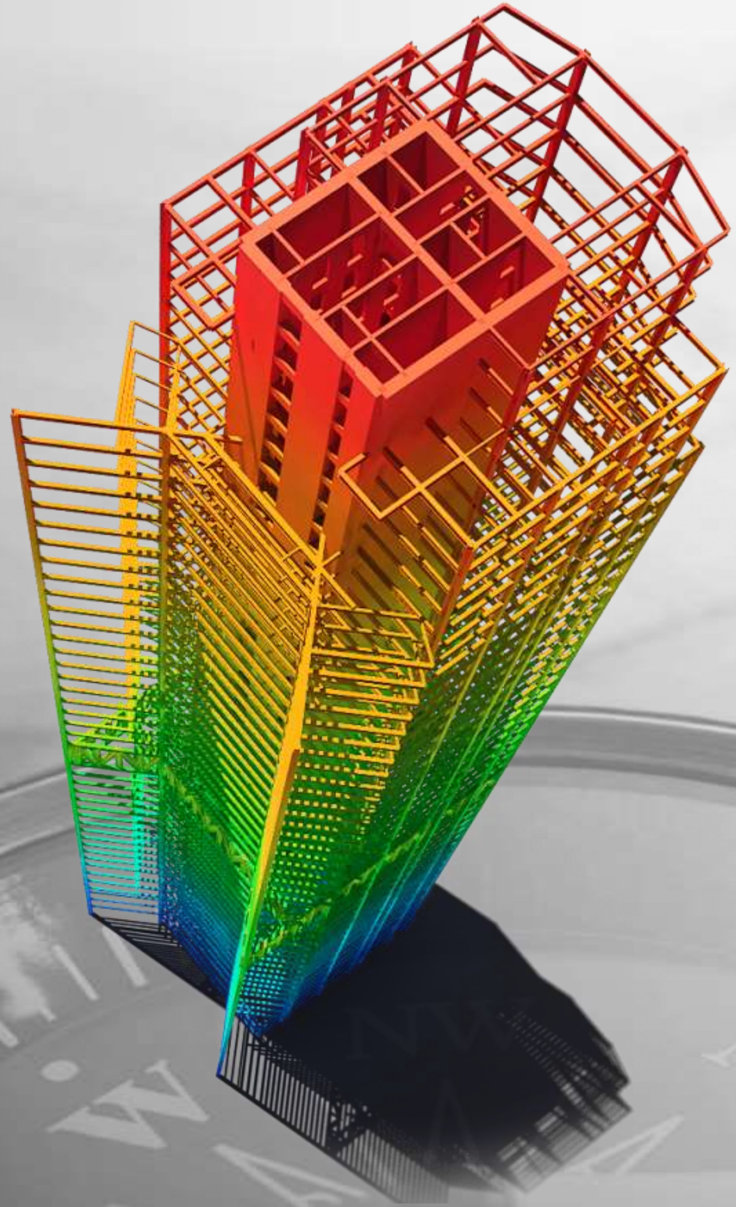
MIDAS GEN Webinar Series

FLAT SLABS

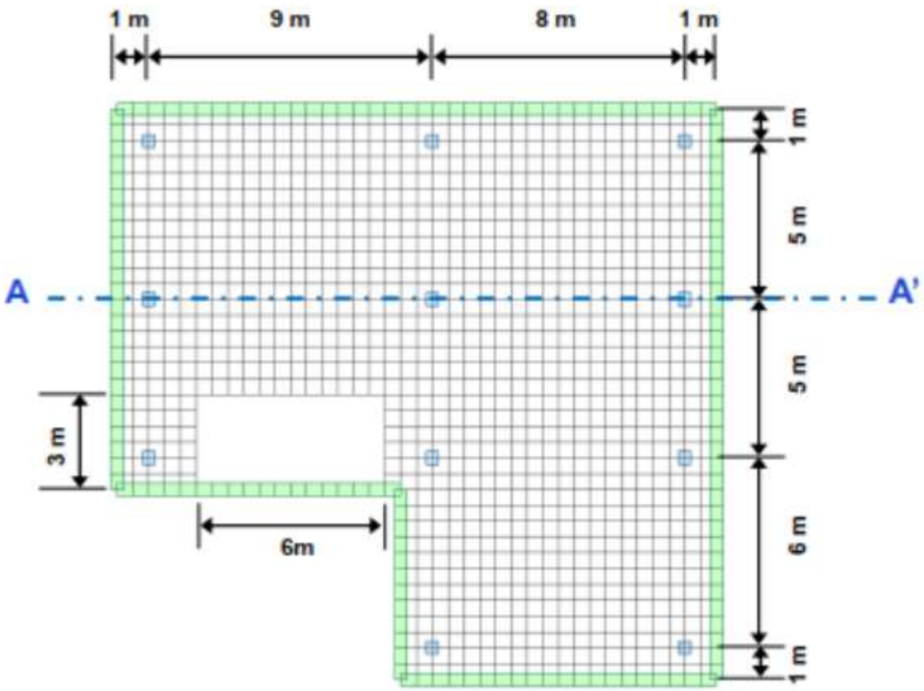
Dev Bharatia
Technical Support Engineer
MIDAS IT



