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Damper Systems for Reinforced Concrete Structures

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Abstract - *Dampers are the members provided to reduce oscillation which develops due to excitation. In this paper different types of dampers are presented. This paper reviews experimental studies carried out on structures provided with tuned liquid damper (TLD). The literature review suggests that for effective damping, damper may be provided at top storey resulting in faster dissipation of oscillations.*

Key Words: Dampers, TLD, Forced Excitation, Oscillation, Dissipation, Lumped Mass, Stiffness.

1. INTRODUCTION

Dampers are provided to reduce oscillation which develops due to excitation. Excitation is caused due to dynamic actions acting on the structure either by earthquake forces, wind forces, blast forces, etc. during this phenomenon oscillation takes places with respect to time. By providing dampers resistance is offered to oscillation, hence continuous reduction in amplitude takes place and finally it rests [1,2,11–20,3,21–23,4–10].

1.1 Types of Dampers

There are different types of dampers used in structures to dissipate oscillation some of them are Hysteretic damper[1,2], Viscous damper [1], Liquid tuned mass damper [3,4,13–17,5–12], tuned mass damper [12], Liquid tuned column damper[15,18–23], etc. damping phenomenon of these dampers are due to their material properties either due to friction within the material, viscosity of the material, sloshing effect caused by the material.

1.2 Experimental Study Carries out

Performance of the TLD is studied through experiment by preparing the model of 3-DOF system placed on shake table fixed at bottom, forced excitation is produced to it and characteristics of vibration is obtained[3,7,13] . Mass of roof and columns of each storey is considered as one lumped mass connected to a single spring of stiffness (Kb) where Kb is the combined effect of all the column in the respective storey[7]. Experiment is conducted for the system without provision of dampers and for the system provided with dampers. For dampers provided at top storey resulting in faster dissipation in oscillations.

2.1 Types of Dampers

- Hysteretic damper
- Viscous damper
- Liquid tuned mass damper
- Tuned mass damper
- Liquid tuned column damper

Table -1: Types of Dampers

Hysteretic damper	Damping takes place by friction with in a material. Usually, low yield strength steel is used due to its good ductility performance [1,2].
Viscous damper	Damping takes place due to viscosity of the material. It is a stainless-steel dashpot; fluid viscous dampers work at ambient temperature of 40°C to 70°C.
Liquid tuned mass damper (TLD)	Damping caused by sloshing effect of the liquid on the walls of the tank. Water, viscous liquids such as oil, kerosene, water combined with sand etc. are used. usually, water tank with large area or swimming pool is provided as the damper[3,7,13].
Tuned mass damper	**TMD include pneumatic or hydraulic dashpots, viscoelastic materials,** and magnetic damper [12].
Liquid tuned column damper (TLCD)	Induces oscillations in a liquid column rather than sloshing tank [15,18–22].

2.1 Experimental study carried out:

Experiment is conducted by developing 3-DOF system on the shake table and subjected to two types of trails. (1) free vibration test and (2) excited vibration test.

Free vibration is conducted by pulling the system by 50mm and released due to which system starts oscillating and comes to rest after some time, corresponding response of the system is recorded [3,7].

Excited vibration test is conducted provided with frequency varying from 0.9-2.5Hz and displacement of each storey is calculated (a) by without providing TLD and (b) providing TLD in each storey individually and corresponding response of the system is recorded[3].

In first trail TLD is placed in first storey and excitation is provided and corresponding response is recorded. Similarly, second and third trails is carried out by placing TLD in second floor and third floor respectively [3,7].

