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Analysis of Soft Story Building with Different Percentages of Shear Walls by Using ETABS Software

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Abstract: In late decades, shear walls and tube structures are the most proper basic structures, which have made the stature of solid structures be taken off. In this way, ongoing RC tall structures would have more confounded auxiliary conduct than previously. Here in this paper; we will examine the auxiliary parts of one of the tallest RC structures, situated in Hyderabad seismic zone, with 15 stories where shear wall framework with sporadic openings are used under both horizontal and gravity stacks, Because of utilitarian necessities, for example, entryways, windows, and different openings, a shear wall in building contains numerous openings. The size and area of openings may fluctuate for building and utilitarian perspective. Hence this examination is done on 15 story outline wall building utilizing Response range investigation by utilizing ETABS V 9.7.4. The models are examined with increment in level of shear mass of 15%, 18%, 28% through and through story.
Keywords: Structural forms, Irregular openings, Drift, Shear, and Moments

I. INTRODUCTION

A. General

Numerous medium-ascent flat structures are being developed, in India, utilizing shear walls to give seismic tremor protection from fortified solid casings. These shear walls may have openings for the windows, entryways and pipe spaces for utilitarian reasons. The number, area and size of openings influence the conduct of a structure and additionally worry in the shear wall. The number, area, size, and state of opening influences the conduct of structure as diversion, worry in the individuals. These openings genuinely impacts the effectiveness and exactness of the investigation.

B. Shear Wall

Shear walls are vertical hardening components intended to oppose sidelong powers applied by wind or seismic tremor. The shape and area of shear wall have noteworthy impact on their auxiliary conduct under parallel burdens. Sidelong loads are appropriated through the structure going about as a level stomach, to the shear walls, parallel to the power of activity. Shear walls are significantly stiffer than flat unbending casings. In this way shear walls are temperate up to 35 stories.

Shear Wall Components

1) *Column Sections:* A segment portion is a vertical part whose stature surpasses three times its thickness and whose width is under two and one-half occasions its thickness. Its heap is generally overwhelmingly hub.
2) *Wall Docks:* A wall wharf is a section of a wall whose level length is somewhere in the range of two and one-half and six times its thickness and whose unmistakable tallness is no less than two times its even length.
3) *Wall Sections:* Wall portions are segments that are longer than wall wharfs. They are the essential opposing parts in the shear wall.

C. Shear Wall With Opening

Encircled structures with shear walls are much of the time received as the basic framework for tall structures, the openings might be window, entryway compose openings as portrayed already. To this opening in plane solidness of the whole building diminishes because of reduction of in plane firmness. In the event that the building is a private building, openings like window, entryway, and passageway are adequate while for exceptional building like film theaters, work lobbies, lodgings, network corridors it requires extensive openings to meet the prerequisites.

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D. Objective Of The Study

The following are the main objectives of the project

1) To study the seismic behavior of multi story building by using IS 1893:2002
2) To compare the multi story buildings with 0% shear wall, 15% shear wall,28% shear wall, 38% shear wall .
3) To compare the results of Story Drift, Shear force, Bending moment, Building torsion of buildings with 0% shear wall, 15% shear wall,28% shear wall, 38% shear wall .
4) To study the buildings in ETABS V9.7.4 in Response spectrum analysis.

II. MODELLING OF SHEAR WALL

In this part, shear wall models created for the parallel load examination of multistory structures in versatile district are exhibited. Since the strategies for displaying building structures are broke down independently. Shear wall demonstrating studies can likewise be researched in as indicated by the two and three dimensional methodologies.

A. Equivalent Frame Model (Wide Column Analogy)

In the identical edge strategy, which is otherwise called wide section similarity, each shear wall is supplanted by a romanticized outline structure comprising of a segment and unbending pillars situated at floor levels. The segment is set at the wall's centroidal hub and doled out to have the wall's inactivity and hub region. The inflexible bars that join the section to the associating bars are situated at each encircling level [8]. An example demonstrate is appeared in Figure 1. In this strategy, the hub zone and dormancy estimations of inflexible arms are relegated vast qualities contrasted with other edge components.

