Analysis of High Rise Building Using Tuned Mass Damper Method Using Etabs

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Abstract: The present work aims to demonstrate the performance of building. Here, models of 15,25 and 40 storeys without and with TMD were prepared by considering symmetrical R.C moment resisting frame. Tuned Mass Dampers with varying mass ratio of 3% applied. Analysis of NLTH is done utilising 1893:2002 for designing a RCMRF structure for seismic force and gravity load. It has been proposed to develop a suitable TMD that should be effective enough to reduce base shear, story drift, story displacement etc. for doing so optimal parameters of TMD where calculated using Den hutong's equation and parameters like frequency ratio, damping ratio, effective stiffness of TMD and effectual TMD damping. Using this parameters TMD was modelled in SAAP 2000 and result where compared with TMD and without TMD.

Keywords: TMD, nonlinear dynamic analysis, time history analysis, SAAP 2000.

I. INTRODUCTION

A quake is a characteristic loss or wonder achieved by sudden severe shuddering of the earth outside layer which happens at or underneath the surface. The word common is basic here, since it avoides shock waves achieved by atomic tests, man-made blasts, and so forth,

Tremor doesn't execute people, yet the structures do. Consequently, it is primary architect prime duty to consider all conceivable information from past encounters and furthermore potential dangers that structure may be exposed to, later on, for the protected plan of system. Primary designers with the point of advancement in the usage of structures have created procedures through the Finite component programming which capably model, look at and show the outcomes in the attentive manner. Examination in the Civil Engineering has reached to a lot more extensive skylines than what one might have ever envisioned. The progression in the innovation of programming designing was acknowledged by the Structural specialists as it spared a ton of human effort and time. The structures are typically intended to make them yield in view of the exceptionally granted powers welcomed on by the tremor.

These days tall structures are basic in developed regions because of high economy of land, absence of terrains, and inadequacy of open space. The tall structures are by and large profoundly frail to parallel powers emerging out of quakes. Planning these structures to withstand these intermittent horizontal powers is over the top expensive; consequently it isn't interminably alluring. Any proper system is proposed to dispense with the impact of parallel powers on structure is exceptionally excited. Throughout a time-frame, an exploration was proceeding to know the techniques for decrease of the parallel power, the amplitudes of vibration and the recurrence of the structure utilizing various methodologies. Among this, the most natural techniques are the base disengagement and the presentation of TMD.

1.1 TUNED MASS DAMPER

Tuned mass dampers (TMD) is usually made for vibration control in MECH Engineering system. As of late, TMD hypothesis is utilised to decrease vibrations of high rise structures & many more structures of civil engineering. Tuned mass dampers and Dynamic absorbers are the apprehension of tuned absorber and tuned damper for applications in control vibration of structures. The inertial, adaptable, and dissipative parts in such instrument are: mass, spring and dashpot (or material damping) for direct applications and their turning partners in rotational applications. Contingent upon the application, these gadgets are estimated from a couple of ounces (grams) to various tons. Various arrangements, for instance, sloshing fluid safeguards/dampers and pendulum safeguards/dampers have in like manner been recognized for vibration relief applications.

TMD involves in positioning of a structure over an existing building and also reducing the effect of dynamic loads. The TMD will have certain stiffness, damping and mass. Tuning of TMD refers to suitably adjusting the value of stiffness, damping and mass to eliminate the dynamic outcome of a given building subjected to dynamic forces /displacement. However not much of headway was made in the field of TMD due to absence of rational theories of structural dynamics.The mass is for the most part joined to the building via a spring-dashpot system and energy is dispersed by the dashpot as relative motion is created between the mass and the structure.

1.2 OBJECTIVES OF THE STUDY

The following are the objectives of present study:

- To study Seismic demands of regular R.C buildings utilising the nonlinear dynamic analysis.
- To study the effects on the response of the High-rise Symmetric Buildings with TMD (Tuned mass damper).

- To study various responses such as B.S, Overturning moment, S.F, BM, axial force, storey drift, storey shear, etc., of buildings

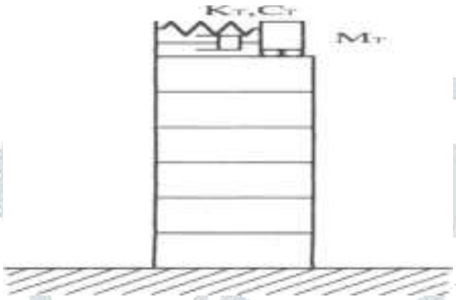
1.3 SCOPE OF THE STUDY

The current work focuses on to display the impact of Tuned mass damper methods for tall building structures. The structure concentrated in this part in 15,25&40-story RC Special instant Resisting Frames intended for magnitude and Seismic burdens using nonlinear unique Analysis. The formation is assessed as per seismic code IS - 1893 : 2002 under seismic zone v investigation with the guide of the sap 2000 form.

