

FLAT SLABS

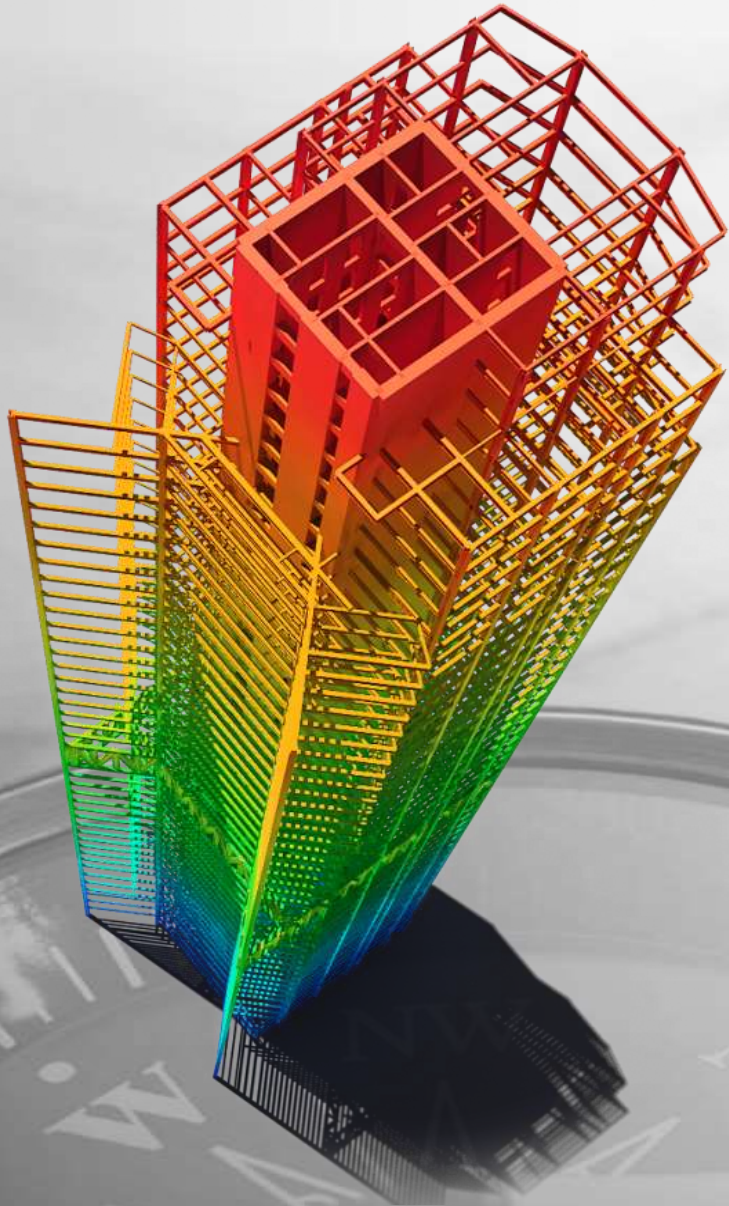


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MIDAS IT



CONTENT

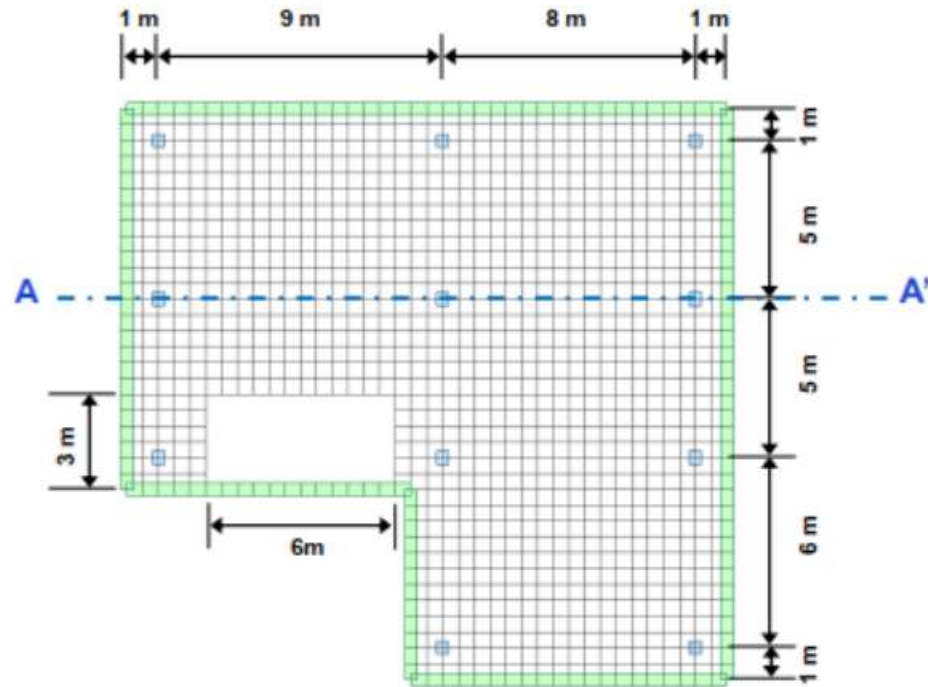


- Modeling for Drop Panel and Column Capital
- Analysis and Result Extraction
- Flat Slab Flexural Design as per EC2-04
- Punching Shear Check
- Serviceability Check- Uncracked Section Check
- Cracked Section Analysis for long-term deflection check

