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

Kirtikumar K. Prajapati[1], Prof.Arjun M. Butala[2]

[1]M.Tech Student, Department of civil Engineering, UVPCE, Ganpat University, Mehsana, Gujarat, India
[2]PG Coordinator(SE), Assistant Professor, Department of Civil Engineering UVPCE , Ganpat University, Mehsana, Gujarat, India

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Abstract - *Dampers are used to resist lateral forces coming on the structure. These dampers help the structure to reduce the buckling of columns and beams. At the time of earthquake multi-storey building is damaged and large deformation occurred in multi-storey building. 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 behavior 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 analyzed 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.*

Key Words*: *viscous dampers, Time history Analysis, Displacement, Drift, Base Shear, Column forces

1. INTRODUCTION

In addition to the loads due to the effects of gravity, earthquake loading must be considered when designing structures located in seismically active areas. The philosophy in the conventional seismic design is that a structure is designed to resist the lateral loads corresponding to earthquakes.

Structures are designed to resist dynamic forces through a combination of strength, deformability and energy absorption.. 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. 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.

1.1 Viscous damper

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

Fig -1: Viscous damper

1.2 Review of literature

M.S Landge & Prof. P.K. Joshi study in 2017 on behavior of G+7 R.C.C. building with various types of dampers by using ETABS 2015 software. They applied earthquake load as per IS 1893-2002 part 1 for Zone-4. They Compare various parameters namely storey shear, storey drift, displacement. Selection of suitable type of damper which will be more resistant to earthquake for the selected building. By comparing the results they concluded that lateral deflection, storey drift, story shear for RC building with viscous damper as compared to other dampers is minimum.

Puneeth sajjan & Praveen birada in 2016 study on effect of viscos damper in symmetrical plan Building in ETABS software. They applied earthquake load as per IS 1893-2002 part 1 for Zone-3 & they measure result of displacement, storey drift with or without damper. By comparing the results they concluded that viscous damper in structure, decrease of building displacement and building drift.

1.3 Objective

- To study the behavior of building for different number of dampers with Elcentro earthquake time history analysis.
- Study of results in terms of displacement, story drift, base shear, column Forces.

- To study how Number of dampers affect the seismic response of a frame structure

2. DATA OF THE BUILDING

- Analysis of G+4 building with damper and without damper.
- The ELCENTRO Earthquake data have taken

Table -1: Elcentro earthquake PGA value

Elcentro	PGA(g)
EQX	0.31
EQY	0.31

- Damper property
- Damper property taken from the Taylor device guide line.

