COMPARATIVE ANALYSIS OF REGULAR AND IRREGULAR BUILDINGS WITH AND WITHOUT SHEAR WALL

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ABSTRACT: Modern residential structure is going higher and higher these days. The impact of lateral loads in the form of wind/Earthquakes affects the performance of these structures dramatically. It is often a practice among structural engineers to use shear walls in place of columns. However, the shear walls do help a lot in resisting the lateral shear but it is often the reason for making the structure unnecessarily stiff. While columns do improve the ductility of a structure but they are often not capable of resisting the entire shear. Thus, it becomes necessary to decide the right proportion of shear walls and columns to be used for structures of particular height.

Here an attempt had been made to investigate the seismic performance of different regular and irregular structures of varying height with shear walls by using ETAB software. Computer models have been analyzed and base line parameters have been decided. Numerical/ analytical studies have been carried out to investigate the impact of these base line parameters on our problem. Finally, regression analysis has been carried out to understand the impact of the base line parameter.

Here an attempt has been made to study the behavior of different structures of reinforced concrete with different heights with and without shear walls. Coupled shear walls have also been studied to understand the comparative merit or demerit of framed structures with shear wall structures. Studies have been carried out on sample model structures and analysis has been carried out by ETABS software. It has been ensured to consider sample models that represent the current practices in structural design to include different structural configurations. Models having varied structural configurations like framed, shear wall, core in core etc. have been taken into consideration. The inherent asymmetry present in the structures has also been dealt.

The results have been tabulated and plotted to study their comparative behavior and interaction with each other. The findings of the study have been summarized and discussed.

Keywords: Shear walls, seismic analysis, response spectrum, drift ratio, modal period

1. INTRODUCTION

Tall towers and buildings have fascinated mankind from the beginning of civilization, their construction being initially for defense and subsequently for ecclesiastical purposes. The growth in modern tall building construction, however, which began in the 1880s, has been largely for commercial and residential purposes.

Tall commercial buildings are primarily a response to the demand by business activities to be as close to each other, and to the city centre, as possible, thereby putting intense pressure on the available land space. Also, because they form distinctive landmarks, tall commercial buildings are frequently developed in city centers as prestige symbols for corporate organizations.

The rapid growth of the urban population and the consequent pressure on limited space has considerably influenced city residential development.

1.1 BACKGROUND

Shear walls are structural systems which provide stability to structures from lateral loads like wind, seismic loads. These structural systems are constructed by reinforced concrete, plywood/timber unreinforced masonry, reinforced masonry at which these systems are sub divided into coupled shear walls, shear wall frames, shear panel and staggered walls. The present paper work was made in the interest of studying various research works involved in enhancement of shear walls and their behavior towards lateral loads. As shear walls resists major portions of lateral loads in the lower portion of the buildings and the frame supports the lateral loads in the upper portions of building which is suited for soft storey high rise building, building which are similar in nature constructed in India, As in India base floors are used for parking and garages or officers and upper floors are used for residential purposes.

1.2 PURPOSE

Shear walls are not only designed to resist gravity / vertical loads (due to its self-weight and other living / moving loads), but they are also designed for lateral loads of earthquakes / wind. The walls are structurally integrated with roofs / floors (diaphragms) and other lateral walls running across at right angles, thereby giving the three-dimensional stability for the building structures. Shear wall structural systems are more stable. Because, their supporting area (total cross-sectional area of all shear walls) with reference to total plans area of building, is comparatively more, unlike in the case of RCC framed structures. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building. Shear walls are quick in construction, as the method adopted to construct is concreting the members using formwork. Shear walls doesn't need any extra plastering or finishing as the wall itself gives such a high level of precision, that it doesn't require plastering.

1.3 NECESSITY OF PROJECT

Irregularity is different types such as vertical irregularity and horizontal irregularity. In Vertical irregularity, it refers to sudden change of strength, stiffness, geometry and mass results in irregular distribution of forces and /or deformation over the height of building. In Horizontal Irregularity, It refers to asymmetrical plan shapes (e.g.: L-, T-, U-, F-, +-) or discontinuities in the horizontal resisting elements(diaphragms) such as cut-outs, large openings, re-entrant corners and other abrupt changes resulting in torsion, diaphragm deformations and stress concentration

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1.4 OBJECTIVE OF THE PROJECT

The object of the work is to compare the seismic behavior of multi-storey buildings having horizontal irregularity with that to regular building of similar properties with and without shear wall by using ETAB software. For this purpose, four multi-storey building plans are considered that are symmetric plan, L shape, T shape, and + shape. For the comparison, parameters taken are lateral displacement and storey drift. All the four buildings will analyze for zone IV.

