|| Volume 6 || Issue 7 || July 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
AND ENGINEERING TRENDS

ANALYSIS OF DUMBBELL SHAPED SHEAR WALL IN HIGH RISE BUILDING IN ETAB SOFTWARE

Minal Dnyaneshwar Jadhav[1], Prof. S.V.Shelar [2]

[1]Department of Structural Engineering, Trinity College of Engineering and Research, Pune,

[2]Associate Professor, Department of Structural Engineering, Trinity College of Engineering and Research, Pune,

Email: minaljadhav2711@gmail.com

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Abstract: In general, the earthquake has a lengthy history of fatal devastations in the past. Earthquakes may be assessed by measuring amplitude, frequency and position of seismic waves and also by assessing intensity, i.e. the damaging impact of ground shaking on people, buildings and natural characteristics. The structure's reaction to ground motion is an important element in analysing and designing any resistant construction against earthquakes. Shear wall is a structural component placed in a structure from the base level to the top level, which is used to withstand lateral pressures that are parallel to a wall plane. The most essential task is to make the job done till now a final mark. The results have been observed for the universal axis as well as the standard limit given by the code. The findings contrasted both pushover and dynamic time history analyses and to quantify the outcomes developed the performance indices. The static pushover analysis is the primary source of the performance index; it defines the growing base shear for displacement. To quantify the whole labour done for both types of analysis, the ranges from the original analysis and pushover analysis to standard codes must be presented in a suitable manner. As The functioning of the building relies primarily on certain findings for the study of time history.

Keywords: *Shear wall, ETABS, Earthquake, and Dumbbell.*

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I INTRODUCTION

1.1 INTRODUCTION

Earthquake in general had a long history of deadly devastations in the past. Earthquakes can be measured in terms of energy release i.e. measuring amplitude, frequency, and location of seismic waves and also by evaluating intensity i.e. considering the destructive effect of shaking ground on people, structures and natural features. Basically the response of the structure due to ground motion is an essential factor to analyze and design any earthquake resistant structure. The loads or forces which a structure subjected to earthquake motions are called upon to resist, the distortions induced by the motion of the ground on which it rests.

The properties of a building are lateral stiffness, lateral strength and ductility. Lateral stiffness refers to the initial stiffness of the building, even though stiffness of the building reduces with increasing damage. Lateral strength refers to the maximum resistance that the building offers during its entire history of resistance to relative deformation. Ductility towards lateral deformation refers the ratio of the maximum deformation and the idealized yield deformation. The effect of the vertical component of ground motion is generally considered not to be significant and is neglected except in cantilevers.

1.2 SHEAR WALL AND ITS PROPERTIES

Shear wall is a structural member positioned at different places in a building from foundation level to top parapet level, used to resist lateral forces i.e parallel to the plane of the wall. There are different materials by which shear wall can be constructed but reinforced concrete (RC) buildings often have vertical plate-like Reinforced concrete walls (Figure 1.1) in addition to slabs, beams and columns. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings.

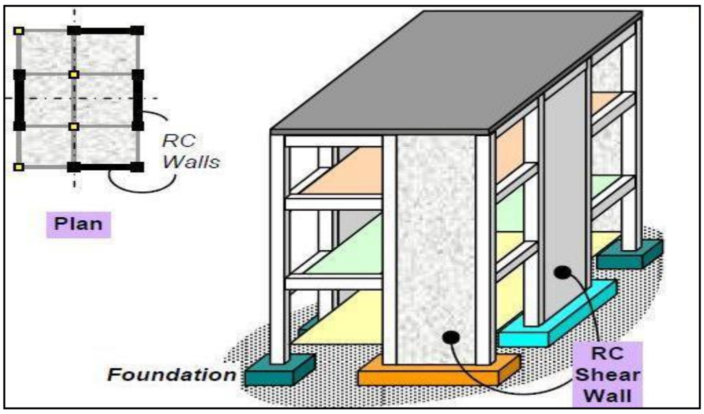

Figure No 1: Shear Wall in Building

These walls are more important in seismically active zones because during earthquakes shear forces on the structure increases. Shear walls should have more strength and stiffness. Shear walls provide adequate strength and stiffness to control lateral displacements. Shear walls perform dual action that is they as lateral as well as gravity load-bearing elements. Concrete Shear wall buildings are usually regular in plan and in elevation.