Table -2: damper Property Data

Stiffness	875634.2 KN/m
Damping	6694.31 KN(s/m)
Damping exponent	0.3

Table -3: 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

- **Methodology**

2.1 Model A-Building analysis with Elcentro Earthquake data non- linear time history analysis

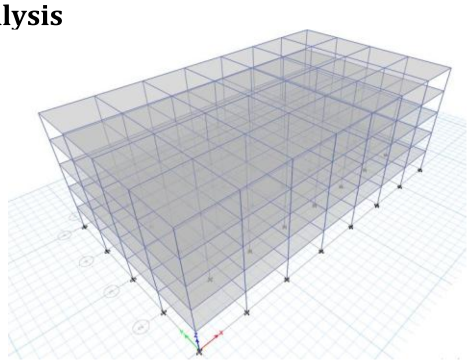

Fig -2: Model without damper

2.2 Model B - Building analysis with Elcentro Earthquake data non- linear time history analysis using 16 damper

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

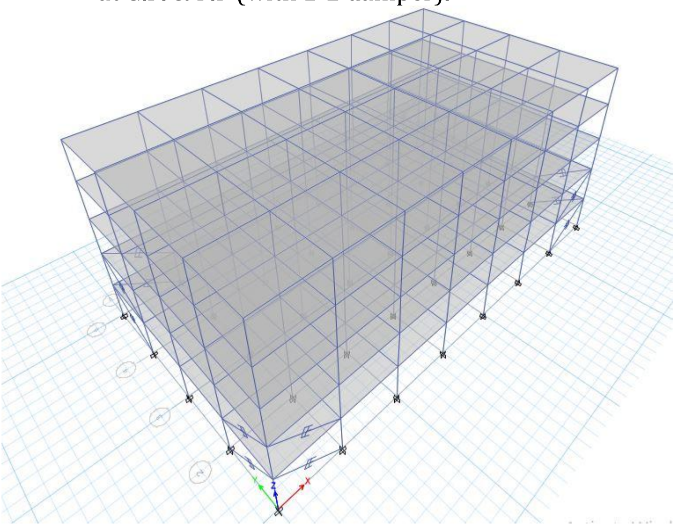

Fig - 3: Model with 1-2 damper

2.3 Model C - Building analysis with Elcentro Earthquake data non- linear time history analysis using 16 damper

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

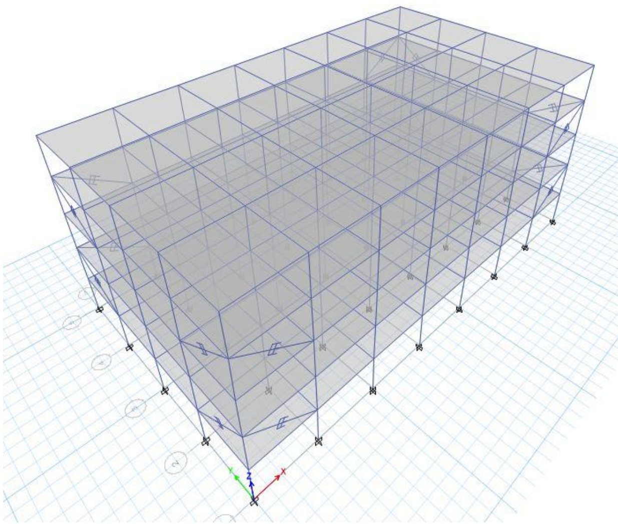

Fig -4: Model with 2-4 damper

2.4 Model D - Building analysis with Elcentro Earthquake data non- linear time history analysis using 24 damper

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

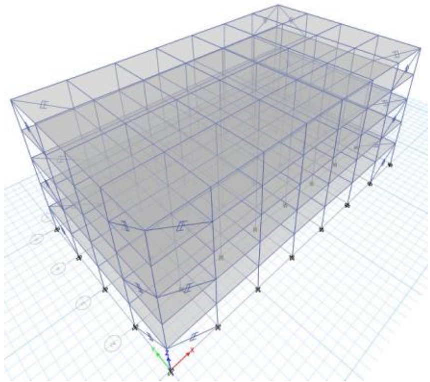

Fig -5: Model with 1-3-5 damper

2.5 Model E - Building analysis with Elcentro Earthquake data non- linear time history analysis using 40 damper

- Number of damper use – 40
- at All Floor (with 1 to 5 damper)

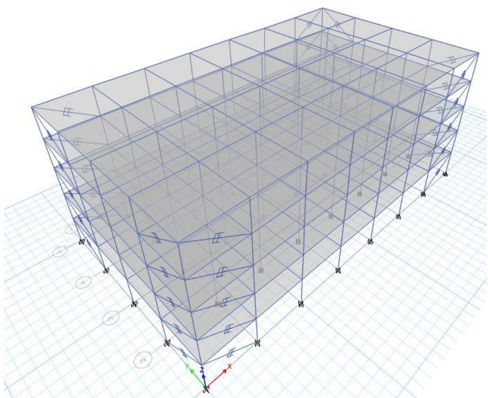

Fig -6: Model with 1 to 5 damper

3. RESULT AND DISCUSSIONS

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, column forces.

3.1Comparing the result of models in terms of displacement

X-direction:

Table -4: X-direction displacement Data

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	61.203	32.661	29.765	31.261	13.086
4	54.699	26.902	25.707	27.666	12.021
3	43.396	18.869	20.483	20.811	10.188
2	27.923	10.276	12.046	14.186	6.387
1	10.864	3.624	5.325	4.421	2.035
0	0	0	0	0	0

