DEFORMATION AND FAILURE OF STEEL COMPARTMENTS SUBJECTED TO INTERNAL BLAST

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Beyond the requirements of warship structural design for normal operations and sea loads, special consideration is required to maximize survivability against explosive warhead effects which may be inflicted in combat. Such an analysis requires detailed knowledge of the unique and complex loading, deformation and failure mechanisms associated with blast effects. Blast hardening of ship compartments calls for special insight, and is challenged by practical limitations to work with certain materials, fabrication methods, and to minimize ship top-weight.

Over the period 1993 - 1996, the Naval Platform Survivability Section of the Australian Defence Science and Technology Organization conducted a series of test to study the effects of internal blast loading on welded steel compartments. The interest concerns the detailed dynamic response and failure mechanisms for this type of construction particularly at the edge attachments. The objective of the program is to improve the survivability of current and future RAN warship to threats such as anti-ship missiles. The overall test program comprised three stages: generic sub-scale 1 M3 steel boxes, full-scale mock-ups of ship compartments, and finally full-scale tests on a decommissioned warship, Detroyer Escort HMAS Derwent.

A common failure mode observed in all trials was the rupture of bulkheads at their deck and deckhead boundaries at an early time in the blast loading unassociated with any late-time Quasi-static' process. lt was evident that an understanding of both the early compound shock reflection phase of the blast event, and the shock-induced dynamic structural response, is critical to any re-design of these structures for damage mitigation.

Based on these observations an experimental test apparatus has been designed to facilitate the study of the relative performance of alternate bulkhead attachment designs as well as construction techniques and procedures. This paper describes both the preliminary experimental outcomes and predicted deformation results obtained using the LS-DYNA3D finite element analysis code.