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A COMPARATIVE STUDY ON ANALYSIS OF RCC FRAMED STRUCTURE USING VISCOUS DAMPER AND TUNED MASS DAMPER

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Abstract: The earthquakes are most dangerous and unpredictable in nature. The seismic behavior of the structure is always an area of concern and requires special attention from structural designers. Presence of plan irregularity further complicates the seismic behavior of the structure. and also make the structure more vulnerable to seismic forces. Push over analysis has gaining property as an effective tool to quantify the seismic vulnerability of structures. Push over method is a good method deal with irregular structure. Current research objective is to know seismic performance of structure when we apply various dampers to the structure like Viscous damper and Tuned Mass Damper. In current research a G+10 Storey RCC irregular structures has been modeled and analyzed. The parameters compared are Storey displacement, Storey drift, and also time period. An attempt was made to study and quantify the improvement in seismic capacity of the structure. The result of analysis reveled that the dampers applied to the structure reduces displacement, drift, and time period.

Keywords— Plan irregularity, Viscous damper, Tuned Mass Damper

I INTRODUCTION

The largest number of earthquakes in the world leads to deaths due to severe damage and collapse of buildings. Various structures, such as commercial buildings, residential buildings, historic buildings and industrial buildings, are designed for earthquakes to prevent the risk of earthquakes. Earthquakes also have a large economic impact on the affected areas. Every structure should have strength and ductility so that at the time of earthquake less damage may occur. Earthquake occurrence time, day date cannot be predicted because earthquake is a natural phenomenon. The technology to prevent earthquake are not yet developed. However, damages due to earthquake are minimized by providing proper care. From the data collected during the past earthquakes desirable geometry, form and material of construction can be arrived at. Hence, much is there to learn from the past experiences failure and learning could be crucial in future design.

II OBJECTIVES OF THE STUDY

- To Study the impact of plan irregularity on the seismic performance of RCC models subjected to lateral loads.
- To quantify the seismic performance of different shapes of plan irregular buildings by introduction of viscous damper and tuned mass damper by Pushover analysis method
- To compute the seismic capacity of RCC framed structure in terms of displacement, drifts, and & time period.

III METHODOLOGY

Plan irregular shapes like L-shaped, T-shaped, rectangular, plus-shaped and T-shaped buildings with G+10 storey's are considered. Push over analysis is used for analyzing structures and to evaluate seismic performance. Parameters considered for the comparison of seismic performance are story displacement, story drifts, story shears & time period. IS 456 and IS 1893 are used for loading consideration. ACT 40 and FEMA 273 are used for push over analysis. The Hinge properties are defined like beam hinge and column hinge in ETABS software & assign defined hinges to beams and columns respectively. All Plan irregular building analyzed by providing viscous damper at corner of the structures and also TMD at the Top Storey of the structure reducing seismic performance of the structure and to control vibration of the structure.

IV DETAILS OF MODELS

Building type	Residential building
Spacing of each bays	5m
Base support	Fixed
Floor to floor height	3m
Structural type	RCC Framed Structure
Density of concrete	$25KN/M^3$
Type of slab	One way or Two way slab
Slab thickness	150 mm
Size of the column	500 X 500 mm
Size of beam	230X450 mm

Grade of concrete	M 25
Grade of steel	Fe500
Wall thickness	250mm
Poisson's. ratio	0.2
Seismic zone	Zone 4
Live. load	$3KN/M^2$
Importance factor	1
Reduction factor	5
Damping ratio	0.05
Floor finish	$1.5 KN/M^2$

The 3-D models of G+10 Storey structures in ETABS are shown in following figures. The models considered are irregular in configuration. One regular model and 5 irregular models are considered for the analysis. Regular model is in symmetrical in shape. Irregular models are L shape, T shape, PLUS shape, rectangular Shape, and C shape.