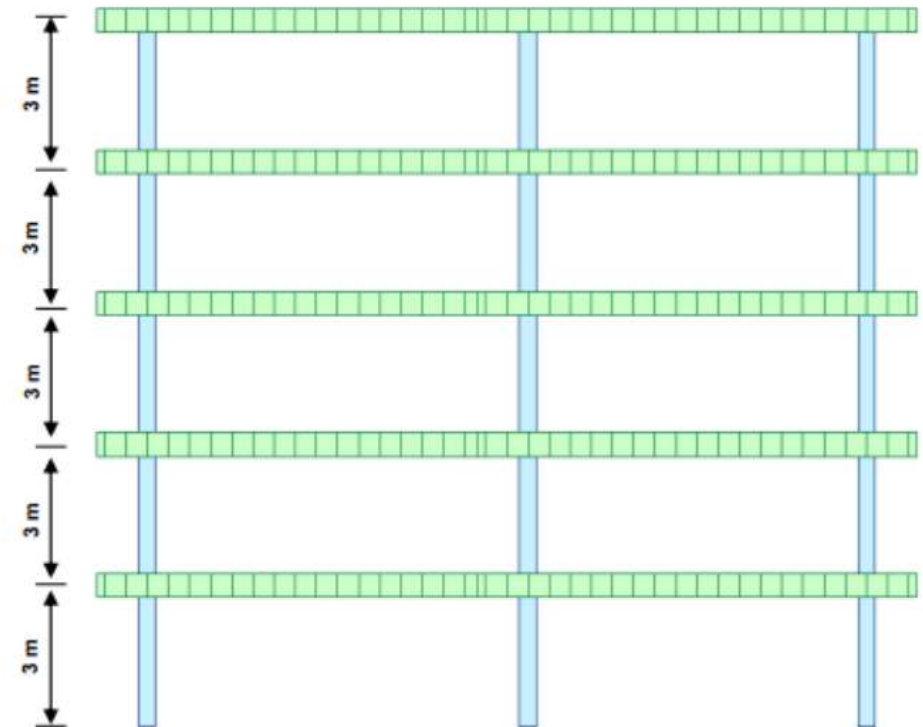
Software Version: **MIDAS Gen 2025 v1.2**



Building Details



Typical Floor Plan



A-A' Sectional Elevation



Drop Panel

Node/Element > Flat/Plate Structure > Drop Panel

Step 1 : Define Drop Panel

The 'Define Drop Panel' dialog box is shown. It contains a list of defined drop panels with the following details:

Name	DP
DP	

Buttons: Add, Modify

Add/Modify Drop Panel

Name : DP

Description :

Location:
☒ Top of Column ☐ Bottom of Column ☐ Both

Shape

B1: 1.5 m, B2: 1.5 m, H1: 1.5 m, H2: 1.5 m

Diagram: A square representing the drop panel with dimensions B1, B2, H1, and H2. A central point is labeled 'Node'.

☒ Thickness 0.5 m (Including Slab Thik.)
☐ Angle 0 [deg]

Buttons: OK, Cancel, Apply

Step 2 : Assign Drop Panel

The 'Tree Menu' dialog box is shown with the 'Assign Drop Panel' tab selected. It contains the following details:

Assign Drop Panel

Option:
☒ Add / Replace ☐ Delete

Drop Panel Name:
DP

Buttons: Apply, Close

Step 3 : Apply Auto-Mesh

The 'Tree Menu' dialog box is shown with the 'Mesh' tab selected. It contains the following details:

Auto-mesh Planar Area

Mesh:
Method: Nodes
211, 212, 213, 214
Type: Quadrilateral

☐ Mesh Inner Domain
☒ Include Interior Nodes
☒ Auto ☐ User
☒ Include Interior Lines
☒ Auto ☐ User
☒ Include Boundary Connectivity

Mesh Size:
☒ Length ☐ Div. 1 m

Property:
Element Type: Plate
Material: 1: M40
Thickness: 1: 0.8000

Domain:
Name: 3

☐ Delete Boundary Line Elem.
☒ Subdivide Boundary Line Elem.

Buttons: Apply, Close

Note-When modeling a slab by Auto-Mesh function, the defined drop panel is generated automatically



Column Capital

Node/Element > Flat/Plate Structure > Column Capital

Step 1 : Define Column Capital

Define Column Capital

Name: CP

Add

Modify

Add/Modify Column Capital

Name: CP

Description:

Location

☐ Top of Column ☒ Bottom of Column ☐ Both

Shape & Rigid Link

B1: 0.3 m

B2: 0.3 m

H1: 0.3 m

H2: 0.3 m

☒ Auto Rigid Link

OK Cancel Apply

Diagram showing a square column capital with dimensions B1, B2, H1, and H2. A node is indicated at the center of the capital.

Rigid link is defined for nodes of column capital automatically

Step 2 : Assign Column Capital

Assign Column Capital

Assign Column Capital

Option

☒ Add / Replace ☐ Delete

Column Capital Name

CP

Apply Close

Auto-Mesh considers the size of column capital automatically

Step 3 : Apply Auto-Mesh

Tree Menu

Mesh

Auto-mesh Planar Area

Mesh

Method: Nodes

211, 212, 213, 214

Type: Quadrilateral

☐ Mesh Inner Domain

☒ Include Interior Nodes

☒ Auto ☐ User

☒ Include Interior Lines

☒ Auto ☐ User

☒ Include Boundary Connectivity

Mesh Size

☒ Length ☐ Div. 1 m

Property

Element Type: Plate

Material: 1: M40

Thickness: 1: 0.8000

Domain

Name: 3

☐ Delete Boundary Line Elem.

