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EXPERIMENTAL STUDY OF VEHICLES SUBMITTED TO THE BLAST WAVE OF A MINE: PRESSURES AND IMPULSES MEASUREMENTS

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The risk of accidental explosions must be taken into account when designing structures of a "sensitive" nature in certain industrial or military environment. When a vehicle is hit by the shock wave of a mine, what might happen? Two values can give an answer ; the pressure field and the impulse. The original part of this paper deals with the experimental determination of this last parameter. We note that the vehicle is considered as a rigid body ; neither strains nor stresses are considered.

A mine is characterised by its explosive mass and its specific energy; an equivalent charge of TNT can be deduced. This quantity can be transposed at any scale: a well established similitude law (Hopkinson) enables the results from scaled models to be transported onto full scale structures (Baker et al., 1983). Using this law, a scaled model, respecting geometrical and energetic parameters, can be used to reproduce what truly happens. Pressures are identical, and times are only depending on the scale. The specific loading is induced by a shock wave generated by a detonation. In the laboratory, this specific explosion is carried out using the detonation of a gaseous mixture, confined in soap bubbles (using an appropriate TNT equivalence). This set-up has been validated by numerous works [Renard et al., 2000]. This loading pattern, described notably by Brossard et al, 1993, is deterministic, of very high intensity with an abrupt peak of high pressure, followed by a period of low pressure, decreasing with respect to space and time. The gaseous explosive is a stoichiometric mixture of propane and oxygen. The frame of the vehicle is submitted to a spatio-temporal blast wave. On a plane surface, numerical simulations can predict the exact field of pressure. With 3D structures, the numerical approach usually gives uncertain results, as multiple reflections on elements such as wheels or caterpillar tracks are numerous. Only experiments can predict a confident behaviour of a such structure.

The experimental set-up (fig. 1) consists of a scaled model (1/20°), on which different loading can be applied (e.g. different gaseous volumes). Miniature pressure transducers are used.

Usually, the impulse on a structure is determined by integrating the pressure on both time and space. Concerning this study, the frame of the vehicle cannot be considered as a simple plate. Multiple reflections prevent us to determine the impulse by this method. So, a suitable set-up has been used. The pendulum system (fig. 2) is the simplest way to obtain the impulse, product of the mass by the speed (using contactless sensors). It gives the result, independently of the geometry of the structure (fig. 2). Different shapes of vehicles have been tested, allowing to choose the better ones for the design (e.g. the ones for which the impulse is the lowest, for identical gaseous charges).

In this work, we have assumed that, during the loading, the coupling between the structure and the shock wave was negligible. As the loading is of very short duration, the vehicle does not move during this time. The pendulum's wires are long enough to induce important oscillation periods; displacements of the structure can be properly determined. The study was achieved in the frame of free vibrations of a rigid body (1 DOF system). The initial movement is obtained by an initial speed, given by the detonation.

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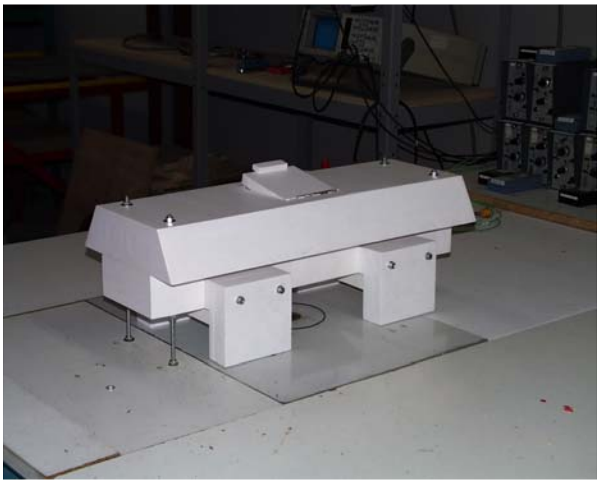

fig. 1: Scaled model of the vehicle

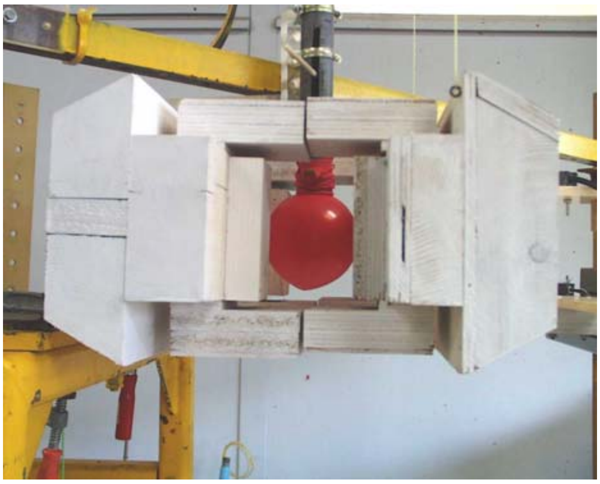

fig. 2: Pendulum system, used to determine impulses

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