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EFFECT OF BRACING ON RCC MULTISTORY BUILDING USING LINEAR TIME HISTORY ANALYIS ON DIFFERENT SEISMIC INTENSITIES

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Abstract - *In India, exorbitant land prices and a lack of available land might lead to the construction of multi-story buildings. Phenomena called an earthquake might provide the most damaging forces for structures. Buildings need to be designed properly to keep people safe. The main goal is to create an earthquake-resistant construction by conducting a seismic study of the building using a static equivalent technique of research and using E-TABS software for both static and dynamic analysis. A G+10 Non Braced and Braced (X, V and Inverted V) building plan is taken into consideration for this. For seismic zone II, III, IV, and V, calculations are made. By calculating all acting loads on the structure, including the lateral loads brought on by Time history data. The Seismic response i.e. Displacement, Storey Drift, Base Shear and Modal mass participating ratio are obtained.*

Key Words: **Linear Time History Analysis**, **Storey Displacement, Storey Drift, Base Shear, Bracing, Seismic Intensities.**

1. INTRODUCTION

Constructions constructed to withstand earthquakes are known as earthquake-resistant structures. The aim of earthquake resistant construction is to erect structures that perform better during seismic activity than their conventional counterparts, even though no structure can be completely impervious to earthquake damage.

1.1 EARTHQUAKE RESISTANT STRUCTURES

The specification of ground motion from prior earthquake data is the foundation for the earthquake design of the structure. Therefore, it is crucial to create any significant construction with earthquake resistance in accordance with seismic frequency to prevent damage. However, because earthquake forces vary and are unpredictable, it is necessary to analyse structures under all seismic forces using software tools.

1.2 DYNAMIC ANALYIS

For buildings that don't resist earthquake forces, a seismic study should be performed. Since dynamic influences might be included in seismic analysis, the accurate analysis will usually become challenging. However, analogous linear static analysis is sufficient for simple regular structures; this kind of analysis is done for regular and low-rise buildings. The multi-story building will undergo seismic analysis in accordance with the requirements of the IS 1893-2016 code (part 1). Either a time history analysis approach or a response spectrum method is used for dynamic analysis.

2. SEISMIC INTENSITIES IN INDIA

Instead of the previous version's five or six seismic zones, the earthquake zoning map of India now splits the nation into four seismic zones (Zones II, III, IV, and V). This partitioning map predicts that Zone V will experience the highest degree of seismicity, while Zone 0 will experience the lowest level of seismicity. Each zone demonstrates how an earthquake's effects at a particular location corroborated the observations of the affected areas and may even be depicted using a descriptive scale like the Medvedev-Sponheuer-Karnik scale, which is a macro unstable intensity scale used to gauge the severity of ground shaking based on effects that have been observed in a specific area of the earthquake's occurrence.

3. BRACED FRAMES

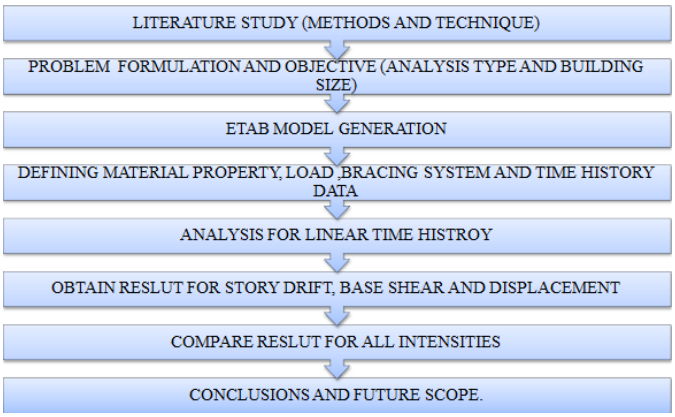
These are the truss-braced structural frames, which primarily use components in tension or compression to withstand lateral forces. Braced frames can withstand stresses better than a rectangular moment-resisting frame because they are more frequently subjected to axial loads. The braced frame structure is intended to perform better. Braces can be arranged in an X-shaped, V-shaped, or inverted V-shaped configuration.

