

Release Note

Release Date : December 2020

Product Ver. : Civil 2021 (v1.1)



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

1. Automatic Generation of Moving Train Loads for Dynamic Analysis
2. Debonded Length of Pretensioned Beam
3. Correction of Tendon Force/Stress within Transfer Length of Pretensioned Beams
4. Moving Load Analysis including Centrifugal Force Effects to AASHTO LRFD
5. Update to CS 454 revision 1 for the UK Bridge Assessment
6. Application of Combined Special Vehicle and ALL model 1 for CS 454 Assessment
7. Separate the Results of Combined Vehicles for CS 454 Assessment
8. Pretensioned Beam Design at Transfer to AS 5100.5
9. Transmission Zone Design of Pretensioned Beam to AS 5100.5
10. Crack control for the Slab of PSC Composite Girder to AS 5100.5
11. Joint Check of Segmental Construction to BS 5400.4
12. Response Spectrum Function : IRC SP 114:2018
13. Auto Temperature Gradient as per IRC 6:2017
14. Improvement in Auto Load combinations as per IRC 6:2017
15. Update in General Section Designer as per IRS Specifications



1. Automatic Generation of Moving Train Loads for Dynamic Analysis

- Generate time-forcing functions without considering the lengths of the element along the track. The required nodal spacing along the track is automatically detected by the program.
- Auto-generate time-forcing function and dynamic nodal loads representing moving train loads. Previously, dynamic nodal loads had to be defined by the user manually.
- This function replaces Tools>Generator>Data Generator>Train Load Generator.

Load > Dynamic Loads > Time History Analysis Data > Train Load Generator

Define Tracks

Train Load Generator

Define Tracks

2 Points Picking Number

0, 0 m

100, 0 m

Operations

Add Insert Delete

| No | Node | Distance(m) |
|----|------|-------------|
| 1 | 1 | 0 |
| 2 | 2 | 1.5 |
| 3 | 3 | 0.5 |
| 4 | 4 | 1 |

Dynamic Load Case: HSLM

Name:

Vehicle Code: Korea

Vehicle Type: KTX, 20 cars, Korea

Number of Wheels: 46

Train Velocity: 200 km/h

Scaling

Scale Factor: 1

Max. Value: 0

Time

Start Time: 0 sec

Direction: -Z

Add Modify Delete Insert

Length: 0 Force: 0

Open... Save As... Show Graph... OK Cancel

Train Load Generator

Add/Modify/Show Time History Functions

Function Name: o_f003

Time Function Data Type

Normalized Accel. Acceleration Force Moment Normal

Scaling

Scale Factor: 1

Maximum Value: 0 kN

Gravity: 9.806 m/sec²

Graph Options

X-axis log scale

Y-axis log scale

F.F.T

| | Time (sec) | Function (kN) |
|----|------------|---------------|
| 1 | 0.0000 | 0.0000 |
| 2 | 0.0180 | 170.0000 |
| 3 | 0.0360 | 0.0000 |
| 4 | 0.0540 | 0.0000 |
| 5 | 0.0720 | 170.0000 |
| 6 | 0.0900 | 0.0000 |
| 7 | 0.2520 | 0.0000 |
| 8 | 0.2700 | 170.0000 |
| 9 | 0.2880 | 0.0000 |
| 10 | 0.3060 | 0.0000 |
| 11 | 0.3240 | 170.0000 |
| 12 | 0.3420 | 0.0000 |
| 13 | 0.3650 | 0.0000 |
| 14 | 0.3830 | 170.0000 |

Time History Data

180

160

140

120

100

80

60

40

20

0

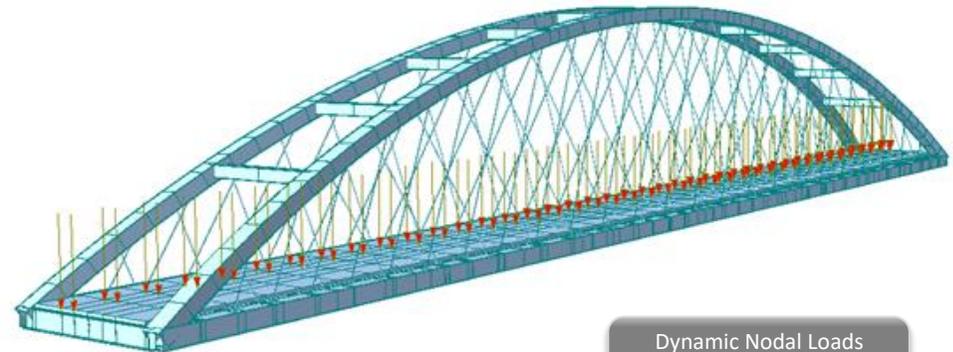
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5

Time (sec)

Description:

Generate Earthquake Response Spectrum...

OK Cancel Apply



Dynamic Nodal Loads

2. Debonded Length of Pretensioned Beam

- Debonded length of pretensioned beam can be directly defined when creating strands from the Tendon Profile dialog box.
- Define the actual whole length of stand including debonded parts at both ends and then enter the lengths for debonded parts.

▪ Load > Temp./Prestress > Prestress Loads > Tendon Profile

Add/Modify Tendon Profile [X]

Tendon Name : Cable_006 Group : Default [v] [...]

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

Assigned Elements : 1to20

Input Type
 2-D 3-D

Curve Type
 Spline Round

Straight Length of Tendon
 Begin : 0 mm
 End : 0 mm

Typical Tendon No. of Tendons : 1

Transfer Length
 User defined Length [v] Begin : 800 End : 800 mm

Debonding Data
 Debonded Length Begin : 3000 End : 3000 mm

Profile
 Reference Axis : Straight Curve Element

Point of Sym.: First Last

Profile Insertion Point : End-I End-J of Elem. 1

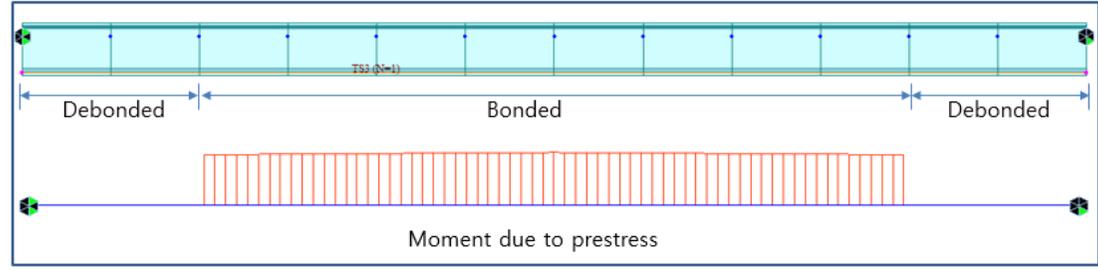
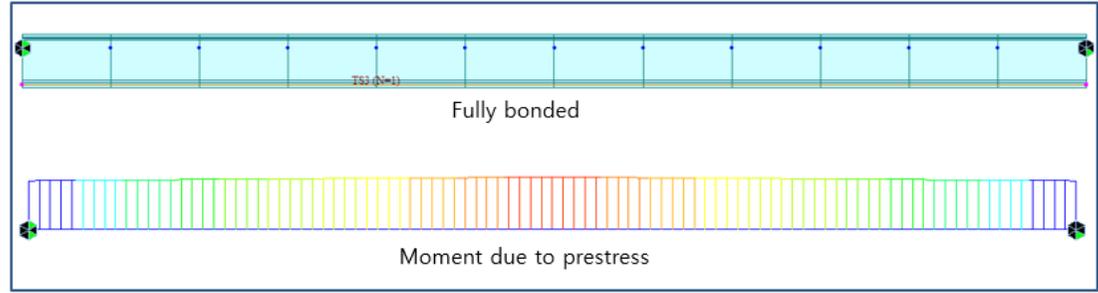
x Axis Direction : I -> J J -> I of Elem. 1

x Axis Rot. Angle : 0 [deg] Projection

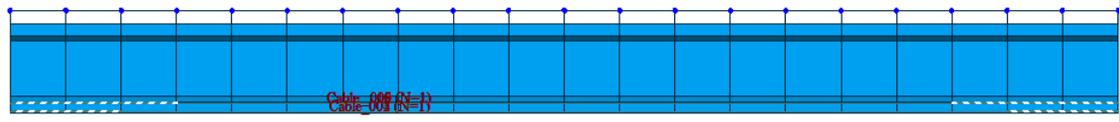
Offset y : 0 mm z : 0 mm

[OK] [Cancel] [Apply]

