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Title: **COMPARATIVE STUDY OF FRAMED STRUCTURE IN DIFFERENT SEISMIC ZONES USING NON-LINEAR TIME HISTORY ANALYSIS WITH DAMPERS**

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COMPARATIVE STUDY OF FRAMED STRUCTURE IN DIFFERENT SEISMIC ZONES USING NON-LINEAR TIME HISTORY ANALYSIS WITH DAMPERS

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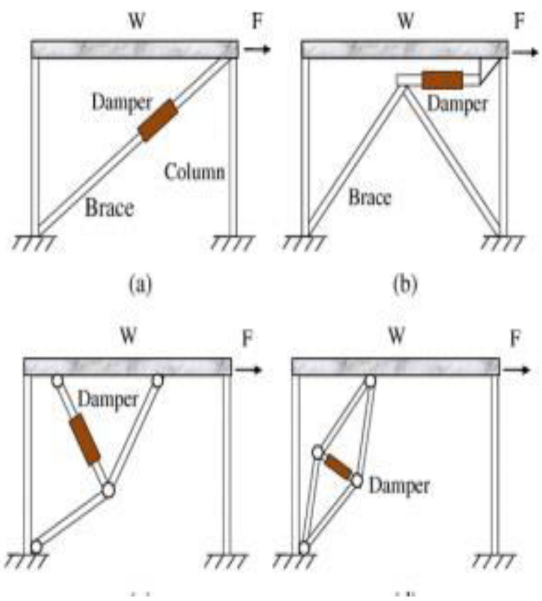
ABSTRACT In the present study three structures without dampers and with dampers such as exponential dampers are considered in modeling of buildings of height G+10 RCC structures having material properties M30 grade for concrete and Fe415 for reinforcing steel and structures dimensions are length = 10x7m = 70m, width = 10x5 = 50m and heights of G+10 is 46.2 m from the plinth level, the support conditions are chosen to be fixed base and foundation depth is considered as 2.5m below the ground level structures are modeled using ETABS in seismic zones II, III, IV, V as per IS 1893-2002 method used for seismic load generation non linear Time history analysis. The results are shown in terms of graphs and tables.

Key words: ETABS, Seismic Analysis, Time history analysis, Dampers

1. INTRODUCTION

During major seismic actions, a significant amount of energy is induced to structures. The means 2 by which this energy is dissipated, determines the level of structural degradation. Special emphasis is placed on avoiding loss of human lives due to the earthquake action. In order to achieve this, the structures are designed ductile so that energy is dissipated by the system's elements by bending, twisting or degradation. If the amount of energy induced in the structure can be controlled or, if part of it can be dissipated mechanically by independent structures, the seismic response of the buildings is improved and the potential damage greatly reduced. Damper is used in machines, car suspension system and clothes washing machine. Damping system in a building use friction to absorbs some of the force from vibrations. A damping system is much larger and is also designed to absorb the violent shocks of an earthquake.



Different arrangements of dampers between the frames of building

Arrangement of dampers in a building

2. MODELLING & METHODOLOGY

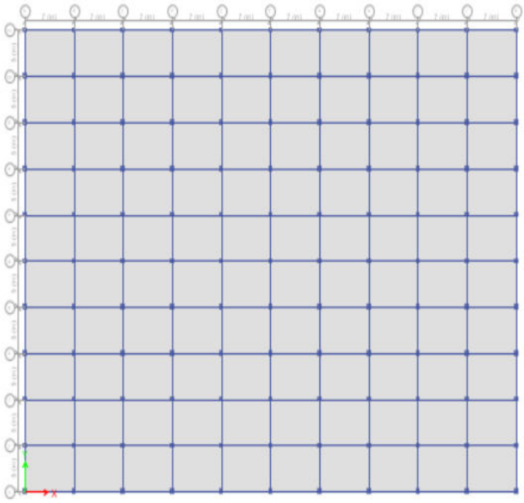
Modeling of structures in ETABS

In the present study three G+10 structure models with foundation depth of 2.5m and bay widths in length is 7m each, and along width is 5m, support conditions are assumed to be fixed at the bottom or at the supports/footings. The structures having length = 10x7 = 70m, width = 10x5 = 50m and height = 44.5 m. The structures modeled in ETABS structural analysis and design software by considering various loads and load combinations by their relative occurrence are considered the material properties considered are M30 grade concrete and Fe415 reinforcing steel bars with and without floating columns to determine the severity effect of floating and non floating columns the plans and elevations of the structures are shown in the figures below.

