

# Release Note

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Release Date : Apr. 20, 2023

Product Ver. : Civil 2023 (v1.1)



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

# Enhancements

## Enhancements in Civil 2023 (v1.1)

1. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II
2. French National Annex to Eurocode 2, 3, 4
3. Eurocode Design Report in French
4. Eurocode Design Report in Word Format
5. Preference Setting for Design Report Language
6. Time Dependent Material: Modulus of Elasticity Suggested by Gilbert and Ranzi
7. PSC Design: User Input of Torsion Parameters,  $A_k$  and  $u_k$
8. Equivalent Beam Stress Results for Construction Stage Analysis
9. GSD Excel Report: Print Results of All Load Combinations
10. Concrete & Rebar Material Database to South Africa: TMH7
11. Concurrent Disp./Vel./Accel. for Time History Analysis
12. Transmission Zone Design of Pretensioned Beam to AASHTO LRFD
13. SNI/SP PSC Design: Crack Opening Coefficient by Tendon Material
14. Concurrent Joint Forces
15. Improvement in Auto Load combinations as per IRC 6
16. Improvement in PSC design parameters as per IRC 112:2020
17. Improvement in PSC & RC design as per IRC 112:2020
18. Other Enhancements



## 1. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- Vehicle library has been added for former French national standard.
- Fascicule N° 61, Conception, Calcul et Epreuves des Ouvrages d'art, Titre II - Programmes de Charges et Epreuves des Ponts-Routes (in French)

▪ **Load > Moving Load > Moving Load Code > France**

Define Standard Vehicular Load

Standard Name: Load System A

Vehicular Load Properties  
 Vehicular Load Name: Load System A  
 Vehicular Load Type: Load System A

$A = a1 \times a2 \times A(L)$

$A(L) = 2.3 + 360/(L+12) \text{ kN/m}^2$

$A(L) \times a1 \geq (4 - 0.002L) \text{ kN/m}^2$

Coefficient a1

Number of Loaded Lanes		1	2	3	4	≥5
Bridge Class	First Class	1	1	0.9	0.75	0.7
	Second Class	1	0.9	-	-	-
	Third Class	0.9	0.8	-	-	-

Lane Width Coefficient a2 = v0/v    v = Loadable Width/Number of Lanes

Nominal Width (m)		v0
Bridge Class	First Class	3.5
	Second Class	3
	Third Class	2.75

OK    Cancel    Apply

Load System A

Define Standard Vehicular Load

Standard Name: Load System Bc

Vehicular Load Properties  
 Vehicular Load Name: Load System Bc  
 Vehicular Load Type: Load System Bc

No	Load(kN)	Spacing(m)	Distance Between two Vehedes Min = 4.5m Max = Infinite
1	60	4.5	
2	120	1.5	
3	120	end	

Coefficient bc

Number of Loaded Lanes		1	2	3	4	≥5
Bridge Class	First Class	1.2	1.1	0.95	0.8	0.7
	Second Class	1	1	-	-	-
	Third Class	1	0.8	-	-	-

Apply Dynamic Factor

OK    Cancel    Apply

Load System Bc

Define Standard Vehicular Load

Standard Name: Military Load

Vehicular Load Properties  
 Vehicular Load Name: System Mc 80  
 Vehicular Load Type: System Mc 80

Min. Distance Between Two Vehicles: 35.4 m

P: 720 kN    D: 4.9 m

Apply Dynamic Factor

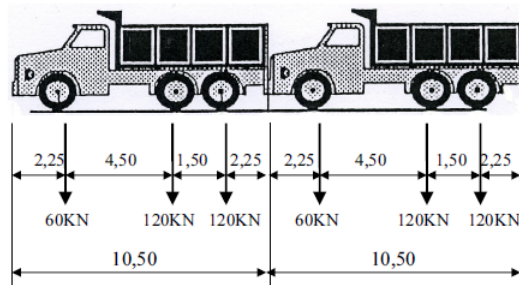
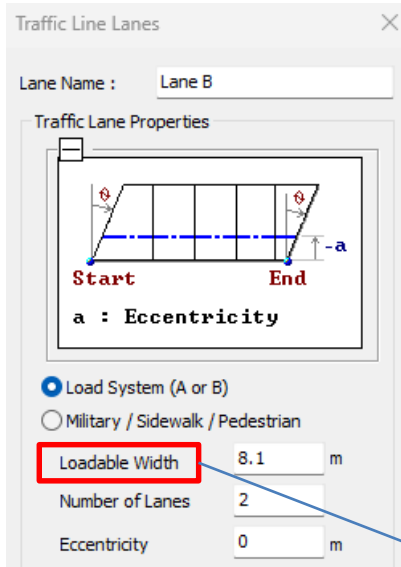
OK    Cancel    Apply

Military Load Mc 80

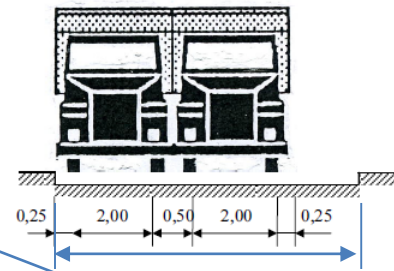
## 1. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- Define the roadway width in the lane definition rather than the individual lane.

- Load > Moving Load > Moving Load Code > France



Longitudinalement



Loadable Width

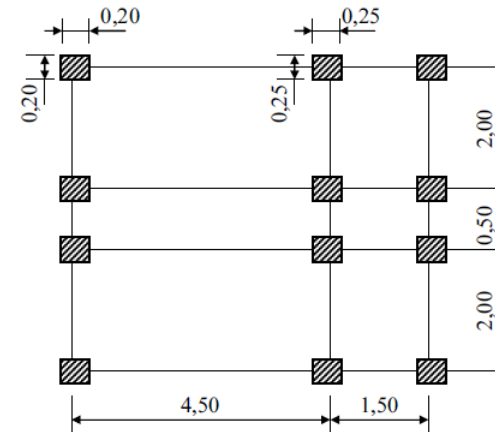


Figure 4.1 : Système B<sub>e</sub>

## 1. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- Enter the span length and span weight for each span to calculate the dynamic factor,  $\delta$ .
- The maximum weights of load system Bc for each span are determined by program.

### ▪ Load > Moving Load > Moving Load Code > France

```

MIDAS/Text Editor - [MVmaxBcFz62_DetailResult]
File Edit View Window Help
+ midas Civil France Moving Load Data ++
+ Moving Load Cases : MVmaxBc
+ Key Element : B2
+ Components : Fz
+ Maximum Value : 5.0809e+02
-----
[Lane1 ]
+ Multiple Lane Factor(bc), 1st Vehicle : 1.100
+ Multiple Lane Factor(bc), 2nd Vehicle : 1.100
+ Dynamic Factor for Each Axle : 1.241, 1.161, 1.161, 1.161, 1.161, 1.161
[Lane2 ]
+ Multiple Lane Factor(bc), 1st Vehicle : 1.100
+ Multiple Lane Factor(bc), 2nd Vehicle : 1.100
+ Dynamic Factor for Each Axle : 1.241, 1.161, 1.161, 1.161, 1.161, 1.161
Ln 0 / 21.
    
```

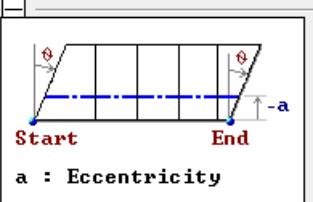
- Dynamic Factor

$$\delta = 1 + \frac{0,4}{1 + 0,2L} + \frac{0,6}{1 + 4 \frac{G}{S}}$$

Traffic Line Lanes

Lane Name : Lane B

Traffic Lane Properties



**a : Eccentricity**

Load System (A or B)

