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Effective Location of Shear Wall and Bracings for Multistoried Asymmetrical Building.

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Abstract: Earthquake happens all around the globe and it is a natural calamity and can occur across the world. It affects the structure by producing tough ground signals. To overwhelmed the Earthquake there is establishment of Shear wall and Bracing to increase the crosswise stiffness, ductility of the structure. To plan a building storey drift and crosswise displacement are crucial. The building is analyzed by Linear static and Linear dynamic method by E-tab software. In present paper G+25 multistoried building is analyzed by insertion of Shear wall and bracing at Corners, End and central core of the structure. The responses like Displacement, Storey drift, Time period and Base shear is calculated and equated.

Key Word: E-TAB, Shear Wall, Bracings, Linear static method, Linear dynamic method.

I.INTRODUCTION

The main purpose of this paper is to find the active places of shear wall and bracing for analysis of the structure which is subjected to seismic forces. In this work the structure is analysed by Linear static and Linear dynamic method by using E-TAB software (2018). The responses are calculated and compared.

A. Shear Wall

Shear walls are large reinforced concrete wall (or) a large column member that resist the seismic forces. They minimize the storey displacement when the ground signals hits the structure. Usually, the load is transferred to the wall through the Diaphragm (the structural section which crosswise the lateral load to the upright resisting section of the structure. These are largely in straight but can be tilted for parking the vehicles). Commonly the width of the shear wall will be around 150-200mm or more is commonly provided. Since, the structure may not have appealing presence if the structure is sealed with shear wall along the building. So, to overcome bracing is approved to decrease the lateral forces and wind forces along with the shear wall. Nowadays combination os shear wall and bracing are adopted for the structure at different location.

- In this paper the regular shear wall is used of thickness 230mm.

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B. Bracings

The structure frame is combined with bracing section to resist the Earthquake and Wind forces. They can absorb the larger energy encounter during Earthquake. They are largely used to resist the lateral displacement during the strong ground signals in the structure.

These are having high flexibility, economical, easy to erect and provide large strength and stiffness to the structure.

- In this paper the bracing of ISA 100mm x 100mm x 10mm are used for analysis.

II. OBJECTIVES OF THE PROJECT

A. To investigate the actual location of shear wall and bracing on the basis of story displacement under lateral loading.

B. To determine the percentage reduction in story displacement with different location of shear wall and bracing and on different model when compared to without shear wall and bracing.

C. Equivalent static method and Response Spectrum method are used to analyse the structure by using E-tab software (2018).

D. To investigate the responses like Displacement along X- direction, Story drift, Time period and Base shear are evaluated and compared with above two method.

III. METHODOLOGY

In this paper an attempt is taken to investigate the seismic effect on G+25 multistoried RCC building model with shear wall and bracing. The models of 26 storeyed RCC building is created and analysed by ETAB (2018) software. After successfully completion of models, the finest position of shear wall and bracing is found out by changing the position of shear wall and bracing to minimize the seismic effect. Different models were created and results are compared with additional models.

The height of each storey is maintained 3.2m. The considered seismic zone is V and soil is medium. In this paper the structure includes live load, earthquake load and dead load and these are accordingly to IS 875 part 1, IS 1893-2016, IS 875 part I respectively. The structure is analysed by Linear static method and Linear dynamic method. The responses like Displacement, storey drift, Time period and Base shear are calculated. After analyzing the structure, the obtained values are used to form table, graphs and lastly the conclusion.

A. Linear static method

This method is used to find the crosswise (horizontal) signals. This method is simple and required less computational energy and that is calculated according to the IS code of practice. In this method firstly the design of Base shear is calculated for the whole building and then the obtained results of Base shear is circulated all along the height of the building. The crosswise signal of each floor is circulated to each horizontal resisting section.

B. Linear dynamic method

IS 1893(part 1): 2002 has recommended the method of dynamic analysis of buildings in case of (i) Regular buildings-those higher than 40 m in height in zones IV and V, and those higher than 90 m in height in zones II and III.(ii) Irregular buildings- all framed buildings higher more than 12m in height in zones IV and V and those higher than 40m in height in zones II and III. The main aim of dynamic analysis is to find the design seismic signals, which is circulated to various point along the height of the building and to the different crosswise load resisting section of the structure and the analysis is somewhat similar to linear static method. In case of dynamic analysis the whole masses are assumed to be lumped at the storey level and at each storey only sway displacement is permitted. The analysis of dynamic method, it is assumed that irregular type of building is based on 3D modelling of that building that will have adequate stiffness and mass circulation along the height of the building so that its responses could be predicted easily and with more accuracy.

