A quasi-static nonlinear analysis for assessing the fire resistance of 3D frames exploiting time-dependent yield surfaces

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ABSTRACT

In this work an automatic procedure for evaluating the axial force-biaxial bending yield surface of frame sections in fire is proposed. It provides an accurate time-dependent expression of the yield condition by a section analysis carried out once and for all [1], accounting for the strength reduction of the materials, which is a function of the fire duration. The equilibrium state of 3D frames with such yield conditions, once discretized using beam finite elements, is formulated as a nonlinear vectorial equation defining a curve in the hyperspace of the discrete variables and the fire duration. A generalized path-following strategy is proposed for tracing this curve and evaluating, if it exists, the limit fire duration, that is the time of exposure which leads to structural collapse. Compared to the previous proposals on the topic, which are limited to local sectional checks, this work is the first to present a global analysis for assessing the fire resistance of 3D frames, providing a time history of the fire event and taking account of the stress redistribution by using. The stress update is performed at the finite element level in order to preserve the stress interpolation [2, 3]. Numerical examples are given to illustrate and validate the proposal.

REFERENCES