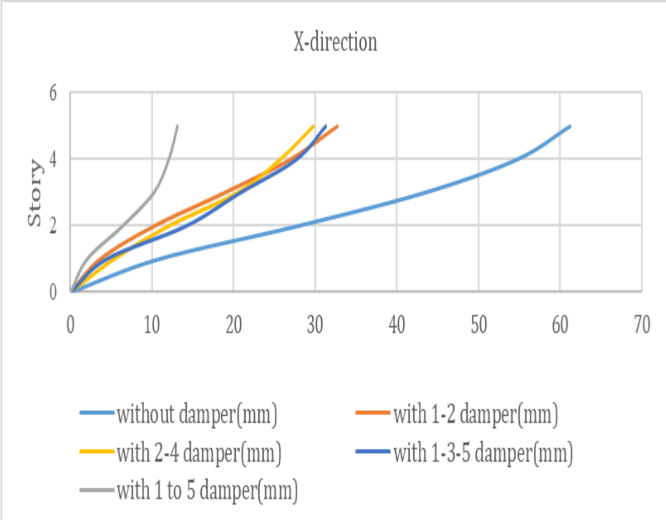

Fig -7: X-direction displacement graph

Y-direction:

Table -4: Y-direction displacement Data

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	68.631	33.742	30.824	32.103	16.064
4	61.073	28.46	26.7	28.273	14.6
3	48.204	20.521	21.606	21.939	12.104
2	30.792	11.218	12.942	15.098	8.607
1	11.821	3.718	5.611	4.791	2.777
0	0	0	0	0	0

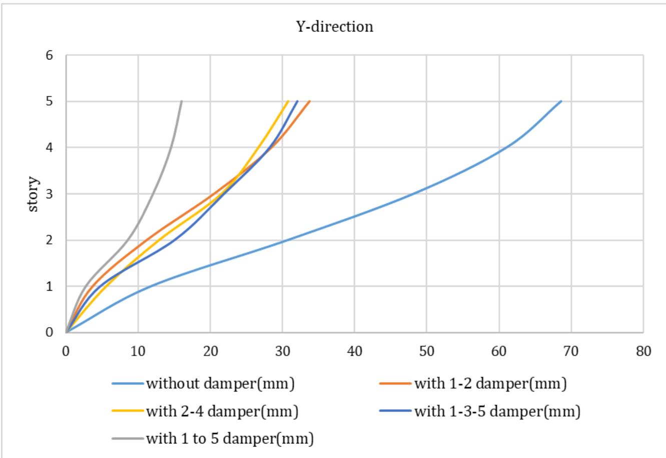

Fig -8: Y-direction displacement graph

- X- direction Result decrees in percentage

Table -5*:* X-direction displacement result in Percentage

Story	Withot damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
5	0	46.60%	51.37%	49%	78.62%

- Y-direction Result decrees in percentage

Table -6*:* 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	50.8%	55%	53.2%	76%

3.2Comparing the result of models in terms of drift

X-direction:

Table -7: X-direction Drift Data

Story	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
5	0.00229	0.002	0.00185	0.00125	0.00039
4	0.00378	0.00324	0.00196	0.00293	0.00067
3	0.00516	0.00388	0.00369	0.00251	0.00136
2	0.0057	0.00228	0.00251	0.00374	0.00149
1	0.00362	0.00121	0.00178	0.00147	0.00068
0	0	0	0	0	0

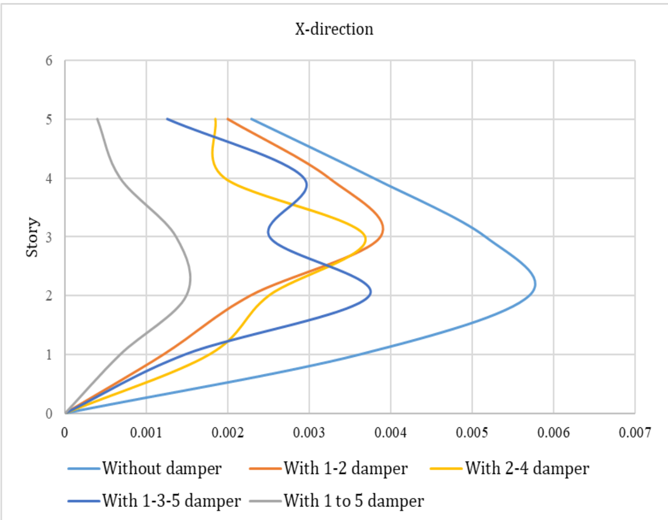

Fig -9: X-direction drift graph

Y-direction:

