The 10th International Conference on Coasts, Ports and Marine Structures (ICOPMAS 2012)
Tehran, Iran, 19-21 Nov. 2012

Numerical Analysis of the Stability of Breakwater Armor Units due to Sea Wave Attacks

[Ali . Pak علی پاک]
[محمد سرفراز Mohammad . Sarfaraz]

Key Words: *Coastal Structures, High-Crested Breakwaters, Armor Stability, Sea Wave Loads, Numerical Modeling*

1-Introduction

Breakwaters play an important role in providing a calm and safe area in coastal waters. For design of these structures, the stable weight of armor units must be carefully determined which depends fundamentally on an accurate estimation of the wave forces acting on the armor units.

Presently, the stable weight of breakwater armor units is determined using some empirical formulae such as Hudson [1] and van der Meer [2]. Then by conducting physical tests the accuracy of the result is evaluated. These formulae are proposed mostly for rock stones, rather than concrete blocks. In these formulae the relationship between the magnitude of the wave forces on the armors and armor weight is not considered, rather, the wave height is used for determination of armor weight. Also they do not indicate the instability mode of the armour unit, i.e. uplift, sliding and overturning.

A more rational approach is taking the magnitude of wave forces on the armor units into account. Few studies about the wave forces acting on armor units have been conducted so far, mostly by physical tests on submerged breakwaters (e.g. [3] and [4]). Similar researches approve that the maximum wave forces implied on the armour unit has no monotonic relations with the wave parameters, besides the fact that breaking wave causes very complex flow field near the breakwater [3, 4, 5, 6].

The novel aspect of this research is evaluating the stability of armor units based on numerically-derived wave forces which consists a solid ground for design of breakwaters instead of using empirical relations.

2- Numerical Simulation

In this research FLOW-3D® is employed to compute the flow field parameters, i.e. pressure and velocity, induced by the incoming regular waves by solving the continuity (1) and Navier-Stokes (2) equations in 2D, incorporating k-ε and LES turbulence models [7]:

$$\frac{\partial u_i}{\partial x_i}=0, \quad i=1,2,3 \qquad (1)$$

$$\frac{\partial u_i}{\partial t}+\frac{\partial}{\partial x_j}u_i u_j=-\frac{\partial P}{\partial x_j}+\frac{\partial}{\partial x_j}\left[\nu\left(\frac{\partial u_i}{\partial x_j}+\frac{\partial u_j}{\partial x_i}\right)-\tau_{ij}\right], \quad i,j=1,2,3 \qquad (2)$$

Where, u is the velocity vector, P is the pressure, ν is the dynamic viscosity, and τ_{ij} *is the stress tensor. VOF[1] scheme is used to capture the free surface of fluid [7]:*

[1] Volume of Fluid