Analysis of Multi-Storey Building Based on Different Shear Wall Locations Using Etabs

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Abstract
The demand for earthquake-resistant buildings has increased due to recent earthquakes, leading to revised codal provisions and increased emphasis on earthquake-resistant structures. Shear walls are structural vertical members that can resist lateral, momentary, and axial loads. Ferro concrete walls, including raised wells, are standard for multi-structure buildings. Shear walls are structurally economical solutions for lateral load resistance, making them popular in high-rise buildings. However, the choice of shear wall placement in multi-story buildings is not well-researched, and the project aims to determine the strength of RC shear walls in high-rise buildings through dynamical shear wall location.

Keywords: Displacement, Drift, Base shear

Introduction

Shear walls are structural vertical members that can resist lateral loads induced by wind and earthquakes, ensuring the structural integrity of multi-storey buildings. They are commonly used in reinforced concrete walls, including lift wells, to increase rigidity and resist lateral loads. Shear walls can be rectangular, irregular, or barbell-shaped, and can be used to divide space or contain services like elevators. The choice of shear wall systems is crucial in choosing the appropriate structural system for a project. Shear walls are designed to resist horizontal forces induced by wind, earthquakes, and other factors, enhancing the overall structural integrity and preventing collapse under seismic forces. This research focuses on studying shear wall frame structures in multi-storey buildings, aiming to identify the most efficient shear wall locations for optimal load resistance against earthquakes. The study explores the impact of lateral loads on structures and suggests future research directions, such as investigating braced frame systems to reduce the effects of lateral loads. Shear walls in multi-storey buildings, built in wood, concrete, and CMU, provide lateral strength to resist horizontal earthquake forces. They transfer these forces to other elements in the load path. Without a shear wall, heavy beam and column sizes can cause problems, requiring the use of shear walls for economy and horizontal displacement control.

Reinforced concrete (RC) buildings often feature vertical plate-like Shear Walls, which provide significant strength and stiffness in the direction of their orientation. These walls, which can be as low as 150mm or as high as 400mm, significantly reduce lateral sway and damage to the structure. They are particularly effective when located along the exterior perimeter of the building, as this layout increases the building's resistance to twisting.

Shear walls are crucial for resisting horizontal earthquake forces and transferring these forces to other load path elements. They also provide lateral stiffness to prevent excessive side-sway and non-structural damage, ensuring buildings with sufficient stiffness are less susceptible to earthquakes.

Review of literature

The base shear was ascertained and compared through the seismic analysis of reinforced concrete frame structures utilizing both static and dynamic techniques. With reduced displacement in the longitudinal direction and interstorey drift in the longitudinal direction, Model 5 had the largest base shear along the longitudinal and transverse directions. Shear walls can strengthen and stiffen the frame structure while having a major impact on its seismic behavior. Compared to previous models, Model-5 demonstrated superior shear wall localization because of reduced lateral displacement and inter-storey drift.

The primary aim was to design a skyscraper and ascertain the best position for shear walls. STAAD Pro V8i software's Response Spectrum Analysis technique was utilized to assess the performance of reinforced concrete frames with and without shear walls. For study, an 11-story G+10 regular structure located in seismic zone 5, a high seismic zone, was taken into consideration. A number of variables were examined, including structural weight, axial force, torsion, node displacement, support responses, and shear force.

The significance of shear walls in associate degree irregular high rise structures was also investigated in this study. According to the findings, shear walls in associate degree irregular buildings offer considerable protection from lateral hundreds. Both structures underwent lateral load analysis, response spectrum methods, and dynamic linear analysis. The findings demonstrated that as soon as shear walls were installed at suitable intervals with the least amount of lateral strain, the lateral forces dropped.

In order to reduce structural damage during earthquakes, the dynamic analysis of concrete structures with irregular setups is the main topic of this article. ETABS 9.5, a metal-based computer code, is used to study four models of G+5 structures, one with a symmetrical arrangement and one with an irregular one. The effect of building changes on the structural response building is also investigated in this study. Using the Response Spectrum approach and IS1893-2002(part1), dynamic reactions to various earthquakes are investigated.

In the high unstable zone, the research also looks at the structural elements of a 56-story RC tall structure. Under each lateral and gravitational mass, the shear wall system with irregular apertures is employed, which leads to problems with the behavior of structural elements such as coupling beams and shear walls. To confirm the tower's behavior, non-linear calculations were carried out using retrofitting pointers such as FEMA 356.

This study examines the tower's unique features and evaluates its unstable load-bearing system while taking essential variables into account. The ideal design and construction of the tower style will be determined by a general investigation of the malleability levels in shear walls.

