

*Theoretical Studies on Steady Fluid Motion Under a Free Surface**

GORDON C. K. YEH** & JOHANN MARTINEK

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Summary. This paper contains research results applicable to steady and certain unsteady fluid motions under a free surface. Simple harmonic oscillatory motion of an inviscid, incompressible, and irrotational fluid under a plane free surface is considered. The first part establishes a new theorem for expressing the velocity potential due to the undisturbed potential in the presence of a rigid body and the free surface by means of an integral equation in terms of a Green's function. The second part presents an alternative formulation for the same problem with axial symmetry in terms of multipole representations. In the third part, the Green's function for the corresponding two-dimensional case is obtained, and is shown to be a powerful tool for theoretical solutions, not only for stationary and oscillating phenomena, but also for steadily moving phenomena.

Introduction. In previous work (Ref. (1)) on steady fluid motion under a free surface, a theorem of considerable generality was established, and was published in the *Proceedings of the Royal Society* (Ref. (2)). A special case of the theorem expresses the disturbance velocity potential in closed form in terms of any given potential in an unlimited domain due to the presence of a plane boundary with the condition

$$(1) \quad \frac{\partial \phi}{\partial z} + K\phi = 0 \quad \text{on } z = 0$$

where K is zero or positive and $\partial/\partial z$ denotes normal differentiation away from the region of the definition of the velocity potential ϕ .

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