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Study on the Performance of Reinforced Concrete Structure with Viscous Damper with Bhuj Earthquake Time History

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Abstract: Structures are designed to resist earthquake forces through a combination of strength, deformability and energy absorption. Due to the earthquake forces Building behaviour change in displacement, story drift, base shear. Building may be damage or collapse due to the earthquake forces Dampers are used to resist lateral forces coming on the structure. Dampers are the energy dissipating devices which also resist displacement of RC building during earthquake. These dampers help the structure to reduce the buckling of columns and beams. This study deals with different number of damper which will be more resistant to earthquake for the selected building. The dissertation work is concerned with the comparative study of number of dampers and without damper for multi-storey RCC. Building. Time history method is used to analyses seismic behaviour of G+4 storey building with and without dampers. For the analysis purpose Etabs 2017 software is used. Results of these analyses are discussed in terms of various parameters such as maximum displacement, storey drift, storey shear, time vs shear, Column forces. The structure is analysed with and without number of dampers. From these comparisons it is concluded that maximum displacement, storey drift, storey shear, time vs shear, column forces values are more in case of RC building without damper as compared to RC building with dampers.

Keywords: Viscous dampers, Time history Analysis, Displacement, Drift, Base Shear, Column forces

I. INTRODUCTION

Structures are designed to resist dynamic forces. These structures may deform well beyond the elastic limit, for example, in a severe earthquake. It indicates that structures designed with these methods are sometimes vulnerable to strong earthquake motions. In order to avoid such critical damages, structural engineers are working to figure out different types of structural systems that are robust and can withstand strong motions. Alternatively, some types of structural protective systems may be implemented to mitigate the damaging effects of these dynamic forces.In order to avoid such critical damages, structural engineers are working to figure out different types of structural systems that are robust and can withstand strong motions. Alternatively, some types of structural protective systems may be implemented to mitigate the damaging effects of these dynamic forces. The structural control response system is use to minimize structural damage and to control the structural response. The structural control response system also known as Earthquake protective systems. The protective system has grown to include passive, active and semi- active system.

Viscous Damper: In this type of damper by using viscous fluid inside cylinder energy dissipated. Viscous dampers are used in high-rise building in seismic areas. Viscous damper reduces the vibrations induced by both strong wind and earthquake.

Fig-1 Viscous damper

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II. DATA OF THE BUILDING

A. *Analysis of G+4 building with Damper and Without Damper*

Table 1 Building data

Building	G+4
Height of the building	15 Meter
number of bay	7 x 4
Spacing of bay	5 meter
All storey height	3 meter
Ground floor Column size	700mm x 700mm
Column size	600mm x 600mm
Beam size	300mm x 600mm
Slab thickness	150mm
Live load	3 KN/M^2
Wall load periphery(light weight block)	3.5 KN/m
Wall load parapet	1.35 KN/m

B. *The BHUJ Earthquake Time history Data Have Taken*

Table 2 Bhuj earthquake data Data

Bhuj	PGA(g)
EQX	1.04
EQY	0.78

1) Damper property
2) Damper property taken from the Taylor device guide line.

Table 3 damper Property Data

Stiffness	1751268.5 KN/m
Damping	6694.3 KN(s/m)
Damping exponent	0.3

C. *Modal A-Building analysis using Bhuj earthquake data Non-linear time history analysis*

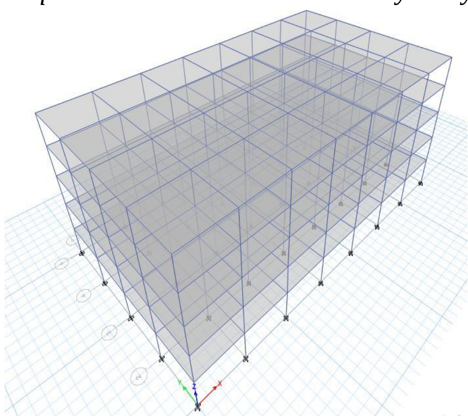

Fig 2. Modal without damper

D. Modal B-Building analysis using Bhuj earthquake data Non-linear time history analysis using 16 damper

1) Number of damper use – 16
2) at G.F. & F.F (with 1-2 damper)

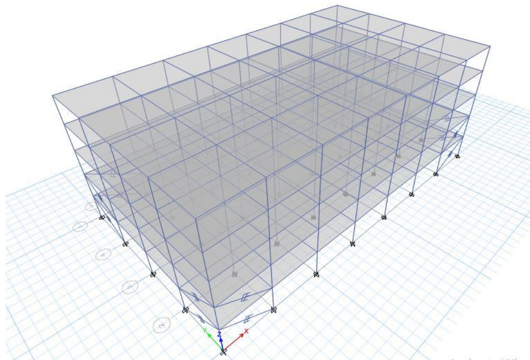

Fig 3. Modal with 1-2 damper

E. Modal C-Building analysis using Bhuj earthquake data Non-linear time history analysis using 16 damper

1) Number of damper use – 16
2) at F.F. & T.F (with 2-4 damper)