Table -8: X-direction Drift Data

Story	Without damper	With 1-2 damper	With 2-4 damper	With 1-3-5 damper	With 1 to 5 damper
5	0.00253	0.00213	0.001972	0.001349	0.00055
4	0.0043	0.00338	0.002171	0.00301	0.00088
3	0.0058	0.00397	0.003789	0.002718	0.00133
2	0.00633	0.00256	0.002798	0.003811	0.0021
1	0.00394	0.00124	0.00187	0.001597	0.00093
0	0	0	0	0	0

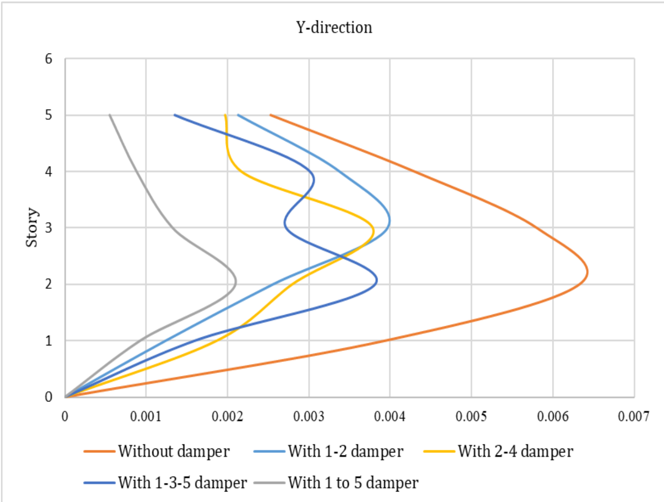

Fig -10: Y-direction drift graph

3.3 Comparing the result of models in terms of shear

X-direction:

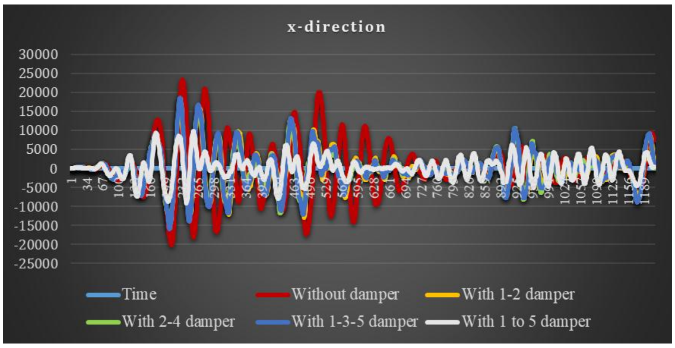

Fig -11: x-direction Shear vs time graph

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Y-direction:

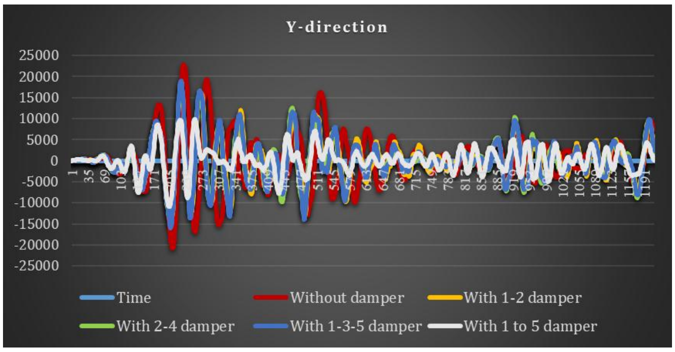

Fig -12: Y-direction Shear vs time graph

3.4 Comparing the result of Base shear

X-direction:

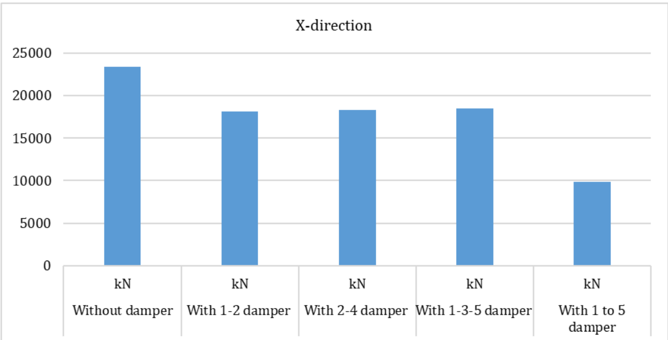

Fig -13: X-direction Base Shear graph

Y-direction:

