Nonlinear seismic assessment of lightly reinforced concrete intake towers

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SYNOPSIS. Published guidance on the seismic analysis of reinforced concrete intake/outlet towers is limited, especially for their nonlinear response, due to limited knowledge on the nonlinear characteristics of existing and new towers. Proving the integrity of existing towers is an international problem for dam owners, and an industrial need exists for a rational, cost-effective and validated method for their assessment.
This paper describes a series of tests aimed at investigating the seismic performance of typically reinforced, non-seismically designed towers. Monotonic and cyclic push-over tests were performed on $1/6^{th}$ scaled models. The results from the physical tests were used to validate a 3D nonlinear finite element model of the towers, using embedded steel reinforcement and a smeared crack model to simulate crack properties of the concrete material. The dynamic performance of the structures was investigated by developing a simplified single degree of freedom model and performing a number of simulations to obtain fragility curves of the system. This simplified model was capable of simulating the degrading, hysteretic properties of the towers and was used to perform nonlinear time history analyses using a range of parameters. A probabilistic approach was selected as the basis of the performance evaluation process using fragility analyses as a tool for modelling the uncertainty associated with the parameter selection. Based on the experimental and analytical results, a three-staged assessment procedure for the seismic performance assessment of the towers was proposed.

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