CALCULATION TABLE FOR OBLIQUE ECCENTRIC COMPRESSION COLUMN BY INTERACTIVE CHART METHOD

Part 3 - Method of calculating reinforcement area

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ABSTRACT

Interactive diagrams have been widely used in countries around the world and have been included in design standards such as ACI-318, BS-8110. In Vietnam, recent studies have also mentioned the construction of interactive charts to design reinforced concrete columns. The article researches to set up an automatic calculation table to calculate reinforcement for rectangular columns subjected to oblique eccentric compression. The author team also built a calculation table to check the bearing capacity of columns by the interactive chart method. many calculation examples were also conducted to verify the proposed calculation table and compare it with the calculation theory and the existing reinforcement calculation program. The author organizes the implementation according to the five main contents consist of: Part 1-Methodological content; Part 2-Principles of building interactive charts according to current Vietnamese standards; Part 3- Method of calculating reinforcement area; Part 4-Simulate the system on specialized software; Part 5- Evaluate calculation results.

Keyword: *Interactive chart, oblique eccentric compression, rebar calculation, bearing capacity, reinforced concrete column.*

1. INTRODUCTION

Reinforced concrete column structures subject to simultaneous effects of longitudinal forces and bending moments in both directions of the section is very common in multi-story building construction. In frame structural systems, columns supporting load-bearing beams are members subjected to both bending moment and compressive force, often they are called eccentric compression members. The column members in the frame will receive the load from the floors above, they transmit this load to the floors below and the building foundation through the foundation structure. If these compression-bearing members are not capable of bearing forces at adverse locations, they can cause damage to the entire structure. Damaged columnar structure in a building can cause more damage to people and property than horizontal load-bearing structures such as beams and bars. So the design is often calculated with a higher level of safety. Failures due to the compressive or brittle failure are more abrupt than plastic failure.

A column subjected to oblique eccentric compression is a column that is simultaneously subjected to an axial compression force N and a bending moment in the two directions Mx, My taken for the major axes of the section. Currently, there are several methods of calculating oblique eccentric columns such as: The additive method introduced by Moran, the reinforcement is calculated separately from (N, Mx)và (N, My), then add the results, detailed in [1]; Method to convert oblique eccentricity to internal flat eccentric [2], Bresler's test method is based on the idea of failure side [3], the method introduced by Row and Paulay [8] is to use directly the interaction diagram for rectangular cross-section subjected to oblique eccentric compression. Each graph contains four quadrants, each of which corresponds to a load application angle. When the actual load angle does not coincide with the load angle in the chart, it must be interpolated.

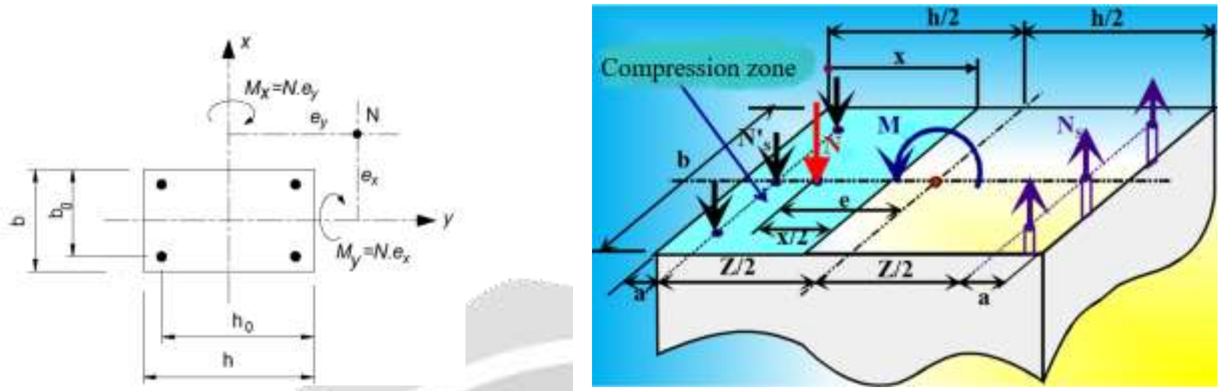

Figure 1. Cross-section of columns subjected to oblique eccentric compression

The internal force to calculate the column subjected to oblique eccentric compression is taken from the result of the load combination, in which it is necessary to pay attention to the following triples of internal forces (N, M_x, M_y):
+ N_{max} and M_x, M_y respectively
+ M_{ymax} and N, M_x respectively
+ M_x and M_y great value and N respectively.