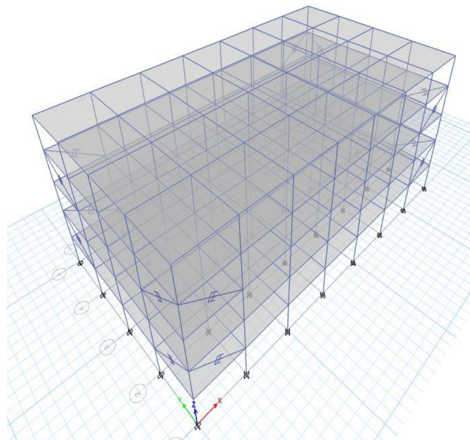

Fig 4. Modal with 2-4 damper

F. Modal D-Building analysis using Bhuj earthquake data Non-linear time history analysis using 24 damper

1) Number of damper use – 24
2) at G.F.,S.F.,F.F (with 1-3-5 damper)

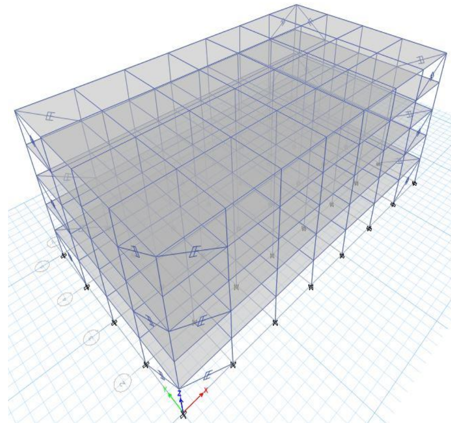

Fig 5. Modal with 1-3-5 damper

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G. Modal E-Building analysis using Bhuj earthquake data Non-linear time history analysis using 40 damper
1) Number of damper use – 16
2) at all floor (with 1 To 5 damper)

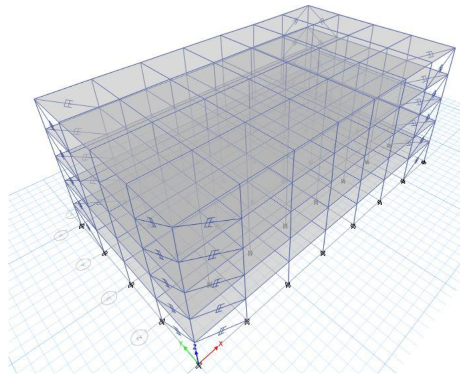

Fig 6. Modal with 1 to 5 damper

III. REVIEW OF LITERATURE REVIEW

A k Sinha & Sharad Singh study in 2017 on the seismic effect on 12 floor building with or without damper in ETABS software. They applied earthquake load as per IS 1893-2002 part 1 for Zone-5. They measure various parameter like time history plots of base shear and story shears.They concluded that The dampers have been effective in reducing shear forces in the structure.

Pouya azarsa & mahdi hosseini study in 2016 of seismic behavior of 4 storey Normal Steel Building, Steel Building with 'X' Bracing and Steel Building with Dampers in SAP2000. Nonlinear time history analysis has been performed for structures and observed the reduction in seismic response. The Bhuj 2001 earthquake data is used as ground motion data for performing nonlinear time history analysis. Parameters studied are roof displacements, storey drifts and base shears. They concluded that The Fluid viscous damper were found to be excellent seismic control devices for controlling forced Responses such as base shear, roof displacements and storey drift for buildings as compare to Normal building and X-bracing Building.

IV. OBJECTIVE

A. To study the behavior of building for different number of dampers with Bhuj earthquake time history analysis.
B. Study of results in terms of displacement, story drift, base shear, column Forces.
C. To study how Number of dampers affect the seismic response of a frame structure

V. RESULT AND DISCUSSIONS

Dampers are used to reduce the seismic effect of the structure which is subjected to the earthquake load. The frames (with and without damper) is modeled according to the properties of the structure which are explained in the work. Time History analysis is carried out by using ETABS 2017 software. The seismic behavior of the Reinforced Concrete structure is judged by observing the parameters such as displacement, story drift and story shear, Time vs shear.

A. Comparing the result in terms of displacement
1) X-direction

Table 4 Bhuj earthquake x-direction displacement value

story	without damper(mm)	with 1-2 damper(mm)	with 2-4 damper(mm)	with 1-3-5 damper(mm)	with 1 to 5 damper(mm)
5	94.287	78.296	70.757	73.204	53.588
4	83.3	68.188	62.439	67.044	50.115
3	64.559	51.03	50.776	52.37	43.127
2	39.482	29.313	30.519	34.297	27.168
1	13.173	9.879	11.812	11.014	8.91
0	0	0	0	0	0

