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# Behaviour, strength and DSM design of cold-formed steel columns affected by distortional-global interaction at elevated temperatures

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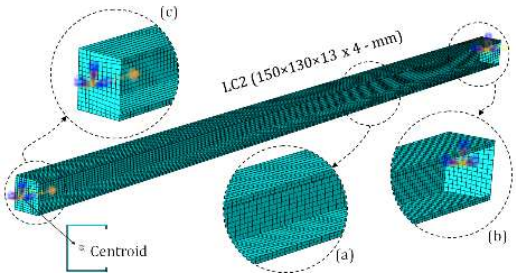
## Summary

This thesis addresses the post-buckling behaviours, strength and design, based on the Direct Strength Method (DSM), of cold-formed steel lipped channel columns affected by distortional-global mode interaction at elevated temperatures caused by fire conditions. The first step consists of identifying column geometries (cross-section dimensions and lengths) susceptible to the occurrence of distortional-global (flexural-torsional) interaction, which requires performing educated trial-and-error" buckling analysis sequences — the objective is to gather column geometries associated with a reasonably wide range of global-to-distortional buckling load ratios. Next, the elastic and elastic-plastic post-buckling behaviours of selected column are investigated, in order to characterise the distortional-global interaction at elevated temperatures — particular attention is paid to the identification of the most detrimental initial geometrical imperfection shape and to study the column imperfection-sensitivity.

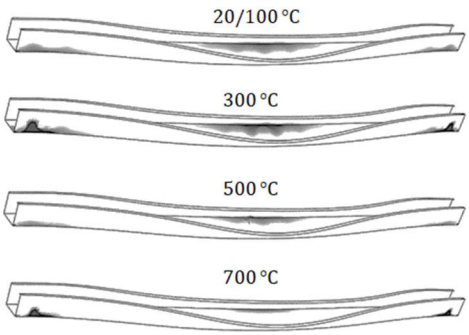
This investigation is carried out by means of geometrically and materially non-linear shell finite element analyses, using the code ABAQUS adopting previously validated models that use the temperature-dependent steel constitutive law prescribed in Eurocode 3 — such analyses simulate the compressive strength of columns under uniform and constant elevated temperatures (steady-state analyses). Next, the ABAQUS shell finite element models are used to perform an extensive parametric study, intended to gather failure load data concerning lipped channel columns with (i) various geometries, ensuring different levels of distortional-global interaction, (ii) flexural-torsional initial geometric imperfections with prescribed amplitudes, (iii) several yield stresses (to cover wide slenderness ranges) and (iv) a fairly large number of elevated temperatures. Finally, the failure loads gathered are used to search for an efficient (safe accurate and reliable) design approach, based on the Direct Strength Method, for the cold-formed steel columns dealt with in the thesis.

## Keywords

Cold-formed steel (CFS), Direct Strength Method (DSM), distortional-global interaction (D-G), Finite Element Method (MEF), fire and elevated temperature behaviour.




*Numerical model: (a) mesh, (b) fixed-end support conditions and (c) loading-end support conditions*




*Column deformed configurations and plastic strain contours at collapse for T = 20/100-300-500-700 °C.*