2. MAIN CONTENT IMPLEMENTED

For concrete columns B30 has size 400x400 mm, column height 3.9m, R_b = 17 MPa, R_{bt} = 1,2 MPa, E_b = 32,5.103 MPa; bar steel CII có: R_s = 280 MPa, R_{sc} = 280 MPa, E_s = 21.104 MPa; The most dangerous pair of internal forces of the column N = 1601,36 kN; My = 108,46 (kNm); Mx = 94,907 (kNm)

Calculation length***:***

$$l_{ox} = l_{oy} = l.\psi = 3900.0,7 = 2730\,\text{mm}$$

Random eccentricity:

$$e_{ax} = \max\left(\frac{1}{600}l;\frac{1}{30}b\right) = \max\left(\frac{3900}{600};\frac{400}{30}\right) = 13,33(\text{mm})$$

$$e_{ay} = \max\left(\frac{1}{600}l;\frac{1}{30}h\right) = \max\left(\frac{3900}{600};\frac{400}{30}\right) = 13,33\ (\text{mm})$$

Thinness in two directions

$$\lambda_x = \frac{l_{ox}}{i_x} = \frac{2310}{0,288.b} = \frac{2730}{0,288.400} = 23,70 < 28 \Rightarrow \eta_x = 1$$

$$\lambda_y = \frac{l_{oy}}{i_y} = \frac{2310}{0,288.h} = \frac{2730}{0,288.600} = 23,70 < 28 \Rightarrow \eta_y = 1$$

$\Rightarrow$ Ignore the effect of longitudinal bending

Calculate the values

$$M_{x1} = \eta_x M_x = 1.94,907 = 94,907(\text{kNm})$$
$$M_{y1} = \eta_y M_y = 1.108,46 = 108,46(\text{kNm})$$
$$\frac{M_{x1}}{C_x} = \frac{94,907}{0,40} = 237,27(\text{kN})$$
$$\frac{M_{y1}}{C_y} = \frac{108,46}{0,40} = 271,15(\text{kN})$$

Because $\frac{M_{y1}}{C_y} > \frac{M_{x1}}{C_x}$ should convert the calculation in the Y direction

So $\text{h} = \text{C}_\text{y} = 400(\text{mm}); \text{b} = \text{C}_\text{x} = 400(\text{mm})$

$\text{M}_1 = \text{M}_{\text{y}1} = 108,46(\text{kNm}); \text{M}_2 = \text{M}_{\text{x}1} = 94,907(\text{KNm})$

Assumption a=40(mm)

$$\text{h}_0 = \text{h} - \text{a} = 400 - 40 = 360(\text{mm})$$
$$\text{Z} = \text{h}_0 - \text{a} = 360 - 40 = 320(\text{mm})$$

Eccentricity

$$e_a = e_{ay} + 0,2e_{ax} = 13,33 + 0,2.13,33 \approx 16$$

$$x_1 = \frac{N}{R_b b} = \frac{1601,36 \cdot 10^3}{17.400} = 235,49(\text{mm}) < h_0 = 360(\text{mm})$$

$$\Rightarrow m_0 = 1 - \frac{0,6 \cdot x_1}{h_0} = 1 - \frac{0,6.235,49}{360} = 0,608$$

$$M = M_1 + m_0 \cdot M_2 \cdot \frac{h}{b} = 108,46 + 0,608.94,907 \cdot \frac{0.4}{0.4} = 166,163(\text{kNm})$$

$$e_1 = \frac{M}{N} = \frac{166,163 \cdot 10^6}{1601,36.10^3} = 103,76(\text{mm})$$

$$\text{e}_0 = \max(\text{e}_1; \text{e}_\text{a}) = \max(103,76;16) = 103,76$$

$$\xi_R \cdot h_0 = 0,573.360 = 206,28(\text{mm}) < x_1 = 235,49(\text{mm})$$

$$\varepsilon_0 = \frac{e_0}{h} = \frac{103,76}{400} = 0,259$$

The area of reinforcement is calculated as follows:

$$A_{st} = \frac{\frac{\gamma_e N}{\varphi_e} - \gamma_b \cdot R_b \cdot b \cdot h}{R_{sc} - \gamma_b R_b} = \frac{\frac{1,837.1601,36 \cdot 10^3}{1} - 0,85 \cdot 17.400.400}{280 - 0,85.17} = 2371,30\,\text{mm}^2$$

$$\mu = \frac{A_{st}}{bh} = \frac{2371,30}{400.400} \cdot 100\% = 1,48\% < 4\%$$

3. CONCLUSIONS

In this paper, the theoretical calculation method has been implemented. A dedicated simulation process will be performed to test the theory of computation performed in the next study, along with comments on the suitability of construction theory to each specific case.

4. ACKNOWLEDGEMENT

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