

# A Review on Optimum Height and Location of Shear Walls in High-Rise Buildings

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**Abstract** - Shear walls are the structural members designed to counteract the lateral forces acting on a structure in seismically active zones when shear forces on the structure increases due to earthquake loads and/or wind load effect. Shear walls tend to provide substantial strength and stiffness as well as the deformation capacity needed for structures to meet the seismic demand. The structural designers, now days, are practicing to combine the moment resisting framed structure for resisting gravity loads and the RC shear walls for resisting lateral loads in tall building structures. As compared to the structures without shear wall, structures with Shear walls have more strength, stiffness and resist in-plane loads acting along its height also have shown very good performance in past earthquakes. This paper compiles the evaluation of optimum height and location of shear wall in high-rise building structure.

**Keywords:** RC shear wall, stiffness, optimum height, location, Seismic performance

## INTRODUCTION

In this era, there's continuous increase in the construction of, as the modern trend is, more tall and slender tall buildings of both types residential and commercial. The most basic lateral load resisting elements in an earthquake resistant building is shear wall which resist lateral forces caused due to wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants. These forces also create powerful twisting (torsion) which can literally tear (shear) a building apart but are resisted by shear walls when placed symmetrically in plan. Reinforcing a frame by attaching or placing a rigid wall

inside it, maintains the shape of the frame and prevents rotation at the joints.

The performance of these frames is analyzed for seismic forces in terms of base shear, storey drift, member forces and joint displacements. And from the results, the optimum height and placement of shear walls in building plan is suggested. Reinforced concrete buildings often have vertical plate-like RCC walls, called shear walls. Shear walls also act like vertically-oriented wide beams that carry earthquake as well as wind loads to transfer them downwards to the foundation. Generally starting from foundation level continues throughout the building height. Their thickness can be as low as 150mm or as high as 400mm in high rise buildings. Whereas shear walls are provided along both length and width of buildings also some of the buildings contains columns. As per the research work carried out, shear walls provide large strength and stiffness to buildings in the direction of their orientation; it significantly reduces lateral sway of the building by reducing damage to structure and its component parts. Hence we can conclude that it is very necessary to determine effective, efficient and ideal location of shear wall.

## REVIEW OF LITERATURE

M. K. Akhil Krishnan et.al. has conducted the pushover analysis for finding optimum location of shear wall for a five story building by providing shear walls in three different locations using SAP2000. By assuming five story RCC wall framed building, pushover analysis for strength of building was performed in which the location of shear wall was changed in each case. Also the strength of

building without shear wall was examined. In his work, the observations made by performing analysis are represented

**AnshulSud et.al.** presented the results of seismic analysis of five story RC building located in seismic zone –V . For analysis, five different configurations of shear walls are considered and to assess performance of building stating effects on base shear, storey drift, member forces and joint displacement. In this paper, study shows that lateral displacement reduces from 29% to 83% in case of frames with shear wall at center and core placed at exterior bays. Also bending moments reduces from 70% to 85% in case of interior and perimeter columns. 86% of reduction has been observed in shear and axial forces acting on columns.

**Anshuman.S. et.al.** made the comparison based on elastic and elasto-plastic analysis using two softwares STAAD Pro 2004 and SAP V 10.0.5 (2000).For analysis, a fifteen storey RCC building located in zone-IV have been considered for determining the best location of shear wall in multi-storied building, few factors such as shear forces, bending moment, storey drift were computed and compared based on the results obtained by using STAAD Pro 2004 and SAP V 10.0.5 (2000) softwares.

**AnujChandiwala et.al.** has performed earthquake analysis of RC building configuration with different positions of shear walls. In this study, optimum steel and reasonable concrete sections have been designed carefully which can achieve economy in RC buildings.The results of moment occurring in a particular column have been displayed which include seismic load and the other lateral load resisting structural systems. The final conclusion have been made by the researcher, that F-shaped shear wall gives best results when placed at end of L-shaped flanged sections, as this end portions have more oscillations than other sections. Hence the placed shear wall can obstruct these oscillations completely which finally reduces bending moments.

**AmeyDhondopantkulkarniet.al.** has assessed the location as well as optimum percentage of shear wall in case of typical RCC building plans located in Solapur , earthquake zone-III , providing different heights and shapes of shear walls. The analysis was made by using software ETABS 2013 in which earthquake loads are applied as per IS 1893 (part-I) 2002 and IS13920:1993. All the plans were analyzed by considering optimum

percentage of shear wall according to the perimeter of the buildings and the results have been displayed.

**G.S. Hiremathet.al.** Analyzed 25- storey building located in zone IV by performing pushover analysis on ETABS V 9.7.1 to calculate displacements and storey drift. From the analysis, it is concluded that shear walls can reduce effects of earthquakes and improving seismic response of RCC building. In this paper studies have been made on effects of shear walls added at different locations and configuration along with varying thickness of shear walls.

**JitendraBabuet.al.** Conducted non-linear analysis of different symmetrical as well as asymmetrical structures located on plain and sloping ground. While performing the pushover analysis, different types of loads have been applied to different structures situated on plain ground and also the sloping ground with 30° inclination have been considered. The results have been compared from both softwares viz. SAP-2000 and ETABS. It has been concluded from the pushover curves that structures having vertical irregularities are critical comparing to that of structures with plain irregularities.

**Mr.K.LovaRaju et.al.** considered eight story building which are located in different zones such as zone-I , III , IV and V as per IS 1893-2002 provisions. Pushover analysis have been conducted using software ETABS and the pushover curves are obtained to compare the effects of earthquakes loads on displacements as well as base shear of these models, in which one model taken as bare frame structure while other three are the dual type structural systems. The non-linear analysis conducted in this paper gives the effective location of shear wall.

**Lakshmi K.O., Prof. JayasreeRamanujan et.al.** determined the effects of seismic loads on building in terms of storey drift, storeyshearand deflection as well as reinforcement requirements. Overall performance level of structure is analyzed on the basis of capacity spectrum method by using the software ETABS 9.5 and SAP 2000.V.14.1. In this study, the static inelastic analysis is used to estimate the deformation demands in design earthquakes, and the strength of structure is estimated by pushover analysis while both results are compared to available capacities.

**M.Pavaniet.al.** conducted analysis and design optimization of shear wall arranged in such a way to resist

the lateral forces in zone-III in case of 45 storey high rise building. The optimization technique was implemented for no. of times to estimate the strength of structure which can resist the forces coming on the structure. Considering the stability of building the analysis was made for two cases, in case –I the dimensions of shear wall is kept same throughout the building and in case –II dimensions of shear wall are increased on the basis of results obtained from case-I . From the analysis it has been concluded that the stiffness as well as torsional irregularities of building depends upon the sudden change in plan of building above 4<sup>th</sup> floor level in case of small horizontal forces such as seismic force strikes the building structure.

### CONCLUSION

In this paper various aspects of optimum height and location of shear walls in high-rise buildings have been discussed based on the studies made by different researchers. The following conclusions can be made from the studies,

- Shear walls placed at central core has significant influence on performance of structure such as 95% of displacement of structure can be reduced by providing shear wall up to 20% of total side length.
- While 70 % to 85% of bending moment effects are reduced in case of interior and perimeter columns at ground floor if the shear walls are provided at central core of building.
- Considering the base shear in ground floor columns, the effects have been reduced by 86% due to contribution of shear walls in high rise structures.
- Also the effects of axial forces are reduced are reduced upto 45% in case of building with shear walls.

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