

Figure 1: Definition of the Problem
(a) Experimental Setup

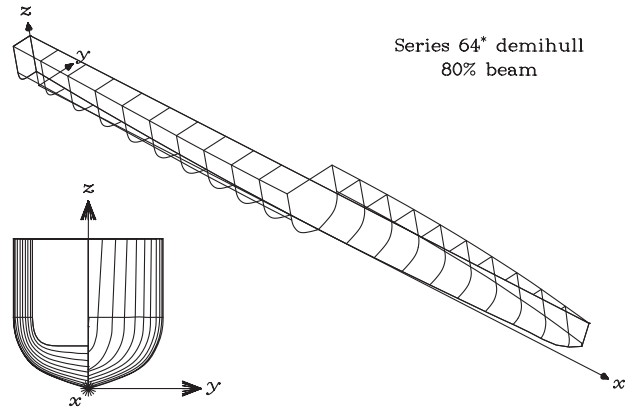


Figure 1: Definition of the Problem
(b) Demihull with 80% Beam

on the assumption that the considered vessels are all geosims (a ne transformations) of each other. With this in mind, it was thought that it would be an instructive exercise to directly test this hypothesis by measuring the wave pattern generated by three similar models, which differed only in their beams.

3 Experiments in Towing Tank

The two parts of Figure 1 provide a schematic of the towing tank setup as well as a pictorial view of the thinnest model, referred to as the 80%-beam model. This model possesses a transom stern and it is a suitable candidate for a high-speed vessel. The model was tested at three offsets from the side wall of the towing tank. Thus, the experiment simulated tests on a catamaran in a tank of twice the actual width. The geometric data pertaining to this vessel is presented in Table 1.

In addition, a 100%-beam version and a 120%-beam version of the vessel were tested. The test conditions and experimental matrix were as follows: effective demihull spacing: $s = 0.300(0.150)0.600$ m, lateral offsets of wave probes: $y = 1.000(0.500)3.000$ m, effective tank width: $w = 7.100$ m, water depth: $d = 0.750$ m and 1.500 m, and Froude number: $F = 0.2$ to 1.0 .

4 Wave-Elevation Curves

Figure 2(a) and Figure 2(b) are plots of the wave elevation on longitudinal cuts at two different lateral offsets, respectively. The data corresponds to the intermediate demihull spacing ($s/L = 0.3$), the smaller depth ($d/L = 0.5$) and a Froude number F of 0.6 .

The wave elevation ζ is rendered dimensionless against the demihull beam B_1 , so that according to linear theory, the three experimental curves corresponding to the three different demihull beams should collapse together. This is seen to be very nearly the case, particularly for the greater offset of $y/L = 2$ in Figure 2(b), where the nonlinear effects are likely to be less. It is difficult to state whether the agreement with the theory from Doctors and Zilman (2004) is better when the demihull beam is smaller, as one would anticipate.

In the theoretical calculations, the following water properties were used: turbulent kinematic viscosity: $\nu = 2 \times 10^{-5}$ m²/s, surface tension: $\tau = 0.0735$ N/m, and surface elasticity: $\epsilon = 0.0050$ N/m.

