STUDY AND ANALYSIS OF DIFFERENT TYPES OF DAMPERS IN REDUCING THE VIBRATION OF STRUCTURE

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Abstract: During an earthquake the principal attack on a structure is by horizontal force in different directions. The resistance of the structure against earthquake depends on elastic strength, in elastic deformability, damping capacity or a combination of all. In recent years there is a considerable research and development of structural control devices to control seismic response of buildings. many vibration control measures like passive, active semi active and hybrid has been developed of structural control devices to control vibration dampers served as one of the most effective active systems. There are many types of dampers in based on that there if efficiency effectiveness varies.

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Introduction

Vibration control is an important aspect when designing buildings, especially if they are tall. Due to lateral forces building faces vibrations in even directions which causes in general auxiliary removal and moving of CG of the structure. The present pattern toward the buildings of regularly expanding statures and the utilization of light-weight, high quality materials, and propelled construction procedures have prompted progressively adaptable and daintily damped structures. Justifiably, these structures are exceptionally delicate to ecological excitations, for example, wind, sea waves and seismic tremors. This causes undesirable vibrations prompting conceivable auxiliary disappointment, inhabitant distress, and glitch of equipment. Henceforth it has turned out to be imperative to scan for useful and viable gadgets for concealment of these vibrations.

In this study we are considering a tall Steel structure of G+10 storey, considering tuned liquid damper at C.G. of the structure considering Non-linear seismic load (Zone-III &V) as per I.S. 1893-I:2016.

Damper_Dampers are strategically placed in the building structure to control floor vibration and building displacement cutter for occupancy comfort and mitigate against major seismic events. The energy generated by floor vibration and building displacement is absorbed by the damper and dissipated through heat energy.
Type of Damper

- Viscous damper
- Friction damper
- Tuned mass damper
- Yielding damper
- Magnetic damper

Viscous damper: viscous damping is a way to add energy dissipation to the lateral system of a building structure. A viscous damper dissipates energy by pushing fluid through an orifice, producing a damping pressure which provides a force or seismic energy. In this damper, by using viscous fluid inside a cylinder, energy is dissipated. Due to ease of installation, adaptability and coordination with other members also diversity in their sizes, viscous dampers have many applications in designing and retrofitting.

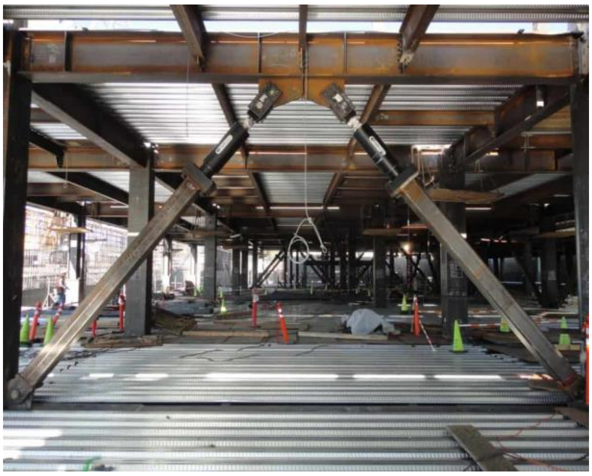

FIG: Viscous damper (For homes) FIG: Viscous damper (For bridges)

Application – automobile, bracing in buildings, with base isolators, bridges.

Friction damper: Friction Dampers are normally modeled directly in structural design software either directly or more commonly, as a fictitious yielding element The two main outputs of the structural design being the required response force and travel. With these two parameters, Quaketek can provide Dampers ranging from 0.5kip (2kN) to 350kips (1500kN) of tested response force per damper with travels commonly between 0.5inches (12mm) and 12inches (300mm). Larger response forces can be generated by connecting the dampers in parallel, generating in excess of 1,400kips (6,000kN)

Dampers can be designed for indoor or outdoor applications as the finishes can be adapted for different environments.

