HOW EFFICIENT THE WESTERGAARD ADDED MASS IS? THE CASE STUDY OF THE BAKHTIARI DAM, IRAN

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In this paper, the seismic behaviour of the Bakhtiary doubly curved arch dam in Iran has been comprehensively investigated by means of using the simplified Westergaard method as well as the dam-water-foundation rock interaction method. The Bakhtiary dam is designed to have 325 m height which will make it the highest dam, after construction, in the world.

A Finite Element Method (FEM) numerical model was constructed and the input ground motion was selected based on the dam natural period (Ghafory Ashtiany and Azarbakht, 2010; Lotfi, 2010). The response history analysis was performed for eight records based on the two numerical models consisting: (1) the FEM model by using the simplified Westergaard added mass method (Vahdani and Mirghaderi, 2010), and (2) the FEM model by taking the dam-water-foundation rock interaction into account (Sheibany and Ghaemian, 2004). For the purpose of simplicity, the second case is named 'the exact method' hereafter. The top displacement and top acceleration of the given dam are, respectively, shown in Figures 1 and 2 in the case of Imperial Valley earthquake (station of Delta, 352) input for the both considered cases. Additionally, the ratio of the maximum displacement based on the exact analysis over the Westergaard results is summarized in Table 1. As seen in Figure 1, the results show that the initiations of the two curves are meaningfully different since the gravity settlement is different in the two considered cases. This gravity settlement is greater in the case of the Westergaard added mass method when compared with the exact method. In addition, the peak displacement value in the two curves is quite different which confirms that the Westergaard method is somehow conservative. The reason is behind this fact that the amount of the added mass in the Westergaard method is not realistic. This amount of the added mass contributes to changing the dam dynamic behaviour as well as the seismic response.

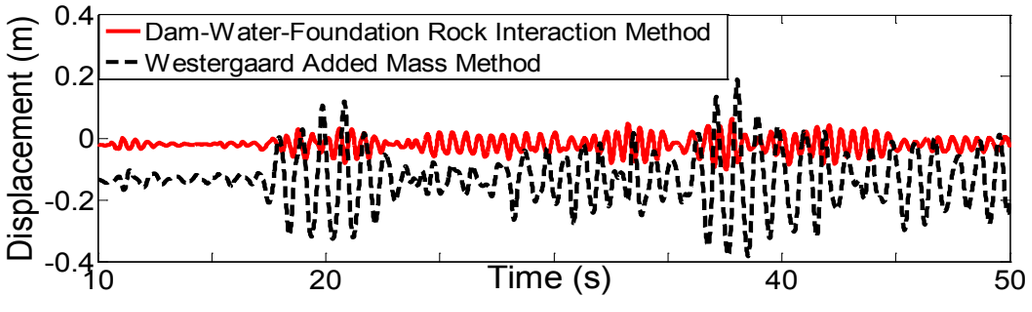

Figure 1. The dam top displacement based on the Wegetergaard and exact methods

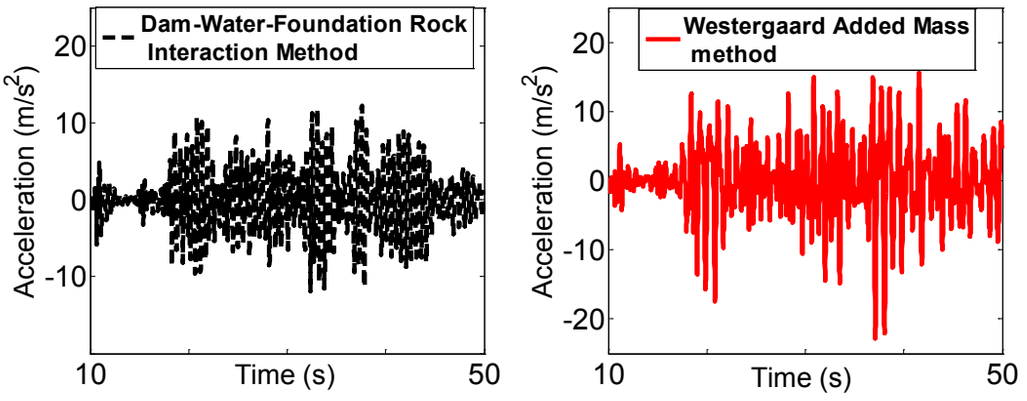

Figure 2. The dam top acceleration based on the Wegetergaard and exact methods

Table 1. The ratio of maximum displacement of the exact model to the Westergaard model for eight selected nodes

Earthquake	Station	Number of nodes on upstream dam							
		9	59	4014	4058	9013	9057	17003	17053
Imperial Valley	Delta, 352	0.53	0.53	0.24	0.4	0.24	0.37	0.31	0.33
Imperial Valley	El Centro,230	1.03	1.06	0.67	0.83	0.43	0.67	0.4	0.4
Landers	Yermo,270	0.41	0.23	0.22	0.27	0.23	0.27	0.27	0.29
Landers	Coolwater,LN	0.8	0.79	0.61	0.7	0.45	0.55	0.38	0.36
Loma Prieta	Gilroy,000	0.63	0.62	0.26	0.52	0.26	0.34	0.3	0.29
Superstition Hills	Poe,360	0.54	0.53	0.27	0.41	0.25	0.33	0.29	0.3
Chi-Chi	TCU045,N	1.01	1	0.4	0.71	0.35	0.5	0.36	0.37
Friuli	Tolmezzo,000	0.85	0.84	0.42	0.6	0.36	0.45	0.34	0.35

REFERENCES

Ghafory-Ashtiany M and Azarbakht A (2010) Strong ground motion record selection for the reliable prediction of the mean seismic collapse capacity of a structure group, Earthquake Engineering And Structural Dynamics in Wiley Online Library, 40:691–708

Lotfi V (2010) Dynamic analysis of concrete arch dams by ideal-coupled modal approach, *Engineering Structures*, 32(5): 1377-1383

Sheibany F and Ghaemian M (2004) Three Dimensional Thermal Stress Analysis of Concrete Arch Dams including earthquake effect, *Proc. of the 13th World Conference on Earthquake Engineering* Vancouver, B.C., Canada, Paper No. 488

Vahdani S and Mirghaderi R (2010) Seismic Analysis of Double Curved Arch Dams Based Performance, *Proceedings of the World Congress on Engineering and Computer Science*, Vol II WCECS 2010, San Francisco, USA