4. OBJECTIVE OF THE STUDY

The current study aims to investigate the seismic analysis of a multi-storey building (G+10) with braced (X, V, and Inverted V) and without braced symmetrical in plan, under earthquake load, by adopting a linear time history analysis method to evaluate storey drift and displacements and other comparisons at zone II, III, IV and V Analysis of structure using dynamic method and finding out drift, displacement, and base shear to understand the fundamental principles of structures. Creating a 3D model of the structure using the E-TABS software to conduct a thorough analysis, to analyse

how a building responds to seismic loads, and compare the various analysis results of buildings in zones II, III, IV, and V.

5. METHODOLOGY



6. SPECIFICATION OF THE BUILDING

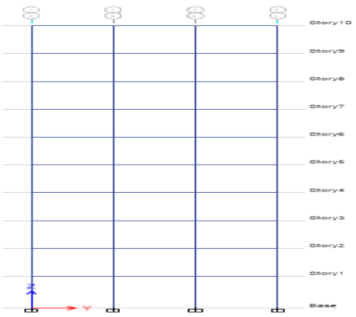


Fig.1 Elevation

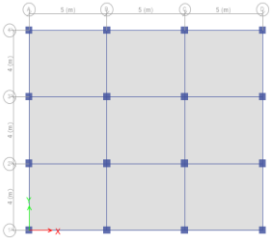


Fig.2 Plan

7. BUILDING DESCRIPTIONS

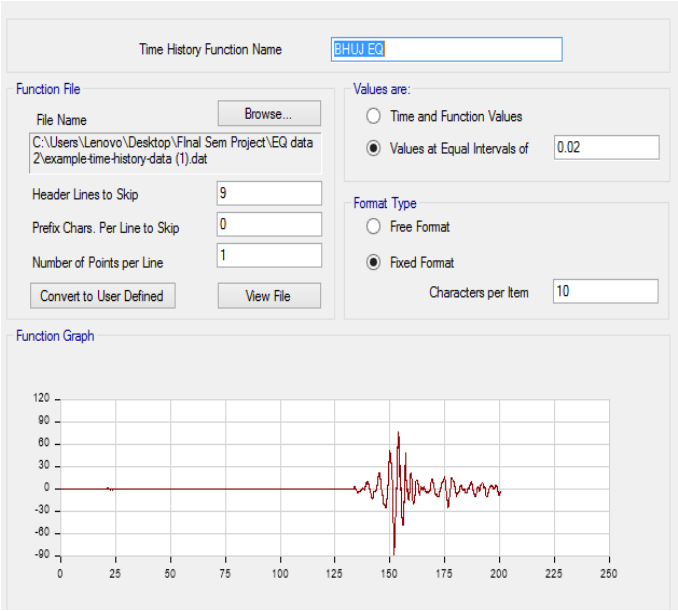
S.NO	Parameters	Values
1.	Length	15m
2.	Width	12m
3.	Height	35.5m
4.	Grade of Steel	Fe500
5.	Grade of Concrete	M25
6.	Steel Section for Bracing	Fe250
7.	Steel Section for Bracing	ISMB300
8.	Top Storey Height	3.5m
9.	Bottom Storey Height	4m
10.	Wall Thickness	0.230m
11.	Slab Thickness	0.150m
12.	Beam size	0.23mX0.45m
13.	Column size	0.45mX0.45m
14.	Live Load	3.5kN/m^2
15.	Floor Finish	1.5kN/m^2
16.	Parapet Wall	1.25m
17.	Density of Concrete	24kN/m^3
18.	Density Of Brick wall	19kN/m^3
19.	Bracings	X,V and Inv V

7. TIME HISTORY DATA

The ETABS analysis uses a variety of time histories as real-time seismic data. It is up to us to choose the data to utilize as the input parameters for the software analysis. The time history of the Bhuj Earthquake, which happened on January 26, 2001 in Gujarat, India, will be taken into account as a linear time history analysis is carried out on a multi-story RCC building frame in this study.