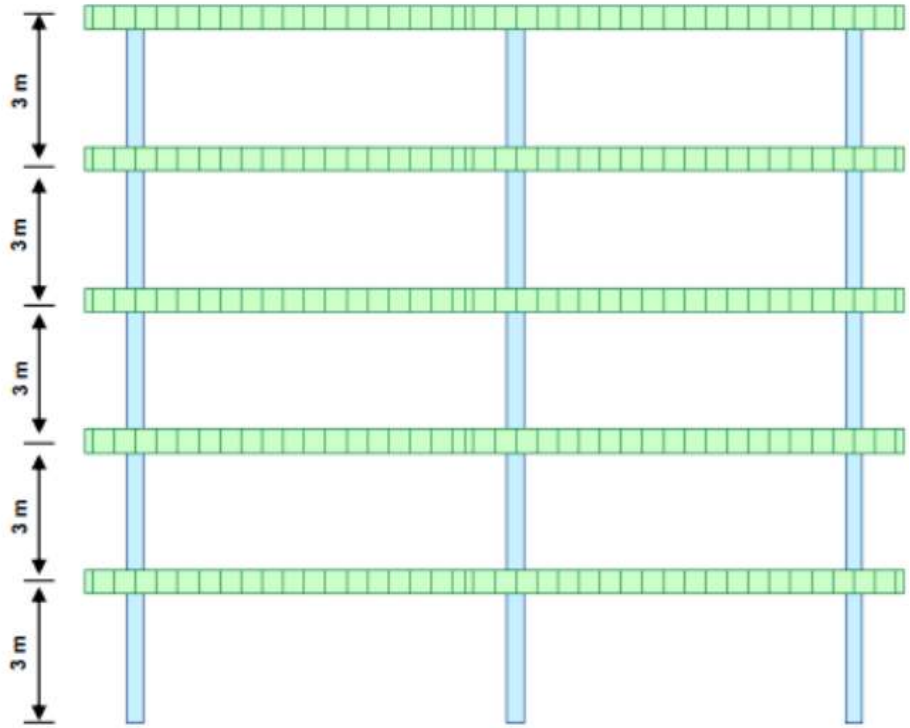
CONTENT

Software Version: MIDAS Gen 2025 v1.2

Building Details



Typical Floor Plan

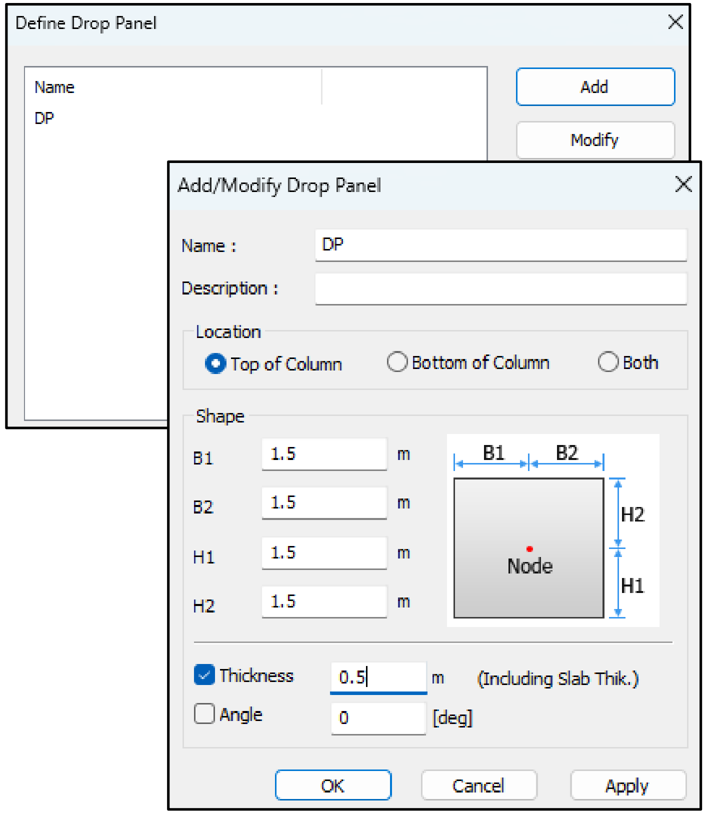


A-A' Sectional Elevation

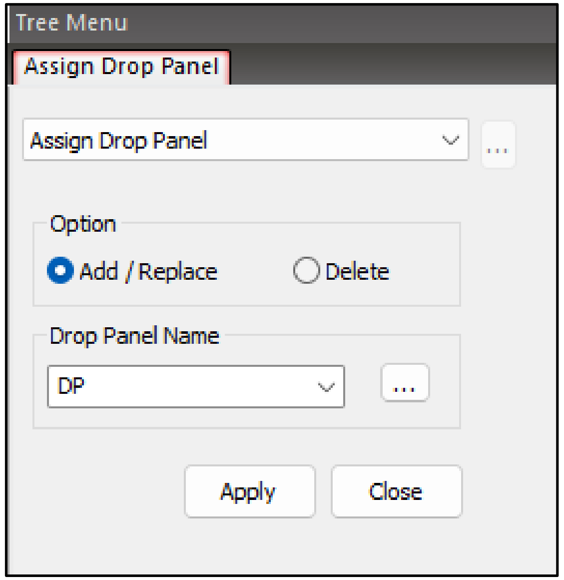
Drop Panel

Node/Element > Flat/Plate Structure > Drop Panel

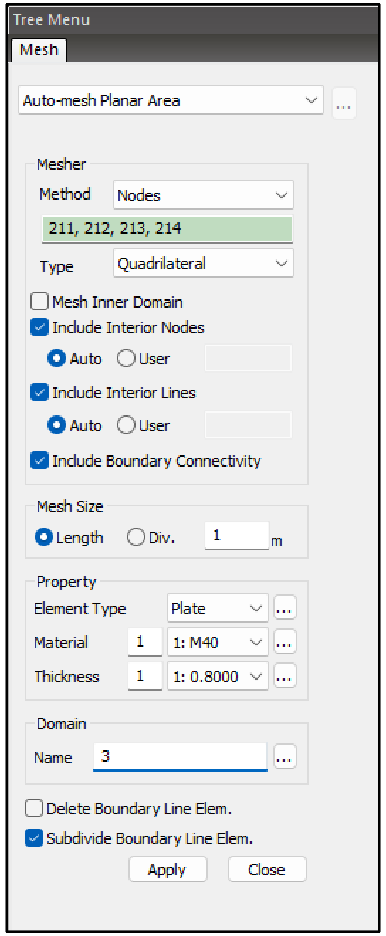
Step 1 : Define Drop Panel



Step 2 : Assign Drop Panel



Step 3 : Apply Auto-Mesh

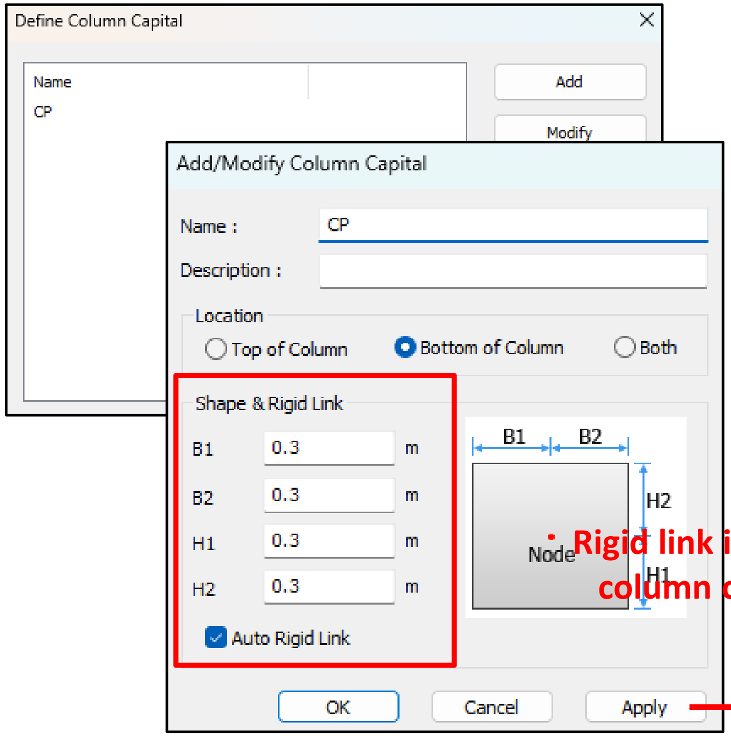


Note-When modeling a slab by Auto-Mesh function, the defined drop panel is generated automatically

Column Capital

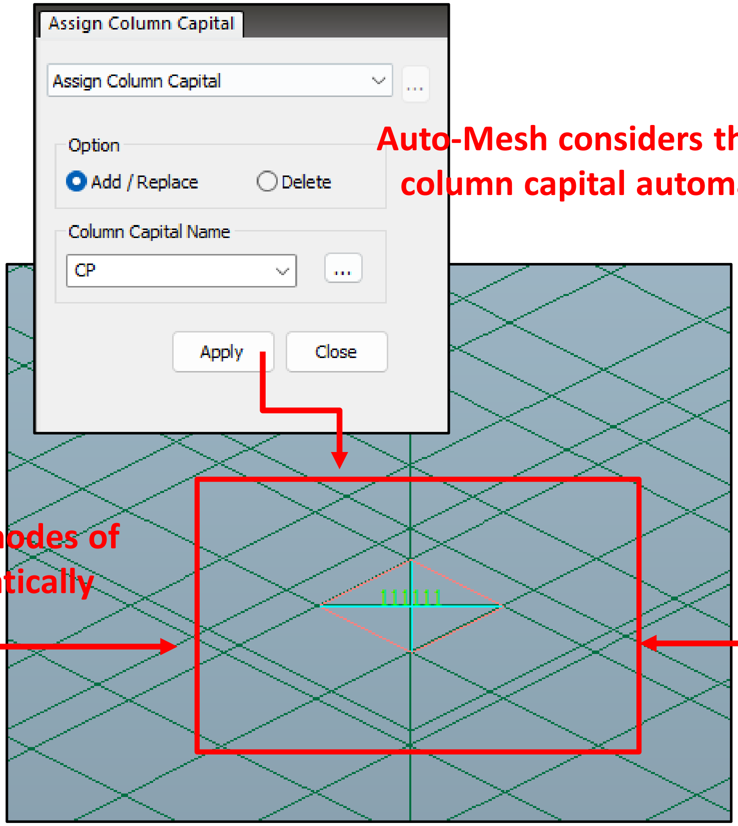
Node/Element > Flat/Plate Structure > Column Capital

Step 1 : Define Column Capital



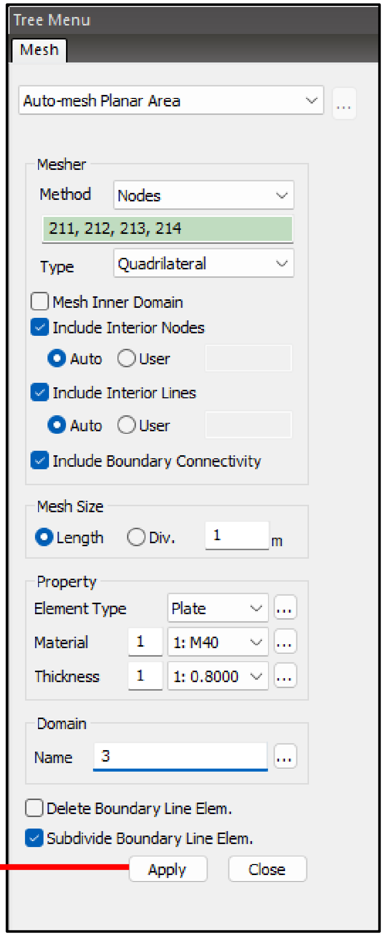
Rigid link is defined for nodes of column capital automatically

Step 2 : Assign Column Capital



Auto-Mesh considers the size of column capital automatically

Step 3 : Apply Auto-Mesh



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/m^2