Tendon Profile



Tendon Primary Moment Diagram

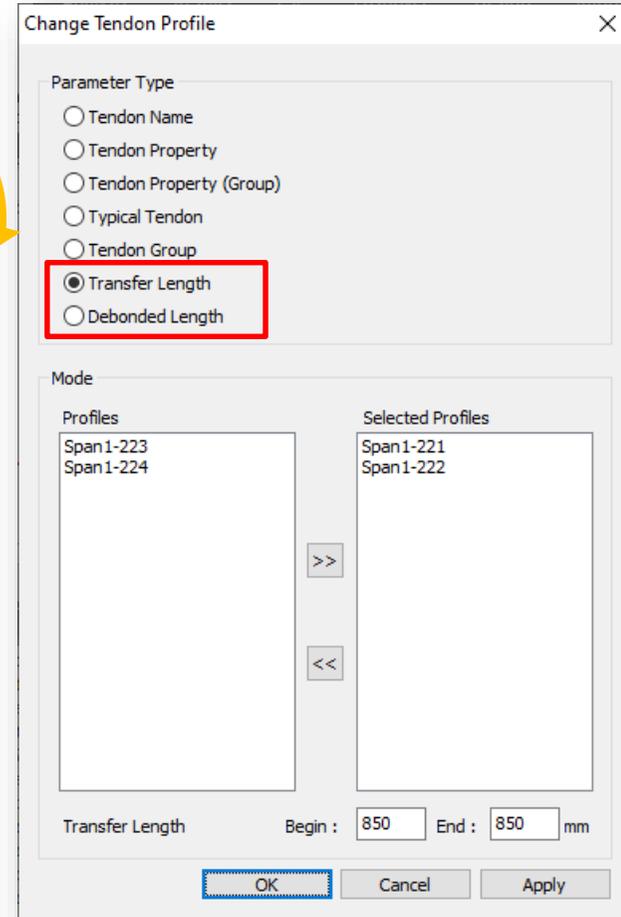
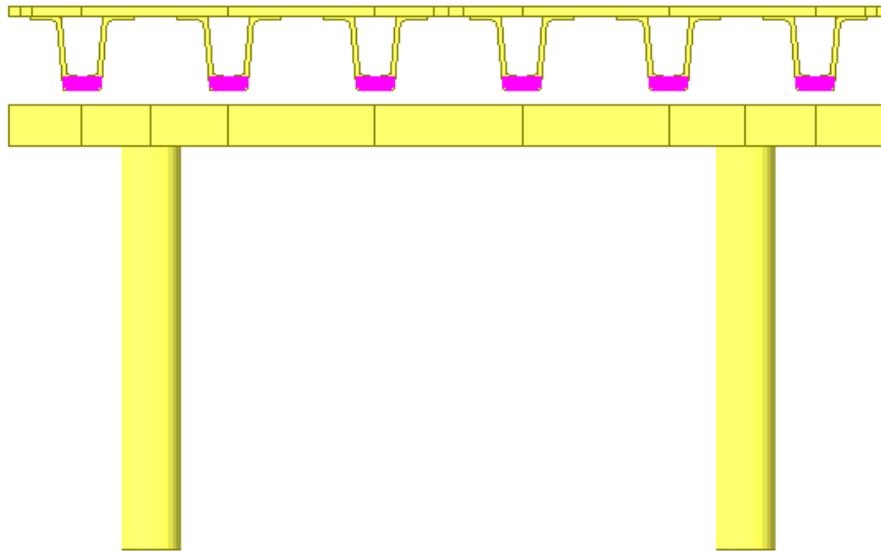
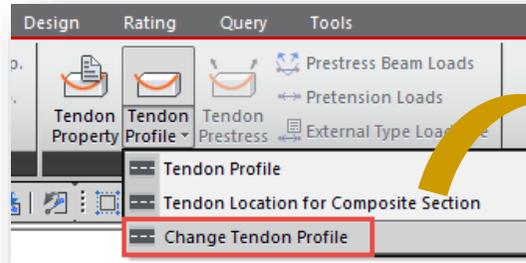


Display of debonded strands

2. Debonded Length of Prestensioned Beam

- Debonded length and transfer length can be modified for the multiple strands at one time.

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



Change Tendon Profile

3. Correction of Tendon Force/Stress within Transfer Length of Prestensioned Beams

- The stress in the prestressing steel is assumed to vary linearly from 0.0 at the point where bonding commences, to the effective stress after losses at the end of the transfer length.

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

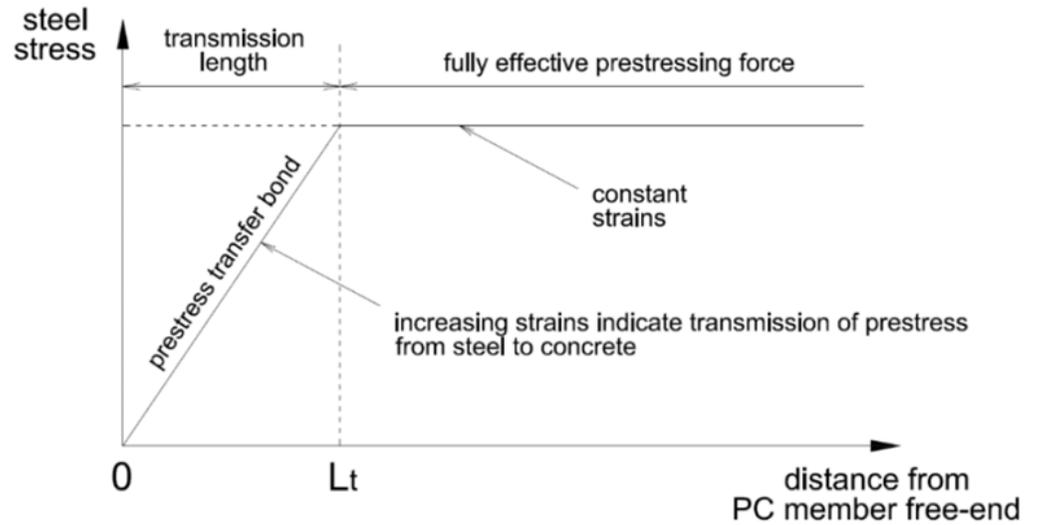
Pre-tension type

Transfer Length

The dialog box 'Add/Modify Tendon Profile' contains the following fields and options:

- Tendon Name: Span1-221
- Group: Tendon-Sp
- Tendon Property: Tendon
- Assigned Elements: 1to34
- Input Type: 2-D (selected), 3-D
- Curve Type: Spline, Round (selected)
- Typical Tendon: (unchecked)
- Transfer Length: User defined Length (selected), Begin: 800, End: 800 mm
- Debonding Data: Debonded Length: Begin: 0, End: 0 mm
- Profile: Reference Axis: Straight, Curve, Element (selected)
- Point of Sym.: First, Last (selected), Make Symmetric Tendon
- Profile Insertion Point: End-I (selected), End-J of Elem. (1)
- x Axis Direction: I -> J (selected), J -> I of Elem. (1)
- x Axis Rot. Angle: 0 [deg], Projection
- Offset y: 0 mm, z: 0 mm

Tendon Profile

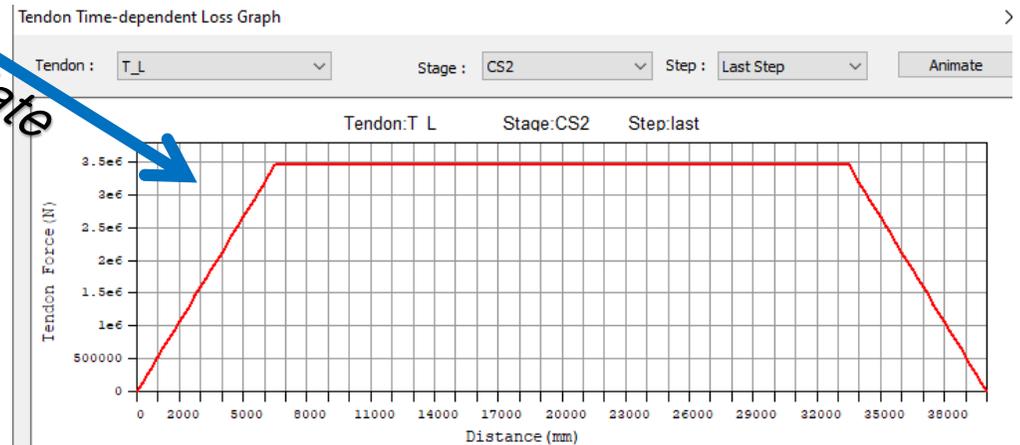
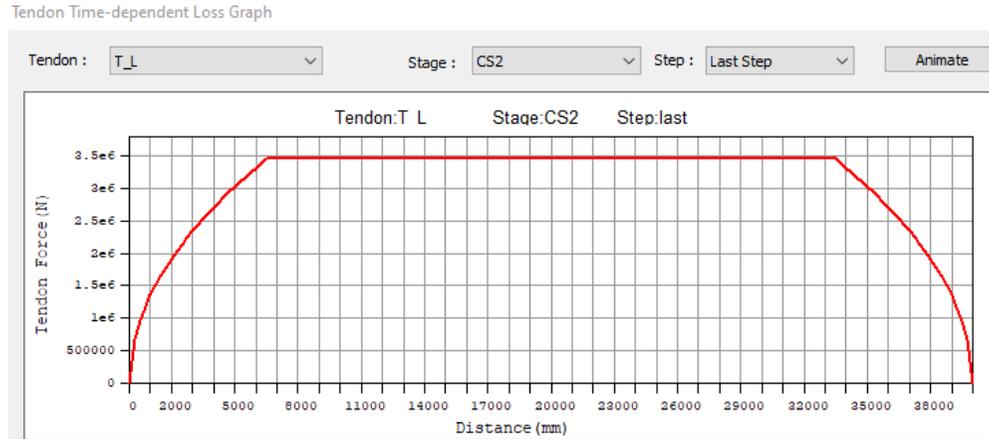


Idealized steel-stress development in PSC member

3. Correction of Tendon Force/Stress within Transfer Length of Pretensioned Beams

- Tendon stresses after immediate loss are determined linearly with the transfer length, and then losses due to creep, shrinkage and relaxation will be calculated along the time.