I will comparison the followings:

- Comparison of Base Shear with different configuration of building
- Comparison of Modal Period and Frequency with different configuration of building.
- Comparison of Storey Displacement of structure with different configuration of building.
- Comparison of Storey Drift with different configuration of building.
- Configuration of Storey Stiffness and storey shear with different configuration of building.

1.5 MODELS CONSIDERED FOR ANALYSIS

Following nine types of models have been considered for analysis. It was attempted to choose models that are representative of actual building types that are being constructed nowadays. Type 1 is regular framed structure with and without shear wall. Type 2, Type-3, Type-4, Type-5 are L-shape Irregular framed structure with and without shear wall. Type A and Type-B are T-shape Irregular framed structure with and without shear wall. Type-C and Type-D are + shape framed structure with and without shear wall.

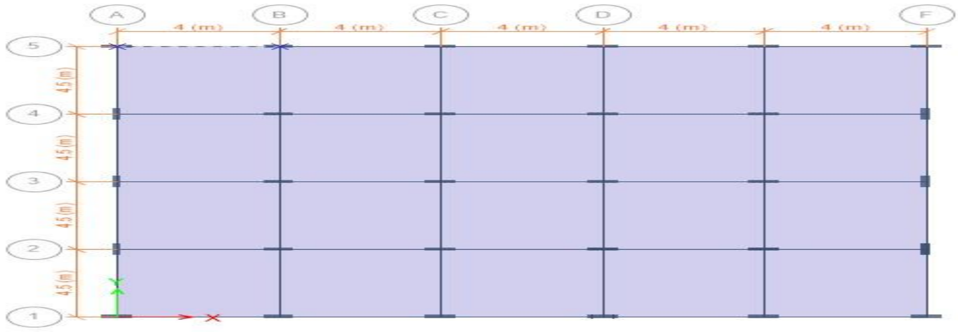


Fig.1: Regular framed structure without shear wall (Type-1)

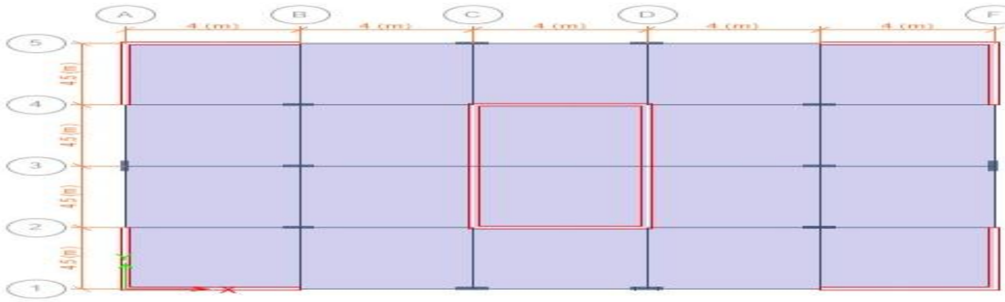


Fig.2: Regular Framed structure with shear wall (Type-1)

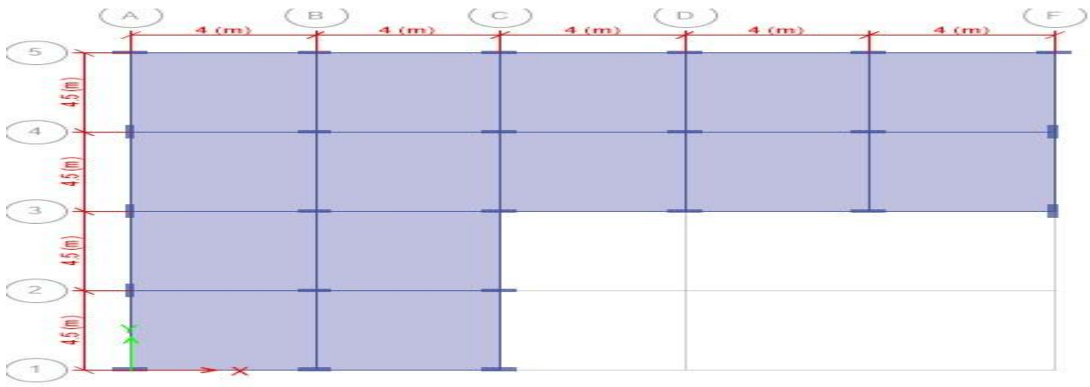


Fig.3: L-shape structure without shear wall (Type-2)

