Effective width method to account for the local buckling of steel thin plates at elevated temperatures

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Steel buildings are commonly composed of columns and beams, which constitute the structural members. Just like the skeleton of a human body these elements guarantee the stability of the whole building and therefore its safety. In the extreme event of a fire, it is fundamental that the security of the people is not compromised by evacuating them before the building collapses. For that purpose, fire safety rules exist influencing the columns and beams design. UA was one of the partners of the EU project FIDESC4 – "Fire Design of Steel Members with Welded or Hot-rolled Class 4 Cross-sections" that aimed at the development of safer and more economical design rules for steel buildings under fire situation. The authors, before studying the behaviour of columns and beams which are made of steel plates joined together to form the cross-section, focused on these smaller scale elements instead. If the ratio between the width and the thickness of the plates is high, they are considered slender (thin) plates (Class 4), and are susceptible to a local failure called local buckling and although it is a local problem it may affect the stability of the whole structure, thus justifying its investigation.

Analysing the behaviour of thin plates at high temperatures with the aid of computerized models made by the finite elements (see Fig. 1a), new analytical expressions were developed to assess their resistance against local buckling in fire. These new rules allow better prediction of the capacity of the plates at elevated temperature (see Fig. 1b), thus the structural elements and consequently the whole structure in fire. The new expressions were validated against fire tests on columns and beams, demonstrating to be accurate. The innovation on the proposed rules is that these developments allowed for a considerable gain in economic terms, demonstrating that it is possible to reduce the material needed for a steel building, with elements composed of thin plates, to resist a fire as required by regulations, replacing older methods that proved to be inadequate. The publishing of these rules in international peer-reviewed journal allowed for the scientific recognition of their merit and validity. Furthermore, in the future, it will be possible to include such rules in the European standards and legislations that govern the design of steel structures in case of fire.

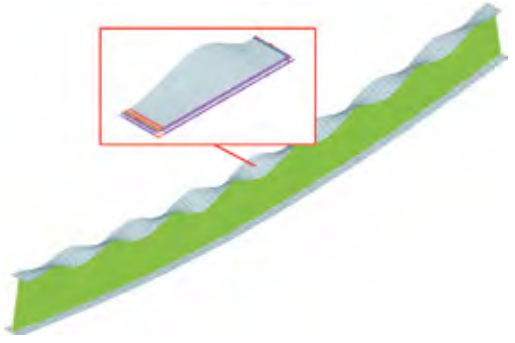

FIGURE 1
Computer model of structural member and smaller thin plate.

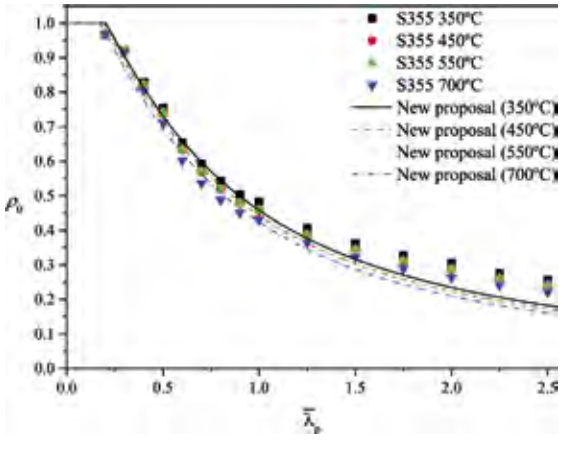

FIGURE 2
Example of the new proposal (lines) and comparison to computer results (points).