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Reduced Effect of Vibration by Using Different Liquids in Tuned Liquid Column Damper: an Overview

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Abstract - An earthquake is the identifiable shaking of the surface of the earth, results in the instant release of kinetic energy in the form of seismic waves. It could be enough for the destruction of structures and thus result in high human casualties along with the financial loss.
Presently tuned liquid column dampers are used in high buildings. A tuned liquid column damper ~TLCD! is a particular type of supplementary damping device which believe on the inertia of a liquid column in a U-tube to prevent the forces acting on the building. Tuned liquid dampers properties can be vary using different shapes of water containers, additional barriers, different types of liquids etc. Tuned liquid column dampers (TLCDs) are energy desolating substructures, which is used to upgrade the dynamics of structures. The main principle of TLCD is the energy transferring from the vibrating host structure to the TLCD.
A Tuned liquid damper is water cramped in a container, generally situated on top of a building that utilizes the sloshing energy of the water to minimize the dynamic response of the system. The TLDs also used to minimize the wind persuade structural vibration. The aim of this paper is to exhibit the efficacy of a tuned liquid damper (TLD) by using different type of liquids.
Keywords—Seismic Response, Tuned liquid column damper, Sloshing energy

I. INTRODUCTION

The current trend regarding buildings of ever growing heights and the utilization of light and high-strength materials led to very ductile and damped structures. Reasonably, these structures are highly sensitive to environmental stimulation like wind and earthquakes. Due to the action of one or a amalgamation of these loads, a building may encounter dynamic load effects which leads to structural failure, fatigue, discomfort. Among many solutions to minimize this serious issue, motion control devices have been implementing in the buildings [1].
A tuned liquid damper ~TLD! is a particular class of tuned mass dampers ~TMD! Where the mass is substitute by liquid ~mostly water. The sloshing of the liquid resembles the movement of the TMD mass. $TLCD_s$ depend on the motion of the liquid column in a U-tube to prevent the forces act upon the structure, with damping established in the oscillating liquid column through an orifice [2].
When an earthquake waves moves through the building, it is subjected heavy forces, acceleration and displacement that creates the building highly unstable and suddenly it fall down. Mass damper, liquid dampers, base isolators are among the different choices to minimize the vibrations on the buildings. A tuned liquid column damper is water cramped in a container that utilizes the sloshing energy of the water to minimize the dynamic response of the system when the system is faced to excitation. TLD has also been highly effective in cancelling vibrations generated due to wind. TLD is highly effective for minimizing low frequency vibrations created due to wind, financially effective, less maintenance and easily executable.
The aim of this paper is to experimentally check that TLD can significantly damp vibrations in a building. The objective of this paper is to verify the effect of vibration by using different liquids in tuned liquid column dampers.

II. OVERVIEW OF TUNED LIQUID DAMPERS

Liquid motion is a composite process with various parameters that normall0y described with the fluid dynamics laws. TLD properties can be generally changed using different types of water, different shapes of water tanks with or without additional barriers inside.
Generally liquid dampers are connected to the main structure. Liquid motion inside the damper creates oscillations in opposite phase to principal structure and relative damping effect.

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A. *Tuned liquid column dampers (TLCD)*

One of the most common categories of liquid dampers is tuned liquid column damper (TLCD). TLCD is U- shaped tube charged with liquid. Liquid moves from one vertical column of U tube to the other generating horizontal damping force due to collision on vertical walls and abrasion between liquid and tube in horizontal part. Liquid movement in TLCD can be elaborated by hydraulic laws. Due to this TLCD are used in engineering practice.

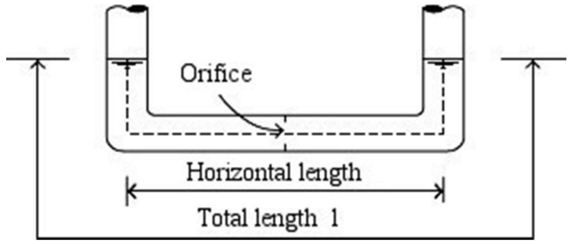

Fig.1 Principle Structure of TLCD [3].

