XI International Conference on Computational Methods in Marine Engineering

Experimental Testing of Glass Fibre/Epoxy Resin Composite Bow Foil Demonstrators for Ships

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ABSTRACT

Bow foils can reduce a ship's CO_2 emissions as they can reduce ship heave/pitch motions and improve the propulsive efficiency, Bowker and Townsend (2022). As energy-saving devices of a ship, bow foils are commonly made using metallic materials, which have low resistance towards salinity. Hence, there is a rising trend to use polymer composites instead of metallic materials in submarine device manufacturing, Natarajan et al. (2023). This paper focuses on the structural testing of two bow foil demonstrators which were manufactured using glass fibre-reinforced polymer composites. The two demonstrators, sharing the same geometry, represent the core component of a bow foil, which mainly resists bending force. The 1.0 m long demonstrators consist of two caps and one web, forming an I-shaped cross-section.

Figure 1: Four-point bending testing of the demonstrator.

One demonstrator was assembled using both adhesive and co-cured joints, while the other one contained two co-cured joints. Four-point bending tests (Figure 1) were performed as the bow foil was expected to suffer high bending. Strain gauges and displacement sensors were employed to monitor the demonstrators' structural performance during testing. Test results revealed that both demonstrators shared a similar failure mechanism, namely local shear failure around the loading region. The co-cured demonstrator failed under a load of 123 kN, which is almost the same as that of the glued demonstrator. In terms of weight, the co-cured demonstrator is approximately 4% lighter than the other one. However, the co-cured demonstrator had approximately 9% more mid-span deflection under the same load. Both demonstrators showed failure loads greater than the scaled foil load, proving that it is promising to use glass fibre/epoxy resin composites to manufacture bow foils. The development of bow foils will result in a reduction in ship fuel consumption of up to 20%, reducing carbon emissions for achieving climate neutrality by 2050.

References

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