Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 12, December -2017

Seismic Analysis of High Rise Building with Lateral Stiffening System using SAP2000

Ayush Khajuria[1],Susanta Kr. Sethy[2], Mukesh Dubey[3] and Ashish 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 high-rise structure to ground motion, as many of the important Indian cities fall under high risk seismic zones, hence proper designing and strengthening of structure for lateral forces is required to increase seismic property of structure. Different models of building are made like bare frame, brace frame and shear wall frame structure are considered in SAP 2000 and change in the storey drifts, base shear and top-storey deflection of the building is observed and compared. This work summarizes the results of a series of analysis on various models which are devoted to assess peculiar aspects in the seismic response of high-rise building prototypes with bracing and shear wall were designed in accordance with Indian rules.*

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

I. INTRODUCTION

Most of the Indian cities are susceptible to damage due to the earthquake as most of them lies in high seismic zone. Therefore, it has become necessary to take in to account the lateral forces for the design purpose in the design high-rise building. Many lateral load resisting systems are used in high-rise building: 1.Braced frame 2.Shear wall frame. In highrise buildings the seismic loads due to earthquake are high as compared to other loads and these seismic forces can produce critical stresses in the building and can induce undesirable stresses in the building and can cause undesirable vibrations or cause excessive sway in the structure. The ground vibration causes the structures resting on the ground to vibrate, developing inertial forces in the structure. Drift is the magnitude of the lateral displacement at the top of the building relative to its base.Seismic design approach state that, the structure should be able to ensure any minor or frequent shaking intensity without sustaining any damage, and leaving the structure serviceableeven after the event of seismic vibration or earthquake. The structure should be able endure moderate level of earthquake ground motion without any structural damage to the building, but possibly with some structural as well as non-structural damageto the building after a high intensity earthquake. Earthquake intensity is taken as, equal to the strongest experienced earthquake in that area or forecast at the site.In present study the effect of bare frame, brace frame and shear wall frame is studied under the seismic loading. The main parameters considered in this study to compare the seismic performance of different models are storey drift, base shear, story deflection and time period.

II. OBJECTIVE OF STUDIES

[1] To analyze the building as per code IS 1893-2002 part I criteria for earthquake resistant structure using SAP2000 software.

[2] Dynamic analysis of the building using pushover analysis.

[3] to analyze building with different lateral stiffness systems at different locations.
[4] To demonstrate the possibilities and limitation of different lateral stiffness system.
[5] To get economical and efficient lateral stiffness system.

III. LITERATURE REVIEW

Chandurkar et al. (2013) evaluated the response of a 10 storey building with seismic shear wall using ETAB v 9.5. And reported that the changing positions of shear wall was found to attract forces, hence proper positioning of shear wall is vital and placing shear wall at substantial locations reduced displacements due to earthquake.
Viswanath K.G (2010) investigated the seismic performance of reinforced concrete buildings using concentric steel bracing. And reported that X- type bracing were found to have minimum bending as compared to other types of bracing.
Kappos ,Manafpour (2000) presented new methodology for seismic design of RC building based on feasible partial inelastic model of the structure and performance criteria for two distinct limit states. It was found that behaviour under "life-safety" was easier to control than under serviceability earthquake because of the adoption of performance criteria involving ductility requirements of members for "life-safety" earthquake.

IV. METHODOLOGY

Analysis of 10 stories high building as shown in the Fig.1 having 5 bays in the X and 5 bays in the Y direction with each bay length of 5m and 5m, was done in SAP2000 as a space frame and pushover analysis was performed to calculate the base shear.. The building is a residential building having G+10 floors with 4m storey height. The building plan is kept symmetrical in both the directions to avoid the torsion irregularity. The columns are of uniform size of 600m x 600cm while the dimensions of the beams are 40cm x 50 cm. The analysis is done as per IS1893-2002, for seismic zone V and soil type II. The building is analyzed by Pushover analysis, which is a linear dynamic analysis. Dynamic Analysis is adopted since it gives better results than static analysis.
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	
Slab Thickness	140mm
Live Load	3kN/m3
Zone	V
Soil Conditions	Medium Soil
Damping Ratio	5%