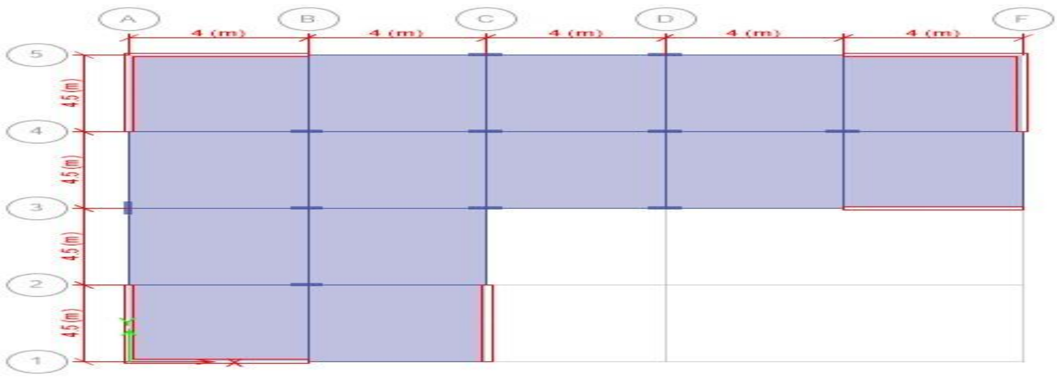


Fig.4: L-shape structure with shear wall (Type-2)

Table 1 Design Data of RCC Frame Structures

S.No	Particulars	Dimension/Size/Value
1.	Model	G+10
2.	Seismic Zones	IV
3.	Floor height	3M
4.	Basement	3.5M
5.	Building height	33.5m,63.5m
6.	Plan size	20mx18m
8.	Size of columns	700mm×300mm (M35)
9.	Size of beams	300mm×600mm (M30) throughout
10	Shear Walls	0.23m
11.	Thickness of slab	150mm
12.	Earthquake load	As per IS-1893-2002
13.	Type of soil	Type -II, Medium soil as per IS-1893
14.	Live load	2 kN/ m2
15.	Floor finish	1.00kN/ m2
16.	Services	1.00kN/ m2
17	Specific wt. of RCC	25.00 kN/ m2
18.	Specific wt. of infill	20.00 kN/ m2
19.	Zone factor Z	0.24, As per Is-1893-2002 Part -1 for different. Zone as per clause 6.4.2.