Sloshing frequency of TLD is calculated using expression

$$f_w=\frac{1}{2\pi}\sqrt{\frac{3.16g}{L}\tanh\left(\frac{3.16H}{L}\right)} \quad \text{............... [3]}$$

where, '*L*' is length of tank in direction of excitation

'*H*' is depth of water

'*g*' is acceleration

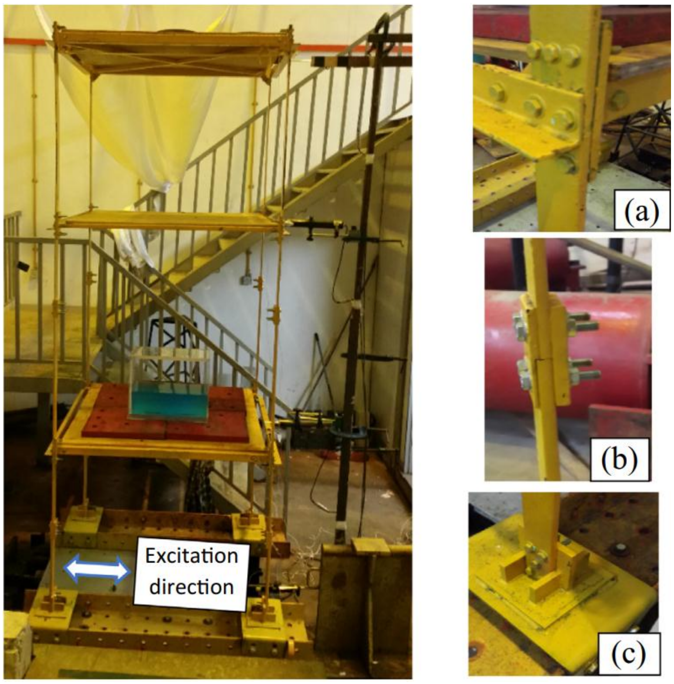

Fig -1: Test setup. (a) Beam-to- column connection (b) column splices (c) connection to the base.

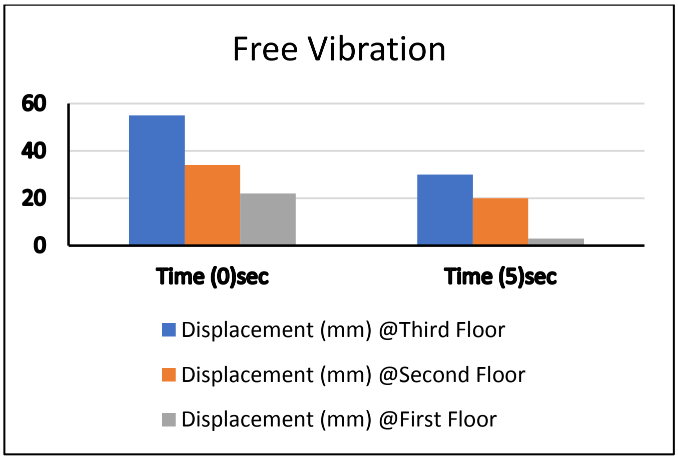

Chart -1: Structural Response of Peak Displacement to Free Vibration.

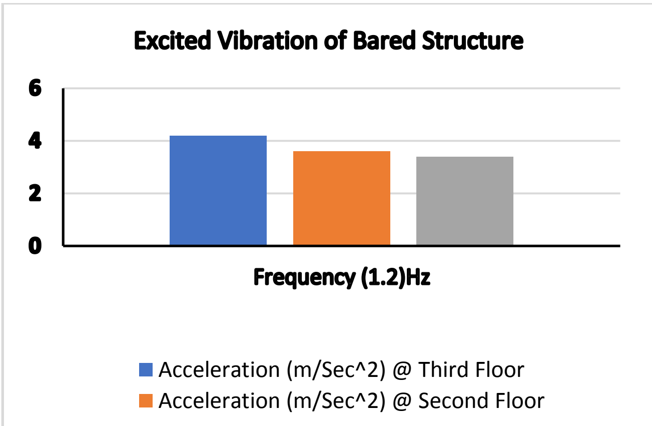

Chart -2: Structural Response of Peak Acceleration to Excited.

