Geophysical Research Abstracts
Vol. 14, EGU2012-453, 2012
EGU General Assembly 2012

Numerical Modeling of Overturning of a Tsunami wave running onto a Shore with an abrupt declination of sea bottom

S. Kshevetskii (1) and K. Thiruvenkatasamy (2)

(1) Department of Theoretical Physics, I Kant Russian State University, Al.Nevsky street, 14, Kaliningrad, Russia (spkshev@gmail.com), (2) Department of Harbour Engineering & Offshore Technology, AMET University, 135, East Coast Road, Kanathur-603112, India (

A 2D motion of an incompressible fluid of variable density, which is placed in the gravity field and over an irregular bottom, is considered. The numerical model has been developed using Euler equations of motion for an incompressible stratified fluid. The ocean and atmosphere over the ocean are considered as a uniform continuous medium. At the interface between water and air the density varies with jump from value $\rho = \rho_{water}$= 1000kg/m^3 for water to value $\rho = \rho_{air}$ = 1.2 kg/m^{3}for air. However, no interface between water and air is specially introduced. The solutions of governing equations are evaluated as generalized one. Really, intensive intermixing of water and air occurs in the region of wave overturning when a wave collapses. Therefore in the overturning region, the water and air mixture, and foam often is formed. Intensive intermixing of water and air in a region of overturning of a wave leads to vanishing of clear interface between water and air. The mathematical apparatus is settled in such a manner that around a place of overturning of a wave, the density is automatically, a little flattened, and a thin layer of fluid of intermediate density is organized.

The theory of generalized solutions is based on two requirements. Realization of fundamental law of conservation of mass, momentum, and energy is first requirement. Stability of solutions is second requirement. Simplified description in the region of overturning of a wave, weakly, affects the behavior of a wave as a whole. Moreover, overturning processes exist only at the expense of energy of the basic wave; the behavior of an overturning wave is reproduced schematically, but in general correctly. Fluid movement takes place over an irregular bottom.

A solitary wave running towards a shore from a deep ocean is used as an initial condition. We construct the initial wave by applying an exact solution for a stream function for a surface solitary wave. Appropriate expression for wave parameters in the atmosphere was calculated from joint conditions (the stream function should be continuous) and from boundary conditions. The center of the initial wave is about 14 km from a shore; the scale of the incoming wave is about 10km.

It is found that the uniform vortex runs to a shore, not being destroyed.

For, t=120 second, the wave propagation velocity is about 100 km/s. It matches to the theory. The wave front is near the shore, and it has experienced the shore. At the front, water level jump starts to be formed.

For, t = 180 seconds, interacting of a wave with shoal water already has been occurred. The wave stopped, because there is no place for further wave running. The water level with steep front rises approximately up to 7 meters.

For, t=240 sec, the wave has already a little run on a land, in the left of the point, it is equal to 0.0. We see that the vortex opposite twirled is formed far from the shore. We suppose, a backward wave has probably started to be formed. A water level with steep front has risen up to 16 meters; wave collapse has begun.

This paper will details on the numerical calculations carried out using finite-difference approximations.

References

[1] Kshevetskii S.P. Study of Vortex Breakdown in a stratified Fluid. Computational Mathematics and Mathematical Physics, 2006. Vol. 46. N11. pp.1988.