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Elastic design of tapered beams submitted to bending and axial force

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ABSTRACT

Tapered structural members may represent an interesting solution for some steel beams, since they allow a better adjustment of the cross-sections resistance to the applied loads. The reduction of size of the beam cross-sections allows a diminution on the intensity of the actions associated to the beam self weight, as well as a cheaper solution, as far as the amount of steel required to its fabrication is concerned.

The beam cross section where the steel yield stress is reached for the first time, in its most strained fibres, is defined as the beam critical section. The elastic limit of the beam corresponds to the elastic limit of its critical cross section.

If the critical section of beams with uniform cross sections is always the one subjected to the most unfavourable combination of loads, that is no longer the case with tapered beams, since both acting and resistant values of the cross section internal loads vary along the length of the beam.

Therefore, one of the main difficulties in the design of these structural members lies on the determination of the beam critical section, which controls the elastic resistance of the entire beam, when this one is not affected by buckling phenomena.

This work presents a method of deduction of analytical expressions for the elastic design of tapered beams submitted to bending and axial force.

These expressions allow to find the beam critical section, its internal forces and the maximum loads carried by the beam at its elastic limit state. Finally, it is possible to compare the reduction of the tapered beam self weight, when compared with a uniform cross section beam with the same elastic limit state.

The expressions presented at this work are written as a function of non dimensional parameters, which allow to analyse the influence of the relative variations in the beam geometry or loading parameters over the tapered beam resistance.