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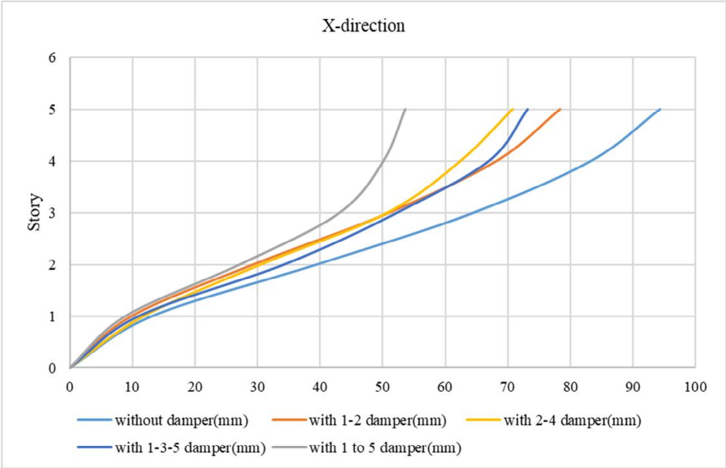

Figure 7 Bhuj earthquake x-direction displacement graph

2) Y-direction

Table 5 Bhuj earthquake Y-direction displacement value

story	without damper(mm)	with 1-2 damper(mm)	with 2-4 damper(mm)	with 1-3-5 damper(mm)	with 1 to 5 damper(mm)
5	124.9	76.295	73.085	74.772	36.529
4	110.123	65.17	64.947	67.4	33.43
3	85.186	47.171	52.687	51.683	28.067
2	51.78	25.839	31.54	33.545	19.95
1	17.064	8.045	12.08	10.58	6.482
0	0	0	0	0	0

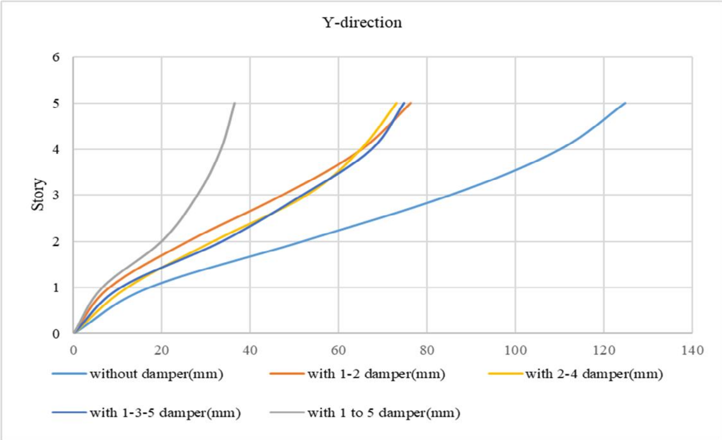

Figure 8 Bhuj earthquake y-direction displacement graph

3) X- direction Result decrees in percentage

Table 6 Bhuj earthquake X-direction displacement result in Percentage

Story	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
5	0	16.9%	24.9%	22.35%	43.1%

4) Y-direction Result Decrees in Percentage

Table 7 Bhuj earthquake Y-direction displacement result in Percentage

Story	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
5	0	38.9%	41.5%	40.1%	70.7%

B. Comparing the Result in Terms of Drift

1) X-direction Result

Table 8 Bhuj earthquake X-direction drift ratio

Story	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
5	0.00371	0.00339	0.003336	0.002231	0.001266
4	0.00627	0.00587	0.004172	0.005566	0.002639
3	0.00837	0.00789	0.007209	0.006325	0.005438
2	0.00878	0.00658	0.00658	0.008077	0.006322
1	0.00439	0.00329	0.003937	0.003671	0.00297
0	0	0	0	0	0

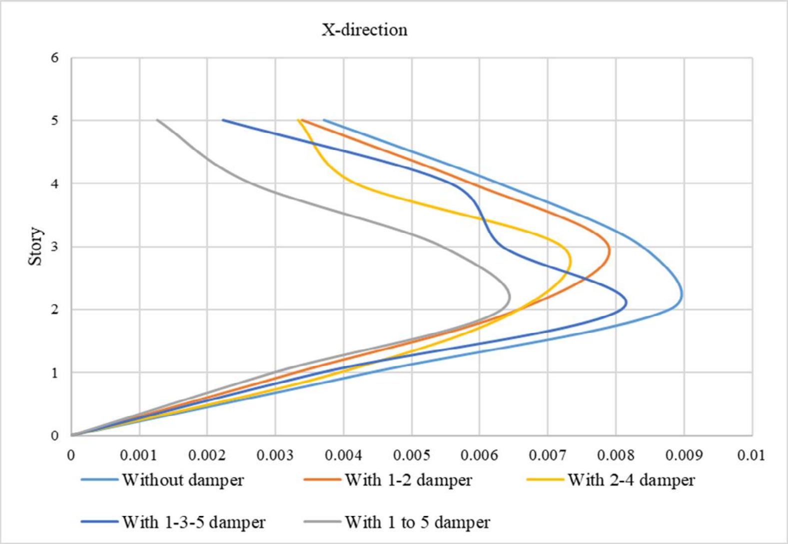

Figure 9 Bhuj earthquake x-direction drift graph

2) Y-direction Result

Table 9 Bhuj earthquake Y-direction drift ratio

Story	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
5	0.005322	0.004056	0.003502	0.002706	0.001192
4	0.008477	0.006536	0.004625	0.006014	0.001797
3	0.011141	0.00792	0.007669	0.006711	0.00306
2	0.01158	0.006003	0.006987	0.008035	0.004798
1	0.005688	0.002682	0.004027	0.003527	0.002161
0	0	0	0	0	0