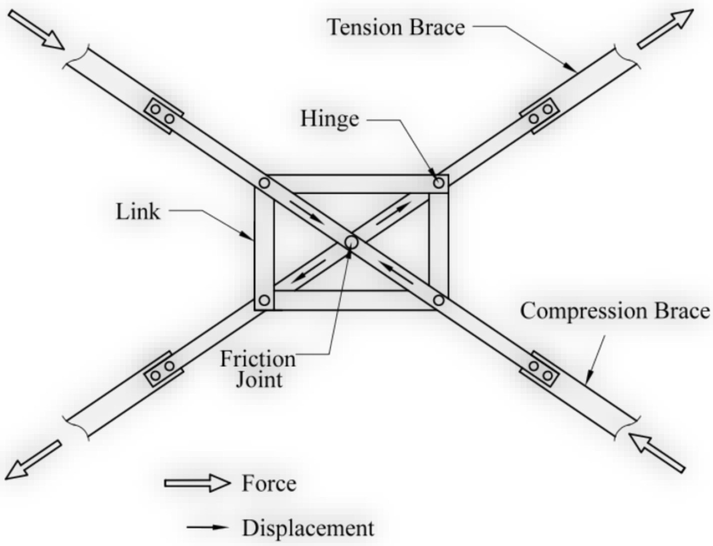

FIG: Friction Damper

Application as a bracing retrofitting of building, low cost.

Tuned mass damper: A **tuned mass damper** (**TMD**), also known as a **harmonic absorber** or **seismic damper**, is a device mounted in structures to reduce mechanical vibrations, consisting of a mass mounted on one or more damped springs. Its oscillation frequency is tuned to be similar to the resonant frequency of the object it is mounted to, and reduces the object's maximum amplitude while weighing much less than it.TMDs can prevent discomfort, damage, or outright structural failure. They are frequently used in power transmission, automobiles and buildings.

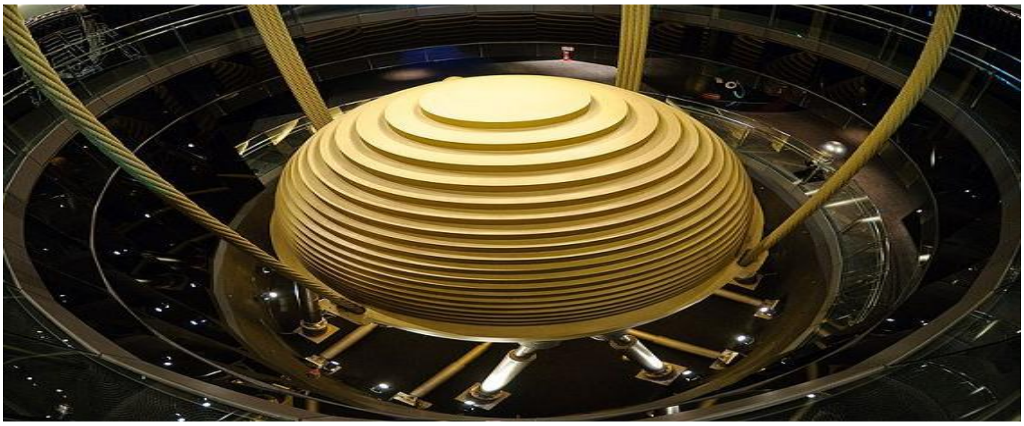

FIG: Tuned mass damper

Application – Transmission line, automobile, Tall buildings, spacecraft

Yielding dampers: Yielding damper or metallic yielding energy dissipation device or passive energy dissipation device is manufactured from easily yielded metal or alloy material .It dissipates energy through its plastic deformation (yielding of the metallic device) which converts vibratory energy and consequently declines the damage to the primary structural elements. yielding dampers are economical, effective, and proved to be a good energy dissipater.

