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Numerical Modeling of Air Shock Wave Generated by Explosive Detonation and Dynamic Response of Structures

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Abstract : The ability to estimate blast load overpressure properly plays an important role in safety design of buildings. The issue of studying of blast loading on structural elements has been explored for many years. However, in many literature reports shock wave overpressure is estimated with simplified triangular or exponential distribution in time. This indicates some errors when comparing real and numerical reaction of elements. Nonetheless, it is possible to further improve setting similar to the real blast load overpressure function versus time. The paper presents a method of numerical analysis of the phenomenon of the air shock wave propagation. It uses Finite Volume Method and takes into account energy losses due to a heat transfer with respect to an adiabatic process rule. A system of three equations (conservation of mass, momentum and energy) describes the flow of a volume of gaseous medium in the area remote from building compartments, which can inhibit the movement of gas. For validation three cases of a shock wave flow were analyzed: a free field explosion, an explosion inside a steel insusceptible tube (the 1D case) and an explosion inside insusceptible cube (the 3D case). The results of numerical analysis were compared with the literature reports. Values of impulse, pressure, and its duration were studied. Finally, an overall good convergence of numerical results with experiments was achieved. Also the most important parameters were well reflected. Additionally analyses of dynamic response of one of considered structural element were made.

Keywords : adiabatic process, air shock wave, explosive, finite volume method
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