IV. STRUCTURAL MODEL

The plan area of the structure is 60.22mx50.22m and height of the structure is 84.24m. The grouping of Shear wall and bracings are placed at different location of structure at corners, end and core of the structure. The crosswise displacement of the structure is calculated and compared.

A. Properties of members

Young's modulus of concrete	35355.33MPa
Poisson's ratio	0.2
Density	25 KN /m^3
Thermal coefficient	0.0000055/°C
Grade of concrete	M_{50}
Yield strength of steel	Fe_{500}

B. Seismic Parameter

Zone value	0.36
Response reduction factor	5
Importance factor	1.5
Damping ratio	0.05

C. Size Of Members

Column size	900mm x 1200mm
Beam size	300mm x 600mm
Slab thickness	150mm
Shear	300mm
Bracings	ISA 100x100x10mm

D. Load Intensity

Live load on each floor	3 KN/m^2
Live load	1.5 KN/m^2
Floor finish	1 KN/m^2
Wall load	11.96 KN/m^2

E. Load Combinations

The load combination is itself calculated by the E-TAB software and the models are analyzed as the calculated load combination.

V. ABOUT E-TAB

ETABS is a delineating programming thing that obliges multi-story building examination and plan. Showing instruments and code-based load cures, examination methodology and approach systems, all make with the system like geometry rise to this class of structure. Fundamental or pushed structures under static or dynamic conditions may be inspected using ETABS. For a pushed evaluation of seismic execution, measured and plan joining time-history examinations may couple with P-Delta and Large Displacement impacts. Nonlinear affiliations and concentrated PMM or fiber turns may get material nonlinearity under monotonic or hysteretic arrange. Regular and supported parts make organizations of any versatile quality profitable to execute. Interoperability with an improvement of plan and documentation stages makes ETABS a sorted out and profitable contraption for outlines which keep running from clear 2D edges to increase current lifted structures. The creative and dynamic new ETABS is a whole framed programming pack for the accomplice examination and plan of structures. Merging 40 years of persevering creative work, this latest ETABS offers unmatched 3D address based showing and portrayal instruments, blazingly savvy quick and nonlinear illustrative power, mind boggling and intensive game-plan limits in regards to a broad accumulation of materials, and skilled sensible introductions, reports, and schematic drawings that connect with customers to quickly and easily unravel and comprehend examination and setup happens. Fig 1 shows the reference axis in E-TAB (2018) software. The X and Y co-ordinates indicates the horizontal direction parameter and Z co-ordinates referred as vertical direction parameter