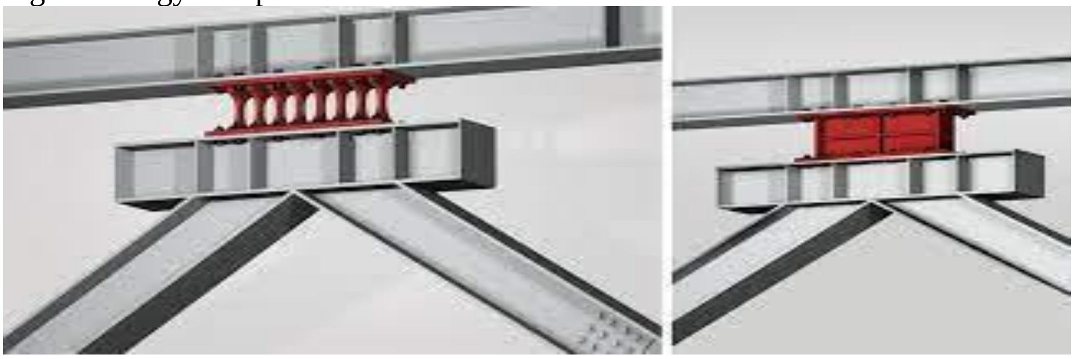

FIG: Yielding damper

Application – To reduce the seismic response of enter story drift.

Magnetic damper: Magnetic Damper consists of two racks, two pinions, a copper disk and rare-earth magnets. This type of damper is neither expensive nor dependent on temperature. Magnetic damping is not strength that is why it is effective in dynamic vibration absorbers which require less damping.

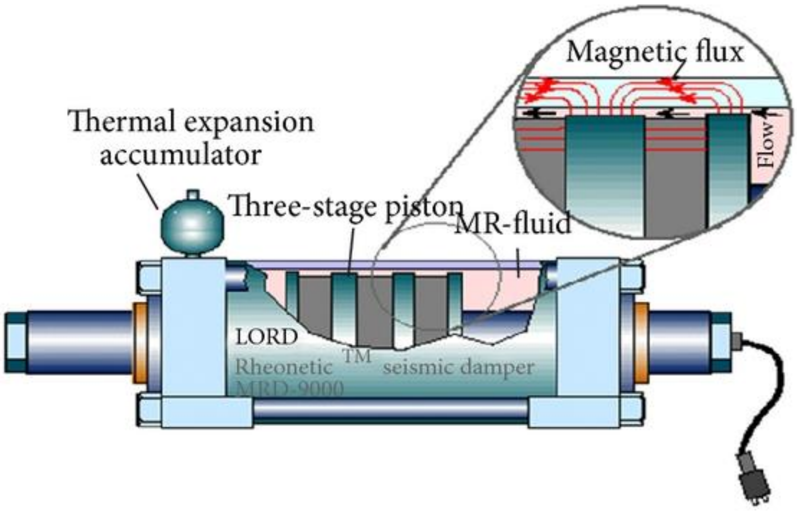

FIG: Magnetic damper

Application – energy is absorbed due to magnetic induction.

LITERATURE REVIEW

Bhattacharya et. al. (2016) The authors paper dealt with evolution of the various numerical codes so as to signify the effectiveness of tuned sloshing dampers considering fluid structure interaction effects. The case study included a five storey structure under harmonic ground excitation maximum percentage reduction of 47.7% in response of the structure as top floor displacement was observed for mass proportioning of 90% at fifth floor and 10% at the fourth floor. It was likewise seen that tuned water tank performed adequately as a damper notwithstanding for the mass proportioning of 60% at fifth floor and 40% at the fourth floor giving a rate decrease of 44.4 in the structure highest floor displacement.