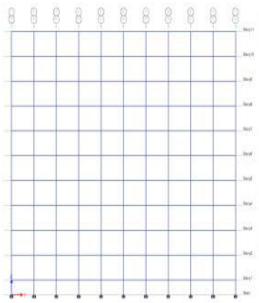
Structure-1: G+10 building without dampers

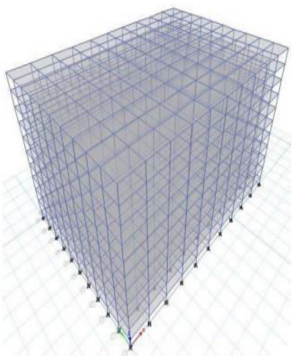
Structure-2: G+10 building with exponential dampers of weight = 10kN

Structure-3: G+10 building with exponential dampers of weight = 1kN

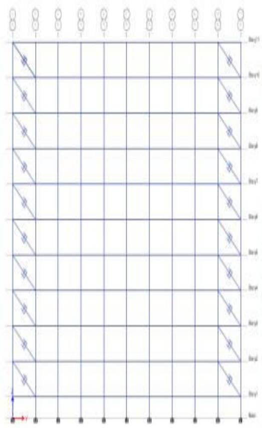


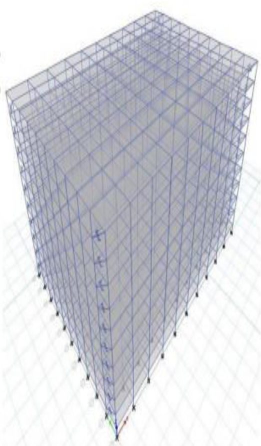
floor plan of structure-1, structure-2 and structure-3





elevation of structure-1 along the length direction 3d view of structure-1





elevation of structure-2,3 with dampers 3d view of structure2,3 with dampers

Design data used in modeling and analysis of structures

Materials	M30, Fe415
Beam	300x500
Columns	600x600
Supports	Fixed
Stories	G+10
Foundation depth	2.5m
Floor to floor height	4.2m
Length	10x7m = 70m
Width	10x5m = 50m
Zones	2,3,4,5
Dampers	Without dampers,
Method	Non-linear time history analysis
Software	ETABS
Loads	DL,LL,EL, load combinations
LL	3.0KN/m^2
Slab	150mm
Member load	17kN/m

i) Codes used in analysis and Design

[1] IS 1893:1984,"Criteria for earthquake resistant design of structures", Bureau of Indian Standards, New Delhi, India.

[2] IS 456: 2000,"Plain reinforced concrete-code of practice", Bureau of Indian Standards, New Delhi, India.

[3] IS 875-3: 1987,"Code of practice for design wind loads(other than earthquake) for buildingsm and structures", Bureau of Indian Standards, New Delhi, India

Parameters	values
Type of building	Residential
Live load	3kN/m^2
Member load	11.5kN/m
Slab thickness	150mm
Response reduction(R)	5
Importance factor	1
Soil type	III
Damper types	Exponential(10kN, 1kN)

Table: seismic design parameters used in analysis and modelling

ii) Loads and load combination considered for analysis In the limit state design of reinforced and pre stressed concrete structures, the following load combinations shall be accounted for:

1) 1.5(DL+LL)

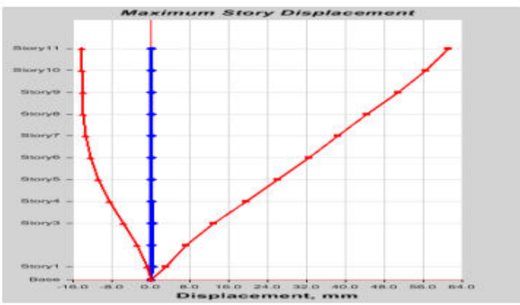
2) 1.2(DL+LL+EL)

