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A REVIEW ON SIESMIC ANALYSIS OF MULTI STORY BULDING HORIZONTALLY DAMPED

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Abstract : The development of high-strength materials and construction technologies has led to longer-spanning and taller buildings. Hence, control of vibrations induced in structures by lateral loads, such as wind and earthquakes, is an important consideration in the design of high-rise buildings. Typical methods to improve the structural safety and serviceability of these high-rise buildings involve installing additional vibration suppression devices in them. The tuned liquid damper (TLD) is an attractive option for passive structural vibration control due to the distinct advantages of low installation and maintenance costs and easy amenability to design modifications.

***Keywords* - tuned liquid damper, high-strength materials, vibrations control . earthquakes**

I. INTRODUCTION

Tuned liquid dampers (TLDs) are being used for controlling the dynamic response (such as displacement, acceleration etc.) of structures subjected to high wind velocities and strong earthquake ground motions (Konar and Ghosh 2021), (Samanta and Banerji 2010). The current trend toward buildings of ever increasing heights and the use of lightweight, high strength materials, and advanced construction techniques have led to increasingly flexible and lightly damped structures (Bhattacharjee et al. 2013). Understandably, these structures are very sensitive to environmental excitations such as wind, ocean waves and earthquakes. This causes unwanted vibrations inducing possible structural failure, occupant discomfort, and malfunction of equipment. Hence it has become important to search for practical and effective devices for the suppression of these vibrations.

Fluid structure interaction formulation

The basic finite element (FE) formulation for fluid-structure (in this case frame structure) considered in this study is mentioned below (Tanveer et al. 2019). A Schematic diagram of a structural frame, attached with TLD at top is shown in Figure 2.

$$[M]\{\ddot{X}\} + [C]\{\dot{X}\} + [K]\{X\} = -[M]\{\ddot{X}_g\} + \{F_{TLD}\}$$

where, $[M]$ is a global mass matrix of the frame

$[C]$ is global damping matrix of the frame and here it is assumed to be null matrix as inherent damping of structure is neglected

$[K]$ is global stiffness matrix of the frame

$\{X\}$ is global displacement vector for all degrees of freedom

$\{\ddot{X_g}\}$ is ground acceleration vector

$\{F_{TLD}\}$ is resisting force to the structure at respective nodes offered by TLD.

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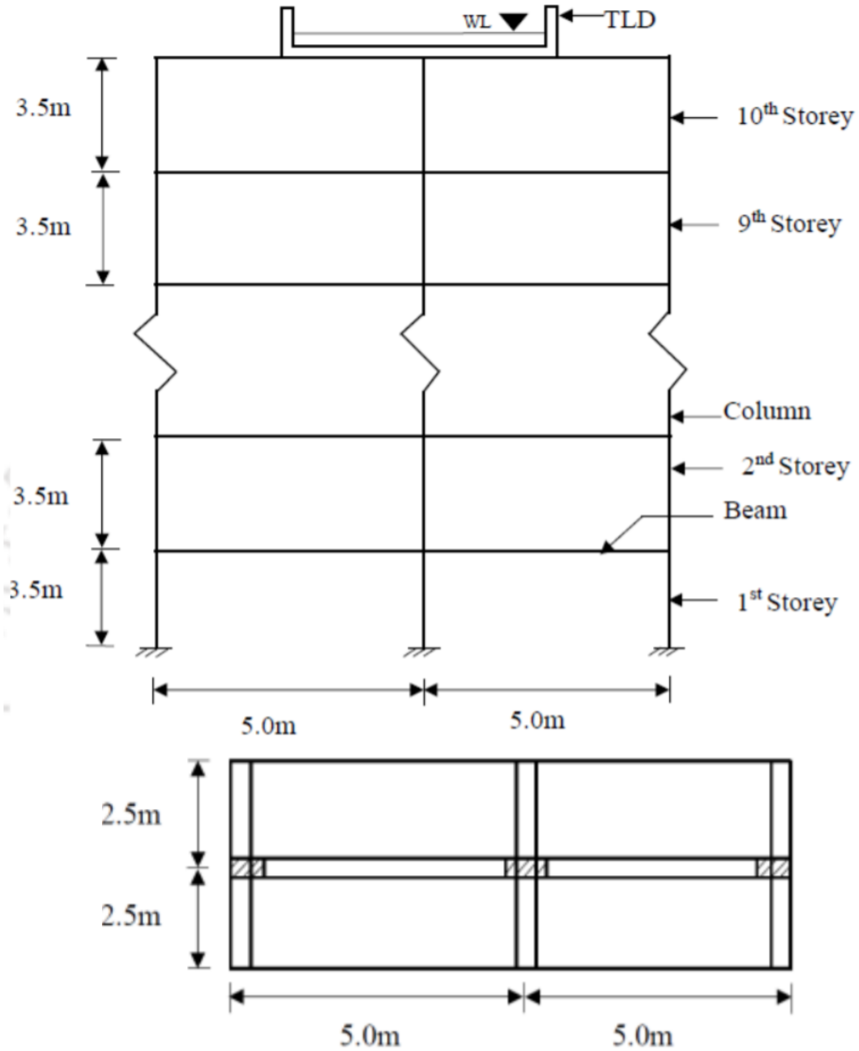