5 Root-Mean-Square Wave Elevation

As a measure of the overall wave-generation

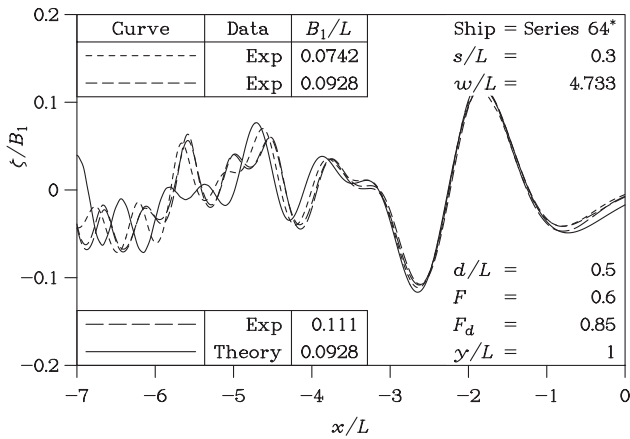


Figure 2: Similarity of Wave Profiles
(a) $d/L = 0.5$, $F = 0.6$ and $y/L = 1$

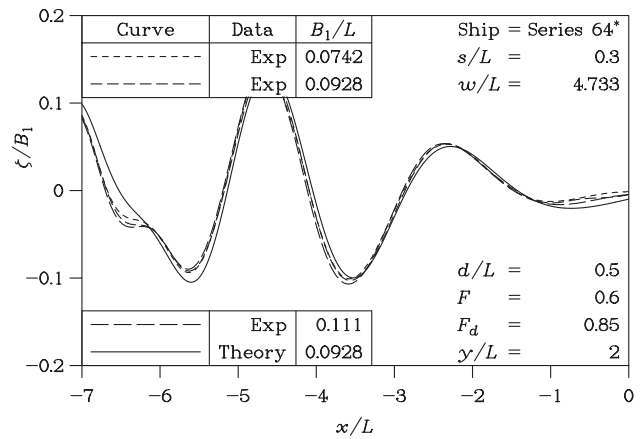


Figure 2: Similarity of Wave Profiles
(b) $d/L = 0.5$, $F = 0.6$ and $y/L = 2$

characteristics of the catamarans, we now turn to Figure 3. This is a pair of plots of the nondimensional root-mean-square wave elevation RMS/L against the Froude number F for the smallest demihull spacing $s/L = 0.2$. The shallower case of $d/L = 0.5$ in Figure 3(a) shows the excellent agreement between the theory and the experiment for all three model demibeams. The linear theory, of course, breaks down near the critical depth Froude number $F_d = 1$. In the same conditions, it is unlikely that the experimental data is any more reliable, because of the great difficulty in achieving a steady-state condition.

The deeper case of $d/L = 1$ is shown in Figure 3(b). In this case, the critical depth Froude number occurs at the right-hand side of the graph.

Finally, we replot this data in a normalized form, namely RMS/B_1 , in the two parts of Figure 4. It is encouraging to observe the very high degree of collapse of the data onto a single curve — confirming the essential linearity. It may be observed also that, for the high-speed end of the range, there is better agreement between the theory and the data for the smallest demibeam, as one would expect. Also, the theoretical curves do not collapse perfectly (specifically at the low-speed end of the range), because the transom-stern

hollow model introduces a minor geometric nonlinear feature into the calculations.

6 Conclusions

The extensive experiments have confirmed that linear wave theory can be applied to the case of practical marine vessels, even those with a relatively high beam-to-length ratio.

An interesting future extension of this work could involve further increasing the beam to test the ultimate useful limit of linear theory.

7 Acknowledgments

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8 References

Doctors, L.J.: "The Influence of Viscosity on the Wavemaking of a Model Catamaran", *Proc. Eighteenth International*