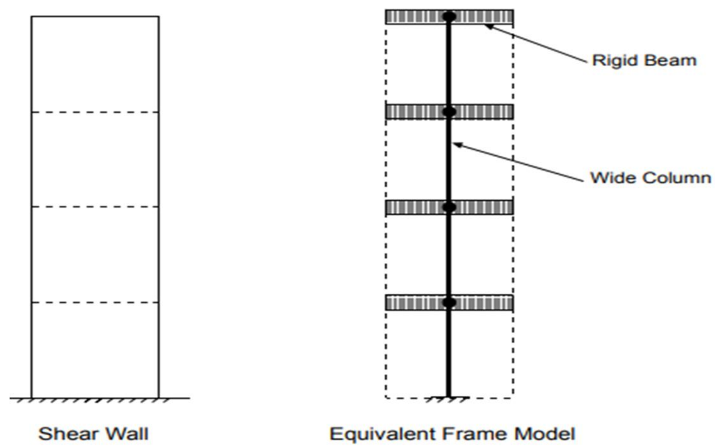

Fig. 1 Equivalent Frame Model of a Shear Wall

B. Analogous Frame Method

This elective technique, proposed by Smith et al.[53], was created for demonstrating planar and nonplanar shear walls. The motivation behind their investigation was to beat the fake flexure and inordinate shear distortions because of discrete displaying of nonstop vertical joints between nearby planar wall units in the traditional identical edge strategy. In their investigation, they proposed two distinctive edge models for shear wall examination: the supported wide segment similarity and the propped outline relationship. The supported wide segment relationship is like the ordinary wide section similarity introduced above, however with corner to corner props. A solitary module comprises of inflexible level pillars, measure up to long to the width of the wall, associated by a solitary focal section.

C. Finite Element Models

The limited component technique is generally utilized in three dimensional investigation of building structures. Different kinds of limited components, which vary fit as a fiddle and the quantity of degrees of flexibility at the hubs, have been produced. An itemized survey of these examinations can be found in [3] and [62].

SAP2000 [4] is the most regularly utilized limited component program for three dimensional investigation of building structures. The shell component of SAP2000, which is a mix of a layer component and a plane pressure component, is a quadrilateral component with six degrees of flexibility at every hub

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III. METHODOLOGY

A. *Response Spectrum Method*

The portrayal of greatest reaction of romanticized single degree opportunity framework having certain period and damping, amid tremor ground movements. This investigation is done by the code IS 1893-2002 (part1). Here sort of soil, seismic zone factor ought to be entered from IS 1893-2002 (part1). The standard reaction spectra for kind of soil considered is connected to working for the investigation in ETABS 2013 programming. Following graph demonstrates the standard reaction range for medium soil compose and that can be given as day and age versus unearthly increasing speed coefficient (Sa/g).

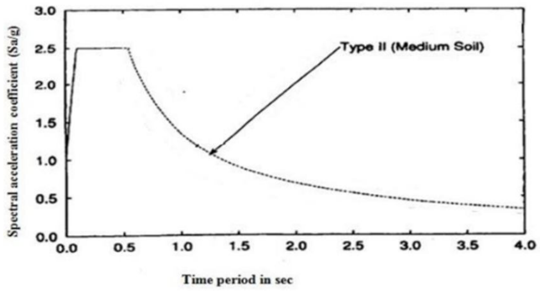

Fig .2 Response spectrum for medium soil type for 5% damping

This approach allows the numerous methods of reaction of a working to be considered (in the recurrence space). This is required in many construction laws for all aside from extremely straightforward or exceptionally complex structures. The reaction of a structure can be characterized as a blend of numerous unique shapes (modes) that in a vibrating string relate to the "consonant" PC investigation can be utilized to decide these modes for a structure.

B. *Different Types Of Loads Acting On The Structure*

Types of loads acting on the structure are:

1) Dead loads
2) Imposed loads
3) Wind loads
4) Snow loads
5) Earthquake loads
6) Special loads

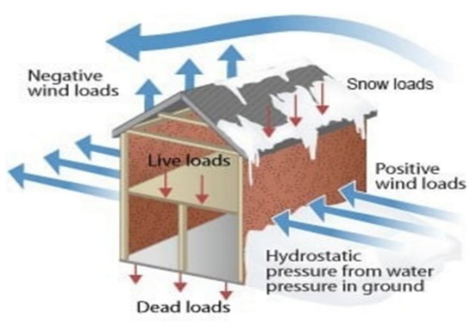

Fig: 3 Loads acting on a building

a) *Dead Loads (DL):* The estimation of dead heaps of each structure are figured by the volume of each area and duplicated with the unit weight. Unit weights of a portion of the regular materials are exhibited in table beneath.
b) *Imposed loads or Live loads (IL or LL):* The second vertical load that is considered in outline of a structure is forced loads or live loads. Live loads are either portable or moving burdens with no increasing speed or effect. These heaps are thought to be created by the planned utilize or inhabitance of the building including weights of versatile allotments or furniture and so forth. Live load continues changing now and again. These heaps are to be appropriately accepted by the planner. The base estimations of live loads to be expected are given in IS 875 (section 2) – 1987. It relies on the proposed utilization of the building.

c) *Wind Loads:* Wind stack is essentially even load caused by the development of air in respect to earth. Wind stack is required to be considered in basic outline particularly when the heath of the building surpasses two times the measurements transverse to the uncovered breeze surface. Finish points of interest of ascertaining wind stack on structures are given beneath (by the IS-875 (Part 3) - 1987).

