Research Paper on Shear Wall Design of Residential Building

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Abstract*- The aim is construction of shear wall is constructed in residential building (G+2) for safety feature from earthquake and wind. In the alternate use of brick bond masonry work. Shear walls are structural systems which provide stability to structures from lateral loads like wind, seismic loads. Shear walls generally used in high earth quake prone areas, as they are highly efficient in taking the loads. Not only the earthquake loads but also wind loads which are quite high in some zones can be taken by these shear walls efficiently and effectively. The earthquake load is to be calculated and applied to a residential building of plan 9mx10m and 2 no. of (G+2) floors with 9 meters height. For this model, results are calculated and analyzed for the effective location of shear wall. The design of shear wall is design in etabs the conclusion is provide 10mm bars with 250mm spacing in vertical direction and provide 8mm bars with 175mm spacing in horizontal direction.*

Keywords- Shear wall, STAAD. Pro, ETABS, Shear wall in residential building etc.

I. INTRODUCTION

Shear walls are vertical elements of the horizontal force resisting system. Shear walls are constructed to counter the effects of lateral load acting on a structure. In residential construction, shear walls are straight external walls that typically form a box which provides all of the lateral support for the building. When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces.

In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall or vertical truss. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsion) forces. These forces can literally tear (shear) a building apart. Reinforcing a frame by attaching or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints. Shear walls are especially important in high-rise buildings subjected to lateral wind and seismic forces.

In the last two decades, shear walls became an important part of mid and high-rise residential buildings. As part of an earthquake resistant building design, these walls are placed in building plans reducing lateral displacements under earthquake loads. So shear-wall frame structures are obtained. Shear wall buildings are usually regular in plan and in elevation. However, in some buildings, Lower floors are used for commercial purposes and the buildings are characterized with larger plan dimensions at those floors. In other cases, there are setbacks at higher floor levels. Shear wall buildings are commonly used for residential purpose

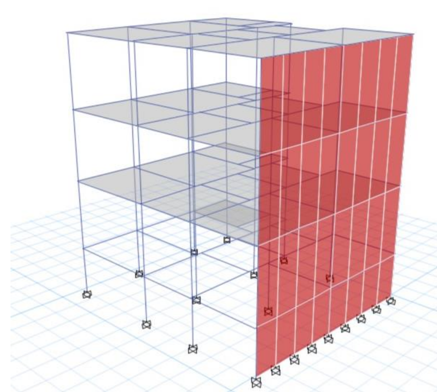


Fig 1: Shear wall

II. LITERATURE REVIEW

Concrete shear walls are most useful type of shear wall for residential building. Many researchers and scholars had researched on the shear wall configuration in any building and types of shear wall. The ability of shear wall to resist lateral forces generated by earthquake and wind force is studied. An effort had been made to study these literatures and conclude over this topic.

Dr.B.Kameshwari analysed the influence of drift and inter storey drift of the structure on various configuration of shear wall panels on high rise structures. The bare frame was compared with various configurations like i) Conventional shear wall ii) Alternate arrangement of shear wall iii) Diagonal arrangement of shear wall iv) Zig Zag arrangement of shear wall v) Influence of lift core shear wall. From the study it was found that Zig Zag shear wall enhanced the strength and stiffness of structure compared to other types. In earthquake prone areas diagonal shear wall was found to be effective for structure.

B. R. Reddy used Stadd Pro software for analysis and design of earthquake resistant structures using Shearwall. According to their research work, **c**onstructions made of shear walls not only provide lateral strength but also increase the strength parameters and effectiveness to bare horizontal loads. Shear walls have a peculiar behavior towards various types of loads. Research work was adopted to the college building of VITS block, Deshmukhi Hyderabad city using shear wall.

Syed Ehtesham Ali and Mohd Minhaj Uddin Aquil is studied the decision about the location of shear wall in multi-storey building is not much discussed in any literatures. In this paper, therefore main focus is to determine the solution for shear wall location in multi-storey building. A RCC building of six storey placed in Hyderabad subjected to earthquake loading in zone-II is considered. An earthquake load is calculated by seismic coefficient method using IS 1893 (PART -I):2002. These analyses were performed using ETABS.

P.Kalpana, R. D. Prasad and B.Kranthi Kumar is studied of an analytical parameter study is done for the structural shear walls with varying height for different models. The load combinations are consideration as per IS 1893 (Part-1):2002. The result in terms of axial forces, lateral displacement and bending moment in the structural shear walls with varying height are compared for different building models considered. Five-storied buildings were taken with shear-walls and without shear-walls. The design is above verified for this same structure using extended three dimensional analysis of buildings (STAAD Pro V8i) software.

A. Ravi Kumar & K. Sundar Kumar they are work on to determine the solution for shear wall location in multi-storey building based on its both elastic and elasto-plastic behaviors. The earthquake load is to be calculated and applied to a multi-storied building of plan 26mx26m and 10 no. of (G+9) floors with 40 meters height. For this model, results are calculated and analysed for the effective location of shear wall. The design above is verified for this same structure using extended three dimensional analysis of buildings (ETABS) software.

