SEISMIC ANALYSIS OF G+10 BUILDING WITH SHEAR WALLS AT DIFFERENT LOCATIONS USING ETABS

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Abstract Now a day's an earthquakes are more affected on concrete structures have been severely damaged or collapsed. So there is a need of to evaluate the seismic adequacy. We can't avoid the future earthquakes but we can manage or prepare the building to safe construction, and to reduce the extent damage and loss. The Pushover analysis first came practice in 1980's, but the potential of the pushover analysis has been recognized for last two decades years. In this procedure mainly estimate the base shear and its corresponding displacement of structure. Pushover analysis is a very useful tool for the evaluation of New and existing structures.

In the present study a G+10 multi story is modeled by using ETABS software and analyzed in push over analysis by using shear wall conditions. The 4 cases of models are taken namely building without shear wall, building with corner shear wall, building with center shear wall and shear wall with alternative shear wall. The results like story drift, story shear, story moment, building torsion, time period, and model stiffness were studied.

Key words: Earthquake, Pushover analysis, story drift, story shear, story moment, building torsion, time period, model stiffness.

I INTRODUCTION

The use of the nonlinear static analysis (pushover analysis) came in to practice in 1970"s but the potential of the pushover analysis has been recognized for last two decades years. This procedure is mainly used to estimate the strength and drift capacity of existing structure and the seismic demand for this structure subjected to selected earthquake. This procedure can be used for checking the adequacy of new structural design as well. The effectiveness of pushover analysis and its computational simplicity brought this procedure in to several seismic guidelines (ATC 40 and FEMA 356) and design codes (Euro code 8 and PCM 3274) in last few years.

Reinforced Concrete (RC) Shear Wall

Reinforced concrete (RC) shear walls are specially designed structural walls included in the buildings to resist horizontal forces which are induced in the plane of the wall due to wind, earthquake and other forces. Shear walls have very high in-plane stiffness and strength, which can be used to simultaneously resist large horizontal loads and support gravity loads.

Reinforced concrete wall thickness varies from 140 mm to 500 mm, depending on horizontal forces due to wind, earthquake etc, building age, and thermal insulation requirements. In general, these walls are continuous throughout the building height; however, some walls are discontinued at the street front or basement level to allow for commercial or parking spaces. Usually the wall layout is symmetrical with respect to at least one axis of symmetry in the plan.

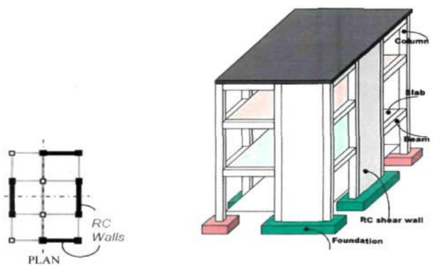


Fig 1: General Configuration of a Shear Wall

Shear walls provide lateral load resistance by transferring the wind or earthquake load to foundation. Besides, they impart lateral stiffness to the system and also carry gravity loads. When shear walls are situated in advantageous positions in the building, they can form an efficient lateral force resisting system.

Objectives of the study

The following are the main objectives of the project

1. To study the seismic behavior of building by using IS 1893:2002
2. To study the results of story drift, shear force, bending moment, building torsion of G+10 building with and without shear wall.
3. To study the multi story buildings in ETABS in push over analysis.

II REVIEWS STUDIES

Asnhuman et al., (2011) - They have conducted study on research on lateral-load resisting system in high rise building. From the study, it was observed that shear wall was very high-in plane stiffness and strength, which can resist large horizontal loads and support gravity loads. Elastic and elasto-plastic analysis was performed using both STAAD pro 2004 and SAP V 10.0.5 (2000) software package. Parameters like shear forces, bending moment and storey drift were computed in both the cases and also for different location of shear wall.

Mohd et al., (2015) - They have studied the G+15 building structure by using STAAD Pro vi8 software in different zones. This study included the main consideration factor which affects the structure to perform poorly during earthquake, in order to achieve the appropriate behavior during future earthquake. IS code 1893(Part 1):2002 was used for seismic analysis. A comparatively analysis was done on base shear, displacement, axial load , moment in Y and Z direction in column and shear force , maximum bending moment and maximum torsion in beam. Modeling was done using STAAD Pro vi8 software.