☒ Subdivide Boundary Line Elem.

Apply Close

Note-When modeling a slab by Auto-Mesh function, the defined drop panel is generated automatically



Load Application

1. Self Weight

2. Pressure Load

- SIDL (floor finish) = 4 kN/m²
- LL = 2.5 kN/m²

3. Wind Load as per Eurocode 1-4 (2005)

- Friction coefficient (Cfr) = 0.01
- Directional Factor = 1
- Seasonal Factor = 1
- Turbulence Factor (k_1) = 1
- External pressure coefficient = Automatic
- Lack of Correlation Factor = Automatic
- Structural Factor = 1

...(Table 7.10 (Surface Smooth))
 ...(expression 4.2, Note 2)
 ...(expression 4.2, Note 3)
 ...(Cl 4.4)
 ...(Table 7.1, Zone D & E)
 ...(Cl 7.2.2, 3, Note)
 ...(Chapter 6)

3. Seismic Load as per Eurocode 8-1 (2004)

- Ground Type = B
- Spectral Type = 1
- Reference Peak Ground Acceleration = 0.08g
- Behaviour Factor, q = 1.5
- Lower Bound Factor, b = 0.2
- Importance Factor, γ = 1
- Fundamental Period, $T = 0.075 \times C_t \times H^{(3/4)}$

...(Table 3.1)
 ...(Table 3.2)
 ...(Cl. 2.2.2 (2))
 ...(Cl. 3.2.2.5(4) Note)
 ...(Cl.4.2.5)
 ...(Cl.4.2.5)
 ...(Cl. 4.3.3.2.2 (3))

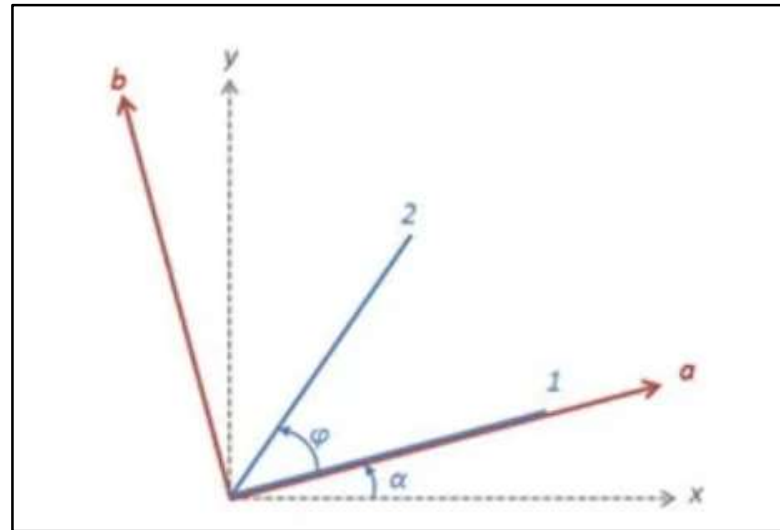


Wood Armer Moment

From the analysis results, following plate forces about the local axis are calculated

- m_{xx}
- m_{yy}
- m_{xy}

In order to calculate design forces in the reinforcement direction, angles α and θ will be taken as shown in the following figure:



x, y: local axis of plate element

1, 2: reinforcement direction

α : angle between local x-direction and reinforcement direction 1

θ : angle between reinforcement direction 1 and reinforcement direction 2



Wood Armer Moment

Wood Armer moments are calculated as shown below:

Internal Moments

$$m_a = \frac{m_{xx} + m_{yy}}{2} + \frac{m_{xx} - m_{yy}}{2} \cos 2\alpha + m_{xy} \sin 2\alpha$$

$$m_b = \frac{m_{xx} + m_{yy}}{2} - \frac{m_{xx} - m_{yy}}{2} \cos 2\alpha - m_{xy} \sin 2\alpha$$

$$m_{ab} = -\frac{m_{xx} - m_{yy}}{2} \sin 2\alpha + m_{xy} \cos 2\alpha$$

W.A. Moments

[Bottom Rebar]

$$m_{ud1} = m_a - 2m_{ab} \cot \varphi + m_b \cot^2 \varphi + \left| \frac{m_{ab} - m_b \cot \varphi}{\sin \varphi} \right|$$

$$m_{ud2} = \frac{m_b}{\sin^2 \varphi} + \left| \frac{m_{ab} - m_b \cot \varphi}{\sin \varphi} \right|$$

When $m_{ud1} < 0$ and $m_{ud2} > 0$,

$$m_{ud1} = 0$$

$$m_{ud2} = \max \left\{ 0, \frac{m_b + |(m_{ab} - m_b \cot \varphi)^2 / (m_a - 2m_{ab} \cot \varphi + m_b \cot^2 \varphi)|}{\sin^2 \varphi} \right\}$$

When $m_{ud1} > 0$ and $m_{ud2} < 0$,

$$m_{ud1} = \max \left\{ 0, m_a - 2m_{ab} \cot \varphi + m_b \cot^2 \varphi + \left| \frac{(m_{ab} - m_b \cot \varphi)^2}{m_b} \right| \right\}$$

$$m_{ud2} = 0$$

When $m_{ud1} < 0$ and $m_{ud2} < 0$,

$$m_{ud1} = 0$$

$$m_{ud2} = 0$$

[Top Rebar]

$$m'_{ud1} = m_a - 2m_{ab} \cot \varphi + m_b \cot^2 \varphi - \left| \frac{m_{ab} - m_b \cot \varphi}{\sin \varphi} \right|$$

$$m'_{ud2} = \frac{m_b}{\sin^2 \varphi} - \left| \frac{m_{ab} - m_b \cot \varphi}{\sin \varphi} \right|$$