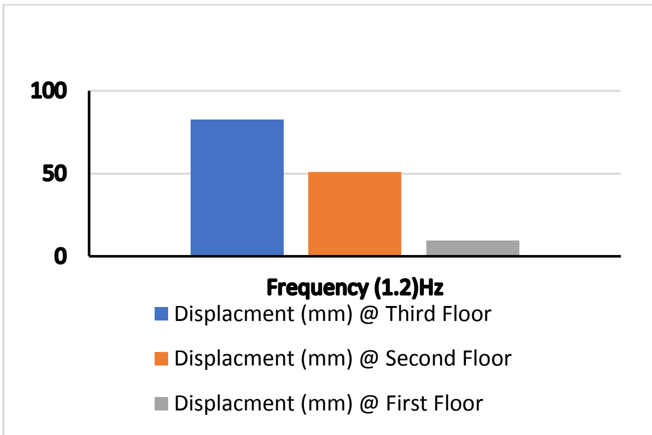

Chart -3: Structural Response of Peak Displacement to Excited Vibration.

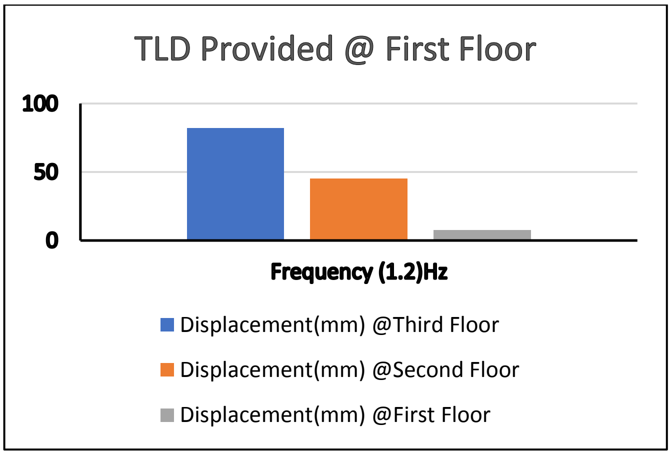

Chart -4: Structural Response of Peak Displacement to Excited Vibration when TLD provided at First Floors.

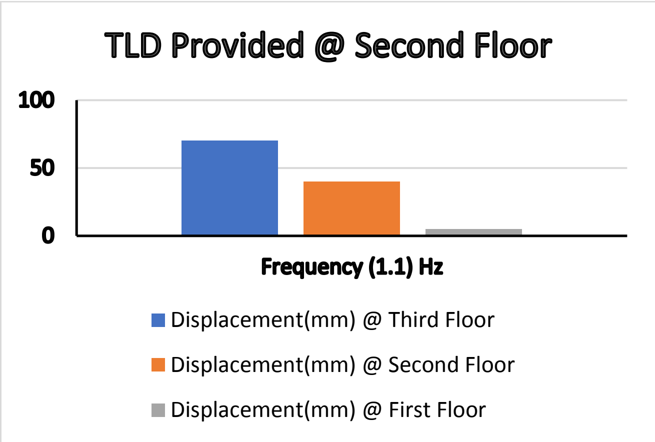

Chart -5: Structural Response of Peak Displacement to Excited Vibration when TLD provided at Second Floor.

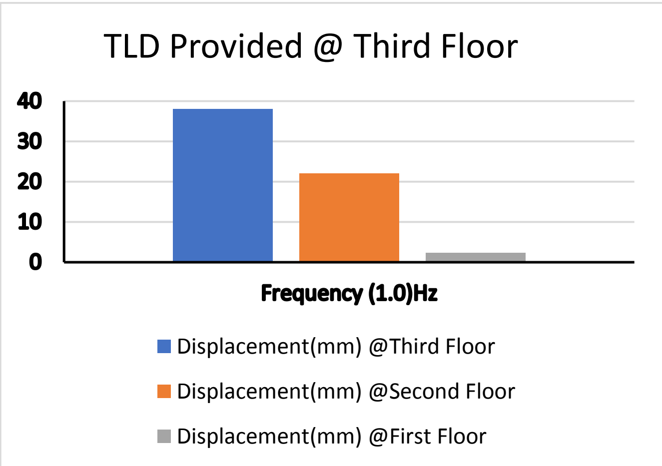

Chart -6: Structural Response of Peak Displacement to Excited Vibration when TLD provided at Third Floor.