Anshuman S. et al. (2011), in this paper focus was to determine the solution for shear wall location in multi-storey buildings based on its both elastic and elasto plastic behaviours. An earthquake load was calculated and applied to a building of fifteen stories located in zone IV. Elastic and elasto plastic analyses were performed using both STAAD Pro 2004 and SAP V 10.0.5 software packages. Performance point comes out to be small which states that analysis gave correct results in linear analysis i.e. no need to perform non linear analysis. Thus results obtained using elastic analysis were adequate.

Chandurkar P. P. and Pajgade P. S. (2013), summarize that in the seismic design of buildings, reinforced concrete structural walls act as major earthquake resisting members. Structural walls provide an efficient bracing system and offer great potential for lateral load resistance. The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. It is observed that the shear walls are economical and effective in high rise buildings. Changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position. If the dimensions of shear walls are large then major amount of horizontal forces are taken by shear walls. Providing shear walls at adequate locations substantially reduces the lateral displacements due to earthquake.

PUSHOVER ANALYSIS

The use of the nonlinear static analysis (pushover analysis) came in to practice in 1970‟s but the potential of the pushover analysis has been recognized for last two decades years. This procedure is mainly used to estimate the strength and drift capacity of existing structure and the seismic demand for this structure subjected to selected earthquake. This procedure can be used for checking the adequacy of new structural design as well. The effectiveness of pushover analysis and its computational simplicity brought this procedure in to several seismic guidelines (ATC 40 and FEMA 356) and design codes (Euro code 8 and PCM 3274) in last few years.

Pushover analysis is defined as an analysis wherein a mathematical model directly incorporating the nonlinear load-deformation characteristics of individual components and elements of the building shall be subjected to monotonically increasing lateral loads representing inertia forces in an earthquake until a „target displacement‟ is exceeded. Target displacement is the maximum displacement (elastic plus inelastic) of the building at roof expected under selected earthquake ground motion. The structural Pushover analysis assesses performance by estimating the force and deformation capacity and seismic demand using a nonlinear static analysis algorithm. The seismic demand parameters are storey drifts, global displacement(at roof or any other reference point), storey forces, and component deformation and component forces. The analysis accounts for material inelasticity, geometrical nonlinearity and the redistribution of internal forces. Response characteristics that can be obtained from the pushover analysis are summarized as follows:

1. Estimates of force and displacement capacities of the structure. Sequence of the member yielding and the progress of the overall capacity curve.
2. Estimates of force (axial, shear and moment) demands on potentially brittle elements and deformation demands on ductile elements.
3. Estimates of global displacement demand, corresponding inter-storey drifts and damages on structural and non-structural elements expected under the 20 earthquake ground motion considered.
4. Sequences of the failure of elements and the consequent effect on the overall structural stability.
5. Identification of the critical regions, when the inelastic deformations are expected to be high and identification of strength irregularities (in plan or in elevation) of the building. Pushover analysis delivers all these benefits for an additional computational effort (modeling nonlinearity and change in analysis algorithm) over the linear static analysis. Step by step procedure of pushover analysis is discussed next.

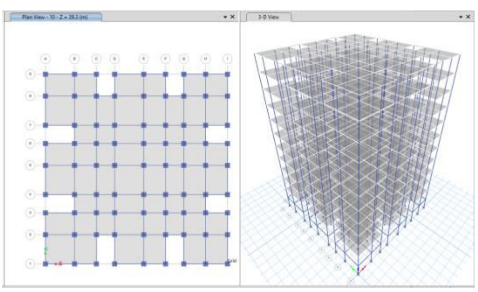
MODELING OF THE BUILDING

The following are the basic data considered for analysis

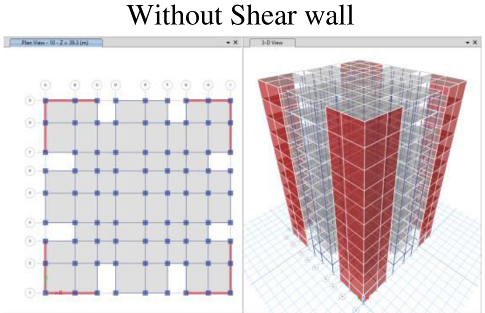
1. Height of typical Storey = 3 m
2. Height of ground Storey = 3 m
3. Length of the building = 15 m
4. Width of the building = 13 m

