UDC 624.012

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PROPOSAL FOR SECTION ANALYSIS OF MEMBERS SUBJECTED TO AXIAL LOAD AND BIAXIAL BENDING

When a structural element is bended about both of its principal axes of cross section, it is subjected to biaxial bending. The most typical example is a column that is subjected to eccentric loads with eccentricity in both directions or bending moments in both directions. Due to biaxial bending, the issue is problematic for square or rectangular columns since the neutral axis of the bending is no longer parallel to a main axis [1].

The problem of calculating the strength of biaxially bended columns with a triangular shape of the compressed concrete area is solved (Fig. 1). The research is based on the prerequisites for calculation according to Eurocode 2 [2]. At the same time, the bi-linear stress distribution is adopted in compressed concrete. To derive the calculation formulas, the general equilibrium equations are written in the form:

$$\sum Z = 0 : N_{Ed} + \sum_{i=1}^{n} N_{si} - N_c = 0; \tag{1}$$

$$\sum M_A = 0 : N_c (y_{Ed} - y_c) + \sum_{i=1}^{n} N_{si} (y_{Ed} - y_{si}) = 0. \tag{2}$$

The obtained expressions for the resultant N_c and the coordinate y_{Nc} of its application in the coordinate plane XOY are:

$$N_c = \frac{f_{cd} X^2 \left(1 + \lambda + \lambda^2\right)}{3 \sin 2\theta}; \tag{3}$$

$$y_{N_c} = \frac{X\left(1 + \lambda + \lambda^2 - \lambda^3\right)}{2\left(1 + \lambda + \lambda^2\right)}, \tag{4}$$

where X – the neutral axis depth;

θ – the angle of inclination of the neutral axis to the horizontal axis of inertia of the section.

To determine fiber relative strains of concrete $\varepsilon_{c(1)}$ at the time of failure, the deformation criterion of strength is used:

$$\varepsilon_{c(1)} = \varepsilon_{cu3,cd} \,. \tag{5}$$

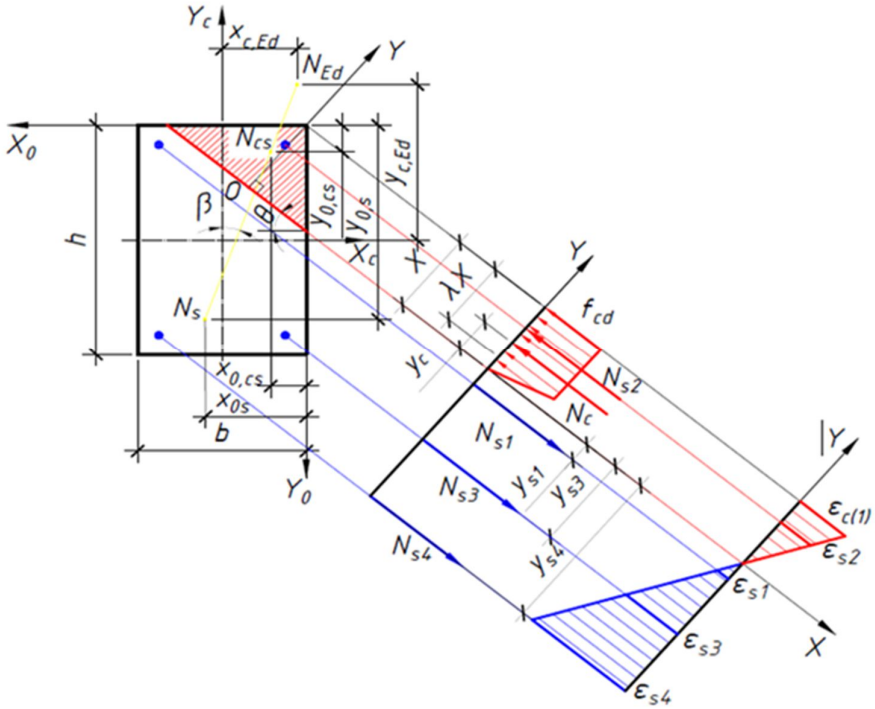

Fig. 1. Design scheme of the normal cross-section of an biaxially bended reinforced concrete column with a triangular shape of the compressed area

To determine the angle θ of the inclination of the neutral axis, the theorem on the location of internal and external forces in the same plane is used:

$$\frac{x_{0,s}-x_{0,Ed}}{y_{0,s}-y_{0,Ed}}=\frac{x_{0,s}-x_{0,cs}}{y_{0,s}-y_{0,cs}}, \tag{6}$$

where $x_{0,cs}$, $y_{0,cs}$ – coordinates of the point of application of the resultant force in triangular compressed concrete area and in compressed reinforcing bars;

$x_{0,s}$, $y_{0,s}$ – coordinates of the point of application of resultant N_s force in tensile reinforcing bars.

Conclusion: As a result of the conducted theoretical studies, analytical dependencies are obtained for solving problems of the strength of biaxially bended reinforced concrete columns with a triangular shape of the compressed concrete area. Equations may be used both when checking the bearing capacity of biaxially bended columns and when designing them.

References

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