Kuriakose and Lakshmi P.(2016) Author proposed TLD tanks for a 40storey building situated in Kerela, India, where the structure was firstly modelled and then its fundamental natural frequency was found out by carrying out free vibration analysis. Second stage was to model TLD into the structure and monitored changes in natural frequencies. The structure was subjected to an earthquake loading (El-Centro Earthquake) and its frequency response was compared without TLD's and with TLD's. The results derived after carrying out the normal mode analysis of the structure with TLD tanks stated that the structural frequency increase with increasing mass ratios, making it less vulnerable to exciting forces. The reduction in amplitude was found as 28.73 %. Eight tanks were proposed with 5 x 4.25 x 3 m dimensions with a water depth in each tank to be maintained was 0.985 m.

Srinivasa et. al. (2015) Here the author presented the performance of a tuned mass damper (TMD) under wind and earthquake loads (multi-hazard loading) considering a 76-story benchmark building for the analysis under multi-hazard loading. The research paper adapted the use of pounding tuned mass damper (PTMD) and performance of the structure was analyzed and obtained results were later compared with a conventional TMD. Along with the comparison, the performance of viscous dampers in reducing earthquake effects was further investigated with a primary objective to further, the comprehension of the effect of multi-peril loading, brought by wind and seismic tremors, on the conduct of tall structures, to apply such information to plan.

METHODOLOGY

In this research work our motive is to evaluate seismic assessment of tuned liquid damper over a steel building considering lateral load as per I.S. 1893

In this study our main motive is to determine the capability or the design life of an steel building frame under lateral loading using analysis tool ETABS.