5. Height of the building =39 m
6. Number of stores = 12
7. Wall thickness = 230 mm
8. Slab Thickness = 150 mm
9. Grade of concrete = M40
10. Grade of the steel = Fe500
11. Support = Fixed
12. Column size = 460X690
13. Beam size =690X690
14. Location of Building =India
15. Live load = 5 KN/m^2
16. Dead load = 3 KN/m^2
17. Density of concrete = 25 KN/m^3
18. Seismic Zones = Zone 5
19. Site type = II
20. Importance factor = 1.5
21. Response reduction factor = 5
22. Damping Ratio = 5%
23. Structure class = C
24. Basic wind speed = 44m/s
25. Risk coefficient (K1) = 1.08
26. Terrain size coefficient (K2) = 1.14
27. Topography factor (K3) = 1.36
28. Wind design code = IS 875: 2015
29. RCC design code =IS 456:2000
30. Steel design code =IS 800: 2007
31. Earth quake design code =IS 1893: 2016

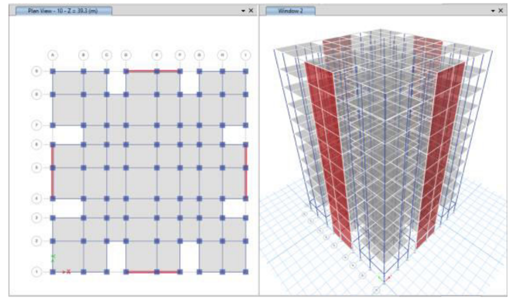
Models used



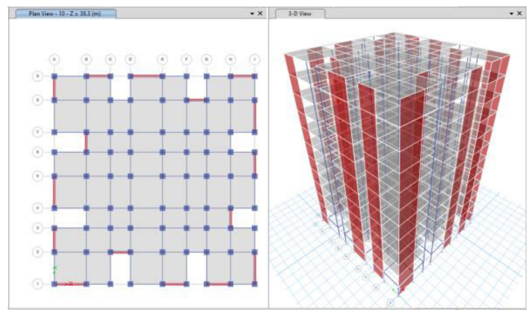
Without Shear wall



With corner shear wall



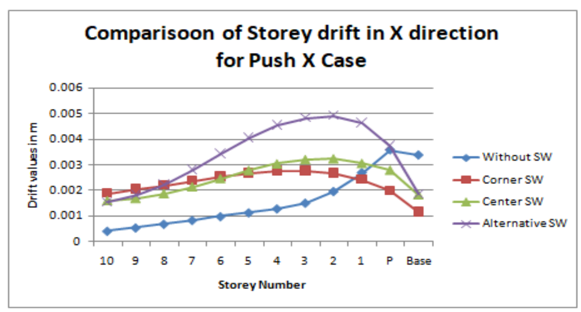