OBJECTIVES

To find the effective and efficient location of Shear Wall using ETABS.

METHODOLOGY

For the purpose of study we use a plan of G+10 floor levels only because we have some restrictions as lack of hardware efficiency of our system, we are analyzing this structure by using only ETABS version

16.2.1

Shear walls are positioned at various points and designed for gravity loads in accordance with IS 456:2000 and lateral loads (seismic loads) in accordance with IS 1893 (part-1):2002 in order to achieve minimum displacement and drift analysis. A ten-storey, regular-plan building with a height of three meters for each story is modeled for this study. Following the Indian Code of Practice for Seismic Resistant Design of Buildings, these structures were designed with seismic resistance in mind. It is assumed that the structures are fixed at the base. The structural elements' parts are rectangular and square in shape. It is believed that building storey heights, including the ground floor, will remain constant. ETABS v 9.7.1 software is used to model the buildings.

Trial 1,2,3, and 4 were the five models with varying shear wall placements in the buildings that were examined. The sole zone 4 in which the models are examined compares each model's lateral displacement and drift. Assuming a partial load factor of 1.0, the storey drift in any given storey resulting from the minimum specified height design lateral force must not surpass 0.004 times the storey height. Buildings that are one story and are intended to allow for storey drift are not subject to a drift limit. Without respect to the lower bound limit on design seismic force stated in IS 1893(part 1):2002 clause 7.8.2, seismic force derived from the building's estimated fundamental period may be used exclusively for the purpose of the displacement requirement.

RESULTS

Storey displacement and drift analyzed for G+10 multistorey building below

TRIAL 1- Shear wall provided at corner and core of building.

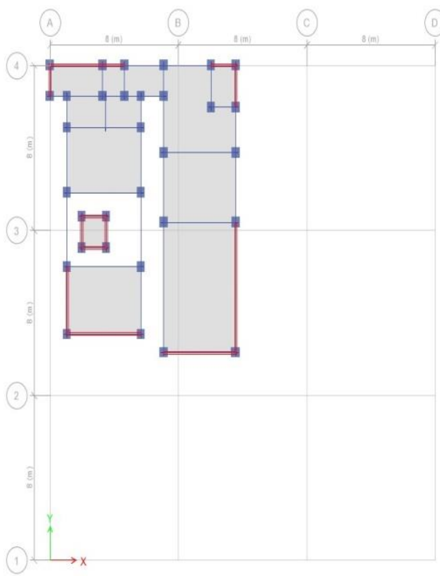


Fig - Plan view

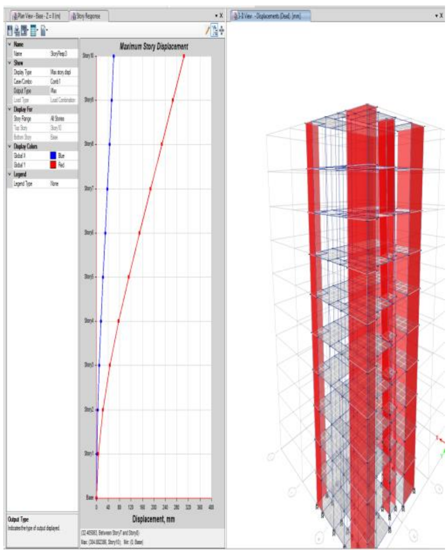


Fig - Maximum storey displacement

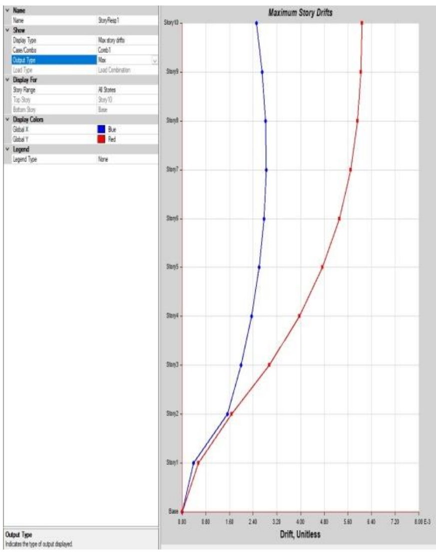


Fig - Maximum storey drift

TRIAL 2- Shear wall provided on three side at base.