S.NO	EQ	Date	Scale	P.G.A g
1.	BHUJ, INDIA	Jan 26 2001	6.9	0.110

Fig 3. Time History Analysis



8. RESULTS- Y-axis is obtained for all results.

Displacement (mm) **Zone II**

Storey	No bracing	X bracing	V bracing	Inv V bracing
10	56.385	13.125	10.53	12.233
9	55.192	11.995	9.754	11.298
8	52.923	10.708	8.971	10.204
7	49.402	9.322	8.109	8.984
6	45.392	7.886	7.182	7.688
5	40.348	6.463	6.208	6.373
4	33.838	5.186	5.216	5.103
3	25.91	4.061	4.236	4.05
2	16.931	3.111	3.324	3.174
1	7.724	2.329	2.376	2.317

Displacement (mm) **Zone III**

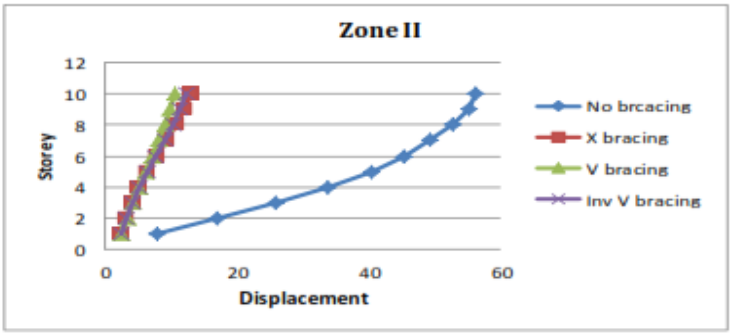
Storey	No bracing	X bracing	V bracing	Inv V bracing
10	108.266	20.989	16.877	19.627
9	105.976	19.182	15.632	18.126
8	101.619	17.124	14.377	16.371
7	94.858	14.907	12.997	14.414
6	87.158	12.61	11.51	12.335
5	77.474	10.335	9.95	10.225
4	64.973	8.294	8.359	8.188
3	49.751	6.494	6.788	6.497
2	32.51	4.975	5.327	5.092
1	14.832	3.724	3.809	3.717

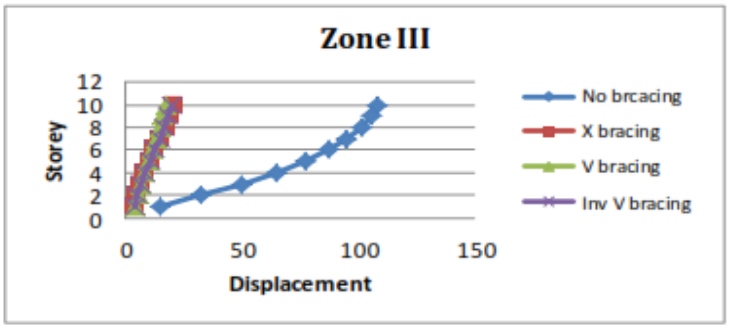
Displacement (mm) **Zone IV**

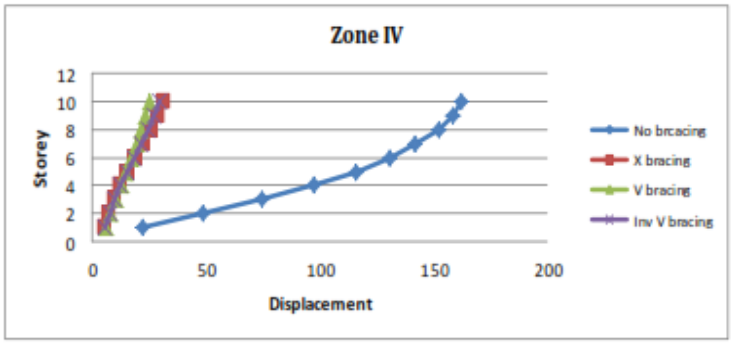
Storey	No bracing	X bracing	V bracing	Inv V bracing
10	162.398	31.483	25.297	29.428
9	158.963	28.773	23.432	27.178
8	152.429	25.686	21.55	24.546
7	142.287	22.36	19.481	21.612
6	130.737	18.916	17.253	18.495
5	116.21	15.502	14.915	15.332
4	97.46	12.441	12.53	12.276
3	74.626	9.74	10.175	9.742
2	48.766	7.463	7.985	7.635
1	22.247	5.587	5.709	5.573

