

Release Note

Release Date : March 2020

Product Ver. : Civil 2020 (v2.1)



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

1. Multiple stage post-tensioning in tendon
2. Auto division of the fiber section (Core and cover)
3. New option for Moving load optimization
4. Application rule change of Military Load Class
5. Improvement in calculation of torsional constant for closed composite section
6. Improvement of the element temperature calculation method for the composite section for C.S.
7. Improvement of the analysis speed for the inelastic time-history analysis
8. Improvement in GSD - Civil pushover hinge export
9. Bridge Assessment to the UK standard: CS 454/19
10. RC Design to IS 456:2000 & Crack calculations by IS 3370(Part 2):2009



1. Multiple stage post-tensioning in tendon

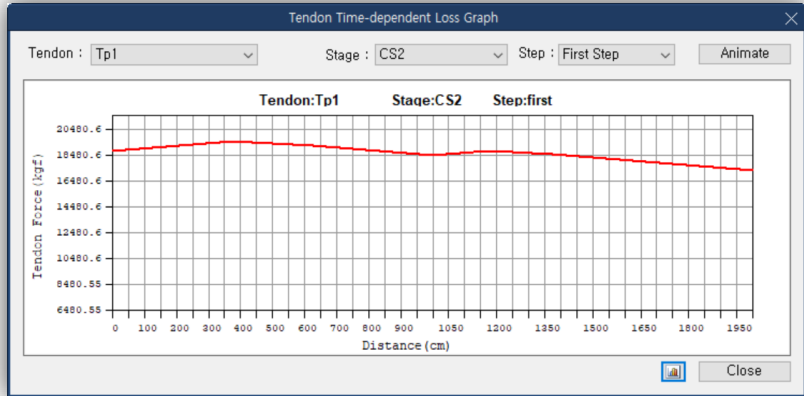
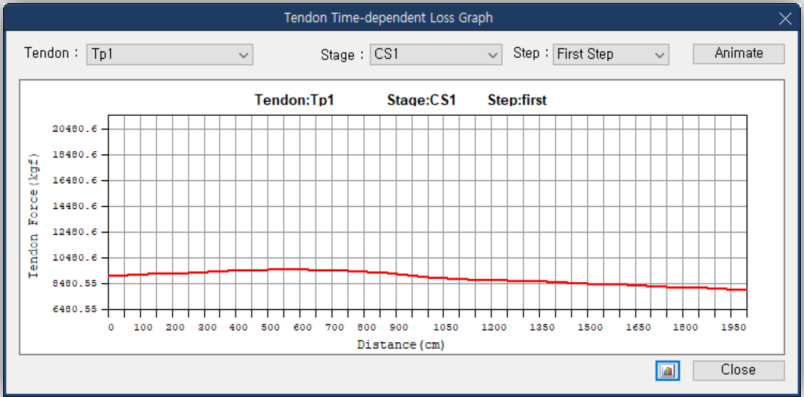
- Re-tensioning of tendon is now supported. Immediate losses and time-dependent losses which occurred before re-tensioning are removed and recalculated based on the summation of multiple stage stressing applied to the tendon starting from the time of re-tensioning.
- Re-tensioning of coupled tendon is not supported

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

Tensioning at stage 1



Re-tensioning at stage 2

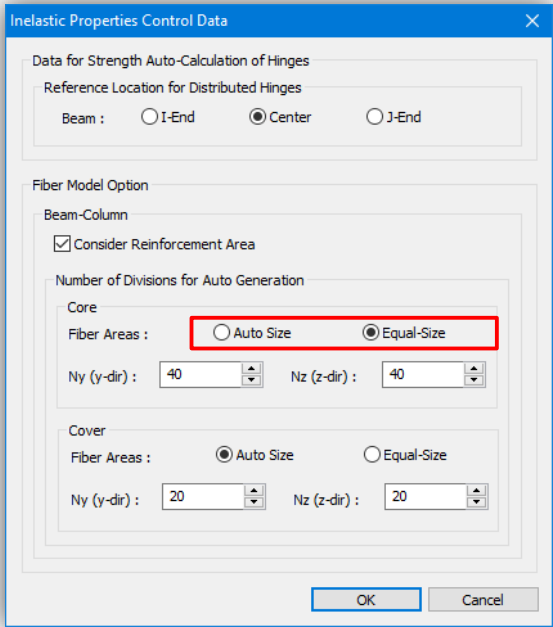


Civil 2020v2.1

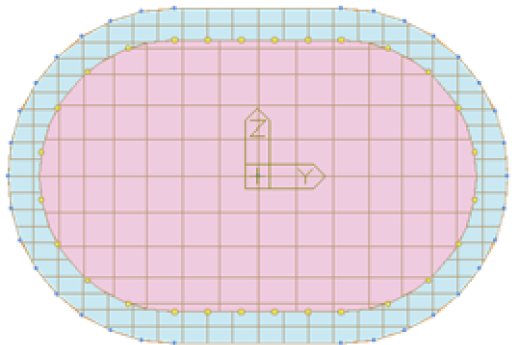
2. Auto division of the fiber section (core and cover)

- In earlier versions, the fiber section was to be manually divided into the core & cover regions and this was to be done for all such sections.
- Now, just the fiber hinge needs to be defined and the fiber division of the section can be done automatically, including differentiation for confined and un-confined concrete. Also, the fiber division can be equal size or auto size.

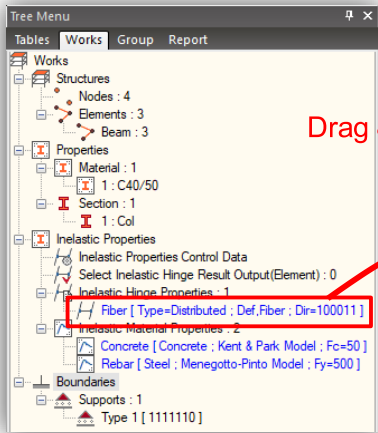
▪ **Properties > Inelastic Material > Fiber Division of Section**



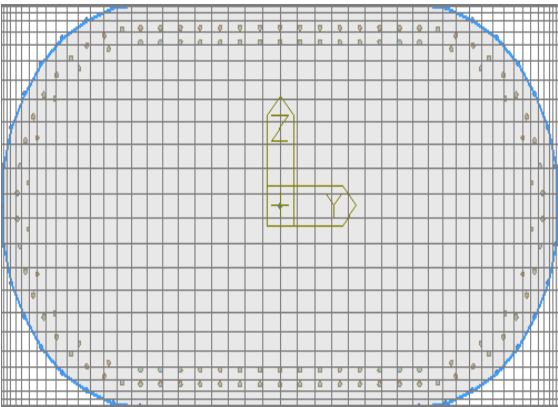
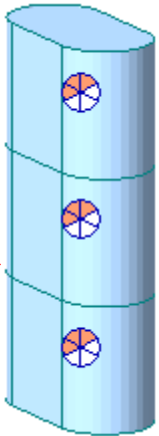
Inelastic Properties Control Data



