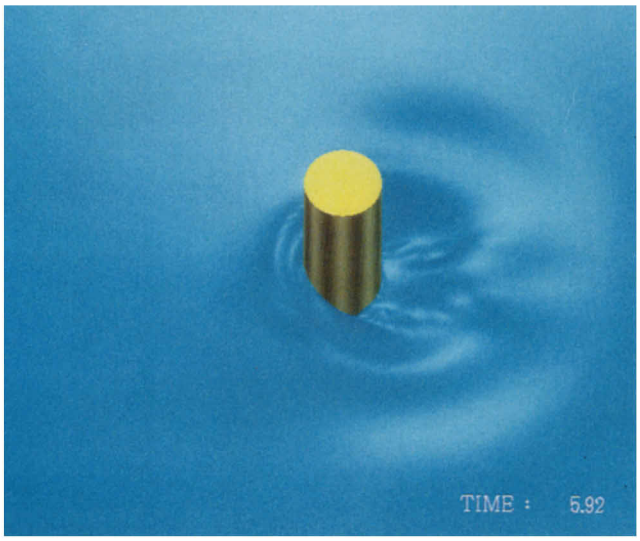

Figure 1

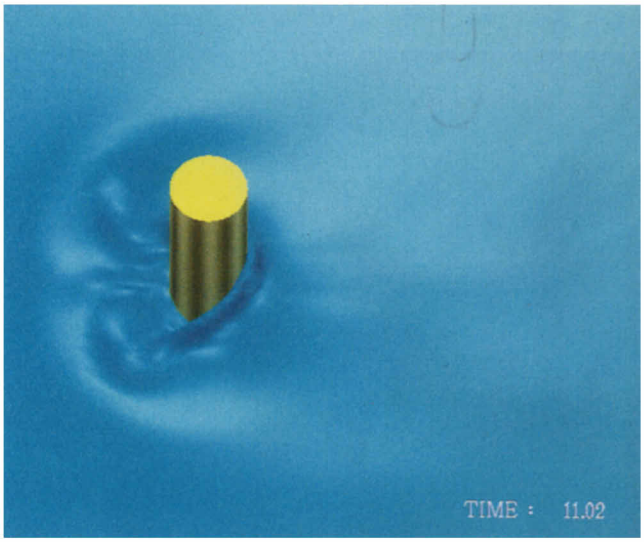

Figure 2

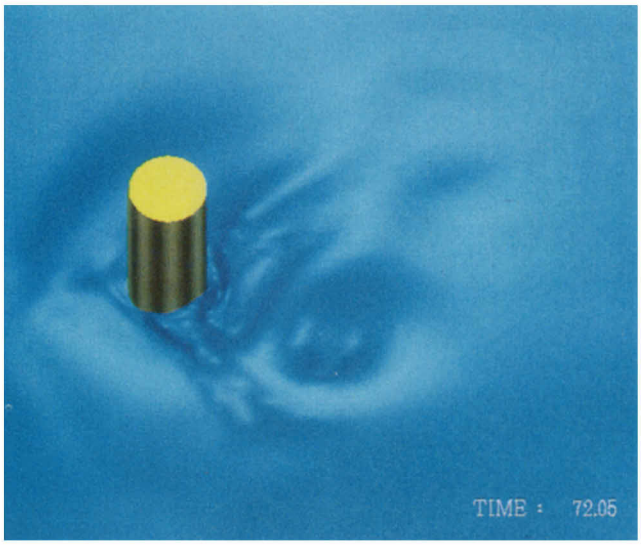

Figure 3

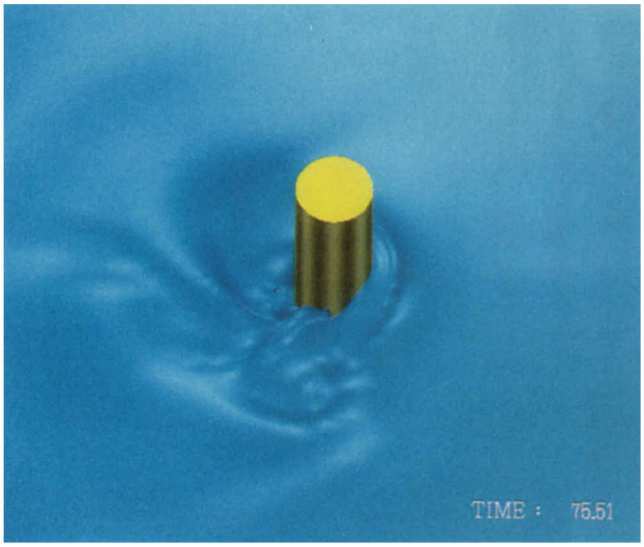

Figure 4

NUMERICAL ANALYSIS FOR FREE SURFACE FLOW AROUND A HARMONICALLY OSCILLATING CYLINDER

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The above pictures represent the numerical results for time evolutions of free surface configuration around a harmonically oscillating cylinder. The cylinder executes oscillations in the horizontal direction and the fluid is at rest at infinity. Vortices are shed by the moving cylinder, and they are clearly visible on the free surface. The interactions of vortices exhibit complicated behavior. The governing parameters are the Keulegan–Carpenter number KC and the Reynolds number Re. The definitions are $KC = 2\pi a/d$ and $Re = 2\pi ad/(Tv)$; a denotes the single amplitude of oscillation, T the period of oscillation, d the cylinder diameter, and v the kinematic viscosity of the fluid.

Figures 1–4 show the results for $KC = 12.56$ and $Re = 6.28 \times 10^4$. At initial stages (Figs. 1 and 2), the shedding is symmetrical with respect to the horizontal line of the oscillation. As time progresses (Figs. 3 and 4), small differences are developed in the newly generated twin vortices, and the asymmetrical vortex shedding takes place. It was reported in the earlier experimental observations that at $KC = 15$ there is a change of vortex shedding pattern from *transverse* to *diagonal* mode. In the present computations, the *diagonal* mode is captured at a slightly lower value of KC.

Here, we adopted a finite difference method with the third-order upwind scheme, together with a free surface conformed grid system. The computation was carried out on the Hitachi S-820/80 supercomputer, using 40 h of CPU time.