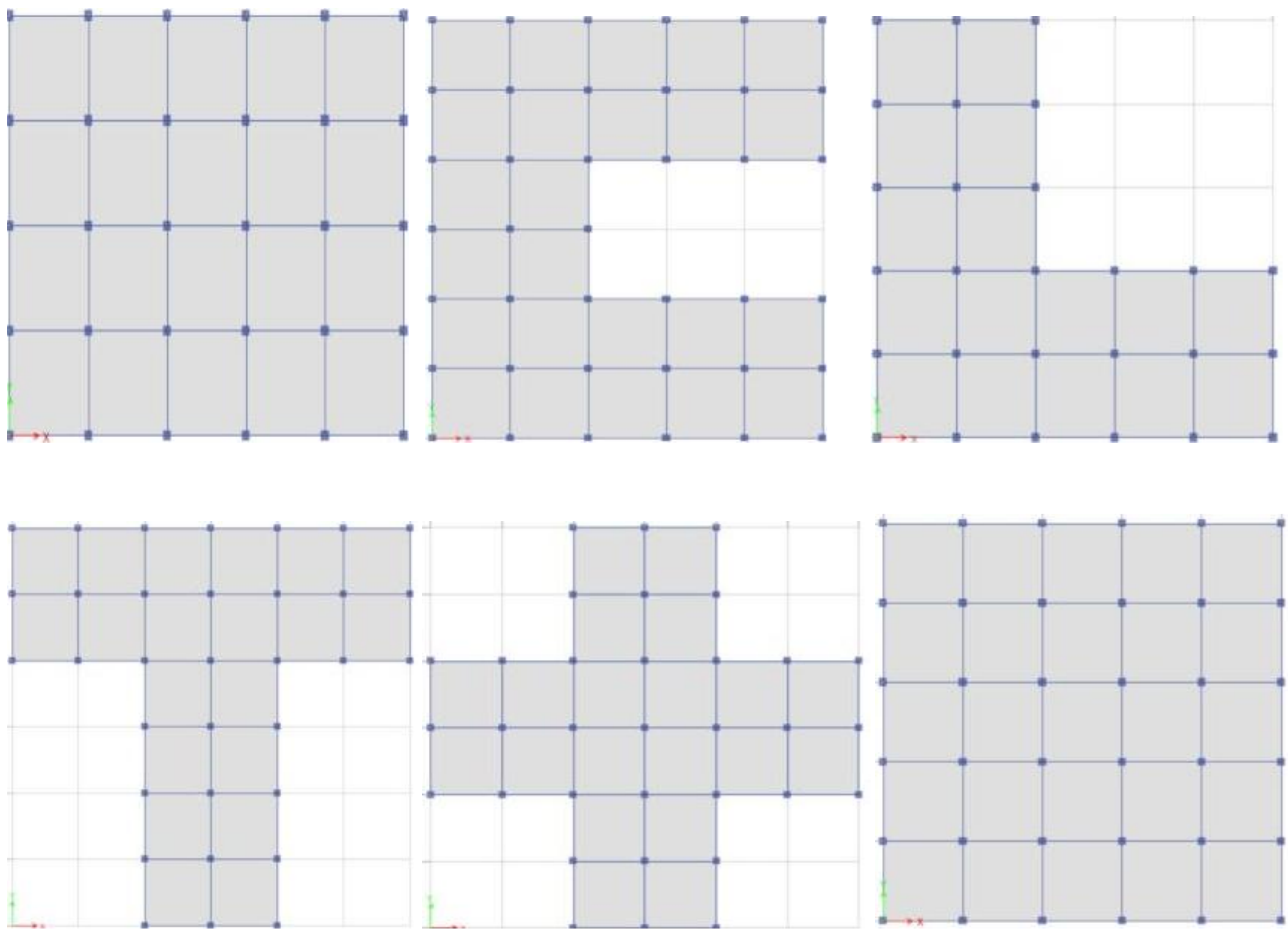

FIGURE NO 1: Plan of all irregular Shape models

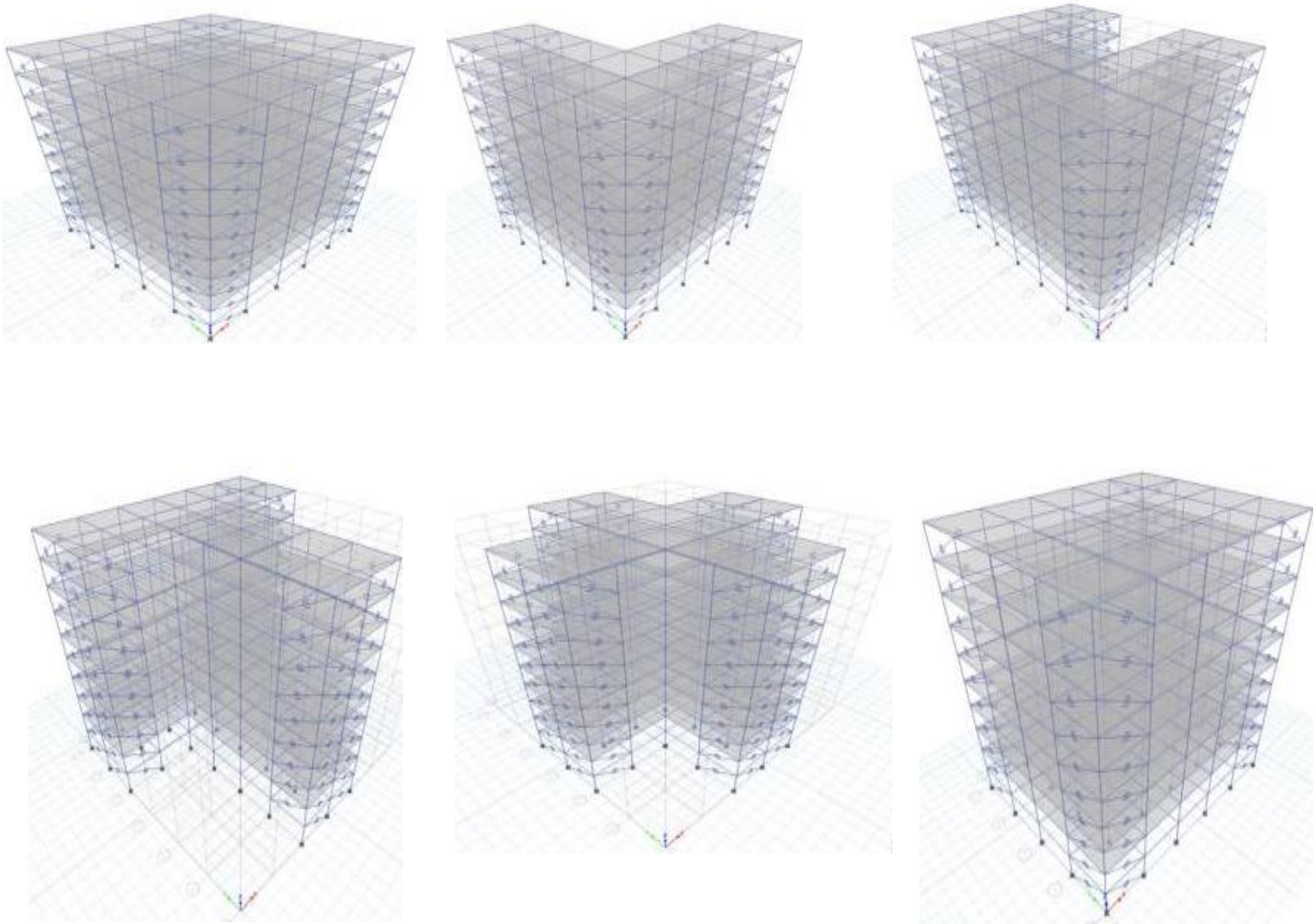

FIGURE NO 2:10 Storey building with VD

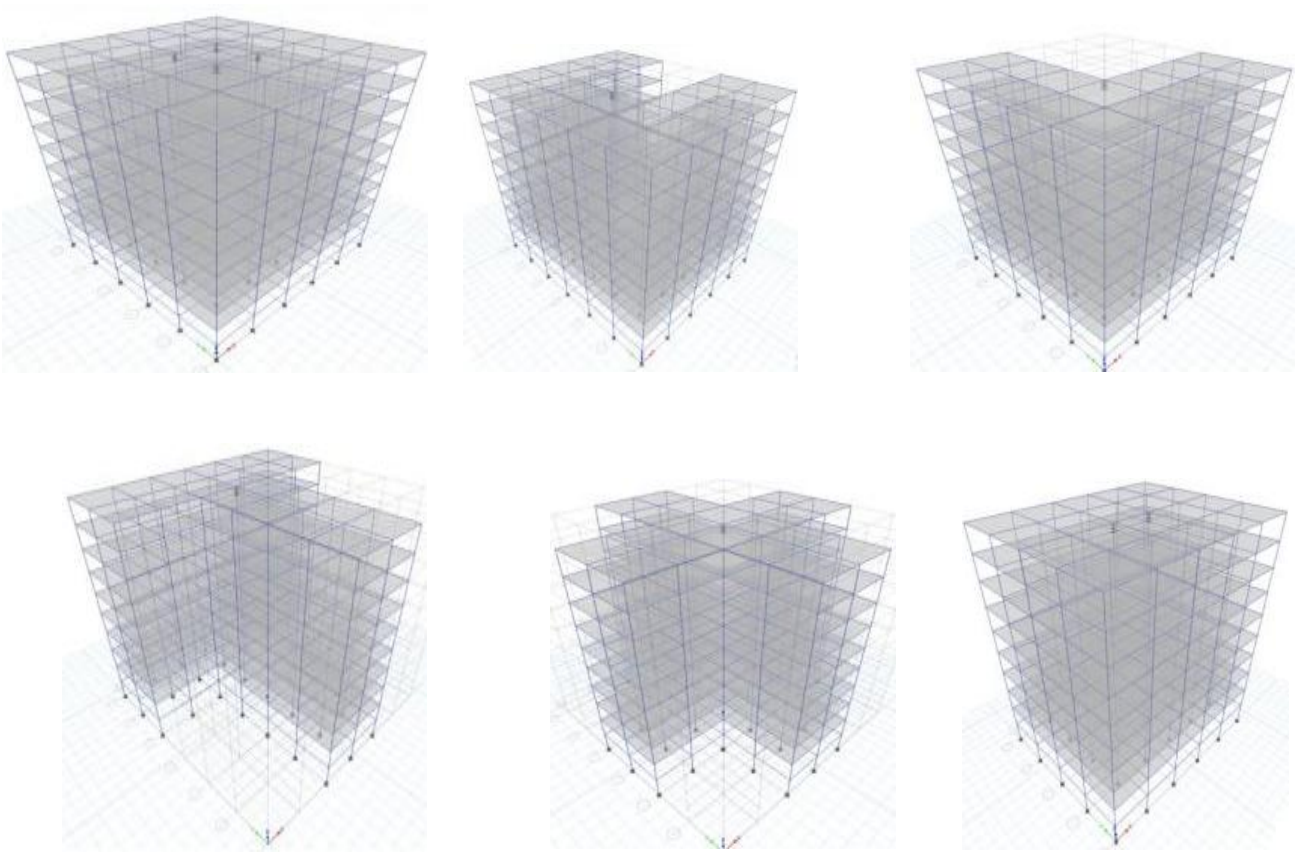

FIGURE NO 3: 10 Storey building with TMD

V RESULTS

A. DISPLACEMENT

TABLE NO 1: Storey Displacement for all models Without Dampers

Various Storey	Displacement Value of models Without damper					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	184.335	171.779	183.073	167.932	171.354	177.73
Storey9	178.802	166.256	176.947	162.677	166.007	172.388
Storey8	169.828	157.583	167.524	154.436	157.492	163.724
Storey7	157.103	145.459	154.457	142.785	145.51	151.441
Storey6	140.674	129.932	137.782	127.771	130.108	135.588
Storey5	120.676	111.145	117.647	109.526	111.421	116.298
Storey4	97.297	89.3	94.279	88.229	89.639	93.754
Storey3	70.883	64.759	68.101	64.207	65.11	68.293
Storey2	42.39	38.479	40.215	38.344	38.771	40.837
Storey1	15.087	13.56	14.026	13.62	13.706	14.534
Base	0	0	0	0	0	0