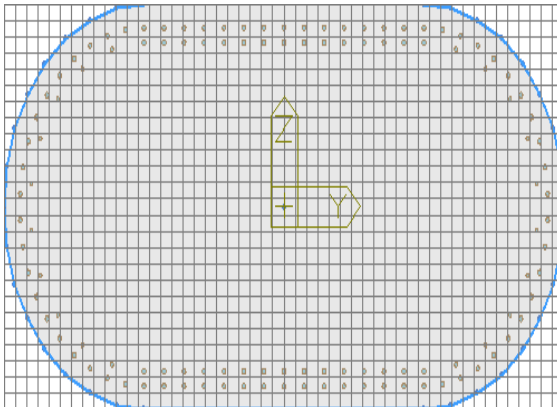
Fiber definition



Drag & Drop



Auto Size option



Equal Size option

3. New option for moving load optimization

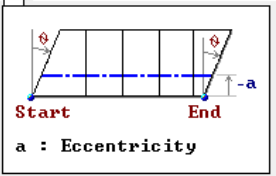
- In earlier versions of midas, there was auto calculation to control the critical position of the analysis lanes in moving load optimization. Lane offset had to be provided manually.
- In this version, the limitation is removed as the number of analysis lanes can be specified by the user and this ensures that vehicle is placed at the extreme ends of the optimization lane.

- **Load > Moving Load > Traffic Line Lanes > Moving Load Optimization**
- **Load > Moving Load > Traffic Surface Lanes > Moving Load Optimization**

Moving Load Optimization [X]

Lane Name : optimization lane

Traffic Lane Optimization Properties



a : Eccentricity

Optimization Lane: 9 m

Lane Width: 3 m

Anal. Lane Offset: 1.5 m

Wheel Spacing: 2 m

Margin: 0 m

Eccentricity: 0 m

Straddling Lane Type

Vehicular Load Distribution

Lane Element Cross Beam

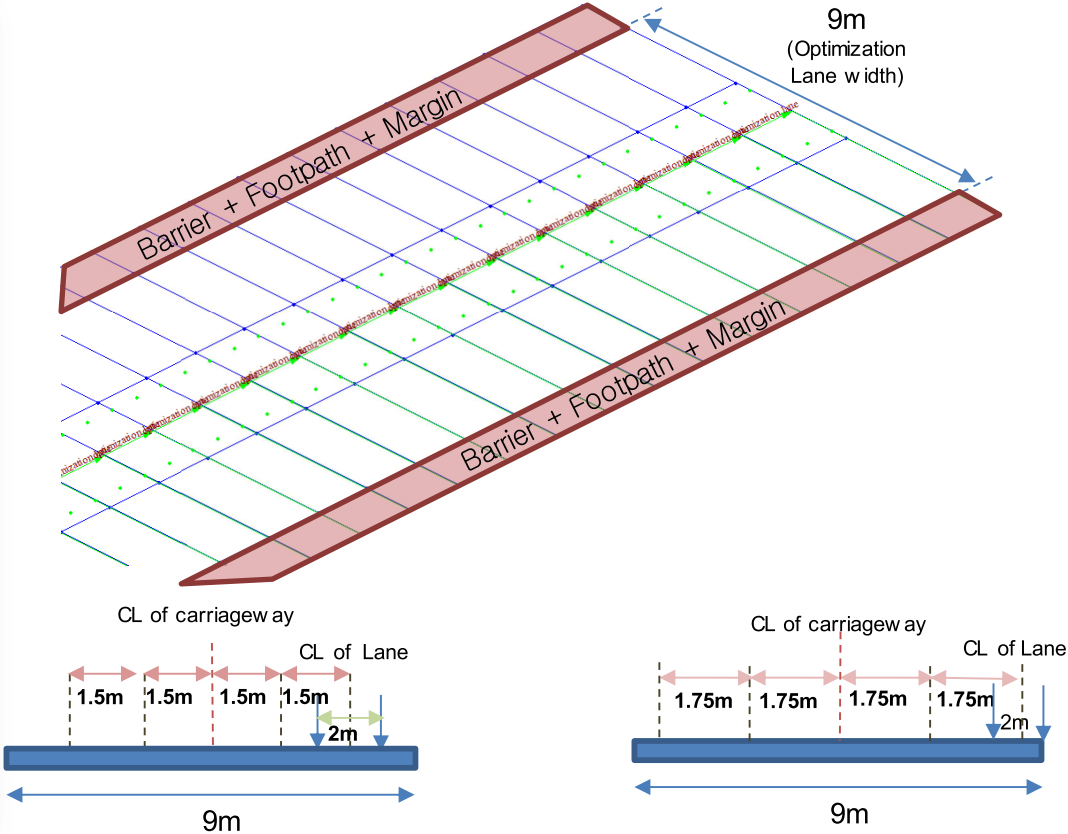
Cross Beam Group

Skew

Start: 0 End: 0 [deg]

Moving Direction

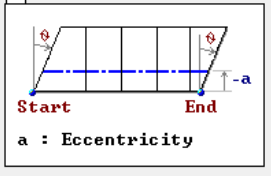
Forward Backward Both



Define Moving Load Optimization [X]

Lane Name : optimization lane

Traffic Lane Optimization Properties



a : Eccentricity

Optimization Lane: 9 m

Lane Width: 3 m

Generate Analysis Lanes

Number of Lanes(2^N+1) N: 2

Offset from Centerline: 1 m

Wheel Spacing: 2 m

Margin: 0 m

Eccentricity: -5.1 m

Straddling Lane Type

Vehicular Load Distribution

Lane Element Cross Beam

Cross Beam Group

Skew

Start: 0 End: 0 [deg]

