Department of public works and highways bridge seismic design specifications 2013, Philippines

▪ **Load > Response Spectrum Data > RS Functions**

Add/Modify/Show Response Spectrum Functions

Function Name: DPWH-LRFD BSBS(2013)

Spectral Data Type: Normalized Accel. Acceleration Velocity Displacement

Scaling: Scale Factor Maximum Value

Scale Factor: 1

Gravity: 9806 mm/sec²

Damping Ratio: 0.05

Graph Options: X-axis log scale Y-axis log scale

| | Period (sec) | Spectral Data (g) |
|----|--------------|-------------------|
| 1 | 0.0000 | 0.5000 |
| 2 | 0.0600 | 0.7357 |
| 3 | 0.1200 | 0.9714 |
| 4 | 0.1527 | 1.1000 |
| 5 | 0.1800 | 1.1000 |
| 6 | 0.2400 | 1.1000 |
| 7 | 0.3000 | 1.1000 |
| 8 | 0.3600 | 1.1000 |
| 9 | 0.4200 | 1.1000 |
| 10 | 0.4800 | 1.1000 |
| 11 | 0.5400 | 1.1000 |
| 12 | 0.6000 | 1.1000 |
| 13 | 0.6600 | 1.1000 |
| 14 | 0.7200 | 1.1000 |

Description: DPWH-LRFD BSBS(2013): GT=I, PGA=0.50, Ss=1.10, S1=0.60, RMF=1.00

Buttons: [OK] [Cancel] [Apply]

Response Spectrum Functions

Generate Design Spectrum

Design Spectrum: DPWH-LRFD BSBS(2013)

Ground Type: I II III

Peak Ground Acceleration Coefficient (PGA): 0.5

Spectral Acceleration Coefficient at Period 0.2 sec (Ss): 1.1

Spectral Acceleration Coefficient at Period 1.0 sec (S1): 0.6

Response Modification Factor (R): 1

Max. Period: 6 (Sec)

Buttons: [OK] [Cancel]

Design Spectrum

22. India Material Database Update

- Concrete: IRC:112-2011, IRS Concrete Bridge Code

Properties > Material > Concrete

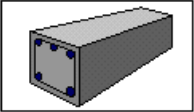
Material Data
✕

General

Material ID: Name:

Elasticity Data

Type of Design:



Type of Material:
 Isotropic Orthotropic

Steel

Standard:

DB:

Concrete

Standard:

Code:

DB:

M15
M20
M25
M30
M35
M40
M45
M50
M55
M60
M65
M70
M75
M80
M85
M90

Steel

Modulus of Elasticity: kN/m²

Poisson's Ratio:

Thermal Coefficient: 1/[C]

Weight Density: kN/m³

Use Mass Density: kN/m³/g

Concrete

Modulus of Elasticity: kN/m²

Poisson's Ratio:

Thermal Coefficient: 1/[C]

Weight Density: kN/m³

Use Mass Density: kN/m³/g

IRC:112-2011

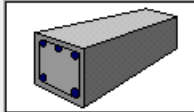
Material Data
✕

General

Material ID: Name:

Elasticity Data

Type of Design:



Type of Material:
 Isotropic Orthotropic

Steel

Standard:

DB:

Concrete

Standard:

Code:

DB:

M20
M25
M30
M35
M40
M45
M50
M55
M60

Steel

Modulus of Elasticity: kN/m²

Poisson's Ratio:

Thermal Coefficient: 1/[C]

Weight Density: kN/m³

Use Mass Density: kN/m³/g

Concrete

Modulus of Elasticity: kN/m²

Poisson's Ratio:

Thermal Coefficient: 1/[C]

Weight Density: kN/m³

Use Mass Density: kN/m³/g

IRS Concrete Bridge Code

23. IRS Load Combination

- Load combination can now be auto-generated based on recommendations in IRS Concrete Bridge Code, including derailment loads
- These load combination could be used for IRS PSC design

▪ **Results > Load Combination**

| No | Name | Active | Type | E | Description |
|----|--------|---------|------|--------------------------|---------------------|
| 1 | cLCB1 | Strengt | Add | <input type="checkbox"/> | 1U-D:SIDL:SM:EP:F |
| 2 | cLCB2 | Strengt | Add | <input type="checkbox"/> | 1U-D:SIDL:SM:rEP: |
| 3 | cLCB3 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:SM:W |
| 4 | cLCB4 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:SM:rW |
| 5 | cLCB5 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:SM:W:F |
| 6 | cLCB6 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:SM:rW:F |
| 7 | cLCB7 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:1.6RS(X) |
| 8 | cLCB8 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:1.6RS(X) |
| 9 | cLCB9 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:1.6RS(X) |
| 10 | cLCB10 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:1.6RS(X) |
| 11 | cLCB11 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:-1.6RS(X) |
| 12 | cLCB12 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:-1.6RS(X) |
| 13 | cLCB13 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:-1.6RS(X) |
| 14 | cLCB14 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:-1.6RS(X) |
| 15 | cLCB15 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:0.48RS(|
| 16 | cLCB16 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:0.48RS(|
| 17 | cLCB17 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:-0.48RS(|
| 18 | cLCB18 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:-0.48RS(|
| 19 | cLCB19 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:0.48RS(|
| 20 | cLCB20 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:0.48RS(|
| 21 | cLCB21 | Strengt | Add | <input type="checkbox"/> | 2U-D:SIDL:-0.48RS(|