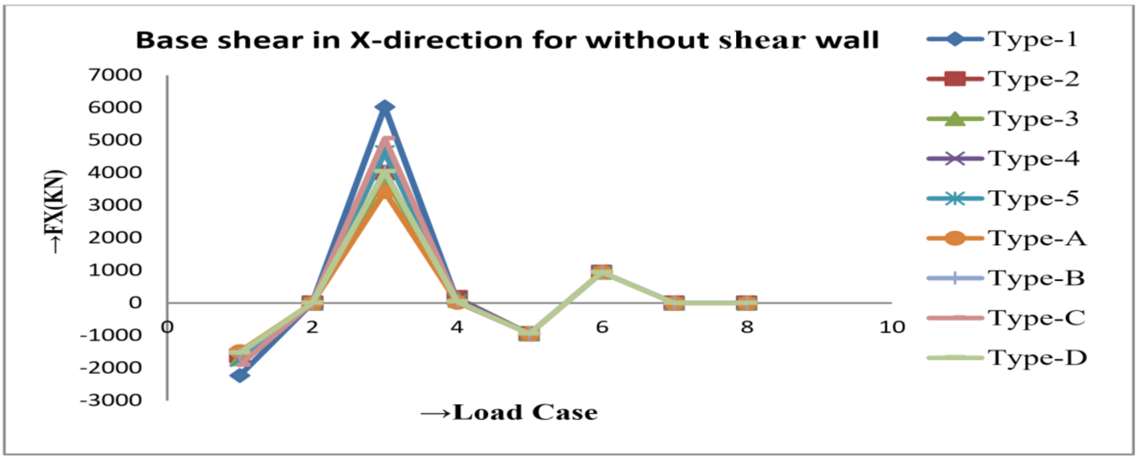
2. Analysis and Results

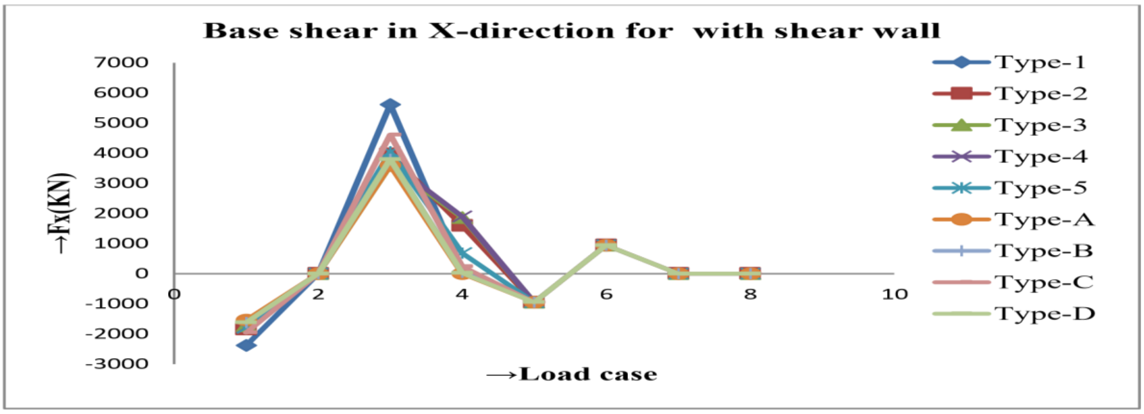
The analysis of different models of varying heights produced a large set of data. Microsoft excel was used for tabulation plotting and analysis of results obtained by ETABS analysis. The first objective was to figure out the key parameters that affected the building.

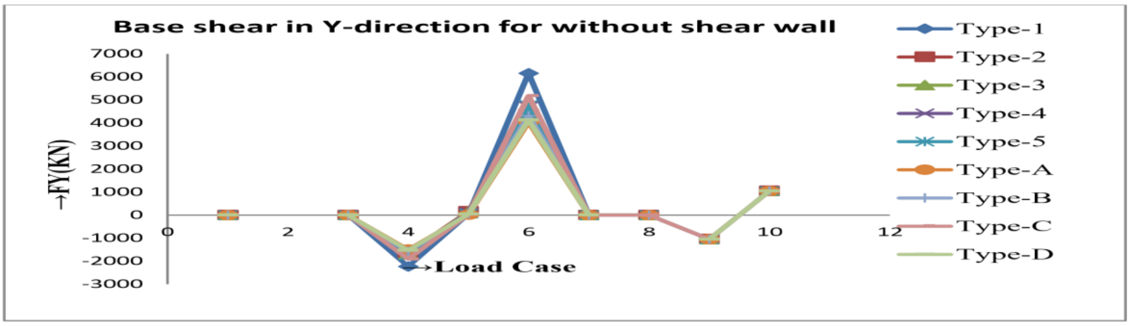
Tabulation was done for different key parameters for all the models.

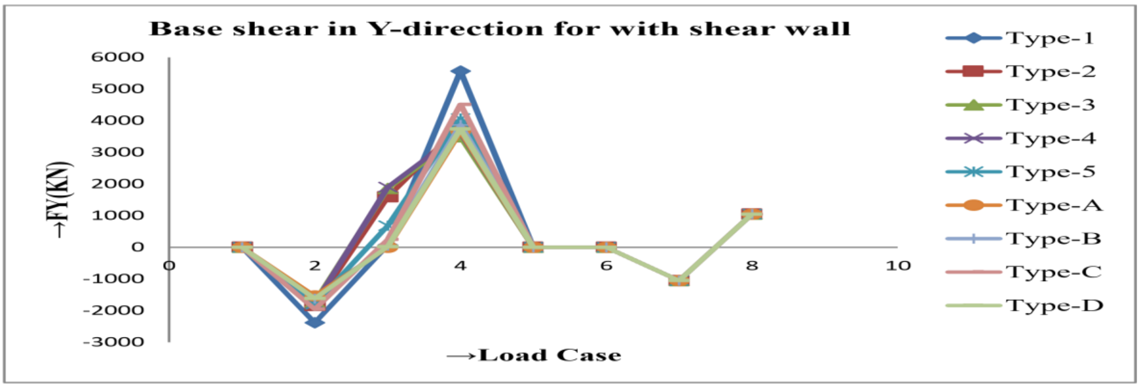
2.1 Comparison of 10 storey building with and without shear wall

