MEASUREMENTS OF REFLECTED OVERPRESSURE IN THE EXTREME NEAR FIELD

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Abstract: Blast protection design requires a detailed knowledge of the loading imparted on a structure by a particular blast threat. This includes an understanding of the mechanisms involved in the rapid energy release that leads to fireball expansion and air shock development. In the far field ($Z > 2$ m/kg$^{1/3}$) reliable semi-empirical methods exist for both the positive and negative phases of the blast wave. In the far field the explosion is sufficiently far away that only the propagating air shock interacts with the structure, while in the near field the fireball is still driving the air shock and can itself interact with the structure. There is currently a lack of reliable experimental data in this near field region, as the incredibly high pressures and temperatures pose particular experimental challenges. This is particularly the case in the extreme near field ($Z < 0.5$ m/kg$^{1/3}$), where semi-empirical and physics-based predictions can vary by an order of magnitude.

This paper presents the design of an experimental facility capable of recording spatially resolved reflected pressures in the extreme near field. The Mechanisms and Characterisation of Explosions (MaCE) facility is an evolution of the Characterisation of Blast Loading (CoBL) facility used for buried blasts, but with key near field-specific adaptations. An array of Hopkinson pressure bars embedded in a stiff target plate is used to make pressure measurements over a 100 mm radius instrumented area. Maraging steel pressure bars and specially designed strain gauges are used to increase the measurement capacity from 600 MPa to 1800 MPa, and 33 pressure bars in a radial grid are used to improve the spatial resolution from 25 mm to 12.5 mm. In addition, the pressure bar diameter is reduced from 10 mm to 4 mm, which greatly reduces stress wave dispersion, increasing the effective bandwidth. This enables the observation of high-frequency features in the pressure measurements, which is vital for validating the near-field transient effects predicted by numerical modelling and developing effective blast mitigation methods.