When $m'_{ud1} > 0$ and $m'_{ud2} < 0$,

$$m'_{ud1} = 0$$

$$m'_{ud2} = \min \left\{ 0, \frac{m_b - |(m_{ab} - m_b \cot \varphi)^2 / (m_a - 2m_{ab} \cot \varphi + m_b \cot^2 \varphi)|}{\sin^2 \varphi} \right\}$$

When $m'_{ud1} < 0$ and $m'_{ud2} > 0$,

$$m'_{ud1} = \min \left\{ 0, m_a - 2m_{ab} \cot \varphi + m_b \cot^2 \varphi - \left| \frac{(m_{ab} - m_b \cot \varphi)^2}{m_b} \right| \right\}$$

$$m'_{ud2} = 0$$

When $m'_{ud1} > 0$ and $m'_{ud2} > 0$,

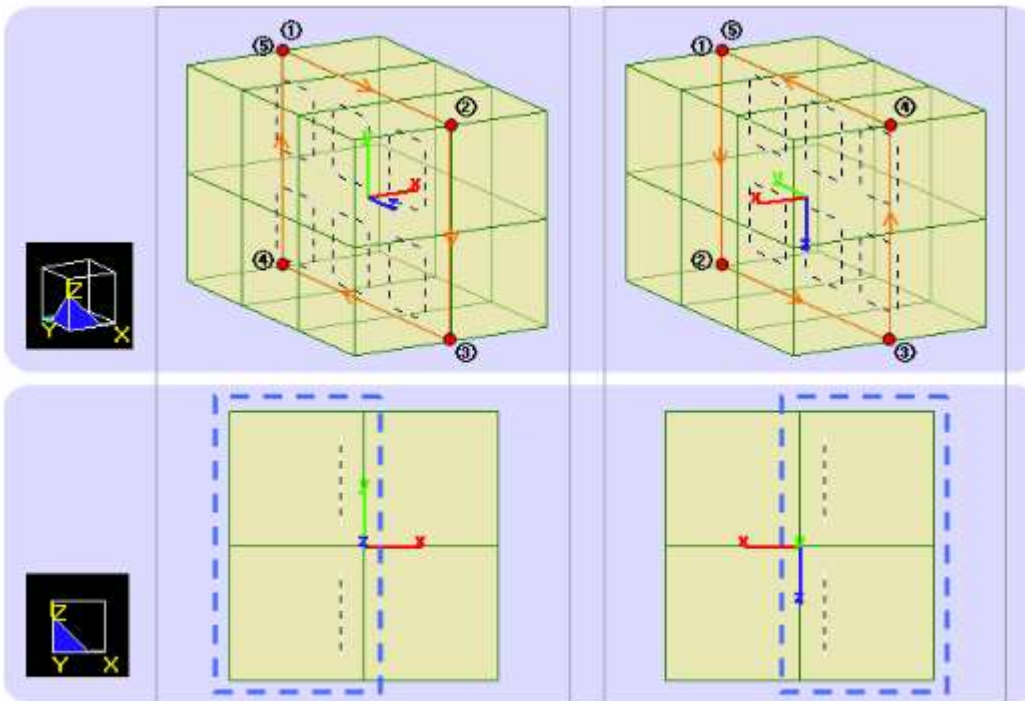
$$m'_{ud1} = 0$$

$$m'_{ud2} = 0$$



Local Direction Force Sum

- It provides internal forces on a selected line or plane in beam, plate and solid elements. The resultant forces and the acting point are calculated on the basis of all the nodal forces included in the selected plane.
- Once a detail analysis is carried out for a specific part of the structure, this function conveniently calculates the member forces for structural design.



Solid Face Polygon

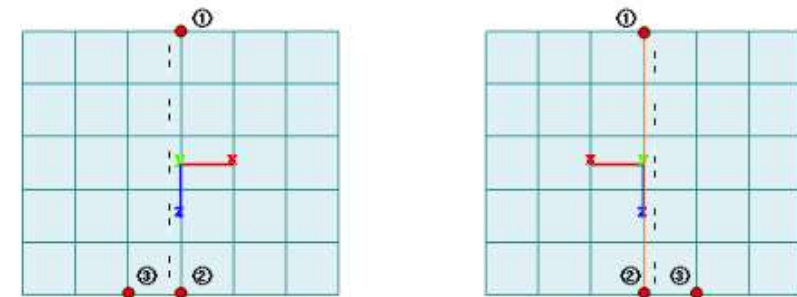


Plate Edge Line

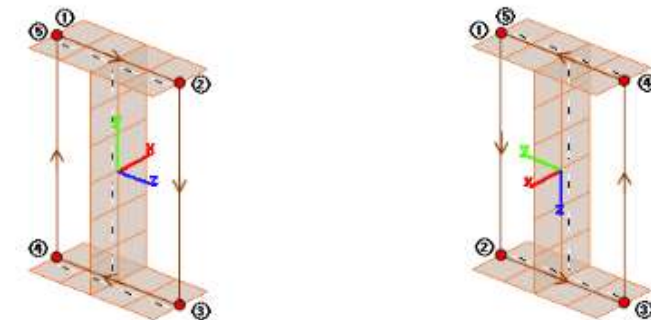


Plate Edge Polygon



Flat Slab Flexural Design as per Eurocode2:04

- Automatic Generation of Load Combination
- Select Load Combinations for design
- Design Criteria for Rebar

