ABSTRACT

The development of a method to simulate the potential flow around a surface ship is described. The velocity potential for the flow of an inviscid fluid past a fixed ship, subject to the tangential velocity condition on the hull and free surface, is calculated through the Rankine source distribution on the boundary surfaces.

The boundary surfaces are replaced by a number of quadrilateral source panels on each of which the source strength is assumed to be uniform. The source panels which represent the free surface, however, do not always coincide with the surface on which the boundary condition is satisfied. These two surfaces are made to approach each other through iteration.

The hull boundary condition is satisfied on the part of the hull under the disturbed water surface.
Non-linear free surface boundary condition is fulfilled on the disturbed water surface (either the Rankine source waves or a simulated wave surface).
The radiation condition is met approximately by transferring the induced effects outside the wave envelope to the region within the envelope.

This is achieved by adding some initial velocities to the free stream so that the difference from the upstream velocity can act as a counterbalance to the induced velocities and by redistributing the transferred quantity along the wave envelope lines*

The simulated wave profiles along hulls and the wake fractions at the propeller location are compared with experimental and other analytical results. The following conclusions are drawn.

1. The iteration process converged very quickly, within two or three iteration, which demonstrated the efficiency of the algorithm. This also proved that the idea works of expanding the induced velocities in Taylor series to include the non-linear terms of the free surface boundary condition.

2. The values of wake fractions in propeller disk show a significant difference between the flat water surface results and those of disturbed water surfaces, which demonstrates numerically the importance of non-linear theories to accurately predict the flow.

3. The non-linear effect has a substantial influence on the flow field beneath the free surface. Thus it was concluded to be requisite to meet the free surface boundary condition on the disturbed water surface itself for an accurate estimation of field quantities within the flow domain. It is logical not to have any singularities within the flow domain, but it may be advantageous to have the source panels away from the boundary by a small distance.

4. The approaches of prescribing field quantities somewhere upstream, whether it be within the flow domain under the free surface or over the free surface itself, did not always serve well to meet the radiation condition to a satisfactory level. Thus it seems that the flow generating mechanism itself (Rankine source) should be modified to meet the radiation condition. Alternatively, the numerical scheme could deal with the condition.