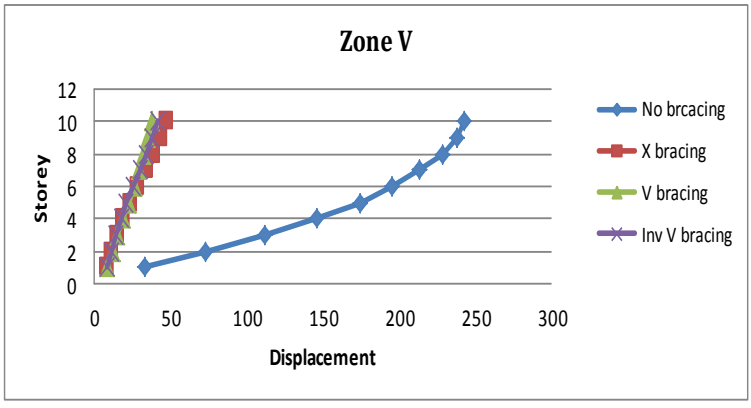
Displacement (mm) **Zone V**

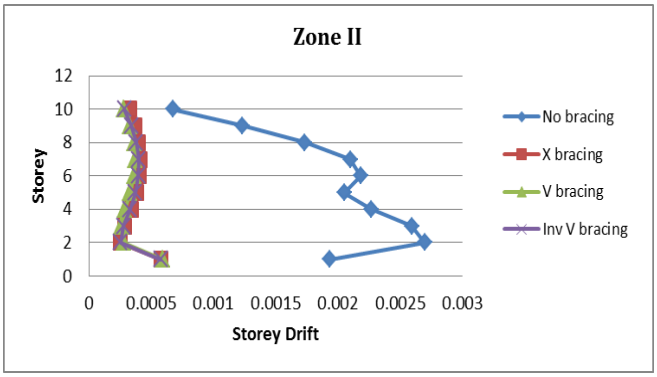
Storey	No bracing	X bracing	V bracing	Inv V bracing
10	243.612	47.267	37.955	41.432
9	238.459	43.198	35.157	38.187
8	228.656	38.564	32.333	34.344
7	213.443	33.57	29.228	30.091
6	196.117	28.399	25.886	25.6
5	174.326	23.274	22.378	21.076
4	146.198	18.678	18.8	17.299
3	111.946	14.624	15.267	13.788
2	73.153	11.205	11.98	10.759
1	33.373	8.387	8.566	7.832









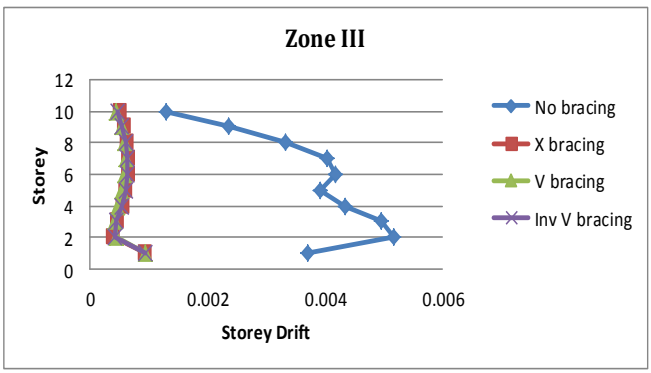


Storey Drift **Zone II**

Storey	No bracing	X bracing	V bracing	Inv V bracing
10	0.000673	0.000326	0.000279	0.000286
9	0.001229	0.000368	0.000329	0.000342
8	0.001736	0.000396	0.000361	0.00038
7	0.0021	0.00041	0.000373	0.0004
6	0.002184	0.000407	0.000363	0.000398
5	0.002049	0.000384	0.000331	0.000374
4	0.002265	0.000345	0.000289	0.000332
3	0.002592	0.000285	0.000261	0.000277
2	0.002698	0.000251	0.00028	0.000255
1	0.001931	0.000582	0.000593	0.000579

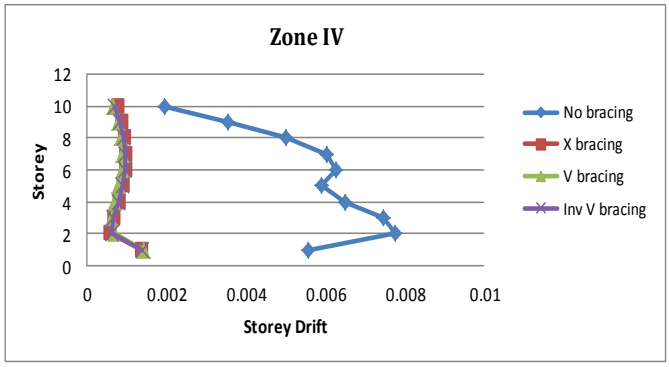
Storey Drift **Zone III**

Storey	No bracing	X bracing	V bracing	Inv V bracing
10	0.001292	0.000521	0.000447	0.00046
9	0.002359	0.000588	0.000527	0.000548
8	0.003333	0.000634	0.000579	0.00061
7	0.004032	0.000656	0.000598	0.000641
6	0.004194	0.00065	0.000581	0.000638
5	0.003934	0.000615	0.00053	0.0006
4	0.004349	0.000551	0.000464	0.000532
3	0.004978	0.000456	0.000419	0.000445
2	0.00518	0.000402	0.000449	0.000409
1	0.003708	0.000931	0.000951	0.000929