Where,
l= Total length of water column

B. *Modified Tuned Liquid Column Dampers*

In this type of tuned liquid column damper two TLCD is placed in orthogonal directions. The effect of damping in both the direction of main vibration will be assumed. Such system is also known as double tuned liquid column damper (DTLCD) [4].

The Circular/torsional tuned liquid column dampers (CTLCD/TTLCD) are recommended for the torsional movement of eccentric structures [1]. In this type of damper the shape of damper tube is circular and should be merging with DTLCD and also to provide the damping effect for all types of main construction motion.

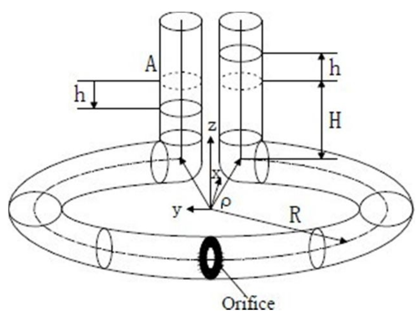

Fig.2. Scheme of Circular/Torsional TLCD [5].

C. *Sloshing liquid dampers (SLD)*

The construction of Sloshing dampers are very simple in comparison to the other types of liquid dampers normally, it is a rectangular or barrel-shaped container with appropriate all the dimensions that is partially filled with liquid. Generally the sloshing dampers are meant by the term tuned liquid dampers due to their simple construction.

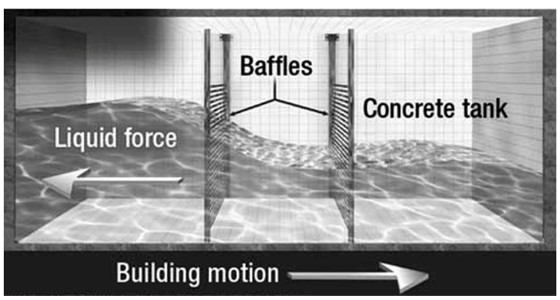

Fig.3.SLD with additional slat screens (baffle) [6].

According to the dimension of dampers, the sloshing liquid dampers are divided into Shallow and Deep dampers. Generally, the effectiveness of dampers decreases, if the water depth to tank length ratio is less than (0, 10)… (0, 15) [7], [8].

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D. Bi-directional liquid dampers (BLD)

In the Bi-directional liquid dampers the transversal direction sloshing effect occurs and such dumper works in one direction as TLCD, but in other as Sloshing liquid damper. This construction is known as bi-directional liquid damper (BLD) or combined liquid damper [9], [10].

III. PROCEDURE

For performing the experiment a skeleton structure of the building is constructed with the help of rigid and flexible members (PASCO). The flexible members were positioned in the direction of the base stimulation. A U-tube container is placed on the top of the building and caged using rigid or flexible members to neglect any movement of U-tube container. A scale is also placed at the top of the building to measure the displacement of building. Also a similar type of skeleton structure of the building is constructed but the U-tube container is not place in this structure.

Insert different viscosity of liquids (water, hair oil, Mobil etc.) one by one to compare the deflection of the building. At last we draw the graph between displacements vs. time to show the result.

IV. FUTURE SCOPE OF STUDY

A. By considering different types of liquids, we can carry out the present study.

B. In which liquid the displacement of structure is minimum is compared?

V. CONCLUSION

The experiment performed is mainly done to verify the efficiency of Tuned liquid dampers. Also this experiment is done to check the displacement caused by the earthquake varies when different viscosity of liquid into the tuned liquid column damper.

VI. ACKNOWLEDGMENT

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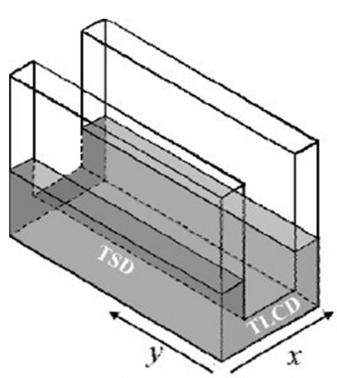