II. METHODOLOGY

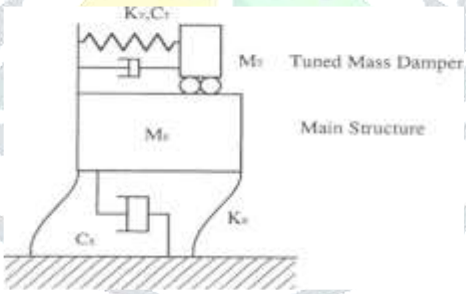
3.1 Principle of TMD (Tuned Mass Damper)

T.M.D is a vibration plan comprising of mass, spring and damper oftenly arranged on the highest point of structures as view in figure underneath. It is happy by the tumult of the structure at the point when the structure begins to vibrate. In this manner, the structure creates the dynamic energy which goes into TMD gadget to be devoured by the gooey damper of T.M.D. For achieving the best energy engrossing limits of TMD, the common time of T.M.D without any other individual info is tuned with the regular time of the structure without help from anyone else from which the framework is classified "Tuned Mass Damper". As an issue of simple support and high constancy, TMD is used in numerous adaptable and softly damped pinnacles, structures, etc in Japan.



3.2 DETERMINATION of the Optimum TMD

The TMD effectively reduces dynamic reaction of just a solitary vibration method of the structure. In actuality, a structure has a few vibration modes, fundamental properties of TMD can be obviously talked about by considering rearranged 2-DOF model comprising of the principle structure and the TMD framework.



3.3 TIME HISTORY ANALYSIS

For performing nlth examination a consistent tremor ground increasing speed information from a spot called bhuj in the condition of gujarat which had demolishing impacts when the quake caused destruction in the year 2001 was taken having seismic zone-v as shown by the is1893-2002 section 1 grouping, which has 0.36 zone segment. the info information of speeding up in time history is having 0.005sec time span. The quake record was progressed to the highest point speeding up to expand the force of the tremor. The reaction history of the structure was appeared at each time step was shown in the yield by the product bundle sap 2000 which included relocation responses, power responses and different responses.

III. ANALYTICAL MODELLING

4.1 GENERAL

Analysis of symmetrical R.C moment resistance frame (RCMRF) of 15,25,40 storey three – dimensional concrete building is proposed to be analysed using SAP 2000 with Tuned Mass Damper (TMD) and without any damping device.

