THE FAILURE OF ARMOUR STEEL BY CONTACT EXPLOSIVES. EXPERIMENTAL TESTING AND NUMERICAL MODELLING.

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Abstract:

The failure of protective structures by the detonation of high explosives in contact with the target can be caused by a variety of weapons including magnetic mines, high explosive squash head munitions, breaching charges and contact IED's. The extreme strain rates and steep gradients in the spatial distribution of loading caused by contact charges can cause armour steel to fail in a number of damage modes including adiabatic shear plugging and spallation which are not seen under general air-blast loading.

This paper presents a series of blast experiments on high hardness armour (HHA) steel to isolate the explosive mass required to fracture the material while in contact with the plate and at a moderate stand-off. These experiments are also used to characterise the target response in terms of deformation behaviour and fracture modes. Numerical modelling of the experiments is performed using a coupled Lagrange-Eularian approach with a state-of-the-art plasticity, fracture and spall model, providing reasonable predictions of target response at both test conditions. The numerical models are used to further characterise the failure modes at each loading condition, highlighting a transition from tensile tearing failure (with some shear component) for the stand-off conditions to incipit spall and shear fracture for the contact charge. With validation of the proposed numerical modelling approach presented in this paper, computational evaluation of armour designs is possible across a wide range of blast loading conditions.