Flow Chart of the study

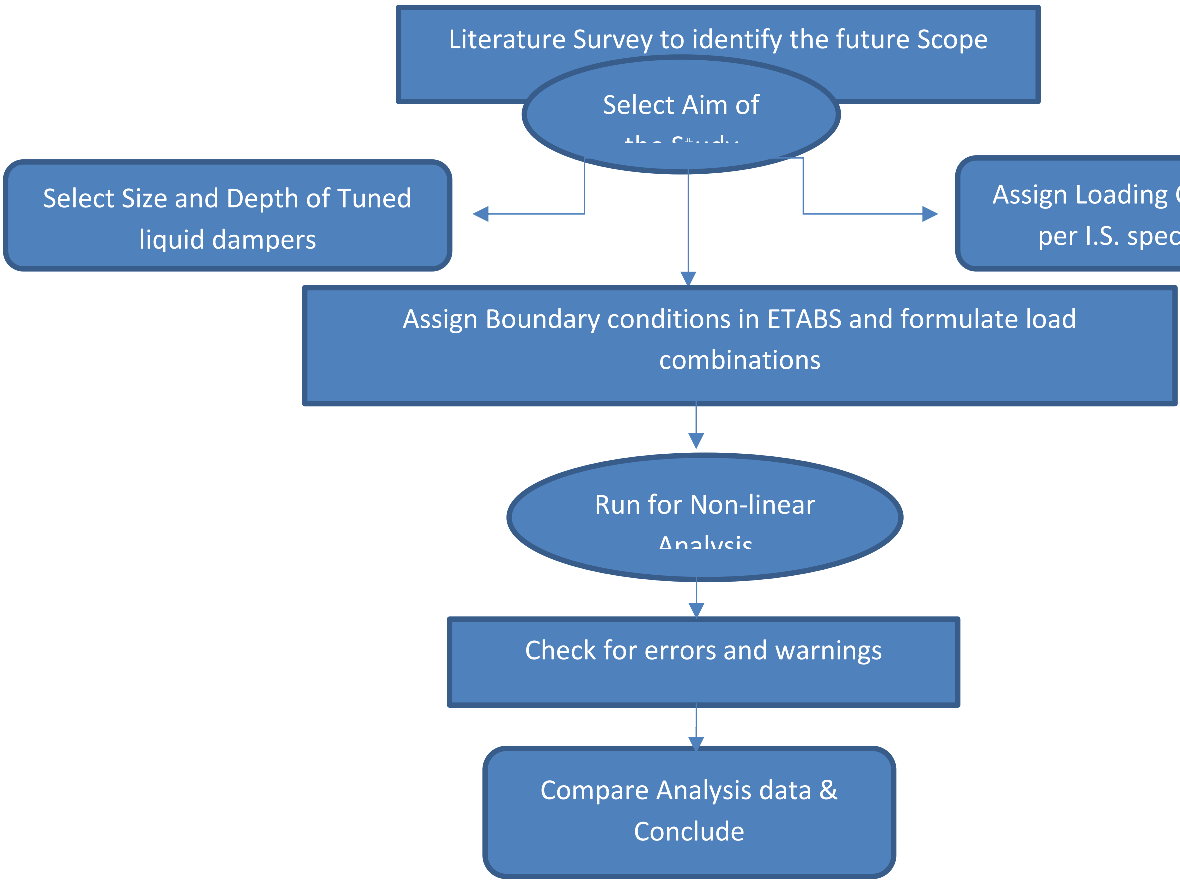

Fig: Flow chart of the study

Table: Max. Shear Force

Max. Shear Force (KN)		
Zone	**General structure**	**TLD structure**
III	**490.34**	**443.2**
V	**877.4**	**794.55**

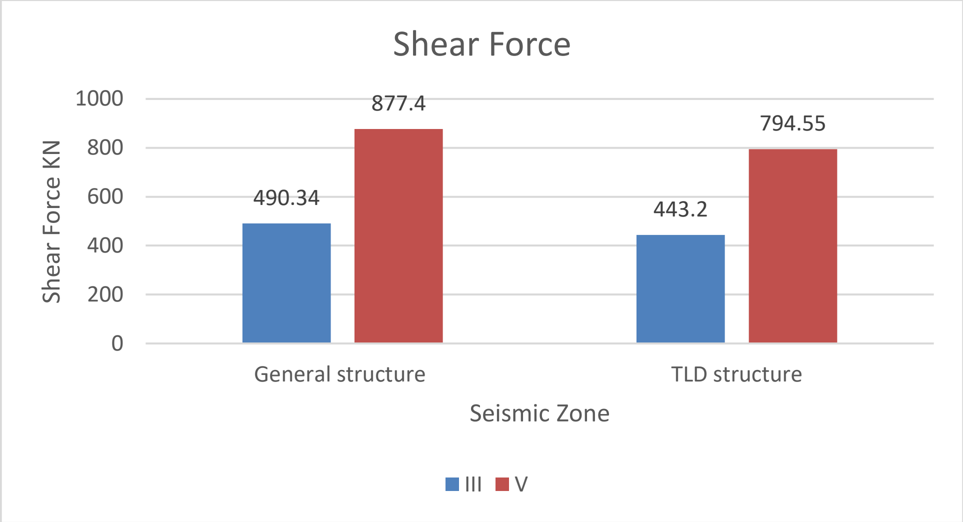

Fig : Max. Shear Force

Maximum Axial Force:

Table : Max. Axial Force

Max. Axial Force (KN)		
Zone	**General structure**	**TLD structure**
III	**1076.5**	**1021.05**
V	**1013.21**	**1063.22**