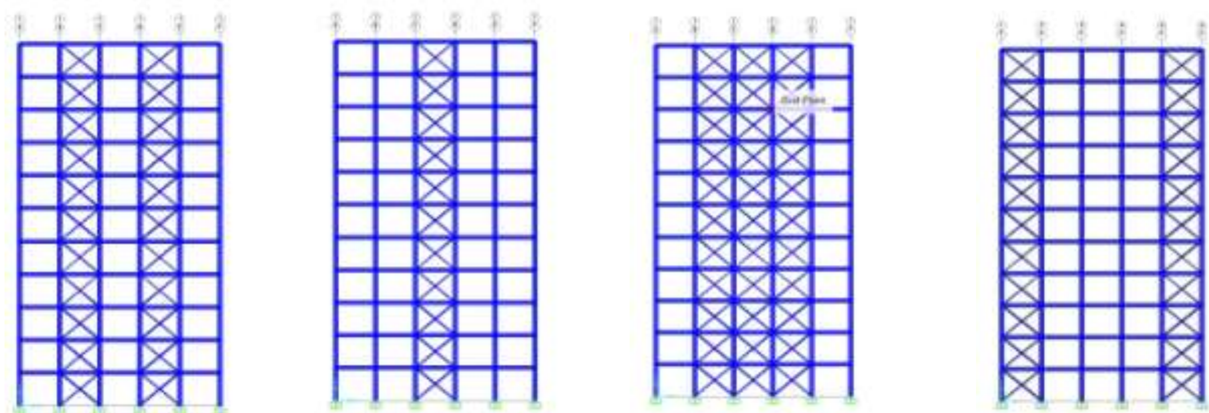
Table 1: Geometrical properties

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

Brace wall frame
Case 1 Brace frame is locatedat second and fourth bay of both X & Y direction throughout height at exterior frame.
Case 2 Brace frame is located at central bayof both X& Y direction throughout the height at exterior frame.

Case 3 Brace frame is located at second, third and fourth bay of building in both X and Y direction throughout height at exterior frame.
Case 4 Brace frame is located at end corners of building in both X and Y direction throughout height at exterior frame.

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) DL+1.5EQX
7) DL-1.5EQX
8) DL+1.5EQZ
9) DL-1.5EQZ



BRACE FRAME1 BRACE FRAME 2 BRACE FRAME 3 BRACE FRAME 4

Figure 1-Different position of bracing

V. RESULT AND DISCUSSION

On all building frames the nonlinear static pushover analysis is performed to investigate various parameters such as storey displacement, Storey drift, story deflection, base shear, time period are calculated at performance point of the building frame. Base shear for bare frame was also calculated using Staad-Pro and compared with SAP2000 they were almost similar.

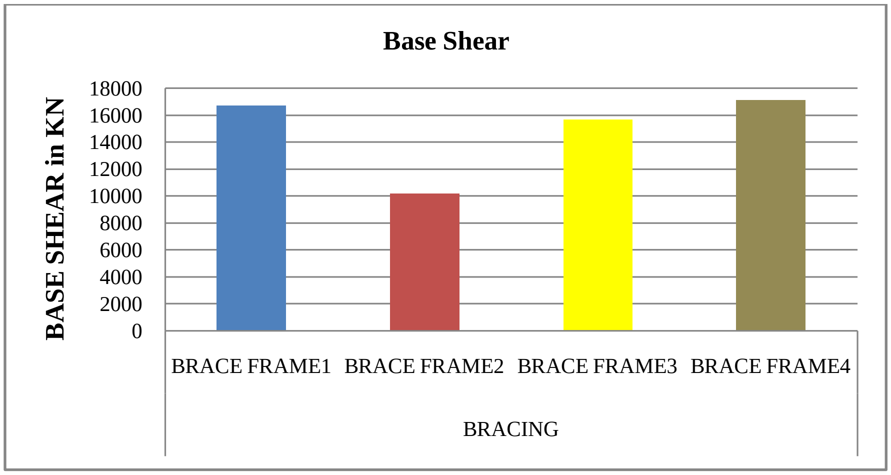
Variation of base shear, story deflection, storey drift and time period
The parametric study to know displacement, Storey drift, story deflection, base shear, time period are calculated at performance point in case of all models are performed here. After pushover analysis the demand curve and capacity curves are obtained to get the performance point of the structure.The results are shown in table 2 to 6 & in graph 1 to 2 which are listed below. From Table 3 and graph 1, it is observed that base shear at performance point in brace frame 2 is less as compared to other bracing position. The base shear for PUSH load case for brace frame 2 is10169.27KN. 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	2.75
Brace frame 2	3.18
Brace frame 3	2.33
Brace frame 4	2.75

Table 2 Time period in sec

Base Shear at Performance Point			
Brace frame1	Brace frame 2	Brace frame 3	Brace frame 4
16735.55	10169.27	15655.17	17113.78