2.1.1 Base Reaction

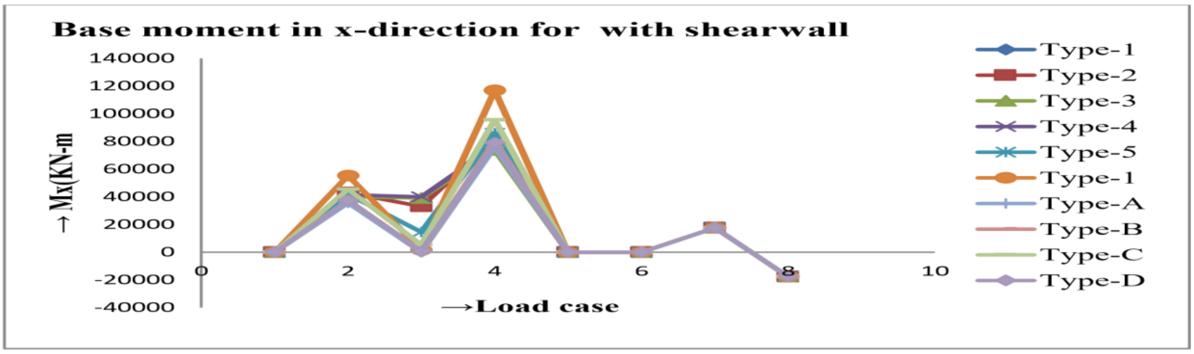


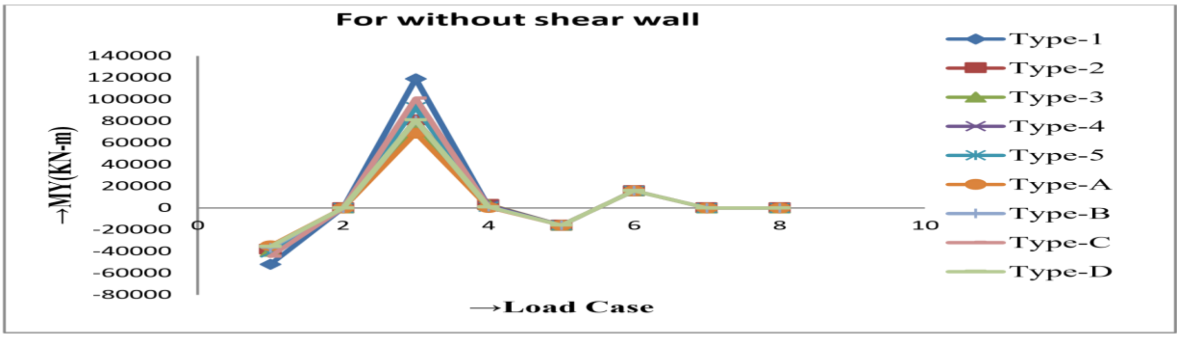


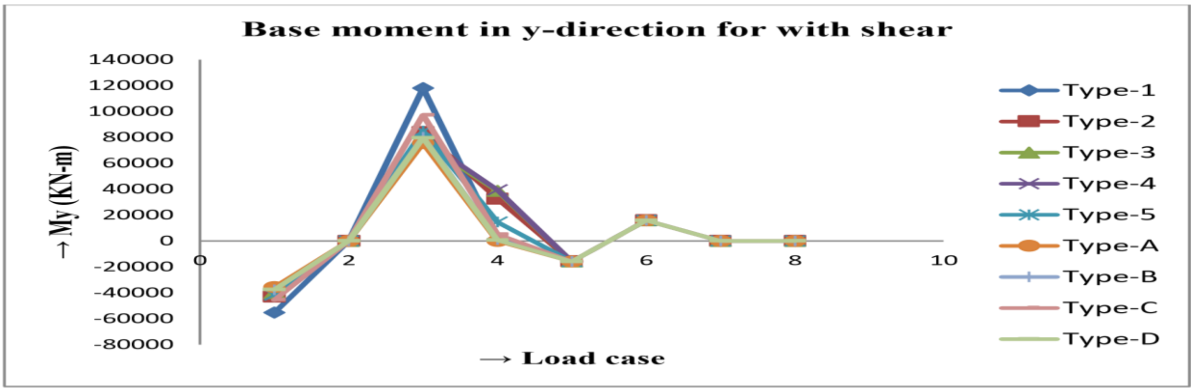


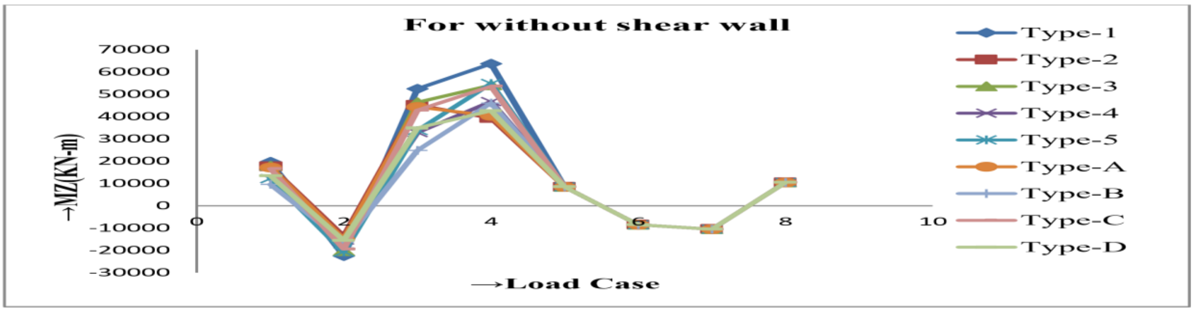


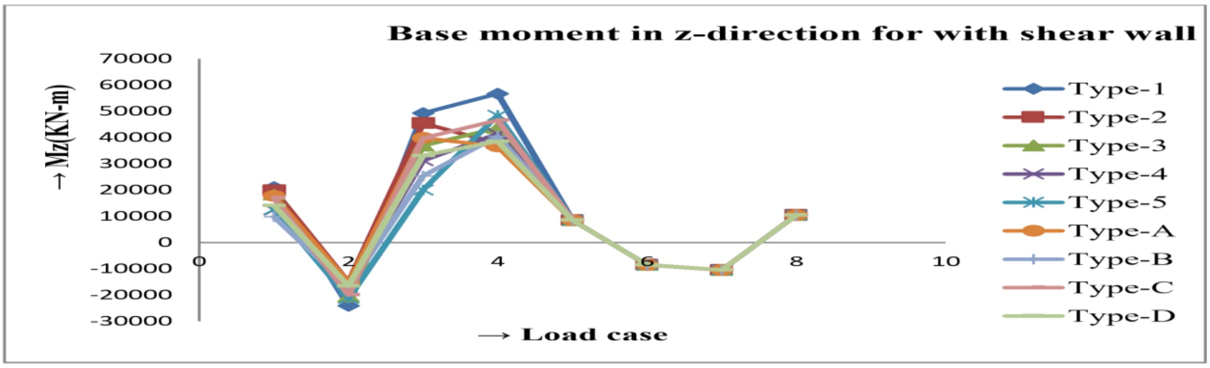

For without shear wall
→MX(KN-m)
→Load Case
Type-1
Type-2
Type-3
Type-4
Type-5
Type-A
Type-B
Type-C
Type-D


Base moment in x-direction for with shearwall
→ Mx(KN-m
→Load case
Type-1
Type-2
Type-3
Type-4
Type-5
Type-1
Type-A
Type-B
Type-C
Type-D


For without shear wall
→MY(KN-m)
→Load Case
Type-1
Type-2
Type-3
Type-4
Type-5
Type-A
Type-B
Type-C
Type-D


Base moment in y-direction for with shear
→ My (KN-m)
→ Load case
Type-1
Type-2
Type-3
Type-4
Type-5
Type-A
Type-B
Type-C
Type-D

