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Research on Seismic Analysis of Multistorey Building for Soft Ground

Narayan Narrotam[1], Bilal Siddiqui[2], Faheem Ahmad Khan[3]

[1]PG Student, Department of civil engineering, Babu Banarsi Das University, U.P., INDIA
[2]Assistant Professor, Department of civil Engineering, Babu Banarsi Das University, U.P., INDIA
[3]Assistant Professor, Department of civil Engineering, Babu Banarsi Das University, U.P., INDIA

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Abstract – *Open ground building (OGS) has had its spot in the Indian urban condition because of the way that it gives genuinely necessary stopping office in the ground story of the structure. Reviews of structures bombed in past quakes demonstrate that this sorts of structures are observed to be one of the most helpless. Nearness of infill dividers in the casing changes the conduct of the structure under horizontal burdens. In any case, it's basic industry practice to overlook the solidness of infill divider for examination of confined structure. Configuration dependent on such investigation results in under-estimation of structure minutes and shear powers in the sections of ground story and thus it might be one reason in charge of the disappointment watched. IS code 1893:2002 permits the examination of open ground story RC confined structure without considering infill solidness yet with a duplication factor of 2.5 in pay for firmness intermittence. According to the code" The segments and Beams of delicate story building are to be intended for 2.5 occasions the story shears and twisting minutes determined under seismic heaps of uncovered edges. This postulation calls for appraisal and audit of the buiding having distinctive help in ground story mid ascent OGS structures. Subsequently goal of this investigation is to check which bolster will give better quality and security of the structure during quake and to consider the impact of infill quality and solidness in seismic examination of OGS structures. Five Different models of existing RC confined structure with open ground story situated in Seismic Zone V is considered for the investigation utilizing business Etabs Software. Infill with openings was demonstrated utilizing a solitary Diagonal Strut, twofold askew swagger, v support and reversed v backing to the ground story and contrast the quality with typical open ground story building. This structure is examined for time history investigation technique (a) considering infill quality and firmness (open ground story), (b) Not considering infill quality and solidness (Bare casing). Infill Stiffness was made in ETABS by utilizing Equivalent Diagonal Strut approach. ETABS programming is utilized for Structural displaying and Time history investigation. Examination is completed for these models and results were thought about.*

Key Words: Time history, Open ground storey, Seismic analysis, RCC,infill, stiffness.

1. INTRODUCTION

Open ground building (OGS) has had its spot in the Indian city condition on account of the manner in which that it gives the ceasing office in the ground story of the structure. The cost of advancement of this kind of structure is generously not as much as that of a structure with basement ceasing. Investigations of structures bombed in the past seismic tremor exhibit that this sorts of structures are seen to be one of the most exposed. The majority of structures that break during the Bhuj seismic tremor (2001) and Gujraat quake were of the open ground story type. The breakdown arrangement of such sort of structure is commonly a direct result of the advancement of sensitive story, in the ground story of this sort of structure. The unexpected lessening in parallel stifness and mass in the ground story realizes higher worry in the sections of ground story under seismic stacking. Brick work infill dividers are commonly used as portions wherever all through the world. Past experience show that constant infill dividers can diminish the shortcoming of the RC encompassed structure. For this situation, infill dividers are not taken in the arrangement since they are not go about as an essential piece of basic part. Freely the infill dividers look like a solid and weak yet the casing is commonly malleable and adaptable. In any case, the joining activity of pillar segment and infill gives additional quality and solidness. Time history strategy A straight time history examination beat all of the drawbacks of a model response run assessment, given non-direct lead is excluded. This system requires increasingly conspicuous computational undertakings for figuring the response at discrete events. In this technique assessment for each extended estimation of time. For this kind of assessment logical model are made with the help of LAPTOP.

In this system base shear timespan are considered, when the base shear time period is resolved one can without a lot of a stretch find the estimation of increase factor. Finally the straight assessment of the strength of open ground story and different structures having distinctive help in ground story are looked at.

Fig-1: Typical open ground storey building

1.1 Aims and Objective of my work

1) To Study the Structure with different supports at ground storey of Open ground storey Building.

