SIMULATION OF COUPLED BLAST AND FRAGMENT INTERNAL DETONATION EFFECT ON THIN WALL STRUCTURES

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Abstract: During the detonation of a fragmentation warhead inside a lightweight structure, the blast, fragments, as well as the structural deformation will have coupled effect. This makes evaluation of structural response a significant challenge. It is especially difficult for thin wall structures that deform and break easily. The large deformation and failure will pose problems in determining the blast strength and the effect of secondary damage due to the failed structural parts.

For structures with thick walls, simplifications can often be made by assuming rigid walls for the fluid solvers for the blast evaluation, and assuming uncoupled fragment effect for individual fragment. On contrary for a flexible thin wall structure, the deformation of the wall and the secondary fragmentation of the structure will have significant effect on the general structural response. The difficulty is in the fully coupled fluid and structure numerical solution for the blast evaluation when the structure is undergoing a fracturing process. In addition, the amount of contacting between the fragments from both the warhead, the failed structure, and the structure itself will lead to great numerical difficulty.

Within this work, attempts have been made to identity various potential numerical algorithms to deal with the problem for application of the numerical method for a full-scale structure, as shown in Fig.1. To verify the numerical solutions, simplified and scaled down tests are performed. This work is based on previous study about the airblast simulations [1] as well as a new study for the basic material characteristics for the structure elements [2]. The numerical FSI (fluid structure interaction) solution is verified with various scaled down experiments [3].

This work demonstrates that the development in the numerical simulation technique has progressed to the stage that significant amount of information about the structure response can be obtained for thin flexible structures subjected to a warhead effect. Nevertheless, significant effort is needed for the validation and verification of both the numerical model and the simulation technique, especially when a fully coupled multi-physics simulation is performed. To ensure the simulation with reasonable results, the material model, the element formulation, as well as the numerical algorithms have to be verified and validated with various controlled experiments. This study shows that the numerical simulation, given its various advantages, will depend on various controlling parameters with those values significantly affecting the outcome of the simulation.

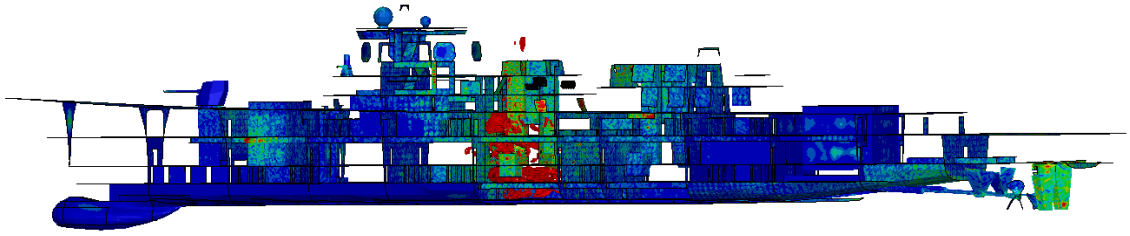

Figure 1: Simulation of the warhead effect inside of a warship

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