Result > Bridge > Tendon Loss Graph



4. Moving Load Analysis including Centrifugal Force Effects to AASHTO LRFD

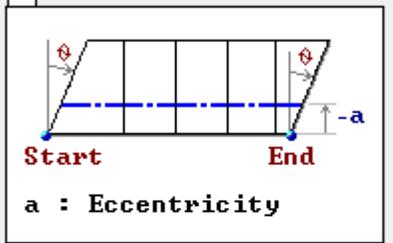
- The overturning component of centrifugal force is now taken into account during the moving load analysis. The results of vehicle application will be the combination of vertical effect and overturning effect of the vehicle. The overturning component causes the exterior wheel line to apply more than half the weight of the truck and the interior wheel line to apply less than half the weight of the truck by the same amount.
- In order to apply centrifugal forces, the 'Add Centrifugal Force' option should be checked on from the Vehicle definition as well as Traffic Line/Surface Lane.

▪ **Load > Moving Load Code > AASHTO LRFD**

Define Design Traffic Line Lane

Lane Name :

Traffic Lane Properties



a : Eccentricity

Lane Width : ft

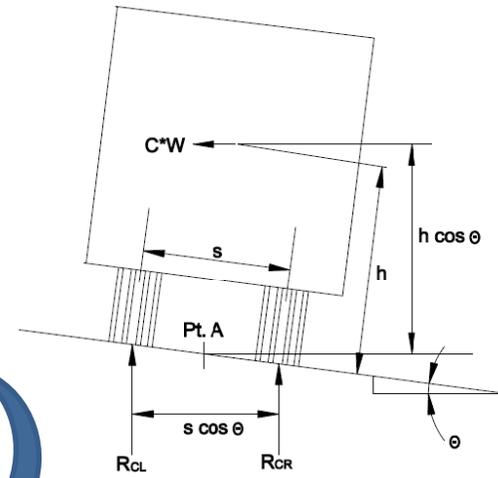
Eccentricity : ft

Wheel Spacing: ft

Centrifugal Force

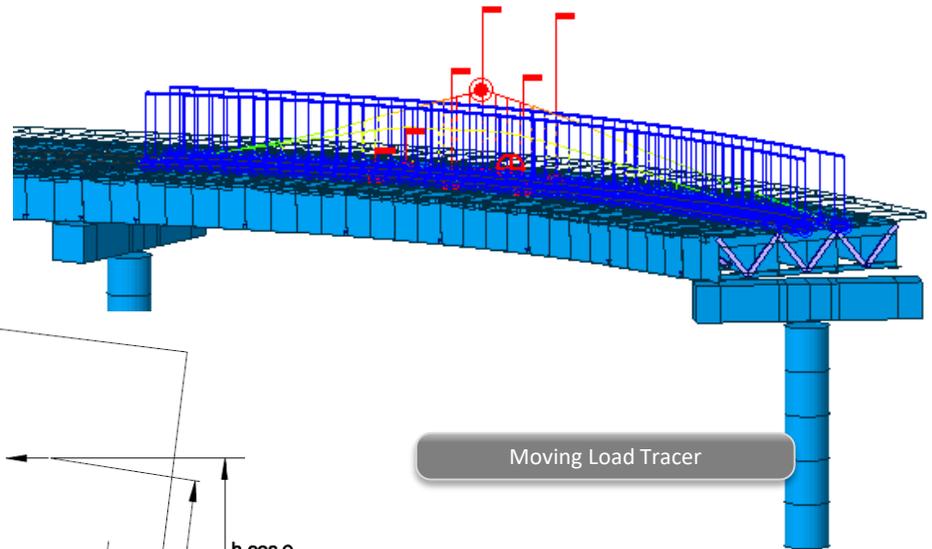
Left Wheel of Vehicle

Moving Forward W



$R_{CL} = 0.6W$

 $R_{CR} = 0.4W$



| No | Load(kips) | Spacing(ft) | W | 0.64 | kips/ft |
|----|------------|-------------|-------|------|---------|
| 1 | 8 | 14 | r | 90 | % |
| 2 | 32 | 14 | Dist. | 50 | ft |
| 3 | 32 | 30 | | | |

Add Centrifugal Force

Traffic Line Lane Vehicular Centrifugal Force Wheel-Load Reactions Vehicle

5. Update to CS 454 revision 1 for the UK Bridge Assessment

- CS 454 revision 1 Assessment of highway bridges and structures
- The existing CS454/19 is replaced by CS454/20. References in the report are changed from BD 86/11, BD 44/15 to CS 458, CS 455, respectively.

Rating > Bridge Rating Design > PSC Bridge > Design Code for Assessment

PSC Rating Design Code

Rating Design Code : CS454/19

OK Cancel

PSC Rating Design Code

Rating Design Code : CS454/20

OK Cancel

1. Design Condition

| Design code | Element | Part(Node) |
|-------------|---------|------------|
| CS454/19 | 16 | J(17) |

2. Assessment factors

The following factors, as in BD 86/11, have been used to compare results of different configurations and combinations.

- Adequacy factor:

$$A = \frac{R_a^*}{S_a^*}$$

- Special Vehicle reserve factor with standard vehicle:

$$\psi = \frac{R_a^* - (S_D^* + S_{ST}^*)}{S^*}$$

- Special Vehicle reserve factor without standard vehicle:

$$\psi^* = \frac{R_a^* - S_D^*}{S^*}$$

CS 454/19 Report

1. Design Condition

| Design code | Element | Part(Node) |
|-------------|---------|------------|
| CS454/20 | 16 | J(17) |

2. Assessment factors

The following factors, as in CS 458, have been used to compare results of different configurations and combinations.

- Adequacy factor:

$$A = \frac{R_a^*}{S_a^*}$$

- Special Vehicle reserve factor with standard vehicle:

$$\psi = \frac{R_a^* - (S_D^* + S_{ST}^*)}{S^*}$$

- Special Vehicle reserve factor without standard vehicle:

$$\psi^* = \frac{R_a^* - S_D^*}{S^*}$$

CS 454/20 Report

5. Update to CS 454 revision 1 for the UK Bridge Assessment

- Changes in CS 455: The assessment of concrete highway bridges and structures (formerly BD 44/15)
 - The compressive stress limit of composite beam is changed.

4.8.2 Stress Limit

a) Non-composite sections:

The compressive stress must be limited to $0.5(f_{cu}/\gamma_{mc})$.

b) Composite sections:

The maximum compressive stress limit can be taken as equal to $0.625 (f_{cu}/\gamma_{mc})$.



BD 44/15

Table 8.15a SLS classes for prestressed elements

| SLS class | Tensile stress limits ^[1,2] | Compressive stress limits ^[3,4] |
|-------------|--|---|
| SLS Class 1 | $\sigma_{ct} < 0$ | $\sigma_c < 0.5 \frac{f_{cu}}{\gamma_{mc}}$ |
| SLS Class 2 | $0 \leq \sigma_{ct} < \frac{0.56}{\gamma_{mc}} \sqrt{f_{cu}}$ | $\sigma_c < 0.5 \frac{f_{cu}}{\gamma_{mc}}$ |
| SLS Class 3 | <p>The tensile stresses in the concrete do not satisfy SLS Class 2 but either of the following are satisfied:</p> <ol style="list-style-type: none"> hypothetical tensile stresses are assessed to be less than the equivalent limits given in Table 8.15b; or, an assessment of crack widths demonstrates that crack widths satisfy SLS design requirements for durability. | $\sigma_c < 0.5 \frac{f_{cu}}{\gamma_{mc}}$ |

CS 455

5. Update to CS 454 revision 1 for the UK Bridge Assessment

2) The tensile stress limit of pre-tensioned class 3 members is changed.

Table 4-5 Hypothetical flexural tensile stresses for class 3 members

| | Limiting crack width mm | Stress for concrete grade | | |
|--------------------------|----------------------------|---------------------------|-------------------------|----------------------------------|
| | | 30 N/mm ² | 40 N/mm ² | 50 and over N/mm ² |
| a) Pre-tensioned tendons | 0.1 | - | 4.1 | 4.8 |
| | 0.15 | - | 4.5 | 5.3 |
| | 0.25 | - | 5.5 | 6.3 |



b) Grouted post-tensioned tendons **Table 8.15b Hypothetical tensile stress limits for SLS Class 3**

| c) Pre-tensioned tendons distributed in the tensile zone and positioned close to the tension faces of the concrete | Prestressing type | Surface environment ^[1] | Hypothetical tensile stress limits for a member of 400mm depth ^[2] | | |
|--|-------------------|------------------------------------|---|-------------------|----------------------|
| | | | $f_{cu} = 30$ MPa | $f_{cu} = 40$ MPa | $f_{cu} \geq 50$ MPa |
| Pre-tensioned tendons / grouted post-tensioned tendons | | Extreme | - | 4.1 | 4.8 |
| | | Very severe | 3.5 | 4.5 | 5.3 |
| | | Severe / Moderate | 4.1 | 5.5 | 6.3 |
| Pre-tensioned tendons distributed in the tensile zone and positioned close to the tension faces of the concrete | | Extreme | - | 5.3 | 6.3 |
| | | Very severe | - | 5.8 | 6.8 |
| | | Severe / Moderate | - | 6.8 | 7.8 |

BD 44/15

Note 1: The surface environment is defined in Table 8.15c for the surface in tension.
 Note 2: The hypothetical tensile stress limits are applicable for a member of 400mm depth. For other depths, the stress limits should be multiplied by the depth factor in Table 8.15d.
 Note 3: The hypothetical tensile stress limits are based on the analysis of a notionally uncracked section where plane sections are assumed to remain plane and the concrete is assumed to have linear elastic properties in tension and compression up to the hypothetical stress limits.
 Note 4: The hypothetical tensile stress limits are not applicable for unbonded tendons; prestressed structures containing exclusively unbonded tendons need not to be checked for cracking, and those containing both bonded and unbonded tendon are treated as reinforced concrete sections in which the effect of prestress is an axial force and moment, and crack widths are calculated as reinforced concrete columns.
 Note 5: The hypothetical tensile stress limits conservatively ignore the effect of additional tensile reinforcement. The effect of additional tensile reinforcement is given in BS 5400-4 [Ref 19.].