Figure 1 Structural model of a 2D representative frame (a) Elevation, (b)Plan

F_{TLD} is given by the expression

$$F_{TLD} = \frac{\rho g b}{2}[(\eta_n + H)^2 - (\eta_0 + H)^2]$$

where ρ is the density of liquid, ηn and ηo is wave height right and left wall, and H is the still height of the liquid in the tank (or TLD).

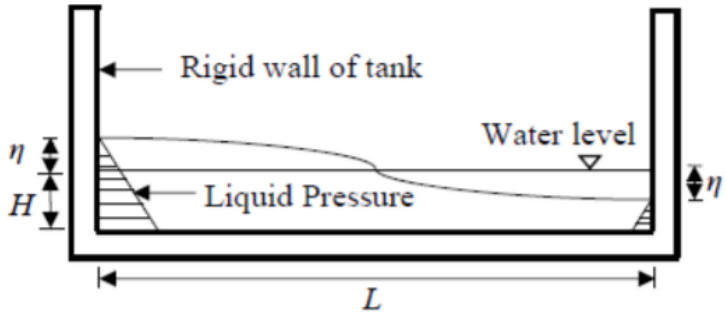

Figure 2 Dynamic liquid pressure on wall of TLD

Assumptions

- The liquid is considered homogeneous, irrotational and incompressible.
- The walls of the damper are treated rigid.
- The structure is considered linear.

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- Wave breaking effect is considered through two empirical constants.
- Structure, behavior is considered linear.
- The pressure on the free surface is considered constant.

The rigid rectangular tank shown in figure 3 with the length 2a, width b and the undisturbed water level h is subjected to a lateral displacement xs. The liquid motion is assumed to develop only in x-z plane.

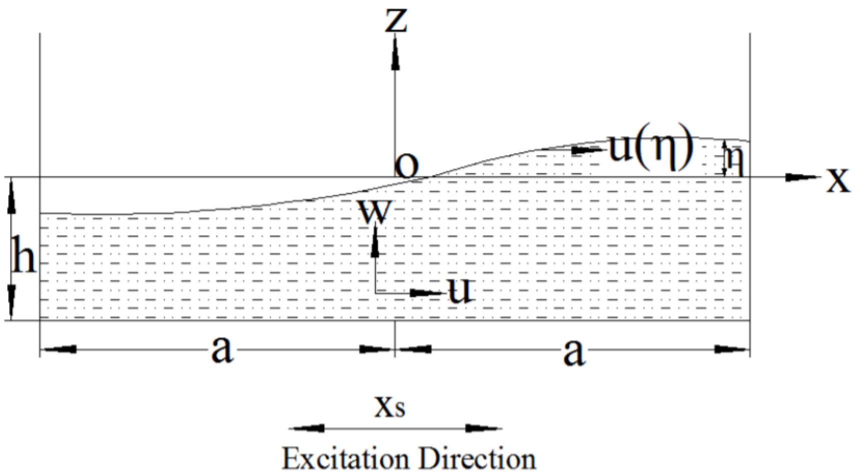

Figure 3 Rigid rectangular tank

II. Literature Review

(Ishak et al. 2021) Earthquake can cause many problems to the structures, which lead to building collapse and may takes humans life. One of the effort to reduce the structural response is by introducing the damping system to the buildings where the energy of the system is slowly reduced until the vibration of the system is eliminated and the system is brought to rest. Several techniques are available nowadays, however passive control system has advantage in term of cost especially in Malaysia where the earthquake is not the major threat like in Japan but it is good to tune existing water tank to became a passive damper where it is there went situation needed. The objective of the present paper is to analyse the practicality of implementing multiple water tank as passive Multiple Tuned Liquid Damper and finding the best position of water tanks, which would reduce peak response of the structure subjected to seismic forces using SAP2000. 15 multi-storey concrete structure attached with five water tanks with 3 different situation of water tanks location under consideration. In order to study the depth ratio parameter, the water level was varies for each situation such as ¼ tank for all water tanks, half tanks for all water tanks and ¾ tank for all water tanks. The results shows that Position 2 filled with ¾ water has highest significant reduction in term of structural displacement which is 12.6mm compare to other water tanks positions and water level.