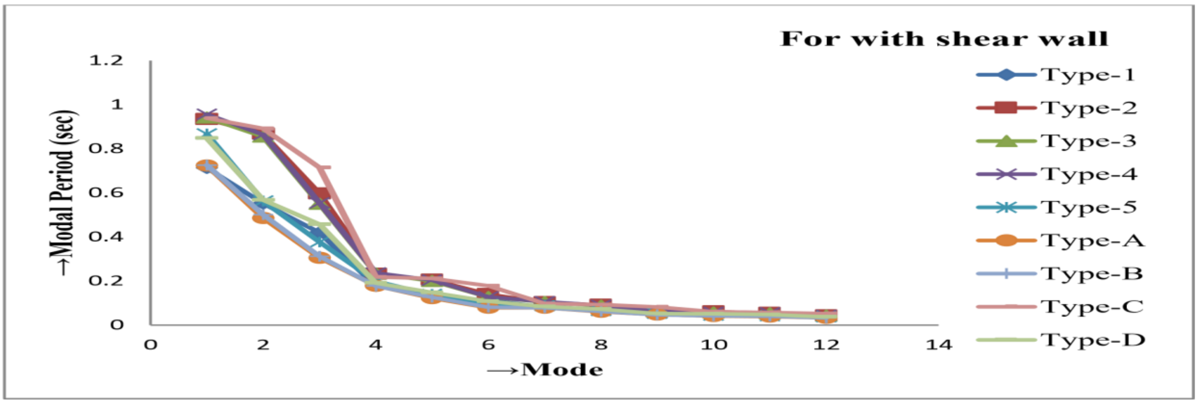


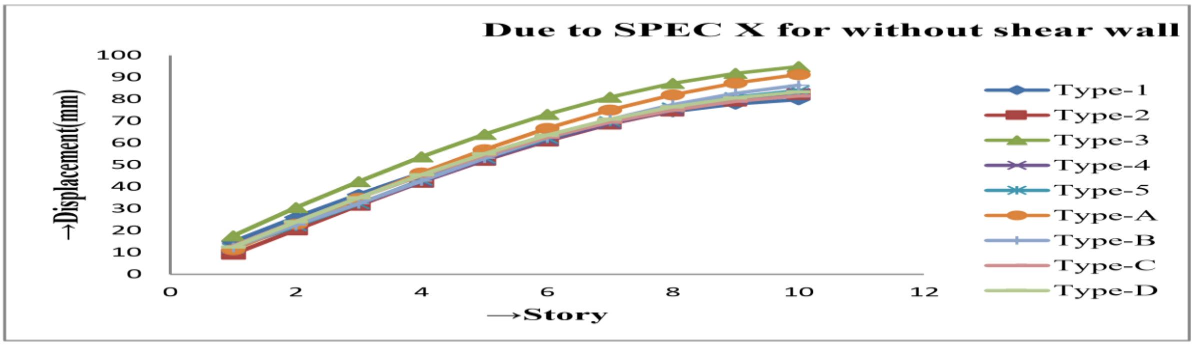


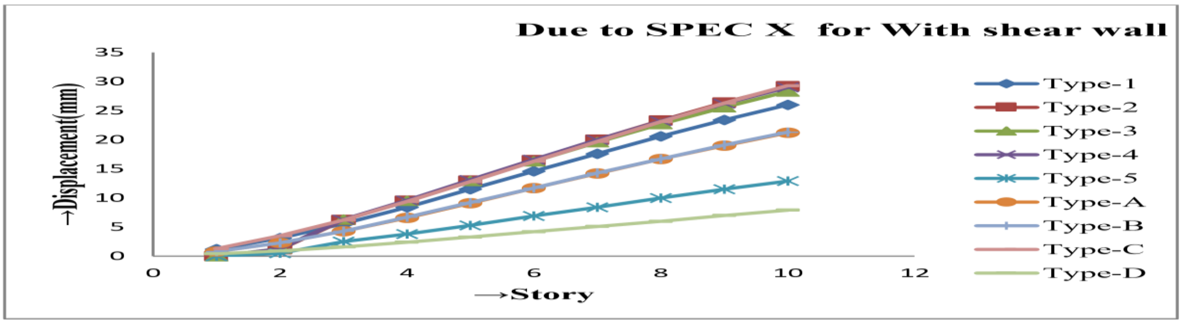
Modal period and frequency

Modal Period (sec) for without shear wall structure										
Case	Mod e	Type -1	Type -2	Type -3	Type -4	Type -5	TypeA	Type -B	TypeC	TypeD
Modal	1	2.212	2.142	2.209	2.252	2.23	2.254	2.347	2.274	2.176
Modal	2	1.543	1.533	1.648	1.554	1.553	1.595	1.59	1.532	1.547
Modal	3	1.487	1.437	1.446	1.508	1.502	1.428	1.505	1.458	1.48
Modal	4	0.728	0.703	0.725	0.739	0.732	0.739	0.77	0.745	0.71
Modal	5	0.502	0.495	0.534	0.503	0.502	0.51	0.51	0.498	0.502
Modal	6	0.485	0.468	0.471	0.492	0.489	0.464	0.49	0.473	0.477
Modal	7	0.422	0.405	0.417	0.424	0.421	0.425	0.44	0.427	0.404
Modal	8	0.294	0.282	0.297	0.294	0.293	0.295	0.305	0.295	0.283

