NONLINEAR SEISMIC EVALUATION AND ACCEPTANCE CRITERIA FOR ARCH DAMS

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ABSTRACT

Seismic performance of concrete arch dams has traditionally been assessed by stress checks using a linear elastic analysis. The design of new dams and evaluation of existing dams built in highly active seismic regions often require advanced nonlinear analyses. There are no established criteria for the nonlinear evaluation of arch dams. The paper attempts to provide a methodology for performing a nonlinear analysis and acceptance criteria for assessing the results.

Arch dams are constructed as individual cantilever blocks separated by vertical contraction joints with or without shear keys. The contraction joints are grouted to create a monolithic structure to resist operating loads. Water loads induce compressive arch stresses that keep the contraction joints closed ensuring a monolithic dam behavior. Severe earthquake ground motions, however, can overcome the hydrostatic compressive stresses and generate net tensile forces across the joint causing them to open and close repeatedly. In addition to the joint opening, the paper also discusses other major nonlinear mechanisms such as cracking at lift joints and foundation contacts as well as the stability of thrust blocks and kinematically moveable rock wedges as coupled systems in combination with the dam. Further, the paper considers the effects of dam-water and dam-foundation interactions and elaborates on the application of a compliant seismic input to excite the dam supported by a foundation model with mass, damping, and non-reflecting boundaries.

The paper presents an example dam to demonstrate the application of the nonlinear seismic evaluation, the acceptance criteria, and the compliant seismic input. The nonlinear analysis of the example dam uses advanced contact surfaces with failure criteria to predict potential cracking and sliding along lift joints and foundation contacts beneath the thrust block and the dam.

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