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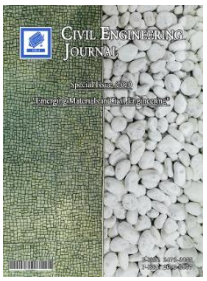

Influence of Nonlinear Fluid Viscous Dampers on Seismic Response of RC Elevated Storage Tanks

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Abstract

The numerical investigation on the seismic response of RC elevated liquid storage tanks installed with viscous dampers is presented. A discrete two-mass model for the liquid and multi-degree of freedom system for staging, installed with the dampers are developed for Reinforced Concrete (RC) elevated liquid storage tanks. The elevated tank is assessed for seismic response reduction when provided with Linear Viscous Damper (LVD) and Nonlinear Viscous Damper (NLVD), installed in the staging. The RC elevated liquid storage tanks are analyzed for two levels of liquid containment in the tank, 100% and 25% of the tank capacity. Three Configurations of placements of dampers viz. dampers at alternate levels (Configuration I and Configuration II) and dampers at all the panels of the staging of the tank (Configuration III) are considered. To study the effect of peak ground acceleration, eight real earthquake time histories with accelerations varying from 0.1 g to 0.93 g are considered. The nonlinearity in the viscous damper is modified by taking force proportional to various velocity exponents. It is found that the nonlinear viscous dampers with lower damping constant result in a comparable reduction in the response of RC elevated liquid storage tank, to that of linear viscous dampers with higher damping constant. A lower damping constant signifies compact the size of the damper.

Keywords: RC Elevated Liquid Storage Tank; Linear Fluid Viscous Damper; Nonlinear Fluid Viscous Damper; State-space; Seismic Analysis.

1. Introduction

The seismic safety of liquid storage tanks is of prime importance, and their response should be controlled using various control strategies. Liquid storage tanks are considered as lifeline structures and should remain functional during and after the earthquakes. Their performance during strong earthquakes is of critical concern. Most of the failures of large tanks during earthquakes are suspected of having resulted from the dynamic buckling caused by overturning moments of seismically induced liquid inertia and liquid surface slosh waves. Due to its complex dynamics and variable liquid levels, behavior of the elevated liquid storage tank cannot be estimated by the similar approaches used in the case of the high-rise buildings.

Several research works reported in the literature, guidelines, and specifications in international codes are available for seismic analysis and design of the liquid storage tanks. Housner (1963) [1] studied the dynamic behavior of ground supported and elevated water tank. Further, Haroun and Housner (1982) [2]; and Haroun [3] carried out vibration studies on ground supported, deformable cylindrical water tanks; and derived parameters of the mechanical model.

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