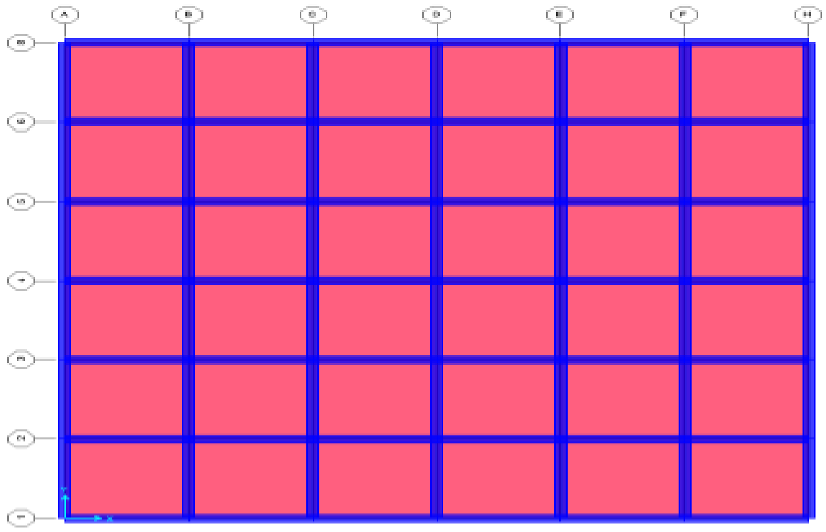
4.2 DESCRIPTION OF ALLMODELS

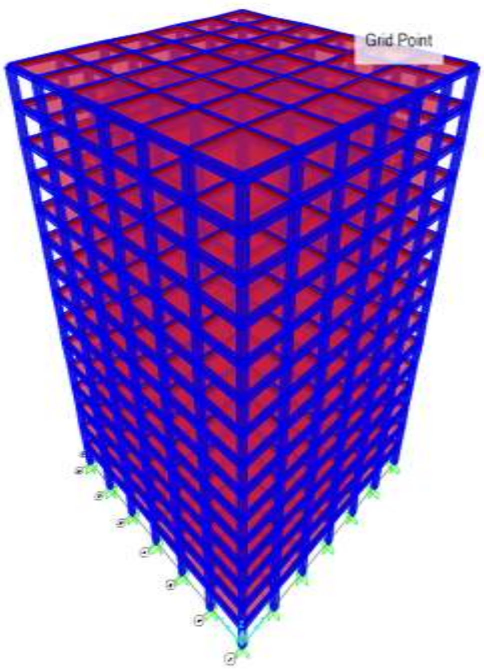
In the present study 15,25,40 storey models have been considered with and without T.M.D. The buildings having tuned mass damper was placed at the centre of top floor or CG of the buildings with mass ratio 3% is applied. In total 6 models were prepared.

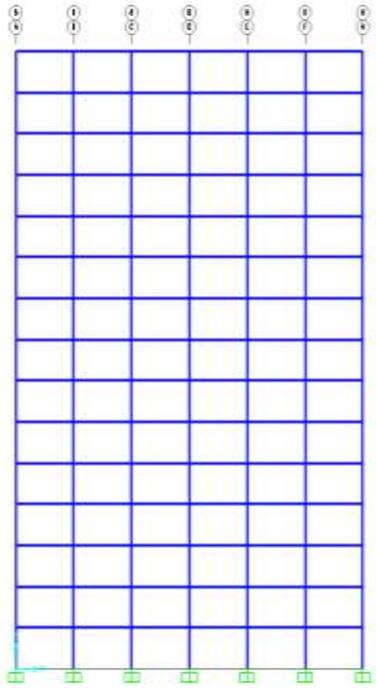
4.3 PARAMETERS CONSIDERED FOR THE MODELS

For 15,25,40 storey models with and without TMD the following parameters were considered.

TYPE OF STRUCTURE	SMRF
Plan Dimension	(36 x 36) m
Number of Bays	6
Size of each Bays	6m
Number of Storey's	G+14
Storey Height	3.0m
Grade of Concrete	
Beams	M30
Columns	M30
Slabs	M30
Grade of Steel	FE415
Beam Size	0.45 X 0.45 m
Column Size	0.60 x 0.60 m
Slab Thickness	0.15 m
Wall Thickness	0.23 m
Load Calculation	
Self Weight Of Wall on Each Floor	12.00 KN/sq.m
Live Load	3 KN/sq.m
Floor Finish	1 KN/sq.m
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, k 1	1
Topagraphy, k3	1