2) To study the effect of infill strength and stiffness in the seismic analysis of Open ground storey building.

1.2 Open Ground Storey Building

The presence of infill dividers in the upper story of the OGS building expands the firmness of the structure, as found in a common Infilled confined structure. Because of increment in the firmness, the base shear request on the structure increments while on account of regular Infilled edge constructing, the expanded base shear is shared by both the casings and infill dividers in all the story. In OGS structures, where the infill dividers are absent in the ground story, the expanded base shear is opposed completely by the segments of the ground story, without the plausibility of any heap sharing by the abutting infill dividers. The expanded shear powers in the ground story sections will actuate increment in the twisting minutes and ebbs and flows, causing generally bigger floats at the primary floor level. The enormous sidelong diversions further outcomes in the bowing minutes because of the P-Δ impact. Plastic pivots gets created at the top and base parts of the bargains story sections. The upper stories stay intact and move practically like an inflexible body. The harm for the most part happens in the ground story segments which is named as commonplace 'delicate story breakdown'. This is additionally called a 'story-component' or 'segment instrument' in the ground story as appeared in the figures underneath. These structures are powerless because of the unexpected bringing down of solidness in the ground story when contrasted with an average Infilled casing building.

1.2 TYPICAL MASONRY INFILLED BUILDINGS

Regular brick work Infilled casings contain infill dividers all through the structure in all story consistently. In spite of the fact that infill dividers are known to give the solidness and solidarity to the structure all inclusive, these are considered as 'non-basic' by configuration codes and are ordinarily overlooked in the plan practice for more comfort. The nearness of infill dividers in a confined structure not just improve the sidelong solidness in the structure, yet additionally changes the transmission of powers in pillars and segments, when contrasted with the exposed casing. In an exposed casing, the protection from sidelong power happens by the advancement of twisting minute and shear power in the pillars and segments through the unbending jointed activity of the shaft section joints.

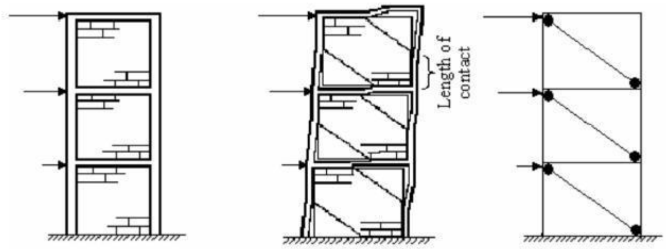

Fig 2. a.infill frame, b.deformed frame, c .strut model

2. LITERATURE REVIEW

Seismic examination could be a noteworthy instrument in earthquake engineering, that is utilized to get a handle on the reaction of structures on account of temperamental excitations in an exceedingly simpler way. Inside the past the any place earthquake is prevailing.

Mayuri D. Bhagwat: during this work dynamic analysis of G+10 multistory practiced RCC building considering for Koyna and Bhuj earthquake is dispensed by time history analysis and response spectroscopy and unstable responses of such building are relatively studied and shapely with the assistance of Etab software package.

Holmes: Under lateral loading the frame and the infill wall stay intact initially. As the lateral load increases the infill wall get separated from the surrounding frame at the unloaded (tension) corner, but at the compression corners the infill walls are still intact. The length over which the infill wall and the frame are intact is called the length of contact. Load transfer occurs through an imaginary diagonal which acts like a compression strut. Due to this behavior of infill wall, they can be modelled as an equivalent diagonal strut connecting the two compressive corners diagonally. The stiffness property should be such that the strut is active only when subjected to compression. Thus, under lateral loading only one diagonal will be operational at a time.

Abeysingye: Determined the inelastic response of the Greveniotikos Bridge during a design-level earthquake using the nonlinear pushover analysis. A three dimensional finite element model of the bridge was used. Parametric studies on the foundation stiffness, P effect and plastic hinge properties were carried out to evaluate the effects of different assumptions made in structural modeling and analysis. Different foundation stiffness did not result in a significant variation in the expected inelastic displacement. The P effect during the structural deterioration was substantially negligible in the bridge. While various properties of plastic hinges and pier cross section were used, the difference in the global response 32 was observed, but this difference was lesser than the result obtained by varying the foundation stiffness.

