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On the Distortional Buckling, Post-buckling and Strength of Cold-formed Steel Lipped Channel Columns Subjected to Elevated Temperatures

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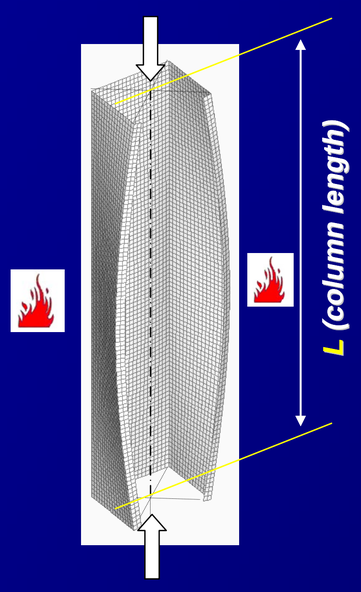
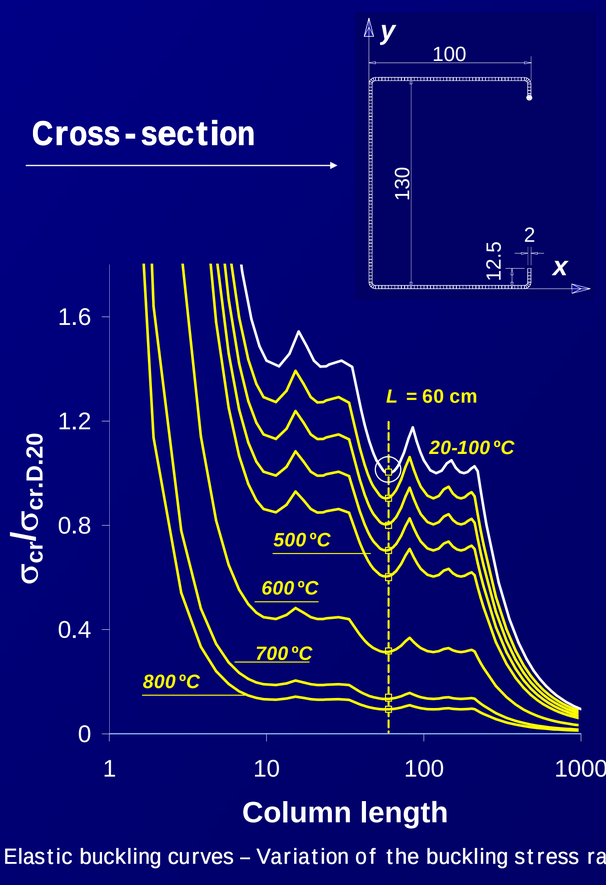
1. Motivation