(Ubair Gull Khan 2020) elevated structure has been built everywhere on over the world and the number is expanding step by step. This isn't just because of worried over high thickness of populace in the urban communities, business zones and space sparing yet additionally to build up land marks. As the seismic burden following up on a structure is a component of oneself load of the structure these structures are made similarly light and adaptable which have moderately low common damping, and in this manner the structures become more vibration inclined under wind and tremor stacking. To guarantee the useful execution of tall structures, different plan adjustments are conceivable, extending from elective basic frameworks to the use of inactive and dynamic control gadgets. This paper presents an outline of cutting-edge measures to lessen basic reaction of tall structures, including a conversation of assistant damping gadgets for moderating the seismic tremor and wind-initiated movement of structures. To guarantee the useful execution of tall structures, different plan adjustments are conceivable, running from elective auxiliary frameworks to the use of aloof and dynamic control gadgets. Latent tuned mass damper (TMD) is broadly used to control auxiliary vibration under wind load yet its viability to lessen tremor-initiated vibration is a developing procedure.

(Gowda et al. 2020) Current patterns in development industry requests taller and lighter structures, which are likewise progressively adaptable and having very low damping worth. This builds disappointment potential outcomes and furthermore issues from usefulness perspective. Presently a-days a few procedures are accessible to limit the vibration of the structure, out of the few methods accessible for vibration control, idea of utilizing TLD is a more up to date one. This study means to consider the feasibility of Tuned Liquid Dampers (TLD) in decreasing the seismic vibration of a structure when it is exposed to horizontal excitation. TLD is a water bound compartment, or essentially a water tank, which utilizes the sloshing vitality of water to diminish the dynamic reaction of a structure when it is exposed to excitation. In this investigation, a technique for design TLD for a structure has been recommended and a strategy has been proposed to demonstrate the TLD in ETABS 2018 software.

(Rana et al. 2018) project aims to study the effectiveness of Tuned Liquid Dampers (TLD) in reducing the seismic vibration of a building when it is subjected to horizontal sinusoidal excitation. TLD is a water confined container, or simply a water tank, which uses the sloshing energy of water to reduce the dynamic response of a structure when it is subjected to excitation. In this study, a procedure for designing TLD for a building is suggested and a method is proposed to model the TLD in SAP2000 software. Then, multiple analyses have been carried out to analyse the effect of different parameters of TLD which may affect its performance. Analyses are conducted with varying mass ratio, tuning ratio, excitation ratio, number of storeys, position of TLD, etc. The structural response is compared based on maximum base shear, maximum relative acceleration and maximum displacement of top storey. With reference to the results from these analyses, conclusions are derived and recommendations are given for an optimal design of TLD.

(Novo et al. 2014) focused on the study of an earthquake protection system, the tuned liquid damper (TLD), which can, if adequately designed, reduce earthquake demands on buildings. This positive effect is accomplished taking into account the oscillation of the free surface of a fluid inside a tank (sloshing). The behaviour of an isolated TLD, subjected to a sinusoidal excitation at its base, with different displacement amplitudes, was studied by finite element analysis. The efficiency of the TLD in improving the seismic response of an existing building, representative ofmodern architecture buildings in southern European countries was also evaluated based on linear dynamic analyses.

(Umachagi et al. 2013) Dampers have become more popular recently for vibration control of structures, because of their safe, effective and economical design. This paper presents an overview of literature related to the behavior of dampers on seismically affected structures. The review includes different types of dampers like metallic dampers, viscoelastic dampers, frictional dampers etc.

III. CONCLUSION

A recent works occurring in the application of tuned liquid damper technology is presented. Now-a-days TLD systems widely used due to their unique advantages such as cost effectiveness, fewer mechanical problem, easy handling and easy tuning. Besides water present in the damper can be used for fire-fighting purpose. Examples of practical application of these technologies to real world structures were also provided. To increase the performance of TLD system and to make them more efficient and effective these are some parameters which can be considered:

- A hole can be placed at the base of the floating container ensures maintenance of required water level above the floating base while the liquid level in the tank fluctuates due to functional requirements.
- Investigation of performance of sloped bottom TLD with variable density and variable viscosity of liquid.
- Investigate performance of tuned liquid damper with curved edges of varying radius at bottom.

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