3. Structural Modeling

It's very important to develop a computational model on which time history analysis is performed. Accurate modeling of non linear properties of various structural elements is very important in analysis. In present study, frame elements were modeled with inelastic flexural hinges using point plastic model. Infill wall is modeled as equivalent diagonal strut elements. Beam and columns are modeled by 3D frame elements. Beams and columns are modeled by giving end-offsets to the frame elements, to obtain the bending moments and forces at the beam and column faces. Beams-Column joints are assumed to be rigid. Beams and columns in present study were modeled as frame elements with center lines joined at the nodes using commercial Etabs Software. Rigid beam-column joints were modeled by using end offsets at the joints. Floor slabs were assumed to act as diaphragms, which ensure integral action of all vertical lateral load resisting elements. Structural analysis means determination of the general shape and all the specific dimensions of a particular structure so that it will perform the function for which it is created and will safely withstand the influences which will act on it throughout its useful life. ETABS was used to create the mathematical model of the building, the input, output and numerical solution techniques of ETABS are specifically designed to take advantage of the unique physical and numerical characteristics associated with building type structures. ETABS provides both static and dynamic analysis for wide range of gravity, thermal and lateral loads. Dynamic analysis may include seismic response spectrum or accelerogram time history. This analysis mainly deals with the study of a regular square shape building, plan using ETABS. A 20m x 20m 11-storeys structure having 4m x 4m bays is modelled using ETABS. The height of each storey is taken as 3m, making total height of the structure 33 m. Loads considered are taken in accordance with the IS-875(Part1, Part2), IS-1893(2002) code and combinations are acc. to IS-875(Part5). Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement are computed and then compared for all the analysed cases.

3.1. LOADING

Loads acting on the structure are dead load (DL), Live load and Earthquake load (EL).

1. Self weight comprises of the weight of beams, columns and slab of the building.

2. Dead load: Wall load, Parapet load and floor load (IS 875(Part1))

a) Wall load= 15 kN/m (acting on the beam)

3. Live load: Floor load: 1kN/m2 (IS 875 (Part 2) acting on beams

4. Seismic Load: Seismic zone: V (Z=0.36), Soil type: I, Importance factor: 1, Response reduction

factor: 5, Damping: 5%. IS 1893(Part-1):2002.

MODEL 1 HAVING NO INFILL IN GROUND STOREY

Maximum storey displacement

Fig 3. Maximum storey displacement of ogs building

Table 1 maximum storey displacement of ogs building

storey	X-dir	y-dir	X-Dir x xdir-Min	Y-ydir-Min
	Mm	mm	mm	mm
Story11	55.734	0.071	55.734	0.071
Story10	53.581	0.029	53.581	0.029
Story9	50.388	0.004	50.388	0.004
Story8	46.154	0.002	46.154	0.002
Story7	41.019	0.002	41.019	0.002
Story6	35.178	0.002	35.178	0.002
Story5	28.8 19	0.002	28.819	0.002
Story4	22.127	0.002	22.127	0.002
Story3	15.306	0.003	15.306	0.003
Story2	8.668	0.003	8.668	0.003
Story1	2.932	0.02	2.932	0.02

Table 2 storey drift of ogs building.

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN	kN
Story11	33	Top	0.039	-0.0887
		Bottom	0.039	-0.0887
Story10	30	Top	0.0823	-0.1869
		Bottom	0.0823	-0.1869
Story9	27	Top	0.1235	-0.2805
		Bottom	0.1235	-0.2805

Story8	24	Top	0.1618	-0.3676
		Bottom	0.1618	-0.3676
Story7	21	Top	0.1964	-0.4463
		Bottom	0.1964	-0.4463
Story6	18	Top	0.2267	-0.515
		Bottom	0.2267	-0.515
Story5	15	Top	0.2518	-0.5721
		Bottom	0.2518	-0.5721
Story4	12	Top	0.2714	-0.6166
		Bottom	0.2714	-0.6166
Story3	9	Top	0.2851	-0.6478
		Bottom	0.2851	-0.6478
Story2	6	Top	0.293	-0.6656
		Bottom	0.293	-0.6656
Story1	3	Top	0.2956	-0.6717
		Bottom	0.2956	-0.6717