Military / Sidewalk / Pedestrian

Loadable Width : 8.1 m

Number of Lanes : 2

Eccentricity : 0 m

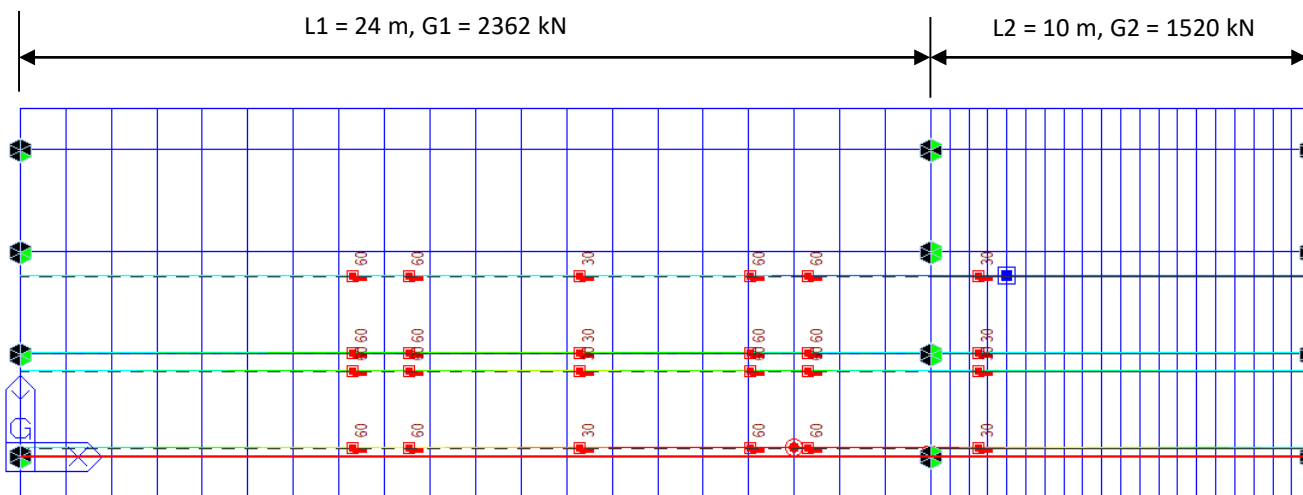
Dynamic Factor for System B

L (Span Length) : 24 m

G (Span Weight) : 2362 kN

Centrifugal Force

Left Wheel of Vehicle Moving Forward : 0.0 W



No	Elem	Eccen. (m)	L (m)	G (kN)	Span Start
1	82	-4.05	24	2362	<input checked="" type="checkbox"/>
2	83	-4.05	24	2362	<input type="checkbox"/>

No	Elem	Eccen. (m)	L (m)	G (kN)	Span Start
40	121	-4.05	10	980	<input type="checkbox"/>

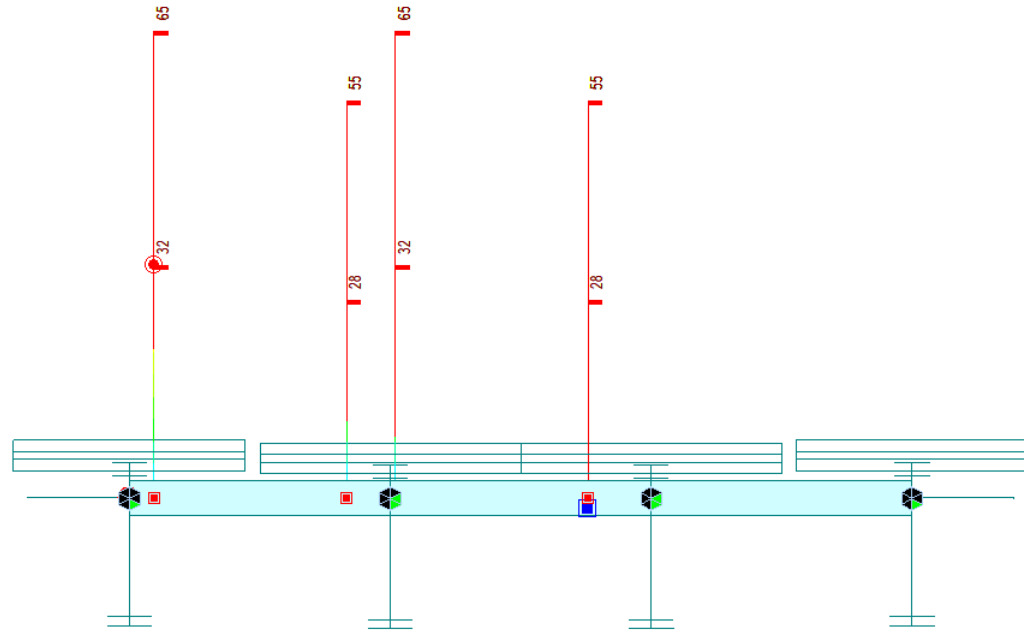
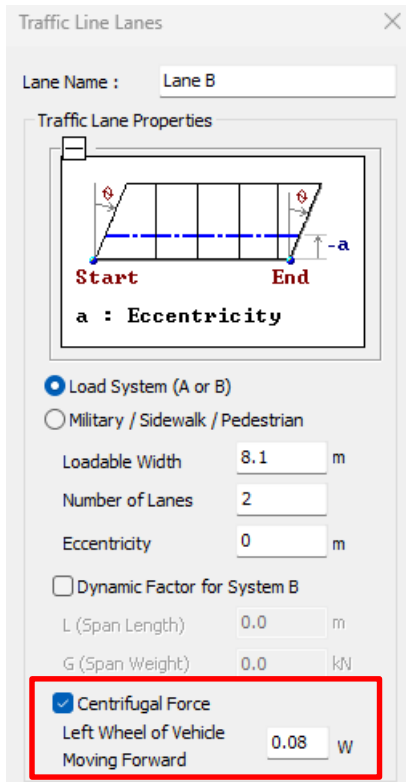
## 1. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- The effects of the centrifugal forces can be added to the effects of vertical loads.

- Load > Moving Load > Moving Load Code > France

- The ratio for the increase of left wheel load to consider the centrifugal forces

$$\frac{R + 150}{6R + 350} \quad \text{if } R < 400\text{m} \qquad \frac{80}{R} \quad \text{if } R \geq 400\text{m}$$



Vertical Loads with Centrifugal Forces

## 2. French National Annex to Eurocode 2, 3, 4

- French national annexes have been added for Eurocode 2, 3, and 4.

▪ **Design > RC Design, Steel Design, Composite Design**    **PSC > PSC Design**

The image displays four overlapping dialog boxes from a software application, set against a background of a French standard document titled "Norme NF EN 1992-1-1/NA Mars 2016".

- Composite Steel Girder Design Parameters:** Shows design code "EN 1994-2" and National Annex "France". It lists various partial factors like Concrete(Gamma\_C), Reinforcing Steel(Gamma\_S), and Structural Steel(Gamma\_M0). It also includes stress limitation parameters (k1: 0.6, k2: ) and shear resistance reduction factors (ks: 0.75). Under Ultimate Limit States, several options are checked, including Bending Resistance, Resistance to Vertical Shear, Resistance to Lateral-torsional Buckling, Resistance to Transverse force, Resistance to Longitudinal Shear, and Resistance to Fatigue.
- PSC Design Parameters:** Shows design code "Eurocode2-2:05" and National Annex "France". It has sections for Input Parameters (Moment resistance, Shear resistance, Prestressing steel type) and Output parameters (Ultimate limit states, Serviceability limit states).
- Steel Design Code:** Shows design code "Eurocode3-2:05" and National Annex "France". It includes options for lateral bracing, buckling resistance, and interaction factors.
- Concrete Design Code:** Shows design code "Eurocode2-2:05" and National Annex "France". It includes parameters for Moment Resistance (Moment Redistribution Factor for Beam: 1), Column Design (Axial load plus biaxial bending), and Shear Resistance (Strut Angle for Shear Resistance: 45 Deg).

At the bottom of the dialog boxes, there are buttons for "Steel Design", "Concrete Design", "Prestressed Girder Design", and "Composite Steel Girder Design".

### 3. Eurocode Design Report in French

- Design reports of Eurocode can now be generated in French.

- **Design > RC Design, Steel Design, Composite Design**
- **PSC > PSC Design**

MIDAS Information Technology Co.,Ltd. Civil 2022 (v1.1) / Vérification

**■ NOM DU MEMBRE : Slab-BC**

**1. Informations de l'élément**

- Code de conception  
EN 1992-2: 2005 ( NA:France )
- Propriété de section  
10 ( ID : 10 )
- Propriété matérielle  
 $f_{ck} = 30.000\text{MPa}$ ,  $f_y = 500.000\text{MPa}$
- Longueur  
 $L = 0.914\text{m}$
- Données de ferrailage  
Bot-Dir.1 : P16@300  
Top-Dir.1 : P16@300  
Bot-Dir.2 : P13@300  
Top-Dir.2 : P13@300

**2. Capacité de Moment ( Dir-x, Négatif )**

Memb No.	740	
Nœud No.	777	
Moment Nég.	LCB	cLCB2
	$M_{Ed} / M_{Rd}$	$-56.696\text{kN-m/m} / -59.070\text{kN-m/m} = 0.960$ <span style="float: right;">OK</span>
	$\rho_{min} , \rho , \rho_{max}$	$\rho_{min} = 0.00151 < \rho = 0.00319 < \rho_{max} = 0.04000$ <span style="float: right;">OK</span>

\* cLCB2 : ( 1.350 )SW+( 1.350 )EHmax+( 1.350 )LS+( 1.350 )MVL1+( 1.350 )EV

- Paramètre de conception  
 $f_{ck} = 30.000\text{MPa}$ ,  $f_{yk} = 500.000\text{MPa}$   
 $b_w = 1,000.000\text{mm}$ ,  $h = 260.000\text{mm}$   
 $d = 210.000\text{mm}$   
 $A_{st} = 670.200\text{mm}^2$   
 $\alpha_{cc} = 1.000$   
 $\gamma_c = 1.500$ ,  $\gamma_s = 1.150$   
 $f_{cd} = \alpha_{cc} f_{ck} / \gamma_c = 20.000\text{MPa}$   
 $f_{yd} = f_{yk} / \gamma_s = 434.783\text{MPa}$