1.3 OBJECTIVES OF THE STUDY

Following are the objective of proposed work

1. To analyse and design the RCC tall building G+25 storied for dynamic responses as per Indian code IS 1893 Part I.
2. To analyse the RCC tall building for dynamic responses with different thickness of boundary elements of Special shear walls as per Indian code IS 1893 Part I.
3. Design of tall structure with special shear wall having different boundary elements.

II. LITERATURE REVIEW

Emmanouil Vougioukas et al. (2016), In this article, author examined the behaviour of strengthened existing non-conforming reinforced concrete shear walls, namely shear walls which are designed and constructed according to older seismic codes non-compliant with modern earthquake design standards. A strengthening method using steel elements (straps and angles) is examined. For the purposes of the present study five shear walls –one reference and four 5 strengthened – with shear ratio equal to 2.0, characterized as medium-rise, were designed and tested as cantilevers under static cyclic loading. The strengthened specimens included four different configurations, targeting each time to restrict the phenomenon of buckling of reinforcing bars under compression and control the cracking width along the web. The four strengthening configurations include only horizontal straps along the height, horizontal straps and corner angles along the height, horizontal straps and corner angles only in the lower part and, finally, combination of horizontal straps and corner angles in the lower part with bidiagonal (X shaped) configuration in the rest of the web.

III. METHODOLOGY

3.1 BEHAVIOUR OF RC BUILDING UNDER EARTHQUAKE

INTRODUCTION

In India, there are a large number of reinforced-concrete buildings that just meet or fall short of the standards of earthquake safety. In addition, many existing reinforced-concrete shear-wall buildings in first-degree seismic zones need seismic evaluation due to noncompliance with old code requirements, updating of codes, and building design practice. Their maintenance and reinforcement is not possible due to economic and technical reasons. A more realistic form of earthquake safety evaluation for existing buildings has come into question. In the India Earthquake Code (IS) in 1975 (IS 1893), performance-based evaluations were emphasized by using advanced knowledge of earthquake engineering. Therefore, performance-based design procedures have been recently investigated for the structures. Several procedures for performance assessment have been discussed in the literature. The nonlinear seismic performance of structures under earthquake effects is determined by static pushover and time history analyses. Pushover analysis allows for direct evaluation of the performance of the structure at each limit state. Nonlinear dynamic analysis (NDA) is the most reliable analysis method among all the nonlinear analysis methodologies. However, static pushover analysis has become important due to its easy application compared to time-history analysis. Many papers have been published on the topic of performance evaluation of existing reinforced-concrete buildings.

LIGHT WEIGHT CONCRETE OBSERVED PERFORMANCE OF BUILDINGS

Losses from the earthquake were estimated to be $30 billion, with more than520 fatalities. From various sources, damage estimates included: over 370,000 houses damaged or destroyed; more than 4,000 schools significantly damaged; approximately 300 highway bridges damaged, including 20 collapsed spans, and 80 hospitals needing repairs.

Given the intensity of shaking, most buildings were generally considered to have performed well in the earthquake. Based on building surveys in selected metropolitan regions in India, the Engineers Association of India estimated that approximately 2% of engineered buildings experienced severe damage or collapse; 12% were damaged such that they were not usable until repaired; and 86%were usable immediately following the earthquake.

Approximately 50 multi-story reinforced concrete buildings were severely damaged, and four experienced partial or total collapse. Immediately following the earthquake, reconnaissance teams began observing recurring patterns of damage in shear walls and other elements of mid-rise and high-rise reinforced concrete buildings. There were many instances of concrete crushing and buckling of longitudinal reinforcement at wall boundaries, with failures that propagated along the entire length of the wall segment (Figure 3.1).

Figure No 2: Concrete Crushing And Buckling Of Longitudinal Reinforcement Initiating At Wall Boundaries And Propagating Along The Length Of Wall Segments

Other vertical and horizontal wall segments experienced shear failures (Figure 2).A few walls exhibited apparent out-of-plane lateral instability that was reminiscent of overall wall buckling behavior (Figure 3). Localized damage attributed to building configuration issues was concentrated at locations of wall discontinuities and structural system irregularities (Figure 4), or unintended coupling of walls through slabs and other elements (Figure 5).

