Abstract of Ph.D. Thesis

The Behaviour of Granular Materials Under Shock and Blast Loading

- A SHOCK TUBE INVESTIGATION

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Granular and porous materials based protective layers have proven to be very good shock absorbing medium. Although sand material is widely used (as sand bags) till date in civil and military applications as a blast mitigating medium, fundamental mechanism involved during the impact of shock/blast wave on sand layers is not well understood. This study presents experimental investigations on the impulsive response of sand to extreme loading conditions. A shock tube facility is used to generate a planar shock wave and further the facility is optimized to simulate the properties of a blast wave. This study is divided into three parts based on the type of loading imparted to the sand samples: Shock loading; Air-blast loading; Buried-blast loading. Part one discusses the performance of the sand barrier systems in attenuating the shock waves. The attenuation characteristics of various granular particles (coarse sand, fine sand, glass bead) are investigated by analyzing the reduction in peak overpressure while transmitting through the granular medium. The attenuating capability of the sand barriers has appreciably improved when the outer surfaces of the barriers are retrofitted with a geotextile layer. In the second part, a laboratory-scale experimental approach is presented for evaluating the effects of air-blast on the sand layers. Efforts have been made to study the stress wave propagation in loose and dense sand medium and its direct consequences on the vibrational response. Visualization of the sand deformation is possible with the help of a high-speed camera; displacement trajectories and strains contours are obtained through digital image correlation (DIC) analyses. Part two also reviews the applications of scaled air-blast study on buried pipelines. By using dimensional analysis procedure shock tube experimental results are scaled up to predict the real scale damage

imparted to the buried pipes during an air-blast explosion. In addition, a three-dimensional finite element analysis of the test condition is simulated using ABAQUS/Explicit to authenticate the fidelity of the scaling laws. The third part discusses phenomenal aspects associated with the sand deposits when exposed to a buried blast explosion. The focus of this study is to understand the various events involved during the interaction of leading blast wave with the sand medium and characterizing the outburst sand-ejecta. The impulse and peak pressure imparted to the rigid target are evaluated using vertical pendulum and fast response pressure transducers. A parametric study involving different target stand-off distances (SoD) with varied burial depth (DoB) of the blast is presented. Sand ejecta does have a greater influence on the impulse at higher SoDs (>40 mm) and the maximum momentum transfer is observed when SoD to DoB ratio is 2.5.