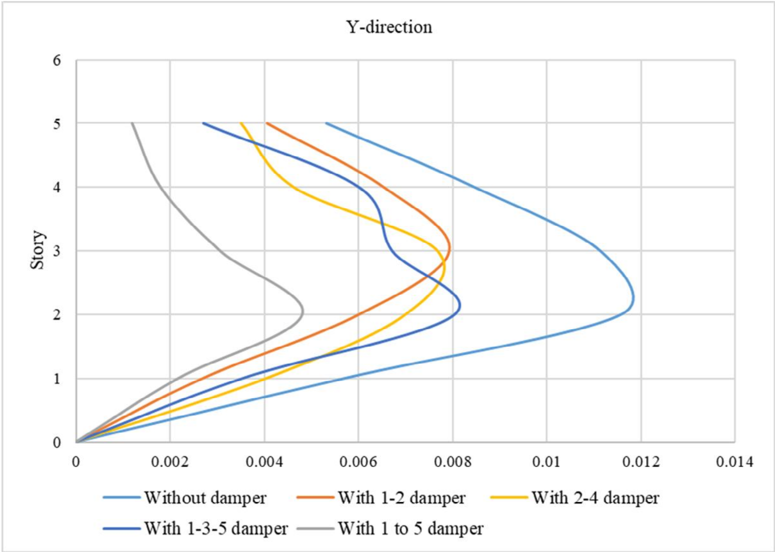

Figure 10 Bhuj earthquake y-direction drift graph

C. Comparing the result in terms of shear vs time

1) X-direction

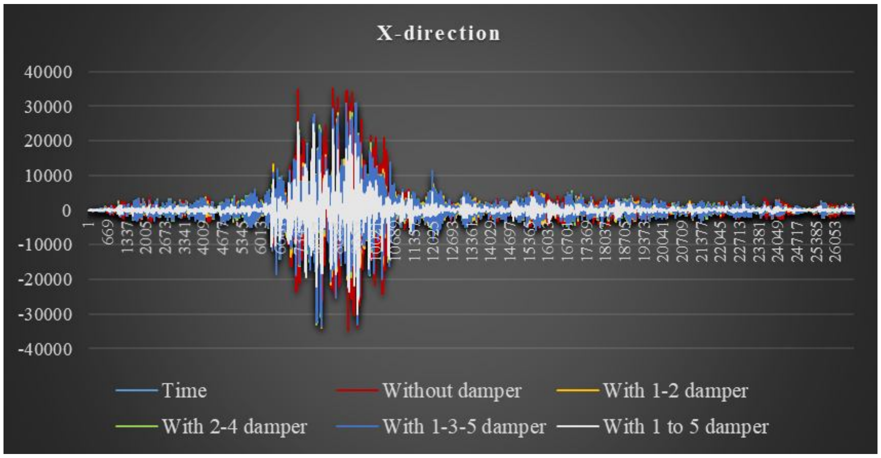

Figure 11 Bhuj earthquake x-direction time vs shear graph

2) Y-direction

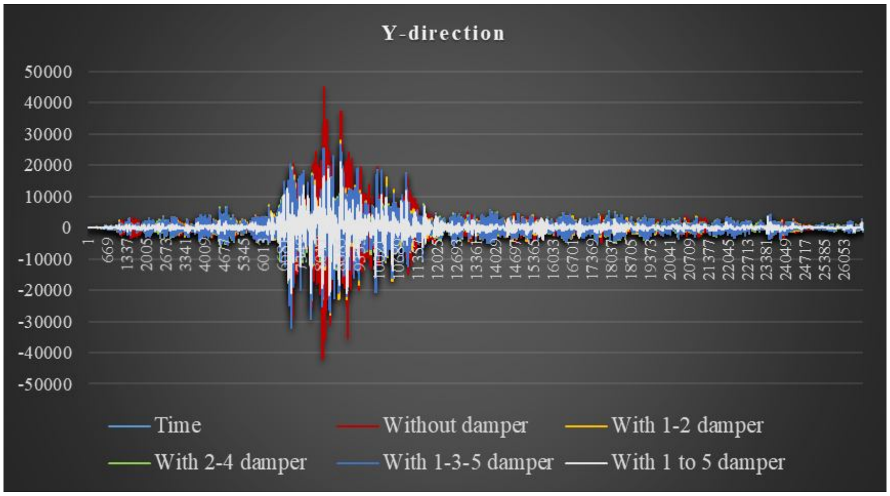

Figure 12 Bhuj earthquake Y-direction time vs shear graph

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D. Comparing the result in terms of shear vs time