- LL = 2.5 kN/m^2

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

- Friction coefficient (Cfr) = 0.01 ...(Table 7.10 (Surface Smooth))
- Directional Factor = 1 ...(expression 4.2, Note 2)
- Seasonal Factor = 1 ...(expression 4.2, Note 3)
- Turbulence Factor (k_1) = 1 ...(Cl 4.4)
- External pressure coefficient = Automatic ...(Table 7.1, Zone D & E)
- Lack of Correlation Factor = Automatic ...(Cl 7.2.2, 3, Note)
- Structural Factor = 1 ...(Chapter 6)

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

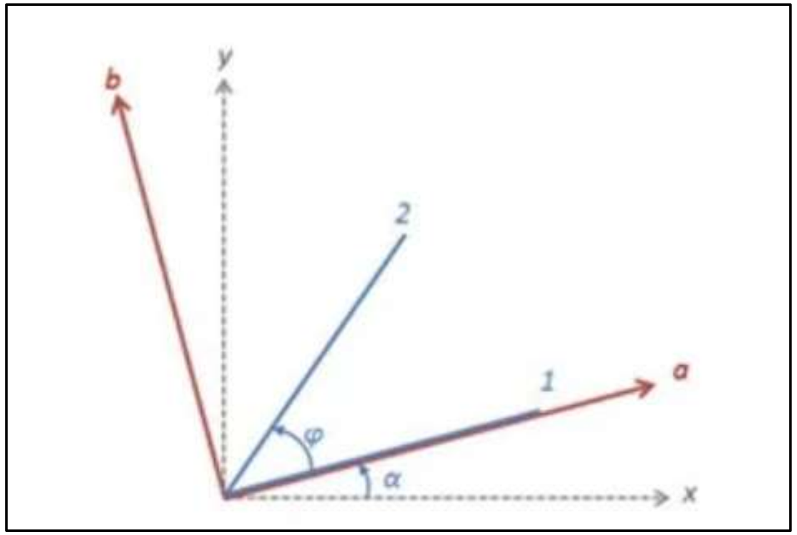
- Ground Type = B ...(Table 3.1)
- Spectral Type = 1 ...(Table 3.2)
- Reference Peak Ground Acceleration = 0.08g ...(Cl. 2.2.2 (2))
- Behaviour Factor, q = 1.5 ...(Cl. 3.2.2.5(4) Note)
- Lower Bound Factor, b = 0.2 ...(Cl.4.2.5)
- Importance Factor, gama = 1 ...(Cl.4.2.5)
- Fundamental Period, T = 0.075 × Ct × H^(3/4) ...(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 a and f will be taken as shown in the following figure:



