SOME COMPUTATIONS OF STEEP UNSTEADY WATER WAVES

by

D.H. Peregrine, J.W. Dold, M. Tanaka, M. Lewy and M. Cooker
School of Mathematics, Bristol University.

Introduction

Examples of numerical integrations are shown. They are calculated using the boundary-integral method described in Dold and Peregrine (1986a) or extensions of that method. They illustrate the range of two dimensional examples that are being investigated with this efficient scheme.

Modulated waves

Deep-water wave trains are unstable to long modulations. The nonlinear evolution is being studied. Wave energy concentrates to a short group of waves (self-focussing). Either the computation must cease because a wave breaks at this stage, or the evolution can be followed to one, or more recurrences of the initial nearly uniform state. A preliminary report is in Dold and Peregrine (1986b). The example in figure 1 shows two modulations on nine waves. The effects of phase and group velocity are subtracted by choosing to show profiles every second period in a moving reference frame. The roughness is due to the plotting routine. Although no frequency down-shifting is observed only seven peaks are visible at the final time.

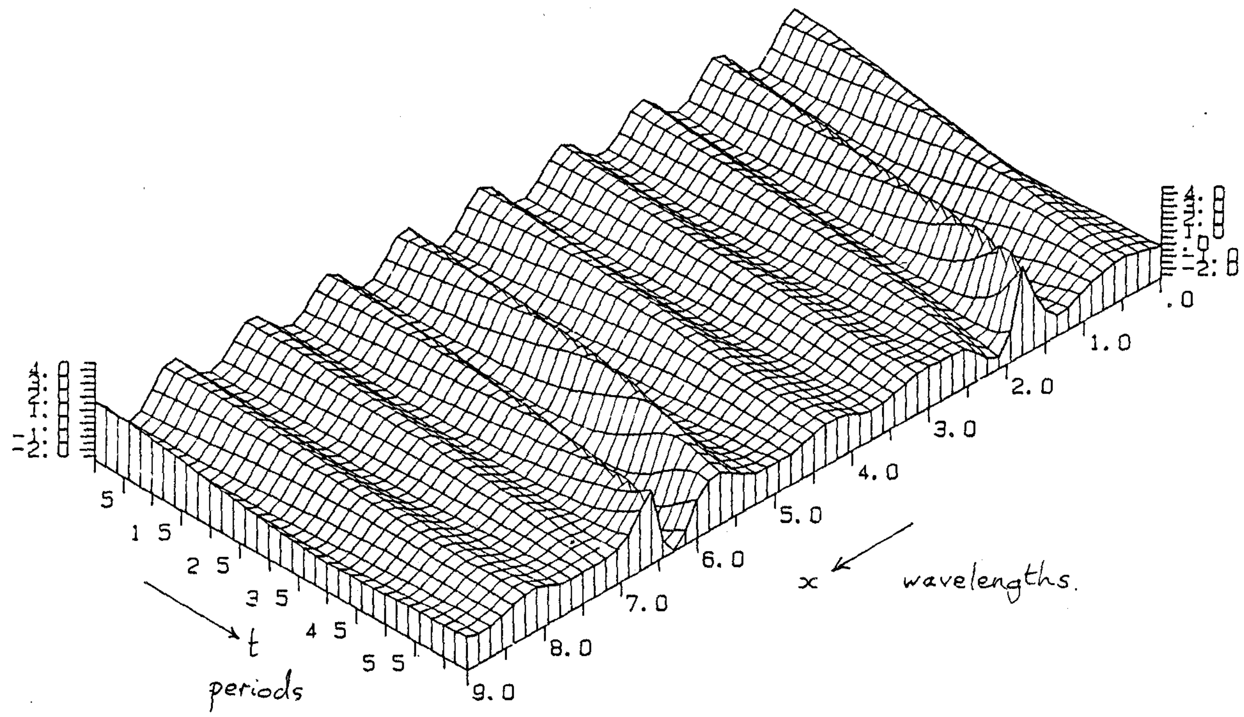

Figure 1.

Instability of solitary waves

Tanaka's (1986) instability calculations for a solitary wave have been used to generate initial conditions corresponding to a high unstable solitary wave plus a small fastest-growing perturbation. Computations show that the eventual nonlinear evolution is of two types depending on the sign of the perturbation. Either the wave evolves to breaking in a time of 8.9 for a perturbation of $O(10^{-2})$ or else asymptotically approaches the lower solitary wave of equal amplitude after a time of around 100. The corresponding increase of mass and momentum in the latter case is achieved by radiation of two long waves, one of height 2×10^{-3} following the solitary wave, the other propagating in the other direction with a height of 10^{-5}. Details are to appear in Tanaka et al (1987).