Sanjeebanee Behera and P.K Parhi studies on location of shear wall in buildings for Structural stability Shear walls provide adequate stiffness to the structure. So that the lateral drift will be in limits. Generally shear walls are the vertical cantilever which acts as a column. This investigation presents the study and comparison of earthquake behaviour of buildings with and without shear wall using STAAD Pro. In this study, reinforced concrete buildings are analyzed by changing the various position of shear wall with different locations considering various parameters such as story drift, lateral displacement and others.

S. P. Sharma and J. P. Bhandari they are studied the Seismic Performance of Multi-Storey Building with Different Locations of Shear Wall and Diagri. The present paper gives an overview of different research works to be done regarding the study of multi-storey RC frame structure with lateral load resisting systems such as shear wall and diagrid system. The present work concerned with the comparative study of seismic analysis of multi-storied building with shear wall and bracing, analysis of multi-storey structure of different shear wall locations and heights and proper location of shear wall in the multi-storey building etc.

Mr. Ankur vaidya & Mr. Shahayajali Sayyed they studied on on Comparing the Seismic Effect on Shear wall building and Without- Shear Wall Building. In this paper review of different researchers on the concept of multistoried building with and without shear wall is paraphrased. In India, most adopted type of earthquake resistant structures is with shear wall. These structural walls may differ based on their design and utility and their position in any building plays an important role for resisting lateral force.

Ashwini A. Gadling & Dr. P. S. Pajgade work on Analysis and Design of RCC Shear Walls with and Without Opening To know the responses of providing openings and the behavior of shear wall without openings is the aim of the given study. Hence, it is necessary to demonstrate work on the analysis, design and post effects of shear walls when seismic forces are applied. In this paper, a review is taken out over the analysis and design of RCC shear walls with and without openings to study more detail analytical results and conclusions.

Manoj S. Mendhekar stated the economic means by which lateral load resistance can be achieved in a multistoried building. In their study, seismic behavior, modes of failure, and factors influencing the structural response of buildings were discussed. Many expressions were developed to estimate the flexural strength of slender rectangular shear wall sections with uniformly distributed vertical reinforcement. In this study various aspects of analysis and design of a shear wall are discussed, also different types of shear wall are discussed with their failure modes. Algebraic expressions for calculating flexural strength of shear wall sections were developed and load-moment interaction diagram were generated using this expressions.

III. METHODOLOGY

Structural analysis was carried out by means of well-known computer program E-tabs issued for the linear structural analysis of buildings subjected to static and dynamic loads, is documented. Efficient model formulation and problem solution is achieved by idealizing the building as a system of frame and shear wall substructures inter-connected by floor diaphragms. Design of 2 storey residential building and optimization of shear wall is done by computer aided software E-Tabs. Plan generated in Auto cad is imported and modeled by manual and in ETABS. This model is analyzed for axial and lateral loads and the results are studied. For optimization of shear wall location shear wall is placed and the results obtained such as displacements, drifts, storey shears are studied and compared.

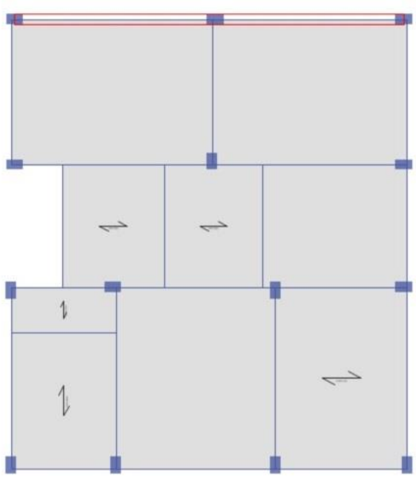


Fig. 2: Plan of Residential Building

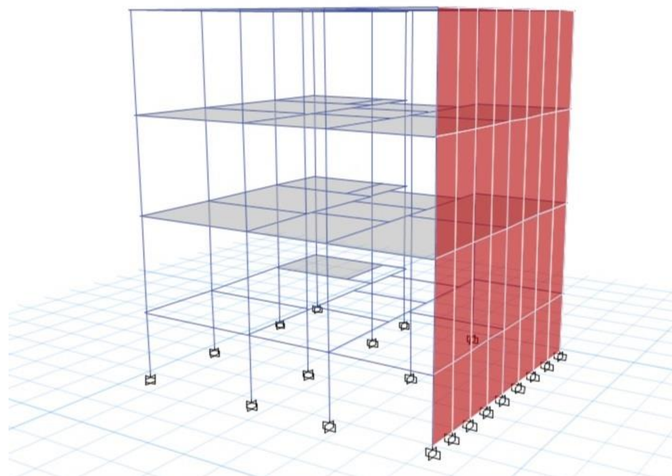


Fig. 3: 3D View of Shear Wall in ETABS

The design of steel and concrete frames composite beams, composite columns, steel joists, and concrete and masonry shear walls is included, as is the capacity check for steel connections and base plates. Models may be realistically rendered, and all results can be shown directly on the structure. Comprehensive and customizable reports are available for all analysis and design output, and schematic construction drawings of framing plans, schedules, details, and cross-sections may be generated for concrete and steel structures. ETABS provides an unequalled suite of tools for structural engineers designing buildings, whether they are working on one story industrial structures or the tallest commercial high-rises. Immensely capable, yet easy-to-use has been the hallmark of ETABS since its introduction decades ago, and this latest release continues that tradition by providing engineers with the technologically-advanced, yet intuitive, software they require to be their most productive.

