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Seismic Margin Assessment of Elevated RCC Water Tank Supported on RCC Circular Shaft

Vipin Kumar Sharma[1], Paresh Kothari[1], Praveen Kumar[1], Leni Ranjith[1], Girish V Shenai[1]

[1]Bhabha atomic Research Centre, Mumbai

Abstract

Many elevated water tanks suffered damage to their staging (support structure) in the Mw 7.7 Bhuj earthquake of January 26th, 2001. The reinforced cement concrete (RCC) circular shaft-type support for elevated tanks lacks redundancy, damping and additional strength typically present in building framing systems and, therefore, require scrutiny of their designs. The elevated water tanks are inverted pendulum-type structures which resist lateral forces by the flexural strength and stiffness of their circular hollow shaft type staging. The section close to the ground is subjected to the maximum flexural demand. Any damage to the staging at this critical section should be considered alarming as it can seriously undermine its lateral load-carrying capacity. Hence, it is essential to study nonlinear behaviour of such critical structure against lateral load. This paper addresses the analytical work on seismic margin assessment of elevated RCC water tank supported on shaft type staging. A Pushover analysis is performed on an elevated water tank of 16-meter height and 65 m^3 capacity. This elevated water tank is supported on the circular RCC shaft. In this study, different practical approaches utilizing frame and shell elements for modelling the RCC elevated water tank (EWT) are used and compared. In framed based model, moment curvature relationship for hollow circular shaft is evaluated for hinge characteristics. In shell element-based model, stress strain curves for the layer of concrete and rebar are defined as layered shell element in SAP2000. Kent and park model for concrete and bilinear model for rebar's are used in both approaches. After pushover analysis, performance point is evaluated using capacity and demand curve as per ATC40 procedure and seismic margin is obtained. The seismic margin of EWT is evaluated for the various cases such as reinforcement disposition on the both faces, reinforcement present only on outer face and for the cut out located at X face of the shaft in presence of both face of reinforcement.

Keywords: Pushover analysis, Nonlinear shell element, Seismic margin, Elevated water tank, Shaft support, Reinforced cement concrete