Dams and Earthquakes

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ABSTRACT

About 2% of the dam failures are said to be due to seismic activity [1]. The Bhuj earthquake, of magnitude (M_w) 7.6, occurred on January 26th, 2001 causing devastating damage to the region surrounding it. The peak free-field horizontal ground acceleration was found to be 0.5g. Many dams and embankments were affected by the bhuj earthquake. Liquefaction in the foundation, failure in upstream and downstream slopes and cracking was observed in the dams' post-earthquake. The consequences of these problems were not very severe at the time of the earthquake since the reservoirs were almost empty. The damage can be explained by few possible reasons. Firstly, it can be attributed to the insufficiency of measures used to combat liquefaction in the region of high alluvial soil deposits. Secondly, the high eccentricity formed due to the newly induced earthquake force, which was not considered during the original design, could have hampered the stability of the structure. Many schemes on strengthening the dams have been proposed to maintain dam safety.

The present study is on Koyna dam. Since the dam was built before the earthquake code IS 1893-1984 was published, failure due to high eccentricity cannot be attributed to a design flaw. Considering that dams are important structures of a growing economy, strengthening them from time to time has been deemed necessary. Strengthening is considered as an important process for the safety of dams. The basis of strengthening is the performance of the dam designed according to code available at time of construction in comparison to the performance of the dam when forces defined by revised code standards are applied to it. The study focuses on whether design flaws or flaws in code provision contribute to damage of the dam. While strengthening is imperative for correcting flaws based on code provisions, in the case of design flaws, strengthening loses meaning. In the present study, the forces acting on Koyna dam in accordance to IS 1893 – 1984 (Dams and embankments) are calculated and the stability of Koyna dam is calculated based on these forces. Based on the results, it is seen if adjustment of dam sections, local reinforcement, and post-tension technique [3], which are integral parts of strengthening, are imperative to the dam due to revision of code provisions or if the design flaws contributed to the damage endured by the dam.

Keywords: Dams, Earthquakes, liquefaction, strengthening.