3) 1.5(DL+EL)

4) 0.9DL+1.5EL

3. RESULTS AND DISCUSSION

i) Storey displacement results



Maximum storey displacement for structure-1

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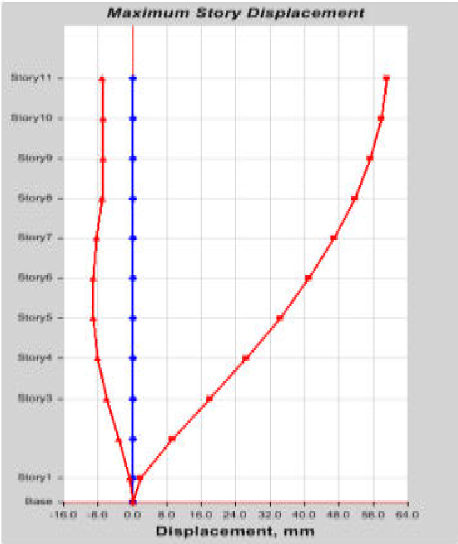
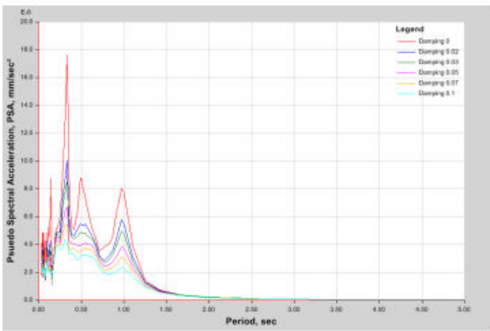


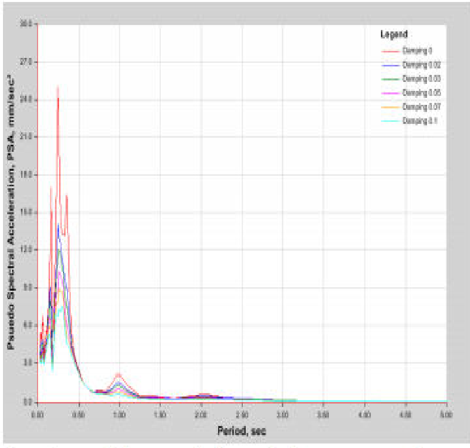
Maximum storey displacement for structure-2