Moving Direction

Forward Backward Both

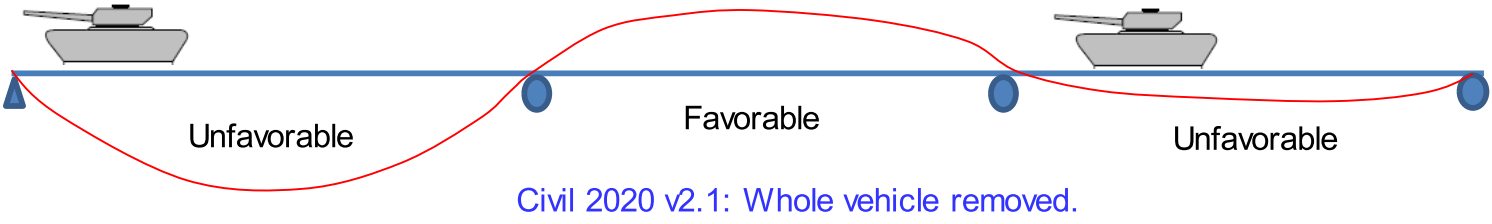
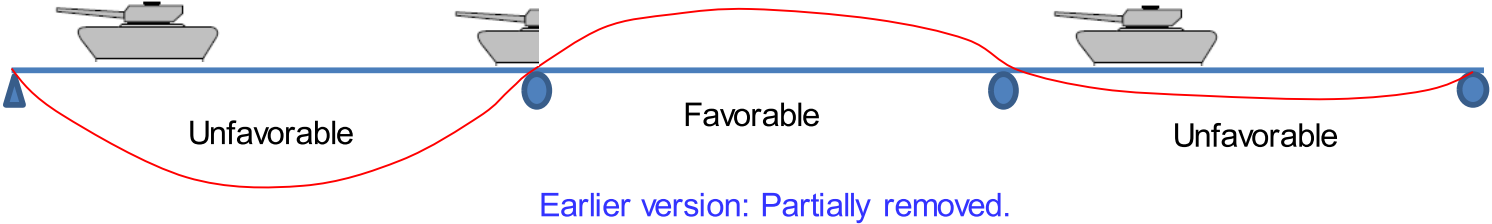
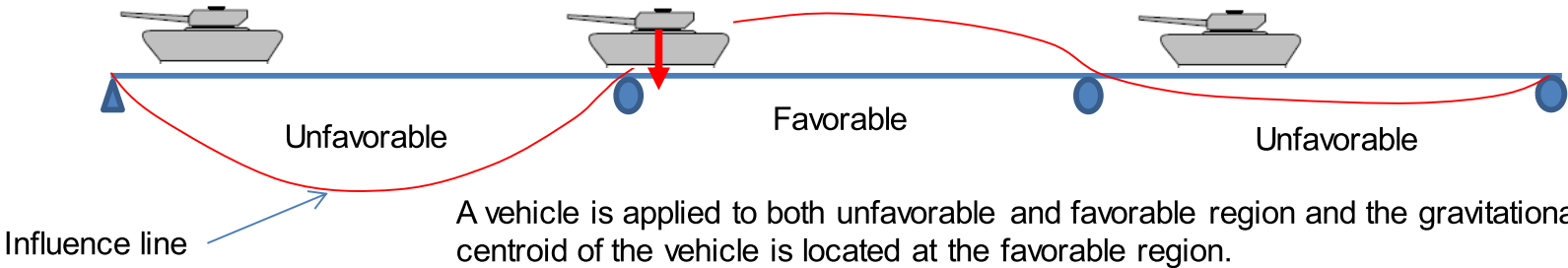
Previous version

Civil 2020 v2.1

4. Application rule change of Military Load Class

- In earlier version, to obtain the most unfavorable condition for the structure, even the partial vehicle load was considered.
- Now, only complete vehicle would be considered to obtain the worst effect on the structure.

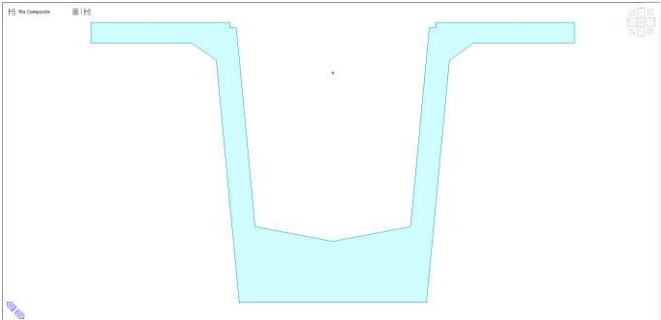
▪ *Load > Moving Load > Moving Load Code > POLAND > Vehicle Add Standard > Military Load Class*



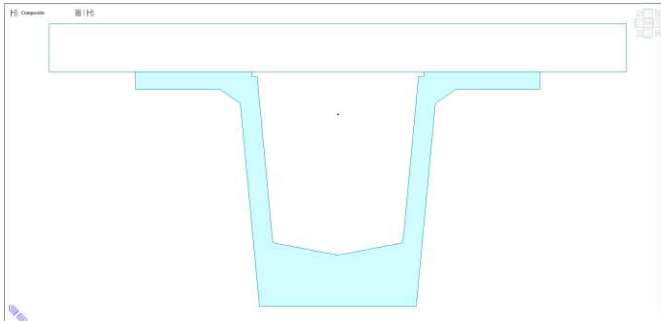
5. Improvement in calculation of torsional constant for closed composite section

- The torsional constant calculation has been improved for composite section which has open cross-section before composite and closed cross-section after composite, e.g. Super T girder.
- Now, the torsional constant is calculated according to finite element based analysis thus calculating for both before composite and after composite separately.

▪ **Properties > Section Properties > Composite**



Part I



Part I + Part II

| | Value(Before) | Value(After) | Unit |
|------------|----------------------|----------------------|----------------------|
| Area | 5.361715e-001 | 1.230545e+000 | m ² |
| Asy | 4.831434e-001 | 4.645265e-001 | m ² |
| Asz | 6.130852e-001 | 5.972085e-001 | m ² |
| Ixx | 7.834168e-003 | 1.506723e-002 | m⁴ |
| Iyy | 1.011163e-001 | 2.928666e-001 | m ⁴ |
| Izz | 1.123795e-001 | 6.331598e-001 | m ⁴ |
| Cyp | 1.050000e+000 | 1.050000e+000 | m |
| Cym | 1.050000e+000 | 1.050000e+000 | m |
| Czp | 6.635581e-001 | 2.185895e-001 | m |
| Czm | 5.514419e-001 | 9.964105e-001 | m |
| Qyb | 0.000000e+000 | 0.000000e+000 | m ² |
| Qzb | 0.000000e+000 | 0.000000e+000 | m ² |
| Peri:O | 7.967478e+000 | 1.446748e+001 | m |
| Peri:I | 0.000000e+000 | 0.000000e+000 | m |
| Center:y | 1.050000e+000 | 1.500000e+000 | m |
| Center:z | 5.514419e-001 | 9.964105e-001 | m |
| y1 | -1.050000e+000 | -1.050000e+000 | m |
| z1 | 6.635581e-001 | 2.185895e-001 | m |
| y2 | 1.050000e+000 | 1.050000e+000 | m |
| z2 | 6.635581e-001 | 2.185895e-001 | m |
| y3 | 4.070000e-001 | 4.070000e-001 | m |
| z3 | -5.514419e-001 | -9.964105e-001 | m |
| y4 | -4.070000e-001 | -4.070000e-001 | m |
| z4 | -5.514419e-001 | -9.964105e-001 | m |

