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Analysis of Multistory Building With and Without Tuned Mass Damper

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Abstract: Urbanization and limited land availability have driven the development of tall buildings, which are highly susceptible to lateral forces induced by seismic activity and wind. Traditional structural designs may not always effectively mitigate these dynamic forces without substantial costs. This review paper examines the application of Tuned Mass Dampers (TMDs)-passive control devices that significantly enhance seismic resistance. The effectiveness of various TMD configurations and their comparative performance with other vibration mitigation systems are explored. A comprehensive literature review supports the utility of TMDs in improving structural resilience, especially in high-rise buildings.

I. INTRODUCTION

Seismic activity remains one of the most unpredictable and destructive natural hazards, posing significant challenges to structural engineers. Buildings must be designed not only for vertical loads but also to withstand the complex dynamics of ground shaking. The Tuned Mass Damper (TMD) is one such innovation that helps mitigate lateral vibrations by absorbing dynamic energy through a secondary mass-spring-damper mechanism.

TMDs are especially relevant in seismic zones and in flexible high-rise structures where conventional strengthening may prove either inefficient or uneconomical.

1. Tuned Mass Damper (TMD) Technologies

1.1 Types of TMDs

- Simple TMD (STMD)
- Viscoelastic TMD (VETMD)
- Pendulum TMD (PTMD)
- Frictional TMD (FTMD)
- Hybrid TMD
- Viscous TMD (VTMD)

1.2 Placement and Design Considerations

- Typically installed at the top floor for maximum displacement capture.
- Mass ratio ranges from 3% to 5% of the total structural mass.
- Proper tuning is essential for effectiveness.

2. Modern Seismic Control Alternatives

- Base Isolation Systems
- Shear Walls
- Moment-Resisting Frames
- Cross-Bracing and Mat Foundations

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II. METHODOLOGY

2.1 Introduction

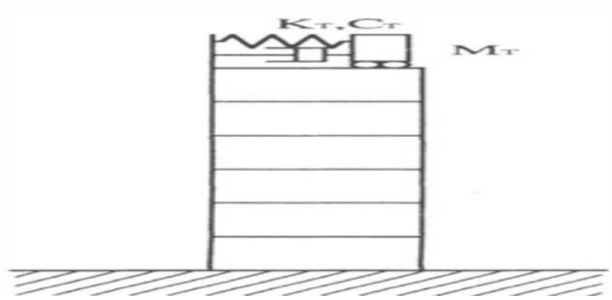
Principle of TMD (Tuned Mass Damper) TMD is a vibration arrangement containing the mass, springs and dampers are situated on the top of structures as view in figure below. It is elevated by the agitation of the structure when the structure begins to vibrate. Thus, the structure generates the kinetic energy which is directed into TMD device in order to consume by the viscous damper of TMD.

For accomplishing more effective energy observing capacities of TMD, the original time of TMD device without anyone else input will tune with the original time of the building by itself from which the system is known as "Tuned Mass Damper". As a matter it is easily maintainable and highly dependable, TMD is also used in lightly-damped buildings as in earthquake prone countries.

In the present study 15,25,40 storey models have been considered with and without Tuned mass damper. The buildings having tuned mass damper was placed at the Centre of top floor or CG of the buildings with mass ratio 4 % is applied (based on the Reference papers). In total 6 models were prepared. For 15,25,40 storey models with and without TMD. The particular dimensions, seismic and wind conditions is mention in the table below.

A.Model I RCC G + 14 Without TMD

For the G + 14 building



Type of Structure	
Plan Dimension	(36*36) m
No. of bays	6
Size of each Bays	6m
No. of Storeys	G + 14
Storey Height	3 m
Grade of Concrete	
Beams	M30
Columns	M30
Slabs	M30
Grade of Steel	FE415
Beam Size	0.45 * 0.45 m
Column Size	0.60 * 0.60 m
Slab Thickness	0.15 m

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Wall Thickness	0.23 m
Load Calculation	
Self Weight of Wall on each floor	12 kn/sqm
Live load	3 kn/sqm
Floor finish	1 kn/sqm
Earthquake analysis as per IS 1893:2002	
Seismic Zone	V
Zone factor	0.36
Importance factor	1
Response Reduction factor	5
Wind Analysis as per IS 875 part 3	
Wind Speed	50 m/s
Terrain Category	2
Structure Class	B
Risk Coefficient k1	1
Topagraphy,k3	1

Table Specification of G + 14 Building

Sr. no		Load	Remaks
1	Total Load each floor	16 kn/sqm	
2	Total Load of structure	240 kn/sqm	
3	Tuned mass damper	9.6 kn/sqm	Placed at top floor