TYPE OF STRUCTURE	SMRF
Plan Dimension	(36 x 36) m
Number of Bays	6
Size of each Bays	6m
Number of Storey's	G+39
Storey Height	3.0m
Grade of Concrete	
Beams	M30
Columns	M30
Slabs	M30
Grade of Steel	FE415
Beam Size	0.45 X 0.45 m
Column Size	0.60 x 0.60 m
Slab Thickness	0.15 m
Wall Thickness	0.23 m
Load Calculation	
Self Weight Of Wall on Each Floor	12.00 KN/sq.m
Live Load	3 KN/sq.m
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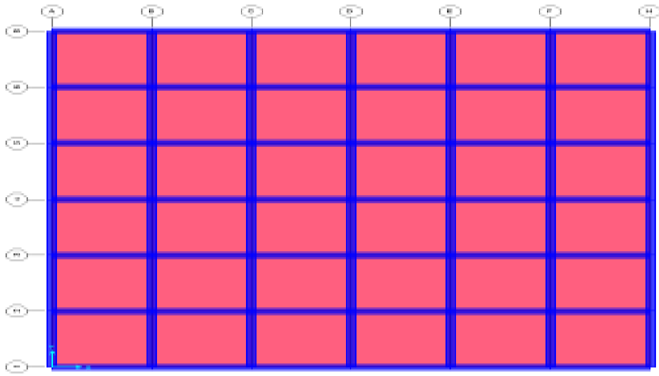
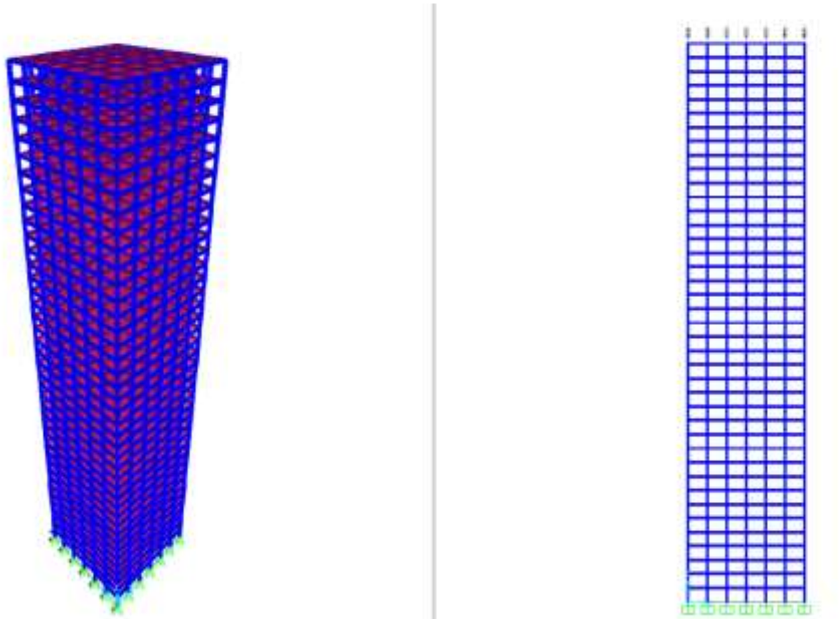
Seismic Zone	V
Zone factor	0.36
Importance factor	1
Response Reduction factor	5
Wind Analysis as per IS 875 part 3	
Wind Speed	50 m/s
Terrain Category	2
Structure class	C
Risk Coefficient, k 1	1
Topography, k3	1





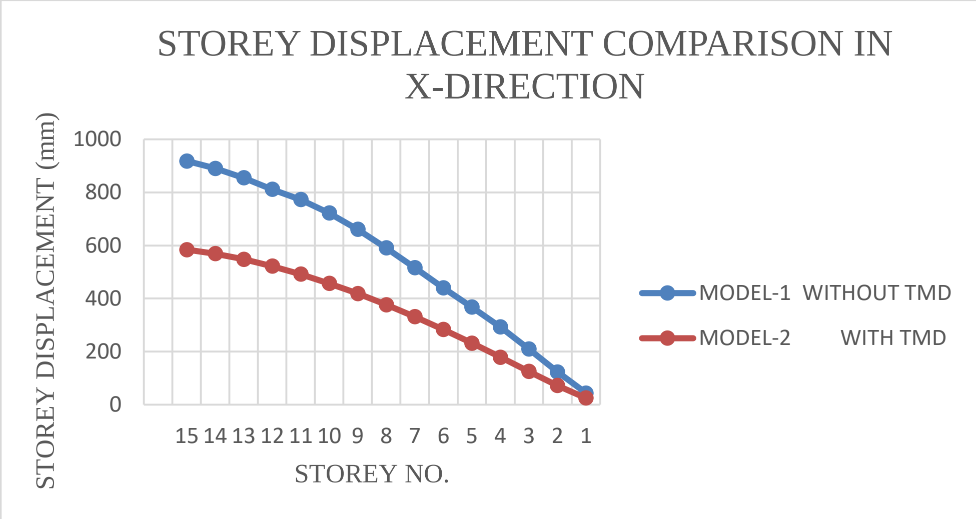
IV. RESULTS AND DISCUSSIONS

For Model-1 and Model-2

1. Storey Displacement

Table 5.1 Storey Displacement (mm) EVALUATION in x-direction

STOREY NO.	MODEL-1 (WITHOUT TMD)	MODEL-2 (WITH TMD)
	Ux	Ux
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	722.11	457.27
9	660.72	419.00
8	591.06	377.06
7	516.04	331.64
6	440.14	283.07
5	367.78	231.90
4	292.95	178.8
3	210.00	125.04
2	123.6	72.23
1	43.7	25.24