Figure No 3: Shear Failures In Vertical And Horizontal Wall Segments

Figure No 4: Overall Wall Buckling Behavior

Figure No 5: Concentrated Damage At: (A) Wall Discontinuities;And (B) Structural Irregularities

Figure No 6: Concentrated Damage At: (A) Coupling Beams; And (B)Cast-In-Place Concrete Stair Elements

Description of Observed Damage to Wall Boundary Elements

IV. MODELS IN ETABS

DESCRIPTION OF MODELS AND SAMPLES

In the present study the behaviour of regular buildings under seismic loads has been investigated for various locations of shear walls. An analysis of regular buildings with twenty five no of stories has been carried out. The buildings were assumed to be located in seismic zone III. The shear walls were provided at central frame, internal frame, and external frame and at combined external & internal frames of the building. The analysis of the building has been carried out by Seismic Coefficient Method Approach using Etabs. The seismic response of various buildings with and without shear walls has been compared in terms of Storey drift and Average displacements

Four RC framed regular buildings with different heights and with four different locations of shear walls situated in seismic zone V have been taken for the purpose of the study. The framed regular buildings are twenty five-storeyed. The size of the building in plan is 30 m x 30 m. The other features of the buildings are as follow.

Height of each storey = 3m

Size of Column = 530mm x 530mm

Size of Beam = 600mm x 300mm

Size of Slab = 200mm

Shear wall thickness = 230mm

Thickness of Floor Finish = 40mm

Concrete Mix Used = M25

No. of bays in X-direction is six and in Z-direction is six.

Spacing between supports is 5 meters.

All the supports are assumed to be fixed in nature.

The plan of the building is shown in Figure 7 and shear wall locations are shown in Figure 8 to Figure 9.

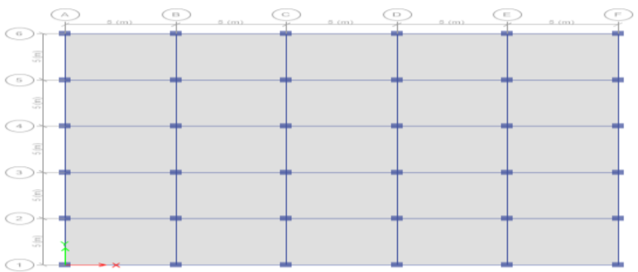

Figure No 7: Plan Of The Building

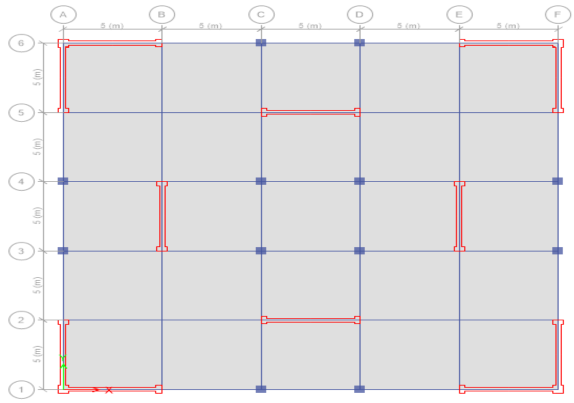

Figure No 8: Position of Dumbel Shape Shearwall Building at 1st Grid Type

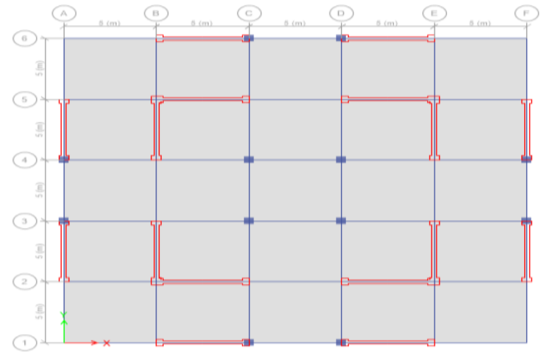

Figure No 9: Position of Dumbel Shape Shear wall in Building at 2nd Grid Type

V. RESULTS AND DISCUSSION

5.1 DISPLACEMENT OF MODEL

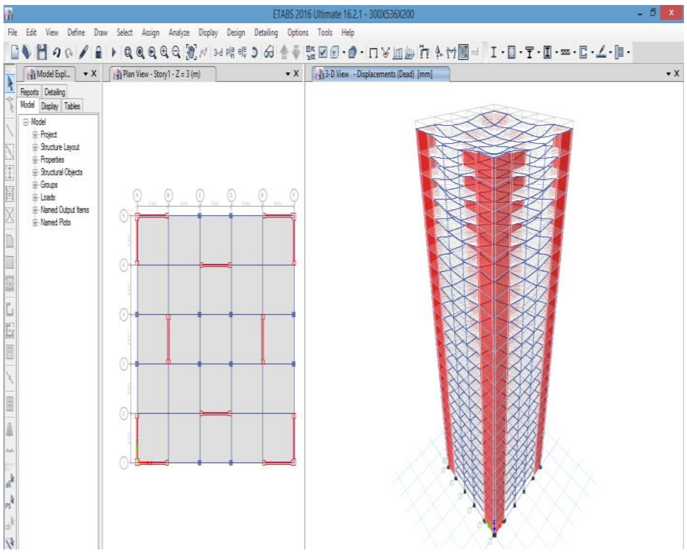

Figure No 10: Displacement Shape Of Twenty Five Story Building With Dumbel Shape Shear Wall Grid Type 1