To get the design wind velocity V_z the following expression shall be used:

$$\mathbf{V_z = k_1.k_2.k_3.V_b}$$

Where k_1 = risk coefficient
k_2 = coefficient based on terrain, height and structure size.
k_3 = topography factor

The design wind pressure is given by

$$p_z = 0.6\,V_z^2$$

Where p_z is in N/m^2 at height Z and V_z is in m/sec. up to a height of 30m, the wind pressure is considered to act uniformly. Above 30 m height, the wind pressure increases.

d) *Snow Loads:* Snow loads constitute to the vertical loads in the building. However, these sorts of burdens are viewed as just in the snow fall places. The IS 875 (section 4) – 1987 manages snow stacks on tops of building. The base snow stack on a rooftop territory or some other region over the ground which is subjected to snow aggregation gotten by the articulation

$$S = \mu S_o$$

Where S = configuration snow stack on plan zone of rooftop
μ =shape coefficient and
S_o = ground snow stack

e) *Quake loads (EL) or Seismic Load:* Tremor powers constitute to both vertical and level powers on the building. The aggregate vibration caused by seismic tremor might be settled in to three commonly opposite headings, typically taken as vertical and two flat bearings. The developments vertical way don't make powers in superstructure any noteworthy degree. Be that as it may, the even development of the working at the season of tremor is to be considered while outlining.

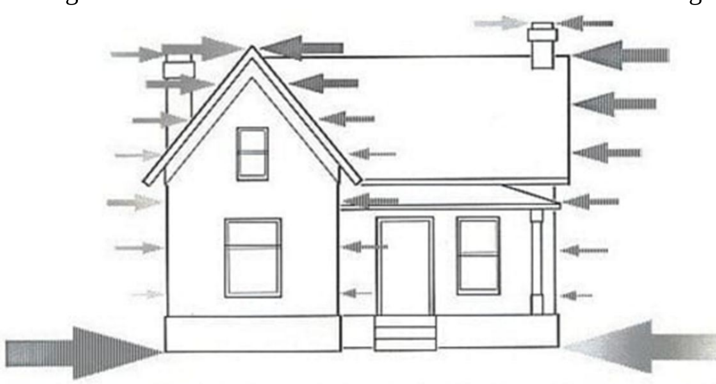

Fig.4 Forces acting on a building

C. *Problem Statement*

In the present study, analysis of G+14 multi-story building in Zone II, zones with 15% shear wall, 28% shear wall, 38% shear wall, is carried out.3D model is prepared in building is in ETABS.

Basic parameters considered for the analysis are

1) Utility of building : Residential building
2) Number of stories : G+14
3) Shape of building : Rectangular
4) Shear wall opening : 0%, 15%, 28%, 38%
5) Geometric details
   a) Ground floor : 3m
   b) floor to floor height : 3m

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6) Material details
   a) Concrete Grade : M40 (COLUMNS AND BEAMS)
   b) All Steel Grades : HYSD reinforcement of Grade Fe415
   c) Bearing Capacity of Soil : 200 KN/m^2
7) Type Of Construction : R.C.C FRAMED structure
8) Column : 0.4m X 0.6m
9) Beams : 0.6m X 0.6m
10) Slab : 0.150m
11) Thickness of Shear wall : 120mm

IV. RESULTS AND ANALYSIS

A. *Storey Drift in X*

Table 1- Comparing drifts in X axis

Story	DriftX with out Shear wall	DriftX with 15% Shear wall	DriftX with 28% Shear wall	DriftX with 38% Shear wall
STORY15	0.000197	0.000233	0.000241	0.000138
STORY14	0.000251	0.000262	0.000263	0.000153
STORY13	0.000305	0.000293	0.000287	0.000167
STORY12	0.000353	0.000323	0.000311	0.000181
STORY11	0.000395	0.000351	0.000334	0.000195
STORY10	0.000432	0.000377	0.000354	0.000207
STORY9	0.000467	0.000399	0.000372	0.000217
STORY8	0.0005	0.000419	0.000385	0.000225
STORY7	0.000531	0.000433	0.000392	0.000229
STORY6	0.00056	0.000441	0.000393	0.000229
STORY5	0.000583	0.000439	0.000382	0.000222
STORY4	0.000598	0.000424	0.000358	0.000208
STORY3	0.000597	0.000389	0.000315	0.000184
STORY2	0.000557	0.000323	0.000245	0.000149
STORY1	0.00034	0.000181	0.000129	0.00009

