Comparative Study of Types of the Shear Wall on the Basis of the Storey Drift

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Abstract - Multistory buildings with open (soft story) the ground floor are inherently vulnerable to collapse due to seismic loads, their constructions is still widespread in develop nations. Auxiliary outline and examination delivers the ability of opposing all the connected loads without failure amid its expected life. The plan of high rise structures is administered by lateral loads predominantly because of the earthquake. The inside basic framework or outside auxiliary framework gives the protection from lateral loads in the structure. The present paper portrays the examination and outline of high rise structure with Single Moment Resisting Frame (SMRF) for 14 storey building with up to a 45m height. In this paper we will define first the reinforcement details by using manual design under IS-Codes and then it will be analyzed in Etab 2017 Version for the most important like Storey Drift and Location of the Shear Wall. We will investigate these results for 3 main types of the shear wall which Rectangular, Core Type and the Column Supported Shear Wall.

Index Terms – *Shear Types, Reinforcement Detailing, Etabv17, Storey Drift, Location of the Shear Wall.*

I. Introduction

A) *General:* In contrast to the worldwide rapid growth of high-rise buildings, no probabilistic assessment for the special building group has been proposed for seismic evaluation. In addition to slab, beam and column, the shear wall stand as a vertical plate like. These walls generally start at foundation level and are continuous throughout the building height. 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. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation.

Shear walled frame building is chosen for study purpose because shear wall is an efficient way of stiffening a structure. The forces in these walls are predominantly shear forces, though a slender wall will also incur significant bending. Ground motion enters the building and creates inertial forces which move the floor diaphragms. This movement is resisted by the shear walls, and the forces are transmitted back down to the foundation a simplified analytical model is proposed for modelling the nonlinear response of flexural-yielding reinforced concrete walls using standard structural analysis software. For evaluating structural response we use a very extra 3 dimensional software i.e. Etab v.17 by means of nonlinear response history analysis. The model is useful for performing practical non-linear static or non-linear dynamic procedures. The walls are modelled using a fine mesh of linear-response shell elements coupled with uniaxial line elements. For such elements we should use the line elements which invoke. In high-rise structures the shear wall is widely used to resist earthquake forces.

B) *Classification of the shear walls:* On the Basis of Shape Shear walls are classified into 6 types as follows:

1. Simple Rectangular Types and Flanged Walls
2. Coupled Shear Walls
3. Rigid Frame Shear Wall
4. Framed Walls with Infilled Frames
5. Column Supported Shear Wall
6. Core Type Shear Wall

1) *Simple Rectangular Types and Flanged Walls:* It is free type free standing walls Barbell type of shear wall is formed when a wall is provided between two columns. The columns are then called boundary elements. This type was the first to be used in construction. These shear walls are subjected to bending and shear by the action of in plane vertical loads and longitudinal shear. Minimum steel over the inner 0.7 – 0.8 L of the wall and placement of the remaining steel at the ends for a length of 0.15 – 0.12 L on either side is more efficient than uniform distribution of steel.

2) *Coupled Shear Walls*: If two structural walls are joined together by relatively short spandrel beams, the stiffness of the resultant wall increases, in addition the structure can dissipate most of the energy by yielding the coupling beams with no structural damages to the main walls. It is easier to repair the coupling beams than the walls. These walls should satisfy the following requirements: The system should develop hinges only in the coupling beam before shear failure

3) *Rigid Frame with Shear Wall*: The deflection of the frame is in shear mode and the wall is in bending

mode. The interaction reduces maximum moment but increases maximum shear in the shear walls. This increases the tendency of shear failure in the shear walls and this factor should be allowed for in the design.

4) *Framed Wall Shear wall, Infilled shear wall*: Framed walls are cast monolithically In filled walls are constructed by casing frames first and in filling it with masonry or concrete blocks. When it is necessary to discontinue the shear walls at floor levels, it becomes necessary to carry the wall to the ground on widely spaced columns.
5) *Column Supported Shear Wall*: In such column supported shear walls, the discontinuity in geometry at the lowest level should be taken care of in the design
6) *Core Type Shear Wall*: In some buildings elevators and other service areas can be grouped in a core which serves to withstand lateral loads. Unsymmetrical produces twisting and if twisting is not present, these walls act as simple shear walls. Cores with designed lintels at regular intervals as in elevator, shafts have good resistance against torsion.