High solitary waves meeting a wall

Figure 2 shows contours of pressure on the wall as a function of time for an incident wave of amplitude/depth = 0.803. The computation ceases when the tip of the sheet of water travelling up the wall has a curvature greater than 100. The maximum pressures and forces occur at a time when the surface water is being accelerated upward at 2g. The thin sheet leads to negligible pressure. Eventual maximum run up height is 3.4 times the depth above the still water level. Surface height, force, moment about the bed and centre of pressure are shown in figure 3. The units used have g and the depth as unity.

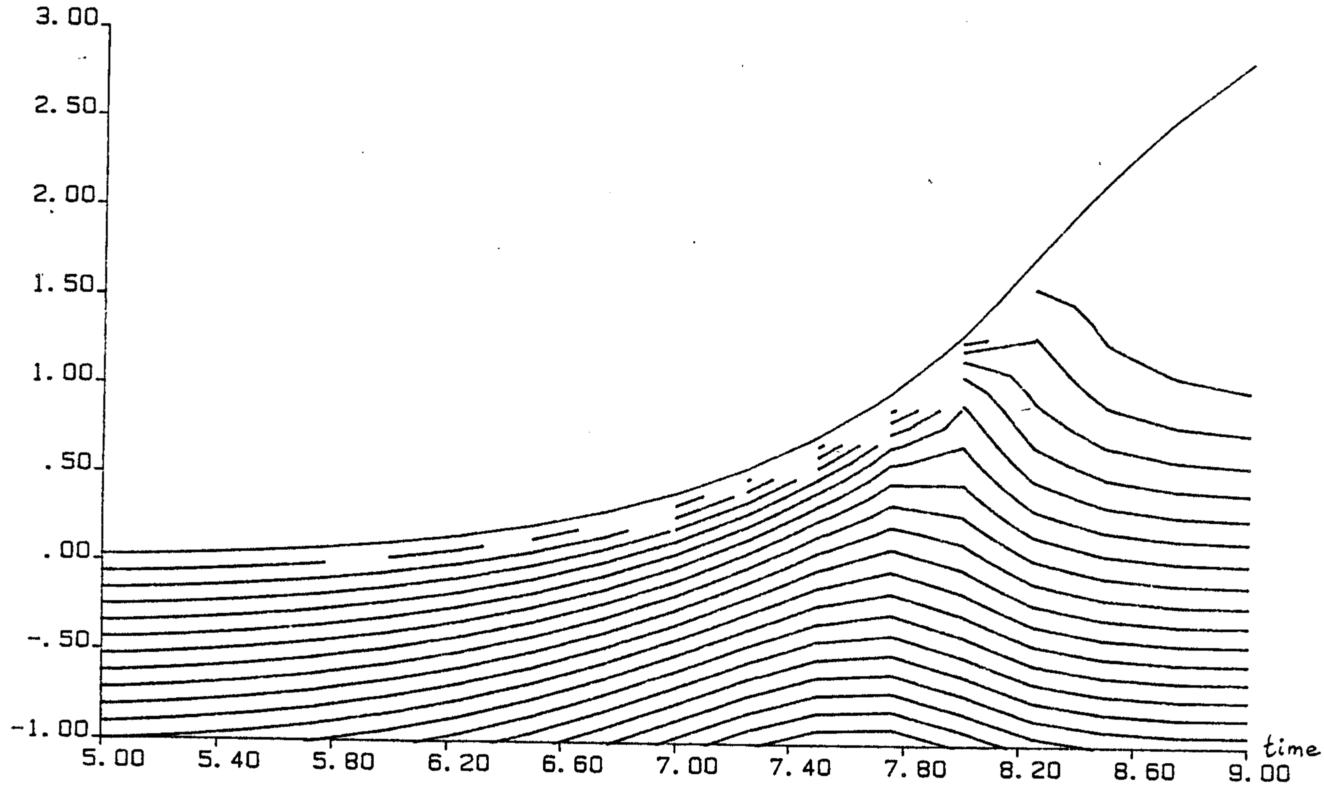

Figure 2

