Predictions of earthquake induced permanent deformations of dams by simplified and advanced methods of analyses

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The objective of this paper is to review the different simplified and advanced analytical methods available, for estimating earthquake induced permanent deformations of dams, and to evaluate their performance in predicting permanent deformations.

Two moderately high dams - El Infiernillo and La Villita - for which deformations during the 1979 Mexico earthquake are well documented, are utilized for this purpose.

The earthquake induced deformations predicted by the five different semi-empirical and empirical methods, like, Seed and Makdisi's method, Newmark's double integration method, Jansen's method, Swaisgood's method and Bureau's method, and by an advanced finite element package (FEM) called PLAXIS have been compared with each other and with the actual deformations of the dams recorded during the 1979 Mexico earthquake.

The present study shows that for the El Infiernillo dam, Makdisi & Seed's method [7] yields the most accurate values for the deformations. Swaisgood's method [15] and the FEM method also yield reasonable values. For the La Villita Dam, Swaisgood's method [15], and the FEM method produce the most reasonable values for deformations. Jansen's method [6] somewhat under predicts, and Makdisi & Seed's method [7] over predicts the deformations. For both dams, Bureau's method [4] significantly over predicts the deformations. Newmark's [8] double integration method gives zero displacement for both cases since the average acceleration (2/3 of peak ground acceleration) for the earthquake considered is lower than the yield acceleration of the dam materials.

The present exercise demonstrates that simplified methods like Swaisgood's and Makdisi & Seed's, along with FEM analysis, give reasonable estimate of earthquake induced deformations for relatively high dams.