Modal Periods (sec) for with shear wall structure										
Case	Mod e	Type -1	Type -2	Type -3	Type -4	Type -5	Type -A	Type -B	Type -C	Type -D
Modal	1	0.713	0.934	0.941	0.956	0.867	0.724	0.726	0.939	0.848
Modal	2	0.552	0.867	0.855	0.864	0.563	0.486	0.501	0.892	0.568
Modal	3	0.42	0.597	0.55	0.554	0.377	0.305	0.312	0.715	0.457
Modal	4	0.177	0.232	0.234	0.237	0.199	0.178	0.177	0.218	0.191
Modal	5	0.131	0.206	0.2	0.204	0.139	0.122	0.126	0.212	0.148
Modal	6	0.113	0.14	0.127	0.128	0.094	0.079	0.081	0.178	0.108
Modal	7	0.082	0.103	0.105	0.106	0.088	0.079	0.079	0.098	0.084
Modal	8	0.061	0.091	0.088	0.09	0.066	0.06	0.062	0.093	0.072







3. RESULTS & DISCUSSION

- The comparisons have been made between the different types of models considered.
- The obvious choice was the 10 and 20 storey range for comparisons.
- Dynamic analysis was carried out on the structure and the forces.
- The model was found for all displacement criteria for Wind and Earthquake loads.
- We can see here that by providing the shear wall the story displacement in x direction and y-direction, story drift in x-direction and y-direction, story stiffness are reduces very much as compared to without shear wall structure. So, in case of multistory irregular structure shear wall is very much effective to reduce the effect of horizontal forces (i.e., seismic forces and wind forces).
- In the result the comparison has been shown for mode Vs modal period and story Vs Story displacement for EQX, EQY, SPEC X, SPEC Y, Wind X and Wind Y for 10 storey and 20 storey structures with and without shear wall.

4. CONCLUSIONS

Nine types of models have been considered for analysis. It was attempted to choose models that are representative of actual building types that are being constructed nowadays. Type 1 is regular framed structure with and without shear wall. Type 2, Type-3, Type-4 and Type5 are L-shape framed structure with and without shear wall. Type A and Type-B are Tshape framed structure with and without shear wall. Type D is tube structure. Type C and Type-D are + shape framed structure with and without shear wall.

The choice of any particular type of structure will ultimately depend upon the storey range, type of materials available, architectural requirements, functional use and the economy involved.

Looking at most of the comparisons with Wind forces, it is evident that Wind plays a vital role in the behavior of the building, especially when going beyond 10 storeys. It is clearly seen that the response of almost all types of building shows critical for earthquake loads for buildings up to 10 storey and not wind loads. But, we go beyond 10 storeys the response due to wind load starts exceeding the response due to earthquake loads.

The approach for design of structures for wind and earthquake are diagonally apart. Wind forces are generally push forces that tries to topple or bend the structure vertically. They are applicable on the exposed face of the structures. In order to safeguard the structure for wind, one very simple solution can be to make the structure heavier. Heavier the structure, better its ability to resist wind forces.

But earthquake forces are totally different. They are basically inertia forces, which depend on the mass of the structures. The structures on action of earthquake forces rarely topple over or fall down. They actually collapse just under its own vertical axis. Since earthquake forces depend upon the weight/mass of the structure, heavier the structure, more earthquake force it attracts. The idea is to make the structure lighter.

Lighter the structure, better it is for the structure to resist earthquake forces.

The overall conclusion between different types of 10 storey structure without shear wall for mode Vs. modal period in chronological order

Here we can clearly see that in case of 10 storey building without shear wall Type-1,

Type-2, and Type-D are good on performance wise. And with shear wall Type-D, Type2, Type-5, Type-A, Type-B.

In case of 20 storeys building the performance of structure without shear wall are Type1, Type-C and Type-D. And with shear wall are Type-D, Type-C and Type-1.

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