

FIRE PERFORMANCE OF NON-LOADBEARING LIGHT STEEL FRAME EXTERNAL WALLS: NUMERICAL SIMULATION

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ABSTRACT

This work investigates the fire behaviour of external walls, presenting a numerical study of six different typologies usually found in LSF practice with two fire scenarios affecting the inner and outer sides of the walls. The conclusions show that the temperature evolution is slower for outer side fires but, in these cases, the critical temperature of 350 °C is reached earlier in the steel profiles. Finally, this work shows that more studies are necessary to describe the fire resistance of external walls, in particular, when these elements have a loadbearing requirement.

Keywords: light steel framing; external walls; numerical simulation; fire resistance.

INTRODUCTION

The global trend suggests that the use of LSF systems in construction will increase since it provides a sustainable solution for the construction market, converging with the policies observed in Europe. Previous investigations (Alves et al., 2021; Tao & Mahendran, 2021) on the fire behaviour of LSF walls mainly focused on internal configurations while the increasing number of forest and urban fires affecting the external walls of buildings suggests that their fire behaviour also must be understood. Using a numerical model developed in ANSYS (see Figure 1), two-dimensional (2D) analyses were performed using the finite element PLANE55 and SURF151 to calculate the temperature evolution in an LSF external walls consisting of different materials and layers for inner and outer fire scenarios.

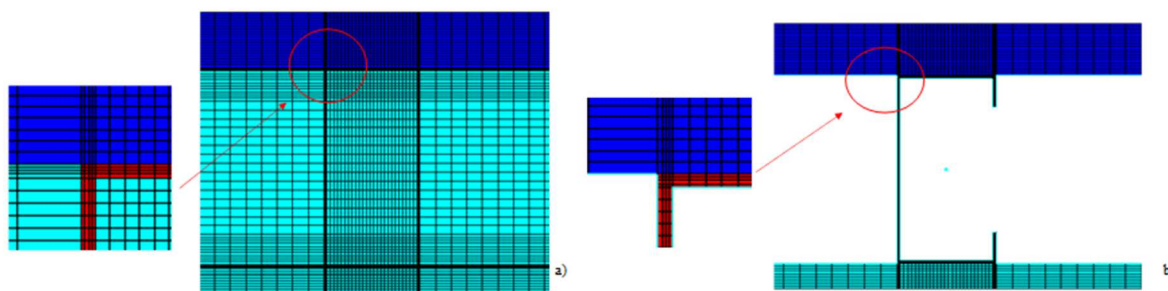


Fig. 1 – Finite element mesh a) with and b) without material in the cavity.

RESULTS AND CONCLUSIONS

The results allow comparing the insulation fire resistance of different LSF external wall typologies, as well as their temperature history behaviour across the wall as plotted in Figure 2.

A7 - LSF_04_EF

A10 - LSF_04_IF

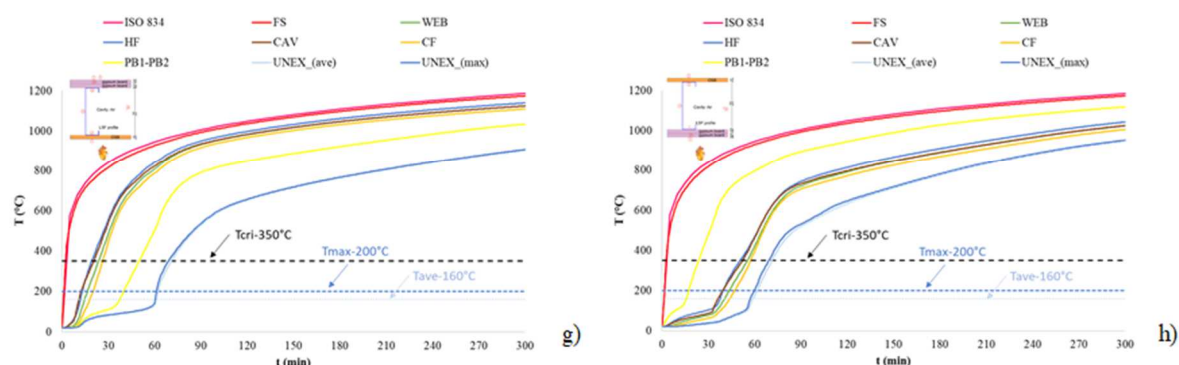


Fig. 2 – Results of the time history for temperature during the numerical simulations of the samples.

With this study, it was concluded that the evolution of temperature is slower in the LSF walls when exposed to fire from the outside (EF). In fact, comparing the behaviour of the same typology for a standard fire simulation, the differences in the insulation fire resistance can be higher than 60 min. between a LSF wall exposed from the inner side (IF) or the outer side (EF). On the other hand, the fire from the outer side (EF) should be less severe and, in these circumstances, higher fire resistance should be expected.

In terms of insulation material, generally the results showed a higher fire resistance for samples with superwool insulation in the cavity, compared to the other samples with rockwool or assuming the void cavity modelled by radiation. In addition, a higher fire resistance of the samples with a cavity of 150 mm was observed, due to the existence of a thicker wall.

However, a crucial point was observed related to the critical temperature in the steel profiles which was reached earlier for the EF scenarios. This raises some concerns that the fire resistance can be greatly impacted because the steel profiles have a key role in the capacity of these walls added up to the fact that it is expected that they may also have a load bearing requirement.

Finally, this work highlights the need to carry out more research, particularly experimental tests, to validate and confirm these findings. Also, given the limited research on the topic it is expected that this exploratory study will drive more attention to this subject by the fire research community and thus contribute to enhance the global understanding of the fire behaviour of LSF external walls, ultimately leading to safer structures against fire.

REFERENCES

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