Load Combinations

General | Steel Design | Concrete Design | SRC Design | Cold Formed Steel Design | Footing Design | Aluminum Design

Load Combination List

No	Name	Active	Type	Description
1	cLCB1	Strengt	Add	1.35D + 1.5(1.0LL)
2	cLCB2	Strengt	Add	1.35D + 1.5(1.0LL) + 1.5
3	cLCB3	Strengt	Add	1.35D + 1.5(1.0LL) + 1.5
4	cLCB4	Strengt	Add	1.35D + 1.5(0.7LL) + 1.5
5	cLCB5	Strengt	Add	1.35D + 1.5(0.7LL) + 1.5
6	cLCB6	Strengt	Add	1.35D + 1.5(1.0LL) - 1.5
7	cLCB7	Strengt	Add	1.35D + 1.5(1.0LL) - 1.5
8	cLCB8	Strengt	Add	1.35D + 1.5(0.7LL) - 1.5
9	cLCB9	Strengt	Add	1.35D + 1.5(0.7LL) - 1.5
10	cLCB10	Strengt	Add	1.0D + 1.0(0.3L) + 1.0E
11	cLCB11	Strengt	Add	1.0D + 1.0(0.3L) + 1.0E
12	cLCB12	Strengt	Add	1.0D + 1.0(0.3L) - 1.0E
13	cLCB13	Strengt	Add	1.0D + 1.0(0.3L) - 1.0E
14	cLCB14	Service	Add	SERV : 1.0D + (1.0LL)
15	cLCB15	Service	Add	SERV : 1.0D + (1.0LL) +
16	cLCB16	Service	Add	SERV : 1.0D + (1.0LL) +
17	cLCB17	Service	Add	SERV : 1.0D + (1.0LL) -
18	cLCB18	Service	Add	SERV : 1.0D + (1.0LL) -
19	cLCB19	Service	Add	SERV : 1.0D + (0.7LL) +
20	cLCB20	Service	Add	SERV : 1.0D + (0.7LL) +
21	cLCB21	Service	Add	SERV : 1.0D + (0.7LL) -
22	cLCB22	Service	Add	SERV : 1.0D + (0.7LL) -

Load Cases and Factors

LoadCase
Self Weight(ST)
SIDL(ST)
LL(ST)
*

Copy Import... Auto Generation... Spread Sheet Form

File Name: D:\Webinars\25.02.26 Gen Flat Slabs\Demo\Flat Slab Bar Browse Make Load Combination Sheet Close

Slab/Wall/Shell Load Combinations

Slab/Mat

Strength

- ☒ cLCB1
- ☒ cLCB2
- ☒ cLCB3
- ☒ cLCB4
- ☒ cLCB5
- ☒ cLCB6
- ☒ cLCB7
- ☒ cLCB8
- ☒ cLCB9
- ☒ cLCB10
- ☒ cLCB11
- ☒ cLCB12
- ☒ cLCB13

Serviceability

- ☒ cLCB14
- ☒ cLCB15
- ☒ cLCB16
- ☒ cLCB17
- ☒ cLCB18
- ☒ cLCB19
- ☒ cLCB20
- ☒ cLCB21
- ☒ cLCB22
- ☒ cLCB23
- ☒ cLCB24
- ☒ cLCB25
- ☒ cLCB26
- ☒ cLCB27

Deflection(Cracked)

- ☒ cLCB28

Wall

Strength

- ☒ cLCB1
- ☒ cLCB2
- ☒ cLCB3
- ☒ cLCB4
- ☒ cLCB5
- ☒ cLCB6
- ☒ cLCB7
- ☒ cLCB8
- ☒ cLCB9
- ☒ cLCB10
- ☒ cLCB11
- ☒ cLCB12
- ☒ cLCB13

Shell

Strength

- ☒ cLCB1
- ☒ cLCB2
- ☒ cLCB3
- ☒ cLCB4
- ☒ cLCB5
- ☒ cLCB6
- ☒ cLCB7
- ☒ cLCB8
- ☒ cLCB9
- ☒ cLCB10
- ☒ cLCB11
- ☒ cLCB12
- ☒ cLCB13

Description :