x, y: local axis of plate element
1, 2: reinforcement direction
a: angle between local x-direction and reinforcement direction 1
f: 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,

$$m_{ud1} = 0$$
$$m_{ud2} = \max\{0, \frac{m_b + |(m_{ab}-m_b\cot\varphi)^2/(m_a - 2m_{ab}\cot\varphi + m_b\cot^2\varphi)|}{\sin^2\varphi}\}$$

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

$$m_{ud1} = \max\{0, m_a - 2m_{ab}\cot\varphi + m_b\cot^2\varphi + \left|\frac{(m_{ab}-m_b\cot\varphi)^2}{m_b}\right|\}$$
$$m_{ud2} = 0$$

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,

$$m'_{ud1} = 0$$
$$m'_{ud2} = \min\{0, \frac{m_b - |(m_{ab}-m_b\cot\varphi)^2/(m_a - 2m_{ab}\cot\varphi + m_b\cot^2\varphi)|}{\sin^2\varphi}\}$$

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

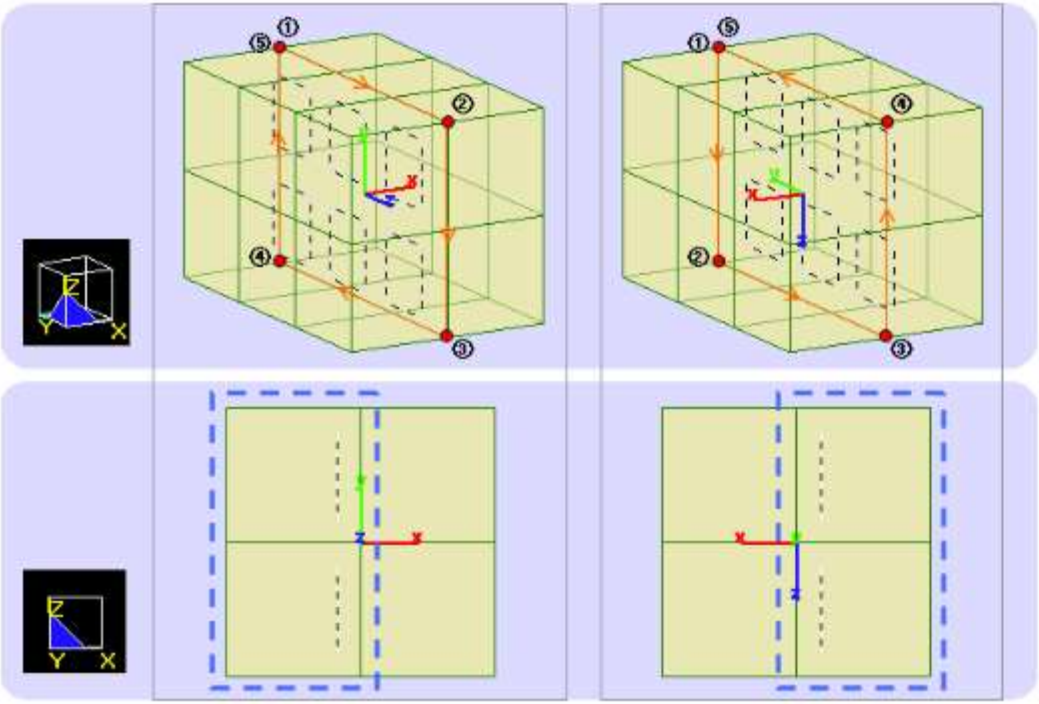
$$m'_{ud1} = \min\{0, m_a - 2m_{ab}\cot\varphi + m_b\cot^2\varphi - \left|\frac{(m_{ab}-m_b\cot\varphi)^2}{m_b}\right|\}$$
$$m'_{ud2} = 0$$