	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
1																																	
2	Číslo prvku		16																														
3	Position Information		J																														
4																																	
5	<b>1.Nastavení posudku</b>																																
6	1.1 Návrhové parametry																																
7	- Dílčí součinitele pro mezní stav únosnosti (EN 1992-1-1:2004, 2.4.2.4)																																
8	Návrhové situace		$\gamma_c$ beton				$\gamma_s$ betonářská výztuž				$\gamma_s$ předpjatá výztuž																						
9	Trvalé & Dočasné		1.500				1.150				1.150																						
10	Mimořádné		1.200				1.000				1.000																						
11																																	
12	- součinitel $\alpha_{cc}$ , $\alpha_{ct}$ : Součinitel pro dlouhodobé účinky únosnosti v tlaku a tahu.																																
13	$\alpha_{cc} =$		0.850		(pro únosnost betonu v tlaku)																												
14	$\alpha_{ct} =$		1.000		(pro únosnost betonu v tahu)																												
15																																	
16	1.2 Průřezy																																
17	$b_w$		8500.0 mm				$I_y$		7.8668E+12 mm <sup>4</sup>				$A_{sl}$		0.000 mm <sup>2</sup>																		
18	$h$		3000.0 mm				$I_z$		2.9574E+13 mm <sup>4</sup>				$A_{sc}$		0.000 mm <sup>2</sup>																		
19	$d_c$		0.0 mm				$C_y$		4250.0 mm				$A_{sw}$		0.000 mm <sup>2</sup>																		
20	$d_t$		0.0 mm				$C_z$		1790.6 mm				$A_{wt}$		0.000 mm <sup>2</sup>																		
21	A		6208720.000 mm <sup>2</sup>										$A_{it}$		0.000 mm <sup>2</sup>																		
22																																	
23	1.3 Materiály																																
24	- Beton																																
25	$f_{ck} =$		40.000 MPa				$E_c =$		35220.000 MPa																								
26																																	
27	- Výztuž																																
28	$f_{yk} =$		400.000 MPa				$E_s =$		200000.000 MPa																								
29																																	
30	1.4 Předpjaté kabely																																
31	Typ		Název kabelu				Pozice (mm)		Plocha (mm <sup>2</sup> )		Pevnost (MPa)				$E_p$ (MPa)																		
32			$f_{ck}$		$f_{p0.1k}$																												
33	1		S_A2L				500.0		2635.300		1900.000		1600.000		200000.000																		
34	2		S_A3L				700.0		2635.300		1900.000		1600.000		200000.000																		
35	3		S_A4R				900.0		2635.300		1900.000		1600.000		200000.000																		
36	4		S_A4L				900.0		2635.300		1900.000		1600.000		200000.000																		



## 4. Eurocode Design Report in Word Format

- Design reports of Eurocode are now generated in Word format, which is faster than Excel format and enables the user to change the report style with ease.
- PSC design report is still in Excel format in this version.

### ■ Design > RC Design, Steel Design, Composite Design

The image displays three overlapping screenshots of Microsoft Word documents generated from MIDAS Civil 2023, showing design reports for different member types.

**Left Screenshot: RC Design Report**  
**MEMBER NAME : 500x300 ( Section ID : 1, Element No.1 )**  
 1. Member Information  
 1) Design Code: EN 1992-2: 2005 ( NA/Italy )  
 2) Section Property: 500x300 ( ID : 1 )  
 3) Material: Concrete ( $f_c = 25.00\text{MPa}$ ,  $E_{cm} = 31.475\text{MPa}$ ), Reinforcement ( $f_{yk} = 430\text{MPa}$ ,  $E_s = 206.000\text{MPa}$ )  
 4) Length:  $L = 6.000\text{m}$   
 5) Reinforcement Data: Top 2-P24, Bottom 2-P24, Stirrups 2-P14@200  
 2. Moment Capacity ( Negative ) ( Sector I, 0.25L )  
 Memb No. 1, Neg. LCB LCB1,  $M_{ed} / M_{rd} = 0.000\text{kNm} / 136\text{kNm} = 0.000$   
 $\rho_{min} = 0.00155 < \rho = 0.00685 < \rho_{max} = 0.04000$

**Middle Screenshot: Steel Design Report**  
**MEMBER NAME : Column 7 W8x35 ( ID : 1 )**  
 1. Member Information  
 1) Design Code: EN 1993-2: 2006 ( NA-Recommended )  
 2) Material:  $f_y = 1,711.357\text{MPa}$ ,  $E_s = 199,948.024\text{MPa}$   
 3) Length:  $L = 3.658\text{m}$   
 4) Partial factors:  $\gamma_{M0} = 1.000$ ,  $\gamma_{M1} = 1.000$ ,  $\gamma_{M2} = 1.250$   
 5) Section Properties:  $A = 6,645.146\text{mm}^2$ ,  $I_y = 32,861.391051\text{mm}^4$ ,  $I_z = 17,731,458.731\text{mm}^4$ ,  $r_{y0} = 0.000\text{mm}$ ,  $C_y = 101.854\text{mm}$ ,  $C_z = 103.124\text{mm}$ ,  $r_{y1} = 89.154\text{mm}$ ,  $r_{z1} = 51.562\text{mm}$ ,  $W_{pl,y} = 511,278.397\text{mm}^3$ ,  $W_{pl,z} = 173,702.878\text{mm}^3$ ,  $W_{pl,y1} = 568,631.121\text{mm}^3$ ,  $W_{pl,z1} = 263,831.730\text{mm}^3$ ,  $I_{tw} = 320,498.198\text{mm}^4$ ,  $I_{tp} = 1,601,112\text{mm}^4$   
 2. Check Axial Resistance  
 Axial LCB sLCB1,  $N_{ed} / N_{td} = 287.283\text{kN} / 2,325.666\text{kN} = 0.124$  OK  
 1) Check slenderness ratio of compressive member  
 $\frac{KL}{i} = 70.996 < 200.000 \rightarrow \text{OK}$

**Right Screenshot: Composite Design Report**  
**MEMBER NAME : Steel Composite : 1 - j**  
 1. Member Information  
 1) Design Code: EN 1994-2 ( NA : Recommended )  
 2) Section Property: Comp  
 3) Material: Steel ( $f_y = 345.000\text{MPa}$ ,  $E_s = 210,000.000\text{MPa}$ ), Concrete ( $f_{ck} = 30.000\text{MPa}$ ,  $E_{cm} = 33,000.000\text{MPa}$ ), Reinforcement ( $f_{yk} = 500.000\text{MPa}$ ,  $E_s = 200,000.000\text{MPa}$ )  
 4) Length:  $L = 1.000\text{m}$   
 5) Partial factors  

	Factor
$\gamma_c$ for concrete	1.500
$\gamma_s$ for reinforcing steel	1.150
$\gamma_{st}$ for structural steel	1.000
$\gamma_{st}$ for structural steel	1.100
$\gamma_{st}$ for headed stud	1.250
$\gamma_{st}$ for equivalent constant Amplitude stress range	1.000
$\gamma_{st}$ for fatigue strength	1.000
$\gamma_{st}$ for fatigue strength of studs in shear	1.000