CS 455

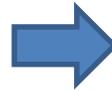
5. Update to CS 454 revision 1 for the UK Bridge Assessment

3) When additional reinforcement is contained within the tension zone, the provision of increase in the tensile stress limit of pre-tensioned class 3 members is removed.

6.3.2.4 Cracking

When additional reinforcement is contained within the tension zone and positioned close to the tension faces of the concrete, these hypothetical tensile stresses may be increased by an amount that is proportional to the cross-sectional areas of the additional reinforcement expressed as a percentage of the cross-sectional area of the tensile concrete. For 1 % of additional reinforcement the stresses in Table 25 may be increased by 4.0 N/mm^2 for members in groups a) and b) and by 3.0 N/mm^2 for members in group c). For other percentages of additional reinforcement the stresses may be increased in proportion, except that the total hypothetical tensile stress should not exceed one-quarter of the characteristic cube strength of the concrete.

Where the hypothetical tensile stresses in Table 25 are to be increased to allow for additional reinforcement, and where the depth factors in Table 26 also apply, the values to be used should be obtained by first multiplying the basic stress from Table 25 by the appropriate factor from Table 26 and then adding the allowance for additional reinforcement.



Removed

BD 44/15 referring to BS 5400-4

CS 455

5. Update to CS 454 revision 1 for the UK Bridge Assessment

- 4) Some formulae for ULS shear check are changed.
- 5) The vertical component of the prestressing force may be added to Vmax as per clause 8.20.2. Additional option is introduced to consider this change.

ULS Shear check

$$V_{max} = (0.36(0.7 - f_{cu}/250) f_{cu}/\gamma_{mc}) b d_s$$

$$V_{co} = \frac{Ib}{S} \sqrt{f_t^2 + \sigma_{cpb} f_t}$$

$$V_{cr} = (1 - 0.55 f_{pe}/f_{pu}) v_c b d_s + M_o/(M/V - d_s/2)$$

$$\frac{M}{z} + \frac{(V - \xi_s v_c b_w d)}{2}$$

BD 44/15

$$V_{max} = 0.36 \left(0.7 - \frac{f_{cu}}{250} \right) \left(\frac{f_{cu}}{\gamma_{mc}} \right) b_w d + P_v$$

$$V_{co} = 0.67 b h \sqrt{f_t^2 + \sigma_{cp} f_t}$$

$$V_{cr2} = \left(1 - 0.55 \frac{f_{pe}}{f_{pu}} \right) V_{uc'} + \frac{M_0}{M/V - d/2}$$

$$A_{st} \frac{f_{put}}{\gamma_{ms}} + A_{su} \frac{f_{yu}}{\gamma_{ms}} \geq \frac{M}{z} + \frac{V - V_{uc}}{2} (1 - \cot \alpha)$$

CS 455

Assessment Parameter ✕

Condition Factor(Fc)

Material Strength used for Assessment

Characteristic Strength

Worst Credible Strength

User Input

Modify Design Parameters

Option for Shear Resistance

Add Vertical Component of Prestressing Force to Vmax (d. 8.20.2)

Ultimate Limit State

Flexure

Shear

Torsion

Serviceability Limit State

Stress/Crack

Detailed Report

Ultimate Limit State

Serviceability Limit State

Option in Assessment Parameter

6. Application of Combined Special Vehicle and ALL model 1 for CS 454 Assessment

- CS 454: Assessment of highway bridges and structures
- ALL mode 1 (single or convoy) can be applied along with special vehicle or HB load.

- **Load > Moving Load Code > BS**
- **Load > Moving Load Analysis Data > Moving Load Cases**

Define Moving Load Case

Load Case Name :

Description :

Moving Load Optimization

Select Load Model

Standard Load (BD 37/01, BS 5400)

Special Load (BD 86/11)

CS 454 Assessment (ALL Model 1, Special Load)

CS 454 Assessment (ALL Model 2, Special Load)

Auto Live Load Combination

Type of Design Combination Factor

Ultimate Limit State

Serviceability Limit State

Combination of Loads

Combination 1

Combination 2 or 3

Load Case Data

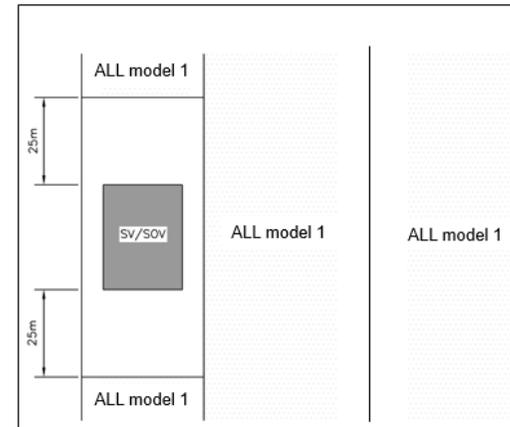
Standard Load :

Special Load :

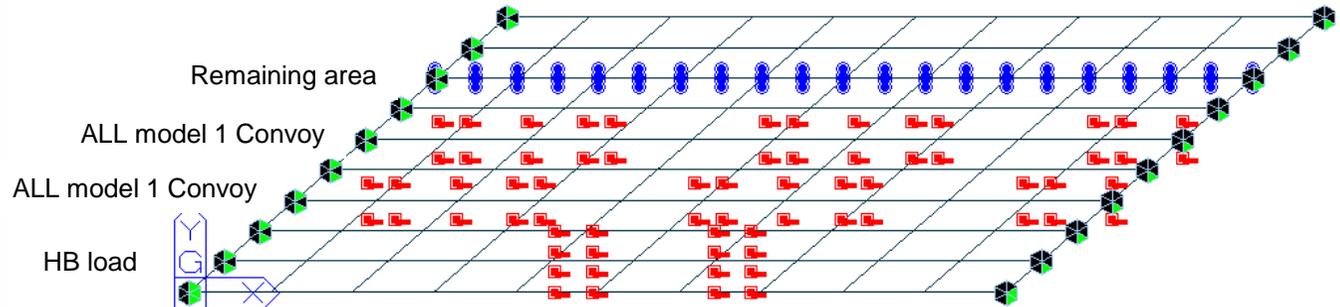
Assignment Lanes

| Line of Lanes | Selected Lanes | Straddling Lanes |
|---------------|----------------------------|------------------------------------|
| | Lane 1 Lane 2 Lane 3 | Lane 1 : Lane 2 Lane 2 : Lane 3 |
| | | Remaining Area Lane 4 |

OK Cancel Apply



Combined SV and ALL model 1



Moving Load Tracer

Moving Load Case Dialog Box

7. Separate the Results of Combined Vehicles for CS 454 Assessment

- The results of combined special vehicle and ALL model can be viewed separately by vehicles.
- This is useful when calculating reserve factors for special vehicles applied together with ALL model 1 or 2.

▪ Load > Moving Load Code > BS

Define Moving Load Case ✕

Load Case Name :

Description :

Moving Load Optimization

Select Load Model

Standard Load (BD 37/01, BS 5400)

Special Load (BD 86/11)

CS 454 Assessment (ALL Model 1)

CS 454 Assessment (ALL Model 2, Special Load)

Auto Live Load Combination

Type of Design Combination Factor

Ultimate Limit State

Serviceability Limit State

Combination of Loads

Combination 1

Combination 2 or 3 **Combined Vehicles**

Load Case Data

Standard Load :

Special Load :

Assignment Lanes

| Line of Lanes | Selected Lanes | Straddling Lanes |
|---------------|----------------------------|------------------------------------|
| | Lane 1 Lane 2 Lane 3 | Lane 1 : Lane 2 Lane 2 : Lane 3 |

Results > Result Tables > Beam > Forces

| | Elem | Load | Part | Axial (kN) | Shear-y (kN) | Shear-z (kN) | Torsion (kN-m) | Moment-y (kN-m) | Moment-z (kN-m) |
|---|------|-------------------|------|------------|--------------|--------------|----------------|-----------------|-----------------|
| ▶ | 1 | ULS-combined(max) | I[1] | 729.73 | 10.91 | 0.00 | 19.71 | 874.94 | 13.47 |
| | 1 | ULS-combined(max) | J[2] | 729.73 | 10.91 | 0.00 | 19.71 | 2142.31 | 205.19 |
| | 2 | ULS-combined(max) | I[2] | 624.96 | 17.12 | 40.42 | 18.02 | 2096.93 | 35.66 |
| | 2 | ULS-combined(max) | J[3] | 624.96 | 17.12 | 40.42 | 18.02 | 3716.00 | 105.83 |
| | 3 | ULS-combined(max) | I[3] | 577.18 | 25.54 | 73.49 | 0.78 | 3660.09 | 39.48 |
| | 3 | ULS-combined(max) | J[4] | 577.18 | 25.54 | 73.49 | 0.78 | 4814.77 | 148.97 |

