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Comparative Analysis of Drift and Displacement Using L, T, and Cross shape Column for Seismic Load

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ABSTRACT- The effect of earthquake can be prevented or minimized by taking certain preventive measures as per standard scientific guidelines. In Earthquake prone areas, some measures may prevent the loss of lives and material [1]. As building increases in height, the lateral displacement of the building becomes one of the primary concerns [2]. An excessive lateral displacement or inter-story drift causes the failure of both structural and non-structural elements. In this study G + 25 story building has been analyzed for Drift, Displacement and Base shear by using Etab tool. In design specifications, the calculated displacement at the top of a high-rise building and inter-story drifts at the final stage of the structural design process must be checked not to exceed specified limits with respect to building height as well as individual story height.

KEYWORDS:: *Displacement, Drift, Etab*

1.INTRODUCTION

1.1 History: Every year more than 3 million earthquakes take place, most of these unnoticed by humans. In contrast, a severe earthquake is the most frightening and catastrophic event of nature which can occur anywhere on the surface of our planet! Although usually lasting only seconds, a severe earthquake in a densely populated area may have catastrophic effects causing the death of hundreds of thousands of people, injuries, destruction and enormous damage to the economies of the affected area.

Thousands of people have been killed by earthquakes despite scientists being able to predict and forewarn in advance and engineers construct earthquake-safe buildings. Unfortunately earthquakes occur often in countries which are unable to afford earthquake-safe construction. Earthquake-resistant structure, Building designed to prevent total collapse, preserve life, and minimize damage in case of an earthquake or tremor. Earthquakes exert lateral as well as vertical forces, and a structure's response to their random, often sudden motions is a complex task that is just beginning to be understood. Earthquake-resistant structures absorb and dissipate seismically induced motion through a combination of means: damping decreases the amplitude of oscillations of a vibrating structure, while ductile materials (e.g., steel) can withstand considerable inelastic deformation^[3].

1.2 Earthquake and Civil Engineering

An earthquake is the shaking of the surface of the Earth resulting from a sudden release of energy in the Earth's lithosphere that creates seismic waves. Earthquakes can range in size from those that are so weak that they cannot be felt to those violent enough to propel objects and people into the air, and wreak destruction across entire cities. We cannot control the earthquake but can construct the earthquake resistant structure by taking certain preventive measures as per standard scientific guidelines

1.3 Drift and Displacement

Storey drift is the difference of displacements between two consecutive storeys divided by the height of that story. And Story displacement is the absolute value of displacement of the storey under action of the lateral force

1.4 Objectives- The main objective of present research work are:

1. To Calculate Drift and Displacement of structures using L, T, Cross (+) shape column for Seismic loading.
2. To analyze Drift and Displacement of structures using L, T, Cross (+) shape column for Seismic loading.
3. To analyze Base shear of structures using L, T, Cross (+) shape column for Seismic loading

- To provide life safety (or no collapse) under the design earthquake by reducing Drift and Displacement of structure.

Displacement in mm						
Story	load	direction	L shape	T shape	cross (+)	Combine
Story25	EQ X	X	192.76	234.658	213.442	286.575
Story24	EQ X	X	189.953	231.247	210.483	282.393
Story23	EQ X	X	186.678	227.283	207.017	277.541
Story22	EQ X	X	182.862	222.673	202.95	271.905
Story21	EQ X	X	178.494	217.401	198.267	265.483
Story20	EQ X	X	173.581	211.473	192.976	258.289
Story19	EQ X	X	168.137	204.906	187.092	250.341
Story18	EQ X	X	162.18	197.718	180.633	241.659
Story17	EQ X	X	155.727	189.928	173.618	232.267
Story16	EQ X	X	148.799	181.557	166.065	222.187
Story15	EQ X	X	141.412	172.627	157.994	211.443
Story14	EQ X	X	133.588	163.159	149.426	200.059
Story13	EQ X	X	125.346	153.178	140.38	188.063
Story12	EQ X	X	116.705	142.707	130.877	175.481
Story11	EQ X	X	107.687	131.77	120.937	162.341
Story10	EQ X	X	98.311	120.394	110.582	148.673
Story9	EQ X	X	88.599	108.604	99.832	134.507
Story8	EQ X	X	78.573	96.429	88.709	119.875
Story7	EQ X	X	68.255	83.898	77.237	104.811
Story6	EQ X	X	57.672	71.044	65.441	89.35
Story5	EQ X	X	46.859	57.906	53.354	73.53
Story4	EQ X	X	35.875	44.548	41.034	57.398
Story3	EQ X	X	24.858	31.105	28.614	41.034
Story2	EQ X	X	14.168	17.952	16.466	24.674
Story1	EQ X	X	4.85	6.274	5.727	9.332

