EVALUATION OF SEISMIC FRAGILITY CURVE OF A TYPICAL EMBANKMENT DAM

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Dam is an important part of infrastructures, the failure of which would lead to catastrophic effects on a regional scale. Seismic fragility analysis is one of the most effective methods for evaluating seismic performance of structures. This method can effectively estimate the risk of earthquake-induced damage to the structure and can predict the probability of exceeding a certain limit state for different intensity measures of ground excitation (Bernier et al., 2016; Hariri-Ardebili and Saouma, 2016; Jin and Chi, 2019).

Fragility is the conditional probability of attainment or exceedance of the prescribed limit states for a chosen intensity measure of ground excitation, as shown in Equation 1.

$$P(fragility) = P[LS|IM = x] \quad (1)$$

in which LS refers to limit state or the performance level, and IM represents the intensity measure of input ground seismic hazard with intensity level x.

Due to the various characteristics of ground motion, analytical models, structural materials, definition of limit states, etc., randomness and uncertainties generally exist on dam structures (Escuder-Bueno et al., 2016; Lin and Adams, 2008). This randomness and uncertainty can influence the seismic response of dams.

The purpose of this study is to assess the seismic response of an embankment dam subjected to earthquakes and derive analytical fragility functions. Nevertheless, the time required to run a model, considering all of randomness and uncertainties is prohibitive. Hence, for simplicity, only the variation of input ground motion is taken into account in this paper.

This study estimates the fragility curve of an embankment dam based on a set of earthquake records. Vertical deformation is obtained using 2D finite element elasto-dynamic analysis. In this study, a set of seismic records were employed to present the variability in ground motion based on the spectrum in the Iranian national seismic code. The fragility parameters were obtained for minor damage limit state only. The semi-infinite environment is modelled using perfectly matched layer (PML) and dam-foundation interaction has been considered (Davoodi et al., 2018).

The model used in this study is shown in Figure 1.

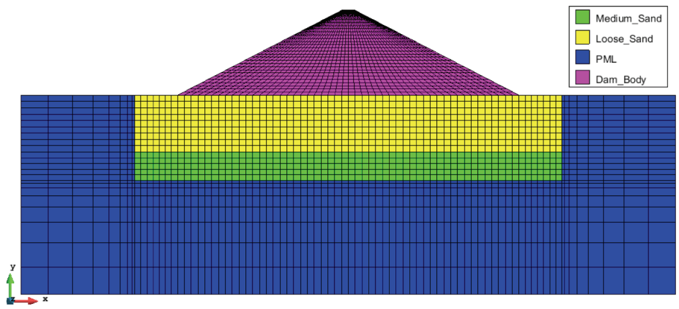

Figure 1. Geometry and mesh for a typical embankment dam.

The procedure for deriving analytical-based fragility curves for embankment dams is comprised of the following steps: 1) Generate an analytical 2D finite element model of the introduced dam; 2) Select earthquake ground motion records which are applicable to the geographical area of interest; 3) Scale the PGA of the selected records to different excitation levels; 4) Perform elasto-dynamic response analyses using the scaled records; 5) Obtain the seismic responses of the dam model; 6) Compare the obtained results with the limit states predefined in the model; 7) Set up reasonable parameters to produce fragility curves; 8) Produce analytical fragility curves of the dam as depicted in Figure 2.

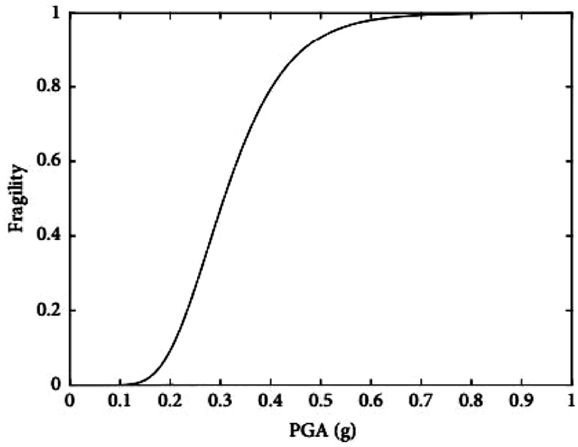

Figure 2. Fragility curve produced based on the PGA of embankment dam.

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