1) X-direction

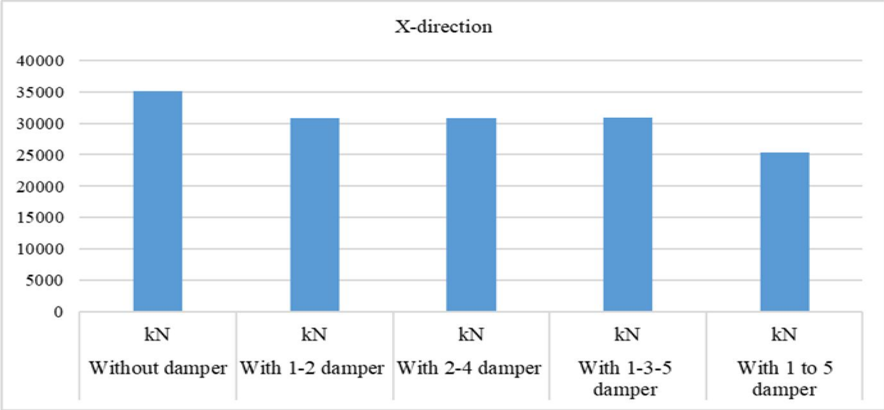

Figure 13 Bhuj earthquake base shear in x-direction

2) Y-direction

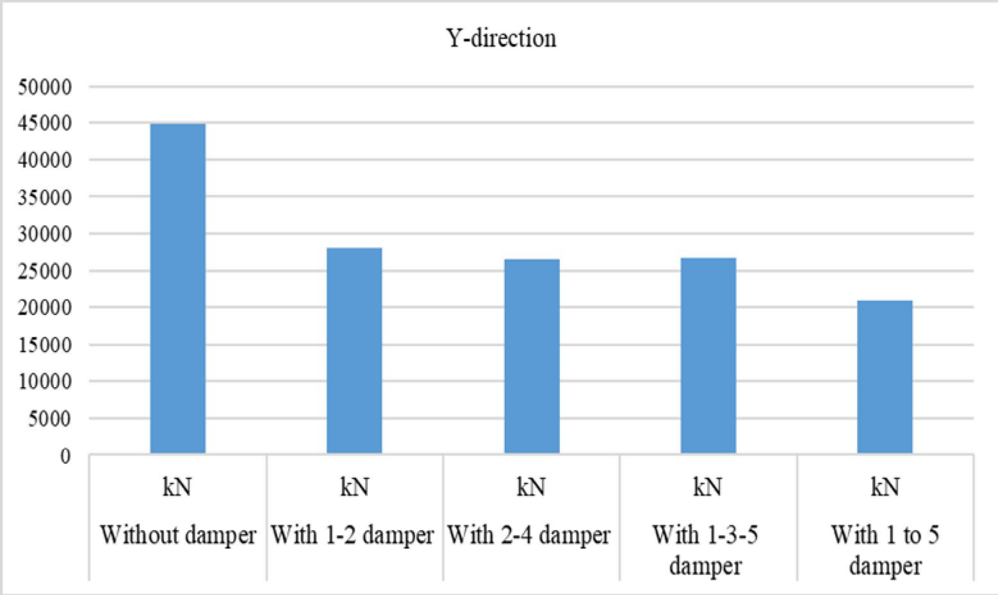

Figure 14 Bhuj earthquake base shear in Y-direction

3) X- direction Result Decrees in Percentage

Table 10 Bhuj earthquake X-direction decreased result of base shear in percentage

	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
Base shear	0	12.10%	12.11%	11.85%	27.7%

4) Y-direction Result decrees in percentage

Table 11 Bhuj earthquake Y-direction decreased result of base shear in percentage

	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
Base shear	0	37.5%	41%	44.3%	53.4%

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E. Comparing the result in terms of Column forces

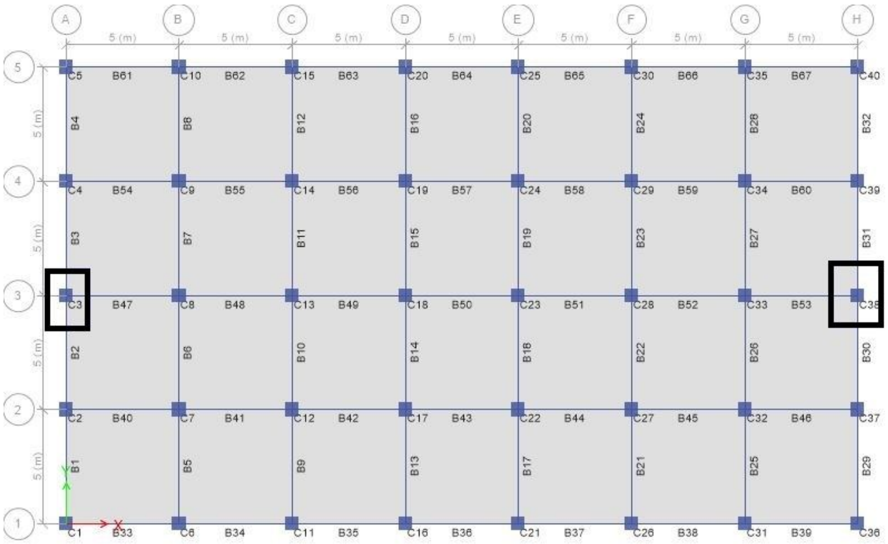

Figure 15 column number

1) Column –C3

a) X-direction

Table 12 Bhuj earthquake X-direction column C-3 forces

Story	Column	Without damper (KN)	With 1-2 damper (KN)	With 2-4 damper (KN)	With 1-3-5 damper (KN)	With 1 to 5 damper (KN)
Story5	C3	109.899	97.3304	106.701	33.6169	22.7738
Story4	C3	284.91	277.588	123.52	267.983	69.7298
Story3	C3	392.245	378.417	367.239	240.011	266.234
Story2	C3	542.934	364.761	362.555	523.284	405.64
Story1	C3	709.187	509.209	649.308	562.483	458.041