◀ ▶ **Beam Force**

View by Max Value

| | Elem | Load | Part | Component | Shear-y (kN) | Shear-z (kN) | Torsion (kN-m) | Moment-y (kN-m) | Moment-z (kN-m) | |
|---|------|-------------------|------|-----------|--------------|--------------|----------------|-----------------|-----------------|--------|
| ▶ | 1 | ULS-combined(max) | I[1] | Moment-y | 729.73 | 10.49 | 0.00 | 19.71 | 610.40 | 13.47 |
| | 1 | ULS-combined(max) | J[2] | Moment-y | 729.73 | 10.49 | 0.00 | 19.71 | 1490.96 | 142.59 |
| | 2 | ULS-combined(max) | I[2] | Moment-y | 624.96 | 16.48 | 40.42 | 18.02 | 1534.39 | 28.40 |
| | 2 | ULS-combined(max) | J[3] | Moment-y | 624.96 | 16.48 | 40.42 | 18.02 | 2991.74 | 91.46 |
| | 3 | ULS-combined(max) | I[3] | Moment-y | 577.18 | 25.51 | 73.49 | 0.00 | 2990.64 | 38.52 |
| | 3 | ULS-combined(max) | J[4] | Moment-y | 577.18 | 25.51 | 73.49 | 0.00 | 3965.49 | 100.88 |

◀ ▶ Result By Max Value-[Beam Force] / Result By Max Value-[Beam Force]_Standard / **Result By Max Value-[Beam Force]_Special** /

View by Load Cases

| | Elem | Part | ULS-combined | ULS-combined_Standard | ULS-combined_Special |
|-------------------------------|------|------|--------------|-----------------------|----------------------|
| | | | max | max | max |
| Output: Moment-y(kN-m) | | | | | |
| ▶ | 1 | I | 874.94 | 264.55 | 610.40 |
| | 1 | J | 2142.31 | 651.35 | 1490.96 |
| | 2 | I | 2096.93 | 562.54 | 1534.39 |
| | 2 | J | 3716.00 | 724.25 | 2991.74 |
| | 3 | I | 3660.09 | 669.45 | 2990.64 |
| | 3 | J | 4814.77 | 849.28 | 3965.49 |

◀ ▶ **Moment-y**

S*_{ST}

S*

- SV reserve factor

$$\Psi_{SV} = \frac{R_A^* - (S_D^* + S_{ST}^*)}{S^*}$$

8. Pretensioned Beam Design at Transfer to AS 5100.5

- Pretensioned beam design at transfer is provided as per clause 8.1.6.2 and 8.6.2 of AS 5100.5.
- Load combination type for transfer check is added.
- Compressive strength, fcp during transfer needs to be defined manually for the design checks.

▪ **PSC > Design Parameter > AS 5100.5: 17**

Load Combinations

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

Load Combination List

| No | Name | Active | Type | E | Description |
|----|-------|---------|------|--------------------------|---|
| 1 | cLCB1 | Strengt | Add | <input type="checkbox"/> | ULS : Minimum Strength and Stability - 1.35(cEL2) |
| 2 | cLCB2 | Strengt | Add | <input type="checkbox"/> | ULS : Minimum Strength and Stability - 0.9(cEL2) |
| 3 | cLCB3 | Strengt | Add | <input type="checkbox"/> | ULS6 : 1.8M[1]+2.0(cEL2)+1.0(cTs)+1.2(cCR)+1.2(cSH) |
| 4 | cLCB4 | Strengt | Add | <input type="checkbox"/> | ULS6 : 1.8M[1]+0.8(cEL2)+1.0(cTs)+1.2(cCR)+1.2(cSH) |
| 5 | cLCB5 | Strengt | Add | <input type="checkbox"/> | ULS7 : 1.8M[1]+2.0(cEL2)+1.0(cTs)+1.2(cCR)+1.2(cSH) |
| 6 | cLCB6 | Strengt | Add | <input type="checkbox"/> | ULS7 : 1.8M[1]+0.8(cEL2)+1.0(cTs)+1.2(cCR)+1.2(cSH) |
| 7 | cLCB7 | Service | Add | <input type="checkbox"/> | SLS18 : 1.0M[1]+1.3(cEL2)+1.0(cTP)+1.0(cTs)+1.0(cCR)+1.0(cSH) |
| 8 | cLCB8 | Service | Add | <input type="checkbox"/> | Transfer: 1.0(cDL)+1.0(cTP)+1.0(cTs) |

Load Cases and Factors

| LoadCase | Factor |
|----------------------|--------|
| Dead Load(CS) | 1.0000 |
| Tendon Primary(CS) | 1.0000 |
| Tendon Secondary(CS) | 1.0000 |
| * | |

Load Combination

Modify Concrete Materials

Material List

| ID | Name | fc fck R | Chk | Lambda | Main-bar | Sub-bar |
|----|------|----------|-----|--------|----------|---------|
| | | | | | | |

Concrete Material Selection

Code : Grade :

Specified Compressive Strength (fc|fck) : 0 kN/m²

Compressive Strength at Transfer, fci (Pre-tension) : 0 kN/m²

Light Weight Concrete Factor (Lambda) : 0

Manual input option for strength at transfer

View Structure Node/Element Properties Boundary Lo

AS 5100.5:17

PSC Design Material Exposure Class

Parameters Design/Output Position

Transfer Load Combination

Design Parameter PSC Design Data

Transfer Load Combination

Serviceability

cLCB7

At Transfer

cLCB8

OK Cancel

Transfer Load Combination

8. Pretensioned Beam Design at Transfer to AS 5100.5

- Compressive stress of concrete and crack control are checked.
- Excel report and table summary are provided.

PSC > Design Parameter > AS 5100.5: 17

▲ 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

57 2. Transfer check

58 - Transfer stage : at CS1

60 1) Concrete compressive stress check

61 ■ Top

62 - Load combination at transfer: cLCB14

63 - Stress at top surface (Concrete)

64 $f_t = 14.86$ (MPa)

66 - Stress limit

67 $0.6 f_{cp} = 19.20$ (MPa)

68 $f_{cp} = 32.00$ (MPa)

70 - Check Stress

71 $f_t = 14.86$ (MPa) $\leq 0.6 f_{cp} = 19.20$ (MPa)

85 2) Crack control

102 ■ Bottom $0.25\sqrt{f_c}$

103 - Exposure class : A

104 - Maximum service limit load combination : cLCB14

105 - Maximum service limit load combination type: -

106 - Stress at bottom surface (Concrete)

107 $f_b = 4.08$ (MPa)

109 1) Crack control for flexure in prestressed beams (General)

110 ■ Maximum stress analysis at surface

111 $f_{surface} = 4.08$ (MPa) $> 0.25\sqrt{f_c} = 1.58$ (MPa)

112 ∴ Since maximum tensile stress is exceeded, spacing check consideration is needed.

| Elem | Part | LCom Name | CHK | FT (N/mm ²) | FB (N/mm ²) | FTL (N/mm ²) | FBL (N/mm ²) | FTR (N/mm ²) | FBR (N/mm ²) | FMAX (N/mm ²) | ALW (N/mm ²) |
|------|-------|-----------|-----|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|--------------------------|---------------------------|--------------------------|
| 2 | J[2] | cLCB14 | OK | 2.5999 | 7.4502 | 2.5999 | 7.4502 | 2.5999 | 7.4502 | 7.4502 | 19.2000 |
| 2 | J[3] | cLCB14 | OK | 6.2791 | 3.9898 | 6.2791 | 3.9898 | 6.2791 | 3.9898 | 6.2791 | 19.2000 |
| 3 | J[4] | cLCB14 | OK | 6.2791 | 3.9898 | 6.2791 | 3.9898 | 6.2791 | 3.9898 | 6.2791 | 19.2000 |
| 4 | J[5] | cLCB14 | OK | 9.3452 | 1.1061 | 9.3452 | 1.1061 | 9.3452 | 1.1061 | 9.3452 | 19.2000 |
| 4 | J[6] | cLCB14 | OK | 9.3452 | 1.1061 | 9.3452 | 1.1061 | 9.3452 | 1.1061 | 9.3452 | 19.2000 |
| 4 | J[5] | cLCB14 | OK | 11.7980 | -1.2009 | 11.7980 | -1.2009 | 11.7980 | -1.2009 | 11.7980 | 19.2000 |
| 5 | J[6] | cLCB14 | OK | 11.7980 | -1.2009 | 11.7980 | -1.2009 | 11.7980 | -1.2009 | 11.7980 | 19.2000 |
| 5 | J[5] | cLCB14 | OK | 13.6376 | -2.9311 | 13.6376 | -2.9311 | 13.6376 | -2.9311 | 13.6376 | 19.2000 |
| 6 | J[6] | cLCB14 | OK | 13.6376 | -2.9311 | 13.6376 | -2.9311 | 13.6376 | -2.9311 | 13.6376 | 19.2000 |
| 6 | J[7] | cLCB14 | OK | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | 19.2000 |
| 7 | J[7] | cLCB14 | OK | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | 19.2000 |
| 7 | J[8] | cLCB14 | OK | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | 19.2000 |
| 8 | J[8] | cLCB14 | OK | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | 19.2000 |
| 8 | J[9] | cLCB14 | OK | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | 19.2000 |
| 9 | J[9] | cLCB14 | OK | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | -4.6613 | 15.4773 | 19.2000 |
| 9 | J[10] | cLCB14 | OK | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | 19.2000 |
| 10 | J[10] | cLCB14 | OK | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | -4.0846 | 14.8641 | 19.2000 |