1.5 Methodology

In this study G+25 story building has been design. The properties are - Type of frame: Special RC moment resisting frame fixed at the base, Seismic zone: V, Number of storey: Twenty-five, Floor height: 3.0 m, Depth of Slab: 150 mm, Size of beam: (230 × 600) mm, Size of column (L and T shape): (web - 400 × Flange -1000) mm, Size of column (Cross shape): (Web - 700 × Flange - 700) mm, Spacing between frames: 3.5 m along x and 4.5m along y- directions, Live load on floor: 2 KN/m², Floor finish: 1.0 KN/m², Wall load: 9.936 KN/m Materials: M 30 concrete, Fe 500 steel Material, Thickness of wall: 230 mm, Thickness of Column: 230mm, Density of concrete: 25 KN/m³, Density of infill: 20 KN/m³, Type of soil: Hard, Response spectra: As per IS 1893(Part-1):2002, Damping of structure: 5 percent.

1.6 Models

- Building with L shape column at Corners
- Building T shape Column at T joint
- Cross shape (+) column at intermediate column
- Combine L, T, cross (+) shape columns

1.7 Result

Comparative Analysis of Displacement in X direction

Table no: 1 - Comparative Analysis of Displacement in X direction

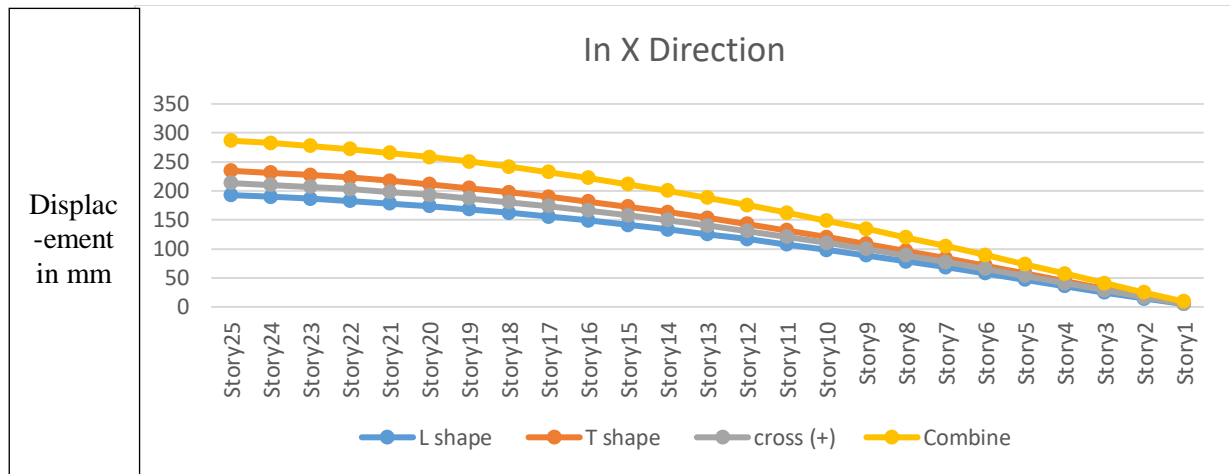


Figure no 1 – Comparative analysis of Displacement in X direction

Comparative Analysis of Displacement in Y direction

Table no: 2 - Comparative Analysis of Displacement in Y direction

Displacement in mm						
Story	load	direction	L shape	T shape	cross (+)	Combine
Story25	EQ Y	Y	246.102	265.712	273.758	311.632
Story24	EQ Y	Y	243.11	261.959	270.804	307.195
Story23	EQ Y	Y	239.458	257.576	267.061	302.039
Story22	EQ Y	Y	235.074	252.456	262.481	296.03
Story21	EQ Y	Y	229.954	246.581	257.078	289.154
Story20	EQ Y	Y	224.111	239.956	250.87	281.423
Story19	EQ Y	Y	217.564	232.6	243.88	272.856
Story18	EQ Y	Y	210.335	224.533	236.13	263.477
Story17	EQ Y	Y	202.446	215.777	227.641	253.309
Story16	EQ Y	Y	193.917	206.355	218.435	242.376
Story15	EQ Y	Y	184.771	196.29	208.535	230.705
Story14	EQ Y	Y	175.028	185.607	197.961	218.321
Story13	EQ Y	Y	164.711	174.33	186.736	205.252
Story12	EQ Y	Y	153.842	162.484	174.88	191.525
Story11	EQ Y	Y	142.44	150.095	162.416	177.169
Story10	EQ Y	Y	130.529	137.189	149.365	162.213
Story9	EQ Y	Y	118.13	123.793	135.749	146.686
Story8	EQ Y	Y	105.264	109.934	121.587	130.621
Story7	EQ Y	Y	91.954	95.643	106.902	114.049
Story6	EQ Y	Y	78.222	80.953	91.716	97.005
Story5	EQ Y	Y	64.098	65.908	76.048	79.528
Story4	EQ Y	Y	49.629	50.586	59.925	61.679
Story3	EQ Y	Y	34.931	35.164	43.388	43.584
Story2	EQ Y	Y	20.371	20.129	26.588	25.642
Story1	EQ Y	Y	7.213	6.928	10.365	9.284

