NUMERICAL MODEL VALIDATION OF A FLOATING CHARGE EXPLOSION (FLOATEX) CLOSE TO A SHIP PANEL

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ABSTRACT

Naval ships may be vulnerable to small-boat attacks loaded with High-Explosive (HE) onboard which once detonated the air blast and water shock breach through the hull. Such an event was seen in at least two maritime incidents: the USS 'Cole' (October 2000) and the French oil tanker 'Limburg' (October 2002). Structural modifications to the hull may help reduce the amount of damage from such threats. For that purpose it is important to predict the correct loading on the structure from this type of event referred to as Floatex (a floating charge explosion). The loading from a Floatex event consists of an air blast, an under-water shock, the closure of the hull cavitation region and possible afterburning above the water line (and possibly in the breached ship compartment). Furthermore, not only the Fluid-Structure Interaction (FSI) is essential in the simulation approach, the structural response can also get challenging with large deformation and shear type failure of the platting and stiffeners. Furthermore, subsequent to structural failure, the model should be capable to predict the inflow of water, air and detonation products through the breached hull. Due to the overall level of complexity to predict the loading and response of Floatex events, it is important to properly validate the simulation approach. In this study dedicated experiments on Floatex near a ship panel are presented and used as validation results. Coupled numerical simulations between Apollo (loading) and LS-DYNA (response) are performed to predict the amount of deformation and possible failure of the panel. Parametric and sensitivity variations on numerical parameters are provided to optimize the numerical setup (such as the required mesh size to capture the relevant physics). For the structural model, dedicated material tests are conducted to calibrate the panel material model adequately (for both plasticity and failure). Ultimately this study provides the required elements to the numerical setup to correctly predict the load and response of a panel subjected to a Floatex event.