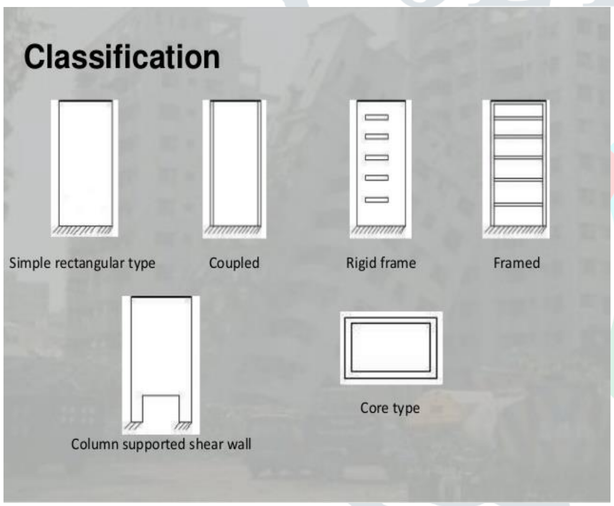


Fig 1.1 Classification of the Shear Wall

II. OBJECTIVES OF THE SHEAR WALL

1) To increase resistance of structure against lateral force this is produced by earthquake.
2) To make realize the importance of Shear wall by comparing it with regular building and analyzing it.
3) To study the various types of the Shear wall on the basis of Drift, Displacement, Base Shear and Storey Acceleration.
4) To analyze the various location of Shear Wall on the basis of Drift, Displacement, Base Shear and Storey Acceleration.
5) To study the opening of Shear wall on the basis of Drift, Displacement , Base Shear and Storey Acceleration
6) To prevent additional cost and operation of retrofitting of structure in future.
7) To increase the accessibility time for users during earthquake.

III. LITERATURE REVIEW

A) Reviews of Various Literatures:

Different researchers made study of design of earthquake resistance shear walls structures. They applied different types of methods for this study.

1) *Shahzad Jamil Sardar* [1] *Umesh. N. Karadi*[2] *September 2013*: This paper mainly focused on Multi-storeyed structures is gaining wide popularity now days. Generally any structure which has height more than 35 metres is considered as a high rise structure. The project also aims at finding the most suitable method along with design of a G+25 structure using INFILL WALL, SHEAR WALL and BRACING. The analysis is carried out using analytical methods as well as ETABS software.

2) *M R Suresh*[1] *Ananth Shayana Yadav*[2] *June-2015*: In this study, a two-story reinforced concrete block scaled building was tested to failure under fully reversed displacement-controlled loading. The building's seismic force-resisting system (SFRS) consisted of eight structural walls in total, with four walls, aligned along the loading direction, placed asymmetrically to result in a center of rigidity eccentricity from the floor center of mass of approximately 20% of the building width, evaluated on the basis of elastic analysis. The study showed that the variation in the inelastic response characteristics of the different walls comprising the building's SFRS and wall strength contributions to the overall building capacity and SFRS performance.

3) *Mr. Archin A Shah* [1]*. Ms. Megha Thomas* [2]*. Dr. V. R. Patel*[3] *, May -2017:*This paper worked on Wall-type precast reinforced concrete (WPC) residential buildings, which are assembled using prefabricated concrete panels for the slabs and walls. In this research, reinforcement design for new openings was developed and improvement of seismic performance was examined in half-scale cyclic loading tests. Numerical analysis models were also developed and the ehaviour of the walls was well simulated.