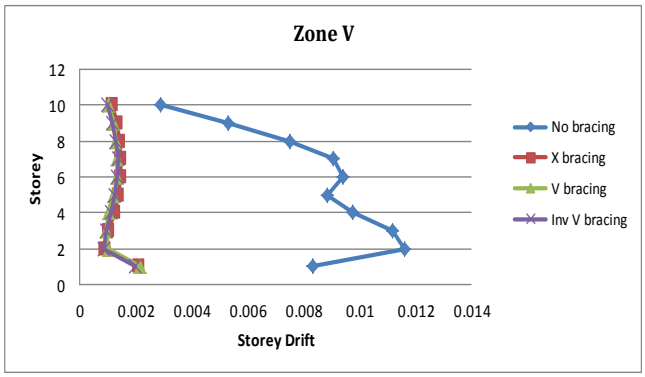
Storey Drift **Zone IV**

Storey	No bracing	X bracing	V bracing	Inv V bracing
10	0.001938	0.000782	0.00067	0.000689
9	0.003539	0.000882	0.00079	0.000822
8	0.005	0.00095	0.000867	0.000915
7	0.006047	0.000984	0.000896	0.000962
6	0.006291	0.000975	0.000871	0.000957
5	0.005901	0.000922	0.000795	0.000899
4	0.006524	0.000827	0.000695	0.000798
3	0.007467	0.000684	0.000627	0.000667
2	0.00777	0.000602	0.000673	0.000614
1	0.005562	0.001397	0.001425	0.001393



Storey Drift **Zone V**

Storey	No bracing	X bracing	V bracing	Inv V bracing
10	0.002908	0.001174	0.001006	0.00099
9	0.005309	0.001324	0.001185	0.001173
8	0.0075	0.001427	0.001301	0.001296
7	0.009072	0.001477	0.001344	0.001351
6	0.009437	0.001464	0.001307	0.001332
5	0.008852	0.001384	0.001192	0.001239
4	0.009786	0.001242	0.001043	0.001121
3	0.011201	0.001027	0.000941	0.000927
2	0.011656	0.000904	0.001009	0.000866
1	0.008343	0.002097	0.002139	0.001958



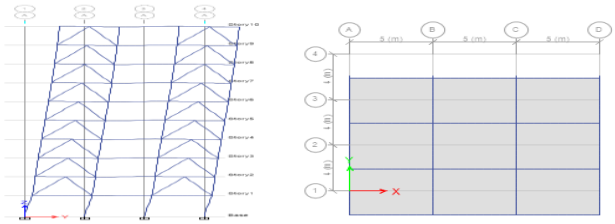
Base Shear (kN)

Zone	X- Bracing	V - Bracing	Inv V Bracing
2	491.570	489.760	489.190
3	786.090	784.940	784.860
4	1179.140	1176.580	1176.800
5	1770.310	1765.920	1757.550

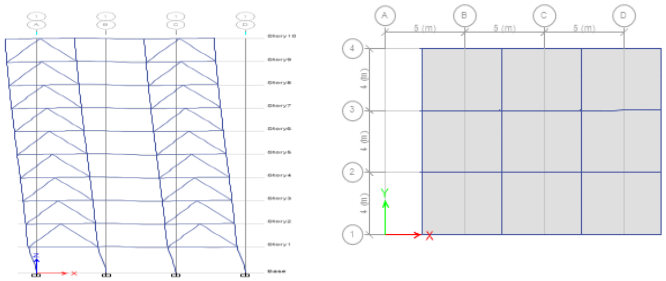
Modal mass participating ratio.

