Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 2, No. 10, October, 2016

Numerical Simulation of Impulsive Water Waves Generated by Subaerial and Submerged Landslides Incidents in Dam Reservoirs

Vafa Khoolosi [a*], Sedat Kabdaşli [b]

[a] PhD student, Department of Civil Engineering, Istanbul Technical University, Istanbul, Turkey.

[b] Prof. of Department of Civil Engineering, Istanbul Technical University, Ayazağa Campus, Istanbul, Turkey.

Received 16 September 2016; Accepted 24 October 2016

Abstract

The water wave generation by a freely falling rigid body is examined in this paper. Landslides on the margins of dam reservoirs may generate large waves that can produce flooding over the banks or overtopping the dam crest. In the present investigation, landslide generated waves are studied using a numerical model based on Navier-Stokes equations. Impulse wave amplitude, period, energy is studied in this work. The effects of bed slope angle on energy conversion from slide into wave are also investigated, and the numerical model we used in this study is the full three dimensional commercial code Flow-3D. Results of the Navier-Stokes model show that waves generated are highly dependent upon the details of slide mechanism and kinematics. Numerical solutions for the velocity fields, pressure distributions, and turbulence intensities in the vicinity of the falling rigid body are also presented. Results show that the general pattern of wave in all cases is the same but the amplitude and period are different. Data analysis shows that the maximum wave crest amplitude in subaerial induced waves is strongly affected by bed slope angle, landslide impact velocity, thickness, kinematics and deformation and by landslide shape.

Keywords: Impulsive Water Waves; Subaerial; Submerge; landslide; Dam Reservoir.

1. Introduction

Empirical studies of water waves generated by underwater landslides have been conducted by Wiegel [1], Iwasaki [2], Heinrich [3], and Watts [4]. All these studies considered the motion of solid blocks or boundaries. Iwasaki conducted a wide variety of numerical studies for water waves generated by solid underwater landslides of various geometries, using the linear shallow water wave equations. Heinrich performed similar studies using a finite volume discretization of the Navier–Stokes equations; these computations agreed remarkably well with experimental results. Jiang and Leblond [5, 36] developed a model of deformable underwater landslides, generating waves governed by the nonlinear shallow water wave equations. Verriere and Lenoir [6] solved a linearized velocity potential problem to describe water waves generated by perturbations around a circular island. Harbitz [7] used the linear shallow water wave equations to model the Storegga landslide as a sliding solid block generating waves [14, 35].

Dams are usually built in valleys where active erosion is present, and some are in active earthquake areas. Therefore, reservoirs can be vulnerable to landslides activated by earthquakes or by heavy rains and they could generate large waves that can produce flooding over the banks or overtopping the dam crest [8]. Water waves generated by the sliding movement of land volumes (landslides or slumps) into nearby water bodies are of great interest to coastal and ocean engineering. Landslides are natural phenomena that occur under certain conditions such as earthquakes, underwater mass movement, heavy rainfalls and storms, erosion and water fluctuations [10]. In such events, landslides are capable of generating several types of long waves, such as tsunamis, due to energy transfer to the

* Corresponding author: vafa1881@yahoo.com