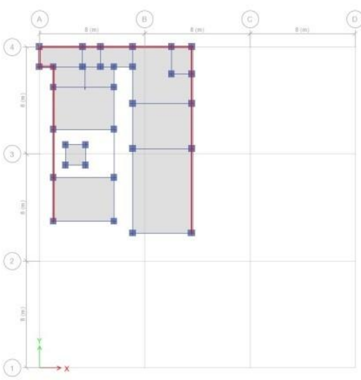
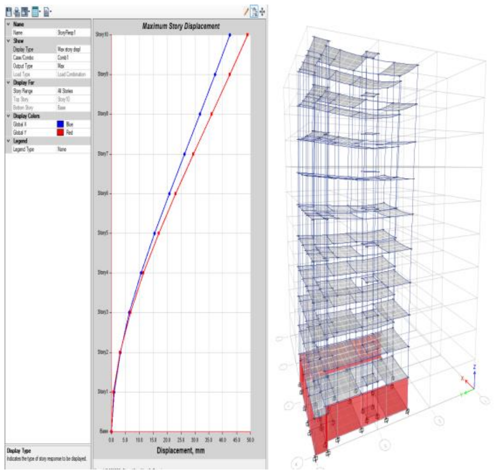
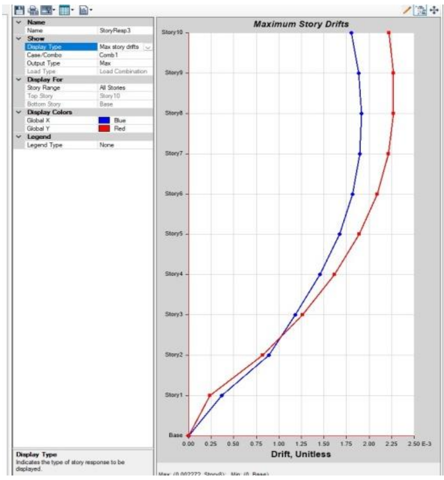




Fig - Plan view **Fig - Maximum storey displacement** **Fig - Maximum storey drift**

TRIAL 3- Shear wall provided at all four corners.

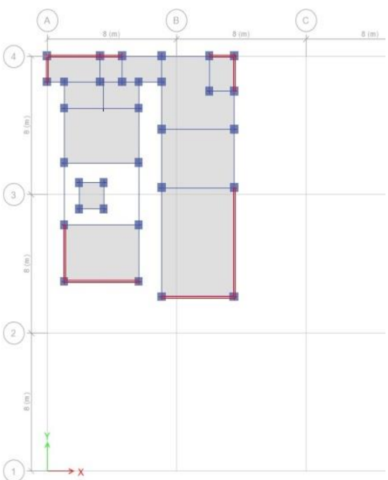
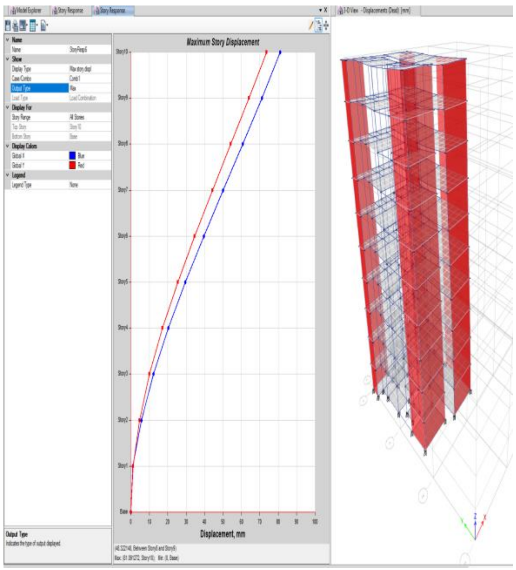
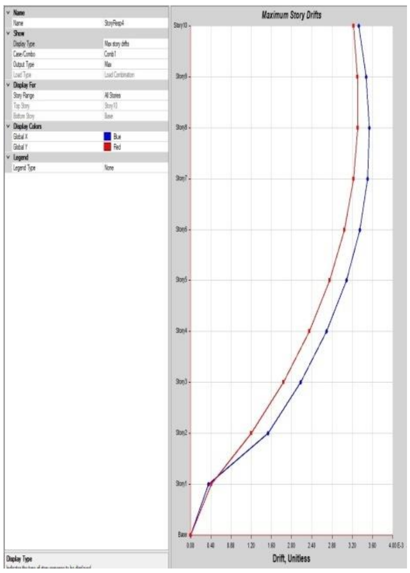




Fig - Plan view **Fig - Maximum storey displacement** **Fig - Maximum storey drift**

TRIAL 4- Shear wall provided at base and at periphery upto storey 10.