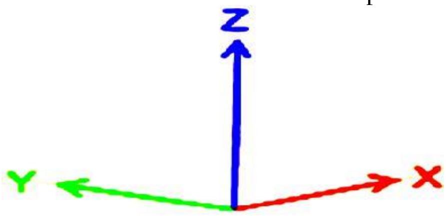


Fig 1: Generalized Coordinates in ETABS 2018

VI. PLAN AND 3D VIEW OF DIFFERENT MODELS

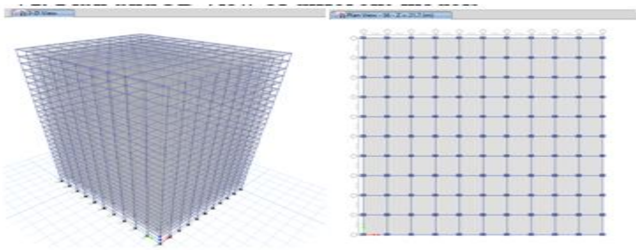


Fig 2: Regular building without shear wall and bracings

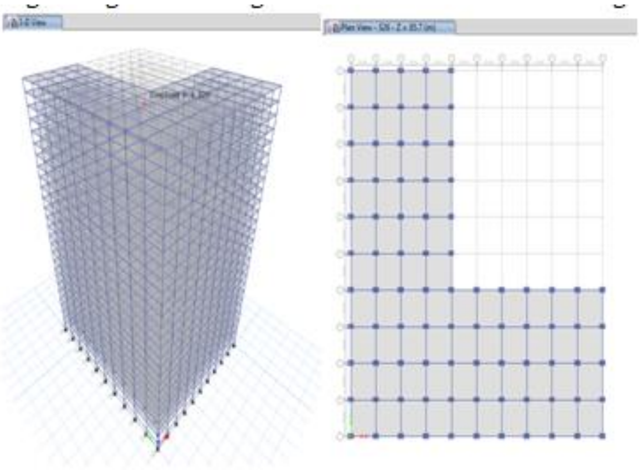


Fig 3: Regular L- Shape building without shear wall and bracings

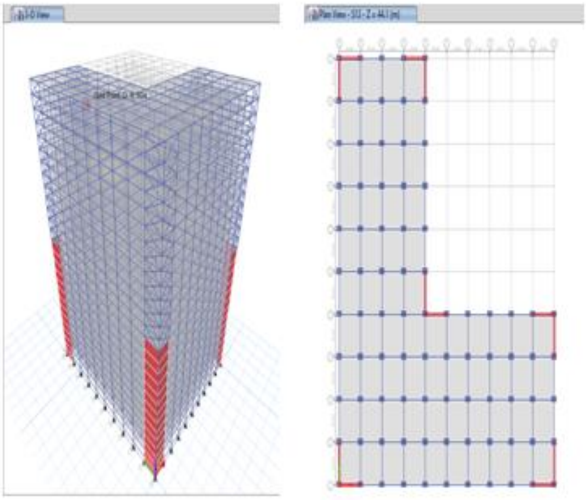


Fig 4: L- shape building with shear wall and bracings @corners

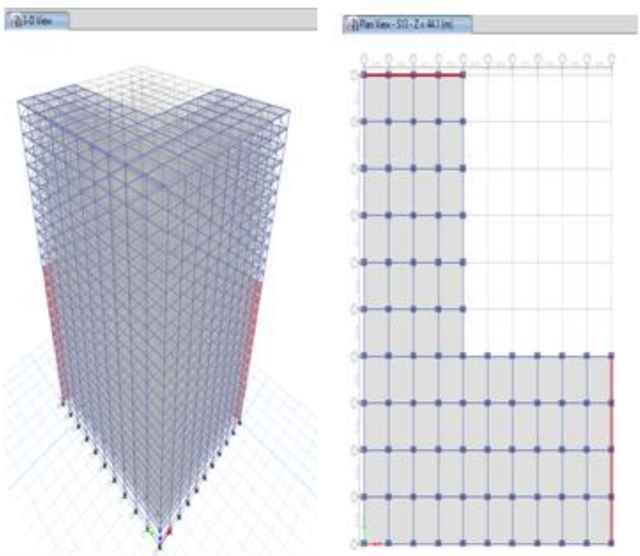


Fig 5: L-Shape building with shear wall and bracings @end

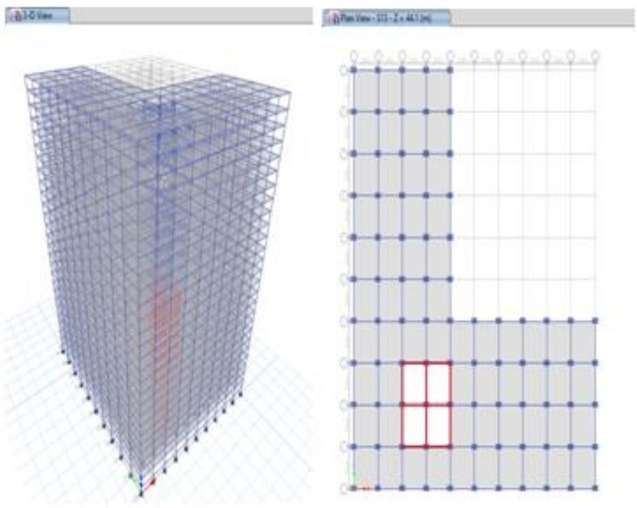


Fig 6: L-Shape building with shear wall and bracings @Central core

VII.RESULTS AND DISCUSSION

The results of lateral of Normal building and dual system building with combination of shear and bracings) placed at corners, end and central core of building. The lateral responses like displacement, storey drift, time period and base shear is evaluated and compared.