TABLE NO 2: Storey Displacement for all models With VD

Various Storey	Displacement Value of models With VD					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	67.867	32.795	42.691	54.437	22.67	56.526
Storey9	59.692	28.34	37.119	47.805	19.68	49.507
Storey8	51.373	23.873	31.519	41.1	16.694	42.383
Storey7	42.955	19.452	25.942	34.352	13.739	35.208
Storey6	34.549	15.155	20.476	27.638	10.862	28.079
Storey5	26.332	11.097	15.257	21.095	8.133	21.166
Storey4	18.566	7.416	10.458	14.927	5.633	14.7
Storey3	11.597	4.275	6.291	9.364	3.467	8.98
Storey2	5.845	1.941	3.042	4.769	1.757	4.359
Storey1	1.87	0.581	0.994	1.403	0.665	1.34
Base	0	0	0	0	0	0

TABLE NO 3: Storey Displacement for all models With TMD

Various Storey	Displacement Value of models With TMD					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	76.483	57.238	85.579	72.573	65.729	66.347
Storey9	81.44	63.009	89.325	76.795	70.789	71.888
Storey8	84.477	67.182	91.035	79.197	74.13	75.67
Storey7	83.951	68.187	89.212	78.338	74.17	76.008
Storey6	79.587	65.596	83.589	73.986	70.634	72.62
Storey5	71.468	59.49	74.262	66.227	63.604	65.589
Storey4	59.783	50.071	61.451	55.245	53.271	55.105
Storey3	44.844	37.661	45.539	41.333	39.945	41.47
Storey2	27.397	22.989	27.406	25.19	24.347	25.394
Storey1	9.852	8.229	9.654	9.037	8.707	9.142
Base	0	0	0	0	0	0

B. Storey Drift

TABLE NO 4: Storey Drifts for all models Without Dampers

Various Storey	Drifts of all models Without Dampers					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	0.001844	0.001841	0.002042	0.001753	0.001782	0.001781
Storey9	0.002991	0.002891	0.003141	0.002758	0.002839	0.002888
Storey8	0.004242	0.004041	0.004356	0.003885	0.003994	0.004094
Storey7	0.005476	0.005176	0.005558	0.005005	0.005134	0.005284
Storey6	0.006666	0.006262	0.006712	0.006082	0.006229	0.00643
Storey5	0.007793	0.007282	0.00779	0.007099	0.007261	0.007514
Storey4	0.008805	0.00818	0.008726	0.008007	0.008176	0.008487
Storey3	0.009498	0.00876	0.009295	0.008621	0.00878	0.009152
Storey2	0.009101	0.008306	0.00873	0.008241	0.008355	0.008768
Storey1	0.005029	0.00452	0.004675	0.00454	0.004569	0.004845
Base	0	0	0	0	0	0

TABLE NO 5: Storey Drifts for all models With VD

Various Storey	Drifts of all models With VD					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	0.002725	0.001485	0.001857	0.002211	0.000997	0.00234
Storey9	0.002773	0.001489	0.001867	0.002235	0.000995	0.002375
Storey8	0.002806	0.001474	0.001859	0.002249	0.000985	0.002392
Storey7	0.002802	0.001432	0.001822	0.002238	0.000959	0.002376
Storey6	0.002739	0.001353	0.00174	0.002181	0.00091	0.002304
Storey5	0.002589	0.001227	0.0016	0.002056	0.000833	0.002155
Storey4	0.002323	0.001047	0.001389	0.001854	0.000722	0.001907
Storey3	0.001917	0.000778	0.001083	0.001532	0.00057	0.00154
Storey2	0.001325	0.00051	0.000683	0.001122	0.000364	0.001006
Storey1	0.000623	0.000194	0.000331	0.000468	0.000222	0.000447
Base	0	0	0	0	0	0