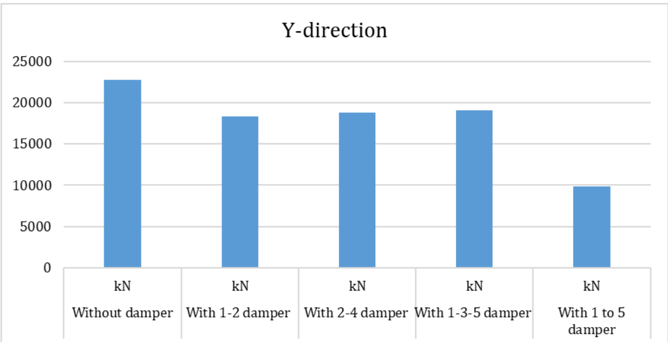

Fig -14: Y-direction Base Shear graph

- X- direction Result decrees in percentage

Table -7: X-direction decreased result 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	22.6%	21.8%	53.2%	76%

- Y-direction Result decrees in percentage

Table -8: Y-direction decreased result 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	19.47%	17.63%	16.36%	56.9%

3.5 Comparing the result of Column forces

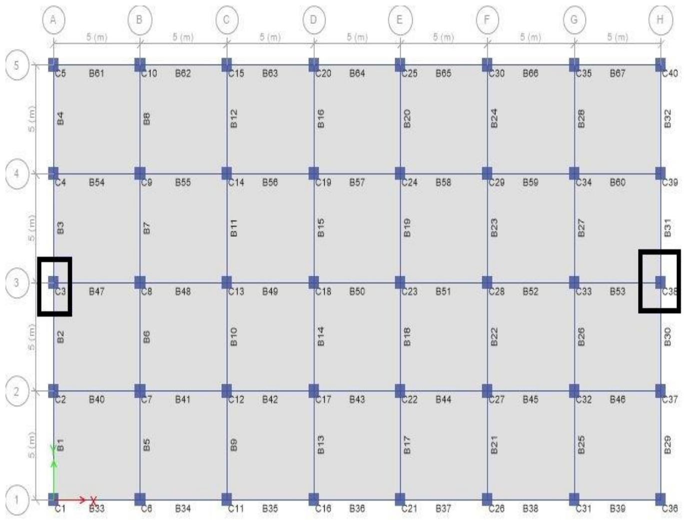

Fig -15: Building plan with column number

- **Column –C3**
- **X-direction**

Table -9: 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
5	C3	68.99	63.0	61.4	23.8	9.6
4	C3	172.9	168.1	52.5	142.7	16.1
3	C3	239.3	199.7	197.0	63.6	63.8
2	C3	300.9	103.2	113.8	246.8	97.8
1	C3	415.2	182.3	289.8	215.3	98.9

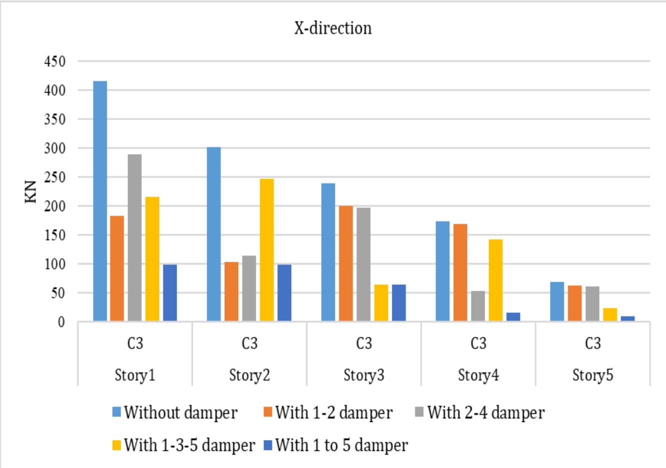

Fig -16: X-direction Column C-3 forces

Y-direction:

Table 10:- 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
5	C3	190.1	174.3	206.5	74.8	51.3
4	C3	345.8	294.6	61.1	327.1	78.5
3	C3	483.4	384.0	439.1	99.0	66.4
2	C3	571.9	136.6	129.4	468.8	239.8
1	C3	567	285.9	480.2	228.9	155.6