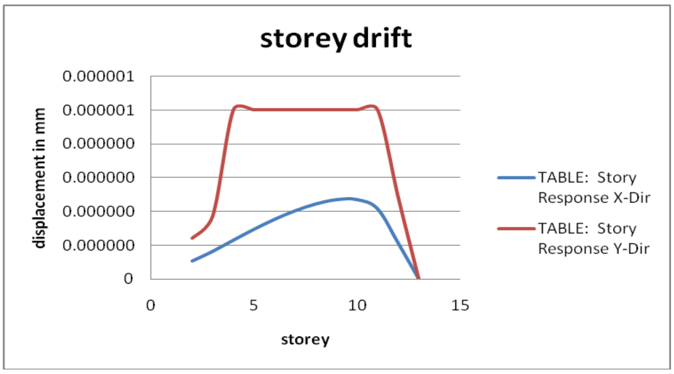

Fig 4.storey drift of ogs building

***Table 3** Time period and frequency of ogs building*				
Mode	**Period**	**Frequency**	**Circular Frequency**	**Eigenvalue**
	sec	cyc/sec	rad/sec	rad²/sec²
1	1.621	0.617	3.8772	15.0325
2	1.621	0.617	3.8772	15.0325
3	1.494	0.669	4.2044	17.677
4	0.514	1.944	12.2152	149.2101
5	0.514	1.944	12.2152	149.2101
6	0.474	2.108	13.248	175.509
7	0.283	3.531	22.1849	492.1696
8	0.283	3.531	22.1849	492.1696
9	0.261	3.826	24.0395	577.8976
10	0.183	5.455	34.277	1174.9128
11	0.183	5.455	34.277	1174.9128
12	0.169	5.929	37.2506	1387.6081

Model 2 single cross bracing

Fig5. Maximum storey displacement of single cross braced building

Table 4 Maximum storey displacement of single cross braced building				
storey	**x-dir**	**y-dir**	**X-Dir Min**	**y- dir Min**
	mm	mm	mm	mm
Story11	55.678	4.263	55.678	4.263
Story10	56.833	4.214	56.833	4.214
Story9	53.365	4.178	53.365	4.178
Story8	48.76	4.167	48.76	4.167
Story7	43.179	4.156	43.179	4.156
Story6	36.83	4.141	36.83	4.141
Story5	29.923	4.116	29.923	4.116
Story4	22.665	4.059	22.665	4.059
Story3	15.307	3.905	15.307	3.905
Story2	8.231	3.455	8.231	3.455
Story1	2.513	2.171	2.513	2.171