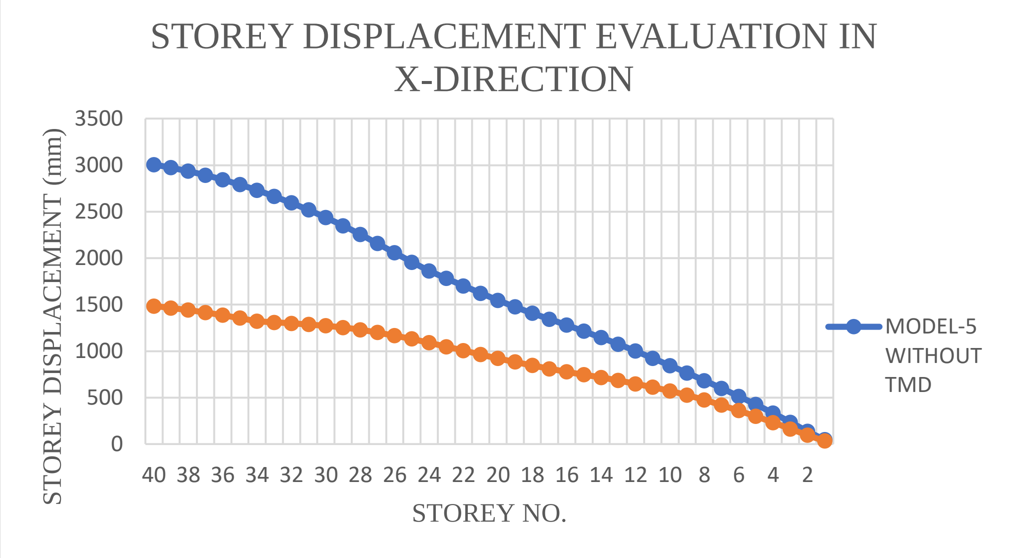


For Model-5 and Model-6

1. Storey Displacement

Table 5.19 Storey Displacement(mm) EVALUATION in x-direction

STOREYNO.	MODEL-1 (WITHOUT TMD)	MODEL-2 (WITH TMD)	STOREY NO.	MODEL-1 (WITHOUTTMD)	MODEL-2 (WITH TMD)
	Ux	Ux		Ux	Ux
40	3006.8	1485.03	20	1547.54	921.8
39	2974.5	1465.09	19	1476.56	884.94
38	2936.32	1441.81	18	1407.93	845.59
37	2893.06	1415.59	17	1343.18	809.76
36	2845.13	1386.73	16	1279.77	778.25
35	2791.00	1355.52	15	1215.08	746.64
34	2730.69	1322.26	14	1145.05	717.23
33	2664.9	1308.76	13	1075.07	684.86
32	2595.47	1298.65	12	1001.02	648.51
31	2519.49	1286.76	11	923.20	612.82
30	2437.29	1272.83	10	845.22	572.16
29	2349.3	1254.12	9	765.48	526.44
28	2256.16	1230.30	8	683.25	475.71
27	2158.68	1201.17	7	599.39	420.20
26	2057.86	1167.32	6	514.05	361.51
25	1956.24	1131.28	5	427.13	298.80
24	1864.01	1091.12	4	333.48	232.45
23	1782.43	1048.09	3	235.48	163.66
22	1702.02	1006.97	2	137.04	95.05
21	1622.31	962.90	1	48.10	33.3



VI. CONCLUSION

6.1 GENERAL

As of late, use of seismic control systems has extended anyway picking best damper and bringing it into a structure is basic for reducing vibration in structures when presented to seismic stacking. The controlling gadgets decrease harm essentially by expanding the primary wellbeing, workableness and keep the structure from breakdown during the tremor. Present study focused on the capacity of TMD to reduced seismic tremor instigated underlying vibration. The models in this study created by using SAP 2000 program. Three models 15, 25 and 40 storey created with and without TMD and EVALUATION between the responses of these models when subjected to seismic ground motion load.

6.2 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:

•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 structures arranged in quake inclined territories.

For 15 Stories:

- The storey displacement were decreased by 36.38% for 15-story symmetric building in both the directions under Zone V & medium soil suggesting the effectiveness of Tuned mass damper for Buildings symmetric.
- The story drift were decreased by 45.3% in both the direction compared to building with TMD and without TMD.
- The time periods were reduced by 33.02% for 15-story symmetric building with TMD compared to building without TMD.
- The base shear for building with TMD is reducing by 53% compared to building without TMD.

For 40 Stories:

• The story displacement were decreased by 50.6 % for forty story symmetric building under Zone V & medium soil suggesting the effectiveness of Tuned mass damper for Buildings symmetric.

- The story drift were decreased by 38.26% in both the direction compared to building with TMD and without TMD.

• The time periods were reduced by 17.3% for forty story symmetric building with TMD compared to building without TMD.

• The base shear for building with TMD is reducing by 50.4% compared to building without TMD.

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