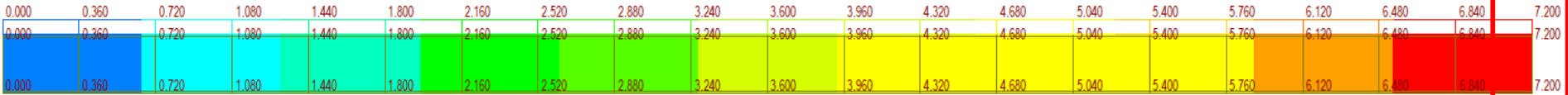
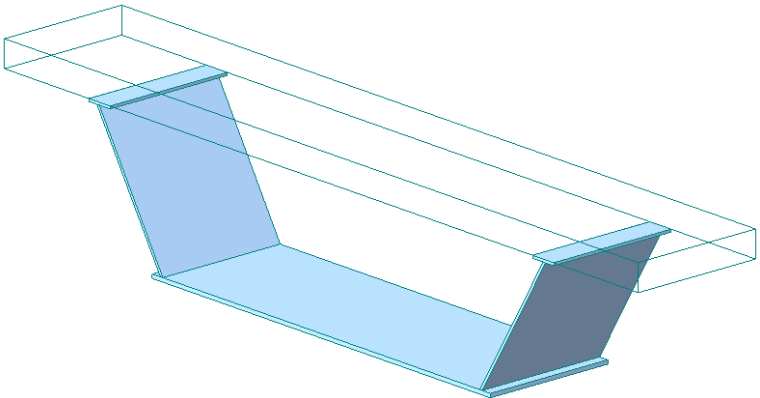
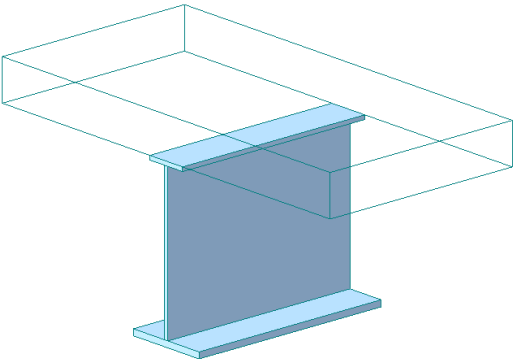
Previous version

| | Value(Before) | Value(After) | Unit |
|------------|----------------------|----------------------|----------------------|
| Area | 5.361715e-001 | 1.230545e+000 | m ² |
| Asy | 1.237778e-001 | 7.374340e-001 | m ² |
| Asz | 2.125628e-001 | 2.803497e-001 | m ² |
| Ixx | 6.700396e-003 | 1.916471e-001 | m⁴ |
| Iyy | 1.011163e-001 | 2.928666e-001 | m ⁴ |
| Izz | 1.123795e-001 | 6.331598e-001 | m ⁴ |
| Cyp | 1.050000e+000 | 1.050000e+000 | m |
| Cym | 1.050000e+000 | 1.050000e+000 | m |
| Czp | 6.635581e-001 | 2.185895e-001 | m |
| Czm | 5.514419e-001 | 9.964105e-001 | m |
| Qyb | 0.000000e+000 | 0.000000e+000 | m ² |
| Qzb | 0.000000e+000 | 0.000000e+000 | m ² |
| Peri:O | 7.967478e+000 | 1.446748e+001 | m |
| Peri:I | 0.000000e+000 | 0.000000e+000 | m |
| Center:y | 1.050000e+000 | 1.500000e+000 | m |
| Center:z | 5.514419e-001 | 9.964105e-001 | m |
| y1 | -1.050000e+000 | -1.050000e+000 | m |
| z1 | 6.635581e-001 | 2.185895e-001 | m |
| y2 | 1.050000e+000 | 1.050000e+000 | m |
| z2 | 6.635581e-001 | 2.185895e-001 | m |
| y3 | 4.070000e-001 | 4.070000e-001 | m |
| z3 | -5.514419e-001 | -9.964105e-001 | m |
| y4 | -4.070000e-001 | -4.070000e-001 | m |
| z4 | -5.514419e-001 | -9.964105e-001 | m |

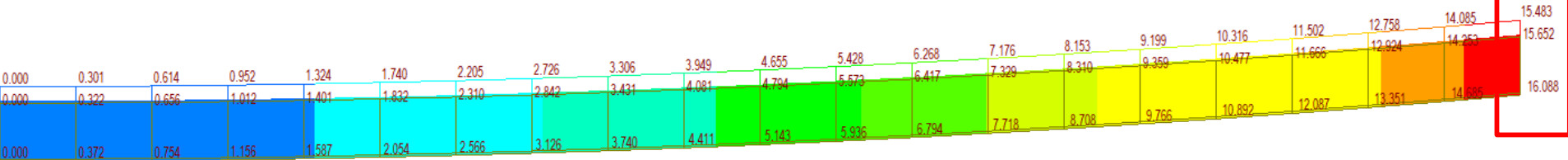
Civil 2020v2.1

6. Improvement of the element temperature calculation method for the composite section for C.S.

- In earlier version, uniform temperature loads like system temperature, nodal temperature and element temperature were applied to transformed properties of composite beam elements.
- In new version, these loads are applied individually to each part based on temperature coefficient to predict more realistic behavior of structure, when composite section for construction stage are defined.