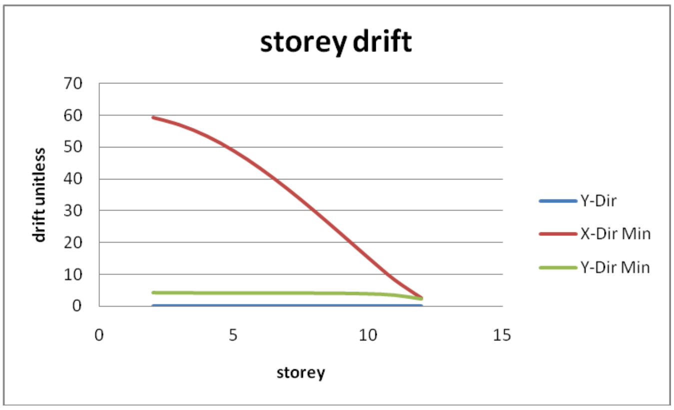

Fig 6.storey drift of single cross bracing building

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Maximum Storey drift

Table no.5 storey drift of single cross bracing buildingMaximum Storey drift

Story	X-Dir	Y-Dir	X-Dir Min	Y-Dir Min
11	0.000019	0.000019	59.17784	4.2628
10	0.000007	0.000007	56.83285	4.213879
9	0.000003	0.000003	53.3645	4.178013
8	0.000002	0.000002	48.76042	4.167469
7	0.000003	0.000003	43.17877	4.15581
6	0.000004	0.000004	36.83001	4.141376
5	0.00001	0.00001	29.92308	4.116277
4	0.000027	0.000027	22.66454	4.058684
3	0.000082	0.000081	15.30732	3.904684
2	0.000274	0.00027	8.230956	3.454674
1	0.000373	0.000368	2.513456	2.171396

Time period or frequencies

Table 6 Time period or frequencies of single cross braced building

Mode	Period	Frequency	Circular Frequency	Eigenvalue
	sec	cyc/sec	rad/sec	rad^2/sec^2
1	1.512	0.661	4.1543	17.2586
2	1.511	0.662	4.1578	17.2877
3	1.392	0.718	4.514	20.376
4	0.476	2.099	13.1868	173.8918
5	0.476	2.101	13.2016	174.2822
6	0.439	2.277	14.3095	204.7629
7	0.261	3.837	24.1059	581.0938
8	0.26	3.842	24.1375	582.6204
9	0.24	4.164	26.1609	684.3918
10	0.167	5.974	37.5343	1408.826
11	0.167	5.983	37.5941	1413.314
12	0.154	6.503	40.8568	1669.275

Model 3 X cross bracing

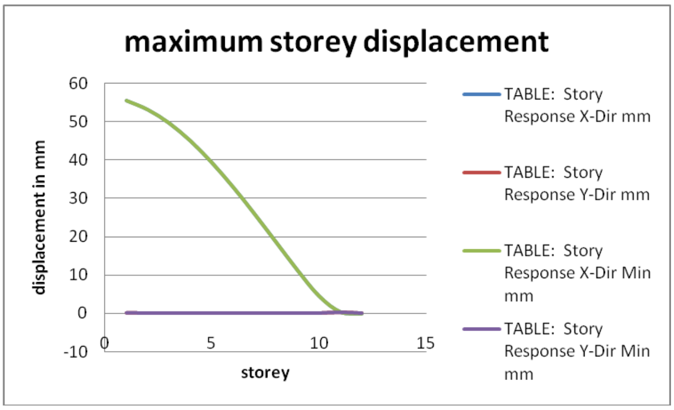

Fig .7 Maximum storey displacement of x braced building

TABLE7: maximum storey displacement x braced building

Story	X-Dir	Y-Dir	X-Dir Min	Y-Dir Min
	mm	mm	Mm	Mm
Story11	55.53	0.069	55.53	0.069
Story10	53.165	0.029	53.165	0.029
Story9	49.648	0.004	49.648	0.004
Story8	44.978	0.002	44.978	0.002
Story7	39.315	0.002	39.315	0.002
Story6	32.876	0.002	32.876	0.002
Story5	25.88	0.002	25.88	0.002
Story4	18.564	0.003	18.564	0.003
Story3	11.246	0.002	11.246	0.002
Story2	4.574	0.016	4.574	0.016
Story1	0.418	0.227	0.418	0.227

