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Evaluation of the elastic critical load of tapered columns with hollow circular or square cross-sections

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ABSTRACT

Tapered structural members may represent an interesting solution for some types of steel structures. Nevertheless, the verification of their safety may present some difficulties, such as the evaluation of their elastic critical loads.

One possible solution for this problem lies on the use of numerical methods, such as the finite element method for example. However, computer programs that include special formulation for tapered finite elements, and allow the evaluation of the structural members critical loads, are not usually available for most of designers.

On the other hand, the use of finite elements with uniform cross-sections to solve this problem requires a very fine discretisation of the tapered members, which makes this method very tedious due to the large amount of data that must be prepared before doing the computer calculations.

Some analytical methods have been proposed by other authors, which usually depend on coefficients quantified by tables or diagrams. The use of these methods is liable to calculation errors, resulting from the need of interpolating between tabulated values.

This work proposes an adaptation of the Euler expression to the evaluation of the elastic critical load of tapered members with circular or square cross-sections, full or hollow, under simple compression. The diameter of the circular cross-sections or the width of square sections varies linearly between two extreme values located at the member ends.

The adaptation is made by means of a coefficient, whose value depends on several parameters that characterise the influence of the ratio between the extreme values of the cross-section dimensions, and of the ratio between these and the thickness of the cross-section wall. The proposed method for quantifying this coefficient, by means of simple analytical expressions, has been developed after the results of a parametrical study of more then one hundred different tapered columns.

The results given by the proposed method have been compared with those obtained by numerical methods, by means of different computer programs. The differences found were very satisfactory, usually smaller than 0,3%.