Maximum storey displacement for structure-3
8

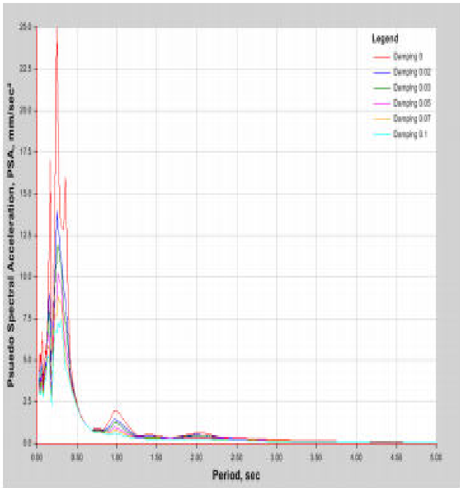
ii) Acceleration and time period graphs



Acceleration and time period graph for structure-1

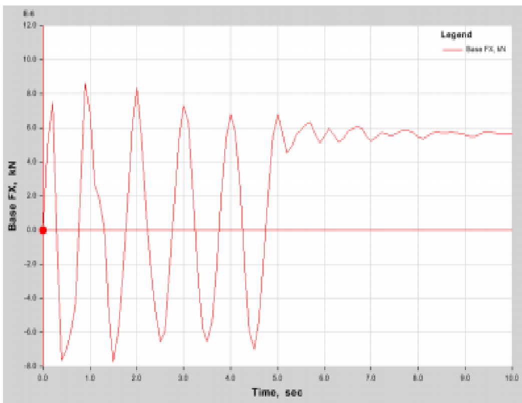


Acceleration and time period graph for structure-2



Acceleration and time period graph for structure-3

iii) Time history plot at the base along x-direction



Time history plot for structure-1

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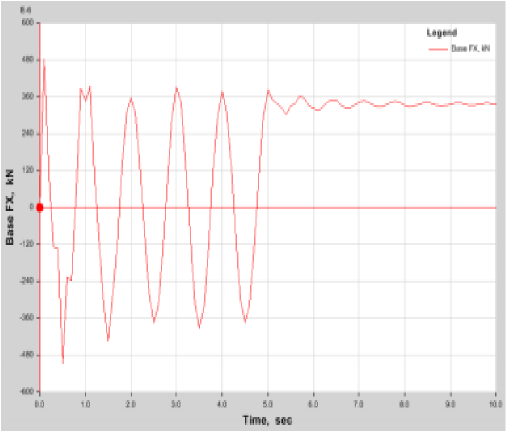
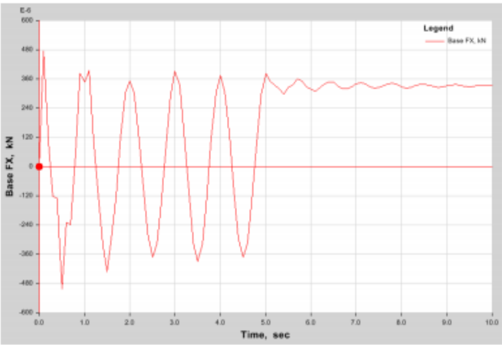


Time history plot for structure-2



Time history plot for structure-3

iv) Storey displacement at different levels

Story	Load Case/Combo	UX
		Mm
Story11	1.5DL+1.5ELX Max	71.837
Story4	1.5DL+1.5ELX Max	31.914
Story3	1.5DL+1.5ELX Max	21.822
Story2	1.5DL+1.5ELX Max	11.206
Story1	1.5DL+1.5ELX Max	2.112
Base	1.5DL+1.5ELX Max	0

Joint Displacements for structure-1, zone-2

Story	Load Case/Combo	UX
		Mm
Story11	1.5DL+1.5ELX Max	258.612
Story5	1.5DL+1.5ELX Max	146.713
Story4	1.5DL+1.5ELX Max	114.89
Story3	1.5DL+1.5ELX Max	78.559
Story2	1.5DL+1.5ELX Max	40.34
Story1	1.5DL+1.5ELX Max	7.604
Base	1.5DL+1.5ELX Max	0

Joint Displacements for structure-1, zone-5

Story	Load Case/Combo	UX
		Mm
Story11	1.5DL+1.5ELX Max	71.238
Story5	1.5DL+1.5ELX Max	40.564
Story4	1.5DL+1.5ELX Max	31.774
Story3	1.5DL+1.5ELX Max	21.762
Story2	1.5DL+1.5ELX Max	11.257
Story1	1.5DL+1.5ELX Max	2.224
Base	1.5DL+1.5ELX Max	0

Joint Displacements for structure-2, zone-2

Story	Load Case/Combo	UX
		Mm
Story11	1.5DL+1.5ELX Max	256.414
Story5	1.5DL+1.5ELX Max	145.976
Story4	1.5DL+1.5ELX Max	114.332
Story3	1.5DL+1.5ELX Max	78.293
Story2	1.5DL+1.5ELX Max	40.51
Story1	1.5DL+1.5ELX Max	7.922
Base	1.5DL+1.5ELX Max	0

Joint Displacements for structure-2, zone-5

Story	Load Case/Combo	UX
		Mm
Story11	1.5DL+1.5ELX Max	256.225
Story5	1.5DL+1.5ELX Max	145.908
Story4	1.5DL+1.5ELX Max	114.283
Story3	1.5DL+1.5ELX Max	78.262
Story2	1.5DL+1.5ELX Max	40.495
Story1	1.5DL+1.5ELX Max	7.918
Base	1.5DL+1.5ELX Max	0