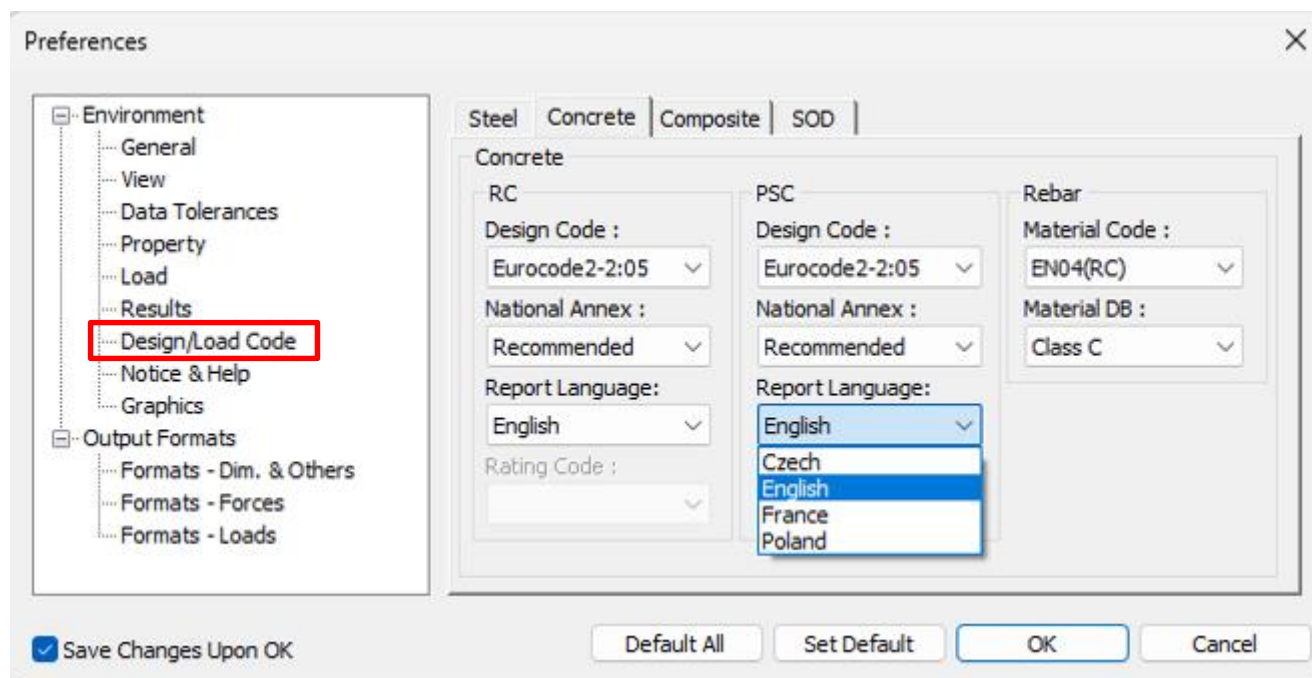
 6) Section Properties  

	Steel Section	Composite Section( Positive )	Composite Section( Negative )
Area	34,687.500mm <sup>2</sup>	155,867.976mm <sup>2</sup>	43,132.020mm <sup>2</sup>

## 5. Preference Setting for Design Report Language

- The preferred language of the design reports can now be selected from the Preference for Eurocode and AASHTO LRFD.
- The preferred unit system of the design reports can now be selected from the Preference for AASHTO LRFD.

### ▪ *Tools > Setting > Preferences > Design/Load Code*

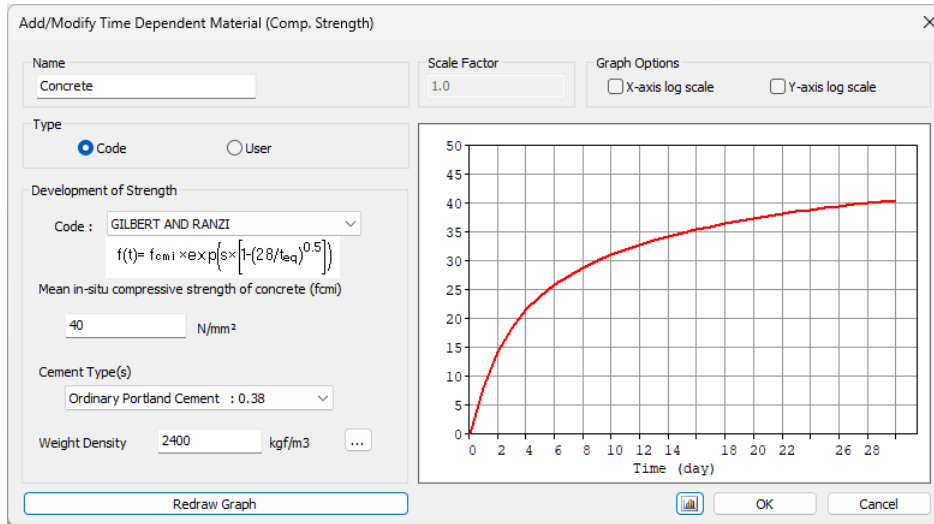


Report Language of Preference

## 6. Time Dependent Material: Modulus of Elasticity Suggested by Gilbert and Ranzi

- Time-dependent modulus of elasticity suggested by Gilbert and Ranzi has been added.
- Time-dependent behavior of concrete structures by Raymond Ian Gilbert and Gianluca Ranzi, 2010

### ▪ Properties > Time Dependent Material > Comp. Strength > GILBERT AND RANZI



Development of Compressive Strength

- Modulus of elasticity

For  $f_{cmi} \leq 40$  MPa:

$$E_c = \rho^{1.5} 0.043 \sqrt{f_{cmi}} \text{ (in MPa)}$$

For  $40 < f_{cmi} \leq 100$  MPa:

$$E_c = \rho^{1.5} [0.024 \sqrt{f_{cmi}} + 0.12] \text{ (in MPa)}$$

- Modulus of elasticity with time

$$E_c(t) = \left( e^{s(1-\sqrt{28/t})} \right)^{0.5} E_c(28)$$

## 7. PSC Design: User Input of Torsion Parameters, Ak and uk

- Area and perimeter for the torsion design can now be user-defined for the PSC-Value type, PSC-Composite type, and General-Composite type sections.

### Properties > Section > Section Manager > Reinforcements

Section Manager

Mode: Reinforcements

Target Section & Element:

- Section : 3
- 1 : T1-2 1500
- 2 : Super T End
- 3 : Super T Mid

Grid : 100 mm

Longitudinal Reinforcement | Shear Reinforcement

Same Rebar Data at i & j-end

Diagonal Reinforcement:

Pitch: 150 mm  
 Angle: 90 [deg]  
 Aw: 402.2 mm<sup>2</sup>

Steel Bar for Web:

Pitch: 0 mm  
 Angle: 90 [deg]  
 Ap: 0 mm<sup>2</sup>  
 Pe: 0 N  
 Shear Reduction Factor: 1

Torsional Reinforcement:

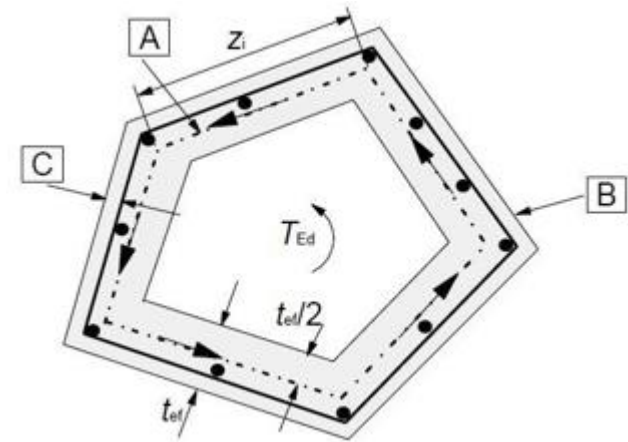
Pitch: 100 mm  
 Awt: 201.1 mm<sup>2</sup>  
 Alt: 1963.6 mm<sup>2</sup>

Enclosing Stirrup:

Auto Calculation  User Input

Ak_centerline	1304467	mm <sup>2</sup>
uk_centerline	4820	mm
Ak_outside	1539582	mm <sup>2</sup>
uk_outside	5707	mm

Copy Reinforcements to... | Super T End | G : 1088.6, -781.67 | VIEW | Apply | Close



- A - centre-line
- B - outer edge of effective cross-section, circumference  $u$ ,
- C - cover

Shear Reinforcement of Section Manager

## 8. Equivalent Beam Stress Results for Construction Stage Analysis

- Equivalent beam stresses including von-Mises stresses of the steel beam sections are now provided for the construction stage analysis.

### ▪ Results > Stresses > Beam Stresses (Equivalent) or Beam Stresses Diagram (Equivalent)

**Main Control Data**

Auto Rotational DOF Constraint for Truss/Plane Stress/Solid Elements

Auto Normal Rotation Constraint for Plate Elements

Tension / Compression Truss Element (Elastic Link / Inelastic Spring)

Number of Iterations/Load Case: 20

Convergence Tolerance: 0.001

Consider Section Stiffness Scale Factor for Stress Calculation

Transfer Reactions of Slave Nodes to the Master Node

Calculate Equivalent Beam Stresses (Von-Mises and Max-Shear)

Consider Reinforcement for Section Stiffness Calculation

Change Local Axis of Tapered Section for Force/stress Calculation

Main Control Data

React... Deform... Forces Stres... Strains

Beam Stresses(Equivalent)

Load Cases: CS: Summation

Step: Last Step

Stresses:

Normal  Von-Mises

Tau\_xy  Max-Shear

Tau\_xz  Princ. (max)

Princ. (min)

Position:

Maximum

1 (-y, +z)

2 (+y, +z)

3 (+y, -z)

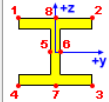
4 (-y, -z)

5 (N.A. -y)

6 (N.A. +y)

7 (N.A. -z)

8 (N.A. +z)



Type of Display:

