Fire design of stainless steel I beams prone to lateral torsional buckling under end moments

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It is known that the loading type (bending moment diagram shape) influences the resistance of laterally unrestrained steel I-beams to lateral torsional buckling (LTB), which led to the development of Eurocode 3 (EC3) design rules accounting for the beneficial effect of non-uniform bending. New design formulae for stainless steel beams under fire conditions have recently been proposed for incorporation in the second generation of EC3 – their safety evaluation in the context of different bending moment diagrams is still a relevant issue that needs to be investigated.

This work presents a numerical study on the resistance of laterally unrestrained stainless steel I-beams with slender and non-slender cross-sections and undergoing LTB when acted by end moments at elevated temperatures, focusing on the influence of the (linear) bending moment diagram shape.

The safety and accuracy of the EC3 design approaches (current and second generation versions), as well as a design proposal previously developed for beams with stocky stainless steel sections, were assessed through an extensive numerical (finite element) parametric study using the software ANSYS. The validation of the numerical model developed was carried out through the comparison with results (failure moments and load-displacement equilibrium paths) obtained from experimental tests, and respective numerical simulations, reported in the literature. The parametric study comprised a total of 8701 I-section beams, (i) acted by five bending moment diagrams, (ii) made of three stainless steel grades (austenitic, duplex and ferritic), (iii) exhibiting various cross-section dimensions and LTB slenderness values and (iv) subjected to different elevated temperatures.

A design proposal previously developed for stainless steel-beams with non-slender sections was shown to provide the best failure moment predictions for beams with both non-slender and slender sections.

FIGURE 1
Failure mode of a slender beam used on the model validation.

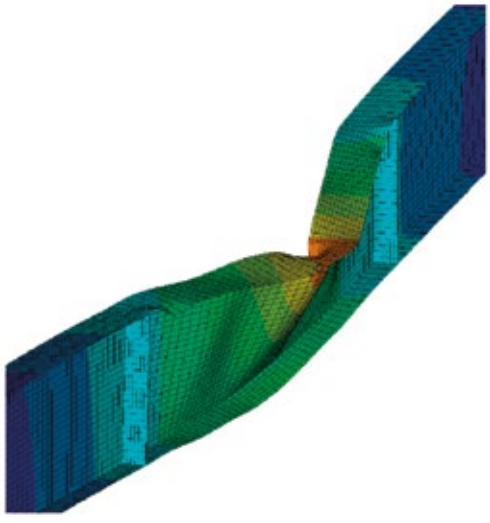

FIGURE 2
Results concerning the I-beams with slender sections acted by three bending diagrams.