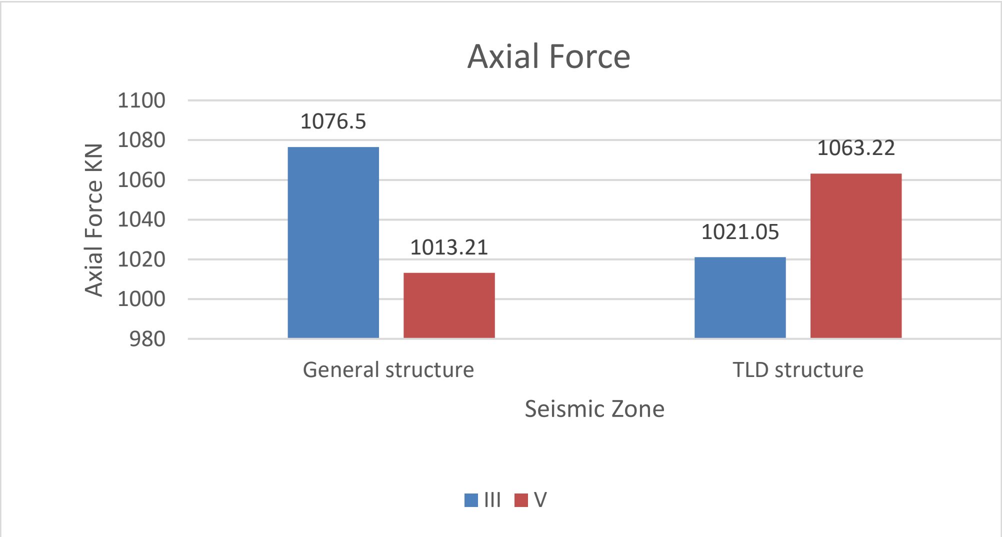

Fig : Max. Axial Force

Storey Displacement in Zone III:

Table : Storey displacement in zone III (MM)

S.NO.	**Storey displacement in Zone III**	
	Conventional	**TLD**
10 STOREY	31.045	18.351
9 STOREY	28.21	16.44
8 STOREY	25.307	14.537
7 STOREY	22.358	12.647
6 STOREY	19.379	10.788
5 STOREY	16.387	8.969
4 STOREY	13.396	7.225
3 STOREY	10.42	5.59
2 STOREY	7.472	4.075
1 STOREY	4.571	2.706
GF	1.809	1.512
BASE	0	0

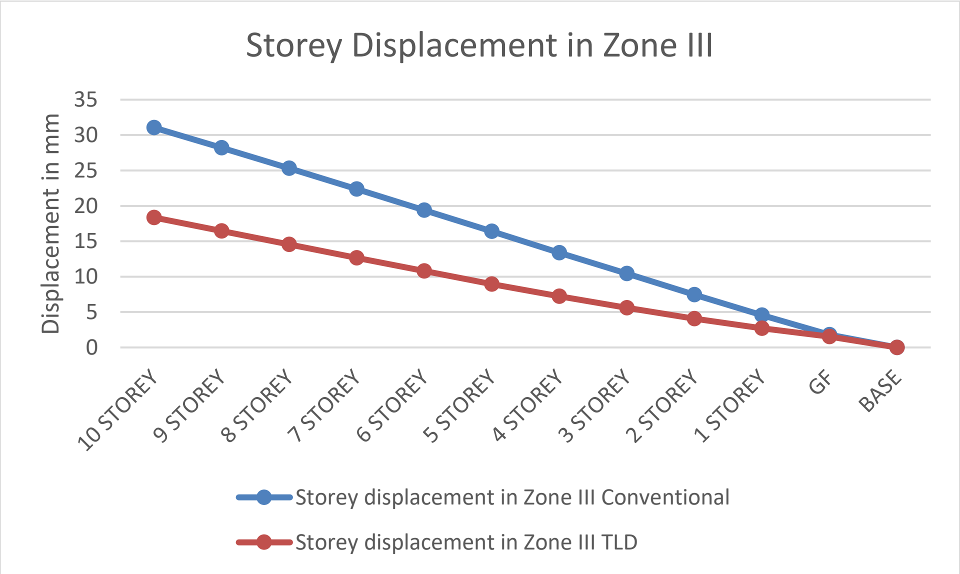

Fig : Storey Displacement in Zone III

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Max. Storey Displacement in Zone V:

Table Storey displacement in zone V (MM)

S.NO.	Storey displacement in Zone V	
	Conventional	TLD
10 STOREY	69.852	43.594
9 STOREY	63.471	38.927
8 STOREY	56.941	34.294
7 STOREY	50.305	29.725
6 STOREY	43.603	25.276
5 STOREY	36.87	20.967
4 STOREY	30.141	16.848
3 STOREY	23.445	12.98
2 STOREY	16.811	9.44
1 STOREY	10.285	6.393
GF	4.071	3.966
BASE	0	0