IV. DESIGN AND DISCUSSION

The innovative and revolutionary new ETABS is the ultimate integrated software package for the structural analysis and design of buildings. This latest ETABS offers unmatched 3D object based modeling and visualization tools, blazingly fast linear and nonlinear analytical power, sophisticated and comprehensive design capabilities for a wide-range of materials, and insightful graphic displays, reports, and schematic drawings that allow users to quickly and easily decipher and understand analysis and design results.

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQX according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = X

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.229$ sec

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 4$

Importance Factor, I [IS Table 8] $I = 1$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.2] $\frac{S_a}{g} = 2.5$ $\frac{S_a}{g} = 2.5$

Equivalent Lateral Forces

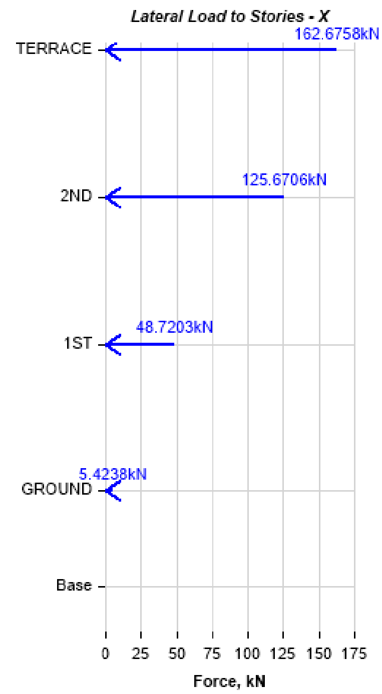
Seismic Coefficient, A_h [IS 6.4.2]

$$A_h = \frac{ZI\frac{S_a}{g}}{2R}$$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
X	0.229	6849.8094	342.4905

Applied Story Forces



Story	Elevation	X-Dir	Y-Dir
	m	kN	kN
TERRACE	9.45	162.6758	0
2ND	6.45	125.6706	0
1ST	3.45	48.7203	0
GROUND	0.45	5.4238	0
Base	-1.5	0	0

IS 1893:2016 Auto Seismic Load Calculation

This calculation presents the automatically generated lateral seismic loads for load pattern EQY according to IS 1893:2016, as calculated by ETABS.

Direction and Eccentricity

Direction = Y

Structural Period

Period Calculation Method = User Specified

User Period $T = 0.226$ sec

Factors and Coefficients

Seismic Zone Factor, Z [IS Table 3] $Z = 0.16$

Response Reduction Factor, R [IS Table 9] $R = 4$

Importance Factor, I [IS Table 8] $I = 1$

Site Type [IS Table 1] = II

Seismic Response

Spectral Acceleration Coefficient, S_a /g [IS 6.4.2] $\frac{S_a}{g} = \frac{1.36}{T}$ $\frac{S_a}{g} = 1.939476$

Equivalent Lateral Forces

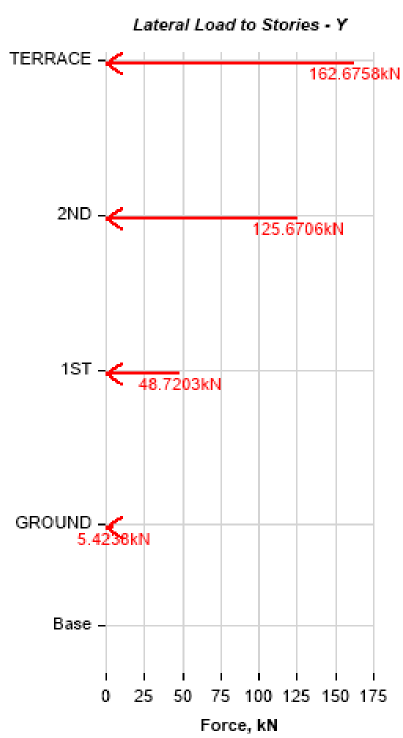
Seismic Coefficient, A_h [IS 6.4.2]

$$A_h = \frac{ZI \frac{S_a}{g}}{2R}$$

Calculated Base Shear

Direction	Period Used (sec)	W (kN)	V_b (kN)
Y	0.226	6849.8094	342.4905

Applied Story Forces



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Base	-1.5	0	0

III. CONCLUSION

- As per our design reinforcement of the shear wall is given below.
- For length 4.45 meters provided 10 mm bars with 250mm spacing in vertical direction and in horizontal direction provide 8mm bars with 175 mm spacing for 230 mm of wall.
- For length 4.17 meters provided 10 mm bars with 250mm spacing in vertical direction and in horizontal direction provide 8mm bars with 175 mm spacing for 230 mm of wall.
- This is the conclusion of shear wall design in residential building.

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