PERFORMANCE PREDICTION OF A YACHT SAILING IN WAVES

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SUMMARY

The aim of the thesis was to provide the necessary data from which an optimum windward performance strategy for a 12-metre sailing yacht could be determined. This was a subsection of the overall plan for performance prediction modelling developed by the Taskforce 87 America's Cup Defence syndicate and the Centre for Marine Science & Technology (CMST) at Curtin University of Technology, during the period 1985-1987. The prediction of wave influences on performance is central to the issues addressed in the thesis.

Added resistance is the principal topic investigated, with stability and sideforce effects addressed to a lesser degree. The results of theoretical predictions of added resistance developed by Sutherland (1988) are combined with static drop tests and regular wave tank tests conducted by the author to yield a set of response amplitude operators. A calm water velocity prediction program is then adapted to include these results and the output from a second generation wave field model (Young, 1987), to provide on-board real time predictions of speed loss due to the instantaneous ocean wave field.

The calm water VPP employs the *Standfast* systematic yacht series (Gerritsma et al, 1977) for estimation of upright resistance, and the van Oossanen (1981) method of calculating sideforce and induced resistance. Sail coefficients are adapted from the *BayBea/Standfast* data. The upright resistance predictions contain an unresolved 2.63% error, reflecting a boatspeed error of up to 1%.

Tank tests were conducted by the author on a conventional 12-metre hull form with interchangeable keel. A wing keel configuration showed no discernible difference from the conventional keel in terms of heave, pitch and added resistance response. The added resistance and motions of the model when heeled were considerably less than for the upright condition, a finding supported qualitatively by the theoretical predictions. Heave and pitch motions were found to vary linearly with wave amplitude, whilst the relationship between added resistance and wave amplitude exhibited considerable structure. Rough water righting moment was found to be less than 2% greater than calm water dynamic righting moment.

Drop tests were conducted on three full size yachts to determine pitch moment of inertia and damping. Froude analysis of the pitch decrement curve illustrated the influence of hull form and keel type on damping.

The principal aim of supplying on-board estimation of the speed loss due to waves was achieved. The greatest limitation on accuracy was the need to load a single wave scenario before the start of sailing, as the wave model

was too large for real-time running on the yacht.

An onshore race simulation program was written which included the rough water VPP. This program is still in the early stages of development but provided predictions of windward leg elapsed times typically 3% different from real times. A significant source of error in absolute boatspeed prediction lies in estimating the vertical wind gradient.