Check Compressive Stress at Transfer /

OK

Check Compressive Stress at Transfer

| Elem | Part | Top/Bottom | LCom Name | CHK | ft (N/mm ²) | fb (N/mm ²) | 0.25*sqrt(fc) (N/mm ²) | 0.5*sqrt(fc) (N/mm ²) | s (mm) | s_max (mm) | fs (N/mm ²) | fsa (N/mm ²) |
|------|------|------------|-----------|-----|-------------------------|-------------------------|------------------------------------|-----------------------------------|--------|------------|-------------------------|--------------------------|
| 1 | J[1] | Bottom | cLCB14 | OK | 1.6926 | -11.4874 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -59.3296 | 160.0000 |
| 1 | J[2] | Bottom | cLCB14 | OK | -2.5999 | -7.4502 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -41.4847 | 160.0000 |
| 2 | J[2] | Bottom | cLCB14 | OK | -2.5999 | -7.4502 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -41.4847 | 160.0000 |
| 2 | J[3] | Bottom | cLCB14 | OK | -6.2791 | -3.9898 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -26.1891 | 160.0000 |
| 3 | J[3] | Bottom | cLCB14 | OK | -6.2791 | -3.9898 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -26.1891 | 160.0000 |
| 3 | J[4] | Bottom | cLCB14 | OK | -9.3452 | -1.1061 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -13.4428 | 160.0000 |
| 4 | J[4] | Bottom | cLCB14 | OK | -9.3452 | -1.1061 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -13.4428 | 160.0000 |
| 4 | J[5] | Bottom | cLCB14 | OK | -11.7980 | 1.2009 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -9.0974 | 160.0000 |
| 5 | J[5] | Bottom | cLCB14 | OK | -11.7980 | 1.2009 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | -9.0974 | 160.0000 |
| 5 | J[6] | Bottom | cLCB14 | NG | -13.6376 | 2.9311 | 1.5811 | 3.1623 | 0.0000 | 200.0000 | 14.2382 | 160.0000 |

Check Crack Control at Transfer /

(see. 8.6.2.1)

Check Crack Control at Transfer

Transfer Check in Excel Report

9. Transmission Zone Design of Pretensioned Beam to AS 5100.5

- Pretensioned beam design is performed considering stress development in tendons as a bi-linear relationship defined by the transmission length and development length as per AS 5100.5.
- Flexural resistance at ULS within development length.

▪ PSC > Design Parameter > AS 5100.5: 17

2.Flexure design for a section

■ Moment Direction : Positive

- Method of calculation : Strain compatibility

- Maximum strength limit load combination : dLCB3

- Maximum strength limit load combination type : -

- Maximum factored moment (M'): 243.25 (kN-m)

| Axial force in tendons(Bond) by strain compatibility | | | | | |
|--|-------------|-----------------|----------------|----------------------------|------------------------------|
| No. | Tendon name | ϵ_{ps} | f_{ps} (MPa) | $T_{ps}=A_{ps}f_{ps}$ (kN) | $A_{ps}f_{ps}(d_p-c)$ (kN-m) |
| 1 | S_Span1-223 | 0.129213 | 1458.66 | 204.21 | 321.91 |
| 2 | S_Span1-222 | 0.129212 | 1458.36 | 204.17 | 321.85 |
| 3 | S_Span1-221 | 0.129208 | 1457.76 | 204.09 | 321.71 |
| 4 | S_Span1-224 | 0.129215 | 1458.96 | 204.25 | 321.98 |

Tendon stress at ULS within development length

| Development Length | | | | | |
|--------------------|-------------|---------------|------------|---------|----------------|
| No. | Tendon name | L_{ps} (mm) | L_p (mm) | L (mm) | f_{ps} (MPa) |
| 1 | S_Span1-223 | 800.00 | 1505.98 | 1000.00 | 1667.16 |
| 2 | S_Span1-222 | 800.00 | 1506.43 | 1000.00 | 1667.16 |
| 3 | S_Span1-221 | 800.00 | 1507.33 | 1000.00 | 1667.16 |
| 4 | S_Span1-224 | 800.00 | 1505.53 | 1000.00 | 1667.16 |

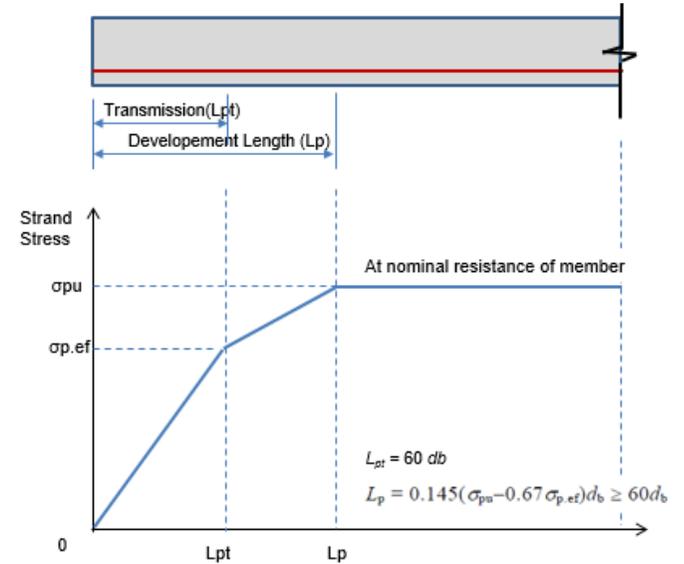
Transfer Length & Development Length

* The section is located within the development length

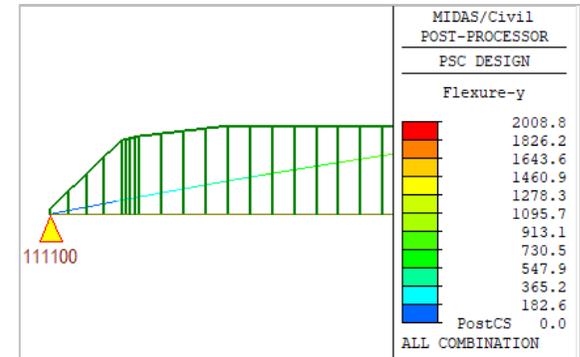
Development Length in Report



Flexural Resistance Diagram



Stresses in the Tendon at ULS



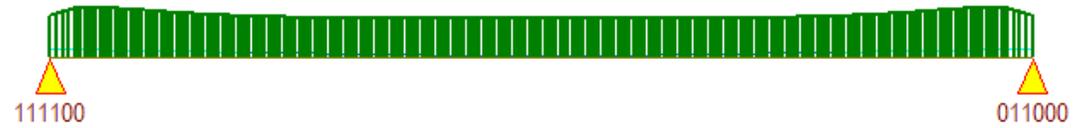
9. Transmission Zone Design of Prestensioned Beam to AS 5100.5

- Shear resistance at ULS within transmission length.

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

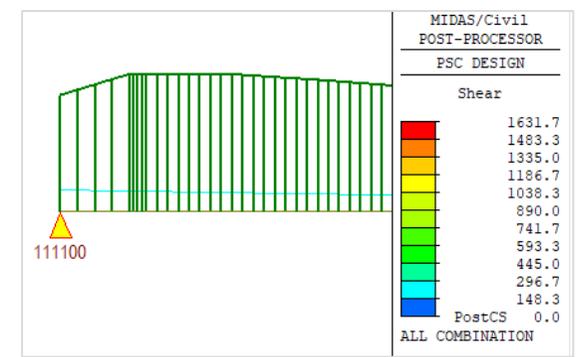
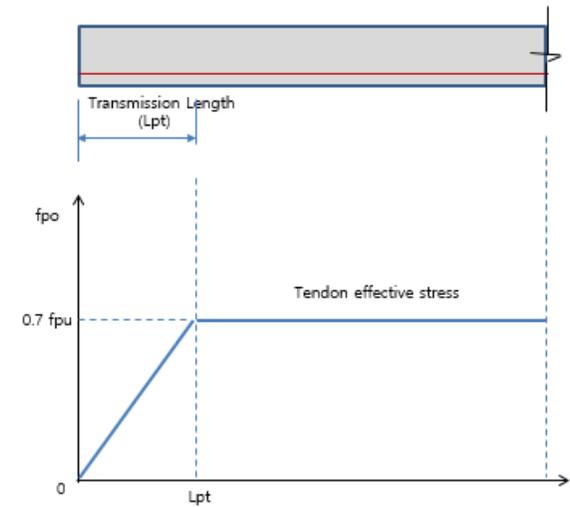
| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| 234 | 3. Shear design for a section | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 235 | - Section type : Box | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 236 | - Strength limit load combination : cLCB3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 237 | - Strength limit load combination type : - | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 238 | - Factored shear force : $V' = -219.71$ (kN) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 239 | - Factored moment : $M' = 470.81$ (kN·m) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 240 | - Factored axial force : $N' = 0.00$ (kN) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241 | - Resistance factor for shear : $\Phi = 0.70$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 242 | - Component of prestressing force | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 243 | in direction of the shear force : $P_v = \sum A_{ps} \cdot f_{st(z-df)} = 0.00$ (kN) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 244 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 245 | 2) Determination of the longitudinal strain in concrete (ϵ_x) for shear | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 246 | ▪ Longitudinal strain (ϵ_x). (Eq. 8.2.4.3-1) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 247 | $\epsilon_x = \frac{ M'/d_v + V' - P_v + 0.5N' - A_{ps}f_{po}}{2(E_c A_{ct} + E_p A_{st})} = 0.0012$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 248 | $\therefore \epsilon_x = 0.0012$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 249 | * ϵ_x shall be taken within the limits ($0 \leq \epsilon_x \leq +3.0 \times 10^{-3}$) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 250 | * V' and M' are absolute values. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 251 | * N' is taken as positive for tension and negative for compression. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 252 | where, $M' = \text{Max}[M', (V'-P_v) d_v] = \text{Max}[470.81, 265.76]$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 253 | $= 470.81$ (kN·m) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 254 | $f_{po} = 595.00$ (MPa) The section is located within the transfer length | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 255 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Tendon stress f_{po} within transfer length



Shear Resistance Diagram

▪ **Stress in prestressed tendon when stress in surrounding concrete is zero**



10. Crack Control for the Slab of PSC Composite Girder to AS5100.5

- Slab crack control as per clause 8.6.1. is provided for PSC composite beams. Slab crack review controlled primarily in flexure at the top of the Slab.