Table I. Displacement due to Equivalent Static Method

DISPLACEMENT DUE TO EQUIVALENT STATIC METHOD					
storey	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
	X-DIR	X-DIR	X-DIR	X-DIR	X-DIR
S26	114.046	147.547	113.317	95.48	131.251
S25	112.739	145.471	110.792	94.36	128.895
S24	111.149	143.06	107.876	92.988	126.123
S23	109.183	140.202	104.466	91.283	122.802
S22	106.807	136.85	100.526	89.216	118.881
S21	104.015	132.998	96.06	86.782	114.358
S20	100.819	128.659	91.098	83.995	109.264
S19	97.244	123.861	85.688	80.879	103.651
S18	93.317	118.638	79.898	77.465	97.593
S17	89.069	113.029	73.821	73.786	91.187
S16	84.532	107.073	67.592	69.876	84.563
S15	79.735	100.809	61.425	65.764	77.906
S14	74.711	94.275	55.668	61.457	71.485
S13	69.487	87.509	50.569	56.996	65.569
S12	64.093	80.548	45.577	52.458	59.922
S11	58.555	73.427	40.606	47.839	54.376
S10	52.9	66.18	35.692	43.15	48.869
S9	47.155	58.845	30.872	38.41	43.386
S8	41.348	51.458	26.192	33.64	37.936
S7	35.511	44.061	21.697	28.865	32.537
S6	29.683	36.708	17.44	24.115	27.217
S5	23.915	29.466	13.475	19.43	22.008
S4	18.284	22.434	9.864	14.869	16.957
S3	12.907	15.762	6.673	10.518	12.133
S2	7.971	9.682	3.98	6.521	7.655
S1	3.786	4.57	1.866	3.117	3.749
GR	0.867	1.039	0.505	0.718	0.88

Table II. Displacement due to Response Spectrum Method

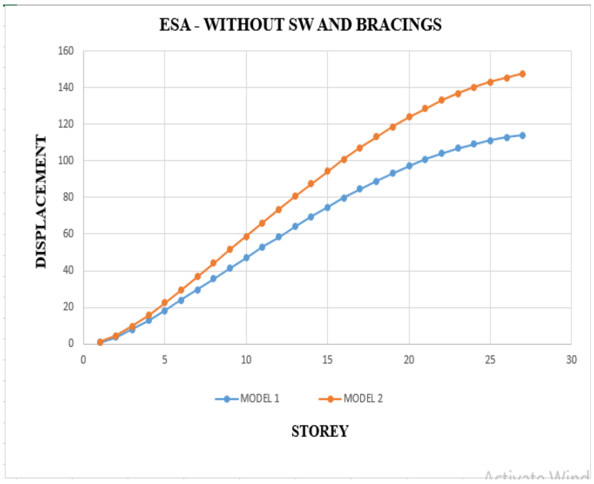
DISPACEMENT DUE RESPONSE SPECTRUM METHOD					
storey	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
	X-DIR	X-DIR	X-DIR	X-DIR	X-DIR
S26	102.777	180.973	71.063	82.552	115.163
S25	101.783	178.891	69.777	81.689	113.326
S24	100.579	176.454	68.261	80.632	111.141
S23	99.092	173.542	66.467	79.319	108.493
S22	97.296	170.103	64.394	77.731	105.341
S21	95.186	166.128	62.058	75.868	101.687
S20	92.764	161.626	59.48	73.744	97.551
S19	90.039	156.615	56.683	71.378	92.972
S18	87.019	151.115	53.692	68.792	88.004
S17	83.712	145.146	50.535	66.007	82.724
S16	80.129	138.728	47.244	63.043	77.247
S15	76.28	131.879	43.86	59.915	71.752
S14	72.177	124.616	40.436	56.639	66.511
S13	67.83	116.958	37.052	53.226	61.799
S12	63.251	108.922	33.782	49.651	57.328
S11	58.45	100.525	30.508	45.908	52.889
S10	53.439	91.784	27.207	41.999	48.387
S9	48.232	82.718	23.9	37.931	43.783
S8	42.843	73.349	20.613	33.713	39.059
S7	37.289	63.709	17.378	29.359	34.212
S6	31.594	53.847	14.232	24.892	29.247
S5	25.8	43.85	11.22	20.349	24.181
S4	19.983	33.859	8.393	15.79	19.05
S3	14.276	24.116	5.817	11.314	13.931
S2	8.91	15.008	3.565	7.093	8.976
S1	4.27	7.172	1.725	3.42	4.482
GR	0.985	1.648	0.497	0.793	1.068

