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Experimental investigation on interaction ofconcrete gravity dam-reservoir-foundation on shaking table

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Abstract

Interaction of concrete gravity dam with foundation and reservoir is one of the most important subjects in analyzing seismic behavior of dams. This paper presents an experimental study on seismic behavior analysis of dams considering the Interaction among concrete gravity dam, foundation and reservoir. Herein,a scaled dam has been constructed with scale factor of 1:30 (model: prototype)and modeled with foundation and reservoir on shaking table. Using different sensors on critical points of the model and also inside the concrete dam, the interaction behaviorhas been investigated during a specific applied earthquake. In this regard, multiple parameters have been evaluated during the earthquake, including displacements, hydrodynamic pressurein upstream, variation of acceleration/pore-water-pressure from bottom layers of foundation to free surface andfinally, variation of the soil dynamic responses beneath the dam.The results of experimental model are useable for verifying numerical models.

Keywords: Dam foundation reservoir Interaction,Concrete gravity dam,shakingtable tests, Dynamic responses,Hydrodynamic pressure

1. INTRODUCTION

Safety of concrete dams during earthquakes is one of significant concerns in the seismic regions around the world. Earthquake-induced ground movements create extensive stresses on all types of structures in the form of lateral inertial loads. In addition, impounded reservoir behind dams and other hydraulic structures develop significant hydro-dynamic pressures over and above the persisting hydrostatic pressures on the upstream faces of these structures. The dynamic response of dams dependson several factors including frequency and intensity of earthquake induced ground motion,depth of impounded reservoir, stiffness of structure and geological conditions.

Shaking table tests are often conducted in the 1g gravitational field in order to understand the behaviour of soil structures and foundations during earthquakes. On some occasions, the shaking table tests are conducted for the very complex models; the saturated soil-structure-fluid models under earthquake loadings. There is a study on the similitude of soil structures under dynamic loadings by using the ratios of the forces [1]
There is another study on the similitude of nonlinear dynamic responses of grounds by using Buckingham's π-theorem [2]. Both of the studies resulted in the same similitude. However, the result of their studies is applicable only to the shear deformation of soil structures. There was a need to extend their similitude to a more general form in order to interpret the dynamic model tests of the saturated soil-structure-fluidsystem. FinallyIai by using basic equations which governed the dynamic behavior of the saturated soil-structure-fluid system. [3]

However, only a few experimental studies have been performed to verify the theoretical solutions for interaction of dam-foundation-reservoir due to obvious difficulties in constructing and incrementing realistic physical models at small scale. Oberti and Castoldi carried out large scale tests on dam models excited by actuators to determine the natural frequencies and the mode shapes of the dams. They also tested small scale models on shaking table, together with the static and dynamic loads [4]. Madabhushi first used the dynamic