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Experimental study on the combined damage of multi-layered composite structures subjected to close-range explosion of simulated warheads

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## Highlights

- Ship protective bulkheads were designed to have multi-layered composite structures. These were subjected to close-range hemispherical-nosed warhead explosion, and their performance was experimentally investigated.
- The effects of the explosion posture of the hemispherical-nosed warhead on the structures were studied.
- The characteristics of fragments and shock waves under the hemispherical-nosed warhead explosion were presented, along with the failure mode of each layer in the multi-layered composite structures.
- The damage process and energy dissipation of the multi-layered composite structures were analyzed, and the protective capability of the multi-layered composite structures was compared with that of the steel bulkhead.

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