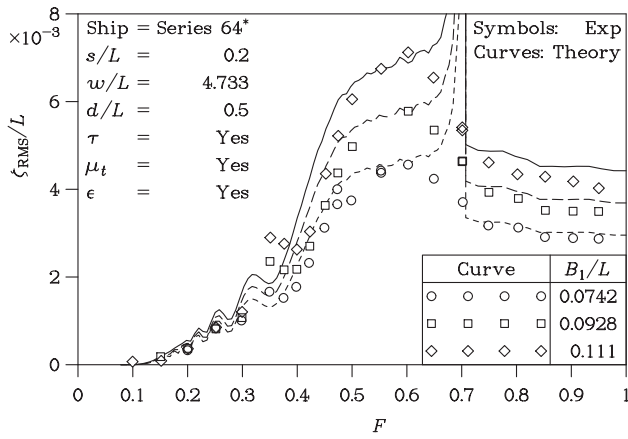


Figure 3: Dimensionless RMS Wave Elevation (a) $d/L = 0.5$ and $s/L = 0.2$

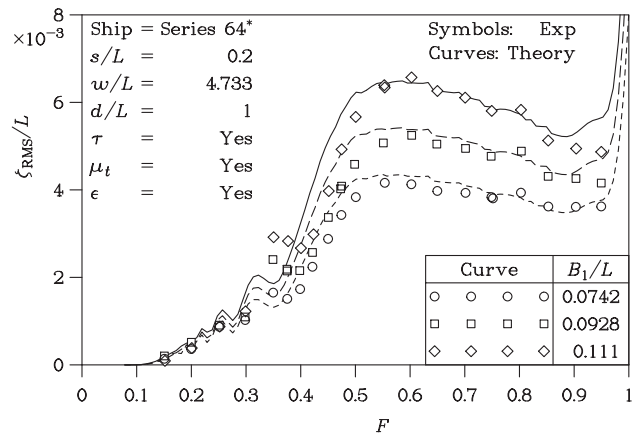


Figure 3: Dimensionless RMS Wave Elevation (b) $d/L = 1.0$ and $s/L = 0.2$

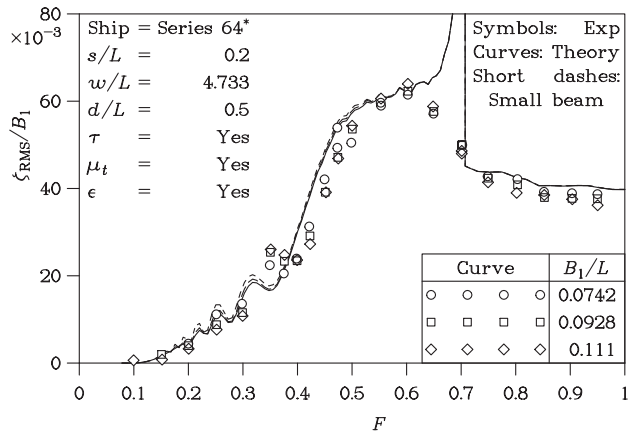


Figure 4: Normalized RMS Wave Elevation (a) $d/L = 0.5$ and $s/L = 0.2$

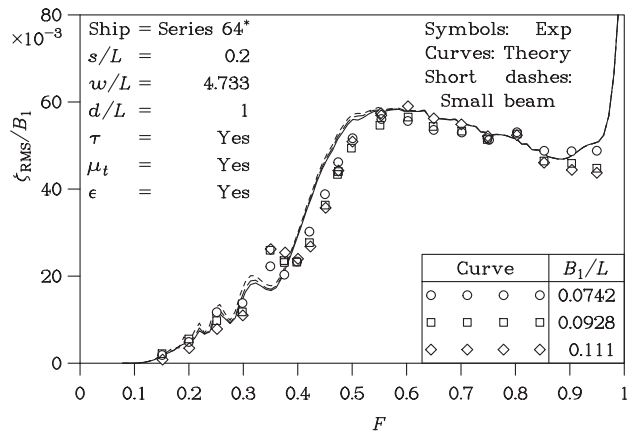


Figure 4: Normalized RMS Wave Elevation (b) $d/L = 1.0$ and $s/L = 0.2$

Workshop on Water Waves and Floating Bodies (18 IWWF), Le Croisic, France, pp 12-1-12-4 (April 2003)

Doctors, L.J., Renilson, M.R., Parker, G., and Hornsby, N.: "Waves and Wave Resistance of a High-Speed River Catamaran", *Proc. First International Conference on Fast Sea Transportation (FAST '91)*, Norwegian Institute of Technology, Trondheim, Norway, Vol. 1, pp 35-52 (June 1991)

Doctors, L.J. and Zilman, G.: "Environmental Wave Generation of High-Speed Marine Vessels", *Proc. Twenty-Fifth Symposium on Naval Hydrody-*

namics, St John's, Newfoundland and Labrador, 16 pp (August 2004)

Michell, J.H.: "The Wave Resistance of a Ship", *Philosophical Magazine*, London, Series 5, Vol. 45, pp 106-123 (1898)

Sretensky, L.N.: "On the Wave-Making Resistance of a Ship Moving along in a Canal", *Philosophical Magazine*, Series 7, Supplement, Vol. 22, No. 150, pp 1005-1013 (November 1936)

Tuck, E.O., Scullen, D.C., and Lazauskas, L.: "Ship-Wave Patterns in the Spirit of Michell", *Proc. IUTAM Symposium on Free-Surface Flows*, Birmingham, England, 8 pp (July 2000)