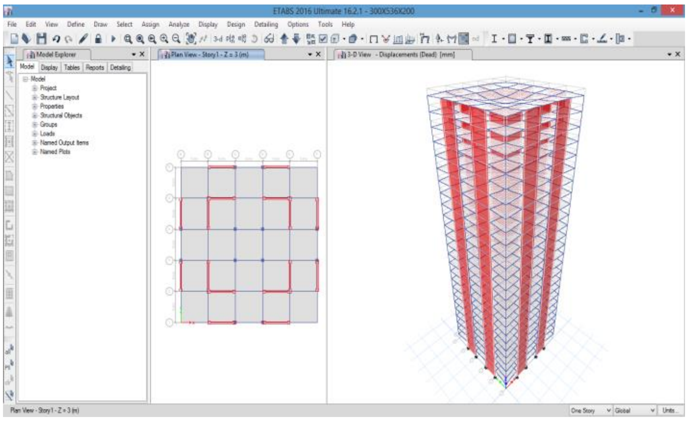

Figure No 11: Displacement Shape Of Twenty Five Story Building With Dumbel Shape Shear Wall Grid Type 2

5.2 STORY DRIFT

Table 1: Maximum Storey Drift For Type 1 Grid Building

Length		350	450	550	650	750	850	950	1050	1150	1250
Story	Elevation	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir
S-25	75	0.0087	0.00876	0.0087	0.0087	0.0087	0.0087	0.0088	0.0088	0.0088	0.0088
S-24	72	0.0089	0.00897	0.0089	0.0089	0.0089	0.0089	0.0090	0.0090	0.0090	0.0090
S-23	69	0.0092	0.00925	0.0093	0.0092	0.0092	0.0092	0.0093	0.0093	0.0093	0.0093
S-22	66	0.0095	0.009583	0.0096	0.0095	0.0095	0.0095	0.0096	0.0096	0.0096	0.0096
S-21	63	0.0098	0.009898	0.0099	0.0099	0.0098	0.0099	0.0099	0.0099	0.0099	0.0099
S-20	60	0.0101	0.010186	0.0102	0.0102	0.0101	0.0101	0.0102	0.0102	0.0102	0.0102
S-19	57	0.0104	0.010443	0.0104	0.0104	0.0104	0.0104	0.0105	0.0105	0.0104	0.0104
S-18	54	0.0106	0.010667	0.0107	0.0106	0.0106	0.0106	0.0107	0.0107	0.0107	0.0107
S-17	51	0.0108	0.010858	0.0108	0.0108	0.0108	0.0108	0.0109	0.0109	0.0108	0.0109
S-16	48	0.0110	0.011016	0.0110	0.0109	0.0109	0.0110	0.0110	0.0110	0.0110	0.0110
S-15	45	0.0111	0.011143	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111
S-14	42	0.0112	0.011237	0.0112	0.0111	0.0111	0.0112	0.0112	0.0112	0.0112	0.0112
S-13	39	0.0113	0.011293	0.0113	0.0112	0.0112	0.0112	0.0113	0.0113	0.0113	0.0113

S-12	36	0.0113	0.011303	0.0113	0.0112	0.0112	0.0112	0.0113	0.0113	0.0113	0.0113
S-11	33	0.0113	0.011257	0.01124	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112	0.0112
S-10	30	0.0112	0.011141	0.01112	0.0111	0.0110	0.0110	0.0111	0.0111	0.0111	0.0111
S-9	27	0.0109	0.010936	0.01091	0.0108	0.0108	0.0108	0.0109	0.0109	0.0109	0.0109
S-8	24	0.0107	0.010619	0.0105	0.0105	0.0105	0.0105	0.0106	0.0106	0.0106	0.0106
S-7	21	0.0102	0.01016	0.0101	0.0101	0.0101	0.0101	0.0101	0.0101	0.0101	0.0101
S-6	18	0.0095	0.009526	0.0095	0.0095	0.0095	0.0094	0.0095	0.0095	0.0095	0.0095
S-5	15	0.0087	0.008678	0.0087	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086
S-4	12	0.0076	0.007577	0.0076	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075
S-3	9	0.0062	0.0062	0.0062	0.0061	0.0062	0.0061	0.0061	0.0062	0.0062	0.0062
S-2	6	0.0044	0.004438	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044
S-1	3	0.0022	0.002229	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022
Base	0	0	0	0	0	0	0	0	0	0	0