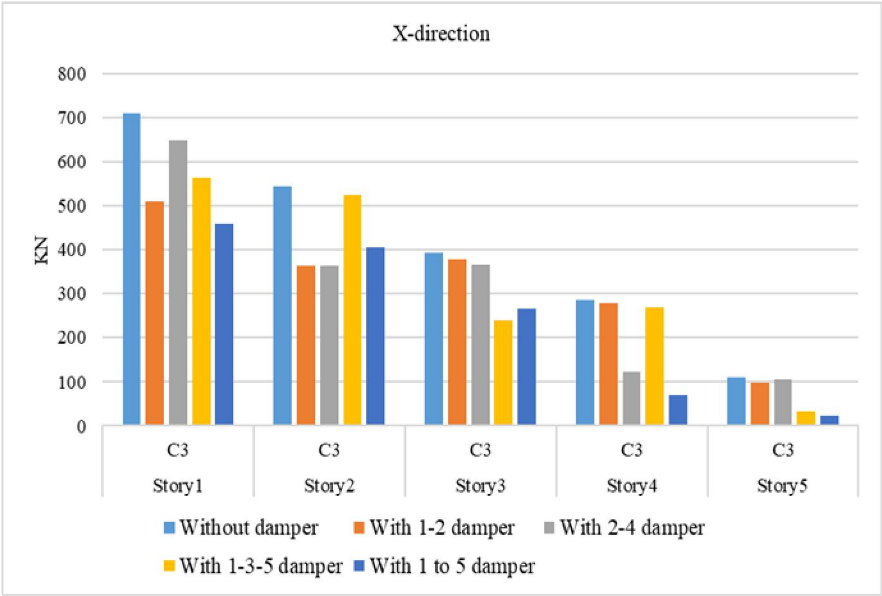

Figure16 Bhuj earthquake x-direction column c-3 forces

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b) Y-direction

Table 13 Bhuj earthquake Y-direction column C-3 forces

Story	Column	Without damper (KN)	With 1-2 damper (KN)	With 2-4 damper (KN)	With 1-3-5 damper (KN)	With 1 to 5 damper (KN)
Story5	C3	417.878	323.678	348.8153	102.099	117.079
Story4	C3	695.786	558.712	228.2185	633.985	143.513
Story3	C3	940.164	741.276	815.085	419.671	194.517
Story2	C3	1098.93	449.188	495.6169	916.164	554.012
Story1	C3	1149.39	556.701	973.1602	565.417	359.774

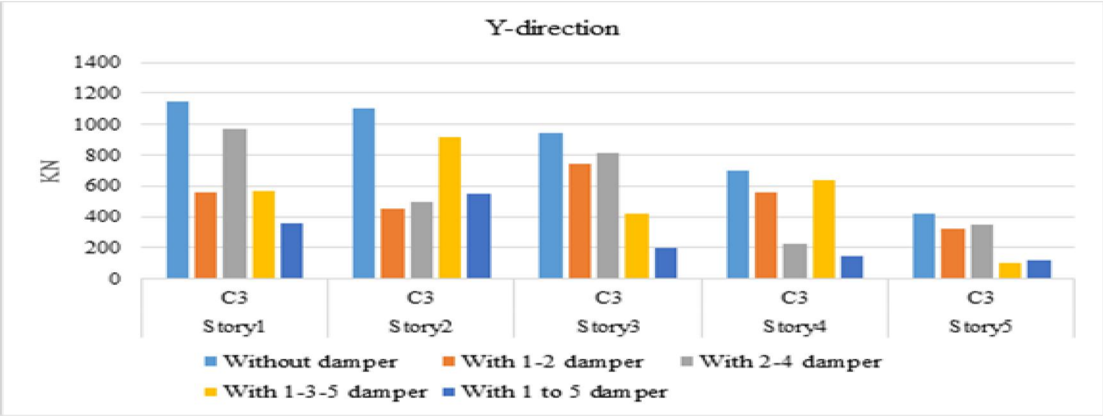

Figure 17 Bhuj earthquake Y-direction column C-3 forces

2) Column-C38

a) X-direction

Table 14 Bhuj earthquake X-direction column C-38 forces

Story	Column	Without damper (KN)	With 1-2 damper (KN)	With 2-4 damper (KN)	With 1-3-5 damper (KN)	With 1 to 5 damper (KN)
Story5	C38	109.899	97.4605	106.7009	33.6457	22.7737
Story4	C38	284.91	277.6422	123.4896	267.9692	69.7298
Story3	C38	392.245	378.7922	367.1497	240.1663	266.234
Story2	C38	542.934	362.9346	364.7182	524.0344	405.6398
Story1	C38	709.187	511.1547	650.9958	564.0017	458.0409