Table 3 Design Base Shear in KN



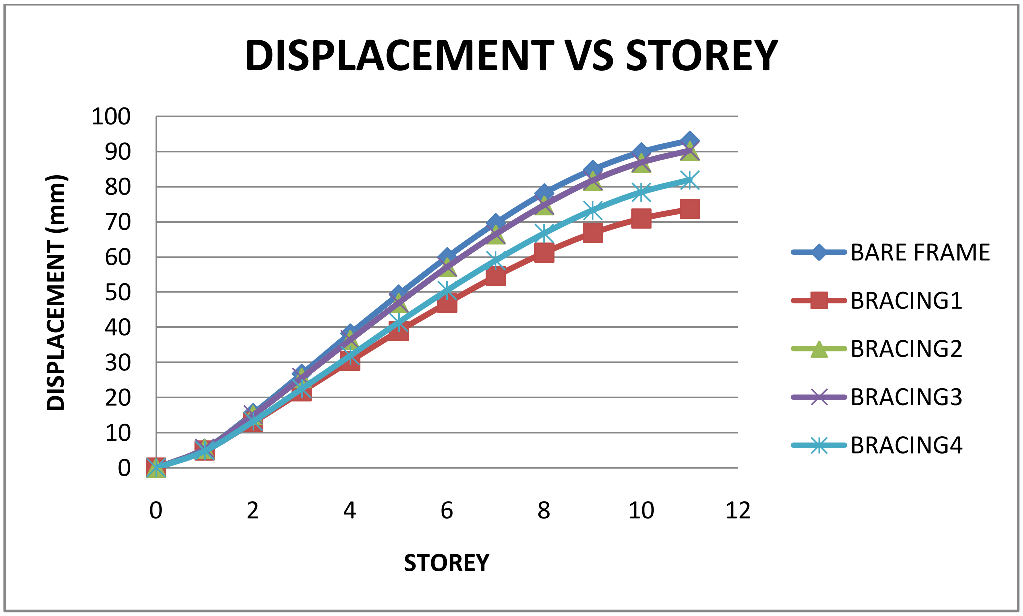
Graph 1Base Shear in KN

STOREY	BRACE FRAME 1	BRACE FRAME 2	BRACE FRAME 3	BRACE FRAME 4
0	0	0	0	0
1	4.8	4.9	5.4	4.8
2	13.2	13.0	15.0	13.2
3	22.4	21.7	25.6	22.5
4	31.8	30.4	36.4	31.9
5	41.0	38.9	46.9	41.4
6	49.9	46.9	57.1	50.5
7	58.2	54.5	66.4	59.0
8	65.6	61.2	74.7	66.7
9	71.8	66.8	81.7	73.3
10	76.7	70.9	86.8	78.4
11	79.8	73.6	90.2	81.9

Table 4 Storey deflection in mm

CASE	BARE FRAME	BRACE FRAME 1	BRACE FRAME 1	BRACE FRAME 1	BRACE FRAME 1
TOP STOREY	93.1	79.8	73.6	90.2	81.9

Table 5 Top Storey deflection in mm



Graph 2 Storey Displacement in mm

CASE	BRACE FRAME 1	BRACE FRAME 2	BRACE FRAME 3	BRACE FRAME 4
S_a	0.114m/s^2	0.089 m/s^2	0.145 m/s^2	0.114 m/s^2
S_d	0.218m	0.227m	0.195m	0.217m

Table 6Structural Acceleration and Displacement

VI. CONCLUSIONS

- Linear analysis could not give useful information. From the analysis results it can be seen that the base shear at performance point in case of building frame with bracing are increased compared to base shear in case of building frame without Bracing. Proper positioning of bracing in building can reduced the natural time period of building and base shear in the building.

- A significant amount of decrease in story drift has been observed in case 2 and 3 i.e. lateral stiffness system is centrally located at exterior frame of X& y direction throughout height and lateral stiffness system is centrally located at exterior frame of X & Y direction throughout height in both brace frame compared to other models.

- A significant amount of decrease in time period of model in case 2 and 3 i.e. lateral stiffness system is centrally located at exterior frame of X direction throughout height and lateral stiffness system is centrally located at exterior frame of X & Z direction throughout height in both brace frame and shear wall frame compared to other models, therefore displacements in the structure are minimized.Building with short time period tends to suffer higher accelerations but smaller displacement.

- Comparing the top storey drift in the longitudinal direction, it can be seen that it decrease by 14.23%, 20.95%, 3.11% and 12.03% in case 1,2, 3 and 4 of brace frame as compared to bare frame.A significant amount of increase in the lateral stiffness has been observed in all models of brace frame as compared to bare frame.
- Plastic Hinges distribution observed wasuniform in all stories. The damages distribution also in all stories uniformly.If the building or structure strengthened and stiffened time period has been decreasing by providing lateral resistance system as well increased base shear

VII. REFERENCES

1) Srikanth, V.Ramesh, "Comparative Study of Seismic Response for Seismic Coefficient and Response Spectrum Methods"
2) Awkar J. C. and Lui E.M, "Seismic analysis and response of multi-storey semi rigid frames",
3) Andreas J. Kappos, AlirezaManafpour, '*Seismic design of R/C buildings with the aid of advanced analytical techniques'*
4) PankajAgrawal, Manish Shrikhande, *'Earthquake Resistant Design of Structures',* Prentice Hall India Publication .
5) Viswanath K.G (2010) 'seismic performance of reinforced concrete buildings using concentric steel bracing'
6) Chopra A.K., Dynamics of structures- theory and applications to earthquake engineering
7) Chopra, A.K and Goel, R.K "A Modal Pushover Analysis Procedure to Estimate Seismic Demands for Unsymmetrical-plan Buildings" Earthquake Engineering Structure.
8) IS CODES:

IS:456:2000 Plain and Reinforced code of practice, IS: 875 Code of practice for design loads,
IS:1893(Part-1):2002 Criteria for earth quake resistant design of structure,
IS:13920:1993 Ductile detailing of RCC structure subjected to earth quake force.