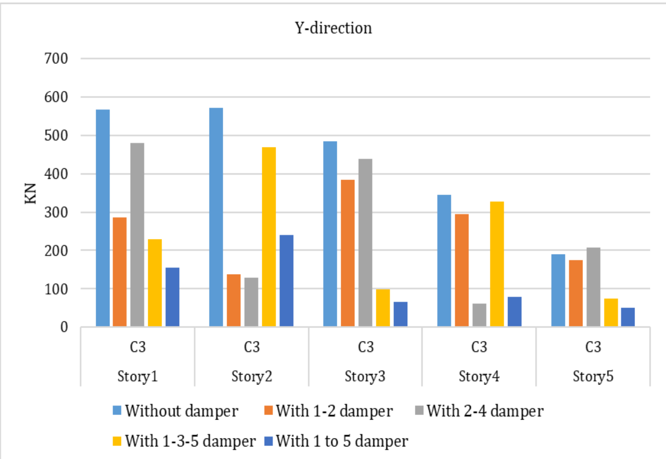

Fig -17: Y-direction Column C-3 forces

- **Column-C38**
- **X-direction**

Table 10:- 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
5	C38	68.9	63.1	61.5	23.8	17.5
4	C38	172.9	168.1	52.6	142.7	16.1
3	C38	239.3	199.2	196.6	63.6	63.8
2	C38	300.9	102.7	114.1	246.6	97.8
1	C38	415.2	182.7	289.6	217.0	98.9

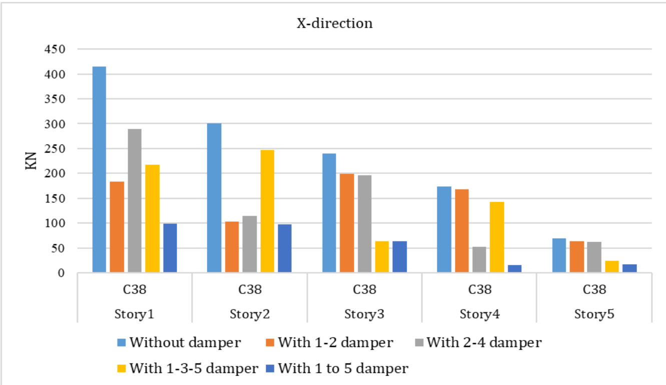

Fig -18: X-direction Column C-38 forces

Y-direction

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
5	C38	190.1	176.7	206.2	74.8	51.3
4	C38	345.8	295.1	61.1	327.1	78.5
3	C38	483.4	383.5	439.0	99.0	66.4
2	C38	571.9	136.6	129.3	468.7	239.8
1	C38	567.0	284.7	480.2	229.0	155.6

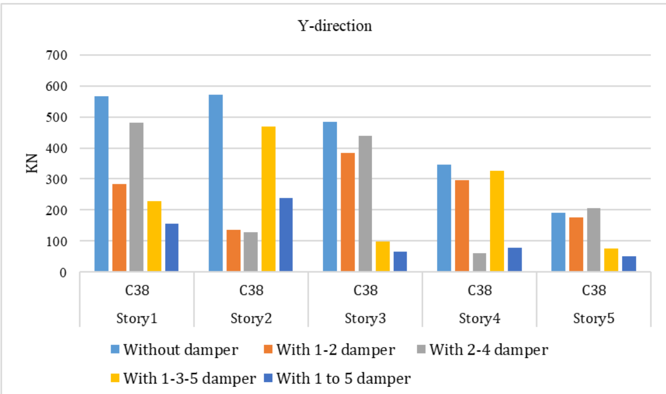

Fig -19: X-direction Column C-38 forces

4. CONCLUSIONS

After carrying out results by using ETABS 2017 software for multi-storey building, various parameters like displacement, story drift and story shear, column forces, Time vs shear are compared. Following conclusions are made.

- From the comparison of current study, following conclusion considered:

  1. 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 elcentro earthquake time history analysis.
  2. 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 elcentro earthquake time history analysis.
  3. 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 elcentro earthquake time history analysis.
  4. 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(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 elcentro, time history analysis.
  5. 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.

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