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Seismic Analysis of High Rise Building using Shear Wall in SAP2000

Ayush Khajuria[1],Susanta Kr. Sethy[2],Mukesh Dubey[3] andAshish Yadav[4]

[1]Research Scholar, M.TechStructural Engineering WithSpl. In Offshore Structures,
University Of Petroleum & Energy Studies, Dehradun-248001, India
[2]Assistant Professor(SS), Department Of Civil Engineering,
University Of Petroleum & Energy Studies, Dehradun-248001, India
[3]Assistant Professor(SG), Department Of Civil Engineering,
University Of Petroleum & Energy Studies, Dehradun-248001, India
[4]Assistant Professor(SS), Department Of Civil Engineering,
University Of Petroleum & Energy Studies, Dehradun-248001, India

ABSTRACT:- *This study aims to analyze the seismic performance of shear wall building to ground motion. Shear wall has a high stiffness and strength which can be used to simultaneously resist large lateral forces.This work summarizes the results of analysis on different models of building and comparing the results obtained. The scope of the present work is to understand the behaviorof the high rise building for various positions of shear walls and to study the effectiveness of shear wall. Modeling of the structure and the performance of the reinforced concrete shear wall building has been studied with the help of SAP2000. Different models of building are made like bare frame and shear wall frame structure are considered in SAP 2000 and change in the performance of building with respect to story drifts, base shear and top-story deflection of the building for different position of shear wall in the building is observed and compared and presented in this paper.*

KEYWORDS: *High rise building, seismic analysis, story deflection, time period, lateral load resisting system, story drift,SAP2000,STAD-Pro*

I. INTRODUCTION

In the present situation land scarcity and increasing cost of land is the major problem that we are facing which has led to advancement in construction techniques and with urbanization, high rise construction has become a necessity, these buildings can be used for both for residential and as well as office purposes and these buildings has a very large impact on economy of society. With the increase in height of building lateral forces on these structure also increases, and poses challenges for seismic design so these buildings are needed to be properly designed for these forces, or else it may lead to the failure of the structures. To overcome these lateral forces Shear wall is provided in the structure. Shear walls are one of the most efficient lateral force resisting elements in multistoried buildings. Many modern construction uses shear wall as main source for lateral force resistance, and can also be used for seismic rehabilitation of existing buildings. Since plastic hinges forms in the beams and not in the wall shear wall, so shearwall is more reliable. In addition, benefit of reducing lateral sway in the building under seismic loading can be available using shear wall.

When shear walls are provided at a proper location in a building they can prove to be very efficient at the same time they can act as a partition wall. When the building is unsymmetrical about one of the principal axis and hence thelocation of theshear wall becomes crucial. It is important to select a position of shear wall that will offer the best resistance against the lateral forces. Building considered for a study purpose is a G + 11 residential building situated in seismic zone V. Structural plan of the building isshown in figure 1, and other analysis data is as shown in table 2 to 5Building is modeled by using finite element software SAP 2000. Beams and columns are modeled as two nodded beam element with six DOF at each node. Slab and shear wall is modeled by using shell element. Four models for the building are prepared as shown in figure 1. Pushover analysis is carried out on the models as per IS 1893:2002 (Part I). Pushover analysis has been the preferred for seismic performance evaluation of structures as Pushover analysis allows tracing the sequence of yielding and failure on member and structural level as well as the progression of the overall capacity curve of the structure. Comparison between each of the following model is made based on analysis results and are presented in graphical format

Model I : Is of frame type structural system or bare frame with no shear wall and other four models are of shear wall frame interaction system.

Model II: Shear walls are provided in-between 2nd to 6th column on all sides of the structure.

Model III: Shear walls are provided centrally i.e. in-between 3rd and 4th column on all sides of the structure.

Model IV: Shear walls are provided in-between 2nd& 3rd and in-between 4th and 5th column on all sides of the structure.

Model V:Shear walls are provided in-between 1st& 2nd and in-between 5th and 6th column on all sides of the structure.

