BLAST RESPONSE OF FIBRE REINFORCED COMPOSITES: EXPERIMENTS AND NUMERICAL SIMULATION

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ABSTRACT

The increasing threats and advances in weapon systems demands for strong and light weight materials for the design of protective structures for military vehicles. Fibre reinforced composites, with their advantages such as high strength to weight ratio, energy absorbing characteristics and over all reduced maintenance costs, have become a primary choice for protective applications. However, to use these materials efficiently, a detailed understanding of their behaviour under dynamic loading conditions is essential. Despite, the availability of vast literature on the response of these materials at low and high velocity impact, there are very limited studies available in open literature on the dynamic behaviour of fibre reinforced composite materials against explosive blast loading.

In the present study, the response of composite plates subjected to explosive blast loading has been investigated through field experiments and corresponding numerical simulations. Field blast experiments consists of both air blast and surface blast conditions. Plastic explosive of 0.5 – 1kg TNT equivalent and 2Kg-5Kg TNT equivalent in spherical shape was used in air blast and surface blast explosive tests respectively. In the experiments, the stand-off distance(SoD) from the centre of the explosive to the composite plate was varied from 0.45 m to 1m. In air blast experiments, the response and damage on composite plates was assessed by pressure, strain field measurements and post blast specimen analysis. The damage patterns of the composite plates subjected to surface blast conditions were monitored by high speed video and post-blast test visual observations. The effect of the thickness of composite plates at each explosive loading was also studied. The reflected pressures on the composites subjected to air blast conditions are found to be approximately 4 times higher than the incident pressures. The damage in air blast conditions up to 1kg of explosive conditions is observed to be a mere transient deformation and surface discoloration. However, in surface blast conditions the main damage mechanisms at lower explosive loading are observed to be bulging, fibre breakage, formation of radial cracks, delamination. Damage mechanisms notably shifted from fibre breakage and delamination at lower blast loads to fracture at higher explosive loads in surface blast experiments. Numerical simulations of Air blast experiments at 1m SoD were carried out using Ansys/ Autodyn and the results are compared with the experimental results in this paper. The results of the study may be helpful for using composite materials for mine proof and other military vehicles.