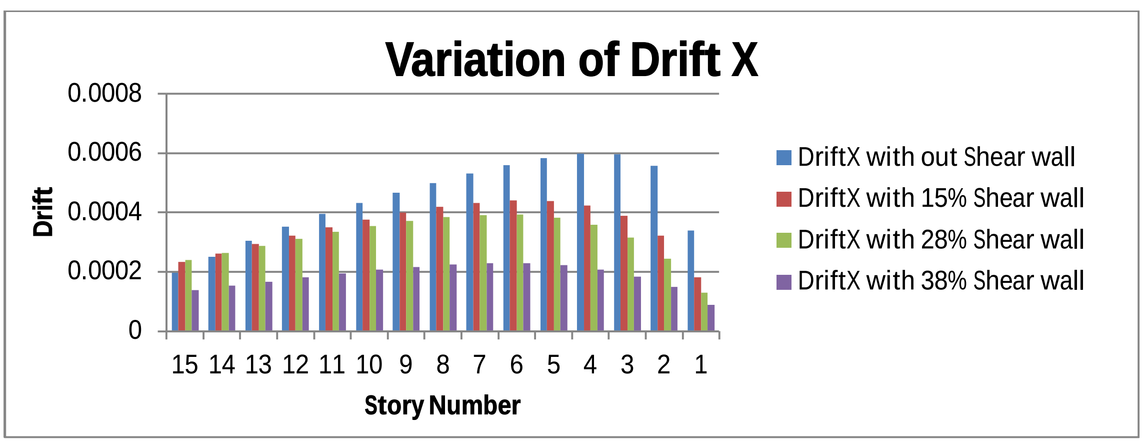

Fig.5 Graphical representation of drifts in X axis

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B. Drift Y

Table 2- Comparing drifts in Y axis

Story	DriftY with out Shear wall	DriftY with 15% Shear wall	DriftY with 28% Shear wall	DriftY with 38% Shear wall
STORY15	0.000222	0.000244	0.000266	0.000218
STORY14	0.000294	0.000294	0.0003	0.000237
STORY13	0.000367	0.000345	0.000336	0.000255
STORY12	0.000432	0.000395	0.000373	0.000273
STORY11	0.000489	0.000442	0.000408	0.000289
STORY10	0.000541	0.000484	0.00044	0.000303
STORY9	0.00059	0.000522	0.000469	0.000314
STORY8	0.000638	0.000558	0.000494	0.000322
STORY7	0.000685	0.000588	0.000512	0.000324
STORY6	0.000729	0.000612	0.00052	0.000321
STORY5	0.000767	0.000624	0.000514	0.000309
STORY4	0.000794	0.000619	0.000489	0.000286
STORY3	0.0008	0.000587	0.000437	0.00025
STORY2	0.000752	0.000508	0.000349	0.000199
STORY1	0.00046	0.000295	0.000189	0.000118

