

On steady non-breaking downstream waves and the wave resistance

Maklakov D., Petrov A.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2015 Cambridge University Press. In this work we have obtained exact analytical formulae expressing the wave resistance of a two-dimensional body by the parameters of the downstream non-breaking waves. The body moves horizontally at a constant speed c in a channel of finite depth h . We have analysed the relationships between the parameters of the upstream flow and the downstream waves. Making use of some results by Keady & Norbury (J. Fluid Mech., vol. 70, 1975, pp. 663-671) and Benjamin (J. Fluid Mech., vol. 295, 1995, pp. 337-356), we have rigorously proved that realistic steady free-surface flows with a positive wave resistance exist only if the upstream flow is subcritical, i.e. the Froude number $Fr = c/\sqrt{gh} < 1$. For all solutions with downstream waves obtained by a perturbation of a supercritical upstream uniform flow the wave resistance is negative. Applying a numerical technique, we have calculated accurate values of the wave resistance depending on the wavelength, amplitude and mean depth.

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Keywords

channel flow, surface gravity waves, waves/free-surface flows