NON-LINEAR SEISMIC RESPONSE OF LOW-RISE LIQUID STORAGE TANK ISOLATED BY LEAD-RUBBER BEARINGS

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Earthquakes have generated serious damages to a great number of industrial equipments, especially liquid storage tanks that are tremendously important regarding to economic and environmental consequences. Therefore, it is highly demanding to utilize methods for decreasing the seismic vulnerability of such structures. Base isolation as a seismic protective device is already recognized and its evolution continues to spread. This study focuses on the seismic assessment of steel storage tanks isolated by Lead-Rubber Bearings (LRB) which modeled in SAP2000 v20.0. Base isolation has appeared as one of the most powerful and valuable high-tech systems for keeping safe infrastructure under real ground motions. The effect of isolation on both the impulsive and the convective (sloshing) responses of the liquid storage is investigated for steel tanks storage, which is presented that base isolation can decrease remarkably the hydrodynamic forces, overturning moments and axial compressive stresses in the storage tank without considerably intensifying the horizontal displacements of the liquid surface expected to the convective motion. The present model is able to simulate the fluid-structure interaction under three-dimensional behavior of the isolated storage tanks including the nonlinear hysteresis behavior of base isolation. Seven pairs of real ground motions records with different characteristics are selected to illustrate the advantage of LRB isolated in minimizing the base shear force values and sloshing displacement for steel storage tank compared with fixed-base support.

Housner (1963) proposed a lumped mass model of rigid liquid storage tanks and examined its seismic response. These models were developed by Haroun (1983), which considers the effect of flexibility for the tank wall in the seismic analysis. Uckan et al. (2018) investigated the seismic response of base isolated liquid storage tanks to real and simulated near-fault pulse type ground motions. The structural model considered for cylindrical liquid storage tank is shown in Figure 1. Based on the design spectrum (Tehran, soil type 2), seven pairs of earthquake records due to Design Basis Earthquake (DBE, with 10% probability of the occurrence in 50 years and the return periods of 475-year) are scaled by SEISMOMATCH corresponding to geotechnical conditions of the site (Table 1).

Table 1. Strong ground motions used in the analyses and their details.

Earthquake	**Bam**	**Cape Mendocino**	**Imperial Valley**	**Kobe**	**Loma Prieta**	**Northridge**	**Tabas**
Station	Cheshmeh Sabz	Cape Mendocino	El Centro	Takarazua	Capitola	Arleta	Tabas
Years	2003	1992	1940	1995	1989	1994	1978
Fault Mechanism	Strike slip	Reverse	Strike slip	Strike slip	Reverse oblique	Reverse	Reverse
Magnitude (M_w)	6.6	7.01	6.95	6.9	6.93	6.69	7.35

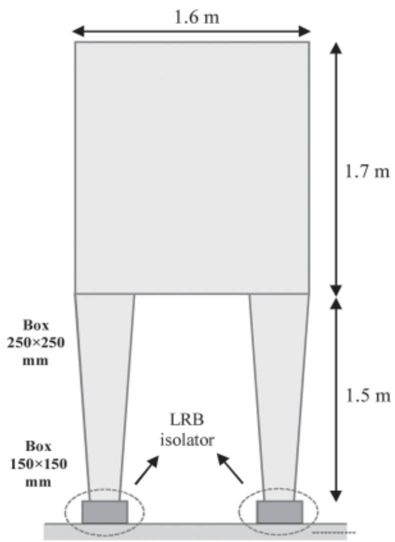

Figure 1. Structural model for cylindrical liquid storage tank and LRB isolator.

The advantage of using LRB isolation system on the steel storage tank is evaluated through seven pairs of real strong ground motions. By concentrating on changing values of base shear and maximum displacement (Figure 2), it can be realized that both of this values considerably decreased according to LRB base isolation.

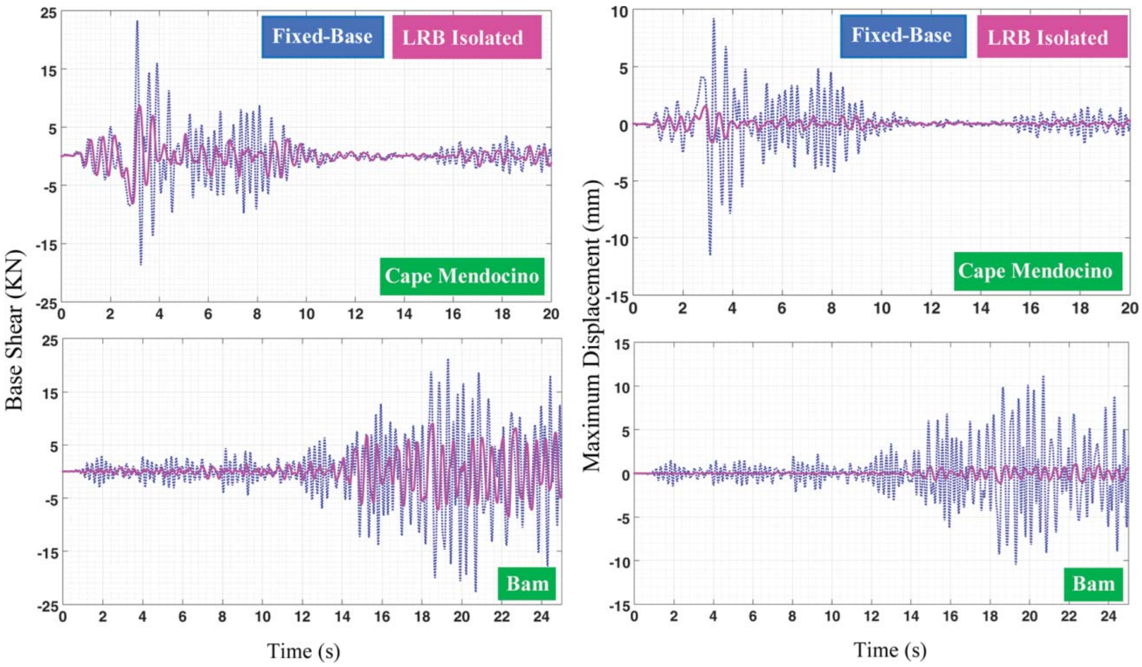

Figure 2. Base shear time history response and maximum displacement under Cape Mendocino and Bam, compared with fixed-base and LRB isolated.

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