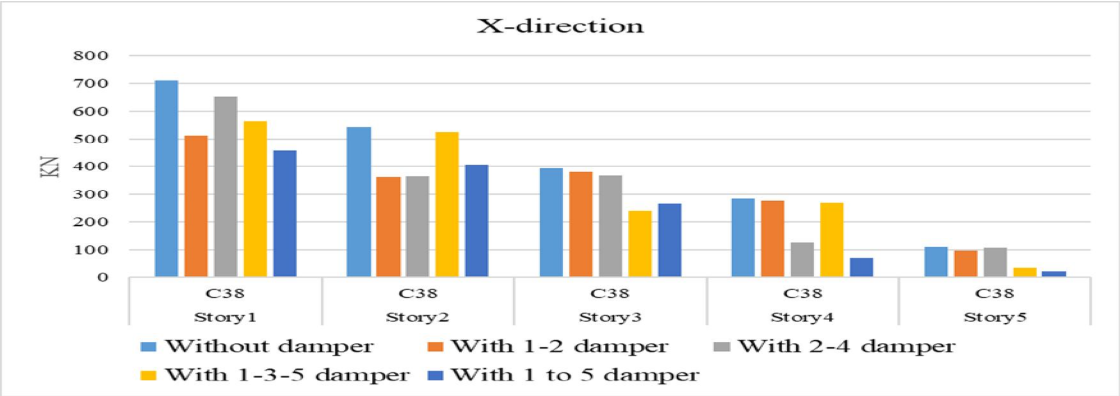

Figure 18 Bhuj earthquake x- direction column C-38 forces

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b) Y-direction

Table 15 Bhuj earthquake X-direction column C-38 forces

Story	Column	Without damper (KN)	With 1-2 damper (KN)	With 2-4 damper (KN)	With 1-3-5 damper (KN)	With 1 to 5 damper (KN)
Story5	C38	417.878	325.1887	348.6042	102.0709	117.0792
Story4	C38	695.786	559.995	228.2986	633.822	143.513
Story3	C38	940.164	741.1864	815.2106	419.1242	194.517
Story2	C38	1098.93	451.8558	495.5559	915.5482	554.0121
Story1	C38	1149.39	555.9764	972.9429	565.5629	359.7741

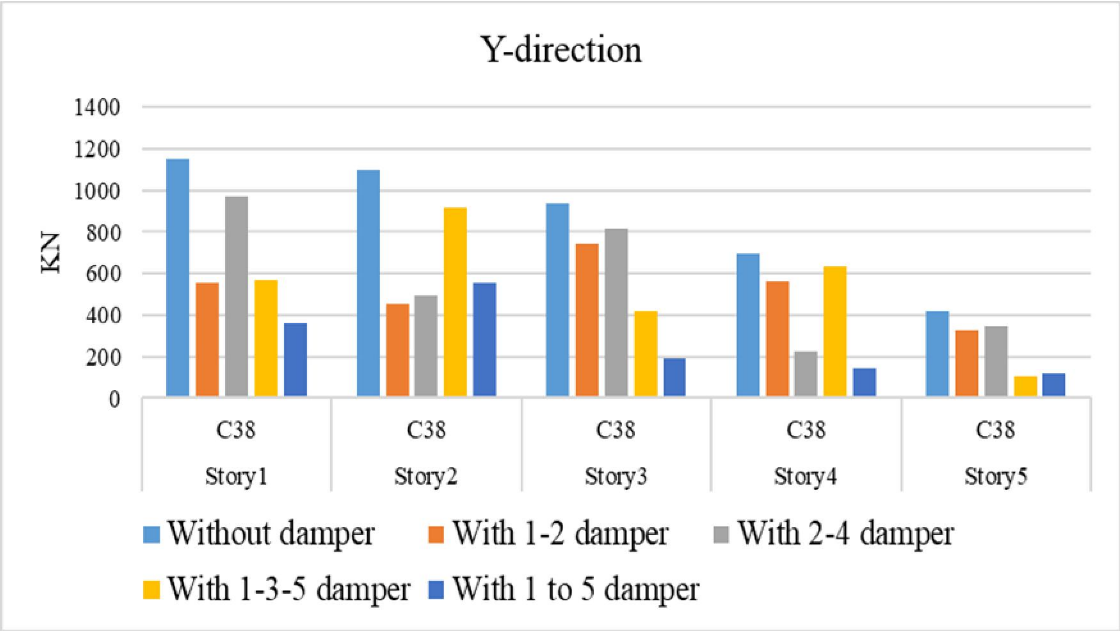

Figure 19 Bhuj earthquake Y- direction column C-38 forces

VI. CONCLUSIONS

From the comparison of current study, following conclusion considered:

A. With increase in number of damper at different story as compare to without damper there is decrees in displacement, but damper at all story (1 to 5 damper) give a less displacement as compare to 1-2 damper,2-4 damper,1-3-5 damper & without damper from the analysis of Bhuj earthquake time history analysis.