Previous version – Axial deformation & no bending

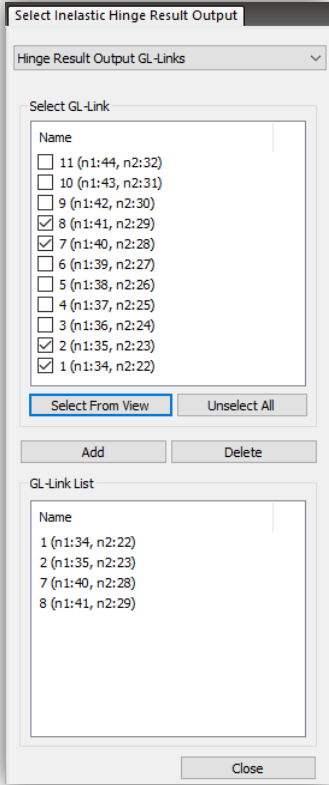


Civil 2020 v2.1 – Axial deformation & bending

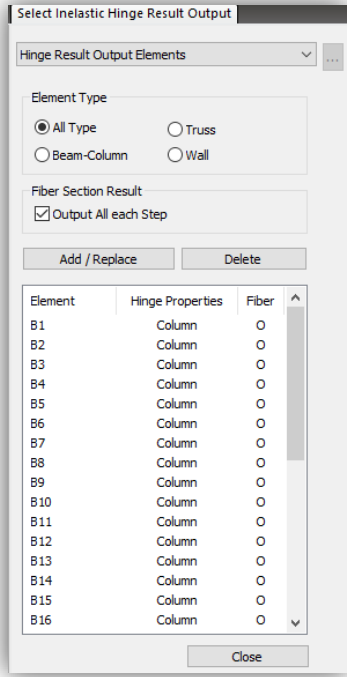
7. Improvement in analysis speed for inelastic time history analysis

- The output for non-linear elastic time history analysis with fiber modelling could now be restricted to required elements or links. This drastically reduces the overall analysis time of the model.

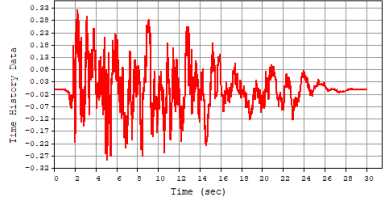
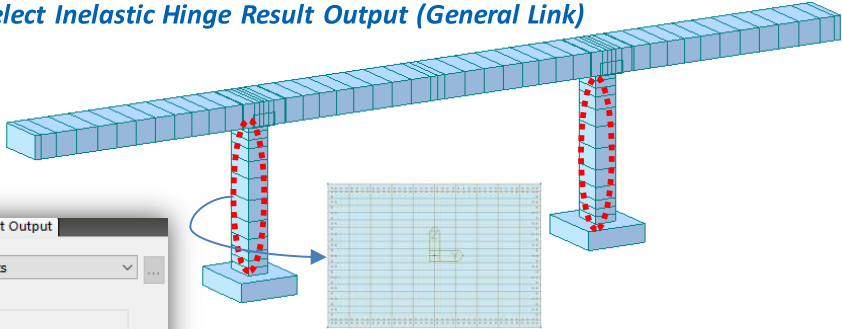
- Properties > Inelastic Properties Control Data > Select Inelastic Hinge Result Output (Element)
- Properties > Inelastic Properties Control Data > Select Inelastic Hinge Result Output (General Link)



Hinge Result Output (General Link)



Hinge Result Output (Element)



- Duration : 30 Second (3000Step)
- Model scale : 86 Beam elements
- Fibercell : 28,248Pieces

```

< TIME HISTORY LOADCASE NO. 2 / 2 >
* ANALYSIS TYPE : NONLINEAR
* ANALYSIS METHOD : DIRECT INTEGRATION
* TIME HISTORY TYPE : TRANSIENT
* MASS TYPE : LUMPED MASS
* DAMPING METHOD : MASS & STIFFNESS PROPORTIONAL (RAYLEIGH DAMPING)
* INCORE MULTI-FRONTAL SOLVER
-----TIME STEPS-----SUBSTEPS-- --ITERATIONS-- --ELAPSED / TOTAL TIME----
3000 / 3000 3000 6031 845.480 / 845.480 [sec]
* SAVE INELAS
* ELEMENT OUT
DISPLACEMENT
PREPARING F
ELEM. :
INELASTIC H
FIBER BEAM
  
```

v1.2 Analysis Time Result Output Time Other Times 1654.19 sec

v2.1 64.8sec

```

-----SOLUTION TERMINATED-----
YOUR MIDAS JOB IS SUCCESSFULLY COMPLETED.
TOTAL SOLUTION TIME...: 1654.19 [SEC]
  
```

2020 v1.2

```

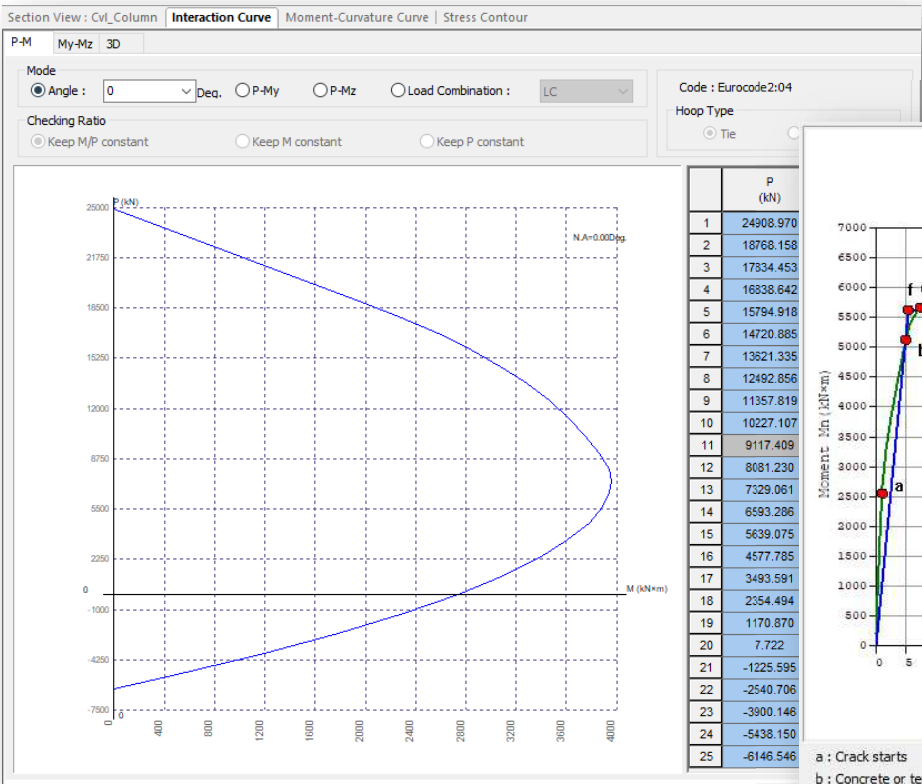
-----SOLUTION TERMINATED-----
YOUR MIDAS JOB IS SUCCESSFULLY COMPLETED.
TOTAL SOLUTION TIME...: 64.80 [SEC]
  