▪ PSC > Design Parameter > AS 5100.5

The screenshot shows the Civil 2021 software interface with the 'PSC' menu open. The 'Check crack control for flexure at service loads...' option is highlighted. Below the menu, a table displays the results for this check.

| | Elem | Part | LCom Name | Type | CHK | SLS | | Permanent | |
|--|------|-------|-----------|------|-----|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| | | | | | | sigma_src (N/mm ²) |
| | 1 | [1] | cLCB7 | - | OK | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | 1 | J[34] | cLCB7 | - | OK | -2.0418 | -16.2489 | 0.0000 | 0.0000 |
| | 2 | [2] | cLCB7 | - | OK | -2.1249 | -16.9097 | 0.0000 | 0.0000 |
| | 2 | J[3] | cLCB7 | - | OK | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

The table title is 'Check crack control for flexure at service loads'. The status bar at the bottom indicates 'Crack control for flexure at service (Slab)'.

- Load Effect considered for two cases:-
 - SLS Load Combination
 - For Beams designed for exposure classifications B2, C1, C2, and U, permanent effects at the SLS.

Rebar stress limit based on 8.6.1 (A), (B).

10. Crack control for flexure at Service for the Slab of PSC Composite Beam to AS5100.5

- For rebar stress check due to SLS load combination, rebar stress for Exposure class A, B1 compared with left column stress limit value of Table 8.6.1 (A), (B).
- For Rebar stress check due to permanent effects at the SLS, rebar stress for Exposure class B2, C1, C2 and U, compared with right column stress limit value of Table 8.6.1 (A), (B).

▪ PSC > Design Parameter > AS 5100.5

| 1) Rebar stress check due to SLS load combination | | (see. 8.6.1) |
|--|------------------|--|
| - Calculated rebar stress | | |
| σ_{scr} = | -16.25 (MPa) | |
| ▪ Neutral axis depth from the extreme compression fiber. | | |
| d_{NA} = | 552.48 (mm) | |
| - Equilibrium forces | | |
| (Compression) | | |
| - Prestress = | 770.52 (kN) | |
| - Reinforcement = | -12.09 (kN) | |
| - Concrete = | 0.00 (kN) | |
| (Tension) | | |
| - Prestress = | 0.00 (kN) | |
| - Reinforcement = | 198.10 (kN) | |
| - Rebar stress limit | | |
| - Stress limit by rebar diameter | | |
| d_b = | 28.00 (mm) | f_{scr1} = 183.53 (MPa) (See Table 8.6.1(A)) |
| - Stress limit by rebar spacing | | |
| s = | 0.00 (mm) | f_{scr2} = 200.00 (MPa) (See Table 8.6.1(B)) |
| - Maximum stress limit | | |
| $f_{scr} = \max(f_{scr1}, f_{scr2})$ = | 200.00 (MPa) | |
| - Rebar stress limit check | | |
| σ_{scr} = | -16.25 (MPa) ≤ ≤ | $f_{scr} = 200.00$ (MPa) OK |

Rebar Stress under Negative Moment (SLS)

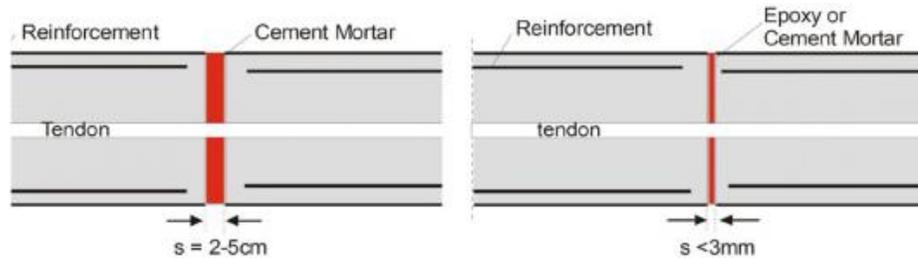
| 2) Rebar stress check due to permanent effects at the SLS | | (see. 8.6.1) |
|---|----------------|--|
| - Calculated rebar stress | | |
| σ_{scr} = | 0.00 (MPa) | |
| ▪ Neutral axis depth from the extreme compression fiber. | | |
| d_{NA} = | 0.00 (mm) | |
| - Equilibrium forces | | |
| (Compression) | | |
| - Prestress = | 0.00 (kN) | |
| - Reinforcement = | 0.00 (kN) | |
| - Concrete = | 0.00 (kN) | |
| (Tension) | | |
| - Prestress = | 0.00 (kN) | |
| - Reinforcement = | 0.00 (kN) | |
| - Rebar stress limit | | |
| - Stress limit by rebar diameter | | |
| d_b = | 28.00 (mm) | f_{scr1} = 141.81 (MPa) (See Table 8.6.1(A)) |
| - Stress limit by rebar spacing | | |
| s = | 0.00 (mm) | f_{scr2} = 280.00 (MPa) (See Table 8.6.1(B)) |
| - Maximum stress limit | | |
| $f_{scr} = \max(f_{scr1}, f_{scr2})$ = | 280.00 (MPa) | |
| - Rebar stress limit check | | |
| σ_{scr} = | 0.00 (MPa) ≤ ≤ | $f_{scr} = 280.00$ (MPa) OK |

Rebar Stress under Negative Moment (Permanent Effect of SLS)

11. Joint Check of Segmental Construction to BS 5400.4

- Shear check and stress check at the joint of segmental construction are provided as per clause 6.3.4.6 and 7.3.3 of BS 5400.4, respectively.

▪ PSC > Design Parameter > BS 5400.4



$$0.7 (\tan \alpha_2) \cdot \gamma_{fL} \cdot P_h$$

where

- γ_{fL} is the partial safety factor for the prestressing force, to be taken as 0.87;
- P_h is the horizontal component of the force after losses appropriate to the construction stage under consideration or, in the case of the completed structure, after all losses.
- α_2 is the angle of friction at the joint. $\tan \alpha_2$ depends on the type of interface; for roughened and moistened segment faces a value of 0.7 may be adopted for erection phases, and 1.4 at completion.

Joint Shear Resistance

7.3.3 Other types of connection. Any other type of connection which can be capable of carrying the ultimate loads acting on it may be used subject to verification by test evidence. Amongst those suitable for resisting shear and flexure are those made by prestressing across the joint.

Resin adhesives, where tests have shown their acceptability, may be used to form joints subjected to compression but not to resist tension or shear.

For resin mortar joints, the flexural stresses in the joint should be compressive throughout under service loads. During the jointing operation at the construction stage, the average compressive stress between the concrete surfaces to be joined should be checked at the serviceability limit state and should lie between 0.2 N/mm^2 and 0.3 N/mm^2 measured over the total projection of the joint surface (locally not less than 0.15 N/mm^2) and the difference between flexural stresses across the section should be not more than 0.5 N/mm^2 .

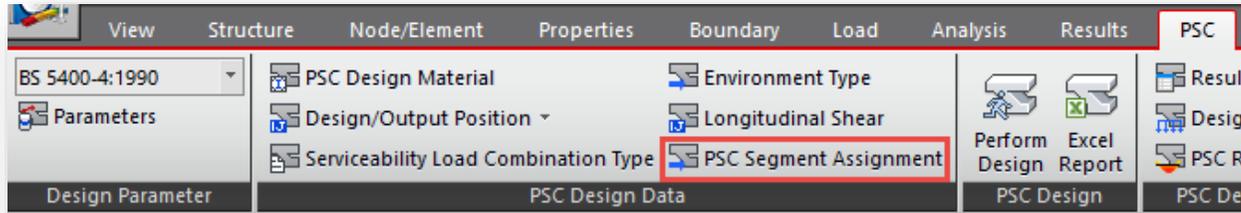
For cement mortar joints, the flexural stresses in the joint should be compressive throughout and not less than 1.5 N/mm^2 under service loads.

Joint Shear Stress Limit

11. Joint Check of Segmental Construction to BS 5400.4

- Segment Joint recognition is determined by the PSC Segment Assignment Function.

