Blast resistance behaviour of steel frame structures

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Summary

The effect of a blast explosion on a typical steel frame building is investigated by means of computer simulations. The simulations help to identify possible hot spots that may lead to local or global failure. The blast energy is transferred to the structure by means of the façade. In particular, attention is paid to the modelling of the façade using adequate failure criteria.

Keywords: blast, explosion, steel frame, glass façade, erosion, finite elements, glass, concrete.

1. Introduction

Explosions in buildings due to terrorist attacks have raised major concerns in many countries and governments. Blast mitigation measures have been proposed, which are being incorporated in new design standards and existing buildings are being retrofitted.

The detonation of a high explosive (e.g. TNT) produces a shock wave, which is transferred to the structure by the facade elements. The response of a building under a blast load is a typical fluid-structure problem. How the energy is transferred to the structure largely depends on the type of facade (e.g. glazing, masonry, etc) and especially on its blast resistance. Upon failure, facade fragments can be projected at high velocities, being a major threat for the people inside. As the blast penetrates in the building, it causes great damage to both structural and nonstructural elements. The amount of damage on the structure depends on how the structural elements are joined together (flexible or stiff joints). Under blast loading, inertia and material rate effects are very important.

In this paper, the response of a steel frame building under blast load is studied by means of finite element computer models. Attention is paid to the various aspects of the problem: blast load; load transfer and failure of the facade and structural elements; material behaviour and failure under highly dynamic loading, etc. The failure models are based on the experimental knowledge existing at TNO. The results of this investigation will provide more insight into the main issues and the knowledge gaps regarding steel frame structures against blast; and finally learn how to build them more efficiently.

The problem is described in section 2, followed by the finite element modelling in section 3. The blast is represented by the ConWep tool in section 4. Finally, results and conclusions are presented in sections 5 and 6 respectively.

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