Influence of large scale breaking waves in the near field of ships

Ph.D thesis Department of Mechanics and Aeronautics,
University of Roma "La Sapienza", Italy

Author: **Fabrizio Pistani**

Tutor: **Renzo Piva**, Dip. Meccanica e Aeronautica Università degli Studi di Roma "La Sapienza"
Guiding professor: **Emilio Campana**, INSEAN (Istituto Nazionale Studi ed Esperienze Architettura Navale)

Thesis defended the day 28th of January2005 in front of the commission:
Bernardo Favini, Associate Professor of Rarefied Gas Dynamics (Dinamica dei Gas Rarefatti), Department of Mechanics and Aeronautics , School of Aerospace Engineering, University of Rome "La Sapienza".
Annalisa Fregolent, Researcher of Meccanica Applicata alle Macchine, Department of Mechanics and Aeronautics , University of Rome "La Sapienza".
Vincenzo Ciampi, Full Professor of Teoria delle Strutture, Analisi non lineare delle strutture, Meccanica computazionale, Department of Civil Engineer, University of Rome "La Sapienza".

Abstract
The influence of the dimensions on the wave breaking in the near field of a model ship is investigated through towing tank test for a fast displacement ship hull carried out on a 10 meters long model (λ=14.320). The wave elevation pattern in the near field of the model and the flow velocity in three transversal sections were measured for conditions corresponding to Froude number 0.35 at fixed sinkage and trim. The resistance force was measured for three models of different scales (l=14.320; 24.824; 46.588) for a range of Froude numbers from 0.05 to 0.45.
A comparison for the measured flow field on two sections, namely 0.20 and 0.40, is provided for the two larger models. The plots of the resistance put in evidence that the resistance coefficient C_F increases more for the larger model as it enters the full breaking state in the higher range of the Froude numbers of test. The wave elevation measurements on the larger model near field show a double peak of the bow wave caused by the secondary splash up of the crest and a surface scar generation highlighted as an area of high *rms* of the signal. The comparison with the wave field relative to the middle scale model highlights the absence of splash up for this case and a higher instability of the wave pattern. The plots of the vorticity show the presence of vortices generated at the bow wave. The comparison of the vorticity for two different model scales on two sections shows the greater intensity of the vortices for the larger model, caused by its more intense breaking. These stronger vortices can partially explain the greater resistance of the larger model at higher Froude numbers.