Table III. Storey Drift due to Equivalent Static Method

STOREY DRIFT DUE EQUIVALENT STATIC METHOD					
storey	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
	X-DIR	X-DIR	X-DIR	X-DIR	X-DIR
S26	0.000408	0.000649	0.000789	0.00072	0.000736
S25	0.000497	0.000754	0.000911	0.000619	0.000866
S24	0.000614	0.000893	0.001066	0.000723	0.001038
S23	0.000743	0.001047	0.001231	0.000833	0.001225
S22	0.000873	0.001204	0.001396	0.000942	0.001413
S21	0.000999	0.001356	0.001551	0.001042	0.001592
S20	0.001117	0.001499	0.00169	0.00113	0.001754
S19	0.001227	0.001632	0.001809	0.0012	0.001893
S18	0.001327	0.001753	0.001899	0.001243	0.002002
S17	0.001418	0.001861	0.001946	0.001242	0.00207
S16	0.001499	0.001958	0.001927	0.001285	0.00208
S15	0.00157	0.002042	0.001799	0.001346	0.002007
S14	0.001632	0.002114	0.001593	0.001394	0.001849
S13	0.001686	0.002175	0.00156	0.001418	0.001765
S12	0.001731	0.002225	0.001553	0.001443	0.001733
S11	0.001767	0.002264	0.001536	0.001465	0.001721
S10	0.001795	0.002292	0.001506	0.001481	0.001713
S9	0.001815	0.002309	0.001463	0.001491	0.001703
S8	0.001824	0.002311	0.001405	0.001492	0.001687
S7	0.001821	0.002298	0.00133	0.001484	0.001663
S6	0.001802	0.002263	0.001239	0.001464	0.001628
S5	0.00176	0.002197	0.001129	0.001426	0.001579
S4	0.00168	0.002085	0.000997	0.00136	0.001508
S3	0.001542	0.0019	0.000842	0.001249	0.001399
S2	0.001308	0.001598	0.000661	0.001064	0.00122
S1	0.000915	0.001106	0.000448	0.000752	0.000899
GR	0.000347	0.000416	0.000202	0.000287	0.000352

Table IV. Storey Drift due to Response Spectrum Method

STOREY DRIFT DUE RESPONSE SPECTRUM METHOD					
storey	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
	X-DIR	X-DIR	X-DIR	X-DIR	X-DIR
S26	0.000438	0.000812	0.000548	0.000519	0.000697
S25	0.000542	0.000972	0.000668	0.000624	0.000843
S24	0.000671	0.001176	0.000804	0.000749	0.001026
S23	0.000798	0.001388	0.000927	0.000865	0.001212
S22	0.000911	0.001588	0.001026	0.000958	0.001383
S21	0.001008	0.001768	0.001105	0.001028	0.001534
S20	0.001093	0.001928	0.00117	0.00108	0.001665
S19	0.00117	0.002069	0.001224	0.001115	0.001775
S18	0.001244	0.002197	0.001265	0.001128	0.001861
S17	0.001316	0.002315	0.001288	0.001153	0.001911
S16	0.001385	0.002426	0.001288	0.001173	0.001904
S15	0.00145	0.00253	0.001256	0.001177	0.001802
S14	0.001511	0.002628	0.001177	0.001181	0.001606
S13	0.001569	0.002721	0.001076	0.001216	0.001511
S12	0.001624	0.002807	0.001063	0.001256	0.001487
S11	0.001675	0.002886	0.001065	0.001294	0.001493
S10	0.001722	0.00296	0.001062	0.001331	0.001511
S9	0.001763	0.003026	0.00105	0.001366	0.001534
S8	0.001796	0.003083	0.001029	0.001398	0.001558
S7	0.001823	0.003128	0.000996	0.001423	0.001582
S6	0.001837	0.003152	0.00095	0.001438	0.001602
S5	0.001832	0.003136	0.000889	0.001436	0.001614
S4	0.00179	0.003051	0.000808	0.001404	0.001604
S3	0.001679	0.002848	0.000705	0.001321	0.00155
S2	0.001451	0.002449	0.000576	0.001148	0.001405
S1	0.00103	0.001731	0.000413	0.000824	0.001069
GR	0.000394	0.000659	0.000199	0.000317	0.000427



