

Measurements of Boat Motion in Waves at Durban Harbour for Qualitative Validation of Motion Model

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Abstract: The Response Amplitude Operator (RAO) theory was used to develop a mathematical model of boat angular motion. Measurements were made on a harbour patrol boat on sea runs off Durban Harbour. Measurements were first calibrated for axis alignment and then analysed using power spectral density techniques. An estimated roll radius of gyration of 0.4 times the breadth of the vessel was used in the model. Comparison of the measurements to the model shows some correspondence in the frequencies present in the spectra. Discrepancies arise, however, in the spectral power values. The model could be improved by parameter optimization.

1. Introduction and Theory

The Response Amplitude Operator theory is a linear theory of ship motion [1]. The RAO theory fits into a linear systems theory description through the result [2]

$$S_m(\omega) = |H(\omega)|^2 \cdot S_\xi(\omega) \quad (1)$$

where $S_\xi(\omega)$ is the wave input spectrum, $H(\omega)$ is the transfer function (RAO) of the hull of the boat and $S_m(\omega)$ is the power spectral density of the motion. The panel method program, Wavescat, was used to evaluate the RAO for the boat under study. The RAO theory consists in evaluating the hydrodynamic velocity potential over the surface of the hull and can be found in [3].

2. Measurements and Analysis

Steady state roll measurements were made on a harbour patrol boat in Durban sea conditions using a 3-axis gyroscopic instrument. The measurements were, in the first instance, calibrated for axis alignment. Due to the effects of gyroscopic drift, the data had to be high-pass filtered. The calibrated measurements were then analysed using power spectral density techniques. Spectral data from a wavebuoy in the vicinity of the sea runs was transformed into the frame of reference of the boat and used to determine a predicted model response from (1).

3. Results

Figure 1 compares the calculated model and measured roll spectra for gyration radius 0.4 times the breadth of the boat. A level of agreement can be seen in the frequencies present in the spectra and the locations of some peaks. Discrepancies are present, however, in the magnitudes of spectral energy. Improvements could be made through adjusting the parameters of the model. Numerical optimization, using the data, could be employed.

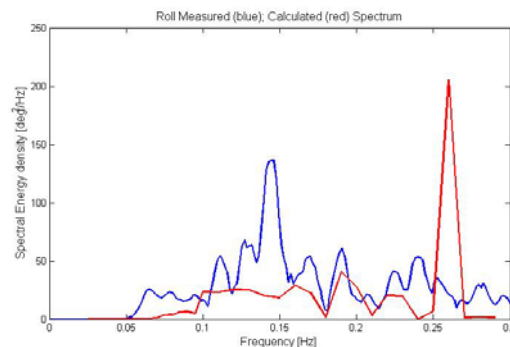


Figure 1: Measured and calculated spectra

4. References

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