Contour  Deform

Values  Legend

Animate  Undeformed

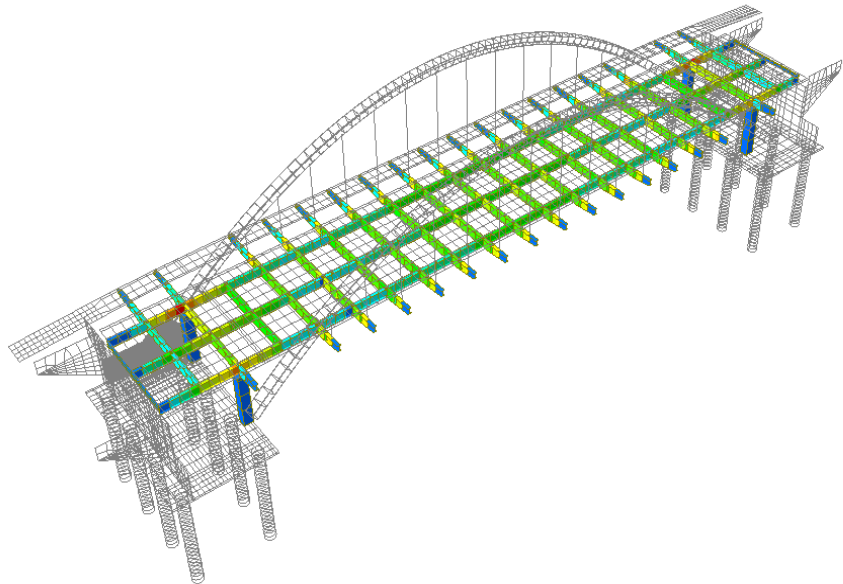
Mirrored

Output Section Location:

I  Center  J

Max  All

Apply Close



Von-Mises Stresses at Centroid of Steel Beam

MIDAS/Civil1  
POST-PROCESSOR

BEAM STRESS (EQUIV.)

Von-Mises

8.42925e+00
7.66295e+00
6.89666e+00
6.13036e+00
5.36407e+00
4.59777e+00
3.83148e+00
3.06518e+00
2.29889e+00
1.53259e+00
7.66295e-01
0.00000e+00

STAGE:CS  
CS: SUMMATION  
LAST

MAX : 60080  
MIN : 3000

FILE: 3D MODEL\_~  
UNIT: N/mm<sup>2</sup>  
DATE: 04/19/2023

VIEW-DIRECTION

X: -0.497

Y: -0.625

Z: 0.602

## 9. GSD Excel Report: Print Results of All Load Combinations

- The design results for all the load combinations are now generated together in the GSD report.

### Tools > Generator > General Section Designer

Define Load Combination X

No.	Load Combination	P (kN)	My (kNxm)	Mz (kNxm)	Vy (kN)	Vz (kN)	T (kNxm)
1	lcb1	0.00	2880.00	0.00	0.00	0.00	0.00
2	lcb2	10000.00	1550.00	0.00	0.00	0.00	0.00
3	lcb3	5000.00	1350.00	1120.00	0.00	0.00	0.00
4	lcb4	7540.00	-2415.00	2640.00	0.00	0.00	0.00
5	lcb5	3590.00	-1450.00	3400.00	0.00	0.00	0.00

Close

Section View: Section1 Interaction Curve Stress Contour

P-M My-Mz 3D

Mode:  Angle: 0.000000  Dea:  P-My  P-Mz  Load Combination: lcb1

Code: Eurocode2:04

Hoop Type:  Tie  Spiral

Checking Ratio:  Keep M/P constant  Keep M constant  Keep P constant

	P (kN)	My (kNxm)	Mz (kNxm)
1	18618.363	0.000	-0.000
2	13854.348	2844.186	-0.000
3	13259.834	3088.594	-0.000
4	12671.983	3308.460	-0.000
5	12091.494	3500.334	-0.000
6	11519.309	3670.993	-0.000
7	10956.736	3820.881	-0.000
8	10405.647	3949.762	-0.000
9	9868.821	4061.676	-0.000
10	9350.626	4158.444	-0.000
11	8858.537	4235.074	-0.000
12	8407.673	4299.348	-0.000
13	8056.967	4343.774	-0.000
14	7846.246	4321.414	-0.000
15	7113.378	4271.786	-0.000
16	6522.025	4185.485	-0.000
17	5889.170	4059.685	-0.000
18	5223.550	3889.404	-0.000
19	4530.596	3670.616	-0.000
20	3814.054	3399.924	-0.000
21	3076.679	3074.359	-0.000
22	2320.593	2690.837	-0.000
23	1547.484	2245.082	-0.000
24	503.778	1558.325	-0.000
25	-1707.374	0.000	-0.000

Report All Report Close

**P-M Curve**

Mode : Load Combination = lcb1  
Checking Ratio = 2.384 (Keep M/P Constant)

	Pu(kN)	Mn(kNxm)
1	18618.363	0.000
2	13854.348	2844.186

**P-M Curve**

Mode : Load Combination = lcb2  
Checking Ratio = 0.677 (Keep M/P Constant)

	Pu(kN)	Mn(kNxm)
1	18618.363	0.000
2	13854.348	2844.186
3	13259.834	3088.594

**P-M Curve**

Mode : Load Combination = lcb3  
Checking Ratio = 1.198 (Keep M/P Constant)

	Pu(kN)	Mn(kNxm)
1	18618.363	0.000
2	15710.463	1047.896
3	14919.966	1155.320
4	14103.774	1232.297
5	13293.674	1314.675

**P-M Curve**

Mode : Load Combination = lcb4  
Checking Ratio = 3.388 (Keep M/P Constant)

	Pu(kN)	Mn(kNxm)
1	18618.363	0.000
2	15473.694	978.839
3	14670.085	1069.599
4	13888.355	1148.447
5	13118.117	1228.088

**P-M Curve**

Mode : Load Combination = lcb5  
Checking Ratio = 6.686 (Keep M/P Constant)

	Pu(kN)	Mn(kNxm)
1	18618.363	0.000
2	14822.449	841.783
3	14096.620	935.683
4	13379.695	1019.282
5	12662.163	1096.550
6	11979.869	1145.635
7	11289.743	1194.251
8	10613.982	1232.493
9	9967.001	1263.977
10	9331.757	1284.925
11	8728.384	1298.148
12	8175.284	1305.567
13	7738.030	1308.730
14	7196.163	1295.125
15	6466.592	1270.877
16	5658.242	1235.319
17	4791.853	1187.060
18	3908.743	1107.766
19	2963.610	1013.575
20	2006.083	915.062
21	1018.217	766.886
22	-16.058	634.672
23	-869.623	468.636
24	-1564.498	89.669
25	-1707.374	0.000



## 10. Concrete & Rebar Material Database to South Africa: TMH7

- Concrete and rebar material database have been added for South Africa TMH7.

### Properties > Material > Concrete > TMH7



**Material Data**

General  
Material ID: 2 Name: Grade 40

Elasticity Data  
Type of Design: Concrete

Steel  
Standard: DB

Concrete  
Standard: TMH7(RC)  
Code: Grade 40

Type of Material  
 Isotropic  Orthotropic

Steel  
Modulus of Elasticity: 0.0000e+00 N/mm<sup>2</sup>  
Poisson's Ratio: 0  
Thermal Coefficient: 0.0000e+00 1/[C]  
Weight Density: 0 N/mm<sup>3</sup>  
 Use Mass Density: 0 N/mm<sup>2</sup>/g

Concrete  
Modulus of Elasticity: 3.1000e+04 N/mm<sup>2</sup>  
Poisson's Ratio: 0.2  
Thermal Coefficient: 1.2000e-05 1/[C]  
Weight Density: 2.3e-05 N/mm<sup>3</sup>  
 Use Mass Density: 2.345e-09 N/mm<sup>2</sup>/g

Plasticity Data  
Plastic Material Name: NONE

Inelastic Material Properties for Fiber Model  
Concrete: None Rebar: None

Thermal Transfer  
Specific Heat: 0 Btu/N-[C]  
Heat Conduction: 0 Btu/mm-hr-[C]  
Damping Ratio: 0.05

OK Cancel Apply

Concrete Material

**Modify Concrete Materials**

ID	Name	fc fck R	Chk	Lambda	Main-bar	Sub-bar
1	Grade 40	40	X	1		

Concrete Material Selection  
Code: TMH7(RC) Grade: Grade 40  
Specified Compressive Strength (fc|fck): 40 N/mm<sup>2</sup>  
 Light Weight Concrete Factor (Lambda): 1

Rebar Selection  
Code: TMH7(RC)  
Grade of Main Rebar: Type C Fy: 450 N/mm<sup>2</sup>  
Grade of Sub-Rebar: Type A Fys: 450 N/mm<sup>2</sup>

Modify Close

Reinforcement Material

**Rebar Material Property**

Rebar Material Code: TMH7(RC)  
Rebar Grade: Type C  
Rebar fy: 450 N/mm<sup>2</sup>  
Modulus of Elasticity: 200000 N/mm<sup>2</sup>  
Stress Strain Curve: Park Strain Hardening

OK Close

Reinforcement Material

**Material Data**

General  
Material ID: 2 Name: Grade 40

Elasticity Data  
Type of Design: RC

Steel  
Standard: DB

Concrete  
Standard: TMH7(RC)  
Code: Grade 40

Type of Material  
 Isotropic  Orthotropic

Steel  
Strength: 0 N/mm<sup>2</sup>  
Modulus of Elasticity: 0.0000e+00 N/mm<sup>2</sup>  
Poisson's Ratio: 0  
Thermal Coefficient: 0.0000e+00 1/[T]  
Weight Density: 0 N/mm<sup>3</sup>  
 Use Mass Density: 0 N/mm<sup>2</sup>/g