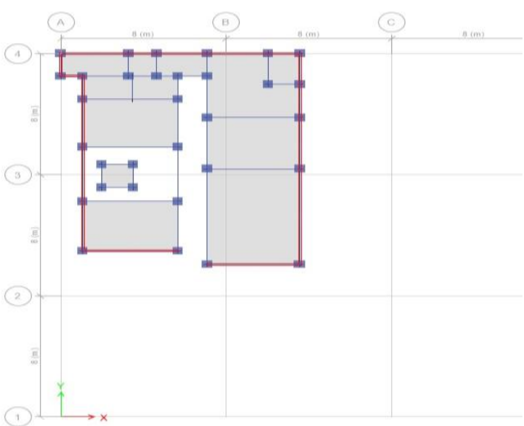
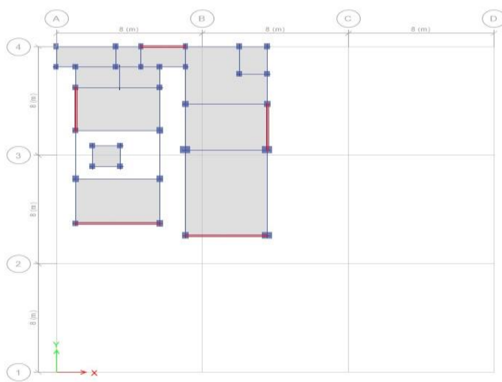
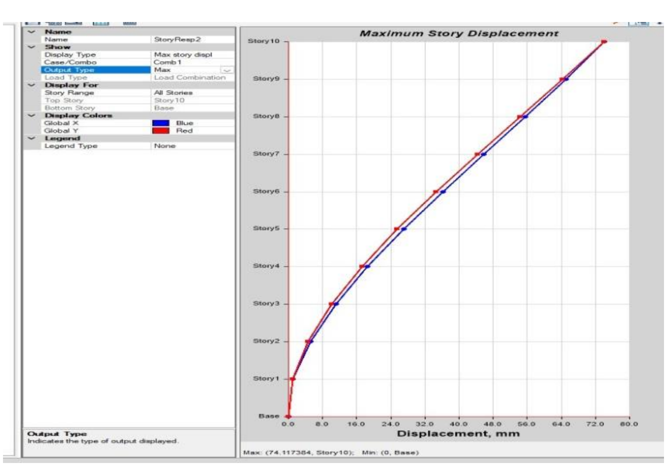



Fig - Plan view when shear wall provided at base **Fig - Plan view when shear wall at periphery**



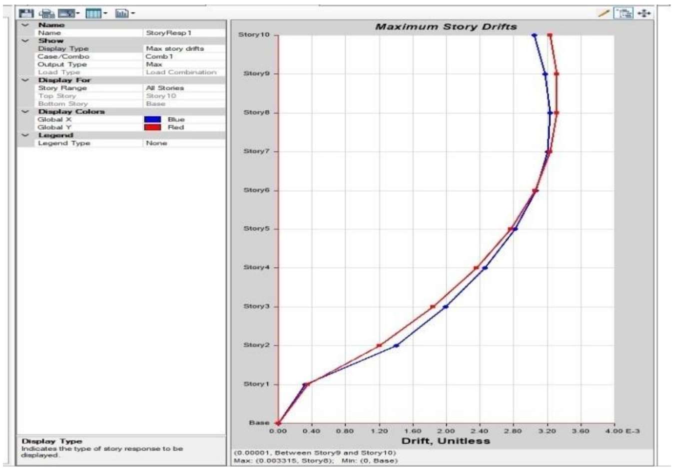


Fig - Maximum storey displacement **Fig - Maximum storey drift**

Among these four trials we observed that the strorey drift and displacement in global x-direction and global y-direction is minimum for case number 2 i.e Shear wall provided on three side at base.

DISCUSSION

1. The study suggests that placing shear walls at appropriate locations is crucial for reducing drift and displacement caused by earthquakes. The position of the wall affects the attraction of forces, so it must be in the correct position.
2. Trial 2 found that the maximum storey displacement in the global x-direction is 43mm and in the global y-direction is 48mm, with a storey drift of 0.0022, within the permissible limit according to IS 1893(part 1):2002.
3. Therefore, the best location for a shear wall is at the base on three sides.

CONCLUSION

The positioning of shear walls influences force attraction, which is important for minimizing seismic drift and displacement. According to Trial 2, the optimal site was at the base on three sides, with a maximum storey displacement of 43 and 48 mm within allowable bounds.

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