Shock Response Analysis of Blast Hardened Bulkhead in Naval Ship under Internal Blast

Sang-Gab LEE
Division of Naval Architecture & Ocean Systems Engineering, Korea Maritime & Ocean University
Busan, Korea

Yong Yook KIM and Gul Gi CHOI
Division of Ocean Systems Engineering, Korea Advanced Institute of Science and Technology
Daejon, Korea

ABSTRACT

It is necessary to restrict the damage area for the enhancement of ship survivability under the internal blast of a Semi-Armor Piecing (SAP) warhead inside a ship’s compartment, and to develop design guidance and performance verification technique of Blast Hardened Bulkhead (BHB) for the protection of its damage diffusion to adjoining compartment and continuous flooding. The objective of this study is to develop shock response analysis technique of BHB under the internal blast using MMALE (Multi-Material Arbitrary Lagrangian Eulerian) formulation and FSI (Fluid-Structure Interaction) analysis technique of LS-DYNA code through the verifications of internal blast tests of reduced scale chamber model.

KEY WORDS: Survivability; Internal Blast; Blast Hardened Bulkhead (BHB); MMALE (Multi-Material Arbitrary Lagrangian Eulerian); Fluid-Structure Interaction (FSI) Analysis Technique; LS-DYNA code.

INTRODUCTION

It is necessary to restrict the damage area for the enhancement of ship survivability under the internal blast of Semi-Armor Piecing (SAP) warhead inside the compartment of naval ship, as shown in Fig. 1, and to develop design guidance and performance verification technique of Blast Hardened Bulkhead (BHB) for the protection of its damage diffusion to adjoining compartments and continuous flooding. BHB was already developed and has been applied to the naval ship in some countries (Galle & Erkel, 2002; Stark & Sajdak, 2012), and has been partially adopted to some navy ships with the foreign techniques.

Diverse scale internal blast tests of BHB were carried out and its design and analysis techniques were also verified for its application abroad. TNO carried out full scale internal blast test of BHB through the internal blast test using retired naval ship (Galle & Erkel, 2002), as shown in Fig. 2, and DSTO, also, internal blast test of part transverse bulkhead model of real one, as shown in Fig. 3(a), and investigated its shock response and factors related to the design constraints (Raymond, 2001). Diverse scale internal blast tests were performed using real scale compartment of naval ship, etc., as shown in Fig. 3(b), in the USA.

Fig. 1 Internal explosion damage of USS Stark (FFG-31) by Exocet Missiles during Iran–Iraq War (Raymond, 2001)

Fig. 2 Internal blast test of retired ship and BHD model by TNO (Galle & Erkel, 2002).

(a) part model by DSTO (Raymond, 2001) (b) real scale in USA

Fig. 3 Internal blast test of part and full scale bulkhead model