```

2020 v2.1

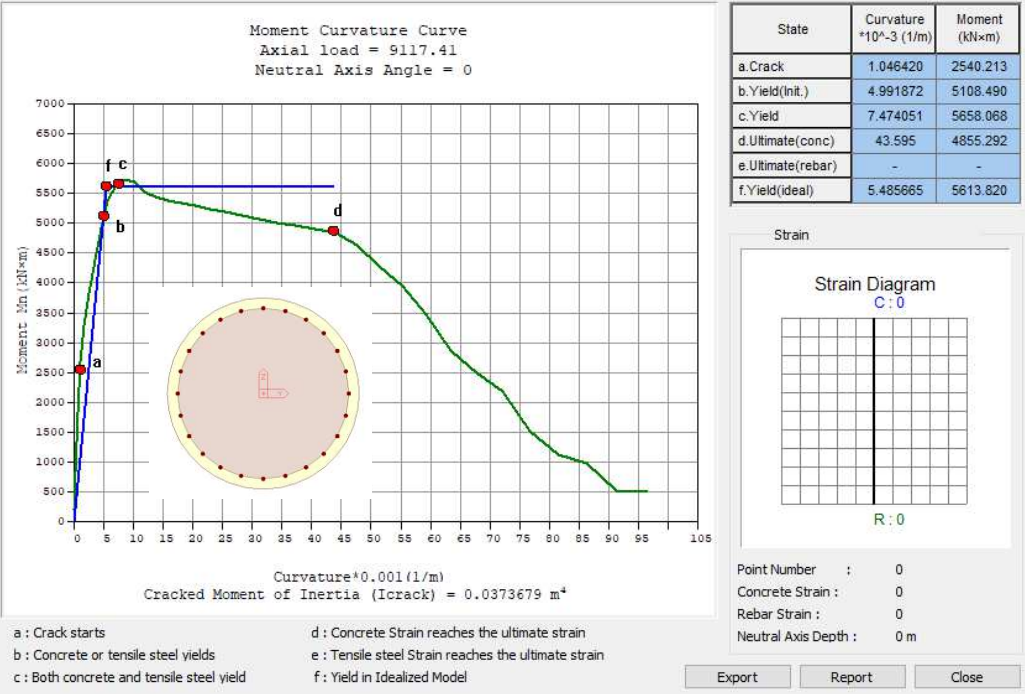
8. Improvement in GSD Pushover Hinge Export

- In earlier version, the yield moment was taken from the PMM interaction curve generated for the design instead of idealized curve in the Moment-Curvature curve.
- In this version, the yield moments depending on axial forces are taken from the idealized curve in the moment-curvature curve when exporting hinge data for pushover analysis.

▪ **Pushover > Hinge Properties > Define Pushover Hinge Type/Properties**



Previous version

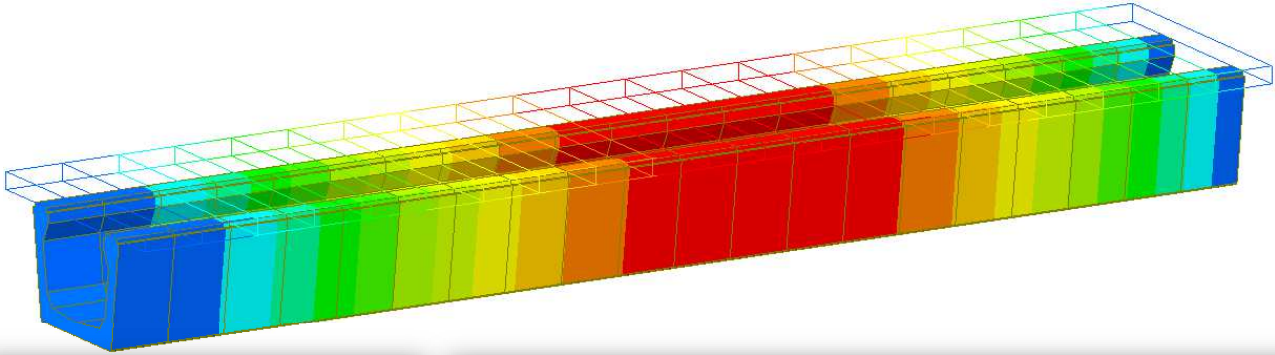


Civil 2020 v2.1

9. Bridge Assessment to the UK standard: CS 454/19

- Level 1 assessment can be performed now for **PSC Box & PSC Composite sections** in midas Civil. All model 2 vehicle is also introduced in accordance to CS 454 Assessment code.
- Assessment load combinations can be defined to obtain output for strength & service limit states.

- **Load > Moving Load > Moving Load Code> BS> Vehicle > CS 454 Assessment**
- **Rating> PSC Bridge > CS 454/19**



Define Standard Vehicular Load

Standard Name: CS 454 Assessment

Vehicular Load Properties

Vehicular Load Name: ALL MODEL 2(UDL+KEL)

Vehicular Load Type: ALL MODEL 2(UDL+KEL)

UDL

KEL

Lane Factor

CS 454 User-defined

| Loaded length, L(m) | UDL (kN/m) | KEL (kN) |
|-----------------------|---|------------------------------|
| $L \leq 20m$ | $\frac{230}{L^{0.67}}$ | 82 |
| $20m < L < 40m$ | $\frac{336}{L^{0.67}} \cdot \frac{1}{1.92 - 0.023 L}$ | $\frac{120}{1.92 - 0.023 L}$ |
| $40m \leq L \leq 50m$ | $\frac{336}{L^{0.67}}$ | 120 |
| $L > 50m$ | $\frac{36}{L^{0.1}}$ | 120 |

Category for K-Factor

Traffic/Surface Category: Hp

Load Level: 40t

OK Cancel Apply

Assessment Parameter

Condition Factor(Fc): 1

Value of Gamma_m(Ultimate limit States)