With center shear wall

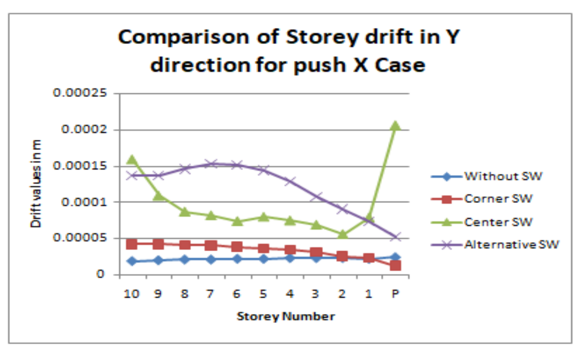


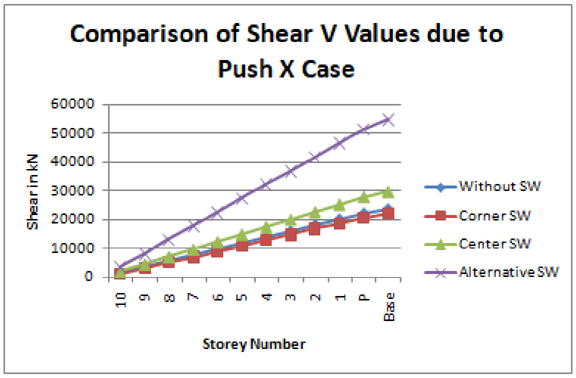
With alternative shear wall

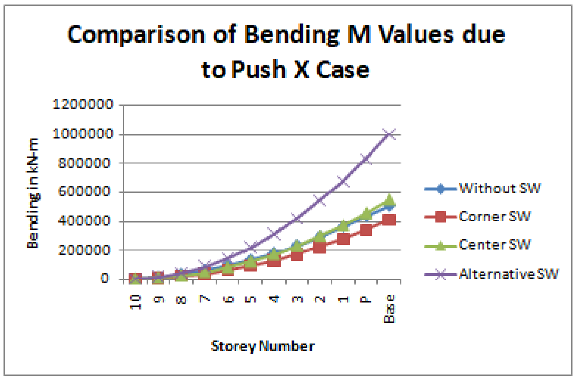
RESULTS AND ANALYSIS

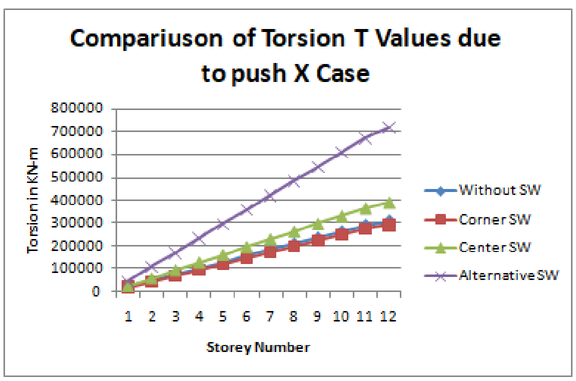
Push X Results

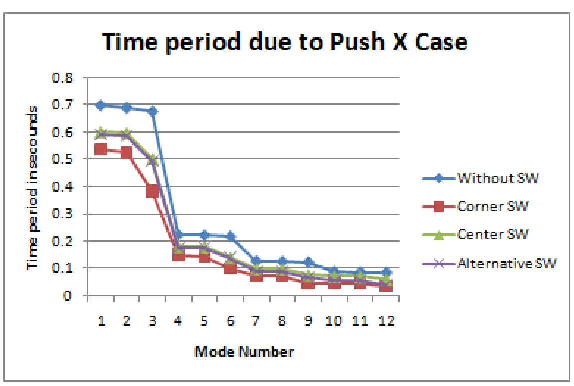


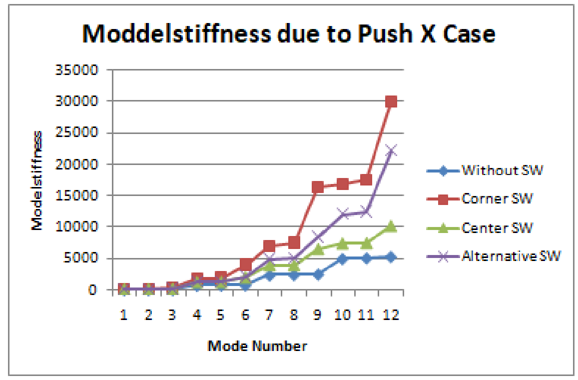




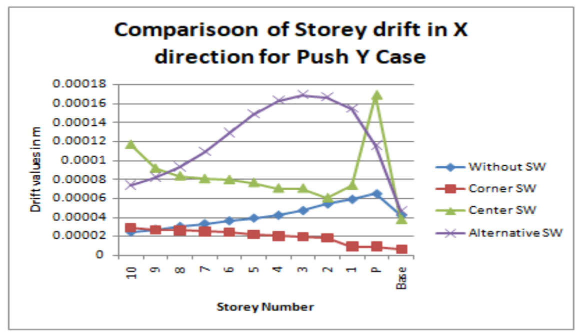


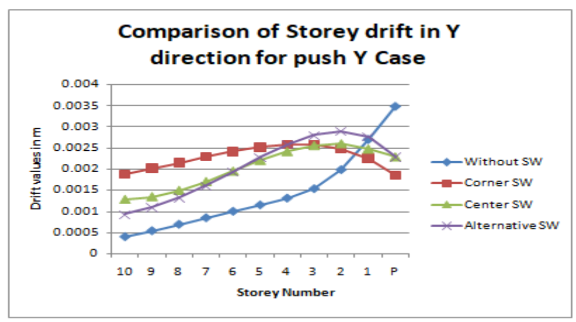


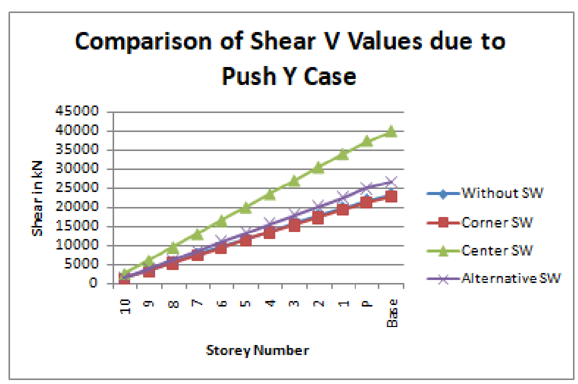


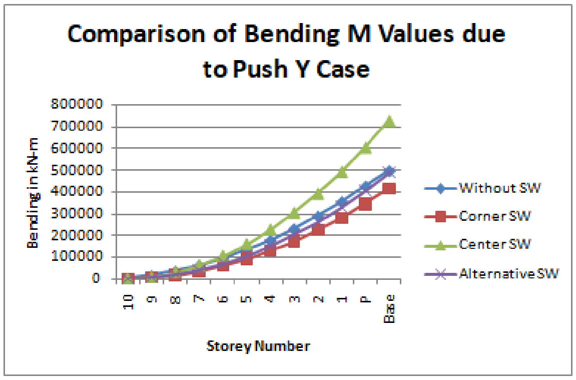


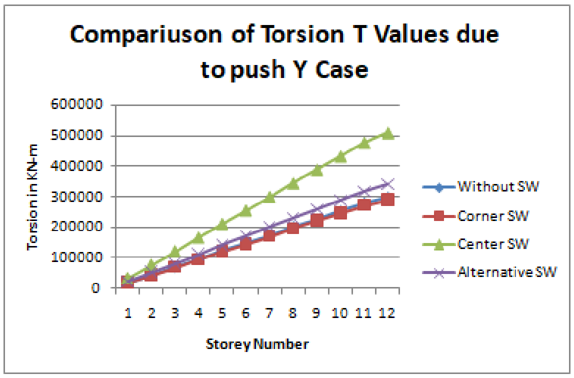
Push Y Results

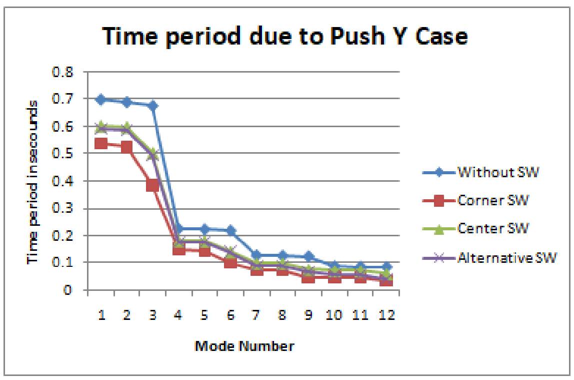


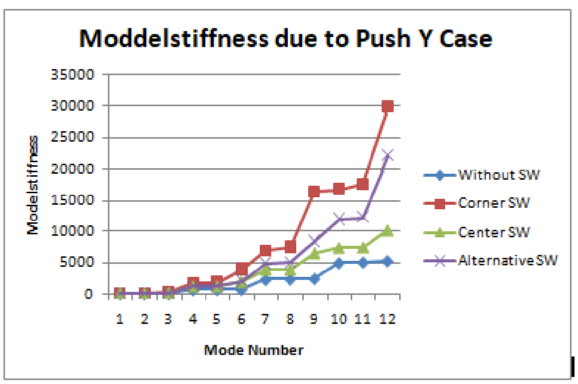












CONCLUSIONS

From this study the following conclusions were made

1. Top deflection was reduced and reached within the permissible deflection after providing the shear wall in shorter direction.
2. The shear wall location was found to be more effective towards shorter column as compared to other locations.
3. Shear wall symmetrically in the outer most moment resisting frames give better performance for regular shape building.
4. The value of drift is found to be lower value for building with shear wall at center than remaining cases.
5. The values of Shear in X Direction and Y Direction found lower value for building with shear wall at corner position than remaining buildings.
6. The values of Bending found lower value for building with shear wall at corner position than remaining buildings.
7. The value of deflection of building is found to be lower value for building with shear wall at center than remaining cases
8. It was observed for a particular opening in wall when the opening position is shifted from one position to other position.
9. From this study it was concluded that increase in the percentage of Shear wall results in decrease in the drift, deflection and increases the Shear force, bending moment.

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