

Abstract

Mitigation-measures, for explosion induced shock wave loading on structures, has become an active field of research because of increase in terrorist activities throughout the world. However due to the limited understanding of the explosion induced shock wave propagation and its concomitant influence on the structures, the current protective measures are often vulnerable under attack. The present thesis attempts to extend the current understanding of phenomena related to explosion induced shock wave loading of structures.

In the present theoretical work, based on continuum mechanics, a number of extensions are proposed to address the lacuna in literature and design guidelines. The analytical formulation is based on Rankine-Hugoniot jump conditions, whereas numerical modelling is done using finite difference method. In the numerical models VonNeumann-Richtmyer artificial-viscosity is used for shock capturing. Numerical models are validated with the cases for which analytical solutions are available.

The present thesis comprises of a number of distinct works that are of interest to non-contact explosion induced shock wave loading of structures: 1) The discrepancy in existing guidelines for air-explosion induced shocks which restricts the maximum value of reflection coefficient (ratio of incident to reflected over-pressure) to 8 is successfully removed by consideration of real-gas models. 2) It is identified that non-linear compressibility of the water medium plays a significant role in non-contact high intensity underwater explosion induced shock waves and simulations based on that philosophy reveals that the impulse transmitted to a rigid free-standing structure for lightweight plates are reduced whereas increased for heavy plates. 3) The importance of considering the effect of shock wave formation at the backside of a rigid free-standing plate due to its movement (upon shock wave impingement at the front side) is also highlighted in this thesis through impulse transmission. 4) Domains of regular and Mach-stem reflection are identified in this thesis for a two dimensional underwater oblique shock wave reflection. 5) The effect of considering sandwich composites in dissipating the energy of a shock wave through core compression is also investigated in this thesis.