PARAMETRIC STUDY BY DIVIDING THE PROPERTIES TO DIFFERENT DAMPERS

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Abstract: *The important feature of TMD is the mass of the damper. According to the TMD design the maximum allowable mass of the TMD is 10% mass of the structure. From the previous studies it is proved that mass of the damper will affect the vibration analysis of the structure. Here in this study TMDs for the mass ratios of 0.25, 0.5, 0.75% and 0.1% are designed and checked. Pendulum length directly affects the period of the TMD. So here the pendulum length is chosen as 0.1m. Then defining of directional properties such as translational stiffness's along the U1, U2, and U3. The linear stiffness along U1 represents axial properties, and it is calculated by EA/L value of the hangers, where E is the modulus of elasticity and L is the length of the pendulum. The linear stiffness properties of U2 and U3 are calculated by the formula Mg/L. M is the mass of the damper.*

Keywords: TMD, time periods, structural response, base shear, max roof displacement

1. INTRODUCTION

The vibration analysis and comparison is carried out by applying TMDs in different configurations in the RC framed structure. The arrangement includes single TMD and multiple TMD configurations. Normally a tuned mass damper will be placed in the top floor. In that case only a single damper is used and it is placed at the top of the structure, so that entire mass of tuned mass damper is taken by the top beam. So that this beam should be that much strong to accommodate the mass of the tuned mass damper. In order to make it economical the properties of the damper are split and provided it to different beams by two or more dampers. For this purpose, different cases are considered. The percentage of varying properties is shown in the table 1.

- Case 1: Single TMD is placed in the top storey.
- Case 2: TMDs are placed in the top two storeys. And the properties of TMD are equally distributed in these two floors.
- Case 3: TMDs are placed in the top three storeys. And the properties of TMD are equally distributed in these three floors.
- Case 4: Multiple TMDs are placed in the top storey. And the properties of TMD are equally distributed in these two dampers in the top floor.

Table 1. Placement of TMDs with Various Percentages of Properties for Different Cases

Floor	Case 1	Case 2	Case 3	Case 4
Fifth			33.33	
Sixth		50	33.33	
Roof	100	50	33.33	50+50

2. PARAMETRIC STUDY BY DIVIDING THE PROPERTIES TO DIFFERENT DAMPERS

In this chapter the effect of tuned mass damper with different configurations are studied. There are total four configurations are considered and in these four models the tuned mass damper is equally distributed in one or more stories.

2.1 Modal Analysis- Frequencies and Modes Shapes

The modal analysis is carried out and the time periods of the models with various modes are taken. Different dampers are considered for each mass ratio of 0.025, 0.05, 0.075 and 0.1.

Table 2. Time periods of mass ratio 0.025 with various dampers

Mode	Without TMD	With TMD Mass ratio			
		Case 1	Case 2	Case 3	Case 4
1	0.984315	1.615823	1.986329	2.212477	1.58
2	0.678643	1.141762	1.409076	1.571245	1.42
3	0.660105	0.732327	0.769796	0.796351	1.06
4	0.323342	0.401226	0.422095	0.540196	0.40

Table 3. Time periods of mass ratio 0.05 with various dampers

Mode	Without TMD	With TMD Mass ratio			
		Case 1	Case 2	Case 3	Case 4
1	0.984315	2.082952	2.644515	2.979119	2.03
2	0.678643	1.477226	1.878435	2.116113	1.91
3	0.660105	0.776821	0.84475	0.891781	1.35
4	0.323342	0.416497	0.513604	0.710323	0.4202

Table 4. Time periods of mass ratio 0.075 with various dampers

Mode	Without TMD	With TMD Mass ratio			
		Case 1	Case 2	Case 3	Case 4
1	0.984315	2.46529	3.169668	3.585829	2.4
2	0.678643	1.750081	2.251757	2.546196	2.3
3	0.660105	0.818559	0.913746	0.97794	1.63
4	0.323342	0.423328	0.602029	0.848538	0.427

Table 5. Time periods of mass ratio 0.1 with various dampers

Mode	Without TMD	With TMD Mass ratio			
		Case 1	Case 2	Case 3	Case 4
1	0.984315	2.79645	3.619624	4.103912	3.727
2	0.678643	1.985954	2.571334	2.913204	3.66
3	0.660105	0.858573	0.978202	1.057246	2.487
4	0.323342	0.427477	0.681417	0.967588	0.43

2.2 Variation in Structural Response

2.2.1 Variation in Base Shear: The base shear obtained for various dampers in several mass ratios are shown in the following tables.