OK Cancel

Meshed Design Criteria for Rebars

☐ Basic Rebar for Slab/Mat/Shell

Top - Dir. 1 : P12 @ 300

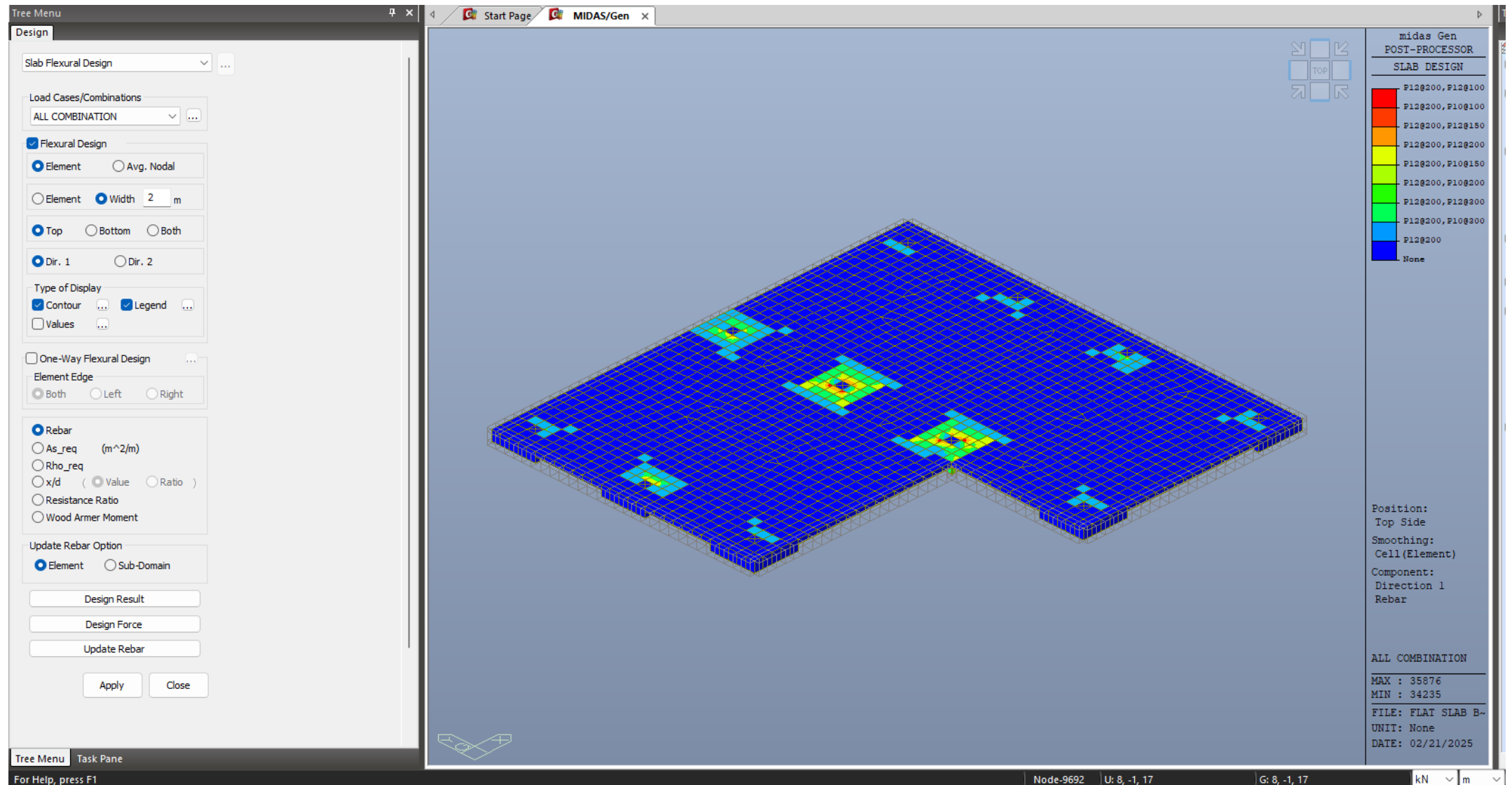
Bot. - Dir. 1 : P12 @ 300

Top - Dir. 2 : P12 @ 300

Bot. - Dir. 2 : P12 @ 300

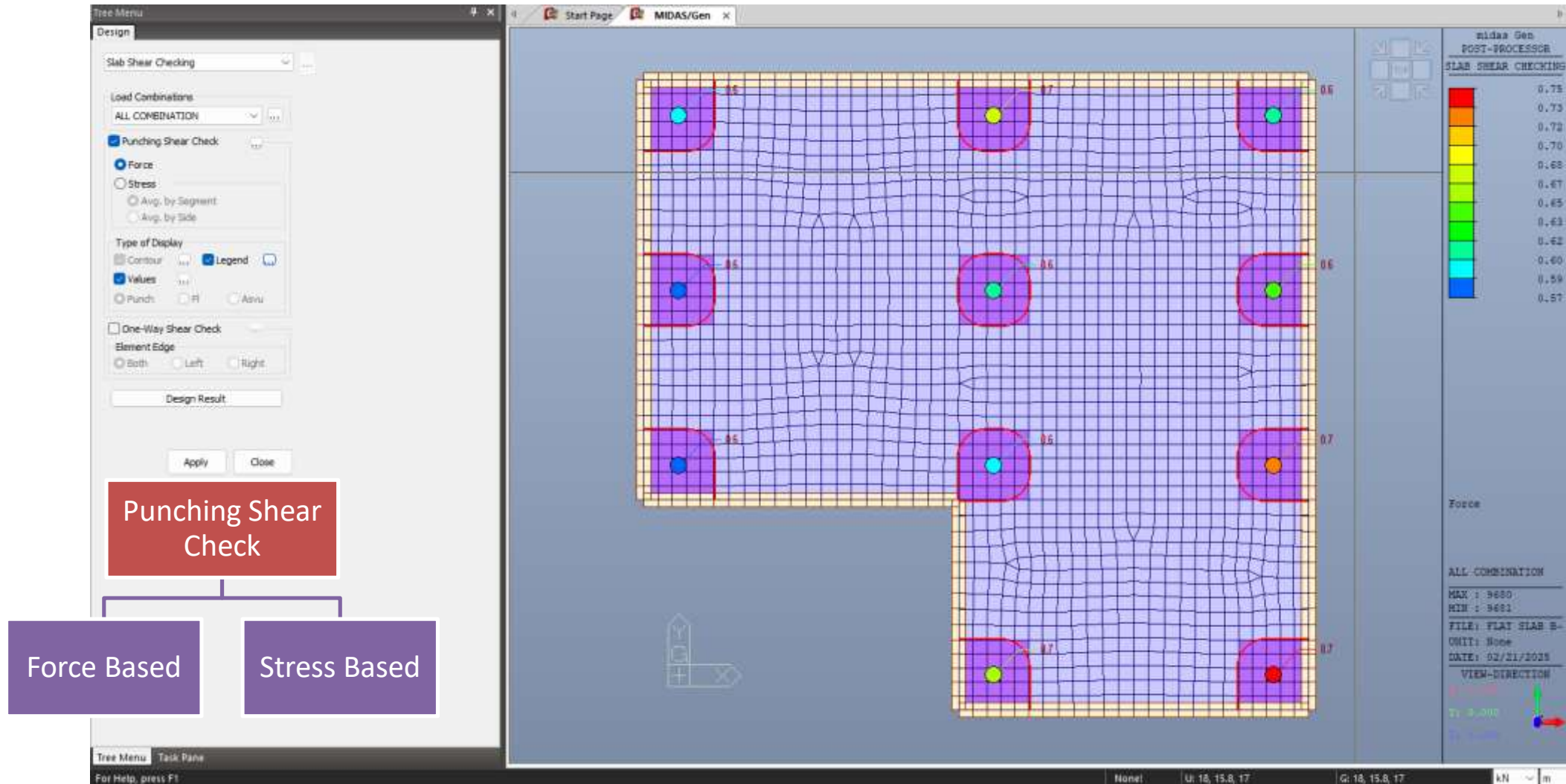


Flat Slab Flexural Design as per Eurocode2:04





Slab Shear Checking



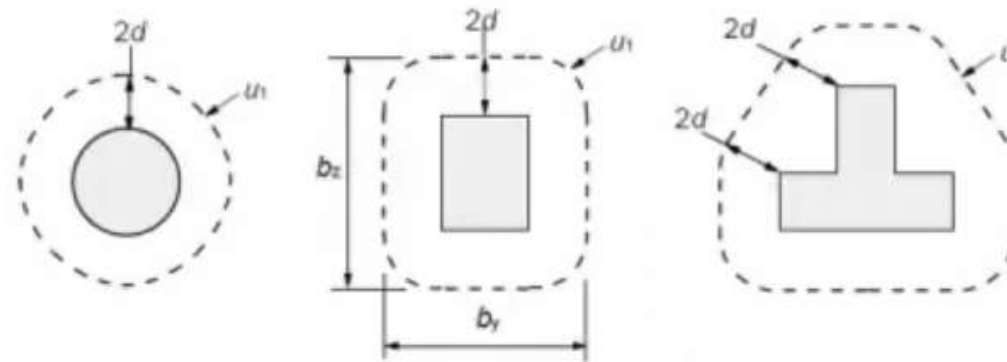


Slab Shear Checking

- Code Based Punching Shear Check**

The program takes the axial force in the column supporting the slab as the shear force (V_{Ed}).

The basic control perimeter (u_1) is taken at a distance $2d$ from the column face.



The shear resistance of the slab (without shear reinforcement) at the basic control section is given by

- $V_{Rd,c} = (0.18/\gamma_c)k(100\rho_l f_{ck})^{1/3}(u_1 d)$, the value of ρ_l is assumed to be 0.02.
- $V_{Rd,c} \geq (0.035k^{3/2} f_{ck}^{1/2})(u_1 d)$
- $V_{Ed} < V_{Rd,c}$: section is safe in punching shear
- $V_{Ed} > V_{Rd,c}$: provide shear reinforcement.
- $A_{sw}/s_r = (V_{Ed} - 0.75V_{Rd,c}) * (u_1 d) / (1.5d f_{ywd,ef})$



Cracked Section Analysis