4) Dr. Suresh Borra[1]*, P.M.B.RajKiran Nanduri*[2]*, Sk. Naga Raju3 Dec-2016:* This paper analyses that Concrete shear walls or structural walls are often used in multistory buildings to resist lateral loads such as wind, seismic and blast loads. Such walls are used when the frame system alone is insufficient or uneconomical to withstand all the lateral loads or when partition walls can be made load bearing, replacing columns and beams. The primary purpose of this paper is believed that structural engineers working in the analysis and design of high- rise buildings will be benefited from the design shear wall

III. PROBLEM STATEMENT

A) *Description of the Building:* We have selected a Hospital Building which is situated in Bihar State. Purpose of selecting that state was to study effect of Seismic Zone Properties on the Shear Wall. Following is the Material and Member Properties of the building:

- Height of typical storey = 3.1 m
- Height of the ground storey = 3.1 m
- Length of the building = 26 m
- Width of the building = 18 m
- Span in X- direction = 6.5 m
- Span in Y-direction = 6 m
- Height of the building = 43.4 m
- Number of storey = 14
- Brick wall thickness = 230 mm
- Slab Thickness = 200 mm
- Grade of the concrete = M20
- Grade of the steel = Fe415
- Thickness of shear wall = 250 mm
- Column sizes = 0.7 m X 0.7 m
- Beam sizes = 0.5 m X 0.5 m
- Live load for floor = 1.5 kN/m^2
- Unit weight of R.C.C. = 25 kN/m
- Unit weight of brick masonry = 19 kN/m
- Floor finish = 1.5 kN/m
- Zone factor = 0.24
- Response reduction factor = 5.0
- Importance factor (I) = 1.5
- Soil Factor for Hard Soil = 1.0
- Damping = 5%

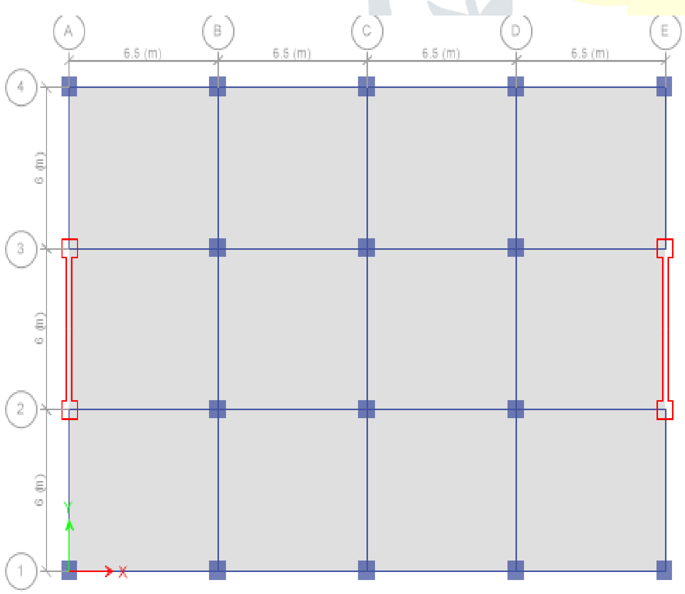
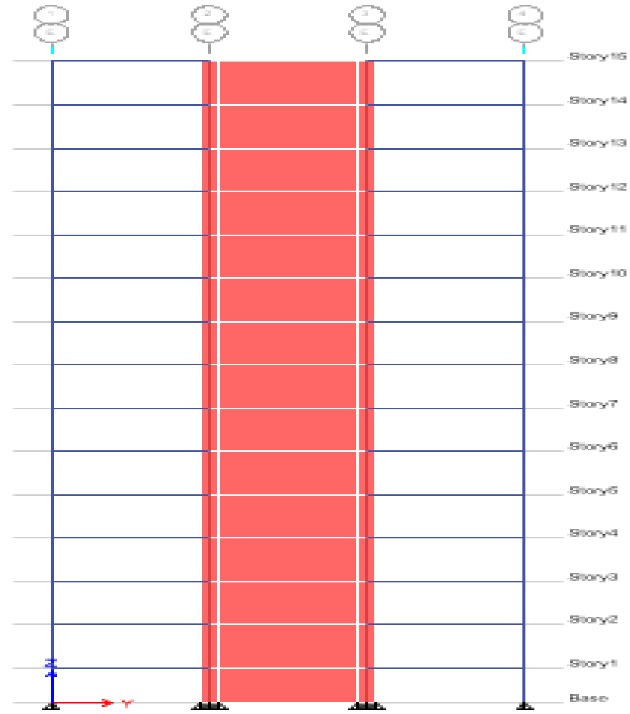


