NZS 3101:2006 Concrete Column Design

Overview

This calculator is for the design of reinforced, non-prestressed concrete columns as per NZS 3101:2006. The following calculations are performed:

Column slenderness is determined in each direction depending on user inputs.
Design bending moments are calculated based on slenderness.
Moment capacities are derived from interaction diagrams, which are drawn based on the section properties of the column.
Shear capacities of the section are determined using the inclined strut truss model.
Detailing checks are performed on the section.

Section Analysis

Interaction Diagrams

The bending capacity of the concrete column is derived from interaction diagrams drawn for each axis. The interaction line is plotted by calculating values of 'M' and 'N' at varying depths of the neutral axis. This is done by determining the strains in the concrete and reinforcement bars for a given depth of the neutral axis. These strains can be converted into forces, which can then be used to calculate the maximum axial load and bending moment that the column can resist for that neutral axis depth.

> **Notes**
>
> - Moments are taken about the plastic centroid of the section.
> - The resultant concrete force is assumed to act at the centroid of the rectangular stress block.
>   - For rectangular sections, this is taken as half the height of the block.
>   - For circular sections, this is calculated by finding the centroid of the segment in compression, where the height of the segment is equal to $\beta_1 c$.

Column Design

Axial Capacity

The ultimate compression strength of a column is defined as $0.85.\varphi.N_{n,max}$. This is calculated as per equation 10-10. The tensile capacity of the section is calculated as the strength of the reinforcement and ignores any contribution from the concrete.

Design Moments

The moments used to design a concrete column depend on the slenderness of the column in the considered axis. If the column is not slender (or 'short'), then the column only needs to be checked for first order moments. The column must be designed for second order moments for each axis about which it is slender.

Users have the option to directly provide second-order moments to be used in the calculation.

Column Moments:

$$M_1 = \min\left[M_{top}\ ;\ M_{bottom}\right]$$

$$M_2 = \max\left[M_{2,min}\ ;\ \max\left[M_{top}\ ;\ M_{bottom}\right]\right]$$

> **Notes**
>
> - M_1 / M_2 is taken as positive when the column is bent in single curvature. In this calculator, this is when the moments have the same sign.
> - $M_{2,min}$ is calculated as N* x (15 + 0.03h) (Eq. 10-9).

Calculate Slenderness:

A column is deemed to not be slender if it is within the limits outlined below. Note that radius of gyration is calculated as $(I / A)^{0.5}$.

Eq. 10-2	$$\frac{kL_u}{r} \leq 34 - 12\frac{M_1}{M_2} \leq 40$$	10.3.2.3.4

Moment Magnification:

If a column is found to be slender, then the design moment is calculated as the first order moment, M_2, multiplied by a magnification factor (δ).

Eq. 10-4	$$\delta = \frac{C_m}{1 - \frac{N^*}{0.75N_c}} \geq 1.0$$	10.3.2.3.5
Eq. 10-5	$$N_c = \frac{\pi^2 EI}{kL_u^2}$$	
Eq. 10-6	$$EI = \frac{0.2E_cI_g + E_sI_{se}}{1 + \beta_d}$$	
Eq. 10-8	$$C_m = 0.6 + 0.4\frac{M_1}{M_2} \geq 0.4$$	

Bending Capacity

The bending moment capacity is calculated in each axis by plotting the coordinates of the design forces (axial load and bending moment) on the interaction diagrams. A line is drawn parallel to the x-axis (N = design axial load). The moment capacity is taken at the point where this line intersects the interaction line.

> **Note**
>
> - No equation for biaxial bending is included in NZS 3101:2006. This calculator only considers the uniaxial capacity and utilisation column.

Shear Capacity

The total shear capacity of the column is calculated as the capacity of the concrete, V_c, combined with the capacity of the shear reinforcement, V_s:

$$\varphi V_n = V_c + V_s \geq V^*$$

Concrete Shear Capacity

Eq. 10-11	$$V_c = k_a k_n v_b A_{cv}$$	10.3.10.3.1
Eq. 10-12	$$v_b = (0.07 + 10p_w)\sqrt{f'_c}$$	
Eq. 10-13	$$0.08\sqrt{f'_c} < v_b < 0.2\sqrt{f'_c}$$	
Eq. 10-14	$$k_n = 1 + \frac{3N^*}{A_g f'_c}$$	

$$\frac{3N^*}{A_g f'_c} \leq 0.3$$

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For members subject to axial tension, k_n is given by:

Eq. 10-15
$$k_n = 1 + \frac{12N^*}{A_g f'_c} \geq 0$$

Steel Shear Capacity

For rectangular sections:

Eq. 10-17
$$V_s = \frac{A_v f_{yt} d}{s}$$
10.3.10.3.2

For circular sections:

Eq. 10-18
$$V_s = \frac{\pi A_h f_{yt} d''}{2s}$$

Confinement and Anti-Buckling

This calculator checks that adequate confinement is provided to the core of the column and that the ties are sufficiently large to prevent buckling of the longitudinal reinforcement.

Concrete Confinement

$$\frac{A_g}{A_c} \leq 1.5$$

$$p_t m \leq 0.4$$

For rectangular sections:

Eq. 10-22
$$A_{sh} = \frac{(1 - p_t m) s_h h''}{3.3} \frac{A_g}{A_c} \frac{f'_c}{f_{yt}} \frac{N^*}{\varphi f'_c A_g} - 0.0065 s_h h''$$
10.3.10.6.1

For circular sections:

Eq. 10-20
$$p_s = \frac{(1 - p_t m)}{2.4} \frac{A_g}{A_c} \frac{f'_c}{f_{yt}} \frac{N^*}{\varphi f'_c A_g} - 0.0084$$
10.3.10.5.1

Lateral Restraint of Longitudinal Bars Against Premature Buckling

For rectangular sections:

Eq. 10-23
$$A_{te} = \frac{\Sigma A_b f_y}{135 f_{yt}} \frac{s_h}{d_b}$$
10.3.10.6.1

For circular sections:

Eq. 10-21
$$p_s = \frac{A_{st}}{155 d''} \frac{f_y}{f_{yt}} \frac{1}{d_b}$$
10.3.10.5.1

Change Log

1) Initial deployment 15/01/2026.

Feedback

We're constantly looking to expand and improve our product offering!

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