Joint Displacements for structure-3, zone-5

Story	Load Case/Combo	UX
		Mm
Story11	1.5DL+1.5ELX Max	71.185
Story5	1.5DL+1.5ELX Max	40.545
Story4	1.5DL+1.5ELX Max	31.76
Story3	1.5DL+1.5ELX Max	21.753
Story2	1.5DL+1.5ELX Max	11.252
Story1	1.5DL+1.5ELX Max	2.223
Base	1.5DL+1.5ELX Max	0

Joint Displacements for structure-3, zone-2

Story	Column	Load Case/Combo	P	V2	V3	T	M2	M3
			kN	kN	kN	kN-m	kN-m	kN-m
Story11	C2	ELX Max	42.882	39.2436	1.9401	0.9607	3.8207	60.6003
Story10	C2	ELX Max	86.7742	132.0898	1.0908	5.3315	1.5234	155.4688
Story9	C2	ELX Max	139.4774	148.4517	1.0643	1.3038	1.4914	134.7135
Story8	C2	ELX Max	218.3394	129.1536	0.6978	0.4842	0.867	53.5511
Story7	C2	ELX Max	318.2103	119.4399	0.4263	1.7962	1.4093	59.6801
Story6	C2	ELX Max	429.3637	139.303	1.1921	3.029	3.1695	140.2621
Story5	C2	ELX Max	546.3615	151.7931	2.0558	3.7248	5.0075	202.1273
Story4	C2	ELX Max	671.2491	150.3049	2.707	3.6896	6.314	222.6873
Story3	C2	ELX Max	809.9914	123.7001	2.9511	3.0335	6.541	188.6581
Story2	C2	ELX Max	956.6723	45.2466	2.4716	3.4159	4.852	86.477
Story1	C2	ELX Max	1141.0068	8.7478	18.5164	48.1728	28.4397	571.8963

Column forces

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Load Case/Combo	FZ	MX	MY
	kN	kN-m	kN-m
DL Max	1360.848	37773.3737	47629.6807
DL Min	-1360.848	-37210.8125	-47629.6811
LL Max	0	663.9312	0.0001
LL Min	0	-4687.8737	-0.0001
ELX Max	1360.848	35794.0083	67325.3684
ELX Min	-1360.848	-35528.6364	-545047
ELY Max	1360.848	688279.2828	47629.6811
ELY Min	-1360.848	-104822	-47629.6813
1.5DL+1.5LL Max	1360.848	38437.3049	47629.6808
1.5DL+1.5LL Min	-1360.848	-41898.6862	-47629.6812
1.2DL+1.2LL+1.2ELX Max	3266.0353	89077.5759	137946.0591
1.2DL+1.2LL+1.2ELX Min	-3266.0353	-92912.7871	-711212
1.2DL+1.2LL+1.2ELY Max	3266.0353	872059.9052	114311.2343
1.2DL+1.2LL+1.2ELY Min	-3266.0353	-176065	-114311
1.5DL+1.5ELX Max	4082.5441	110351.073	172432.5737
1.5DL+1.5ELX Min	-4082.5441	-109109	-889015
1.5DL+1.5ELY Max	4082.5441	1089079	142889.0427
1.5DL+1.5ELY Min	-4082.5441	-213050	-142889
0.9DL+1.5ELX Max	3266.0353	87687.0488	143854.7653
0.9DL+1.5ELX Min	-3266.0353	-86782.6858	-860437
0.9DL+1.5ELY Max	3266.0353	1066415	114311.2343
0.9DL+1.5ELY Min	-3266.0353	-190723	-114311

4. CONCLUSIONS

The following are the conclusions drawn from the analysis results of buildings of height G+10 RCC structures having material properties M30 grade for concrete and Fe415 for reinforcing steel and structures dimensions are length = 10x7m = 70m, width = 10x5 = 50m and heights of G+10 is 46.2 m from the plinth level, the support conditions are chosen to be fixed base and foundation depth is considered as 2.5m below the ground level structures are modelled using ETABS in seismic zones II, III, IV, V as per IS 1893-2002 method used for seismic load generation non linear Time history analysis.