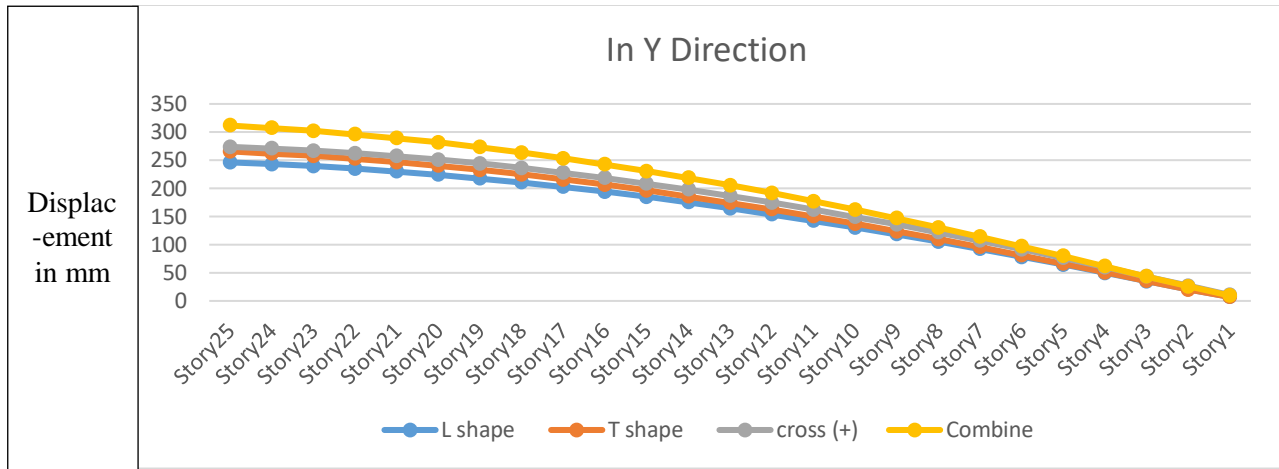


Figure no 2 – Comparative analysis of Displacement in Y direction

Drift Analysis
Drift in X direction

Table no: 3 - Comparative Analysis of Drift in X direction

Drift in mm						
Story	load	direction	L shape	T shape	cross (+)	Combine
Story25	EQ X	X	0.000936	0.001137	0.000986	0.001394
Story24	EQ X	X	0.001092	0.001321	0.001155	0.001618
Story23	EQ X	X	0.001272	0.001537	0.001356	0.001879
Story22	EQ X	X	0.001456	0.001758	0.001561	0.002141
Story21	EQ X	X	0.001638	0.001976	0.001764	0.002398
Story20	EQ X	X	0.001815	0.002189	0.001961	0.002649
Story19	EQ X	X	0.001986	0.002396	0.002153	0.002894
Story18	EQ X	X	0.002151	0.002597	0.002339	0.003131
Story17	EQ X	X	0.00231	0.00279	0.002518	0.00336
Story16	EQ X	X	0.002462	0.002977	0.00269	0.003581
Story15	EQ X	X	0.002608	0.003156	0.002856	0.003794
Story14	EQ X	X	0.002747	0.003327	0.003015	0.003999
Story13	EQ X	X	0.00288	0.00349	0.003168	0.004194
Story12	EQ X	X	0.003006	0.003646	0.003313	0.00438
Story11	EQ X	X	0.003125	0.003792	0.003452	0.004556
Story10	EQ X	X	0.003237	0.00393	0.003583	0.004722
Story9	EQ X	X	0.003342	0.004058	0.003708	0.004877
Story8	EQ X	X	0.003439	0.004177	0.003824	0.005021
Story7	EQ X	X	0.003528	0.004285	0.003932	0.005154
Story6	EQ X	X	0.003604	0.004379	0.004029	0.005273
Story5	EQ X	X	0.003661	0.004453	0.004107	0.005377
Story4	EQ X	X	0.003673	0.004481	0.00414	0.005455
Story3	EQ X	X	0.003563	0.004384	0.004049	0.005453
Story2	EQ X	X	0.003106	0.003893	0.00358	0.005114
Story1	EQ X	X	0.001617	0.002091	0.001909	0.003111

