Sensitivity of Numerical Seismic Response of Concrete Gravity Dams to Mesh-Size and Foundation Rock Stiffness

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Abstract

Seismic safety of concrete gravity dams can only be assessed based on the results of numerical modeling. Even though the Pine Flat Dam of California, USA, has been extensively studied, by numerical simulation, yet none has been focused on the effect of mesh size and foundation moduli on the response of this dam. To study these, computer code, EAGD-84, with its open source, was used. Using this code, several linear time history analyses with four different mesh sizes and three different values for rock modulus of elasticity, when subjected to Taft Earthquake of 1952 were studied in the present research. The results indicated that stresses and displacements vary significantly by decreasing the mesh size, usually asymptotically approaching certain values as the size decreases. As for the foundation modulus, it was concluded that the stresses increase by increasing the modulus and the displacements decrease, and vice versa.

Keywords: Sensitivity Analyses, Concrete Gravity Dam, EAGD-84, Element Size, Foundation Rock Stiffness.

1. INTRODUCTION

Special structures such as concrete gravity dams may incur severe damages when subjected to earthquakes of moderate to large size. The ability to evaluate the effects of earthquake ground motion on concrete dams is essential for assessing the safety of existing dams, for determining the adequacy of modifications planned to improve old dams, and for evaluating designs for proposed new dams. However, the prediction of the performance of concrete dams during earthquakes is one of the most challenging and complex problems found in the field of structural dynamics. Seismic safety of such structures can only be assessed based on the results of numerical modeling, and hence the accuracy of such simulation and its associated results could have a decisive and profound impact on the safety evaluation of these structures under seismic loads.

When evaluating the earthquake behavior of concrete dams, it is reasonable in most cases to assume that the response to low-or moderate intensity earthquake motions is linear. That is, it is expected that the resulting deformations of the dam will be directly proportional to the amplitude of the applied ground shaking. Such an assumption of response linearity greatly simplifies both the formulation of the mathematical model used to represent the dam, reservoir water, foundation rock system and also the procedures used to calculate the response. The results of linear analysis serve to demonstrate the general character of the dynamic response, and the amplitudes of the calculated strains and displacements indicate whether the assumption of linearity is valid [1].