B. There also reduction in Story drift with number of damper at different story as compare to without damper, but damper at all story(1 to 5 damper) give a less story drift as compare to 1-2 damper,2-4 damper,1-3-5 damper & without damper from the analysis of Bhuj earthquake time history analysis.

C. From the comparative study of base shear of all model found that there is decrees in base shear with all story damper (1 to 5 damper) as compare to 1-2 damper,2-4 damper,1-3-5 damper & without damper from the analysis of Bhuj earthquake time history analysis.

D. With comparative study we found that with increase the number of damper as compare to without damper there is also reduction on column forces, but damper at all story damper(1 to 5 damper) give a less force on all story column as compare to 1-2 damper,2-4 damper,1-3-5 damper & without damper from the analysis of Bhuj earthquake time history analysis.

E. From overall study we found that to reduce displacement, all story drift ratio, forces on all story column, base shear there is need to place damper at all story.

VII. ACKNOWLEDGMENT

We gratefully acknowledge the contribution of everyone who helped me during my thesis report. We particularly offer my heartfelt thanks to my guide Prof. Arjun M. Butala for his immeasurable advice and support during the course of seminar work and beyond. I hereby take an opportunity to acknowledge my indebtedness to him for his continual implication and the clarity of the concepts of the topic that helped us a lot during the study

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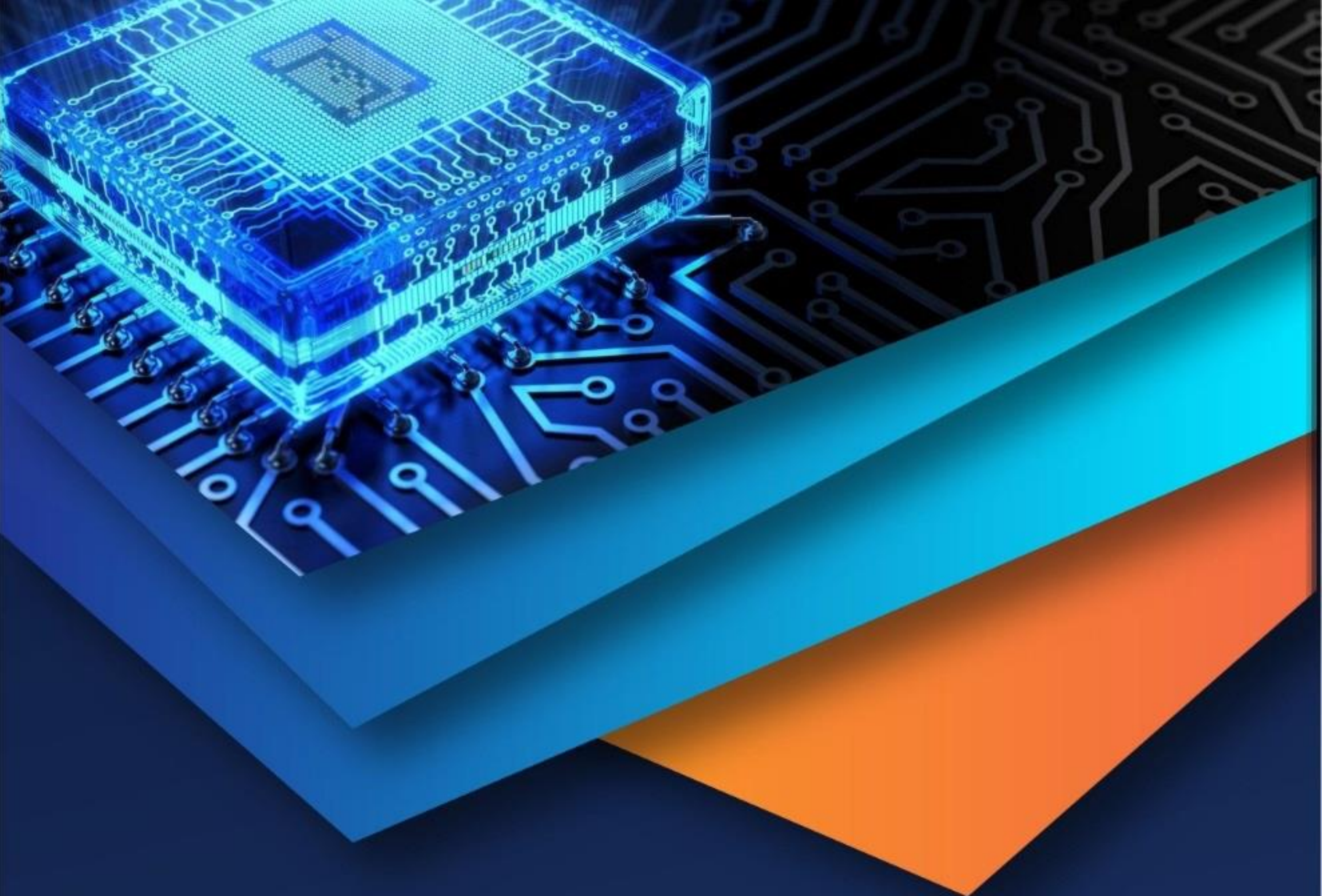

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