Characteristic Strength Worst Credible Strength

User Input

Modify Design Parameters

Strength Limit State

Flexure Shear Torsion

Serviceability Limit State

Stress/Crack

Detail Report

Ultimate Limit State Serviceability Limit State

OK Cancel

Define Assessment Case

| Name | Limit State | Comb. Type | Gamma_f3 |
|-------|-------------|------------|----------|
| SLS-1 | SLS | Comb1 | 1 |
| SLS-2 | SLS | Comb2 | 1 |
| SLS-3 | SLS | Comb3 | 1 |
| SLS-4 | SLS | Comb4 | 1 |
| ULS-1 | ULS | Comb1 | 1.1 |
| ULS-2 | ULS | Comb2 | 1.1 |
| ULS-3 | ULS | Comb3 | 1.1 |
| ULS-4 | ULS | Comb4 | 1.1 |
| * | | | |

| Static Load Cases and Factors(Gamma_f1) | |
|---|--------|
| Static Load Cases | Factor |
| D(ST) | 1.0000 |
| SDL(ST) | 1.2000 |
| L(ST) | 1.0000 |
| * | |

Moving Load Cases and Factors(Gamma_f1)

Standard Vehicle HA(MV) 1.2

Special Vehicle 0

Copy Assessment Load Combination

Copy into General Load Combination

Close

All Model 2 vehicle

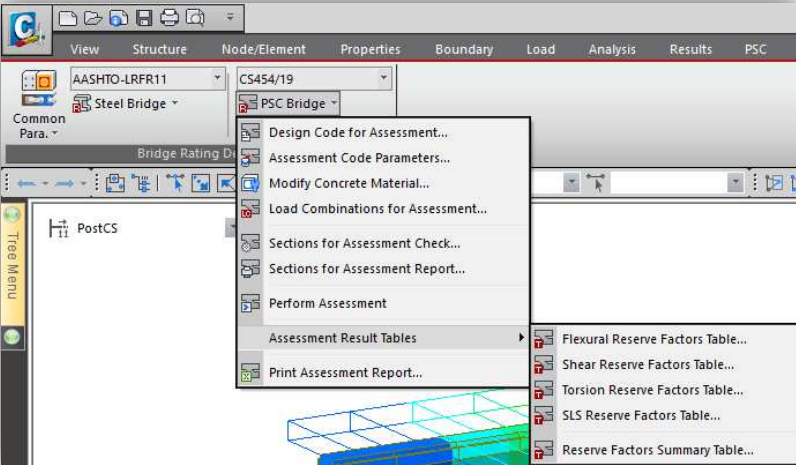
Assessment Parameters

Load combination for assessment

9. Bridge Assessment to the UK standard: CS 454/19

- Assessment results could be viewed in tabular format in midas Civil itself and these can be exported to excel file as well.
- Summary as well as detailed report is provided for Flexural, Shear, Torsion & Service limit state for Class 1 and 2 category.

Rating > PSC Bridge > CS 454/19



Assessment Result Tables

| Element | Part | Rating Case | v | vt | vtu | y1 | vtu(y1/550) | A | Check |
|---------|-------|----------------|-----------|-------|--------|-----|-------------|--------|-------|
| 10 | I[11] | ULS-1_Fxx(Max) | -825.1060 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 7.2718 | OK |
| 10 | I[11] | ULS-1_Fxx(Min) | -1473.094 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 4.0731 | OK |
| 10 | I[11] | ULS-1_Fyy(Max) | -825.1060 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 7.2718 | OK |
| 10 | I[11] | ULS-1_Fyy(Min) | -1473.094 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 4.0731 | OK |
| 10 | I[11] | ULS-1_Fzz(Max) | -825.1060 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 7.2718 | OK |
| 10 | I[11] | ULS-1_Fzz(Min) | -1473.094 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 4.0731 | OK |
| 10 | I[11] | ULS-1_Mxx(Max) | -825.1060 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 7.2718 | OK |
| 10 | I[11] | ULS-1_Mxx(Min) | -1473.094 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 4.0731 | OK |
| 10 | I[11] | ULS-1_Myy(Max) | -825.1060 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 7.2718 | OK |
| 10 | I[11] | ULS-1_Myy(Min) | -1473.094 | 0.000 | 6000.0 | 3.0 | 32727.2727 | 4.0731 | OK |

Tabular output in midas Civil

1. Design Condition

| Design code | Element | Part(Node) |
|-------------|---------|------------|
| CS454/19 | 10 | I(11) |

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:

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

Where:

- R_a^{*} : the assessment resistance
- S_D^{*} : the assessment load effect due to combined dead and superimposed dead loads
- S_{ST}^{*} : the assessment load effect due to standard vehicle
- S^{*} : the assessment load effect due to standard vehicle
- S_a^{*} : the assessment load effect due to standard vehicle

3. Flexural Reserve Factors

| Assessment Case | Load Effect | R _a [*] (kN.m) | S [*] (kN.m) | S _D [*] (kN.m) | S _{ST} [*] (kN.m) | S _a [*] (kN.m) | A | ψ | ψ* | Check |
|-----------------|-------------|------------------------------------|-----------------------|------------------------------------|-------------------------------------|------------------------------------|-------|---|----|-------|
| ULS-1_Fxx(Max) | Positive | 3208.885 | - | 6717.530 | 1186.514 | 7904.044 | 0.406 | - | - | NG |
| ULS-1_Fxx(Min) | Positive | 3208.885 | - | 6717.530 | 0.000 | 6717.530 | 0.478 | - | - | NG |
| ULS-1_Fyy(Max) | | | | | | | | | | |
| ULS-1_Fyy(Min) | | | | | | | | | | |

4. Shear Reserve Factors

| Assessment Case | R _a [*] (kN) | S [*] (kN) | S _D [*] (kN) | S _{ST} [*] (kN) | S _a [*] (kN) | A | ψ | ψ* | Check |
|-----------------|----------------------------------|---------------------|----------------------------------|-----------------------------------|----------------------------------|-------|---|----|-------|
| ULS-2_Fxx(Max) | 429.055 | - | -1245.888 | 99.981 | -158.499 | 2.707 | - | - | OK |
| ULS-2_Fxx(Min) | 605.191 | - | -1245.888 | -390.229 | -158.499 | 3.818 | - | - | OK |
| ULS-2_Fyy(Max) | 429.055 | - | -1245.888 | 99.981 | -158.499 | 2.707 | - | - | OK |
| ULS-2_Fyy(Min) | 605.191 | - | -1245.888 | -390.229 | -158.499 | 3.818 | - | - | OK |
| ULS-2_Fzz(Max) | 429.055 | - | -1245.888 | 99.981 | -158.499 | 2.707 | - | - | OK |
| ULS-2_Fzz(Min) | 605.191 | - | -1245.888 | -390.229 | -158.499 | 3.818 | - | - | OK |
| ULS-2_Mxx(Max) | 429.055 | - | -1245.888 | 99.981 | -158.499 | 2.707 | - | - | OK |

Excel report output

10. RC Design to IS 456:2000 & Crack calculations by IS 3370(Part 2):2009

- Reinforced Concrete Design as per IS456: 2000 is now available in midas civil, where we can perform Beam Design, Beam Checking, Column Design, Column Checking
- We can generate Graphic/Detailed reports which include both Ultimate Limit State and Serviceability Limit State checks as per IS 456:2000. Also, Crack Width Checks as per IS 3370 (Part-2):2009 can be obtained for Beams.