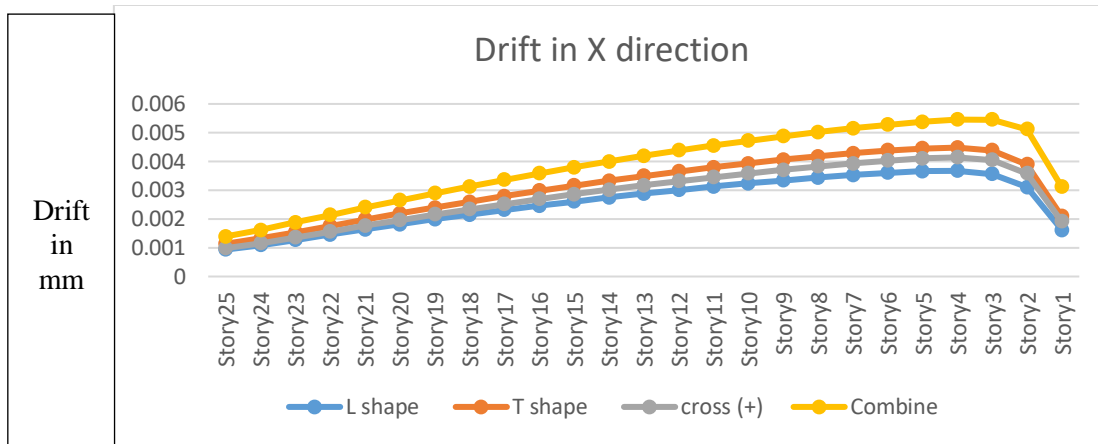


Figure no 3 – Comparative analysis of Drift in X direction

Drift in Y direction

Table no: 4 - Comparative Analysis of Drift in X direction

Drift in mm						
Story	load	direction	L shape	T shape	cross (+)	Combine
Story25	EQ Y	Y	0.000998	0.001251	0.000985	0.001479
Story24	EQ Y	Y	0.001217	0.001461	0.001247	0.001719
Story23	EQ Y	Y	0.001461	0.001706	0.001527	0.002003
Story22	EQ Y	Y	0.001707	0.001959	0.001801	0.002292
Story21	EQ Y	Y	0.001948	0.002208	0.002069	0.002577
Story20	EQ Y	Y	0.002182	0.002452	0.00233	0.002856
Story19	EQ Y	Y	0.00241	0.002689	0.002583	0.003126
Story18	EQ Y	Y	0.00263	0.002919	0.00283	0.003389
Story17	EQ Y	Y	0.002843	0.003141	0.003069	0.003644
Story16	EQ Y	Y	0.003049	0.003355	0.0033	0.00389
Story15	EQ Y	Y	0.003247	0.003561	0.003525	0.004128
Story14	EQ Y	Y	0.003439	0.003759	0.003742	0.004356
Story13	EQ Y	Y	0.003623	0.003949	0.003952	0.004576
Story12	EQ Y	Y	0.0038	0.00413	0.004155	0.004785
Story11	EQ Y	Y	0.00397	0.004302	0.00435	0.004985
Story10	EQ Y	Y	0.004133	0.004465	0.004539	0.005175
Story9	EQ Y	Y	0.004289	0.004619	0.00472	0.005355
Story8	EQ Y	Y	0.004437	0.004764	0.004895	0.005524
Story7	EQ Y	Y	0.004577	0.004897	0.005062	0.005681
Story6	EQ Y	Y	0.004708	0.005015	0.005222	0.005825
Story5	EQ Y	Y	0.004823	0.005107	0.005374	0.00595
Story4	EQ Y	Y	0.004899	0.005141	0.005512	0.006032
Story3	EQ Y	Y	0.004854	0.005012	0.0056	0.005981
Story2	EQ Y	Y	0.004386	0.004401	0.005408	0.005452
Story1	EQ Y	Y	0.002404	0.002309	0.003455	0.003095