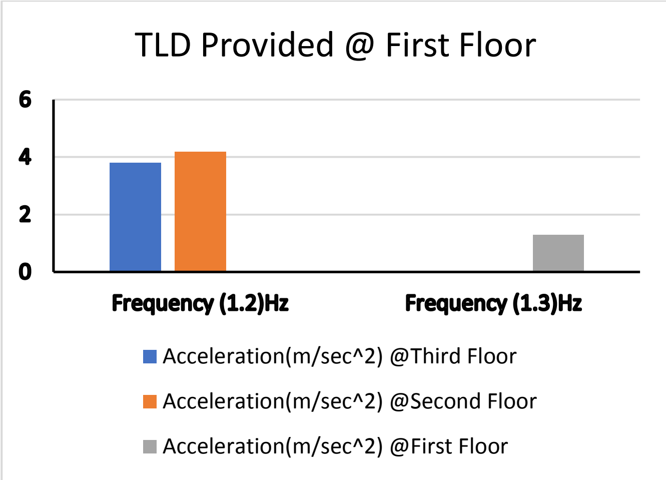

Chart -6: Structural Response of Peak Acceleration to Excited Vibration when TLD provided at First Floor.

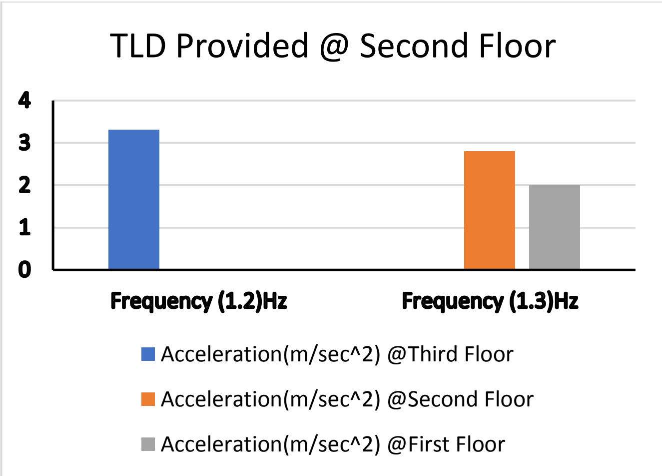

Chart -6: Structural Response of Peak Acceleration to Excited Vibration when TLD provided at Second Floor.

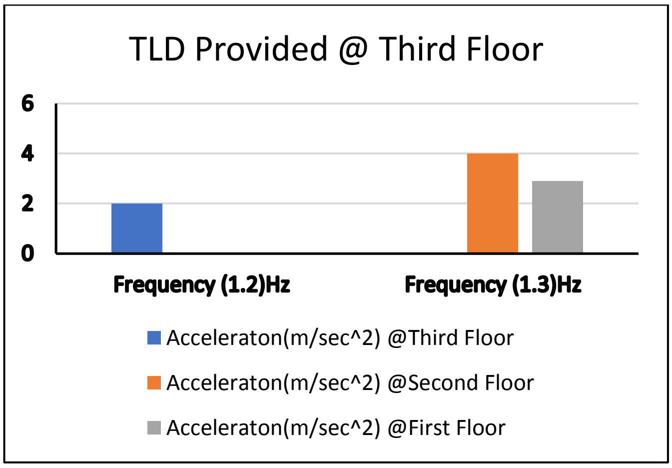

Chart -6: Structural Response of Peak Acceleration to Excited Vibration when TLD provided at Third Floor.

3. CONCLUSIONS

Following are the conclusions are summarised based on type of dampers and effect of damper system on RC structures.

- Hysteretic damper requires less area to provide in structure and it has good ductility characteristic whereas other type of dampers requires more area.
- TLD required large area, swimming pool can be considered or this type and has good response against forced excitation.
- Water used as TLD can reduce 55% of displacement, using oil can reduce 40% of displacement and combination of water and sand particles has good effect of 65% of reduction of displacement [13].
- From experimentation of 3-DOF system it is observed that displacement reduction is more effective when the dampers are provided at third storey level compared with second and storey levels.
- It can be concluded that dampers provided at top storey level has more effective damping effect.

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