Structure-1: G+10 building without dampers

Structure-2: G+10 building with exponential dampers of weight = 10kN

Structure-3: G+10 building with exponential dampers of weight = 1kN

1. The maximum storey displacement s for structure-1, structure-2 and structure-3 are 16mm,7mm and 14mm with provision of dampers the storey displacement is reduced by 56.25% (structure-2) and 12.50% (structure-3) when compared withstructure-1

2. Provision of dampers increases time period of the structures, time period for structure-1,

structure-2 and structure-3 are 2.5sec, 3.5sec and4.7sec.

3. Time period is increased by 40% (structure-2) and 88% (structure-3) when compared withstructure-1

4. Storey shear and overturning moments at base in structures are constant for structure-1, structure-2 and structure-3 are 0.9kN and28kNm.

5. From the time history plots maximum base force FX is 9kN in structure-1 and 480kN in structure-2 andstructure-3

6. Lateral storey displacement at 11th storey for seismic zone-2 in structure-1, structure-2 and structure-3 are 71.83mm, 71.23mm and71.18mm.

7. Lateral storey displacement at 11th storey for seismic zone-3 in structure-1, structure-2 and structure-3 are 114.93mm, 113.97mm and113.88mm.

8. Lateral storey displacement at 011th storey for seismic zone-4 in structure-1, structure-2 and structure-3 are 172.40mm, 170.94mm and170.82mm.

9. Lateral storey displacement at 11th storey for seismic zone-5 in structure-1, structure-2 and structure-3 are 259.61mm, 256.41mm and256.22mm.

10. Lateral storey displacement at 101th storey is decreased by 0.85% (structure-2) and 0.93% (structure-3) when compared withstructure-1

11. Maximum storey drifts are occurred at storey-3 in three structures, maximum permitted storey drift is 0.004 as per IS:1893-2002

12. Maximum storey drift for zone-2, zone-3, zone-4 and zone-5 are 0.0017, 0.0026, 0.0041 and0.0060.

13. Column forces axial and bending are found to be increasing with the zone and these forces are maximum in structure-2 and structure-3 due to additional mass added by dampers.

14. Column forces axial at base for seismic zone-5 in structure-1, structure-2 and structure-3 are 930.97kN, 1147.90kN and1141.1kN.

15. Base reaction MY for seismic zone-5 for EL+X max load in structure-1, structure-2 and structure-3 are 87411.98kNm, 86348.98kNm and86240.15kNm.

16. Base reaction MY is decreased by 12.16%(structure-2) and 13.4%(structure-3) when compared withstructure-1

ACKNOWLEDGEMENT

I feel immense pleasure to express my sincere thanks and profound sense of gratitude to all those people who played a valuable role for the successful completion of my project by their valuable suggestions and advices. I would like to express my gratitude to **Dr. K.V.V. SATYANARAYANA RAJU**, Chairman, Sri. K. RAVI KIRAN VARMA, Managing Director, Sri. K. SASI KIRAN VARMA, Managing Director, Chaitanya group of Institutions for providing necessary infrastructure.

I am thankful to our principal Dr. D. V. RAMA MURTHY, for permitting and encouraging me in doing this project.

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Finally I express my thanks to my other entire faculty, classmates, friends, neighbors and my family members who helped me for the completion of my project and without infinite love and patience this would never have been possible.

DECLARATION

I M.GANESH KUMAR, bearing PIN: 15551D8719, declare that the project entitled

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"COMPARATIVE STUDY OF FRAMED STRUCTURE IN DIFFERENT SEISMIC ZONES USING NON-LINEAR TIME HISTORY ANALYSIS WITH DAMPERS" is a bonafide work carried out by me and has not been submitted to any other University or College for the award of any Degree or Diploma.

5. REFERENCES

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Standards, New Delhi, India.

[2] IS 1893(Part1):2002,"Criteria for earthquake resistant design of structures - General

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Structure using Different Accelerogram"

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0Structure with Dampers at different Location"