Reinforced Concrete Applications

Strength of Rectangular Reinforced Concrete Columns

Introduction

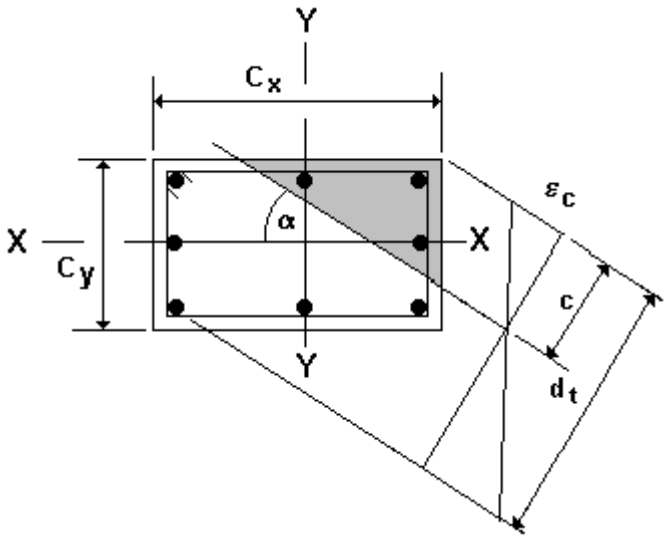
This application calculates the useable strength of tied square or rectangular reinforced concrete columns at the eccentricity of the applied load. The neutral axis location is determined using the Mathcad root function or solve block, and load capacity is computed using stress and strain compatibility, with reinforcing bar stresses calculated for each bar. This approach eliminates the need for approximate methods, tables or interaction diagrams.

The user enters column size and reinforcement, and axial load and bending moment about one or both axes. Concrete strength, reinforcement strength, and clear cover of the reinforcement may also be specified.

Only required input and output are shown in the visible portion of this document. Definitions and functions are shown in the collapsed area of this document. Use of a collapsed lockable area eliminates repetitive display of definitions, functions and intermediate calculations, and protects the application from unintentional alterations.

This application follows the requirements of ACI 318-95 "Building Code Requirements for Structural Concrete."

Input Notation



P_u	factored axial load
M_{ux}	factored moment about the X axis: $P_u e_y$
M_{uy}	factored moment about the Y axis: $P_u e_x$
C_x	width of cross section in the X direction
C_y	thickness of cross section in the Y direction
N_x	number of bars on "X" face, minimum of 2 bars
N_y	number of bars on "Y" face, minimum 2 bars
n	standard reinforcing bar number, 3 through 11, 14 and 18.

Calculations

The function $\phi P'_n(C_x, C_y, N_x, N_y, n, P_u, M_{ux}, M_{uy})$ calculates useable load capacity ϕP_n, stress f_{sp} at the extreme tension steel, and reinforcement ratio ρ.

Concrete strength, steel strength, and concrete cover of reinforcement:

$f'_c = 4\,ksi$ $\quad f_y = 60\,ksi$ $\quad cl = 2\,in$

Example:

$$\begin{pmatrix} P_u & M_{ux} & M_{uy} \end{pmatrix} := \begin{pmatrix} 1200\cdot kips & 1800\cdot ft\cdot kips & 750\cdot ft\cdot kips \end{pmatrix}$$

$$\begin{pmatrix} C_x & C_y & N_x & N_y & n \end{pmatrix} := \begin{pmatrix} 36\cdot in & 36\cdot in & 5 & 3 & 14 \end{pmatrix}$$

$$v := \phi P'_n(C_x, C_y, N_x, N_y, n, P_u, M_{ux}, M_{uy})$$

$$\begin{pmatrix} \phi P_n & f_{sp} & \rho \end{pmatrix} := \begin{pmatrix} v_0\cdot kips & v_1\cdot ksi & v_2 \end{pmatrix}$$

$\phi P_n = 1203.744\,kips$ $\quad f_{sp} = -60\,ksi$ $\quad \rho = 2.083\,\%$

End of application

- Size or reinforcement may be changed until strength is equal to or larger than the applied load. Since strength is calculated at the eccentricity of the applied load it is not necessary to display moment capacities.
- Comments and suggestions are welcome.

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