Concrete  
Strength: 40 N/mm<sup>2</sup>  
Modulus of Elasticity: 3.1000e+04 N/mm<sup>2</sup>  
Poisson's Ratio: 0.2  
Thermal Coefficient: 1.2000e-05 1/[T]  
Weight Density: 2.3e-05 N/mm<sup>3</sup>  
 Use Mass Density: 2.345e-09 N/mm<sup>2</sup>/g

Define Nonlinear Properties

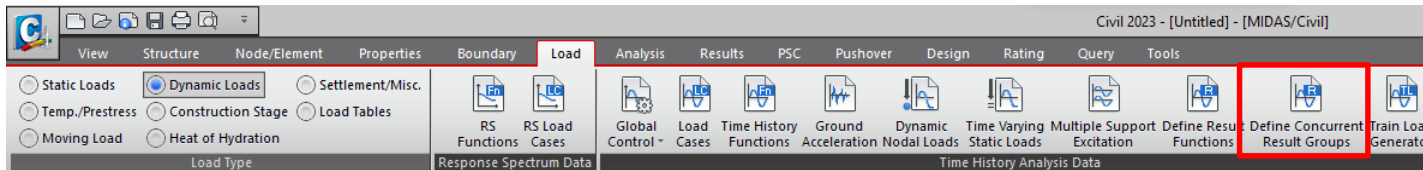
OK Close Apply

Concrete Material

## 11. Concurrent Disp./Vel./Accel. for Time History Analysis

- Concurrent displacements of multiple nodes at the same time step are now available for the linear/nonlinear time history analysis.

- Load > Load Type > Dynamic Loads > Time History Analysis Data > Define Concurrent Result Groups**
- Results > Result Tables > Time History Analysis > Displ./Vel./Accel. (Concurrent)**



**Time History Analysis Data**

Time History Concurrent Result Group: ...

Group Name: G1

Master Node: 72

Sub Nodes: 70 73

Type of Result:  Displ.  Vel.  Accel.

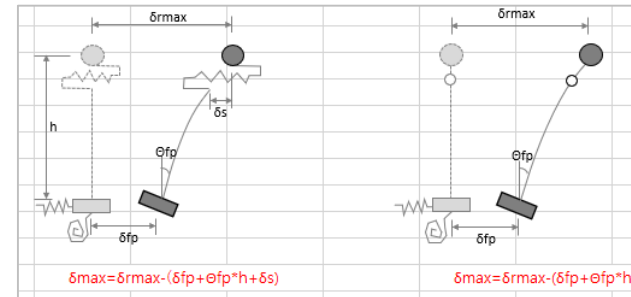
Component: DX

Name	Master Node	Type
G1	72	Displ.
G2	1	Displ.

Operations: Add, Modify, Delete

Define Node Groups

- Reaction
  - Concurrent(Max/Min) Reaction
  - Concurrent(Max/Min) Joint Force
- Displacements
  - Truss
  - Cable
  - Beam
  - Plate
  - Plane Stress
  - Plane Strain
  - Axissymmetric
  - Solid
- Elastic Link
- General Link
- Resultant Forces
- Vibration Mode Shape
- Buckling Mode Shape
- Effective Span Length
- Nodal Results of RS
- Inelastic Hinge
  - Time History Analysis **Displ./Vel./Accel**
  - Heat of Hydration Analysis **Displ./Vel./Accel(Concurrent)**
- Tendon
- Composite Section For C.S.
- Construction Stage
- Equilibrium Element Nodal Force
- Initial Element Force



Group	Load	Node	DX (mm)	DY (mm)	DZ (mm)	RX ([rad])	RY ([rad])	RZ ([rad])
G1	EX(max)	Master Node(72)	97.009600	0.000547	-0.205912	-0.000000	0.001684	-0.000033
		Sub Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
G1	EX(min)	Master Node(72)	24.129700	-0.000193	-0.077511	0.000001	0.001782	-0.000050
		Sub Node(70)	-77.893400	-0.003365	0.440000	0.000013	-0.001365	0.000019
G2	EX(max)	Master Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
		Sub Node(73)	-23.230400	0.000922	0.170059	-0.000003	-0.001508	0.000049
G2	EX(min)	Master Node(1)	131.728000	-0.012116	-0.319860	0.000002	0.000950	-0.000054
		Sub Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
G2	EX(max)	Master Node(72)	96.609000	0.000783	-0.228289	-0.000001	0.001692	-0.000032
		Sub Node(73)	24.106900	-0.000252	-0.086362	0.000001	0.001773	-0.000049
		Master Node(1)	-112.312000	-1.110280	0.590966	0.000043	-0.001041	0.000030
G2	EX(min)	Master Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
		Sub Node(72)	-77.818700	-0.003272	0.432113	0.000013	-0.001381	0.000019
		Sub Node(73)	-22.805700	0.000893	0.167061	-0.000003	-0.001495	0.000046

Concurrent Displacements of Multiple Nodes



## 12. Transmission Zone Design of Pretensioned Beam to AASHTO LRFD

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

### ▪ PSC > Design Parameter > AASHTO LRFD

No.	Tendon Name	k	$f_{ps}$	$T_{ps} = A_{ps} f_{ps}$	$A_{ps} f_{ps} (d_T - c)$
1	S_Span1-263	0.374	44.509	9.658	541.010
2	S_Span1-253	0.374	44.510	9.659	541.027
3	S_Span1-243	0.374	44.204		
4	S_Span1-233	0.374	43.899		

(See 5.6.3.1)

No.	Tendon name	$l_d$ (in)	$l_{tr}$ (in)	$l_{ps}$ (in)	$f_{ps}$ (ksi)
1	S_Span1-263	31.50	152.65	15.75	44.51
2	S_Span1-253	31.50	152.65	15.75	44.51
3	S_Span1-243	31.50	153.15		
4	S_Span1-233	31.50	153.65		

\* The section is located within the transfer length

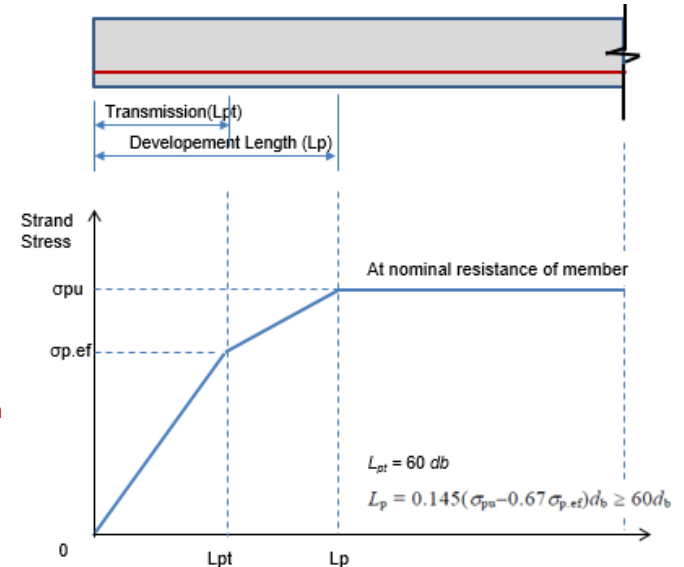
Tendon stress at ULS within development length

Transfer Length & Development Length

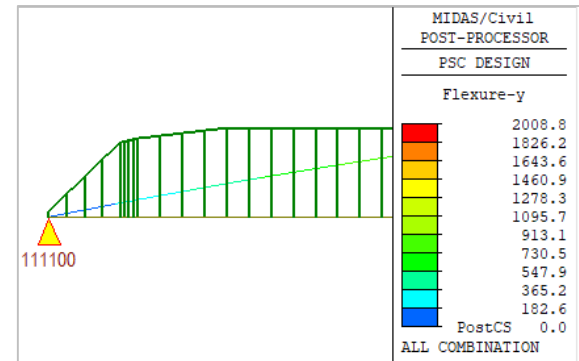
Development Length in Report



Flexural Resistance Diagram



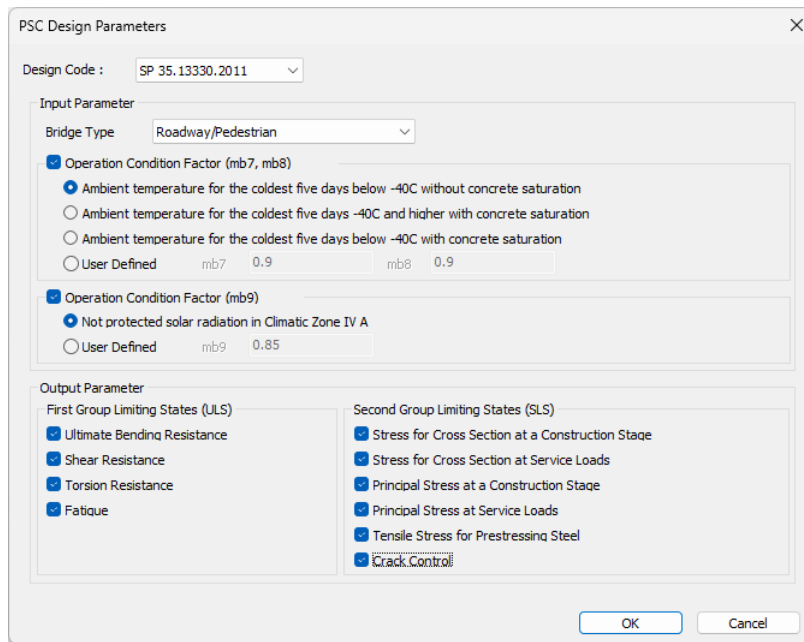
Stresses in the Tendon at ULS



### 13. SNIp/SP PSC Design: Crack Opening Coefficient by Tendon Material

- Crack opening coefficients for different tendon materials have been added for SNIp/SP PSC Design.