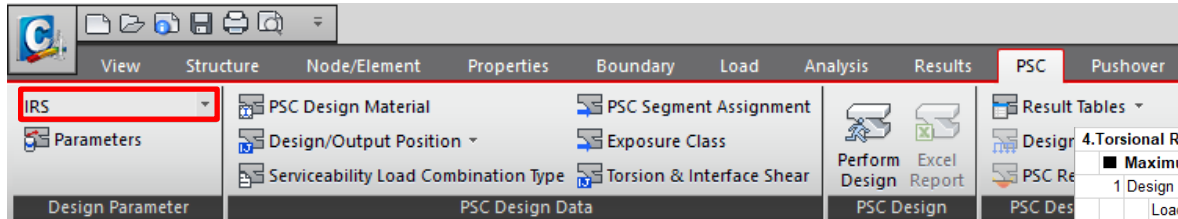
| LoadCase | Factor |
|---------------------------|--------|
| Dead 1(ST) | 1.2500 |
| Bouyancy(ST) | 2.0000 |
| Dead DC(ST) | 2.0000 |
| Dead DW(ST) | 2.0000 |
| Pavement(ST) | 2.0000 |
| Ballast(ST) | 2.0000 |
| Settlement(ST) | 1.0000 |
| Earth Pressure(ST) | 1.7000 |
| Horizontal EP(ST) | 1.7000 |
| Vertical EP(ST) | 1.7000 |
| Earth Surcharge(ST) | 1.7000 |
| Ground Water Pressure(ST) | 1.7000 |
| LL Surcharge(ST) | 1.7000 |
| FPLL(ST) | 1.5000 |
| Live Load(ST) | 1.7500 |
| Centrifugal(ST) | 1.7500 |
| Braking(ST) | 1.7500 |
| SET(SM) | 1.0000 |
| MVLC(MV) | 1.7500 |
| * | |

Load Combination dialogue box

24. Prestressed Concrete Design by IRS Concrete Bridge Code

- Prestressed concrete girder design by IRS Concrete Bridge Code is now available.

■ PSC > Design Parameter > Parameters > IRS



PSC Design Parameters

Design Code : IRS

Input Parameters

Design Parameters (Ultimate limit states)

Moment resistance
 Consider tendons in tensile zone Consider all tendons Prestressing Steel Type
 Smooth bars and wires Strands

User Input Data Modify design parameters...

Construction Type
 Segmental Non-Segmental

Output parameters

| | |
|---|--|
| <p>Ultimate limit states</p> <p><input checked="" type="checkbox"/> Ultimate bending resistance</p> <p><input checked="" type="checkbox"/> Shear resistance</p> <p><input checked="" type="checkbox"/> Torsional resistance</p> | <p>Serviceability limit states</p> <p><input checked="" type="checkbox"/> Stress for cross section at a construction stage</p> <p><input checked="" type="checkbox"/> Stress for cross section at service loads</p> <p><input checked="" type="checkbox"/> Principal stress at a construction stage</p> <p><input checked="" type="checkbox"/> Principal stress at service loads</p> <p><input checked="" type="checkbox"/> Tensile stress for prestressing steel</p> <p><input checked="" type="checkbox"/> Crack control</p> |
|---|--|

Select All Unselect All

OK Cancel

Input & Output parameters

| 4. Torsional Resistance | | | |
|---|---------------------------------------|-----------------------------------|--|
| ■ Maximum Shear Force | | | |
| 1 Design Load | | | |
| Load Combination Name : | ULS1 | | |
| Design Situations : | | | |
| Load Combination Type : | | | |
| N_{Ed} = | -18066.337 | kN | |
| V_{Ed} = | -244.386 | kN | |
| T_{Ed} = | 293.826 | kN · m | |
| M_{Ed} = | 39746.713 | kN · m | |
| - Design strength of concrete (IRS, 6.4.2.8) | | | |
| f_{cd} = | $\alpha_{cc} \cdot f_{ck} / \gamma_c$ | = | 17.867 MPa |
| - Design strength of Reinforcement (IRS, 6.2.2) | | | |
| f_{yd} = | $f_{yk} / \gamma_{s_rebar}$ | = | 434.783 MPa |
| 2 Check Torsional Resistance | | | |
| ■ Closed Section Part | | | |
| - Design Parameters (IRS, 10.5.2) | | | |
| v_t = | $T / (2 \cdot h_{wo} \cdot A_o)$ | = | 0.024 MPa (IRS CBC 15.4.4.4, Equation 9) |
| Where, | | | |
| v_t | = | Torsional Stress | |
| T | = | T_{Ed} | |
| h_{wo} | = | wall thickness for torsion | = 400.077 mm |
| A_o | = | area enclosed by median wall line | = 15612913.33 mm ² |
| $v_{t,min}$ | = | Minimum torsional resistance | = 0.420 MPa (IRS CBC, Table 17) |
| | | $\geq v_t$ | Torsional R/F not required |
| v_{ts} | = | $V / (b \cdot d)$ | = 0.039 MPa (IRS CBC 15.4.3.1, Equation 8) |
| Where, | | | |
| v_{ts} | = | Shear stress in section | |
| V | = | V_{Ed} | = -244.386 kN |

Excel Report