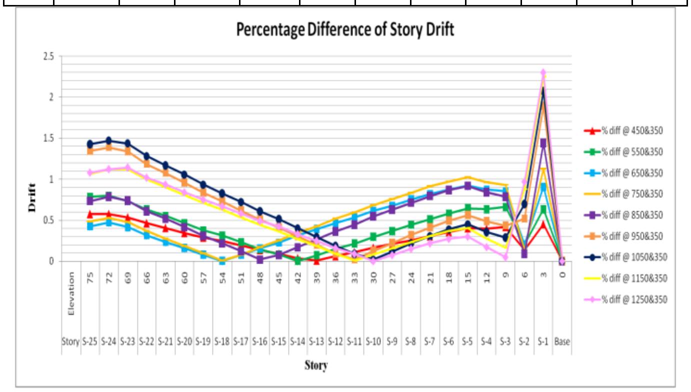

Figure No 12: Percentage Difference Of Story Drift at Response Case For Type 1 Grid

Table 2: Maximum Storey Drift For Type 2 Grid Building

Length		350	450	550	650	750	850	950	1050	1150	1250
Story	Elevation	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir	X-dir
S-25	75	0.006947	0.006976	0.006986	0.006976	0.006978	0.006988	0.007009	0.007011	0.006999	0.006999

|| Volume 6 || Issue 7 || July 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
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S-24	72	0.007197	0.007231	0.007243	0.007232	0.007236	0.007247	0.007273	0.007276	0.007263	0.007262
S-23	69	0.00745	0.007483	0.007493	0.007482	0.007486	0.007498	0.007524	0.007528	0.007516	0.007516
S-22	66	0.007753	0.007784	0.007793	0.007781	0.007785	0.007797	0.007824	0.007828	0.007817	0.007818
S-21	63	0.008047	0.008076	0.008083	0.008071	0.008073	0.008086	0.008113	0.008118	0.008108	0.008109
S-20	60	0.008321	0.008346	0.008351	0.008338	0.00834	0.008353	0.00838	0.008386	0.008377	0.008378
S-19	57	0.008567	0.008588	0.008592	0.008578	0.008579	0.008591	0.008619	0.008625	0.008617	0.008619
S-18	54	0.008782	0.0088	0.008801	0.008788	0.008788	0.008799	0.008826	0.008833	0.008825	0.008828
S-17	51	0.008965	0.00898	0.008979	0.008966	0.008965	0.008976	0.009002	0.009009	0.009002	0.009006
S-16	48	0.009117	0.00913	0.009127	0.009112	0.009111	0.009121	0.009147	0.009154	0.009149	0.009153
S-15	45	0.009239	0.00925	0.009245	0.00923	0.009228	0.009237	0.009263	0.00927	0.009267	0.009272
S-14	42	0.009334	0.009342	0.009335	0.009319	0.009316	0.009325	0.009351	0.009358	0.009356	0.009362
S-13	39	0.009399	0.009404	0.009396	0.009378	0.009375	0.009384	0.00941	0.009417	0.009416	0.009422
S-12	36	0.009431	0.009434	0.009423	0.009405	0.0094	0.009409	0.009435	0.009443	0.009443	0.009449
S-11	33	0.009421	0.009421	0.009409	0.00939	0.009385	0.009393	0.009419	0.009428	0.009428	0.009435
S-10	30	0.009358	0.009355	0.009341	0.009321	0.009315	0.009323	0.009349	0.009359	0.009359	0.009367
S-9	27	0.009222	0.009216	0.009201	0.009181	0.009175	0.009182	0.009209	0.009219	0.009218	0.009227
S-8	24	0.008994	0.008985	0.008968	0.008949	0.008942	0.008949	0.008976	0.008986	0.008987	0.008996
S-7	21	0.008646	0.008634	0.008616	0.008598	0.008591	0.008597	0.008625	0.008635	0.008637	0.008646
S-6	18	0.008146	0.008133	0.008116	0.008098	0.00809	0.008097	0.008126	0.008135	0.008139	0.008148
S-5	15	0.007459	0.007448	0.007432	0.007413	0.007406	0.007415	0.007441	0.00745	0.007455	0.007463
S-4	12	0.006539	0.006532	0.006517	0.006502	0.006497	0.006505	0.006528	0.006537	0.006542	0.00655