Fig. 3.1 Floor plan of the Struture with the Shear Wall

Fig. 3.2 Side Elevation of Structure with Providing the Shear Wall

IV. METHODOLOGY



A) *Indian Standard Code:* For the Reinforcement Detailing of the Shear Wall we required following IS Code and Methods to design Shear Wall. In this we studied the design aspect, also investigated the survival limit state. Other two limit state were also in detailed were studied such as damaged and serviceability.

1) *IS456:2000:* Design for wall describes, design of horizontal shear in clause 32.4 given details of how shear wall have to be constructed.
2) *IS1893-2016(Part-1):* Criteria of Earthquake resistant Buildings Part and the estimation of earth quake loads.
3) *IS 13920:2016 :*It gives the ductile detailing of shear wall as per clause 9, where as 9.1 gives general requirements, 9.2 shear strength requirement, 9.3 gives flexural strength requirement, 9.4 boundary elements.

B) *Design Procedure :*To design the Shear Wall we followed the following

Step 1: Determination of Design Lateral Force

1. Seismic Weight Calculation
2. Calculation of Base Shear
3. Floor Wise Distribution
4. Design lateral forces at each floor in the X- direction corresponding to entire structure and resulting shear.
5. Distribution of seismic storey shears between the frames X-1 and X-2.
6. Design forces in shear wall (frame X-1) under different load cases.

Step 2: General Requirement
Step 3: Shear Strength Requirement
Step 4: Flexural Strength Requirement

Step 5: Boundary Elements
Step 6: Reinforcement Detailing of Shear Wall

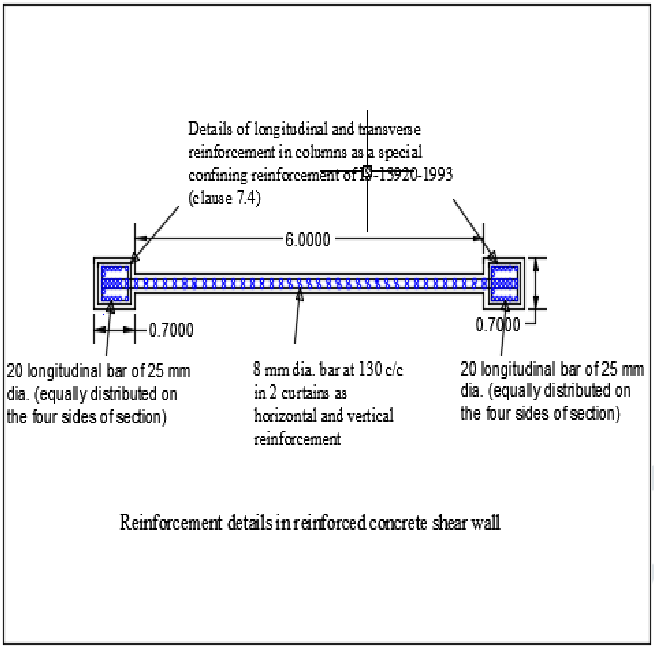


Fig 4.1 Reinforcement Details of Shear Wall

V. ANALYSIS OF SHEAR WALL

We have designed the Shear wall and find the reinforcement details of the Shear Wall by using IS-Code Method.
In the next part we will analyzed this shear wall with its types and location on the basis of two most important parameters i.e. Storey Drift and Location of Shear Wall.

A) Storey Drift: Storey drift is the drift of one level of a multistory building relative to the level below. Interstorey drift is the difference between the roof and floor displacements of any given story as the building sways during the earthquake, normalized by the story height.