II. OBJECTIVE OF STUDIES

a) This study concerns analysis of are frame and shear wall framed structure, using SAP2000 as per code IS 1893-2002 part I criteria for earthquake resistant structure. The effect of brick infill is ignored.
b) This study involves a11 storey building with normal floor loading and no infill walls.
c) To perform Dynamic analysis of the building using pushover analysis.
d) The comparison of fundamental period, base shear, inter-storey drift and top-storey deflection is done.

III. BUILDING DESCRIPTION & MODEL IMPLEMENTATION

A residential building of G+11 story having the base dimension of plan 25m x 25m with a floor of height 4m, the building plan is kept symmetrical to avoid the torsion irregularity. The structure is concrete reinforced structure and is modeled using standard software SAP000 as a space frame with a grid of columns in the vertical direction, interconnected with beam members in the orthogonal directions at each floor level. All slabs are modeled as membrane/shell elements wherever necessary. Fig. 1 shows the plan view of the structure without shear wall. The columns are of uniform size of 600mm x 600mm while the dimensions of the beams are 450x300mm. The analysis is done as per IS1893-2002, for seismic zone V and soil type II. Pushover analysis, analysis is carried out on all the models as per IS 1893:2002 (Part I).Comparison between each of the following model is made based on analysis results and are presented in graphical format. Dynamic Analysis is adopted as it gives better results than static analysis. Dynamic linear analysis using Pushover analysis is performed by taking zone factor Z V, Importance factor 1 and response reduction factor R=5. From the analysis results, obtained base shear are shown in Table
The specifications of the frame are given in Table 1. and the plan and the model of the building is shown in Fig1.

No. of bays along X direction	5
No. of bays along X direction	5
Bay Length along X direction	5
Bay Length along X direction	5
Concrete grade used	M30
Columns	.600x.600m
Beams	.450x.300m
Slab Thickness	140mm
Live Load	3 KN/m3
Zone	V
Soil Conditions	Medium Soil
Damping Ratio	5%

Table 1: Geometrical properties

The parametric study for following mentioned models is carried.
[1] Bare frame
[2] Shear wall structure

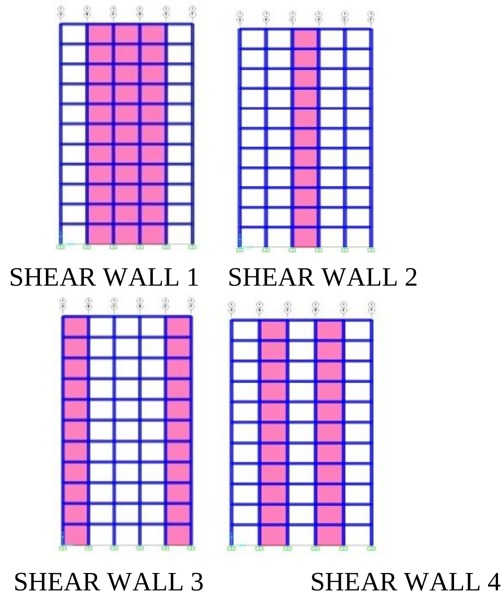


Figure 1-Different position of bracing

SHEAR WALL

Case 1 Shear walls are provided in-between 2^{nd} to 6^{th} column on all sides of the structure.
Case 2 Shear walls are provided centrally i.e. in-between 3^{rd} and 4^{th} column on all sides of the structure.
Case 3 Shear walls are provided in-between 2^{nd}& 3^{rd} and in-between 4^{th} and 5^{th} column on all sides of the structure.
Case 4 Shear walls are provided in-between 1^{st}& 2^{nd} and in-between 5^{th} and 6^{th} column on all sides of the structure.