▪ **PSC> Design Parameter > SP 35.13330.2011**



PSC Design Parameters

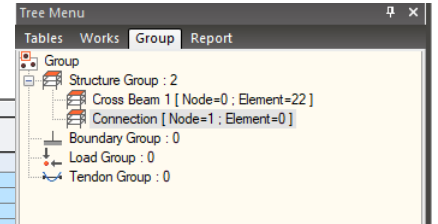
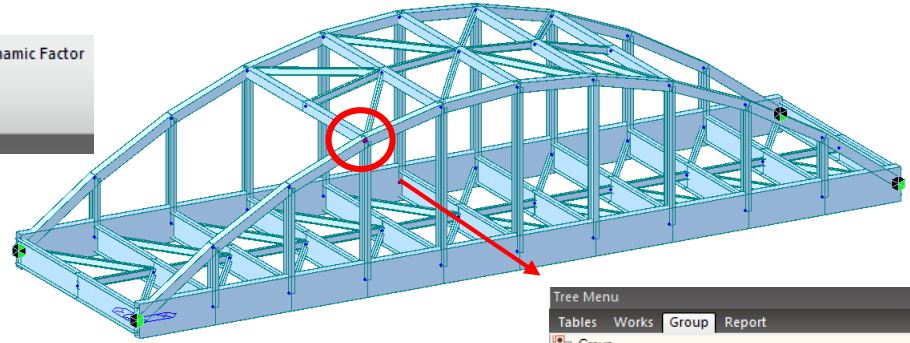
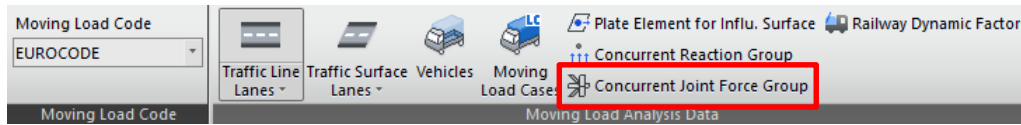
Material (GOST-SP)	Crack Opening Coefficient, $\Psi$
A600	1,5sqrt(Rr)
A800	1,5sqrt(Rr)
AT600	1,5sqrt(Rr)
AT800	1,5sqrt(Rr)
AT1000	1,5sqrt(Rr)
V1500	0,35(Rr)
V1400	0,35(Rr)
V1400 (Group S)	0,35(Rr)
V1400 (Group Zh)	0,35(Rr)
V1300	0,35(Rr)
V1200	0,35(Rr)
Vp1500	1,5sqrt(Rr)
Vp1400	1,5sqrt(Rr)
Vp1200	1,5sqrt(Rr)
K7-1500	1,5sqrt(Rr)
K7-1400	1,5sqrt(Rr)

Crack Opening Coefficients

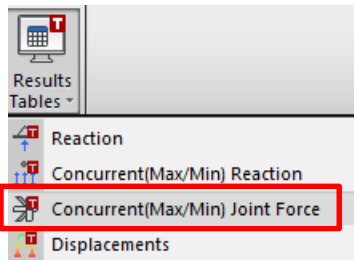
### 14. Concurrent Joint Forces

- Concurrent forces of the elements intersecting at a Joint are provided for the moving load analysis, settlement analysis, and load combinations.
- In this release, only Eurocode is supported.

- Load > Moving Load Analysis Data > Concurrent Joint Force Group**
- Results > Result Tables > Concurrent (Max/Min) Joint Force**



Select Nodes and Assign Structure Group



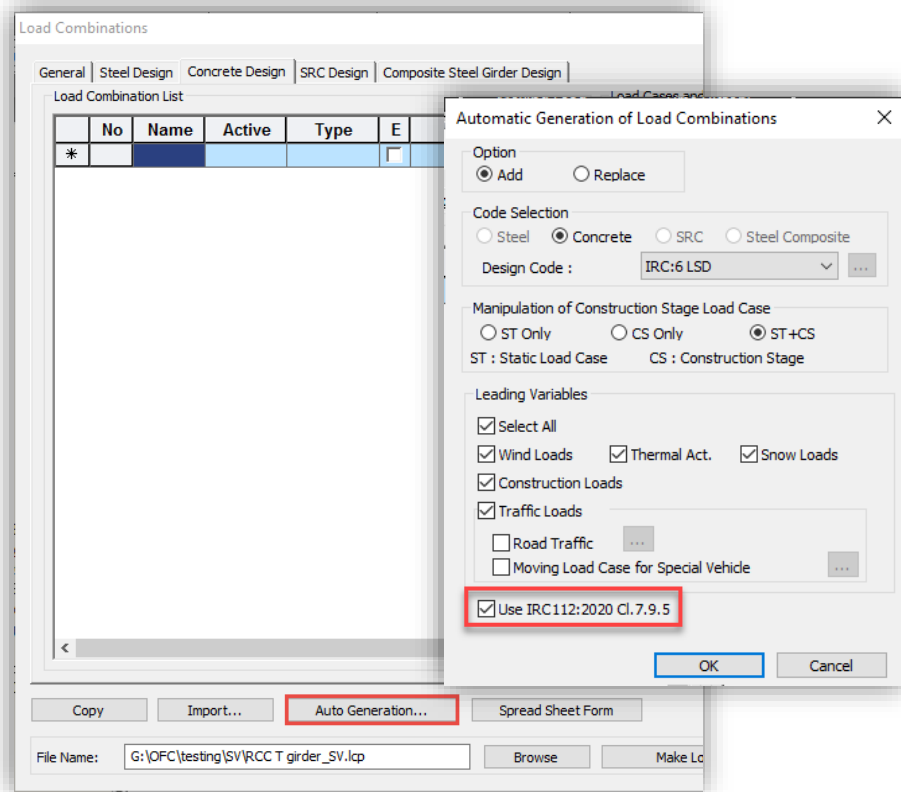
Elem.	Load	Elem. Component	3[U]						4[I]							
			Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)				
111111	Node:4	Apply	Fx	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0	0.0	0.0
3[U]	LM1-U(max)	Fy	-596.7	10.3	2.4	-9.3	-11.2	-87.2	-538.0	-14.8	-2.3	37.8	-913.1	5.4	21.6	-9.3
		Fz	-1011.8	-4.7	28.5	5.1	80.0	39.7	-647.3	7.4	14.0	-21.4	-647.3	7.4	14.0	-21.4
		Mx	-787.0	-8.6	-5.5	16.4	7.1	70.9	-647.3	7.4	14.0	-21.4	-647.3	7.4	14.0	-21.4
		My	-1282.5	-7.4	-17.8	7.8	297.7	61.8	-1119.2	8.4	33.9	-11.9	-1119.2	8.4	33.9	-11.9
		Mz	-1282.0	-11.3	-13.6	12.4	211.7	94.2	-1130.5	12.8	25.1	-21.1	-1130.5	12.8	25.1	-21.1
4[I]	LM1-U(max)	Fx	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0	
		Fy	-1143.7	-11.1	13.1	11.4	149.2	93.0	-1017.1	13.0	19.4	-23.2	-1017.1	13.0	19.4	-23.2
		Fz	-1064.8	-7.7	-14.8	9.1	277.2	64.6	-936.8	8.7	38.6	-16.0	-936.8	8.7	38.6	-16.0
		Mx	-787.8	9.6	0.9	-10.7	-13.9	-81.6	-713.5	-13.8	-6.1	40.2	-713.5	-13.8	-6.1	40.2
		My	-1251.5	-7.3	-17.6	7.9	297.4	60.9	-1108.5	8.2	34.2	-12.1	-1108.5	8.2	34.2	-12.1
13[U]	LM1-U(max)	Mz	-1101.6	-11.2	13.4	12.1	150.9	93.6	-977.3	13.0	20.3	-24.3	-977.3	13.0	20.3	-24.3
		Fx	-1967.4	-6.1	-22.1	5.0	214.2	51.1	-1761.1	6.4	21.3	-0.3	-1761.1	6.4	21.3	-0.3
		Fy	-1186.4	-7.4	13.6	7.5	219.2	61.9	-1061.8	8.6	25.8	-13.8	-1061.8	8.6	25.8	-13.8
		Fz	-678.2	-6.9	9.2	15.9	37.0	57.4	-571.1	5.3	11.7	-21.1	-571.1	5.3	11.7	-21.1
		Mx	-1246.5	-11.1	-13.3	13.7	213.0	92.7	-1096.2	12.3	25.9	-22.8	-1096.2	12.3	25.9	-22.8
111[U]	LM1-U(max)	My	-764.5	-8.5	-5.6	16.4	72.0	69.9	-644.9	7.3	14.1	-21.4	-644.9	7.3	14.1	-21.4
		Mz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		Fx	-1018.2	1.5	-1.6	6.4	-4.0	-13.8	-881.0	-6.1	-5.3	8.8	-881.0	-6.1	-5.3	8.8
		Fy	-1461.5	-10.7	-14.7	12.9	200.7	89.1	-1290.5	11.6	22.9	-19.2	-1290.5	11.6	22.9	-19.2
		Fz	-670.1	-7.3	9.2	16.0	36.3	61.0	-565.2	6.0	11.9	-21.9	-565.2	6.0	11.9	-21.9
125[U]	LM1-U(max)	Mx	-844.6	-4.3	10.4	12.9	37.0	35.9	-543.2	2.3	9.8	-16.1	-543.2	2.3	9.8	-16.1
		My	-668.0	-7.4	9.3	16.0	36.2	61.1	-563.4	6.0	11.9	-21.9	-563.4	6.0	11.9	-21.9
		Mz	-1299.0	-11.0	-13.5	13.7	211.0	92.1	-1143.0	12.1	25.0	-22.2	-1143.0	12.1	25.0	-22.2
		Fx	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	0.0
		Fy	-1474.2	-7.5	-18.5	6.5	277.3	62.5	-1315.5	8.5	26.5	-7.8	-1315.5	8.5	26.5	-7.8
125[U]	LM1-U(max)	Fz	-1420.0	-7.5	-18.7	7.7	291.4	62.9	-1261.3	8.4	31.3	-10.4	-1261.3	8.4	31.3	-10.4
		Mx	-602.7	-4.5	3.0	11.4	-82.0	36.6	-509.6	2.4	-1.8	-9.1	-509.6	2.4	-1.8	-9.1
		My	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Mz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Mz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Concurrent Forces of Members Connected at Joints

