Blast Wave Clearing Behavior for Positive and Negative Phases

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Abstract

This paper discusses the differences between positive and negative phase blast clearing behavior for a typical blast wave. The implications of including negative phase clearing in building blast damage analysis are also discussed.

Blast waves from explosion sources like vapor cloud explosions, pressure vessel burst or high explosives exhibit both positive and negative phases, and the relative magnitude of the positive and negative phases varies among explosion sources and the specific circumstances of each source. A fully reflected blast wave would be produced if an incident blast wave were to strike an infinite wall in a normal orientation (i.e., the blast wave front is parallel to the wall surface), for both the positive and negative phases of the blast wave. However, when an incident blast wave strikes a finite wall in a normal orientation, rarefaction waves are created at the edges of the wall, with the rarefactions sweeping down from the roof and inward from sides. The rarefaction waves result in a clearing effect, for both the positive and negative phases.

The clearing effect always relieves the applied blast load on the facing wall for the positive phase. However, this is not the case for the negative phase. As shown by the results presented in this paper, the clearing effect may either relieve or enhance the applied negative phase loads, depending on the duration from the positive phase peak to the negative phase peak and the wall dimensions.

The impact of negative phase clearing on structural response for generic building components was also investigated. Nonlinear single-degree-of-freedom (SDOF) methods were used to characterize response in terms of peak positive and negative displacements. It was found that the influence of the negative phase is significant, particularly for flexible or elastically behaving components where the peak structural response is governed by negative displacement.