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PAPER TO SWATH MEETING 1984

by

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Swath motion control
Following Waves

Student thesis:

a Mathematical model ship motions of swath in following waves with fixed fins

b Verification of outcome with the results of the model experiments carried out at the Delft Toning Tank

c Investigate changes in fin configuration and their effect on the motions

d Extension of the math. model with fin active control

e Calculation of swath motions with controlled fins, using the swath 6A configuration

The mathematical model was a time domain model, incorporating all the non linearities involved with the use of the fins.
The forces on the fins were dependend on among others: heave and pitch motions and velocities and the orbital velocities of the waves, aspect ratio of the fins, instationary effects, wing body interaction and wing-wing interaction. Effects not included where a.o. the surge velocities and the influence of the wave system of the swath itself.

Hydrodynamic coefficients of the swath were used as computed with the aid of the MOT 35 program of DTNSRDC.

Verification of the math. model with the model experiment yielded reasonable results compared with the MOT 35 program. But it still showed discrepancies, in particular in the phase prediction between the motion and the wave. Later an improvement of the math. model has been made, but the results of that model are not available at this moment.

First the effect of changes in fin configuration have been investigated only to be able to show trends.

So the forward fin position has been changed, the fins have been increased in their surface and their position and area have been chosen in accordance with the optimum position according to Lee and Curphey.

Conclusions from these calculations were:

- the motions were little affected by the position and geometry of the fixed fins and their respective area's.
- the stability of the system decreases when the fin size is decreased and when positioned more forward. This happened although the motion amplitudes decreased.
- although the fin size was increased and decreased with more than 25% the motions altered only with in a range of a few percent. It was evident that the fins did not only contribute to the motioncontrol but also to the exciting forces which means that increasing fin size might yield quite opposite results to the results wanted.
- in the region of the "crash range" of the swath the exciting forces and moments on the swath and the fins were almost in phase with the motions. A shift in phase resulted in much smaller motions, this might explain the influence of the surge motion on the behaviour of the swath in following waves.
- heave is strongly affected by the fins.
- fin control was introduced by means of flaps on the fins, with a length of 30% of the fin chord.
- the control algorithm was one based on the pitch angle and pitch angular velocity, with a time-lag due to the hydrautic actuators and a limited angular velocity of the flaps (i.e. 5 degrees/second).
  The control could be changed from a mode "platforming" to "contouring".
- in the platforming mode the motions could be reduced to about 10% of their values in the uncontrolled mode and in many cases even less. In no situation a crash of the craft occurred. The same was true in the contouring mode.
- in general the flap angles of the forward fins were considerable larger than those of the aft fins.

- in some situations the motions were minimised by flap angle control on the aft fins which reduced the forces on the fins, so flap angle in anti-phase with changes in angle of attack. This was quite the opposite for the forward fins.
- the fin size was reduced to about 20% of its original value and still a satisfactory motion control existed.