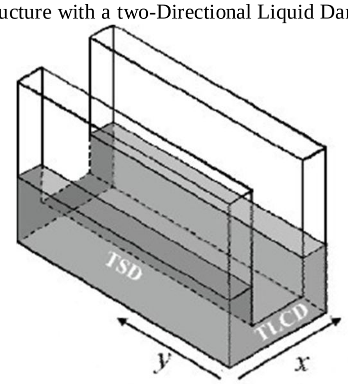

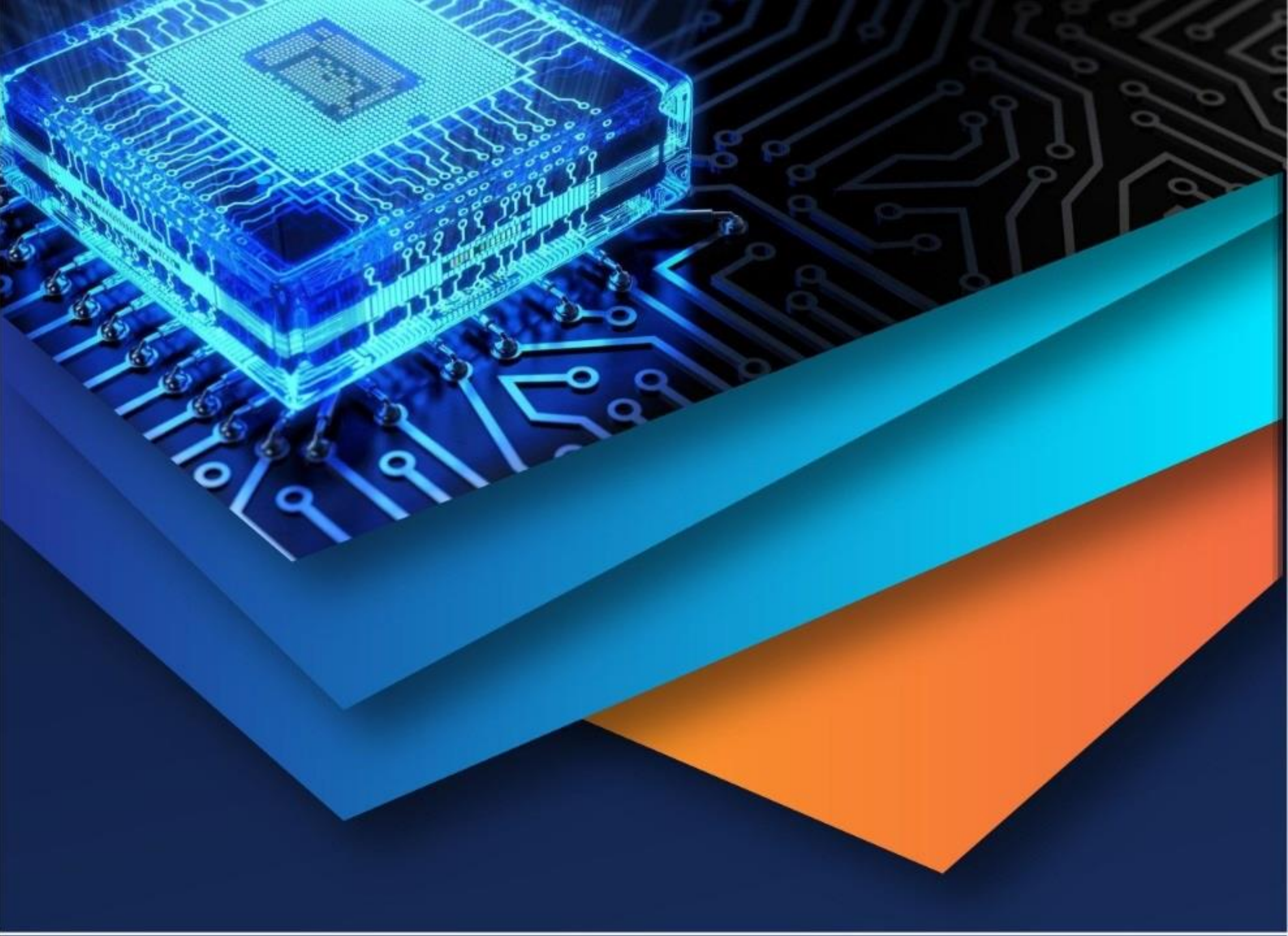

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