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

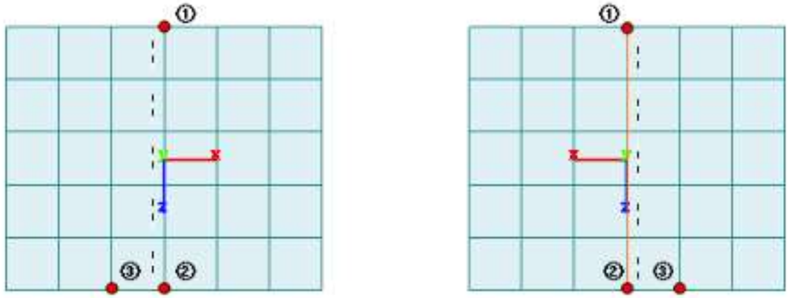


Plate Edge Line

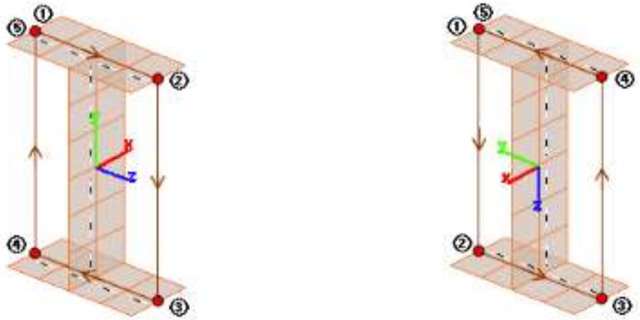
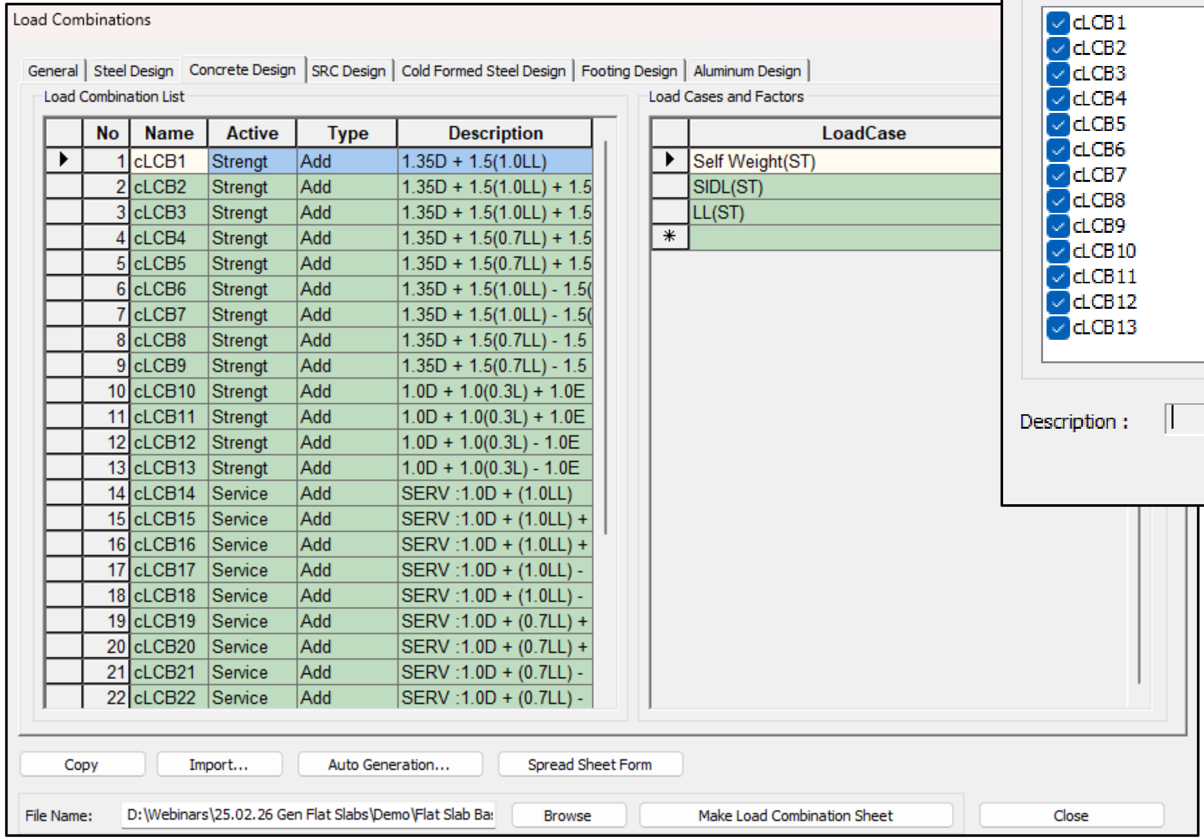
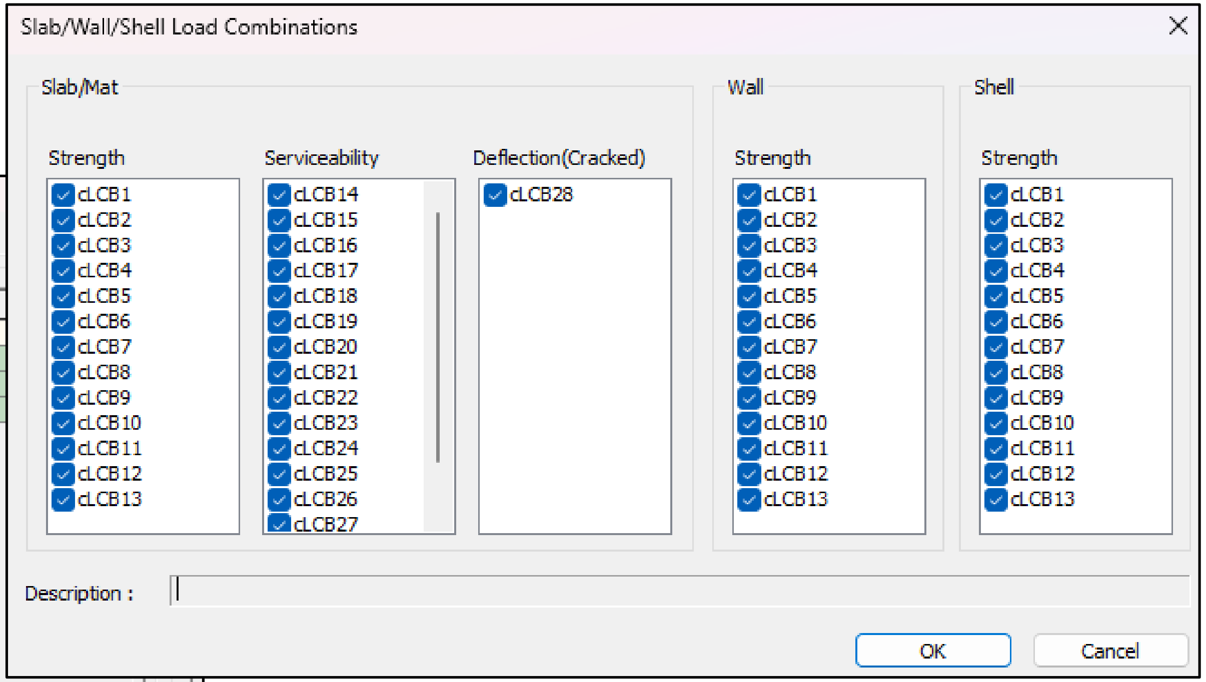