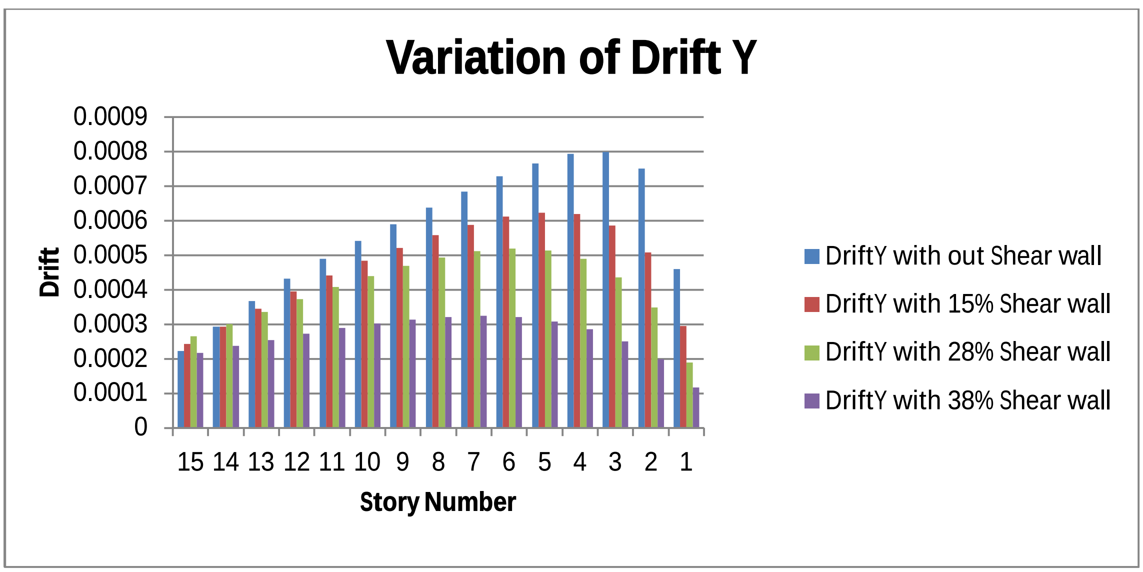

Fig 6 Graphical representation of drifts in Y axis

C. Shear Force (Vx)

Table 3- Comparing Shear Force (Vx)

Story	Shear force (VX) without Shear wall	Shear force (VX) with 15% Shear wall	Shear force (VX) with 28% Shear wall	Shear force (VX) with 38% Shear wall
STORY15	56.83	69.66	75.38	104.6
STORY14	116.79	141.47	153.54	219.84
STORY13	169.24	202.61	219.87	323.28
STORY12	213.4	253.43	274.88	414.92
STORY11	249.55	295.23	320.08	495.5
STORY10	279.04	330.15	357.87	566.29
STORY9	304.02	360.74	391.06	628.84
STORY8	326.85	389.29	422.09	684.55
STORY7	349.37	417.11	452.33	734.25
STORY6	372.31	444.2	481.68	778.04
STORY5	395.05	469.38	508.8	815.34
STORY4	415.92	490.85	531.72	845.22
STORY3	432.83	506.91	548.65	866.81
STORY2	443.92	516.59	558.7	879.87
STORY1	448.37	520.23	562.41	885.14

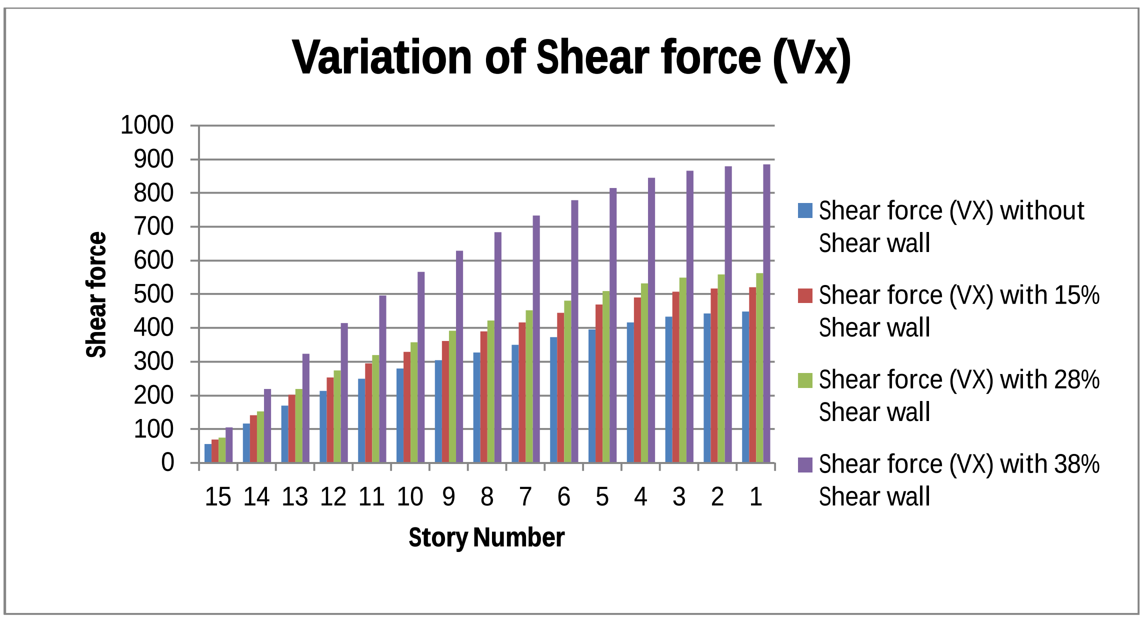

Fig 7 Graphical representation of Shear Force (Vx)

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D. Shear Force (Vy)

Table 4- Comparing Shear Force (Vy)

