SEISMIC ANALYSIS OF CONCRETE RECTANGULAR CONTAINERS ISOLATED BY DIFFERENT ISOLATION SYSTEMS

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ABSTRACT

The liquid storage containers are one of the most important structures of the lifeline and industrials facilities in all over the world. These structures can be used as grounded, pneumatic and embedded containers. The grounded concrete tanks are widely used for the long-term storage of nuclear spent fuel assemblies. Hence, protection of these structures against severe seismic events has become crucial. Numerous studies have been done for the seismic analysis of fluid containers. Most of them are concerned with cylindrical or rectangular tanks with fixed-base. This paper focuses on analyzing the results of seismic responses of flexible rectangular tanks isolated by three types of outstanding isolation systems. The considered systems are high damping rubber-bearing (HDRB), lead-rubber bearing (LRB) and friction pendulum bearing (FPB). An equivalent mechanical model of rectangular tanks is used in this study which contains three lumped masses known as: convective mass, flexible mass and rigid mass. Eventually, the seismic isolation systems are found to be very effective in reducing the base shear and hydrodynamic pressures but usage of this technology found to have adverse or/and neutral effects on the sloshing height. An increase in displacements for all isolation systems in horizontally isolated tanks seems to be inevitable.

INTRODUCTION

Concrete rectangular containers play an important role in the rescue work after an earthquake. These structures are exposed to a wide range of seismic hazards and interaction with other sectors of the built environment too. Based on observation from previous earthquakes, it showed that the seismic response of a flexible tank may be substantially greater than that of a similar rigid tank. Consequently, the seismic response of liquid storage tanks can be strongly influenced by the interaction between the flexible tank and the fluid within it. Recently, Hashemi et al (2013) investigated the dynamic response of flexible 3D rectangular liquid storage tanks with flexible walls on all four sides, subjected to horizontal seismic ground motion and they developed an equivalent mechanical model for estimating the dynamic response of these structures. Flexibility of the walls is particularly expressed in their equivalent model.

Recent research shows that using a seismic isolation system under liquid storage tanks affects the efficiency of seismic behavior of these structures. Chalhoub and Kelly (1990) observed that the sloshing response increases slightly but the total hydrodynamic pressure decreases substantially due to the base isolation of the tanks. Kim and Lee (1995) experimentally investigated the seismic performance of liquid storage tanks isolated by laminated rubber bearings under unidirectional excitation and have shown that the isolation is effective in reducing the dynamic response. Malhotra (1997) investigated the seismic response of base isolated steel tanks and found that isolation was beneficial in reducing the response of the tanks over traditional fixed base tanks without any significant change in sloshing displacement. Shenton and Hampton (1999) studied the seismic response of isolated elevated tanks and found that seismic isolation is effective in