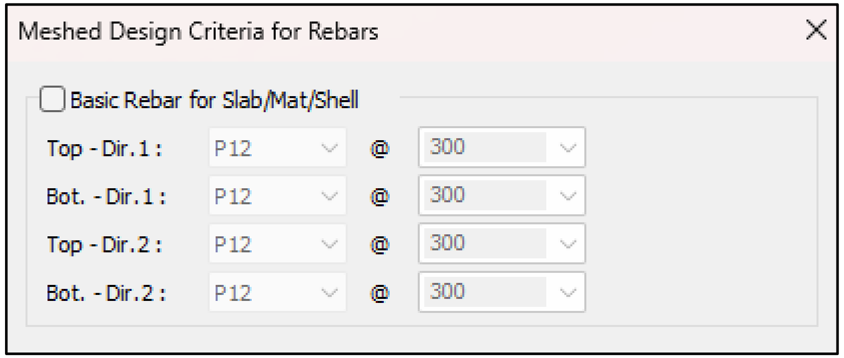
Plate Edge Polygon

Flat Slab Flexural Design as per Eurocode2:04

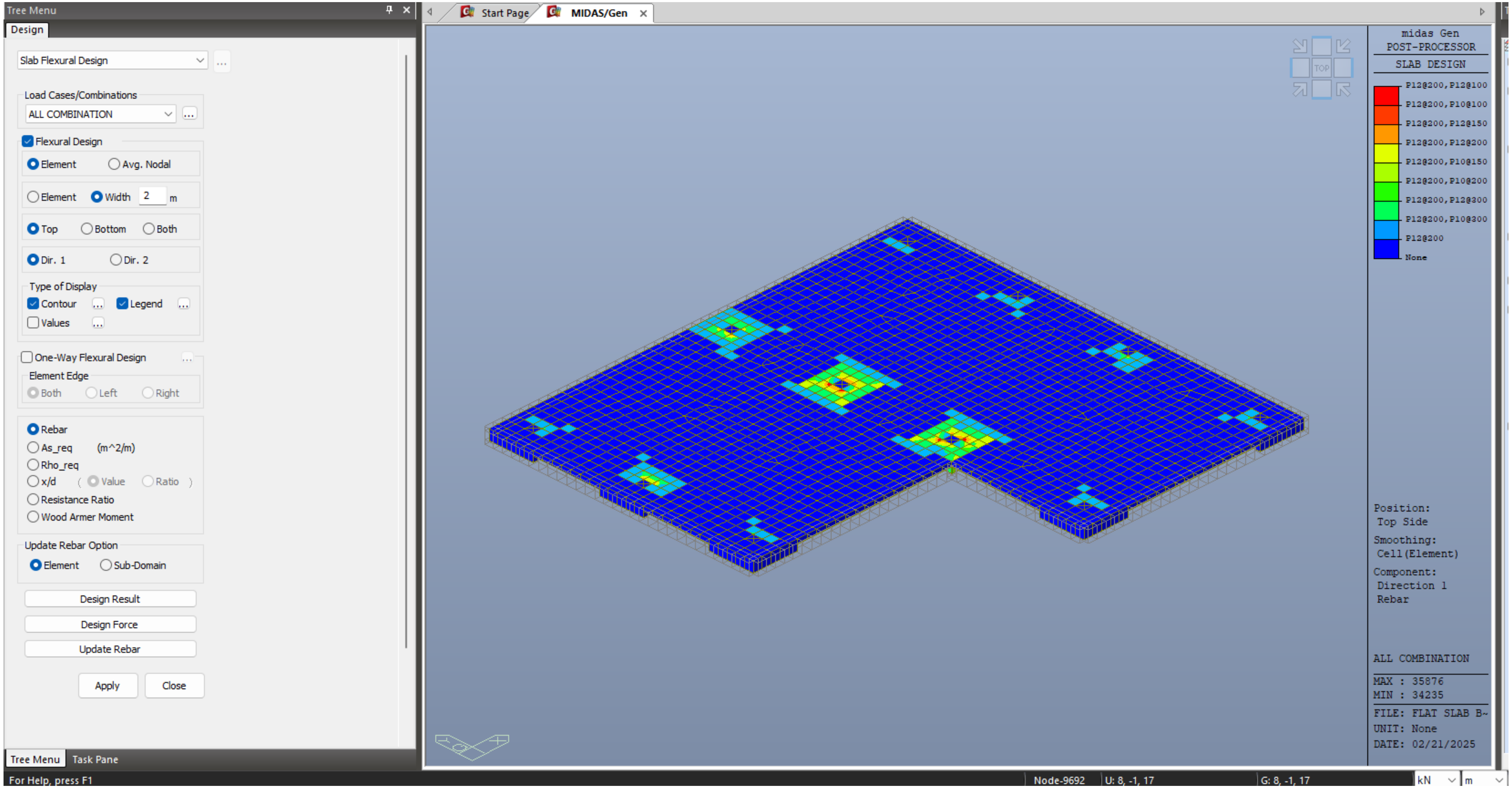
- **Automatic Generation of Load Combination**
- **Select Load Combinations for design**
- **Design Criteria for Rebar**