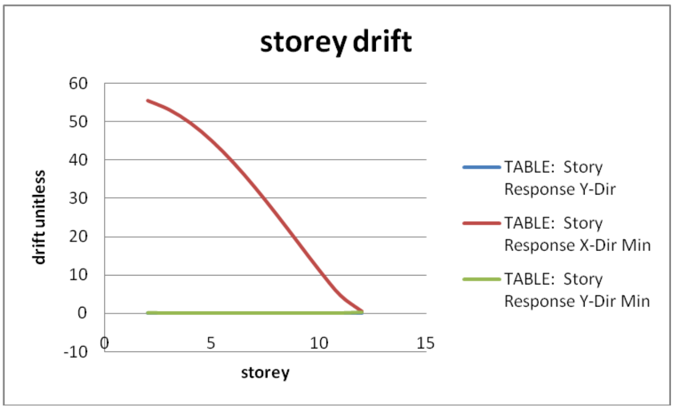

Fig 8storey drift of double cross braced building

TABLE8: maximum storey drift of x braced building				
Story	**X-Dir**	**Y-Dir**	**X-Dir Min**	**Y-Dir Min**
Story11	0.000017	0.000017	55.530244	0.069189
Story10	0.000005	0.000005	53.165137	0.028703
Story9	0.000001	0.000001	49.647703	0.004064
Story8	9.073E-08	9.073E-08	44.978145	0.002096
Story7	7.856E-08	7.856E-08	39.315069	0.001587
Story6	0.000000041	0.000000041	32.875634	0.001903
Story5	1.344E-07	1.344E-07	25.880149	0.00215
Story4	4.736E-07	4.736E-07	18.564389	0.0032
Story3	0.000002	0.000002	11.246148	0.001665
Story2	0.000037	0.000037	4.574459	0.016451
Story1	0.000039	0.000039	0.417582	0.227342

Table9-time period & frequencie of x braced building				
Mode	**Period**	**Frequency**	**Circular Frequency**	**Eigenvalue**
	sec	cyc/sec	rad/sec	rad²/sec²
1	1.504	0.665	4.1775	17.4517
2	1.504	0.665	4.1775	17.4517
3	1.385	0.722	4.5355	20.5705
4	0.474	2.112	13.2671	176.0164
5	0.474	2.112	13.2671	176.0164
6	0.437	2.289	14.3844	206.9096
7	0.259	3.864	24.2763	589.339
8	0.259	3.864	24.2763	589.339
9	0.239	4.189	26.3225	692.8766
10	0.166	6.024	37.8477	1432.4481
11	0.166	6.024	37.8477	1432.4481
12	0.153	6.55	41.1555	1693.7714

Model 4 Vshape bracing

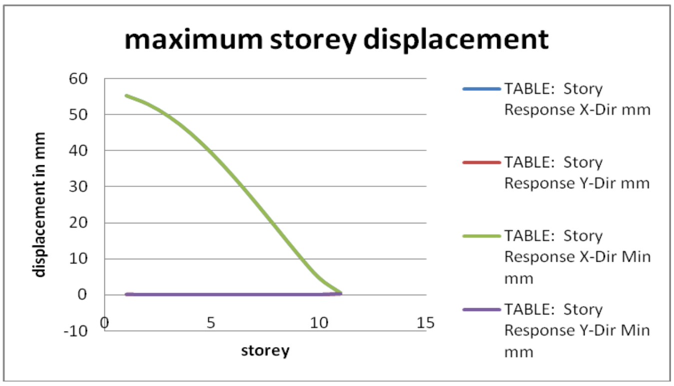

Fig 9 maximum storey displacement of v shape braced building

TABLE:10 9 maximum storey displacement of v shape braced building				
Story	**X-Dir**	**Y-Dir**	**X-Dir Min**	**Y-Dir Min**
	mm	mm	mm	mm
Story11	55.169	0.068	55.169	0.068
Story10	52.831	0.028	52.831	0.028
Story9	49.351	0.004	49.351	0.004
Story8	44.729	0.002	44.729	0.002
Story7	39.123	0.002	39.123	0.002
Story6	32.747	0.002	32.747	0.002
Story5	25.82	0.002	25.82	0.002
Story4	18.573	0.003	18.573	0.003
Story3	11.318	0.002	11.318	0.002
Story2	4.689	0.019	4.689	0.019
Story1	0.528	0.275	0.528	0.275

TABLE:11 maximum storey drift of v shape braced building				
Story	**X-Dir**	**Y-Dir**	**X-Dir Min**	**Y-Dir Min**
11	0.000016	0.000016	55.16931	0.068103
10	0.000005	0.000005	52.831273	0.028263
9	0.000001	0.000001	49.351174	0.003995
8	8.844E-08	8.844E-08	44.729385	0.002091
7	7.896E-08	7.896E-08	39.123035	0.001594
6	4.069E-08	4.069E-08	32.747226	0.001912
5	1.509E-07	1.509E-07	25.819853	0.002144
4	0.000001	0.000001	18.573385	0.0033
3	0.000002	0.000002	11.318495	0.002045
2	0.000041	0.000041	4.689221	0.018694
1	0.000043	0.000043	0.527688	0.275059