S-3	9	0.00534	0.005334	0.005323	0.005312	0.005309	0.005316	0.005335	0.005342	0.005348	0.005353
S-2	6	0.003794	0.003793	0.003789	0.003787	0.003788	0.003795	0.003808	0.003815	0.003821	0.003824
S-1	3	0.001916	0.001921	0.001925	0.001929	0.001933	0.001938	0.001944	0.001947	0.00195	0.001949
Base	0	0	0	0	0	0	0	0	0	0	0

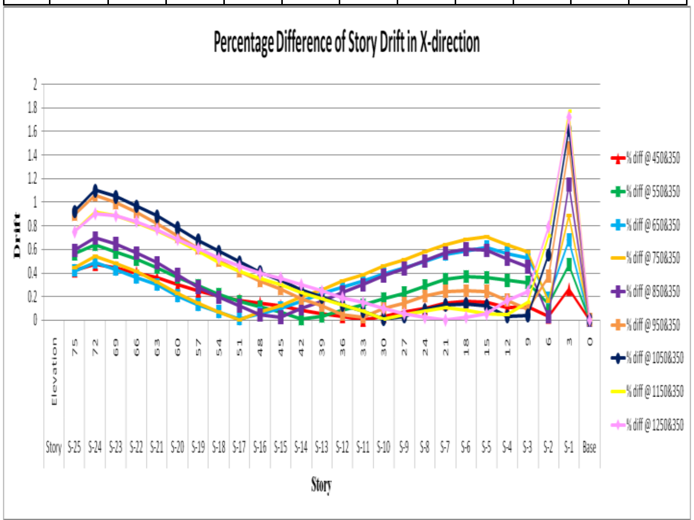

Figure No 13: Percentage Difference Of Story Drift at Response Case For Type 2 Grid

Story drift is the difference of the displacement between successive floors. The story drift is seen maximum for upper story in all the direction as seen in Table 5.1. The least deviation is suffered by first story. All the buildings in this time history analysis shows similarly behavior, the high story drift leads to observe the failure. The percentage difference of story drift in various length with respect to one common length as 350mm is observed. The observation shows that there is uneven distribution of drift that may lead to failure. The overall performance of drift in starting story is more of large length shear wall & end story it is more of 1050mm length dumbel shape shear wall**.**

VI. CONCLUSION

The most important work is to put an ultimate mark on the work done up till now. The results were seen for both the universal axis and were concluded in reference to the standard limit provided by the code. The performance indices were formed on the results compared by both pushover & dynamic time history analysis and to quantify the results. The statical pushover analysis gives the main source of performance index; it specifies the increasing base shear in accordance to displacement. To quantify the whole work done for both the analysis methods needs to be summarized in proper order using the ranges from the initial analysis and pushover analysis with the standard codes. The linguistic interpretation for whole summarization of analysis is used. As specified the ratio of base shear verses displacement is considered in four stages. The ranges are decided on the basis of different performance level described in pushover analysis which is hence followed by dynamic time history analysis. The performance of building mainly depends on some results for time history analysis. The base shear and displacement from time history analysis is compared with the linguistic interpreted performance index.

The ultimate failure pattern observed by the analysis is the standard ductile failure pattern. The R shape building shows the absolute performance in both the governing directions. The L shape & T shape buildings are seen poorly performing in both the direction for this analysis. The demand for the L&T shape building is much higher than the other three shapes of building. As it specifies the poor resistant of the corresponding shape of building.

The conclusion from the performance index of the building is the building are in the collapse level yet the ratio of R,I& C is showing good result while at the same time the L and T shape buildings are collapsed with sever failure. The regular plan building shows the good performance than the building with plan irregularity is shown to be hold good for this analysis. It shows the best performance in pushover analysis. In time history analysis also for some section shows poor performance but in calculating in general it performs best. The C and I buildings follows the performance of R shape building and are serviceable in practice. They do not need any extra provision for their sustainability. The T and L shape buildings shows the poor performance in each analysis. It falls under the critical section. The both shapes suffer the irreparable loss.

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