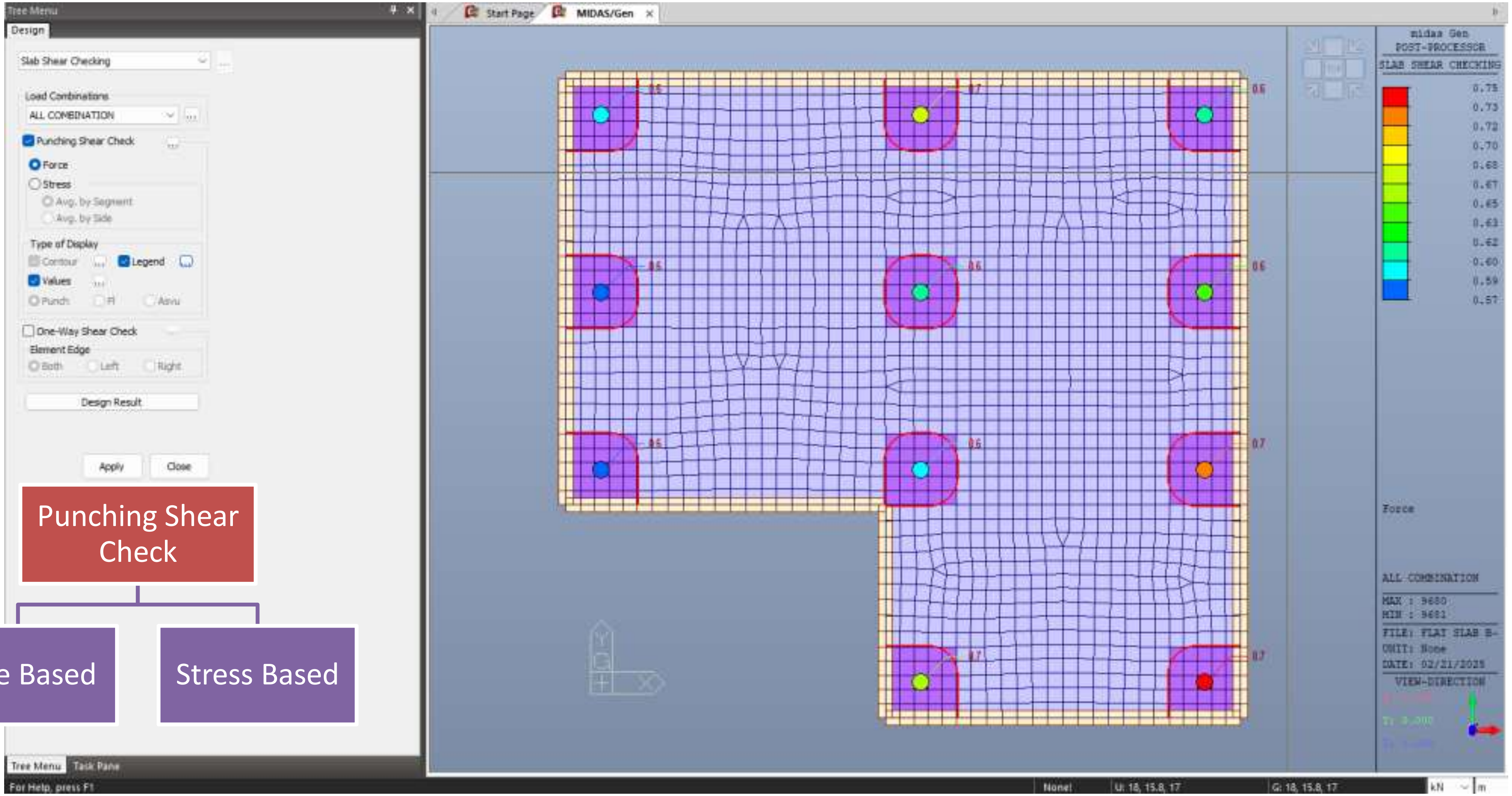




Flat Slab Flexural Design as per Eurocode2:04



Slab Shear Checking



Punching Shear Check

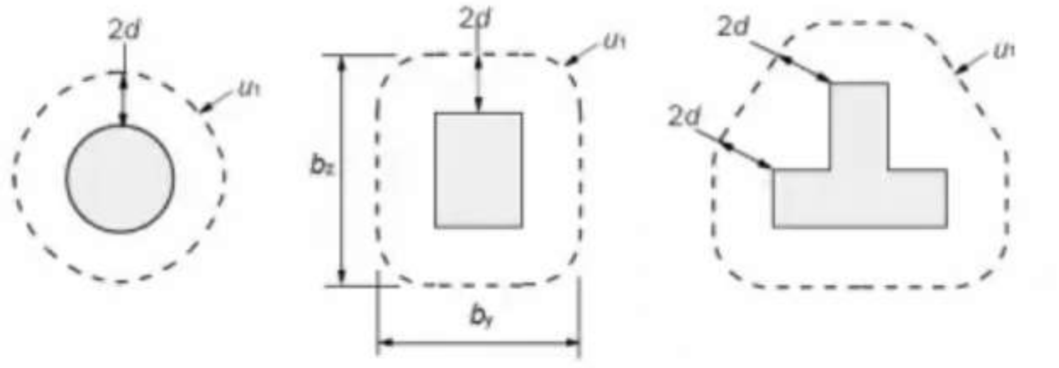
Force Based

Stress Based

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.
- $A_{sw}/s_r = (V_{Ed} - 0.75V_{Rd,c}) * (u_1 d) / (1.5 d f_{ywd,ef})$

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.

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

- Therefore, I_eff (effective second moment of area) can be calculated from the following equation.

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

$$\zeta = 1 - \beta\left(\frac{M_{cr}}{M}\right)^2$$

'$\beta = 0.5$' is applied (long – term loading).

$$M_{cr} = \frac{f_{ctm} bh^2}{6}$$

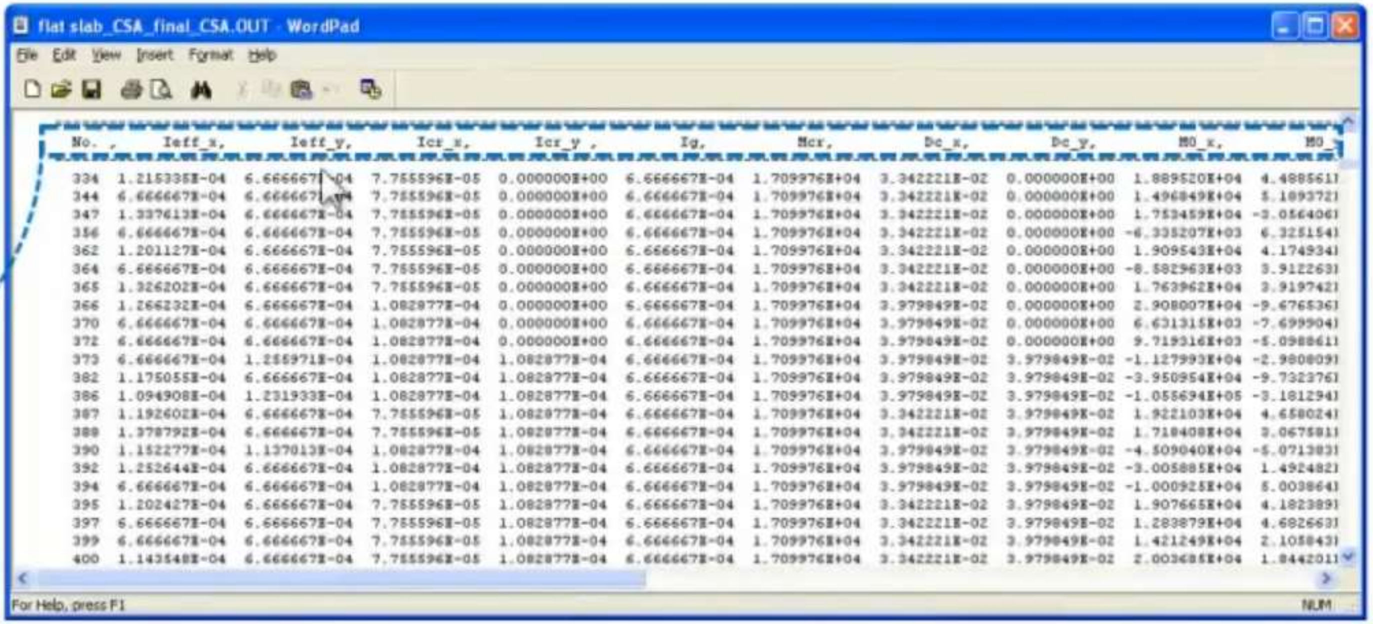
$$I_{cr} = A_s(d-d_c)^2\frac{E_s}{E_c} + \frac{1}{3}bd_c^3$$

$$d_c = \frac{-A_sE_s + \sqrt{(A_sE_s)^2 + 2bA_sE_sE_{c,eff}d}}{bE_{c,eff}}$$

Where, $f$ctm : mean value of axial tensile strength of concrete
bc : 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.