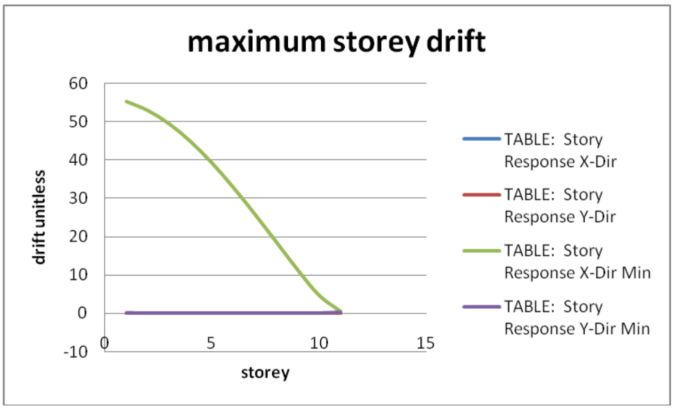

Fig 10maximum storey drift of v shape braced building

Time period and frequencies

Table 12 time period and frequencies of v shape braced building

Mode	Period	Frequency	Circular Frequency	Eigenvalue
	sec	cyc/sec	rad/sec	rad^2/sec^2
1	1.507	0.663	4.1686	17.3769
2	1.507	0.663	4.1686	17.3769
3	1.388	0.72	4.5261	20.4851
4	0.475	2.106	13.2343	175.1476
5	0.475	2.106	13.2343	175.1476
6	0.438	2.284	14.3499	205.9194
7	0.26	3.852	24.2007	585.6723
8	0.26	3.852	24.2007	585.6723
9	0.239	4.177	26.2473	688.9197
10	0.167	6.003	37.7166	1422.5385
11	0.167	6.003	37.7166	1422.5385
12	0.153	6.528	41.0193	1682.5798

Model 5 inverted v bracings

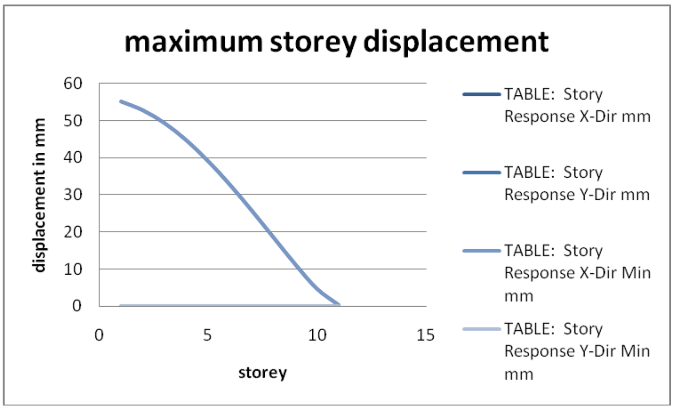

Fig 11.Maximum storey displacement of inverted v braced building

TABLE:13 maximum storey displacement of inverted v braced building

Story	X-Dir	Y-Dir	X-Dir Min	Y-Dir Min
	mm	mm	mm	Mm
Story11	55.201	0.07	55.201	0.07
Story10	52.855	0.029	52.855	0.029
Story9	49.368	0.004	49.368	0.004
Story8	44.74	0.002	44.74	0.002
Story7	39.127	0.002	39.127	0.002
Story6	32.745	0.002	32.745	0.002
Story5	25.812	0.002	25.812	0.002
Story4	18.56	0.003	18.56	0.003
Story3	11.301	0.003	11.301	0.003
Story2	4.683	0.027	4.683	0.027
Story1	0.275	0.021	0.275	0.021