Table No 6: Storey Drifts for all models With TMD

Various Storey	Drifts of all models With TMD					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	0.001652	0.001971	0.001901	0.001482	0.001687	0.001847
Storey9	0.001012	0.001436	0.001383	0.000813	0.001114	0.001261
Storey8	0.000175	0.000336	0.000608	0.000286	0.000013	0.000113
Storey7	0.001455	0.000877	0.001874	0.001451	0.001179	0.001129
Storey6	0.002706	0.002035	0.003109	0.002586	0.002343	0.002344
Storey5	0.003895	0.00314	0.00427	0.003661	0.003444	0.003495
Storey4	0.00498	0.004137	0.005304	0.004637	0.004442	0.004545
Storey3	0.005816	0.004893	0.006044	0.005381	0.0052	0.005359
Storey2	0.005848	0.004925	0.005917	0.005384	0.005213	0.005417
Storey1	0.003284	0.002743	0.003218	0.003012	0.002902	0.003047
Base	0	0	0	0	0	0

C. Time Period

Table No 7: Time Period for all models Without Dampers

Various Storey	Time Period of all models Without Dampers					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	1.4	1.374	1.38	1.392	1.367	1.404
Storey9	1.4	1.365	1.367	1.35	1.367	1.379
Storey8	1.251	1.254	1.277	1.264	1.276	1.237
Storey7	0.446	0.436	0.438	0.442	0.435	0.447
Storey6	0.446	0.434	0.435	0.43	0.435	0.44
Storey5	0.4	0.4	0.406	0.404	0.405	0.395
Storey4	0.247	0.239	0.24	0.243	0.24	0.247
Storey3	0.247	0.239	0.24	0.238	0.24	0.243
Storey2	0.223	0.221	0.224	0.224	0.223	0.22
Storey1	0.16	0.154	0.155	0.157	0.155	0.159
Base	0.16	0.154	0.155	0.155	0.155	0.158

Table No 8: Time Period for all models With VD

Various Storey	Time Period of all models With VD					
	Symmetric	L shape	T shape	C shape	Plus shape	rectangular
Storey10	0.714	0.53	0.519	0.634	0.392	0.666
Storey9	0.699	0.456	0.403	0.546	0.376	0.651
Storey8	0.388	0.233	0.201	0.3	0.18	0.357
Storey7	0.144	0.097	0.096	0.123	0.071	0.131
Storey6	0.141	0.088	0.073	0.103	0.068	0.128
Storey5	0.071	0.042	0.038	0.056	0.032	0.065
Storey4	0.058	0.036	0.036	0.046	0.029	0.052
Storey3	0.053	0.035	0.029	0.039	0.025	0.048
Storey2	0.033	0.021	0.021	0.027	0.017	0.029
Storey1	0.028	0.019	0.016	0.021	0.014	0.025
Base	0.027	0.016	0.015	0.02	0.013	0.025

Table No 9: Time Period for all models With TMD

Various Storey	Time Period of all models With TMD					
	Symmetric	**L shape**	**T shape**	**C shape**	**Plus shape**	**rectangular**
Storey10	1.187	1.262	1.294	1.271	1.276	1.19
Storey9	0.966	0.874	0.916	0.954	0.916	0.925
Storey8	0.966	0.874	0.911	0.944	0.916	0.916
Storey7	0.416	0.405	0.416	0.415	0.405	0.41
Storey6	0.416	0.394	0.402	0.403	0.402	0.405
Storey5	0.397	0.39	0.395	0.401	0.402	0.393
Storey4	0.242	0.232	0.235	0.238	0.234	0.24
Storey3	0.242	0.231	0.234	0.233	0.234	0.237
Storey2	0.222	0.221	0.224	0.224	0.223	0.219
Storey1	0.159	0.153	0.154	0.156	0.153	0.158
Base	0.159	0.152	0.153	0.153	0.153	0.156