B) Location of Shear Wall: The shear wall location is purely dependent on the:

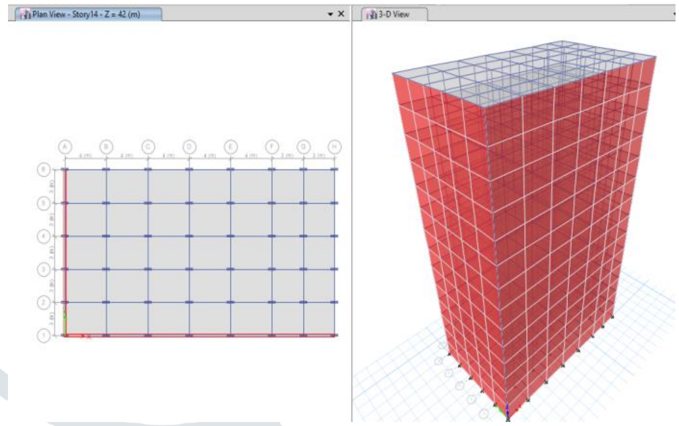
- The plan of the structure
- The core location
- The symmetry of the building
- The lateral force experienced by the structure

The placement of the shear walls at the center may not be common for all type of building. In some situations, their location will be brought to the ends of the plan. In case of difficulty in deciding the best location, analysis of different positions is done and the best is chosen

C) Analyzing various types of Shear Wall on the basis of Storey Drift in Etab v.17. We prepare 3 Model of Shear Wall.

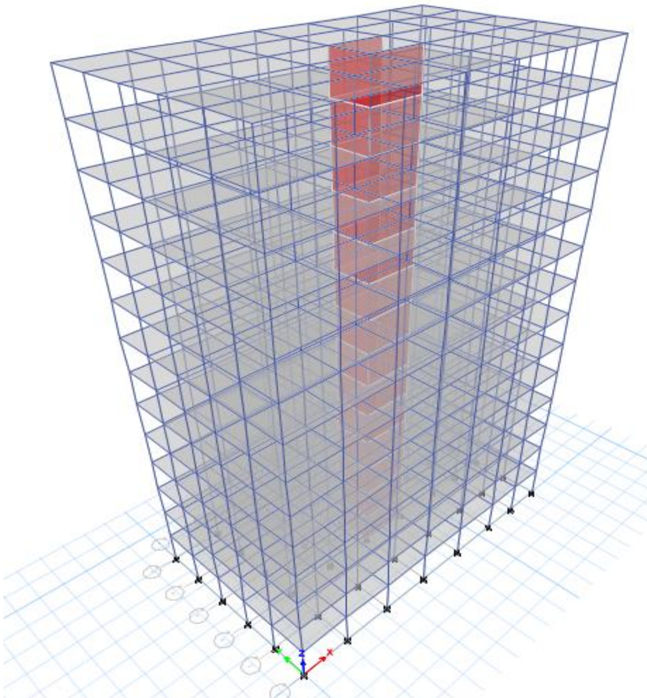
1. Rectangular Type Shear Wall
2. Core Type Shear Wall
3. Column Supported Shear Wall