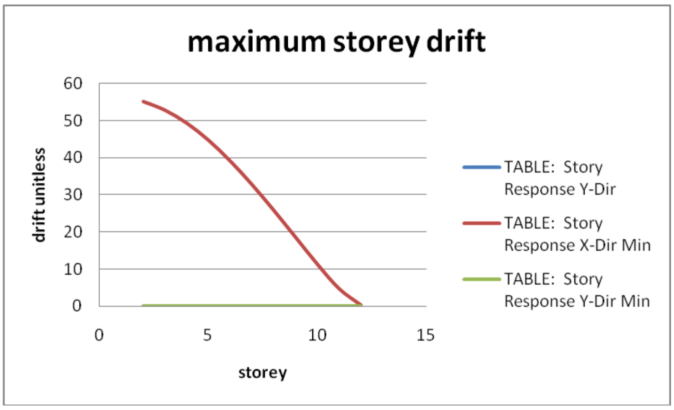

Fig12. Maximum storey drift of inverted vshape braced building

TABLE:14 maximum Storey drift of v shape braced building

Story	X-Dir	Y-Dir	X-Dir Min	Y-Dir Min
11	0.000017	0.000017	55.200599	0.070087
10	0.000005	0.000005	52.85475	0.029014
9	0.000001	0.000001	49.367725	0.004108
8	9.313E-08	9.313E-08	44.739614	0.002091
7	8.055E-08	8.055E-08	39.127179	0.001574
6	3.507E-08	3.507E-08	32.745425	0.001892
5	1.883E-07	1.883E-07	25.812154	0.002117
4	0.000001	0.000001	18.560426	0.003247
3	0.000004	0.000004	11.301205	0.002761
2	0.000001	0.000001	4.68268	0.027307
1	0.000003	0.000003	0.274914	0.021415

Table 15 Time periods and frequencies of inverted v braced building

Mode	Period	Frequency	Circular Frequency	Eigenvalue
	sec	cyc/sec	rad/sec	rad^2/sec^2
1	1.508	0.663	4.1679	17.3715
2	1.508	0.663	4.1679	17.3715
3	1.389	0.72	4.5235	20.4619

4	0.475	2.105	13.2239	174.8713
5	0.475	2.105	13.2239	174.8713
6	0.438	2.282	14.3396	205.6252
7	0.26	3.851	24.1977	585.5274
8	0.26	3.851	24.1977	585.5274
9	0.24	4.175	26.2309	688.059
10	0.167	5.999	37.6926	1420.7313
11	0.167	5.999	37.6926	1420.7313
12	0.153	6.523	40.9838	1679.674

All the above results of maximum storey displacement, maximum storey drift and time period &frequencies of the building is analyzed and studied. It is found that results are coming within IS limit. Means all the five bracing system viz. X-bracing system, V bracing system and Inverted-V bracing, single strut bracing, open ground storey building system are behaving efficiently. Amongst the all bracing system V-bracing system shows best resistant among all the buildings after that inverted v bracing then X bracing, then single cross bracing and after that open ground storey building shows least load resisting capacity.

4. CONCLUSIONS

In this study performance of bracing configuration and suitability in different types of building is checked. Different models have been modeled and checked on a G+ 10 building. Their performance is analyzed using five bracing system which are in practice now a day's viz. X-bracing, V–bracing and Inverted V-bracing, single cross bracing, and at last ogs building with system subjected to earthquake(elcentro), dead and live loading. To check the performance of these different building models time period, maximum storey displacement and maximum storey drift in the column are evaluated and analyzed and drawn the conclusion as under:

->V-bracing is found to be most efficient bracing type than single strut-bracing, inverted v bracing and X bracing type. Effective reduction in displacement is achieved using Inverted V-bracing.

->Lateral load resisting system using bracing provided at multiple bay will be efficient for high-rise buildings.

5. FUTURE WORK

The study carried out in this thesis can be extended further with the following scope of work

1) Use of eccentric bracing can be done enhance the performance of the building.

2) Use combination of bracing types in a single building can be done and performance will be checked.

3) Bracing with the dampers can be used.

4) Use different bracing can be done enhance the performance of the combination building + microwave tower.

5) Openings for such building should also be a major concern which have to be studied further.

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