Graph 1(a): Regular building without SW and bracings (ESA)

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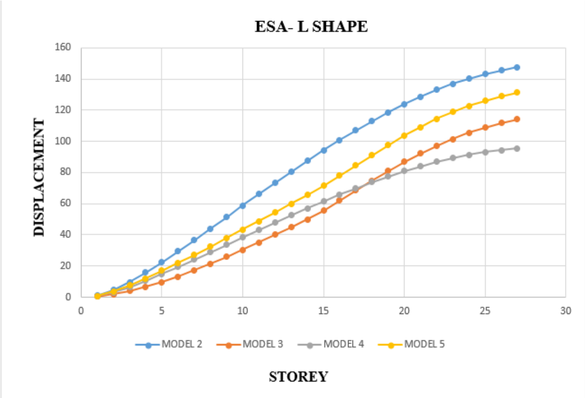
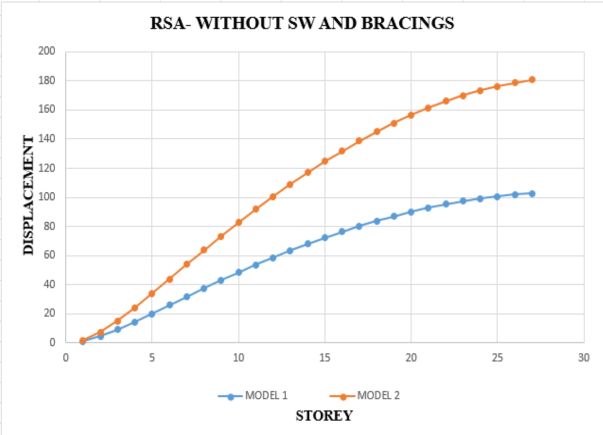
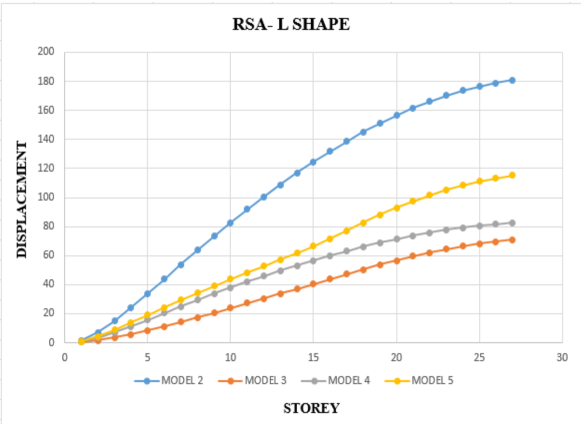


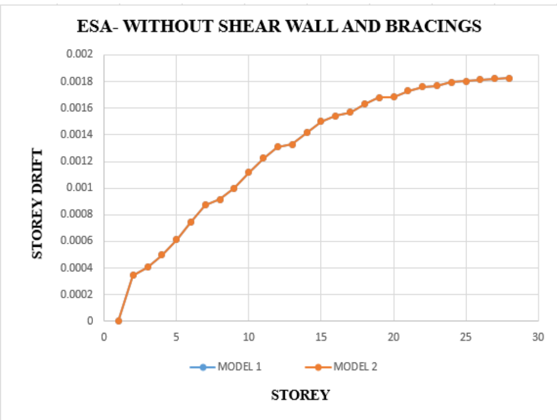
Graph 1(b): L- Shape building with SW and bracings (ESA)



