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NUMERICAL MODELING OF A HIGH-SPEED WEDGE ENTRY IN AERATED WATER

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A wedge entry is a common simplification of water impact events like a free-falling lifeboat, green water on deck, or wave slamming onto a hull. Simplifications often result in a better understanding of the physics involved, such as the interaction between fluid an structure, and between fluids themselves [1]. Impact events and breaking waves from the past can lead to entrained air in water, lasting for several wave periods. The mixture of air and water, assuming homogeneity, modifies the compressibility up to several orders of magnitude. General methods used in the design stage for calculating the occuring forces on maritime structures often do not account for the air content, misinterpreting the acoustic properties of the mixture.

A fully compressible two-phase solver that accounts for the interaction of aerated water, separated air above the free surface, and structure has been developed. The solver is based on the Navier-Stokes equations with a Volume-of-Fluid approach for the free surface. A cut-cell method to account for the structure is used. The mass content of the air in water is assumed constant and the total mixture is assumed to be homogeneous. These two are valid assumptions for structures significantly larger than the bubble size, experiencing high-speed impacts of short duration.

Numerical simulations of a high-speed 2D wedge entry are conducted. The results show a non-linear cushioning effect on the force immediately upon impact, becoming larger when increasing the air content. Oscillations in force of a similar magnitude as the initial impact are caused by pressure waves reflected by the domain boundaries. The oscillation frequency depends on the air content and the distance between wedge and boundaries. The numerical results coincide with experimental results [2] and show that aeration needs to be considered in the design process of maritime structures enduring extreme water impact events.

REFERENCES

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