Story	Shear force (VY) without Shear wall	Shear force (VY) with 15% Shear wall	Shear force (VY) with 28% Shear wall	Shear force (VY) with 38% Shear wall
STORY15	58.76	59.41	69.21	82.06
STORY14	121.46	123.88	142.82	168.41
STORY13	176.75	181	206.48	241.58
STORY12	223.61	229.64	259.98	302.21
STORY11	262.14	269.83	304.14	352
STORY10	293.6	302.78	340.86	393.62
STORY9	320.14	330.62	372.68	430.09
STORY8	344.23	355.82	402.12	464.05
STORY7	367.88	380.45	430.84	497.01
STORY6	391.95	405.37	459.14	528.97
STORY5	415.88	430.04	485.9	558.61
STORY4	437.91	452.71	509.17	583.92
STORY3	455.8	471.09	526.9	603
STORY2	467.5	483.12	537.8	614.79
STORY1	472.12	487.86	541.96	619.48

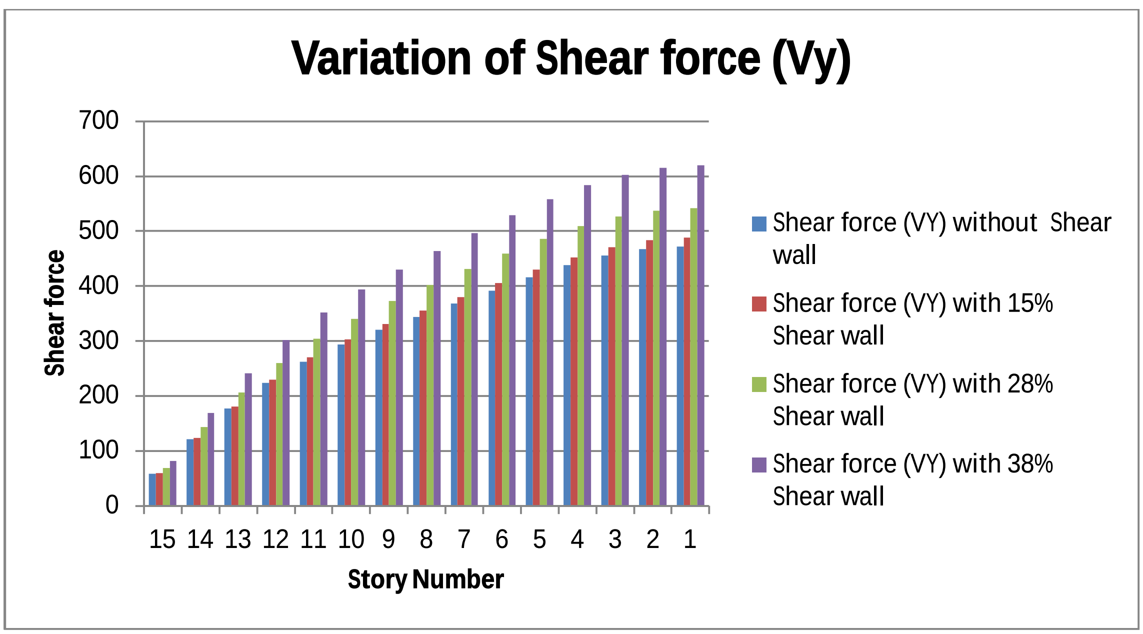

Fig 8 Graphical representation of Shear Force (Vy)

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E. Building Torsion (T)

Table 5- Comparing Torsion (T)

Story	Building torsion (T) with out Shear wall	Building torsion (T) with 15% Shear wall	Building torsion (T) with 28% Shear wall	Building torsion (T) with 38% Shear wall
STORY15	2375.439	2455.504	2812.259	3271.019
STORY14	4908.348	5101.828	5795.802	6731.51
STORY13	7148.171	7443.19	8386.629	9709.312
STORY12	9075.021	9462.992	10607.19	12262.93
STORY11	10734.56	11209.27	12542.39	14511.54
STORY10	12233.5	12790.44	14323.6	16603.85
STORY9	13693.79	14329.9	16073.38	18657.11
STORY8	15196.1	15908.05	17855.31	20717.76
STORY7	16757.7	17539.1	19662.03	22762.06
STORY6	18337.37	19177.29	21427.79	24715.21
STORY5	19849.93	20733.78	23050.46	26475.32
STORY4	21185.98	22098	24418.08	27938.6
STORY3	22234.54	23160.54	25436.49	29023.47
STORY2	22906.84	23836.79	26055.63	29691.71
STORY1	23170.73	24100.74	26292.44	29962.11