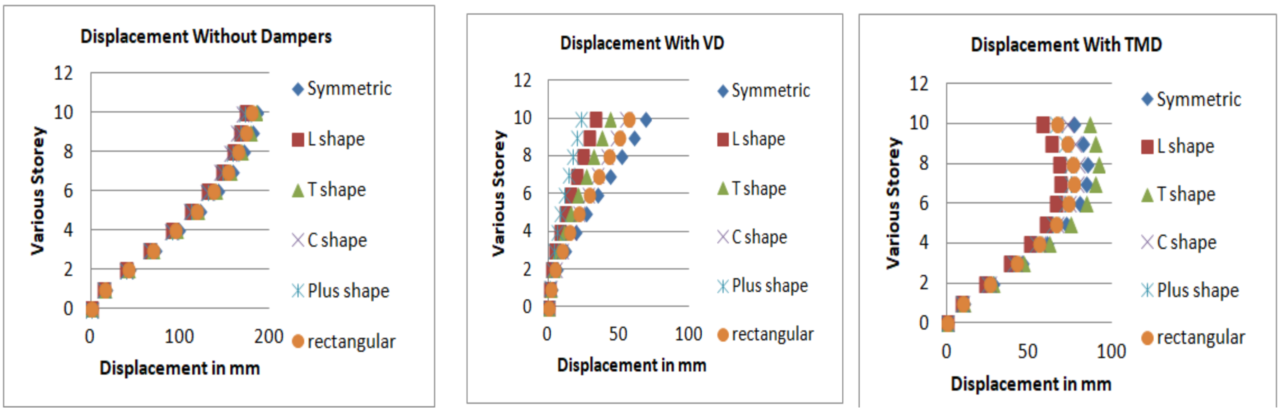

FIGURE NO 4: Story Displacement for all models without Dampers with VD and TMD

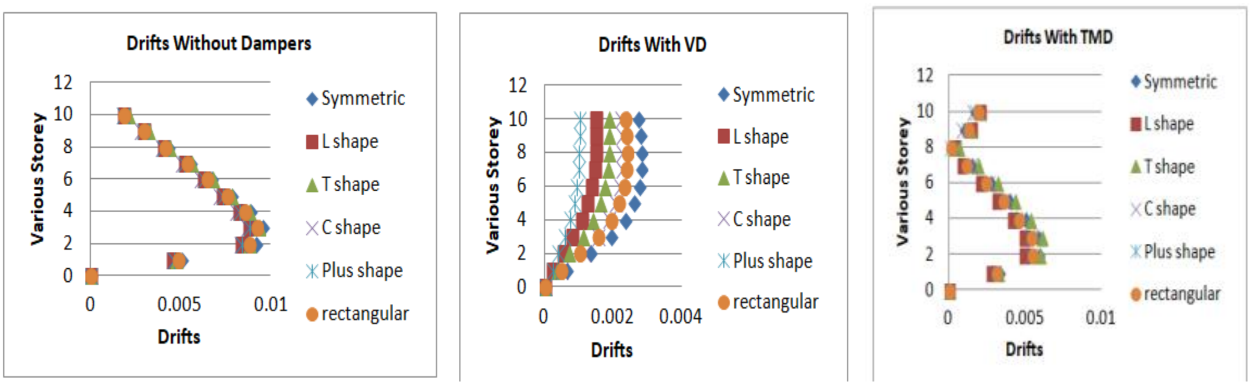

FIGURE NO 5: Story Drifts for all models without Dampers with VD and TMD

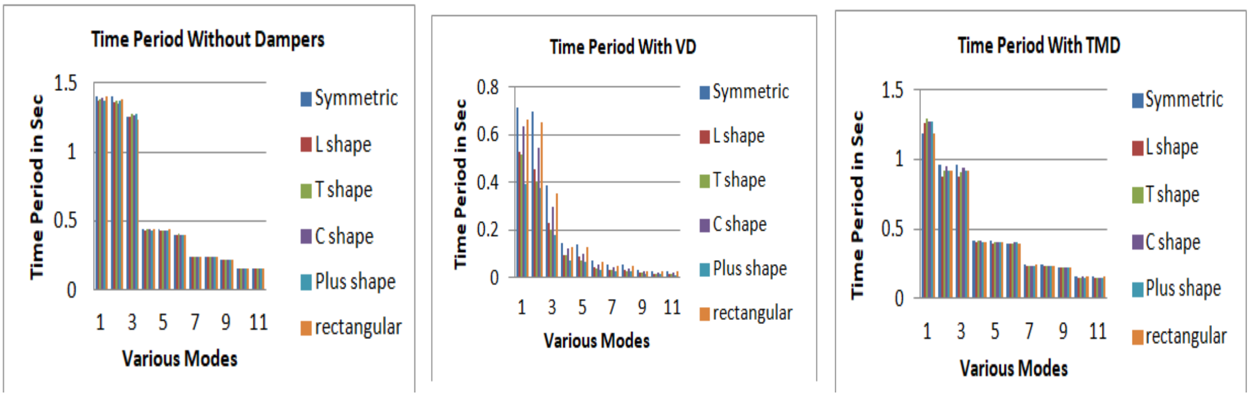

FIGURE NO 6: Time Period for all models without Dampers with VD and TMD

VI CONCLUSION

1. By providing VD and TMD to the structure we saw that the displacement of the building is reduced. We observe that displacement value increases over top of the structure. When we apply viscous damper to Symmetric-Shape plan building it reduces displacement about 65% to 95%. About 60% to 35% of displacement reduced when we provide TMD to Symmetric structure. When we apply viscous damper to L-Shape plan building it reduces displacement about 80% to 95%. About 75% to 50% of displacement reduced when we provide TMD to the L-Shape structure. When we apply viscous damper to T-shape plan building it reduces displacement about 80% to 95%. About 60% to 40% of displacement reduced when we provide TMD to T-shape structure. When we apply viscous damper to C-shape plan building it reduces displacement about 70% to 95%. About 50% to 35% of displacement reduced when we provide TMD to the C-Shape structure. When we apply viscous damper to Plus-shape plan building it reduces displacement about 85% to 95%. About 60% to 40% of displacement reduced when we provide TMD to the Plus- Shape structure. When we apply viscous damper to rectangular shape plan building it reduces displacement about 70% to 90%. About 60% to 40% of displacement reduced when we provide TMD to the Rectangular Shape structure.

2. Applying viscous damper and TMD to the symmetrical plan building reduces drift value about 70% and 40% respectively. Applying viscous damper and TMD to the L-shape plan building reduces drift value about 85% and 45% respectively. Applying viscous damper and TMD to the T-shape plan building reduces drift value about 80% and 35% respectively. Applying viscous damper and TMD to the C-shape plan building reduces drift value about 75% and 40% respectively. Applying viscous damper and TMD to the Plus shape plan building reduces drift value about 90% and 40% respectively. Applying viscous damper and TMD to the Rectangular shape plan building reduces drift value about 75% and 40% respectively.

