FLUID STRUCTURE INTERACTIONS RESEARCH GROUP

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The influence of surface waves on the added resistance of merchant ships

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Background

•In the early days of power prediction the main focus was the resistance a ship experienced in still water conditions.

•Predicting the power needed to achieve the designed service speed in the actual conditions experienced on the intended route quickly became an issue once towing tank testing was established as a reliable way to get the still water resistance.

•Since there was little consistency in studies on the subject, designers used prescriptive percentage additions to the calculated still water resistance based on experience, e.g. +25% for North Atlantic trades, +15% for coastal operations.

•These additions varied widely between different towing tank institutions ranging from 0-30% for North Atlantic.

•Several studies, both full scale[1] and model scale[2] were conducted in the 1920's to try and highlight important phenomena causing added resistance.

•Since then several approaches to developing a reliable prediction algorithm has been made. The most notable are:

•Maruo[3], who showed that the added resistance from individual wave components could be superimposed to get the total added resistance in an irregular sea.

•Gerritsma & Beukelman[4], who managed to derive the added resistance from radiated energy methods which meant not having to solve hydrodynamic boundary conditions as with methods based on hull pressure.

•Faltinsen et. al[5] who presented a versatile method widely used today.

Causes of added resistance in rough seas

•Unfavourable shifts in buoyancy forces causing heaving and pitching. This absorbs energy both from the waves themselves but also from the ships momentum causing speed loss.

•Reflection of incident waves at the bow

•Disturbances of the flow around the hull causing boundary layer distortion and poor propeller performance

•Poor power plant performance in unsteady running conditions

•Increased aerodynamic resistance in strong head on winds

Added resistance is mainly due to wave reflection

Added resistance is mainly due to heaving and pitching

Aims

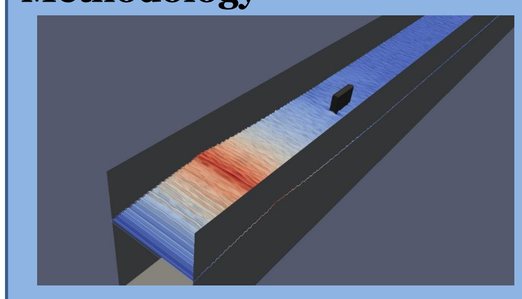
•To assess the different methods of predicting added resistance and identify strengths and weaknesses.

Ulstein X-bow

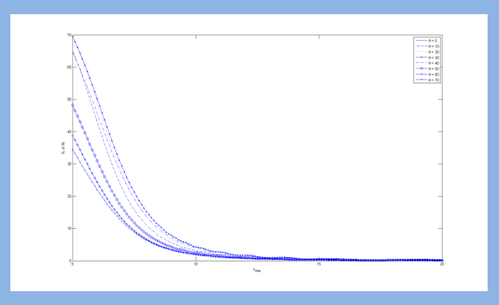
•To Study the influence of the bow shape both above and beneath the waterline on the flow features associated with added resistance.

•From this study identify key areas of the forebody where design improvements could be made.

Methodology



CFD- simulation of object facing a wave



Potential flow results linking reflected wave resistance to bow shape and speed

•The problem can be split up into several individual studies of the different aspects mentioned and the most suitable approach must be chosen for each one. Possible approaches include:

•CFD analysis (e.g. numerical towing tank)

•Custom potential flow approach

•Energy methods

•Towing tank experiments

•Others, yet to conceived

References

1.Kent J.L, The effects of wind and waves on the propulsion of ships , Transactions of the Institution of Naval Architects 1924

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3.Maruo H, The excess resistance of a ship in rough seas, International shipbuilding progress, vol 4, No 35, 1957

4.Gerritsma J & Beukelman W, Analysis of the resistance increase in waves of a fast cargo ship, International shipbuilding progress, vol 19, No 217, 1972

5.Faltinsen O.M , Minsaas K.J Liapis N & Skjordal S.O, Prediction of resistance and propulsion of a ship in a seaway, Proc. 13th symposium of naval hydrodynamics, 1980

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