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DOPPLER BLAST LOADING DIAGNOSTIC

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ABSTRACT

Currently, one area that has proven difficult for the blast loading community is the collection of high-quality data in the extreme pressure near-field regime, because traditional diagnostics do not survive in this environment and do not have sufficient bandwidth to resolve the extremely short temporal aspects of the loading. For extremely near-field blast loading regimes, pressure increases from hundreds of megapascals to several gigapascals. Traditional methods of measuring reflected pressure, such as pressure gauges and Hopkinson pressure bars, are limited by the elastic limit of steel in terms of max pressure and by their own mechanical ability to respond, which limits bandwidth. Features of the loading that need to be measured to properly validate modelling approaches are hundreds of nanoseconds in duration and well beyond the yield strength of even the strongest steels. The bandwidth limitations of the current methods are several orders of magnitude too slow for 100 nanosecond events.

Photon doppler velocimetry (PDV) is a capability that is currently underutilized by the blast engineering and loading characterization community. This research will demonstrate how PDV can be used with a PMMA target to measure higher reflected blast pressures with higher temporal resolution than other current reflected blast measurement techniques. Using PDV to measure extremely short duration air-blast pressures generated by near contact explosive charges is a new application for PDV. The US Department of Energy and Department of Defence regularly use PDV to measure how an explosive is driving another material. However, in most of these applications the explosives are in intimate contact with the other material and air gaps are normally avoided intentionally; whereas in the case of extremely near field blast loading some air gap is often present even if it is small. Conventional blast loading experimental work has mostly taken place at scaled distances that produce peak pressures of several hundred megapascals or lower; while nuclear weapon, shaped charge, and fragment drive experiments are generating tens of gigapascals of pressure on the materials being driven by the explosives. The space between a scaled distance of $0.1 m/kg^{(1/3)}$ and contact charges is where windowed PDV can be used to provide high fidelity reflected pressure data to improve the understanding of the physical mechanisms at play as well as provide model validation data that isn't currently available from tools such as pressure gauges or Hopkinson pressure bars.