- Members which are expected to crack, but may not be fully cracked, will behave in a manner intermediate between the uncracked and fully cracked conditions and, for members subjected mainly to flexure, an adequate prediction of behavior is given by the following expression based on sub clause 7.4.3 (3) in EN 1992-1-1:2004. Following factors including the effective second moment of area by elements for each iteration step can be checked in "File Name_CSA.OUT" file which is automatically generated in the same folder as a model file has been saved after performing the cracked section analysis.

$$\frac{M}{EI_{\text{eff}}} = \zeta \frac{M}{EI_{\text{cr}}} + (1 - \zeta) \frac{M}{EI_g}$$

- Therefore, I_{eff} (effective second moment of area) can be calculated from the following equation.

$$\frac{1}{I_{\text{eff}}} = \zeta \frac{1}{I_{\text{cr}}} + (1 - \zeta) \frac{1}{I_g}$$

$$\begin{aligned} \zeta &= 1 - \beta \left(\frac{M_{\text{cr}}}{M} \right)^2 \\ \beta &= 0.5 \text{ is applied (long-term loading).} \\ M_{\text{cr}} &= \frac{f_{\text{ctm}} b h^2}{6} \\ I_{\text{cr}} &= A_s (d - d_c)^2 \frac{E_s}{E_c} + \frac{1}{3} b d_c^3 \\ d_c &= \frac{-A_s E_s + \sqrt{(A_s E_s)^2 + 2 b A_s E_s E_{c,\text{eff}} d}}{b E_{c,\text{eff}}} \end{aligned}$$