## 15. Improvement in Auto Load combinations as per IRC 6

- 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



Auto Generation of Load Combination

#### 7.9.5 Partial factors for prestressing force

- (1) Prestress in most situations, is intended to be favourable. However, under some load combinations the effect may become unfavourable.
- (2) In case of bonded tendons, for ultimate limit state of strength, the design value of prestressing force shall be based on the mean value acting at that time, with partial factor  $\gamma_p=1$ .

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#### IRC:112-2020

- (3) In case of unbonded tendons and external tendons, the stress increase in ultimate limit state of strength may be calculated taking into account the overall deformation of the member. If no such calculations are made, the increase in stress in prestressing tendon shall be taken as nil, and partial factor  $\gamma_p=1$ .

- (4) Where external/unbonded tendons are used for achieving stability and where decrease of force or increase of force becomes unfavourable for stability, partial factors of 0.8 and 1.25 shall be used to decrease or increase the force, as required.

**Note:** These factors account for the possible adverse variation in prestressing force. This shall be over and above the overall safety factors against overturning and sliding required for global stability checks.

- (5) In verification of local effects  $\gamma_{p,unfavourable}=1.3$  shall be used.

- (6) In serviceability limit state, two characteristic values of prestressing force shall be used.

$$P_{k, sup} = \gamma_{sup} \cdot P_m(t)(x) \quad \text{Eq. 7.7}$$

$$P_{k, inf} = \gamma_{inf} \cdot P_m(t)(x) \quad \text{Eq. 7.8}$$

Where

$P_m(t)(x)$  is effective prestressing force at point 'x' at time 't' and  $P_{k, sup}$  and  $P_{k, inf}$  are corresponding superior and inferior characteristic values. The values of  $\gamma_{sup}$  and  $\gamma_{inf}$  shall be as follows:

- for pre-tensioning or unbonded tendons  $\gamma_{sup} = 1.05$  and  $\gamma_{inf} = 0.95$ .
- for post-tensioning with bonded tendons  $\gamma_{sup} = 1.10$  and  $\gamma_{inf} = 0.9$ .

Code provision

## 16. Improvement in PSC design parameters as per IRC 112:2020

- Addition of beta value for interface shear design for PSC Composite Girder design

### ▪ PSC > Parameters

PSC Design Parameters

Design Code :

**Input Parameters**

**Ultimate limit states**

Moment resistance  
 Consider tendons in tensile zone     Consider all tendons

Shear resistance  
 Strut angle  
 (Degree)

Prestressing steel type  
 Smooth bars and wires     Strands  
 Indented wires     Ribbed bars

User input data   

**Serviceability limit state**

Crack control  
 Cement class

**Beta (Interface shear)**  
 1.0     Exact design

**Output parameters**

**Ultimate limit states**

Ultimate bending resistance  
 Shear resistance  
 Torsional resistance

**Serviceability limit states**

Stress for cross section at a construction stage  
 Stress for cross section at service loads  
 Principal stress at a construction stage  
 Principal stress at service loads  
 Tensile stress for prestressing steel  
 Crack control

### 10.3.4 Interface Shear

The shear stress that arises between the interfaces of concrete placed at different times is referred to as interface shear.

Precast beam with cast-in-situ slab is one of the typical case where interface shear has to be designed for.

The interface shear is resisted by friction at the interface and by reinforcement placed across the shear plane.

The interface shear stress should satisfy the following:

$$v_{Edi} \leq v_{Rdi}$$

where

$v_{Edi}$  is the interface shear stress

$$v_{Edi} = \beta V_{Ed} / Z b_i$$

$\beta$  is the ratio of the longitudinal force in the new concrete and the total longitudinal force.

$V_{Ed}$  is the transverse shear force.

$Z$  is the lever arm and

$b_i$  is the width of the interface

$v_{Rdi}$  is the resisting capacity at the section.

$$v_{Rdi} = \mu \sigma_n + \rho f_{yd} [\mu \sin \alpha + \cos \alpha] \leq 0.5 v_{fd}$$

Eq. 10.21

Auto Generation of Load Combination

Code provision

### 17. Improvement in PSC & RC design as per IRC 112:2020

- RC design reports are now generated with reference to IRC 112:2020.
- Similarly, PSC reports are now generated with reference to the latest standard IRC 112:2020

- PSC > Excel Report
- Design > RC Design > Design Code

The image displays two overlapping software windows from the MIDAS suite. The background window is titled 'MIDAS/Civil - RC-Column Design | IRC:112-2020'. It shows design parameters for a column, including material properties, section dimensions, and reinforcement details. A 'Concrete Design Code' dialog box is open in the foreground, with 'Design Code' set to 'IRC: 112-2020'. The dialog also includes options for 'Strut Angle for Shear Resistance' (45 Deg) and 'Apply Special Provisions for Seismic Design'.

The foreground window is a 'PSC Design report' in Excel format. It contains several tables and sections:
 

- 1. Design Condition:** Lists design parameters for ultimate limit states.
- 1.1 Design factors for ultimate limit states:** Shows partial factors for Basic & Seismic and Accidental situations.
- 1.2 Sectional Information:** A table with columns for Section Information and Equivalent Section Modulus (Girder).
- Concrete Material Information:** Lists material properties for concrete, such as  $f_{ck}$ ,  $E_{c(20)}$ , and  $f_{cm}$ .
- Reinforcement Material Information:** Lists material properties for reinforcement steel, such as  $f_{yk}$  and  $E_{s(20)}$ .
- 1.4 Tendon Profile Information:** A table with columns for Tendon Name, Location (mm), Area (mm<sup>2</sup>), Strength (MPa), and  $f_{ps, 1k}$  (MPa).

RC Design

PSC Design report

## 18. Other Enhancements

- Update Interface with BIM software
  - Revit 2023 Interface
  - and Tekla 2022 Interface
- Design based on concurrent member forces due to moving load analysis, settlement analysis and envelope-type load combination.
  - EC2 Concrete Design
  - EC3 Steel Design
- Option for Hambly equation or mesh to calculate the torsional constant of the composite section
  - Check on: Calculate the torsional constant using Hambly equation for beam-and-slab decks. Same value as previous version.
  - Check off: Calculate the torsional constant from the mesh of the cross-section.

[Properties>Section>Composite](#)

Use Hambly Eq. for Ixx