Load Combination

Load combinations considered in this analysis are
1) 1.5(DL+LL)
2) 1.2(DL+LL+EQX)
3) 1.2(DL+LL-EQX)
4) 1.2(DL+LL+EQZ)
5) 1.2(DL+LL-EQZ)
6)0.9 DL+1.5EQX
7) 0.9DL-1.5EQX
8) 0.9DL+1.5EQZ
9) 0.9DL-1.5EQZ

IV. RESULT AND DISCUSSION

The results obtained from the analyses carried out will be summarized in the following. In particular, the responses of the G+11 high structure under study will be compared and used to describe and discuss the behavior of their lateral-force resisting systems, when subjected to earthquake loading.The building frames were subjected to nonlinear static pushover analysis by comparing various parameters such as story displacement, Storey drift, story deflection, base shear, time period and have been shown in the form of graphs. Base shear for bare frame was checked using two different software namely Staad-Pro and SAP2000 and they were almost similar.

Variation of base shear, story deflection, story drift and time period

Displacement, Storey drift, story deflection, base shear, time period are found using sap2000. The results are shown in table 2 to 5& in graph 1 to 2 which are listed below. From Table 3 and graph 1, it is observed that base shear in brace frame 2 is less as compared to other bracing position. The base shear for PUSH load case for brace frame 2. From Table I, time period is also more for case 2 brace frame. As base shear increases time period of models decreases and vice versa. Building with short time period tends to suffer higher accelerations but smaller displacement. Therefore, from table 4 & 5, graph 2 story deflections is also less for case 2 and 1 in brace frame. Story drift i.e. top story displacement is also reduced for case 2 & 1 in brace frame.

Cases	Time period
Bare frame	2.85
Brace frame 1	0.71
Brace frame 2	1.61
Brace frame 3	1.45
Brace frame 4	1.35

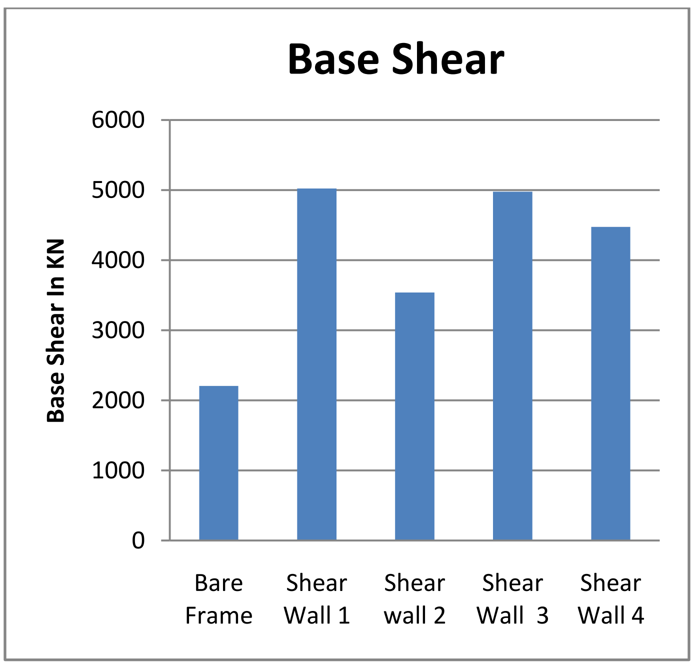
Table 2 Time period in sec

	Base Shear			
Bare Frame	Shear Wall 1	Shear wall 2	Shear Wall 3	Shear Wall 4
2204.56	5022.19	3538.97	4975.59	4476.84