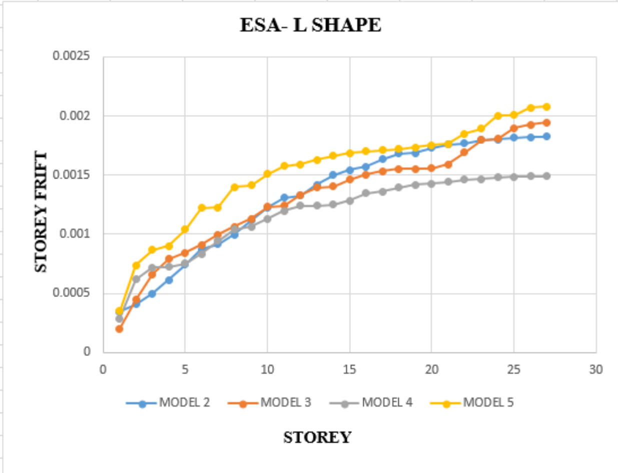
Graph 2(a): Regular building without SW and bracings (RSA)



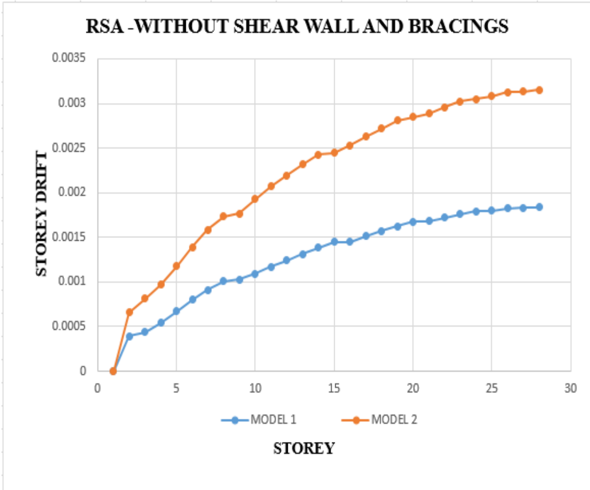
Graph 2(b): L- Shape building SW and bracings (RSA)



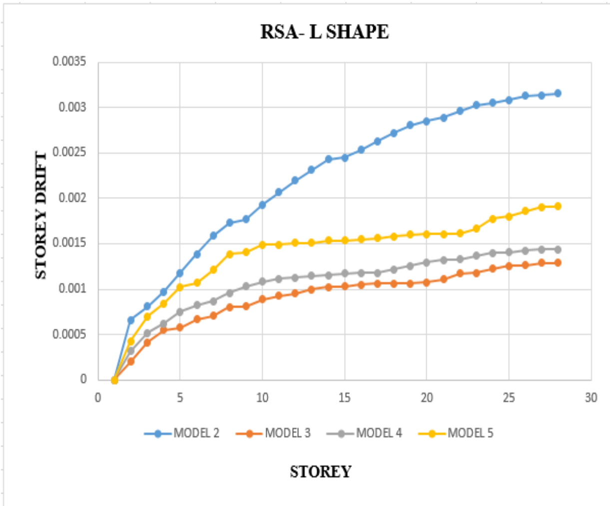
Graph 3(a): Regular building without SW and bracings (ESA)



Graph 3(b): L- Shape building with SW and bracings (ESA)



Graph 4(a): Regular building without SW and bracings (RSA)



Graph 4(b): L- Shape building with SW and bracings (RSA)