Distortional buckling

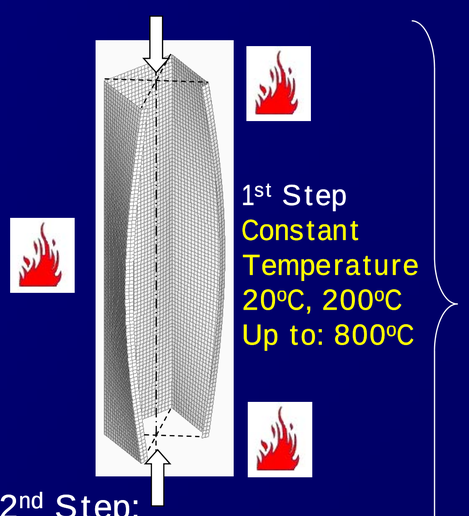


Elastic buckling curves – Variation of the buckling stress ratio

2. Non-Linear Analysis

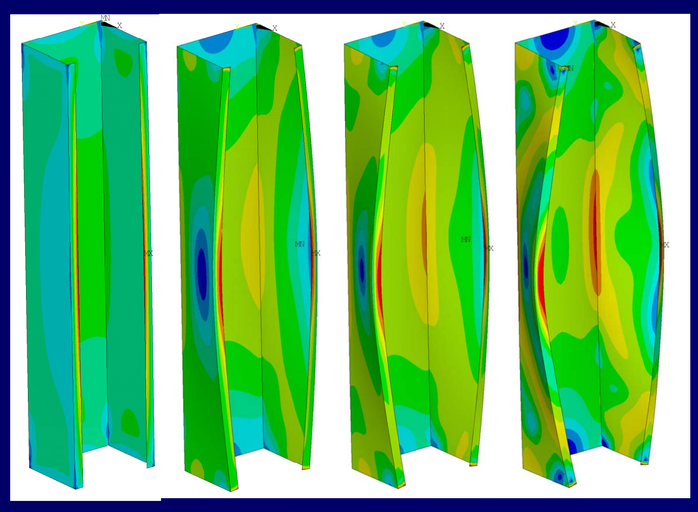
Case 1: STEADY

Failure Loads at Constant Temperature

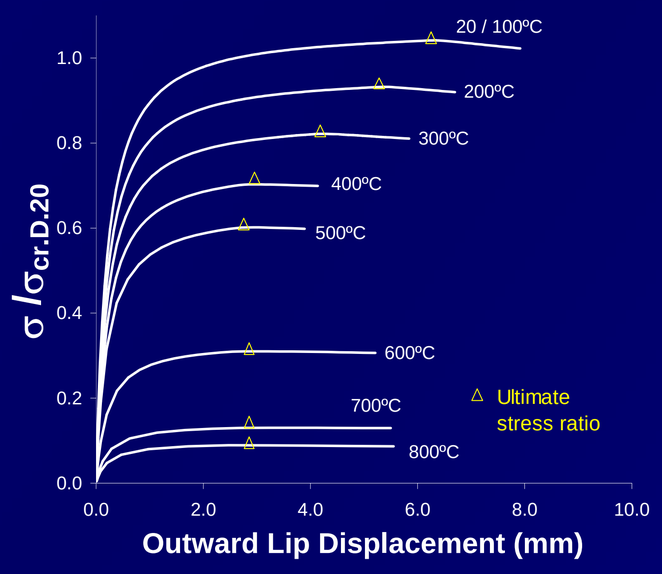


1st Step
Constant Temperature
20ºC, 200ºC
Up to: 800ºC

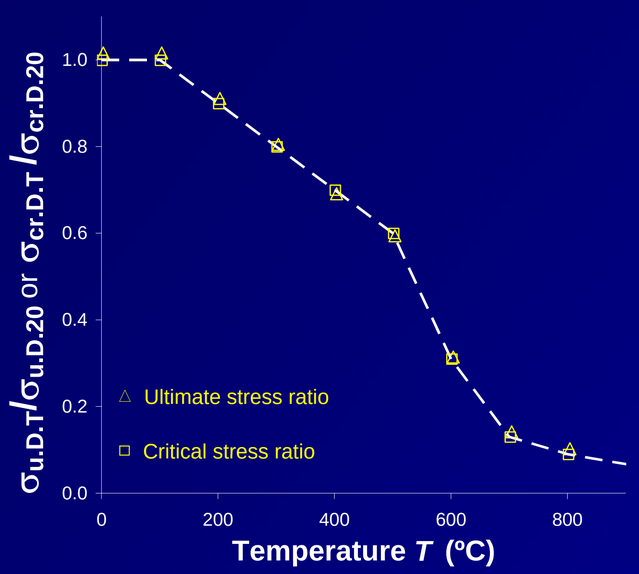
2nd Step:
Incremental Load



Von Mises Stress distribution at distortional collapse for 500ºC



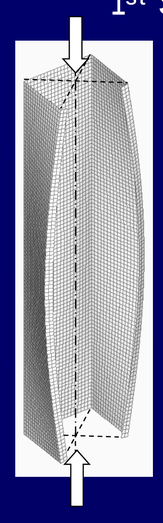
Post-buckling equilibrium paths



Critical and ultimate stress ratios

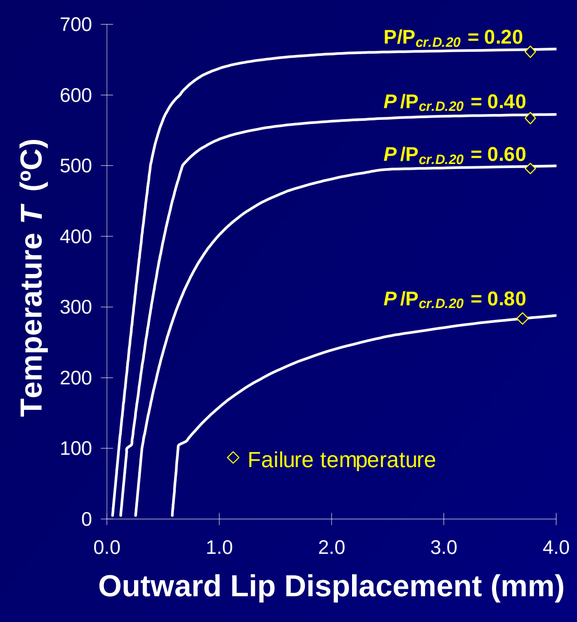
Case 2: TRANSIENT

Failure Temperatures at Constant Load

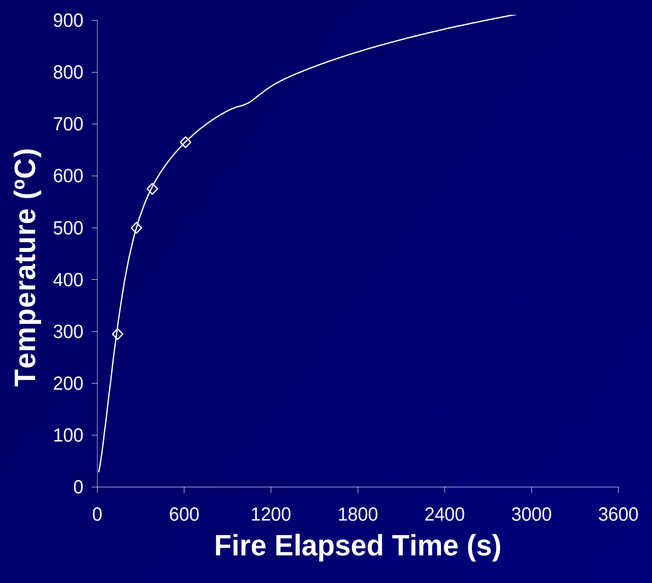


1st Step - Constant Load:
20% up to 80% $P_{cr.D.20}$

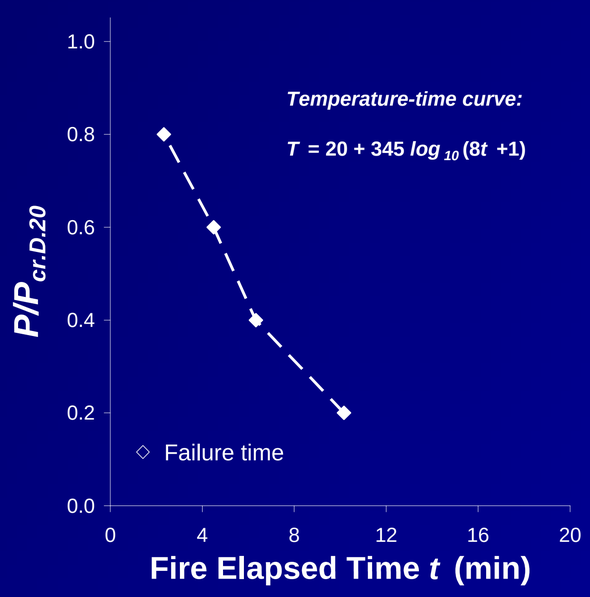
2nd Step:
Incremental Temperature



Critical and ultimate stress ratios



Time-temperature curve



Column failure time

3. Conclusions

1. This paper reported the available results of an ongoing shell finite element investigation on the distortional buckling, post-buckling and ultimate strength behaviour of simply supported cold-formed steel lipped channel columns subjected to (i) concentric compression and (ii) elevated temperatures caused by fire conditions.
2. The steel constitutive relation at high temperatures was taken in accordance with Eurocode 3 and the geometrically and materially non-linear response of the cold-formed steel lipped channel columns was determined by means of shell finite element analyses performed in the code ANSYS.
3. Results for (i) column failure loads and (ii) column failure temperatures are presented, considering the member temperature evolution, column failure times.
4. The column temperature evolution was obtained by means of 2D non-linear heat transfer finite element analyses carried out in the code SAFIR and adopting the fire design curve prescribed in Eurocode 1 in all the column inner and outer surfaces.
5. Finally, it is worth noting that a data bank of (numerically and experimentally obtained) failure loads and temperatures similar to those dealt with in this work should be very helpful in establishing guidelines for the design of cold-formed steel lipped channel columns subjected to elevated temperatures and/or fire conditions – the authors plan to pursue this avenue in the near-to-intermediate future.