Model 1: Rectangular Type Shear Wall

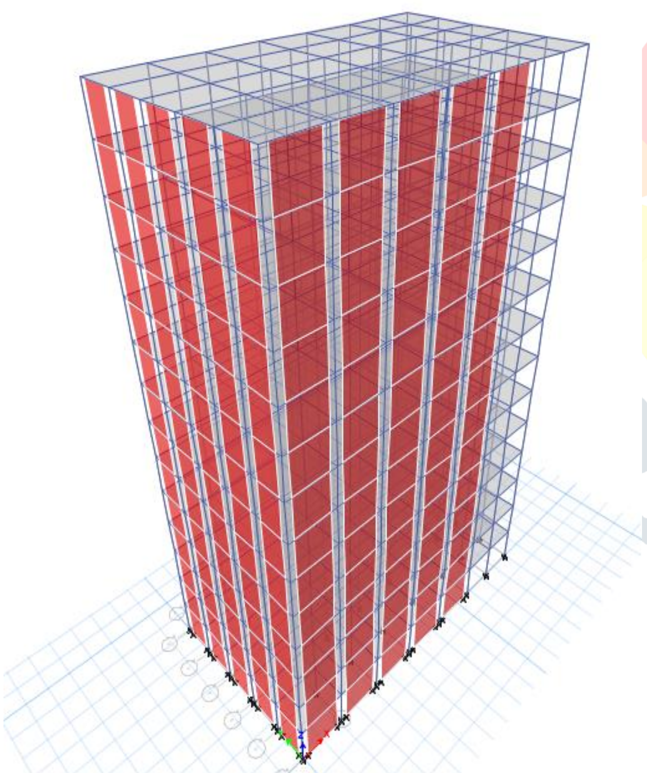


Model 1: Core Type Shear Wall

STOREY	Column supported SW(mm)	Core SW(mm)	Rectangular SW(mm)
14	0.003416	0.004573	0.003449
13	0.005146	0.005485	0.005079
12	0.006612	0.006444	0.006554
11	0.007801	0.007342	0.00767
10	0.008746	0.008079	0.008501
9	0.009494	0.008662	0.009129
8	0.010098	0.009122	0.009634
7	0.010617	0.009492	0.010093
6	0.011088	0.009797	0.010551
5	0.011527	0.010021	0.010998
4	0.01193	0.010094	0.011418
3	0.01224	0.009865	0.011748
2	0.012049	0.008997	0.011674
1	0.009526	0.006234	0.008512



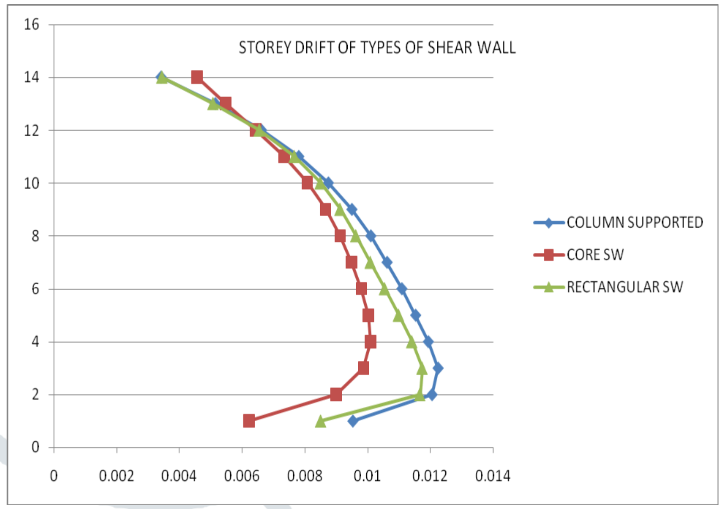
Model 3: Column Supported Shear Wall



So after evaluating the various drift value at each storey we sorted maximum value from the each type and plotted a graph to conclude that which type is more efficient in case of Storey Drift.

Table no 5.1 Maximum Drift value at each storey for 3 types of Shear Wall

From above table we will compare the maximum storey drift for each storey and for each type of Shear Wall in the graphical representation.



Graph 5.1 Graphical Representation Types of Shear Wall on the basis of Storey Drift

From the above graph it is clear that must prefer Core type of Shear Wall. It gives minimum drift value as compared to two other. While Maximum drift is in the Column Supported Shear Wall.

VI. CONCLUSION

This report focuses on improving the resistance and stability of high rise building against the different loads and forces (mainly seismic forces) it is subjected to during its life time.

From all the above analysis, it is observed that in 14 story building, constructing with shear wall along short span at middle (model 2) is effective in resisting seismic forces as compare to building without shear wall. It is also observed that the shear wall is economical and effective in high rise building.

From the above graphical results it is evident that shear wall should be provided in high rise buildings as the performance of these structures when subjected to different forces is not satisfactory.

- Joint displacement and Storey Drift is a minimum when shear wall is used.
- Providing shear walls at adequate locations substantially reduces the displacements due to earthquake.
- After analysing the types of Shear wall such as Rectangular, Core and Column Type Shear Wall on the basis of Storey Drift we found

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