

OPTICAL STRAIN MEASUREMENT OF MARITIME STEEL PLATES SUBJECTED TO NEAR-FIELD AIR BLAST

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Abstract: Understanding the response of maritime structures to blast loading is critical to developing designs with improved survivability for naval platforms. To assess the performance of ship steel on a model scale, the explosion bulge test (EBT) was developed by Pellini [1] in the early 1950s. This enabled the comparative study of weld, heat affected zone, and base plate under a biaxial loading which is applied using uniform pressure from the explosive. Thus, deformation and fracture characteristics of full-size welds and full-thickness plates was made possible under controlled stress and strain conditions [1]. The strain studies (permanent deformation) for EBT were conventionally performed with the help of photogrids applied on the back surface of plates [1]. This was later accompanied with laser displacement transducers to measure the transient displacement on targets (usually centre point). Attempts have also been made to use resistive strain gauges to measure the in-plane deformation during the loading. However, these instrumentation techniques are limited to few locations on the target plate and/or the initial duration of loading well before the onset of fracture.

The advent of optical techniques including digital image correlation (DIC), has facilitated full-field 3D strain measurement of plates for the entire duration of blast [2]. DSTG has previously conducted a number of investigations on the blast response of a wide range of metallic and composite targets using DIC (e.g., [3]). In this study, a series of blast experiments were conducted at several standoff distances to study the comparative performance of welded steel plates. Experiments were conducted using a vertical explosion bulge die and the open-source DIC package Multi-DIC [4]. In addition, conventional strain gauges were used to capture strain at multiple locations for comparison with DIC and finite element models. The paper discusses the challenges and results obtained using both methods.

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