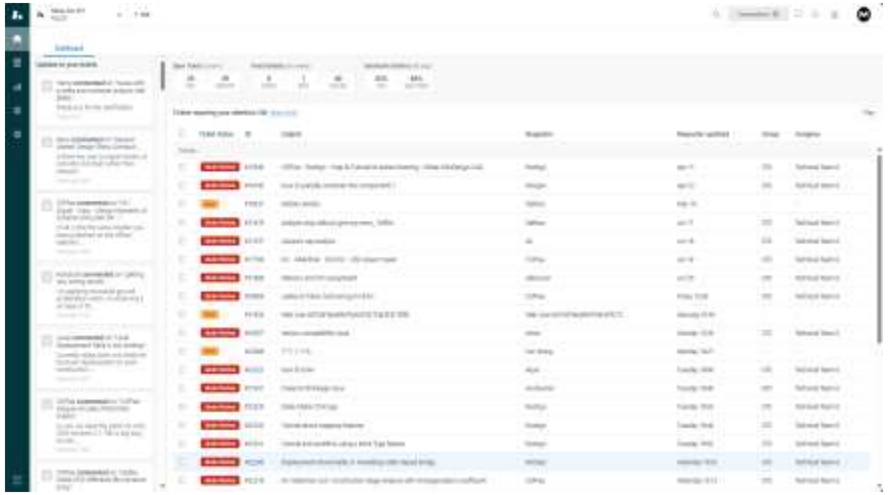


No. ,	Ieff_x,	Ieff_y,	Icr_x,	Icr_y ,	Ig,	Mcr,	Dc_x,	Dc_y,	MO_x,	MO_y
334	1.215335E-04	6.666667E-04	7.755596E-05	0.000000E+00	6.666667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.889520E+04	4.488561
344	6.666667E-04	6.666667E-04	7.755596E-05	0.000000E+00	6.666667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.496849E+04	5.109372
347	1.337613E-04	6.666667E-04	7.755596E-05	0.000000E+00	6.666667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.753459E+04	-3.056406
356	6.666667E-04	6.666667E-04	7.755596E-05	0.000000E+00	6.666667E-04	1.709976E+04	3.342221E-02	0.000000E+00	-6.335207E+03	6.325154
362	1.201127E-04	6.666667E-04	7.755596E-05	0.000000E+00	6.666667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.909543E+04	4.174934
364	6.666667E-04	6.666667E-04	7.755596E-05	0.000000E+00	6.666667E-04	1.709976E+04	3.342221E-02	0.000000E+00	-8.582963E+03	3.912263
365	1.326202E-04	6.666667E-04	7.755596E-05	0.000000E+00	6.666667E-04	1.709976E+04	3.342221E-02	0.000000E+00	1.763962E+04	3.919742
366	1.266232E-04	6.666667E-04	1.082877E-04	0.000000E+00	6.666667E-04	1.709976E+04	3.979849E-02	0.000000E+00	2.908007E+04	-9.676536
370	6.666667E-04	6.666667E-04	1.082877E-04	0.000000E+00	6.666667E-04	1.709976E+04	3.979849E-02	0.000000E+00	6.631315E+03	-7.699904
372	6.666667E-04	6.666667E-04	1.082877E-04	0.000000E+00	6.666667E-04	1.709976E+04	3.979849E-02	0.000000E+00	9.719316E+03	-5.098861
373	6.666667E-04	1.255971E-04	1.082877E-04	1.082877E-04	6.666667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-1.127993E+04	-2.980809
382	1.175055E-04	6.666667E-04	1.082877E-04	1.082877E-04	6.666667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-3.950954E+04	-9.732376
386	1.094908E-04	1.231933E-04	1.082877E-04	1.082877E-04	6.666667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-1.055694E+05	-3.181294
387	1.192602E-04	6.666667E-04	7.755596E-05	1.082877E-04	6.666667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.922103E+04	4.658024
388	1.378792E-04	6.666667E-04	7.755596E-05	1.082877E-04	6.666667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.718408E+04	3.067581
390	1.152277E-04	1.137013E-04	1.082877E-04	1.082877E-04	6.666667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-4.509040E+04	-5.071383
392	1.252644E-04	6.666667E-04	1.082877E-04	1.082877E-04	6.666667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-3.005885E+04	1.492482
394	6.666667E-04	6.666667E-04	1.082877E-04	1.082877E-04	6.666667E-04	1.709976E+04	3.979849E-02	3.979849E-02	-1.000925E+04	5.003864
395	1.202427E-04	6.666667E-04	7.755596E-05	1.082877E-04	6.666667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.907665E+04	4.182389
397	6.666667E-04	6.666667E-04	7.755596E-05	1.082877E-04	6.666667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.283879E+04	4.682663
399	6.666667E-04	6.666667E-04	7.755596E-05	1.082877E-04	6.666667E-04	1.709976E+04	3.342221E-02	3.979849E-02	1.421249E+04	2.105843
400	1.143548E-04	6.666667E-04	7.755596E-05	1.082877E-04	6.666667E-04	1.709976E+04	3.342221E-02	3.979849E-02	2.003685E+04	1.844201

element no.	I_effective (dir_1)	effective I (dir_2)	I_fully cracked (dir 1)	I_fully cracked (dir 2)	I_uncracked	cracked moment	dc (dir 1)	dc (dir2)	Updated moment (dir1)	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

Design guide



MIDAS

Thank you

One Stop Solution for Building and General Structures

https://support.midasuser.com/hc/en-us

dev@midasit.com

midas Gen

http://www.midasuser.com/

MIDAS