Table calculation of G + 14 Building

MODEL-1 G + 14-STOREY NORMAL BUILDING WITHOUT TMD

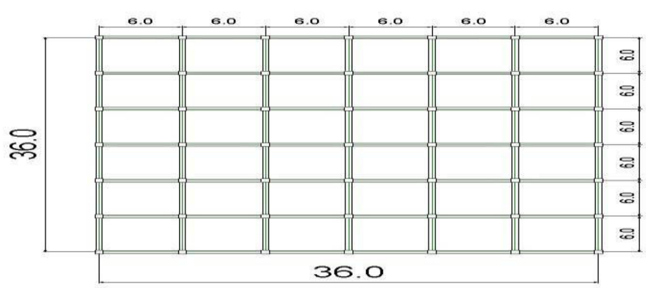

Fig. Top/Plan viewG + 14

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Fig Elevation viewG + 14

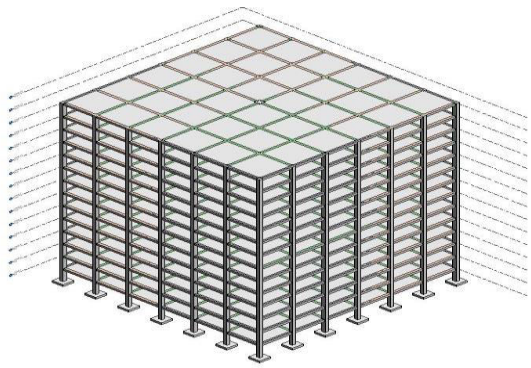

Fig 3D view G + 14

III. RESULT

For Model-1 without TMD and Model-2 with TMD

StoreyNo.	Model-1 without TMD	Model-2 Without TMD
	Ux and Uy	Ux and Uy
15	918.1	584.08
14	890.25	568.85
13	855.09	548.01
12	811.38	522.11
11	772.7	491.72
10	772.11	457.27
9	660.72	419.
8	591.06	377.06
7	516.04	331.64

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6	440.14	283.07
5	367.78	231.9
4	292.95	178.8
3	210	125.04
2	123.6	72.23
1	43.7	25.24

Table Storey Displacement (mm) comparison in x & y –direction

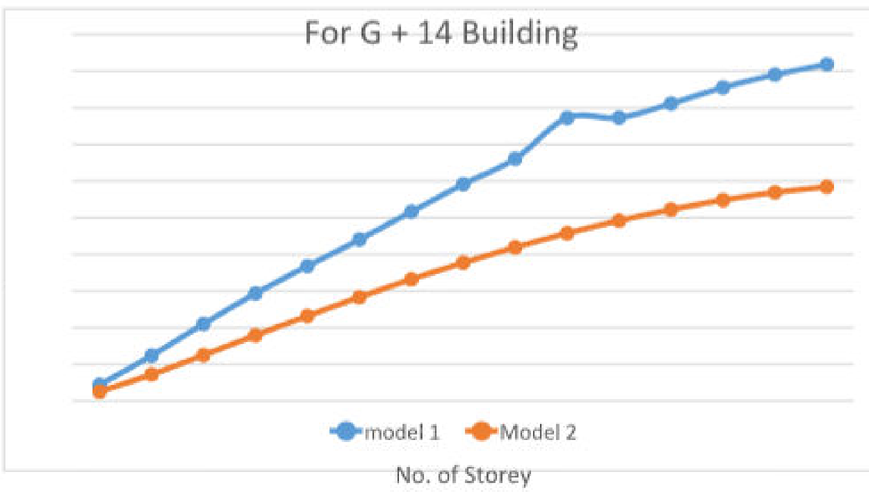

Fig. Storey displacement comparison in x and y direction

StoreyNo.	Model-1 without TMD	Model-2 Without TMD
	Ux and Uy	Ux and Uy
15	27.85	15.23
14	35.16	20.84
13	43.71	25.9
12	38.68	30.39
11	50.59	34.43
10	61.39	38.27
9	69.64	41.94
8	75.02	45.42

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7	75.9	48.57
6	72.36	51.17
5	74.83	53.09
4	82.95	53.77
3	86.4	52.81
2	79.9	46.99
1	43.7	25.24