Table 6. Base shear of mass ratio 0.025 with various dampers

Mass ratio	Base shear	% of reduction
Case 1	3561	20.86
Case 2	3469	22.91
Case 3	4029	10.46
Case 4	2887	35.84

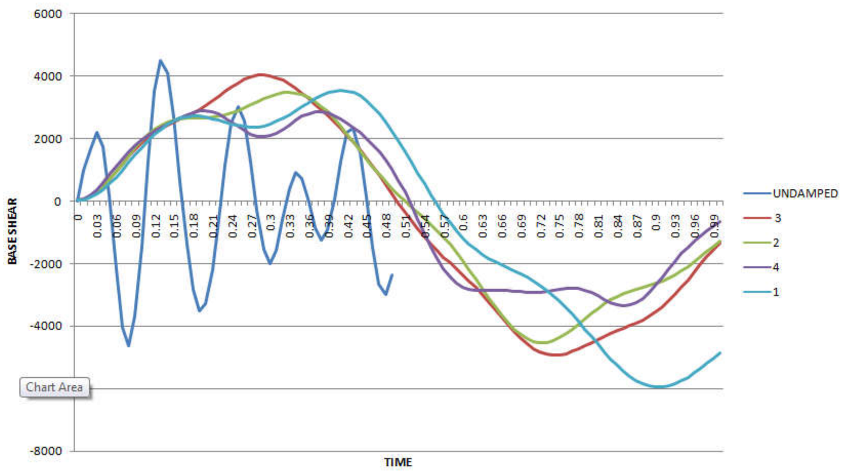

Figure 1. Comparison of base shear of mass ratio 0.025 with various dampers

Table 7. Base shear of mass ratio 0.05 with various dampers

Mass ratio	Base shear	% of reduction
Case 1	3336	25.86
Case 2	3331	25.97
Case 3	3774	16.13
Case 4	2831	37.08

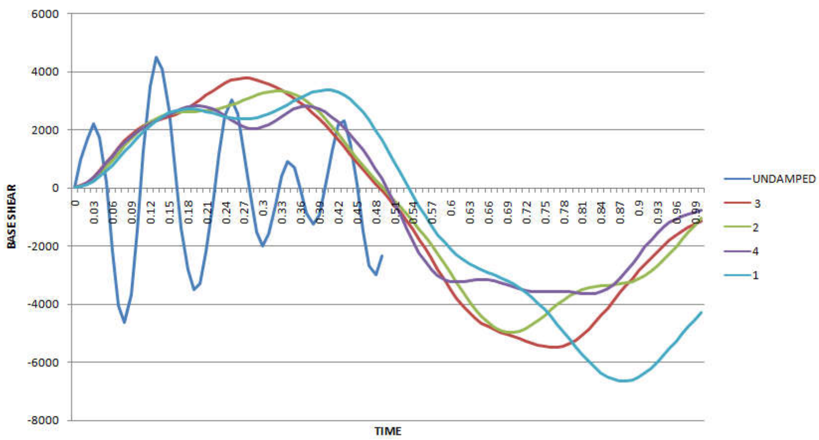

Figure 2. Comparison of base shear of mass ratio 0.05 with various dampers

Table 8. Base shear of mass ratio 0.075 with various dampers

Mass ratio	Base shear	% of reduction
Case 1	2869	36.24
Case 2	2879	36.02
Case 3	3548	21.15
Case 4	2165	51.88

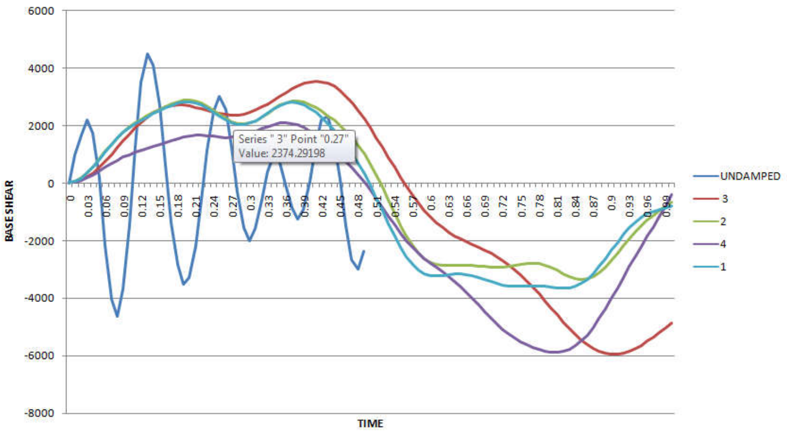

Figure 3. Comparison of base shear of mass ratio 0.075 with various dampers

Table 9. Base shear of mass ratio 0.1 with various dampers

Mass ratio	Base shear	% of reduction
Case 1	2085	53.66
Case 2	2078	53.82
Case 3	2126	52.75
Case 4	1966	56.31