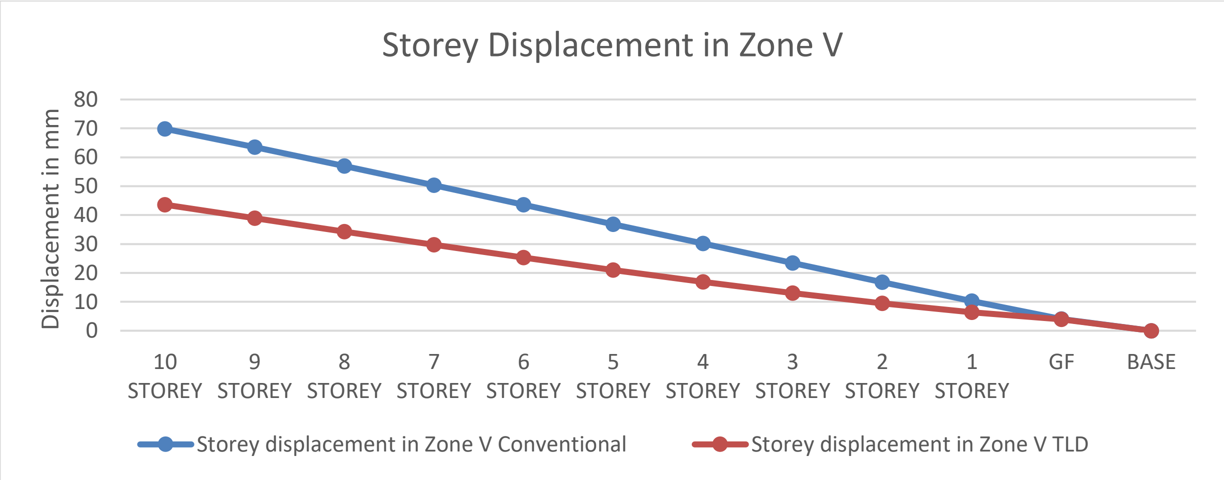

Fig Storey Displacement in zone V

Advantages

- It provides safety and protects lives during earth quake
- It minimize structural damages
- It increases the strength and life span of the structure
- They do not depend on an external power source for there operation
- They can respond to small level of excitation
- Their property can be adjusted in the field
- They can be cost effective
- They require low maintenance
- They can also be introduce in upgrading structure

Disadvantage

- It is costlier
- A large mass or a large space Is needed for their installation
- The effectiveness of a TMD is constrained by the maximum weight that can be practically placed on top of the structure.
- Their effectiveness depends on the accuracy of their tuning but natural frequencies of a structure can not be predicted with great accuracy.

Uses

- Dampers are used to control both direction and volume of air flow.
- To reduce the action of earth quake in seismic areas
- To provide mitigation against wind forces

Conclusion

Storey Displacement:

It is observed that tuned liquid dampers are fit for opposing the general removal of the structure because of seismic forces, in contrast with general structure it is 38.4 % increasingly steady and opposing uprooting which outcomes in keeping up structure in reasonable point of confinement.

Bending Moment:

Tuned liquid damper structure is efficient in contrast with general structure as it has limiting twisting minute which will cause decrease in bending moment and large steel requirement.

Forces:

It is seen that the dispersion of burden become uniform and linear it instance of tuned liquid dampers. As far as hub forces the vertical circulation of forces become steady and flat forces produced

Cost: As observed in cost analysis TLD structure is cost effective than general structure in both the seismic zone with cost reduction of 7%.

Future Scope of the work:

i)In the proposed work high rise steel building is considered which can be increased to some more floors in future with variation in floor to floor height.

ii) In this study seismic analysis is considered whereas in future study wind load or blast load can be consider.

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