Mode	No bracing		X bracing		V bracing		Inv V bracing	
	Time	%	Time	%	Time	%	Time	%
1	2.695	82.11 (UY)	1.526	84.93 (UY)	1.646	84.46 (UY)	1.583	85.41 (UY)
2	2.539	82.19(UX)	1.432	87.31(UX)	1.528	86.43(UX)	1.467	87.59(UX)
3	2.252	82.84(RZ)	1.055	93.54(RZ)	1.125	92.2(RZ)	1.095	93.22(RZ)
4	0.87	9.97(UY)	0.497	13.84 (UY)	0.527	13.59(UY)	0.525	12.78 (UY)
5	0.822	10.21 (UX)	0.474	11.79 (UX)	0.496	12.26(UX)	0.492	11.17 (UX)
6	0.733	9.6(RZ)	0.343	6.14 (RZ)	0.365	7.2 (RZ)	0.358	6.2 (RZ)
7	0.492	3.6 (UY)	0.223	0.97 (UY)	0.254	1.42 (UY)	0.252	1.2 (UY)
8	0.465	3.5 (UX)	0.207	0.69 (UX)	0.23	0.97 (UX)	0.228	0.89 (UX)
9	0.421	3.5 (RZ)	0.143	0.25 (RZ)	0.166	0.44 (RZ)	0.165	0.41(RZ)
10	0.33	1.88 (UY)	0.138	0.16 (UY)	0.165	0.3(UY)	0.164	0.28 (UY)
11	0.315	1.81(UX)	0.131	0.12 (UX)	0.149	0.2(UX)	0.148	0.19 (UX)
12	0.285	1.71(RZ)	0.102	0	0.124	0	0.123	0

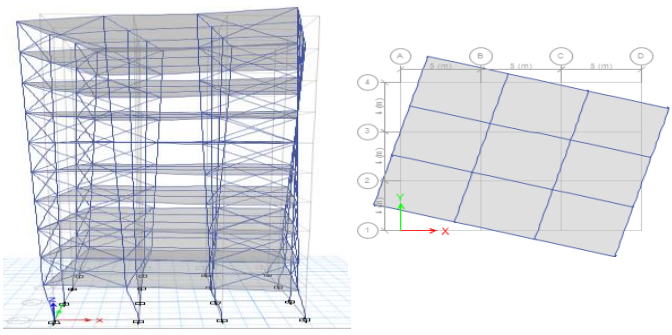
Mode 1 - Translational –UY



Mode 2 – Translational UX



Mode 3 – Rotational RZ



9. CONCLUSIONS

- **1.** The seismic responses of the buildings in both the directions are similar in terms of their intensity. These include base shear, storey displacements, and floor drifts. The intensity of these responses varies significantly across different time periods.

2. The values of seismic responses are computed by taking into account the varying intensities of seismic activities across different time periods. They show that the order of seismic intensity changes with increasing intensity.

3. The displacement of the X bracing structure (47mm) is greater than that of the V (37mm) and Inverted V bracing (41mm) in Zone V, and a similar pattern is followed in all the zones, according to the analysis. It is also noted that the displacement is quite high at the roof and very low at the base.

4. The base shear of the X-bracing structure in Zone V is 1770 kN, which is more than twice as strong as the V-bracing and Inverted V-bracing structures. Similar patterns can be observed in all seismic zones.

5. Storey Drift mostly affects the middle of the building structure, and it is determined that it is higher in the X bracing than in the other bracing structures and that it gets worse as the seismic zone gets bigger. It was 0.000407 in Zone II of the X bracing structure and 0.00146 in Zone V on the fifth floor. This indicates that, when comparing zone II to zone V, the storey drift increases by more than 50%. The storey drift in ground floor of all braced system in all zone has a huge spike. It is due to soft storey effect where in the lateral stiffness of the above storey is more than below.

6. The first two modes, which account for more than 60–65 percent of the mode participation ratio, are translational modes; the third mode, rotation, accounts for 93.22 percent of the bracing structures. Except for the absence of a bracing structure, the modal Participating Ratio of X bracing, V bracing, and inverted V bracing Structure all follow a similar pattern. It is also observed that natural period for braced structure is much less than the unbraced structure, hence less displacement in braced structure.

7. The difference in base shear for all the braced structure (X,V and Inverted V) is not more than 10%.

8. Time History is a realistic seismic analysis method that offers a better assurance of the security of structures that have been examined and developed in accordance with IS code.

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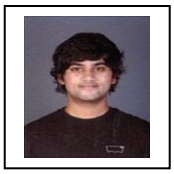

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