Impact of the structural model used on the steel hall fire resistance assessment

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Abstract

It is presented in detail how the selection of a structural model describing steel hall frame in a more or less complex way may affect fire resistance evaluation for such hall. In the examples compiled in this paper the same typical one-aisle and single-story steel hall is subjected to simulated fire action, each time following the same fire development scenario. A resultant fire resistance is identified individually in each case, using various computational models, on an appropriate static equilibrium path obtained numerically. It is shown that the greater the simplification of the model used, the more overstated the estimated fire resistance is in relation to its real value. Such an overestimation seems to be dangerous to the user, as it gives him an illusory but formally unjustified sense of the guaranteed safety level.

Keywords: steel hall; fire resistance; structural model; static equilibrium path; safety evaluation.

1 Introduction

Fire resistance of a steel hall transverse frame is usually interpreted as the time during which such a frame would be able to safely resist the loads applied to it, including the internal forces generated thermally due to the direct or indirect fire influence. In order to obtain a reliable estimate of this resistance one should conduct a precise analysis on the 3D model of the bearing structure of considered hall or, if the available computer resources exclude this option, determine this value approximately, after detailed analysis of only a single frame formally isolated from the whole structural system. The basic goal of this article is to show that the sought resistance, even though it has been calculated based on the analysis of the same hall subjected to the same fire development scenario initially assumed, may vary significantly in value depending on the model selected to represent the considered structure. In general, the fire resistance forecast for a steel frame is determined numerically based on a bar model of all structural components, subject to the assumption that the temperature of these components is evened out not only in the respective cross-sections but also along their whole lengths. In this analysis we intend to verify how the selection of a particular static scheme affects the resultant fire resistance. In order to do that in our study a selected typical one-bay single-story steel hall frame is subjected to a simulated fire action. However, its structural response is modeled each time in a different, more or less complex, way. In each of the considered cases the final fire resistance, specified for the same frame modeled in a different way, is identified on the equilibrium path corresponding to that model. Thus it is measured by the time elapsing between fire initiation and the moment when the displacements authoritative for the performed analysis begin to rapidly increase. The calculations have been conducted using SAFIR [1] computer code.

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