Investigation of granules to increase the crashworthiness of double hull vessels: Modelling and experimental testing

Christian Woitzik*, Mohsin Ali Chaudry°, Peter Wriggers° and Alexander Düster*

* Numerical Structural Analysis with Application in Ship Technology (M-10)
Hamburg University of Technology
21073 Hamburg, Germany
e-mail: christian.woitzik@tuhh.de, web page: https://www.tuhh.de/skf

° Institute of Continuum Mechanics
Leibniz University Hannover
30167 Hannover, Germany
e-mail: chaudry@ikm.uni-hannover.de, web page: https://www.ikm.uni-hannover.de

ABSTRACT

Using double-hull structures for ships is an established approach to increase the collision safety in the maritime transport sector. To gain further improvements, either changes in the design of the double-hull structure can be carried out or – to use existing structures – the filling of the void space between the hulls with energy absorbing and strength increasing material can be considered. The latter method was suggested in [1] for the case of a collision with a bulbous bow.

This contribution deals with the experimental testing of double-hull structures using granules as filling material and its numerical simulation. To do so, a simplified side-hull structure was developed as a test set-up. There, two steel sheets were used as outer and inner side hull. In between a steel box was welded to contain the granules. To model the bulbous bow, a hemisphere is used and driven into the set-up. For reference data, the structure without granules was tested. To increase the energy dissipation using granules, several materials were discussed [2]. Here, multicellular, expanded glass balls with a diameter of around three millimetre are used, for details see [3]. Filled with these granules the experiment was repeated and the force-displacement as well as strain values were monitored.

Using this experimental data, the ability of the granules is determined and the results will be compared with a finite element model, modelling the granules as homogeneous material. Furthermore, the influence of stiffeners will be investigated and the corresponding advantages and disadvantages will be discussed.

REFERENCES

[1] M. Schöttelndreyer, I. Tautz, W. Fricke, E. Lehmann. Side Structure filled with multicellular glass hollow spheres in a quasi-static collision test. Collision and Grounding of Ships and Offshore Structures (Ed: J. Amdahl, S. Ehlers, B. Leira), 101-108. Taylor & Francis Group, London, 2013.

[2] C. Woitzik, A. Düster. Modelling the material parameter distribution of expanded granules. J. of Gran. Matter, 19:52, 1-12, 2017. doi: 10.1007/s40571-017-0169-0.

[3] M. A. Chaudry, C. Woitzik, A. Düster. P. Wriggers. Experimental and numerical characterization of expanded glass granules. J. of Comp. Part. Mech, 5: 297, 2018. doi: 10.1007/s40571-017-0169-0.