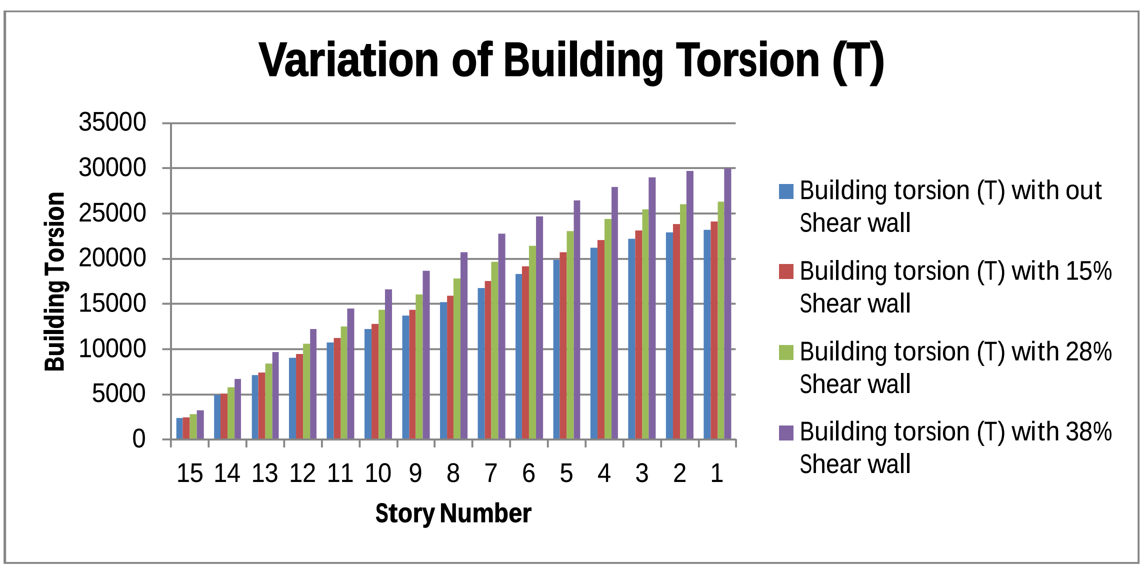

Fig 9 Graphical representation of Torsion (T)

F. Bending Moment (Mx)

Table 6- Comparing Bending moment (Mx)

Story	Bending moment (MX) with out Shear wall	Bending moment (MX) with 15% Shear wall	Bending moment (MX) with 28% Shear wall	Bending moment (MX) with 38% Shear wall
STORY15	176.271	178.224	207.637	246.187
STORY14	540.592	549.807	635.935	751.176
STORY13	1070.405	1092.364	1254.547	1474.697
STORY12	1739.529	1779.595	2031.68	2377.366
STORY11	2521.076	2584.251	2936.812	3423.536
STORY10	3390.504	3481.278	3943.549	4583.918
STORY9	4328.229	4450.507	5031.86	5837.234
STORY8	5321.23	5478.343	6189.036	7170.415
STORY7	6363.229	6557.996	7409.038	8577.174
STORY6	7453.319	7688.125	8690.282	10055.23
STORY5	8593.3	8870.169	10032.48	11602.94
STORY4	9784.452	10105.08	11433.47	13216.33
STORY3	11024.65	11390.37	12887.14	14887.39
STORY2	12306.75	12718.5	14383.04	16604.21
STORY1	13619	14077.26	15908.13	18352.73

