ABSTRACT

The precise and accurate prediction of responses of concrete gravity dams during earthquakes at any age is essential for the safety of the habitations living on its downstream side. The decision of retrofitting or strengthening the existing dams necessitates accurate analysis of the same due to degradation of concrete and accumulation of sediments at the reservoir bottom with time. Therefore, a rational analysis procedure is necessary which should be capable of taking care of the degradation effects due to ageing of concrete, the effect of sediments at the reservoir bottom and the interaction effects among dam, its foundation and the adjacent reservoir. Due to varied geometry of the dam and reservoir bed, the finite element method is considered to be one of the most suitable techniques to model these three systems.

A finite element based code has been developed to study the response of these three systems in a coupled manner. A suitable truncation boundary condition has been incorporated to model the infinite reservoir into finite one. Similarly, the infinite soil-foundation domain has been truncated with a suitable non-reflecting boundary condition at the artificial truncation surfaces. The displacement based finite element is used to formulate the dam and foundation, whereas, the reservoir is modeled by pressure based formulation to reduce the degrees of freedoms as well as the computational time. A direct coupling method has been developed to obtain the dam-reservoir-foundation interaction effects. The present algorithm also includes the time dependent degradation due to environmental condition and mechanical loading in terms of isotropic degradation index. At the same time, the concrete in the gravity dam may deteriorate due to continuous contact with water and for harsh environmental conditions.

The developed algorithm can assess the behavior of dam at any age during life time so that the remedial measure can be undertaken to strengthen or perhaps decommission the dam at the right time. The absorption of pressure waves at the bottom of the reservoir due to the deposition of sediments has also been incorporated in the developed code. The efficacy of the present algorithm has been demonstrated through numerous examples. The parametric study shows the importance of consideration of the ageing, sediments and dam-reservoir-foundation interaction effects.

KEYWORDS: *Dam-reservoir-foundation interaction, Direct coupling, Free field response, Added response, Degradation index, Reservoir bottom absorption, Finite element method, Seismic response*