AN EXPERIMENTAL ANALYSIS OF THE EFFECT OF MOONPOOL RECESS GEOMETRY ON ADDED RESISTANCE

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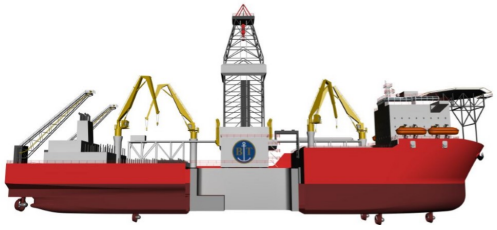
ABSTRACT

Moonpools are openings in ship structures that provide access to the water from inside the ship. When a ship has forward velocity, water motions inside the moonpool can substantially increase the ship's resistance. Samsung Heavy Industries (SHI) received a patent in 2012 describing four geometries for moonpool recesses designed to reduce the added resistance in a 96,000 DWT deep-water drillship. In 2019, Harris used numerical simulations on a Series 60 hull to evaluate the resistance reduction of each SHI moonpool geometry over a range of speeds. Using Harris's test matrix, this thesis investigates the effects of moonpool recess geometry on added resistance. Model tests are performed and resistance trends are derived. The experiments are compared to Harris's numerical results and furnish insight into relationships between numerical and experimental evaluations of moonpool resistance.



Drillship, Cutaway to Show Moonpool with Recess
Source: Hammargren and Törnblom, 2012

BACKGROUND

In 2012, SHI received a patent describing four geometries for aft moonpool recesses for a 96,000 DWT deep-water drillship design. The geometries are designed to reduce the added resistance from the moonpool, but the patent does not provide explicit information on the magnitude of the reductions.

In 2019, Will Harris analyzed the calm-water added resistance of the SHI moonpool recesses using the CFD software Star CCM+. He fitted the moonpool and recesses to a Series 60 hull, which is a publicly available and widely-studied hull form, and found distinct trends for the added resistance of each.

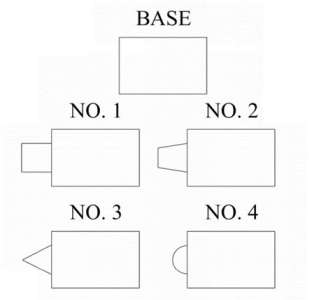
This thesis aims to validate Harris's findings with model testing in Robinson Model Basin (RMB), which is anticipated to represent flow characteristics and added resistance of a moonpool more accurately than CFD software. The results of these tests are also used to evaluate relationships between numerical and experimental analyses of moonpools.

PROCEDURE

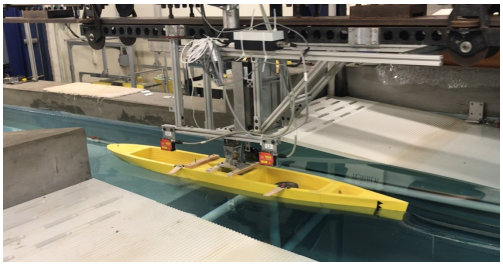
The model is a scaled-down version of the CAD model analyzed by Harris. The model is made from 20-pound-per-cubic-foot precision board intended for precision milling. Toolpaths were generated using Fusion 360 and Partworks2.5V, and the material was cut with a ShopBot PRSalpha 96-48-8 milling machine. The hull pieces were glued together, then coated in epoxy, sanded smooth, and painted.

Removable inserts model each recess geometry at the aft end of the moonpool.

The model was towed in Robinson Model Basin (RMB) with each insert at a range of speeds to determine resistance. Resistance data was collected with a force block, and trim and sinkage were recorded with two laser extensometers. Weights were placed in the model to achieve zero trim and to displace the model to the test draft. Video of the inside of the moonpool was also recorded and analyzed.



SHI Moonpool Recess Geometries, Top View
Source: Harris, 2019



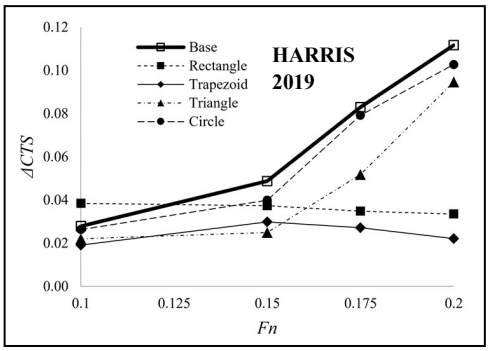
Model in RMB

RESULTS

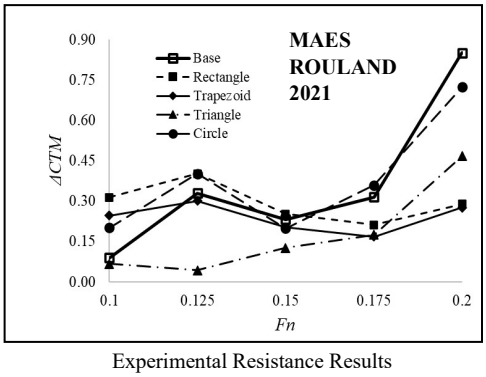
The model test results show the difference in model resistance, ΔCTM , varies substantially for each moonpool configuration over the range of speeds tested. The performance of the circular recess deviated least from that of the base moonpool. The rectangular and trapezoidal recesses performed similarly across the range of speeds and offered a notable reduction in resistance at higher speeds. However, the trapezoidal recess had a lower ΔCTM at each speed than the rectangular recess. The triangular recess significantly outperformed the other configurations at the three lowest speeds.

The addition of a moonpool adds significant resistance to a Series 60 hull. A recess at the aft end of the moonpool was demonstrated to reduce the added resistance at certain speeds. The shape of the recess substantially influences the magnitude of the resistance reduction. Longer, wider recesses were found to be most effective at reducing water motions and resistance at the higher Froude numbers tested, which correspond most closely to the operating speed of a typical drillship.

CFD predictions of added resistance for multiple moonpool recess geometries were compared with the experimental data and observations. The overall trends obtained loosely resemble the numerical predictions, but the experimental data show notable differences from the CFD. The experimental results indicate numerical methods might provide useful estimates of resistance trends but are not reliable for accurately determining the added resistance of a moonpool.



Harris CFD Resistance Results
Source: Harris, 2019



Experimental Resistance Results