▪ Design > RC Design > IS456:2000

Concrete Design Code

Design Code : IS456:2000

Apply Special Provisions for Seismic Design

Moment Redistribution Factor for Beam : 1

Torsion Design

IS 3370(Part 2):2009 Crack Width Check

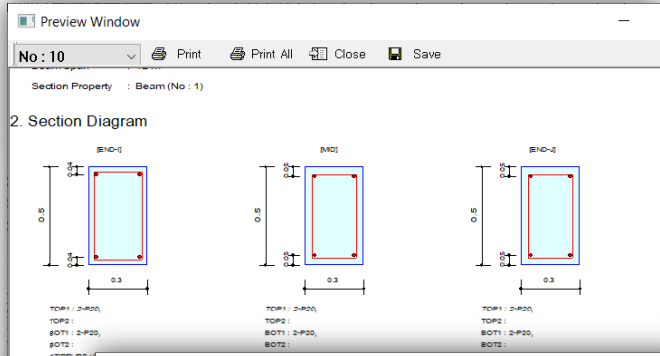
Crack Width due to Temperature & Moisture - Annex A

- Estimated Shrinkage Strain : 0.0025
- Estimated Total Thermal Contraction after Peak Temperature due to Heat of Hydration : 0.0025
- T1 (C) Fall in Temperature between the hydration peak and ambient : 30

Crack Width in Mature Concrete - Annex B

- Limiting Design Surface Crack Width(mm) : 0.2

OK Close



Preview Window No: 4

3. Bending Moment

1. Design Condition

Design Code IS456:2000
 Unit System kN, m
 Member Number 4
 Material Data fck = 40000, fy = 415000, fyw = 415000 KPa
 Column Height 4 m
 Section Property Column (No: 2)

| Rebar Pattern | Pos 1 | Pos 2 | Pos 3 |
|---------------|-------|--------|-------|
| Layer 1 | 6-P32 | 10-P32 | -- |
| Layer 2 | 6-P32 | 10-P32 | -- |

Total Rebar Area Ast = 0.0514688 m² (Rhostr = 0.2145)

2. Applied Loads

Load Combination 3 AT (I) Point
 N_{Ed} = 341.642 kN, M_{Edy} = 126.847, M_{Edz} = 9.56598, M_{Ed} = 127.207 kN-m

3. Axial Forces and Moments Capacity Check

| Concentric Max. Axial Load | N _{Rdmax} | Value | Check |
|----------------------------|------------------------------------|---------------------|---------------------------|
| | 17327.4 kN | | |
| Axial Load Ratio | N _{Ed} /N _{Rd} | = 341.642 / 1074.14 | = 0.318 < 1.000 O.K |
| Moment Ratio | M _{Edy} /M _{Rdy} | = 126.847 / 398.879 | = 0.318 < 1.000 O.K |
| | M _{Edz} /M _{Rdz} | = 9.56598 / 29.1810 | = 0.328 < 1.000 O.K |
| | M _{Ed} /M _{Rd} | = 127.207 / 399.945 | = 0.318 < 1.000 O.K |

MIDAS/Text Editor - [1_Model_IS456_RCDesign.ruc]

```

( ) Compute moment magnification factors for major axis(DBy,DSy).
- Cm1 = 0.85 (Default or User defined value)
- DBy < 1.0 -> DBy = 1.00
- DSy = 1.00 (Default value)

( ) Compute minimum eccentric moments(Mmin)
- Emin = MAX[ MAX[LyLz]/500 * Dmax/30, 20] = 0.028 m.
- Mmin_y = Pu * Emin = 9.57 kN-m.

( ) Compute magnified moments.

* DESIGN CODE : IS456:2000, * UNIT SYSTEM : kN, m
* MEMBER : Member Type = BEAM, HEMB = 10
* DESCRIPTION OF BEAM DATA (ISEC = 1) : Beam
Section Type : Rectangle (RECT)
Beam Length (Span) = 6.000 m.
Section Depth (Hc) = 0.600 m.
Section Width (Bc) = 0.300 m.
Concrete Strength (fck) = 30000.000 KPa.
Main Rebar Strength (fy) = 415000.000 KPa.
Stirrups Strength (fyw) = 415000.000 KPa.
Modulus of Elasticity (Es) = 200000000.000 KPa.

* FORCES AND MOMENTS AT CHECK POINT <I> :
Positive Bending Moment P-M_Ed = 30.82 kN-m., LCB = 1
Negative Bending Moment N-M_Ed = 164.95 kN-m., LCB = 2
Shear Force V_Ed = 85.03 kN., LCB = 1
Torsion T = 2.84 kN-m., LCB = 11

* REINFORCEMENT PATTERN :
-----
Location i di (m.) Rebar Asi (m^2.)
-----
Top 1 0.040 2-P20 0.00063
Bottom 1 0.040 2-P20 0.00063
-----
Stirrups : 2.0-P12 #300

[[[*]]] ANALYZE SHEAR AND TORSION CAPACITY.

( ) Compute design parameters.
- . alpha = 0.642857
- . beta1 = 0.8400
- . Gamma_m = 1.50 (for concrete).
- . fcd = fck / Gamma_m = 20000.000 KPa.
- . Gamma_s = 1.15 (for Fundamental).
- . fyd = fyk / Gamma_s = 36089.565 KPa.

( ) Check area of tensile reinforcement (Rectangular-beam).
- . fyk = 415000.0000 KPa.
- . ecu = 0.0035
- . est = fy/1.15Es + 0.002 = 0.0038
- . As_max1 = (fck*Bc/fy)*(beta1*ecu*d/(est+ecu)) = 0.0040 m^2.
- . As_max2 = 0.04 * (Bc*Hc) = 0.0060 m^2.
- . As_max = min[ As_max1, As_max2 ] = 0.0040 m^2.
- . As_min = 0.85*bt*d/fy = 0.0003 m^2.
- . As_prov = 0.0006 m^2.
- . As_min < As_prov < As_max ----> O.K !

```

Graphic report for beam & column design & checking

Detailed text output with crack calculations