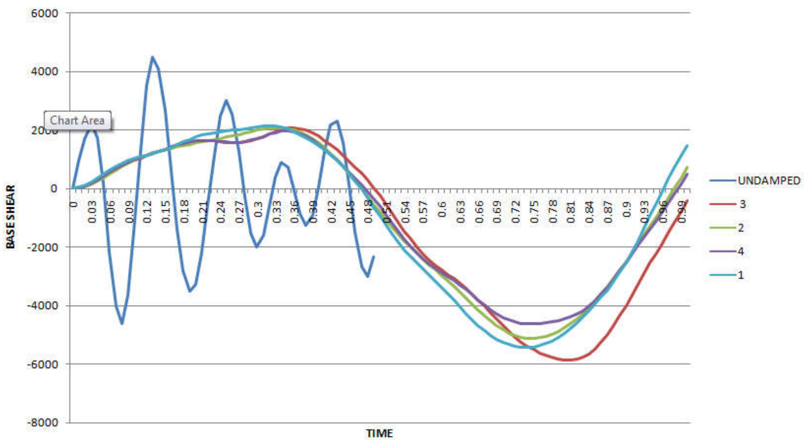

Figure 4. Comparison of base shear of mass ratio 0.1 with various dampers

From the analysis it is clear that case 4 is the best. All the other models are getting the base shear almost same and the reduction is less compared to the first case and case 3 is the worst configuration.

2.2.2 Variation in roof displacement:

Table 10. Max roof displacement of mass ratio 0.025 with various dampers

Mass ratio	Roof displacement	% of reduction
Case 1	0.023	17.13
Case 2	0.026	13.82
Case 3	0.028	7.19
Case 4	0.016	46.96

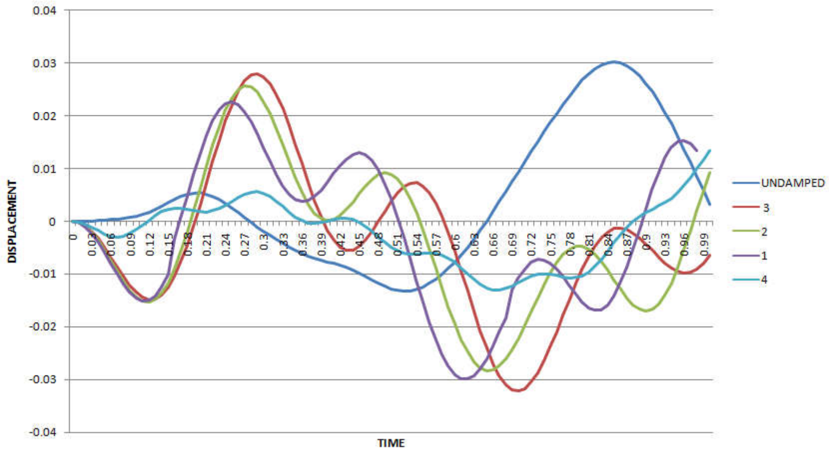

Figure 5. Comparison of roof displacement of mass ratio 0.025 with various dampers

Table 11. Max roof displacement of mass ratio 0.05 with various dampers

Mass ratio	Roof displacement	% of reduction
Case 1	0.018	40.33
Case 2	0.019	37.02
Case 3	0.022	27.07
Case 4	0.015	50.28

