CORNER RADIUS EFFECT IN THIN-WALLED SQUARE SECTION COLUMNS ON THE LOCAL BUCKLING OF WALLS UNDER AXIAL COMPRESSION

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1. INTRODUCTION

During axial-compression of thin-walled square section steel columns, we can determine the local buckling critical stress from the formula valid for a long uniformly-compressed rectangular plate simply supported at all edges (1) [1]:

$$\sigma_{kr} = 4\frac{\pi^2 D}{b_0^2 t} = \frac{\pi^2 E}{3\left(1-\nu^2\right)}\left(\frac{t}{b_0}\right)^2 \tag{1}$$

where: E is Young modulus of column material, ν Poisson's ratio, b_0 - single wall width of square column or rectangular plate, t - wall thickness (or plate thickness). For typical girder design the critical stress values of local buckling are very small in comparison to the structural steel yield point. Then the mechanical strength properties of applied material couldn't be fully used in considered columns [3].

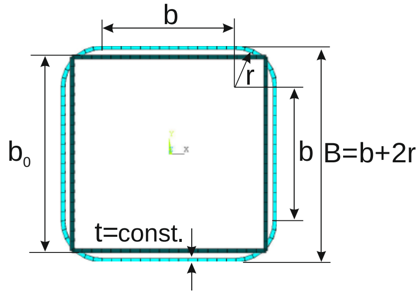

Fig. 1. Square section column cross section with corner radius

2. THE FORMULATION OF PROBLEM

We consider a thin-walled square section columns with corner radius, as it is shown in Fig. 1. The local buckling of thin-walled columns under axial compression with radius corner ($r \neq 0$) and without radius corner ($r = 0$, $b = b_0$) is analysed. The wall thickness and cross-section area of all columns are the same, then the relationship can be established:

$$b = b_0 - \frac{\pi}{2}r \tag{2}$$

For given data: l, b_0, t, E, ν and assumed radius corner r, using the formula (2), one can calculate the width b of a flat part of column wall with assumed radius corner. In the case when $b = 0$, we obtain a cylindrical shell with a total radius $r_c = 2/\pi \cdot b_0 = 0.63662$.

3. RESULTS of CALCULATIONS

The computations of local buckling critical stresses of considered thin-walled square section column with radius corner, exposed to axial compression, were performed with application of the finite element method software ANSYS. The exemplary, detailed computations were executed for the following data: the wall column width without radius corner $b_0 = 1$ m; column height $l = 3b_0 = 3$ m; the flat wall elements width $b = b(r)$; considered wall width: $t = 1, 2, 4$ mm; Young modulus for steel columns E =200 GPa; Poisson's ratio $\nu = 0.3$. The results are shown in Fig. 2.

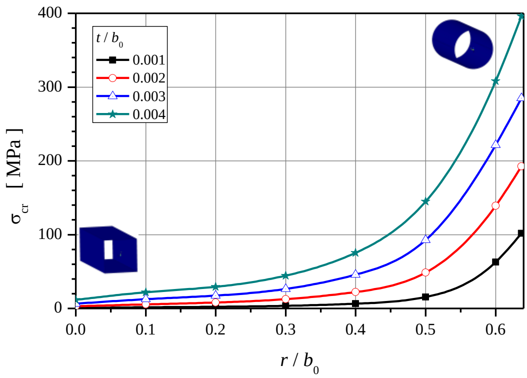

Fig. 2. Corner radius-critical stresses curve

4. COCLUSIONS

From the performed computations and exemplary diagram one can simply conclude that for compressed columns made of the same material with the same boundary conditions, the local buckling stress of walls increases with the increase of radius corner value. It leads also to increase of the ultimate load of considered columns. Introduction of even small radius corner is a design tool to control a local buckling stress value and effective strength utilization of column material.

REFERENCES

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