Table 3 Design Base Shear in KN

CASE	BARE FRAME	SHEAR WALL 1	SHEAR WALL2	SHEAR WALL3	SHEAR WALL4
TOP-STOREY	98.8	35.6	80.6	63.4	66.7

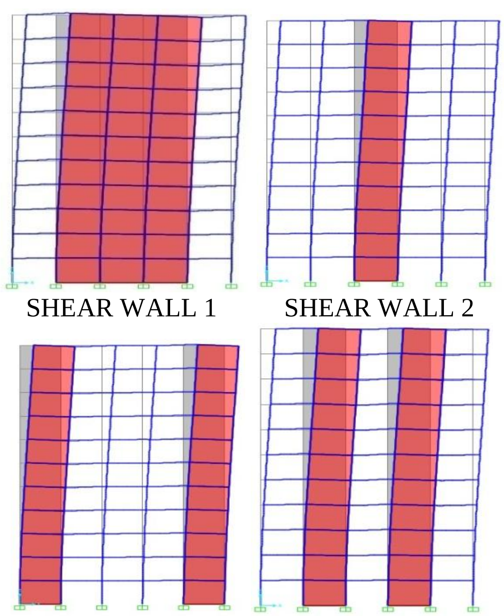
Table 4 Top Story deflection in mm



Graph 1Base Shear in KN

STOREY	BARE FRAME	SHEAR WALL 1	SHEAR WALL 2	SHEAR WALL 3	SHEAR WALL 4
0	0	0	0	0	0
1	5.7	1.7	2.2	1.4	1.4
2	16.4	2.8	6.5	4.5	4.9
3	28.4	5.3	12.9	8.9	9.8
4	40.6	8.4	20.5	14.4	15.9
5	52.4	11.8	29.0	20.7	22.7
6	63.6	15.7	38.4	27.6	30.1
7	73.9	19.6	47.5	34.79	37.6
8	82.9	23.7	55.9	42.0	45.2
9	90.2	27.8	64.4	49.3	52.6
10	95.5	31.8	72.4	56.5	59.8
11	98.8	35.6	80.6	63.4	66.7

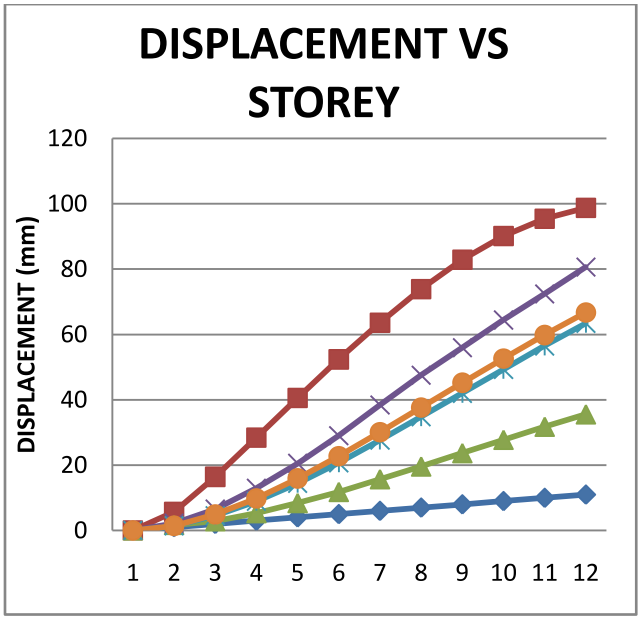
Table 5 Story deflection in mm



SHEAR WALL 1 SHEAR WALL 2

SHEAR WALL 3 SHEAR WALL 4

Figure 2- Story Deflection in Diagram



Graph 2 Storey Displacement in mm

V. CONCLUSIONS

Hence from the obtained results we conclude that the effect of top story displacement, story drift andstory shear are more in case of bare frame which is analyzed using SAP2000 i.e. story drift is not within permissible limit hence there is need of providing shear wall for lateral stiffening of the building. By considering shear wall we have studied the behavior of chosen system. When we studied behavior of all parameters like point displacement, story drift andstory shear by providing shear wall in different location then we had found that the best location for structure. It shows that shear wall is a good lateral stiffening technique.

a) In high-rise multistoried buildings lateral displacement is very high if the shear wall is not provided to the buildings then the displacements are very large..

b) Presence of shear wall in structure influences the story drift. Model 2 shows the minimum value of story drift. It means if we provide shear wall at corner portion then it can reduce maximum drift to the structure.

c) There is 63.93% percentage decrease in top storey displacement for model II, and the storey drift was within permissible limits.

d) It is observed that in cases of shear wall top storey displacement is reduced than bare frame, and all cases of shear wall follows the same trend.

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