PSC > Design Parameter > BS 5400.4



- Shear check provides two results: member shear review and joint shear review.

| | |
|---|--|
| 5) Joint Shear | |
| ▪ Shear Resistance for Joint (V_u) (see BS 5400 - 6.3.4.6) | |
| $V_u = 0.7(\tan \alpha_2) \gamma_{fL} P_h =$ | 5643.43 (kN) |
| Where, | |
| $\tan \alpha_2$: | α_2 is angle of friction at the joint |
| = | 1.40 |
| γ_{fL} : | Partial safety factor for the prestressing force |
| = | 0.87 |
| P_h : | Horizontal component of the prestress force after losses |
| = | 6619.09 (kN) |
| ▪ Shear Check | |
| $V_u \geq V$ | |
| $V_u =$ | 5643.43 (kN) \geq $V =$ -1950.87 (kN) \therefore OK |

Joint Shear Resistance

- Serviceability check: the flexural stresses in the joint should be compressive through and stress limit is different depending upon Joint Type (Resin/Cement). 0 MPa is for resin and 1.5 MPa for cement.

| | |
|--|--|
| 7. Joint stress check for service load combination | |
| - Service limit load combination : cLCBDL1 | |
| - Service limit load combination type - | |
| Joint Type : | Resin mortar joints (see BS 5400 - 7.3.3) |
| σ_j : | Compressive stress on the prestressed concrete |
| = | 2.62 (MPa) |
| $\sigma_{j,limit}$: | Stress Limit |
| = | 0.00 (MPa) |
| Since | |
| $\sigma_j >$ | $\sigma_{j,limit} \therefore$ OK |

Joint Shear Stress Limit

12. Response Spectrum Function : IRC SP 114:2018

- New response spectrum function guidelines for seismic design of road bridges as per IRC SP 114:2018
- In this version, the Response spectrum function can be modified as per user defined Zone Factor, Importance Factor and Response Reduction factor values
- Modification of Auto load combination as per IRC 6-2017 considering the response spectrum cases given in IRC SP 114:2018

▪ Load > Dynamic Loads > RS Functions

Add/Modify/Show Response Spectrum Functions

Function Name: IRC:SP:114-2018

Spectral Data Type: Normalized Accel. Acceleration Velocity Displacement

Scaling: Scale Factor 1 Maximum Value 0 g

Gravity: 9.806 m/sec² Damping Ratio: 0.05

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

| | Period (sec) | Spectral Data (g) |
|----|--------------|-------------------|
| 1 | 0.0000 | 0.0167 |
| 2 | 0.0600 | 0.0317 |
| 3 | 0.1000 | 0.0417 |
| 4 | 0.1200 | 0.0417 |
| 5 | 0.1800 | 0.0417 |
| 6 | 0.2400 | 0.0417 |
| 7 | 0.3000 | 0.0417 |
| 8 | 0.3600 | 0.0417 |
| 9 | 0.4000 | 0.0417 |
| 10 | 0.4200 | 0.0397 |
| 11 | 0.4800 | 0.0347 |
| 12 | 0.5400 | 0.0309 |
| 13 | 0.6000 | 0.0278 |
| 14 | 0.6600 | 0.0253 |

Description: IRC:SP:114-2018: Zone=UD(0.10), Soil=I(Rock/Hard), Damping= 5.00, I=1.00, R=3.00

Buttons: Import File, Design Spectrum, OK, Cancel, Apply

Response Spectrum Functions

Generate Design Spectrum

Design Spectrum : IRC:SP:114-2018

Seismic Zone: II (0.10) III (0.16) IV (0.24) V (0.36) User Defined 0.10

Soil Type: I (Rock or Hard Soil) II (Medium Soil) III (Soft Soil)

Damping(%): 5

Damping Multiplying Factor: 1

Importance Factor (I): 1.0

Response Reduction Factor (R): 3.0

Max. Period: 6 (Sec)

Buttons: OK, Cancel

Design Spectrum inputs

13. Auto Temperature Gradient as per IRC 6:2017

- Auto definition of Temperature Gradient for PSC and Steel composite girders as per IRC 6:2017.
- Applicable for section defined from PSC, Composite tab (not applicable for SPC and Value type sections).

▪ **Load > Temp/Prestress > Beam Section Temperature**

Beam Section Temperature

| H (m) | T ₁ (°C) |
|-------|---------------------|
| 0.2 | 18 |
| 0.3 | 20.5 |

| (m) | T ₁ (°C) |
|-----|---------------------|
| 0.2 | 4.4 |
| 0.3 | |

Auto option as per code provision

14. Improvement in Auto Load combinations as per IRC 6:2017

- Improvement in Auto Load combinations of Temperature load factors (Temperature uniform and Temperature gradient loads).
- Updates in load factors for combinations considered for Special Vehicle as per IRC 6:2017 Amendments.

▪ Results > Load Combinations > Auto Generation

The image displays two overlapping dialog boxes from the software interface. The background dialog is 'Automatic Generation of Load Combinations', and the foreground dialog is 'Assessment of Groups of Traffic Loads'.

Automatic Generation of Load Combinations Dialog:

- Option:** Add Replace
- Code Selection:** Steel Concrete SRC Steel Composite
- Design Code:** IRC:6 LSD
- Manipulation of Construction Stage Load Case:** ST Only CS Only ST+CS
- Leading Variables:**
 - Select All
 - Wind Loads Thermal Act. Snow Loads
 - Construction Loads
 - Traffic Loads
 - Road Traffic
 - Moving Load Case for Special Vehicle

Assessment of Groups of Traffic Loads Dialog:

- Moving Load Cases:** CA, C70R
- Special Vehicle Load Cases:** SV

Buttons: OK, Cancel

File Name: G:\OFC\testing\SV\RCC T girder_SV.lcp

Auto Generation of Load Combination

Special Vehicle provision

15. Update in General Section Designer as per IRS Specifications

- Ultimate check for P-M Interaction and Serviceability check for stresses and crack width as per IRS Concrete code.
- Improvement in material data base as per IRS Concrete code.

Tools > General Section Designer

Design Code ✕

Design Code: IRS

Partial Safety Factors

Ultimate Limit State

Gamma c:

Gamma s:

Alpha_cc:

Serviceability Limit State

Concrete:

Reinforcement:

Crack Width Calculation

Live Load / Dead Load Moment Ratio

Single Ratio

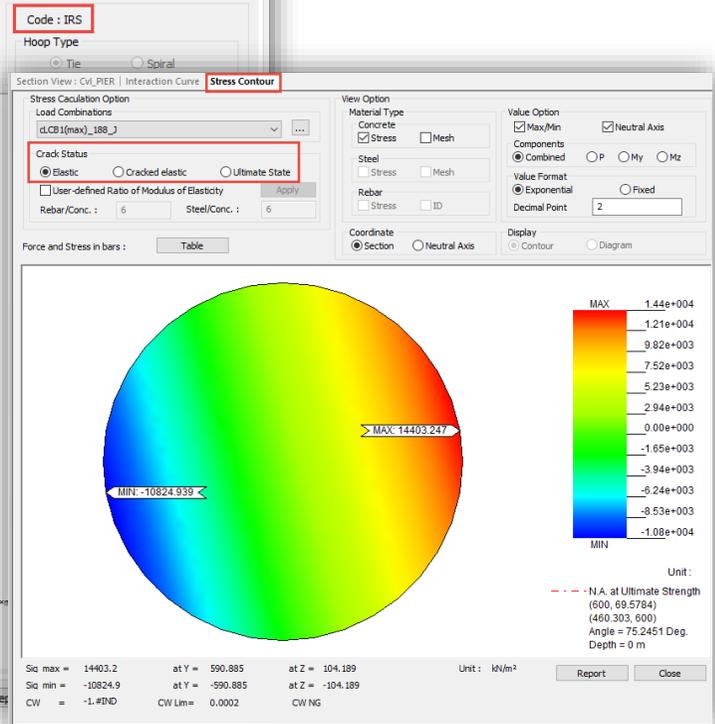
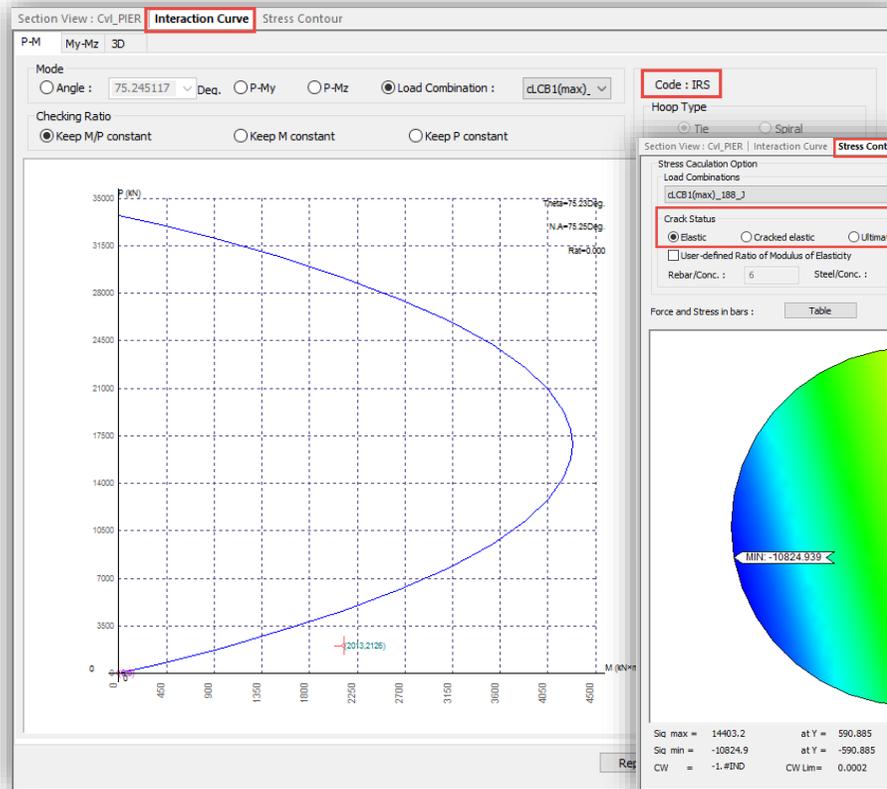
My: Mz:

Enter Ratio for Each Load Combination

Nominal Cover to R/F(Cnom): m

Crack Width Limit: m

Design parameter as per IRS



ULS and SLS Checks as per IRS