Where, f_{ctm} : mean value of axial tensile strength of concrete

$b c$: depth of concrete in compression

(Reference: Designers Guide to EN1992-2, Hendy & Smith, Thomas Telford)



Cracked Section Analysis

"File Name_CSA.OUT" file contains the following data for each iteration step by elements. Final effective second moment of area can be checked in the final iteration step. This file is provided for the user's verification of the cracked section analysis results.

flat slab_CSA_final_CSA.OUT - WordPad

No.	Ieff_x	Ieff_y	Icr_x	Icr_y	Ig	Mcr	Dc_x	Dc_y	MO_x	MO_y
334	1.215338E-04	6.66667E-04	7.755596E-05	0.000000E+00	6.66667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.889520E+04	4.488561E+03
344	6.66667E-04	6.66667E-04	7.755596E-05	0.000000E+00	6.66667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.496849E+04	5.189372E+03
347	1.337613E-04	6.66667E-04	7.755596E-05	0.000000E+00	6.66667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.753459E+04	-3.056406E+03
356	6.66667E-04	6.66667E-04	7.755596E-05	0.000000E+00	6.66667E-04	1.709976E+04	3.342221E-02	0.000000E+00	-6.335207E+03	6.325154E+03
362	1.201127E-04	6.66667E-04	7.755596E-05	0.000000E+00	6.66667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.909543E+04	4.174934E+03
364	6.66667E-04	6.66667E-04	7.755596E-05	0.000000E+00	6.66667E-04	1.709976E+04	3.342221E-02	0.000000E+00	-6.582963E+03	5.912263E+03
365	1.326202E-04	6.66667E-04	7.755596E-05	0.000000E+00	6.66667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.763962E+04	3.919742E+03
366	1.266232E-04	6.66667E-04	1.082877E-04	0.000000E+00	6.66667E-04	1.709976E+04	3.979849E-02	0.000000E+00	2.908007E+04	-9.676536E+03
370	6.66667E-04	6.66667E-04	1.082877E-04	0.000000E+00	6.66667E-04	1.709976E+04	3.979849E-02	0.000000E+00	6.631315E+03	-7.699904E+03
372	6.66667E-04	6.66667E-04	1.082877E-04	0.000000E+00	6.66667E-04	1.709976E+04	3.979849E-02	0.000000E+00	9.719316E+03	-5.098861E+03
373	6.66667E-04	1.255971E-04	1.082877E-04	1.082877E-04	6.66667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-1.127993E+04	-2.980809E+03
382	1.175055E-04	6.66667E-04	1.082877E-04	1.082877E-04	6.66667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-3.950954E+04	-9.732376E+03
386	1.094908E-04	1.231933E-04	1.082877E-04	1.082877E-04	6.66667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-1.055694E+05	-3.181294E+04
387	1.192602E-04	6.66667E-04	7.755596E-05	1.082877E-04	6.66667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.922103E+04	4.658024E+03
388	1.978792E-04	6.66667E-04	7.755596E-05	1.082877E-04	6.66667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.718408E+04	3.067581E+03
390	1.152277E-04	1.137013E-04	1.082877E-04	1.082877E-04	6.66667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-4.509040E+04	-5.071383E+03
392	1.252644E-04	6.66667E-04	1.082877E-04	1.082877E-04	6.66667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-3.005885E+04	1.492482E+03
394	6.66667E-04	6.66667E-04	1.082877E-04	1.082877E-04	6.66667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-1.000925E+04	5.003864E+03
395	1.202427E-04	6.66667E-04	7.755596E-05	1.082877E-04	6.66667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.907665E+04	4.182389E+03
397	6.66667E-04	6.66667E-04	7.755596E-05	1.082877E-04	6.66667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.283879E+04	4.692663E+03
399	6.66667E-04	6.66667E-04	7.755596E-05	1.082877E-04	6.66667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.421249E+04	2.105843E+03
400	1.143548E-04	6.66667E-04	7.755596E-05	1.082877E-04	6.66667E-04	1.709976E+04	3.342221E-02	3.979849E-02	2.003685E+04	1.844201E+03

element no.	I_effive (dir 1)	effective I (dir 2)	I_fully cracked (dir 1)	I_fully cracked (dir 2)	I_uncracked	cracked moment	dc (dir 1)	dc (dir 2)	Updated moment (dir 1)	updated moment (dir 2)
No.	Ieff_x	Ieff_y	Icr_x	Icr_y	Ig	Mcr	Dc_x	Dc_y	MO_x	MO_y
334	1.22E-04	6.67E-04	7.76E-05	0.00E+00	6.67E-04	1.71E+04	3.34E-02	0.00E+00	1.89E+04	4.49E+03

n (Es/Ec)	Rebar Area (dir 1)	Rebar Area (Dir 2)	Effective depth (dir 1)	Effective depth (dir 2)	ξ (dir 1)	ξ (dir 2)	I_eff / I_cracked (dir 1)	I_eff / I_cracked (dir 2)	Final effective I (dir 1)	Final effective I (dir 2)
n(Es/Ec)	AS_X	AS_Y	DD_X	DD_Y	XI_X	XI_Y	RATIO_X	RATIO_Y	RATIO_X*Ig	RATIO_Y*Ig
6.35E+00	7.54E-04	7.54E-04	1.50E-01	1.50E-01	5.91E-01	0.00E+00	1.82E-01	1.000000	1.22E-04	6.67E-04



Thank you

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