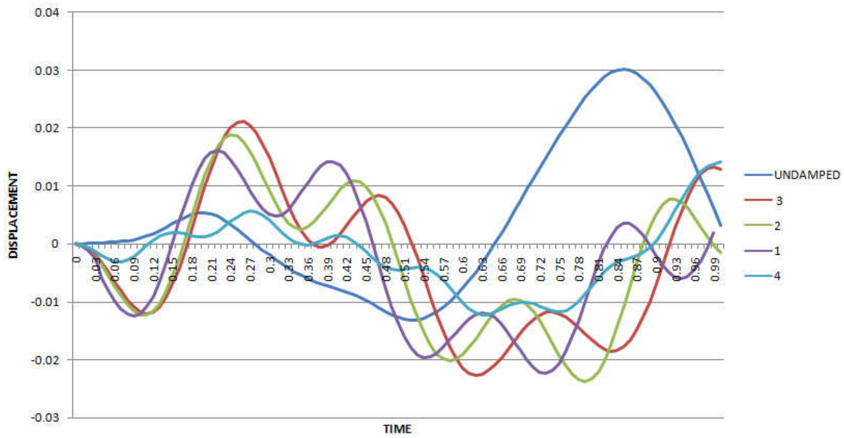

Figure 6. Comparison of roof displacement of mass ratio 0.05 with various dampers

Table 12. Max roof displacement of mass ratio 0.075 with various dampers

Mass ratio	Roof displacement	% of reduction
Case 1	0.017	43.65
Case 2	0.0165	45.30
Case 3	0.019	37.02
Case 4	0.014	53.59

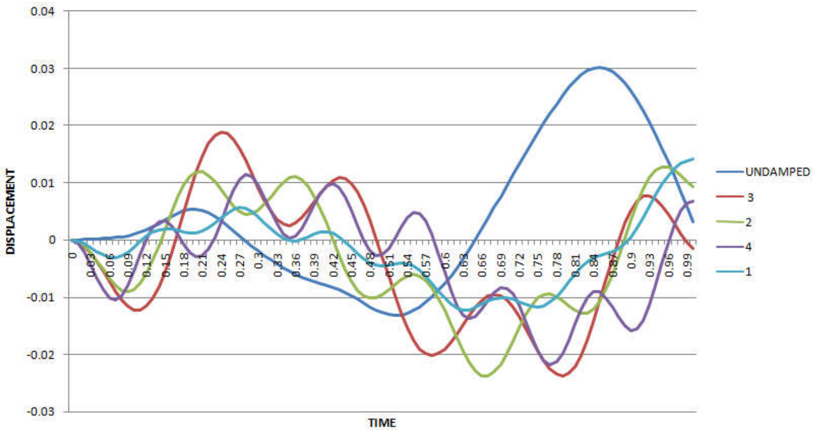

Figure 7. Comparison of roof displacement of mass ratio 0.075 with various dampers

Table 13. Max roof displacement of mass ratio 0.1 with various dampers

Mass ratio	Roof displacement	% of reduction
Case 1	0.016	46.96
Case 2	0.0155	48.62
Case 3	0.015	50.28
Case 4	0.013	56.91

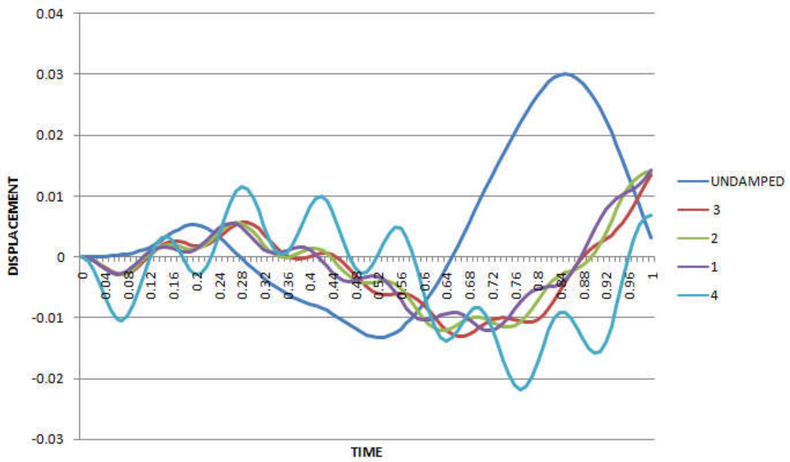

Figure 8. comparison of roof displacement of mass ratio 0.1 with various dampers

From the analysis it is clear that case 4 is the best. All the other models are getting the base shear almost same and the reduction is less compared to the first case. and case 3 is the worst configuration.

3. CONCLUSION

The vibration analysis and comparison is carried out by applying TMDs in different configurations in the RC framed structure. The arrangement includes single TMD and multiple TMD configurations. Normally a tuned mass damper will be placed in the top floor. In that case only a single damper is used and it is placed at the top of the structure, so that entire mass of tuned mass damper is taken by the top beam. So that this beam should be that much strong to accommodate the mass of the tuned mass damper. In order to make it economical the properties of the damper are split and

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