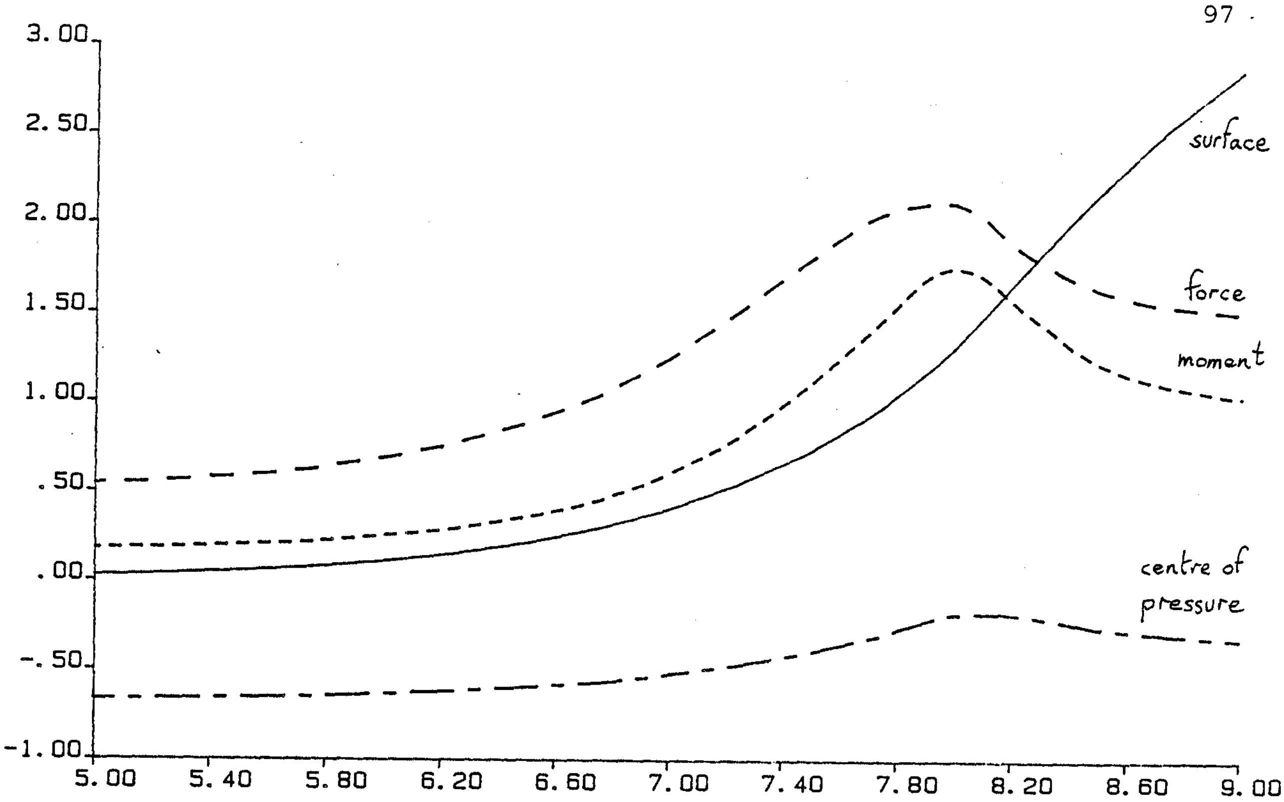

Figure 3.

A solitary wave passing over a submerged semi-circular cylinder

Figure 4 shows a surface profile after a wave with amplitude/depth = 0.462 passes over a semi-circular cylinder of radius 0.8 times water depth resting on the bed. The wave breaks, well after passing over the cylinder, and is also about to break backwards on to the cylinder. Variation of wave and cylinder can eliminate either breaking event. Experiments (M. Losada, private communication, March 1987) confirm the computed behaviour and detailed comparisons are under way.

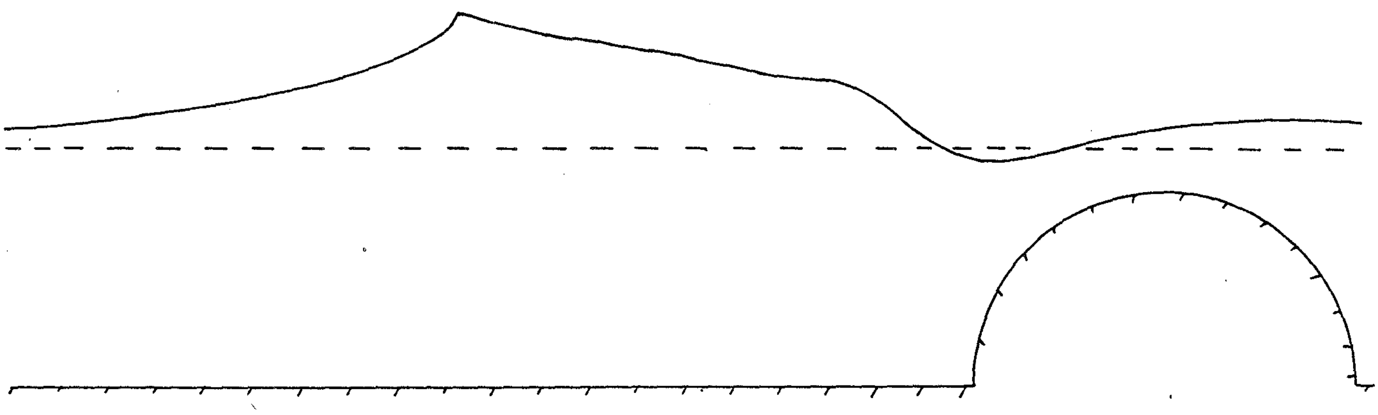

Figure 4.

References

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