Table Storey Drift comparison in x & y -direction

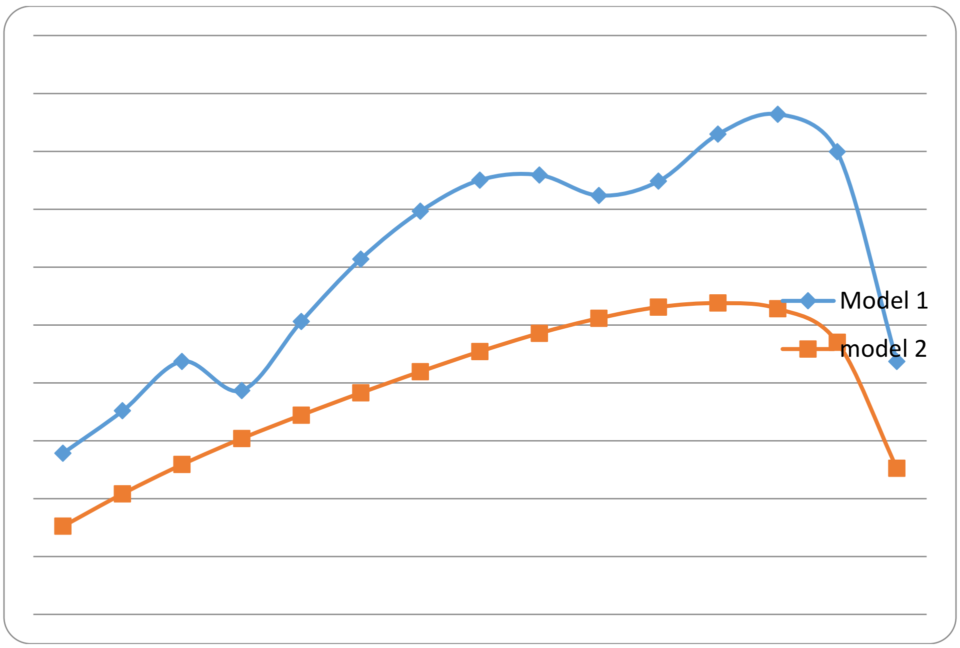

Fig. No. 4.2 Storey drift comparison in x and y direction

Base Shear

	Model-1 without TMD	Model-2 Without TMD
	Ux and Uy	Ux and Uy
Base Shear	83900	38460

Table Base Shear comparison in x & y -direction

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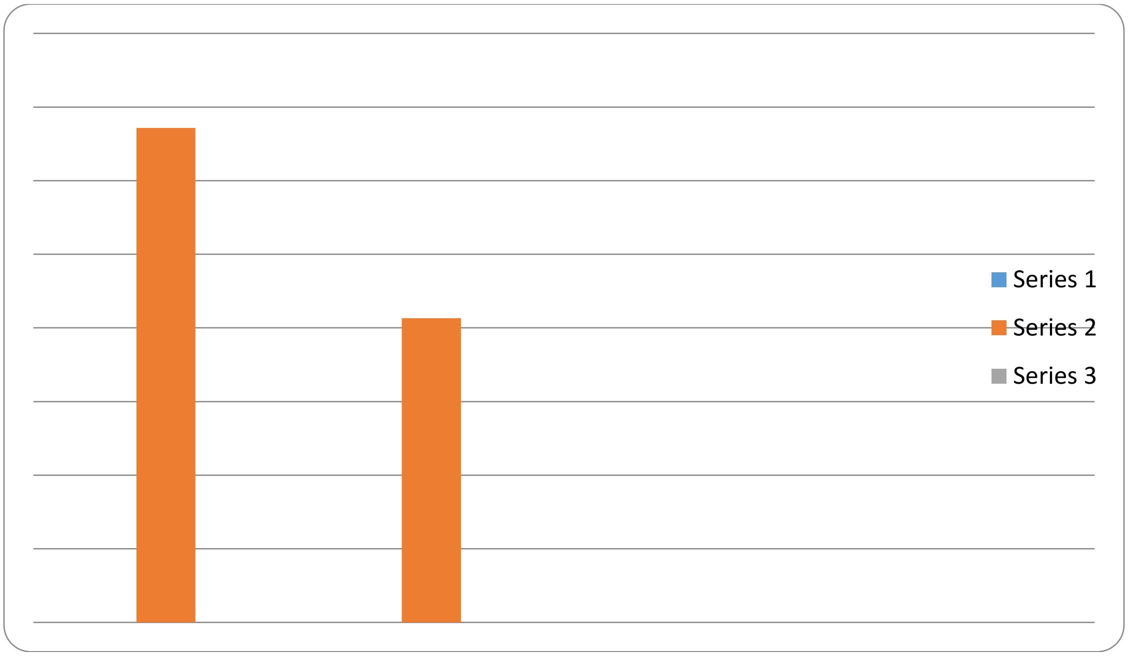

Fig. Base shear comparison in x and y direction

IV. CONCLUSIONS

The outcomes in this examination recommend that the use of TMD is a suitable to alleviate the dynamic reaction of the structures exposed to seismic ground movement. From auditing the outcomes that acquired in this examination the accompanying ends can be drawn: structures arranged in quake inclined territories.

•The generally results recommended that Tuned mass damper were fantastic seismic control gadgets just for high - rise symmetric.
• In end by performing NLTH Analysis, it tends to be shown that Tuned mass damper are successful for skyscraper symmetric Buildings.
•The results unfurls that, the expansion of a housetop tuned mass damper edge lessens the seismic speeding up reaction for most cases despite the way that quickening reaction can increment if the housetop outline isn't tuned to oblige the particular structure's dynamic conduct.

Fromanalysis, it very well may be seenthat it is important to appropriately execute and build a damper in any skyscraper

For 14 Stories:
The storey displacement were decreased by 36.38% for 14-story symmetric building in both the directions under Zone V & medium soil suggesting the effectiveness of Tuned mass damper for Buildings symmetric.

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