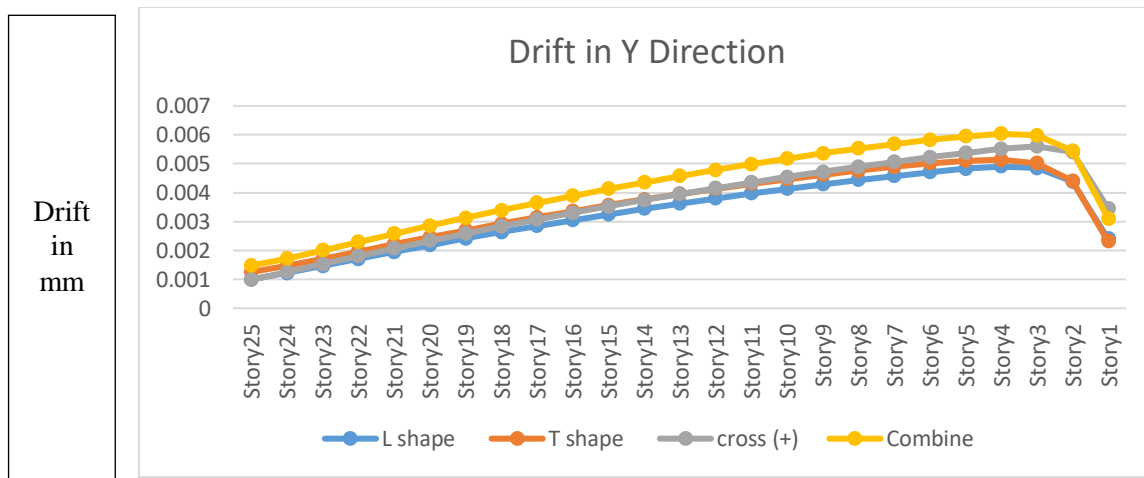


Figure no 4 – Comparative analysis of Drift in Y direction

Analysis of Base shear

Base shear in X and Y direction

Table no: 5 - Comparative Analysis of Base Shear

Sr No	Model	X direction (KN)	Y direction (KN)
1	Model 1 (Using L shape column)	2874.66	2488.04
2	Model 2 (Using T shape column)	2514.46	2343.13
3	Model 3 (Using cross(+) shape column)	2569.57	2197.14
4	Model 4 (Combine L,T,cross shape column)	2103.90	2006.76

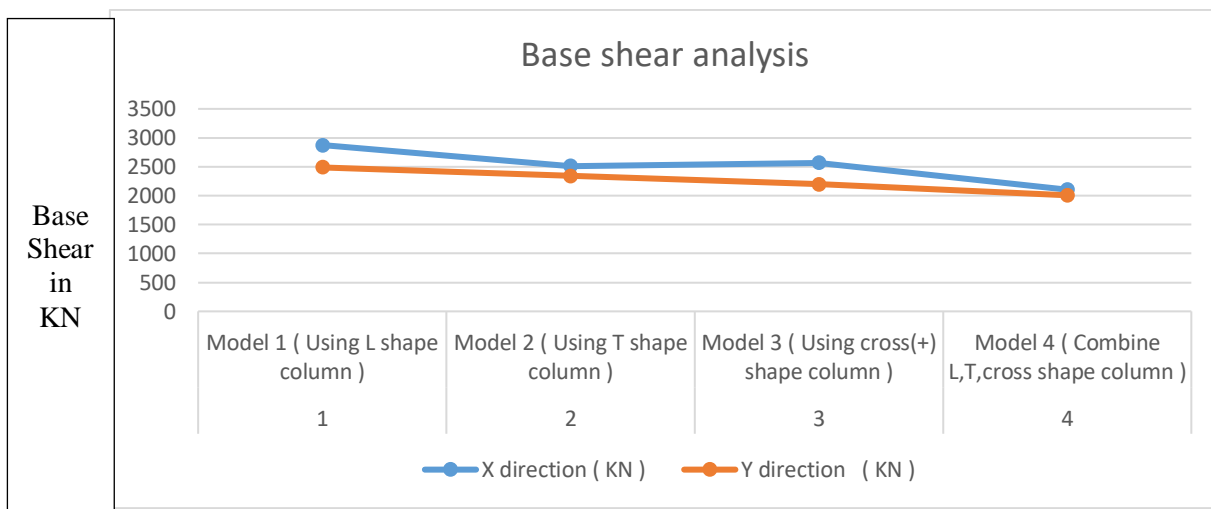


Figure no 5 –Analysis of Base shear

II. CONCLUSION

From the results and discussion of present study following conclusions are drawn.

1. From above Displacement analysis, L shape column is having lesser value than T and cross shaped column.
 - i. Minimum Displacement = 192.7 mm (in X direction)
 - ii. Minimum Displacement = 246.1 mm (in Y direction)
2. From above Drift analysis, L shape column is having lesser value than T and cross shaped column
 - i. Minimum Drift = 0.0009 mm (in X direction)



- ii. Minimum Drift = 0.0009 mm. (in Y direction)
3. From above analysis, it has been found that the maximum base shear in model 1 (using L shape column) as compare to other model. In X direction it is 2874.66 KN and in Y direction it is 2488.04 KN

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