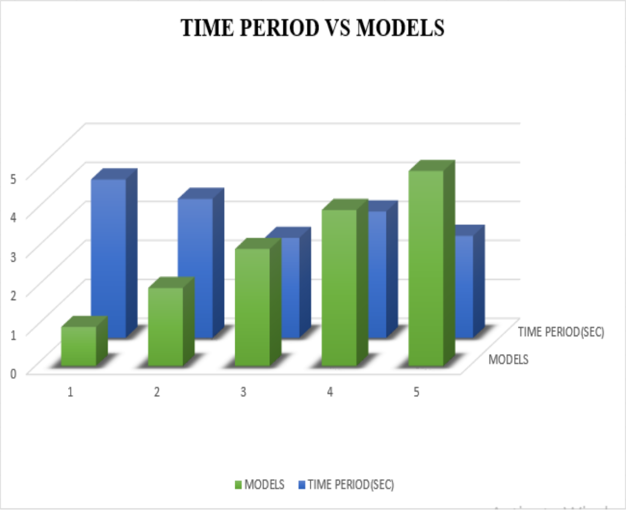


Fig 7: Time Period vs Storey

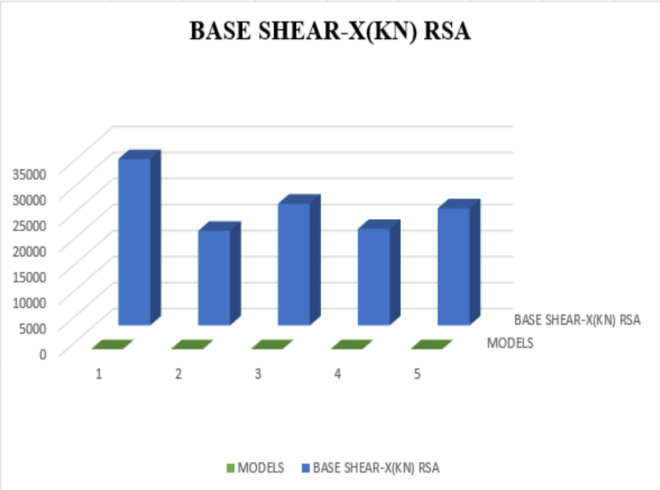


Fig 8: Base Shear of Response Spectrum Method

VIII. DISCUSION

1. The Displacement, Storey drift, Time Period and Base Shear of regular building and L- shape building models are compared. The variation is less in these models because of the same stiffeness and corresponding loads.
2. L- shape models are considered with shear wall and bracing at different location, the models without shear wall and bracing has the higher displacement value because of absence of stiffeners.
3. The shear wall and bracing (combination) plays a important role in reducing the lateral load. Among all the models the shear wall with bracing @corners proves to be more effective than shear wall with bracing at other location.
4. The graph 2(a) shows the highest displacement because of absence of shear wall and bracing (stiffeners)
5. The graph 2(b) shows displacement of all L- shape models with shear wall and bracing. Among all the models the shear wall and bracing @corners proves to be effective than shear wall with bracing at other locations.
6. The graph 4(a) shows the highest storey drift because of increase in displacement value
7. The graph 4(b) shows the storey drift of all the L-shape models with shear wall and bracing. Among all the models the shear wall with bracing @ corners has the lesser storey drift because of decrease in displacement value.
8. The fig 6 shows Time Period vs different models, the model ie L- shape with SW wall bracing @corners has lowest time period because of decrease in displacement.
9. The fig 7 shows the Base Shear vs different models, the model ie L- shape regular has the lowest Base Shear value because of absence of stiffeners.
10. The variation in displacement is found to be 60.73% reduction in model ie L shape with SW & bracings @corners, 54.38% reduction in model ie L-shape with SW & bracings @end, 36.36% reduction in model ie L-shape with SW and bracings @core when compared to the model ie L- shape regular.
11. The variation in time period is found to be 28.21% reduction in model ie L shape with SW & bracings @corners, 9.085% reduction in model ie L-shape with SW & bracings @end, 26.58% reduction in model ie L-shape with SW and bracings @core.

IX.CONCLUSION

A. Equivalent Static Method

1. The displacement for model ie L- shape with SW and bracing @end ie is lowest when compared to all other models because of presence of stiffeners.
2. The displacement in model ie L shape regular ie is highest compared to model ie L- shape with SW and bracing @ corners, model ie L-shape with SW and bracings @end and model ie L- shape with SW and bracings @core.
3. In L- shape models the SW with bracings @end prove to be more effective than SW with bracings @ corners and corners.
4. The time period for models ie L shape regular is highest among the model ie L shape with SW and bracings @corners, L-shape with SW and bracings @end, L-shape with SW and bracings @core.
5. In L- shape models the base shear value is more in L shape with SW and bracings @corners compared to all others L- shape models.

B. Response Spectrum Method

1. The displacement of model ie L shape with SW and bracings @corners is lowest when compared to all others models because of presence of stiffeners.
2. The displacement in model ie L shape regular is highest compared to model ie L- shape with SW and bracing @ corners, model ie L-shape with SW and bracings @end and model ie L- shape with SW and bracings @core.
3. In L- shape models the SW with bracings@ corners prove to be more effective than SW with bracings @ end and corners.
4. The time period for models ie L shape regular is highest among the model ie L shape with SW and bracings @corners, L-shape with SW and bracings @end, L-shape with SW and bracings @core.

5. In L- shape models the base shear value is more in L shape with SW & bracings @corners compared to all others L- shape models because of presence of stiffeners.

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