3. Applying viscous damper to the symmetrical plan building reduces 50% to 85% of Time period value at top and bottom stories. While applying TMD to the structure reduces 15% to 0% of Time period value at top and bottom Storey. Applying viscous damper to the L-shape plan building reduces 60% to 90% of Time period value at top and bottom stories. While applying TMD to the structure reduces 8% to 0% of Time period value at top and bottom Storey. Applying viscous damper to the T-shape plan building reduces 60% to 90% of Time period value at top and bottom stories. While applying TMD to the structure reduces 6% to 0% of Time period value at top and bottom Storey. Applying viscous damper to the C-shape plan building reduces 55% to 90% of Time period value at top and bottom stories. While applying TMD to the structure reduces 9% to 0% of Time period value at top and bottom Storey. Applying viscous damper to the Plus-shape plan building reduces 70% to 90% of Time period value at top and bottom stories. While applying TMD to the structure reduces 7% to 0% of Time period value at top and bottom Storey. Applying viscous damper to the Rectangular-shape plan building reduces 50% to 85% of Time period value at top and bottom stories. While applying TMD to the structure reduces 15% to 0% of Time period value at top and bottom Storey.

4. As compared to TMD the VD play ideal role in decreasing maximum amount of displacement, time period and drift value of the structure. Viscous damper provide better seismic performance other than TMD. Providing viscous damper the Storey shear value variance is less due to weight of damper. The shear value increase greatly when we apply TMD to the structure.

5. Viscous dampers are better compare to Tuned mass damper which helps in reducing seismic forces.

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