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Influence of the stress-strain law modelling on the non-linear analysis of steel structures

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ABSTRACT

The non-linear analysis of steel structures is generally achieved by means of numerical models based on the use of simplified stress-strain laws.

The most common laws are bilinear, each segment representing the elastic and the elastic-plastic domains of the steel behaviour. A zero slope on the second domain assumes a perfect elastic-plastic behaviour for the material before its fracture. A positive slope means that the effects of the material hardening are taken into account along the elastic-plastic domain.

A more accurate approach may be obtained by means of multi-linear or non-linear stress-strain laws, which allow a good fitting to the real steel behaviour representation. However, the introduction of these laws in the numerical models may present considerable difficulties, and the non-linear analysis made with these models may be much heavier.

This paper presents a study of the non-linear behaviour related to an I-shape cross-section, using different approaches for the steel stress-strain law representation, in order to compare their influence on the evolution of its internal loads.

This study is carried out by means of an efficient non-linear model, based on the study of the cross-section global deformations. The results give an evaluation of the benefit that can be obtained by an improved steel stress-strain law, and it emphasises the cases where the differences between the analysis results are more relevant.

This information may help to choose the most convenient numerical model or stress-strain law, depending on the structure behaviour characteristics. A refined estimation of the internal loads may be useful to get a more realistic and accurate solution for their distribution between the structural members, or to achieve a better design of the connections, for instance.

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