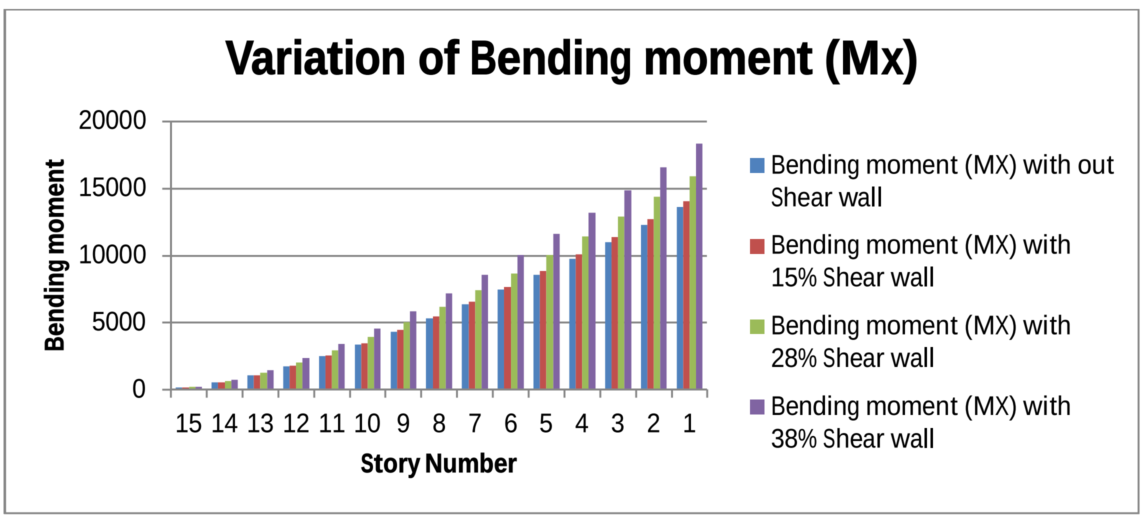

Fig 9 Graphical representation of Bending moment (Mx)

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G. Bending Moment (My)

Table 7- Comparing Bending moment (My)

Story	Bending moment (MY) with out Shear wall	Bending moment (MY) with 15% Shear wall	Bending moment (MY) with 28% Shear wall	Bending moment (MY) with 38% Shear wall
STORY15	170.479	208.973	226.134	313.809
STORY14	520.778	633.181	686.526	973.155
STORY13	1028.004	1240	1344.995	1942.111
STORY12	1666.371	1997.032	2165.948	3184.149
STORY11	2409.954	2874.554	3116.992	4664.055
STORY10	3235.505	3847.89	4171.449	6349.678
STORY9	4124.794	4899.021	5310.025	8213.044
STORY8	5065.963	6016.932	6521.067	10230.58
STORY7	6053.531	7196.493	7799.229	12382.43
STORY6	7086.953	8436.096	9142.802	14651.06
STORY5	8168.043	9734.696	10550.46	17019.65
STORY4	9297.946	11089.13	12018.4	19470.76
STORY3	10474.53	12492.57	13538.82	21985.71
STORY2	11690.99	13934.61	15100.2	24545.15
STORY1	12936.3	15403.07	16689.47	27130.67

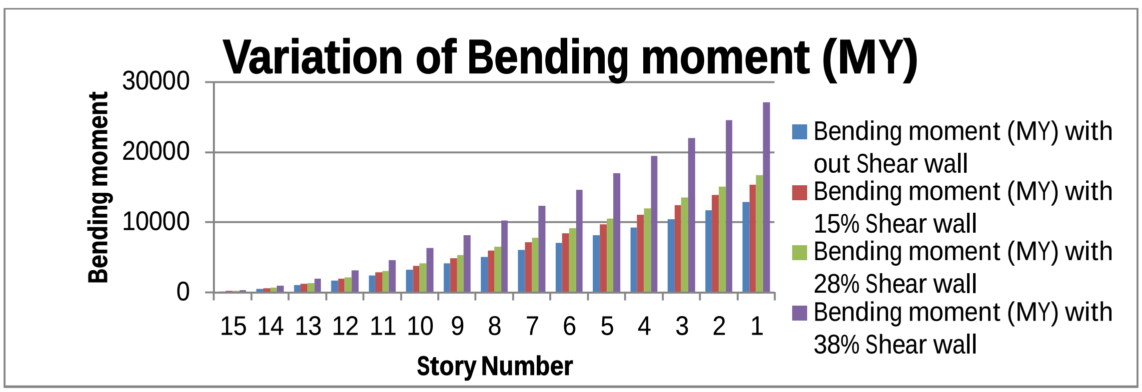

Fig 10 Graphical representation of Bending moment (My)

V. CONCLUSIONS

From the above study the following conclusions were made

A. The values of Drift in both X and Y-Direction are found higher value for building without using shear wall than the building with shear wall. from this it was conformed that increasing the percentage of shear wall will results in decrease in the Drift
B. The values of Shear force in both X and Y-Direction are found higher value for building with 38% shear wall than other buildings. From this it was conformed that increasing the percentage of shear wall will results in increase in the Shear force.
C. The values of Building Torsion (T) found higher value for building with 38% shear wall than other buildings. From this it was conformed that increasing the percentage of Building Torsion will results in increase in the Shear force.
D. The values of Bending moment (M) found higher value for building with 38% shear wall than other buildings. From this it was conformed that increasing the percentage of Bending moment will results in increase in the Shear force.

E. Opening in the shear walls lead to a significant increase in the bending moment and shear force in the columns connected to that shear wall and when opening is to top the percentage of the increase percentage increase it is less for the opening percent.

F. It was observed for a particular opening in wall when the opening position is shifted from one position to other position.

G. From this study it was concluded that increase in the percentage of Shear wall results in decrease in the drift and increases the Shear force, Bending moment, Building Torsion

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