International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** VIII **Month of publication:** August 2016

DOI:

Volume 4 Issue VIII, August 2016
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Seismic Behaviour Of Multistorey RCC Structure With Different Locations Of Rc X Bracing For Different Aspect Ratio

Jumi K M[1], Dr. Sreemahadevan Pillai.[2]
[1]*PG Student, Department of Civil Engineering, NSS College of Engineering, Palakkad, India*
[2]*Professor, Department of Civil Engineering, NSS College of Engineering, Palakkad, India*

Abstract - A structure situated in high seismic area will have to withstand lateral load along with the gravity load. This may result in the development of high stress which leads to the severe damage of the structure. Shear wall, bracings are the most common type of lateral load resisting systems. The types of bracing, location of bracing have significant effects to the lateral capacity of the structure. This paper present an elastic seismic response of reinforced concrete frames with reinforced concrete braces in X braced pattern which are analyzed numerically for eleven storey building with 5-bay structures. The responses of braced frames of different patterns (bay, level and combinations thereof) have been compared with each other and also with unbraced i.e. bare frame. Also the results for different aspect ratio has also been studied. Results are concluded from graphs and discussed comprehensively.
Key Words: Bracing Configuration; Etabs 9.7.2; Linear Static Analysis; Response Spectrum Analysis; Aspect Ratio…..

I. INTRODUCTION

The primary purpose of all kinds of structural system in a building is to transfer the gravity load effectively and thus ensure safety of the structure. Apart from these vertical loads, structure is also subjected to lateral loads which can develop high stress resulting in the sway of the structure. So the structure should be such that it has sufficient strength and stiffness against these loads. Bracings, shear walls are the common lateral load resisting systems.

Reinforced concrete structures having tall heights in earthquake prone areas cannot withstand large displacements on its own. To resist the drifts and large displacements in buildings which may cause damage to buildings and death to humans, can be resisted to a large extend by using bracing systems. The main objective of the present work is to find a suitable bracing configuration that will effectively reduce the response of the structure to external excitation (seismic excitation) along with economy.

The main objectives of this study is to evaluate the seismic behavior of RC building retrofitted with RC X bracing by performing response history analysis. A comparative study of seismic performance is done for concentrically placed lateral load resisting systems at different locations like bay wise, level wise and their combinations. Seismic performance with different aspect ratio is also evaluated. The time period, Storey displacement and storey drift are the parameters considered for the comparison.

II. THEORETICAL BACKGROUND

A Braced Frame is a structural system which is designed primarily to resist wind and earthquake forces. Bracings resist the lateral load by bracing action of inclined members. They stimulate forces in the associated beams and columns such that the whole work like a truss subjected to axial stress. This axial stress reduces the moment which in turn results in the reduced sections of the columns.

The bracing members are arranged in many forms, which carry solely tension, or alternatively tension and compression. The bracing is made up of crossed diagonals, when it is designed to resist only tension. Based on the direction of wind, one diagonal takes all the tension while the other diagonal is assumed to remain inactive. One of the most common arrangements is the cross bracing. Bracings hold the structure stable by transferring the loads sideways (not gravity, but wind or earthquake loads) down to the ground and are used to resist lateral loads, thereby preventing sway of the structure.

Aspect ratio is defined as the ratio of the total height to the base width of the building.

III. MODELLING AND ANALYSIS

Structural modeling is a tool to establish a mathematical models consisting of three basic components: structural members or components, joints (nodes, connecting edges or surfaces), and boundary conditions (supports and foundations).

Structural analysis is a process to analyze a structural system to predict its responses and behaviors. The main objective of structural analysis is to determine internal forces, stresses and deformations of structures under various load effects.

A. Analysis Software

For the present study the software used is ETABS. ETABS is a Powerful and Integrated Structural Analysis and Design Software. ETABS is comprehensive software were we could carry out Finite Element Modelling, Static, Dynamic and Non-Linear Analysis and Design of Structures. The geometry can be idealized by considering the structure to be made up of linear elements and plane two-dimensional elements. The program ETABS is employed herein to perform the response spectrum analysis.

B. Building Configurations and Details

The (G + 10) RCC building with a storey height of 3.5m in each floor has 5 bays in X – direction and 5 bays in Y – direction forming a plan dimension of 25m x 20m. The building is kept symmetric in both mutually perpendicular directions in plan to avoid torsional effects. The orientation and size of column is kept same throughout the height of the structure. The building is considered to be located in seismic zone V as per IS: 1893-2002. Structural details of the building such as grade of concrete, grade of steel, beam sizes, column sizes and all the other parameters are assumed as per Table I.

Table 1: Description of Building Model

No	Building Details	
1	Grade of concrete	M25
2	Grade of steel	Fe 415
3	Floor to floor height	3.50 m
4	Slab thickness	120 mm
5	Column	450 X 900
6	Beam	350 X 500
7	Bracing	200 X 200
10	Live load	3.5 kN/m^2
11	Floor finish	1.5kN/m^2

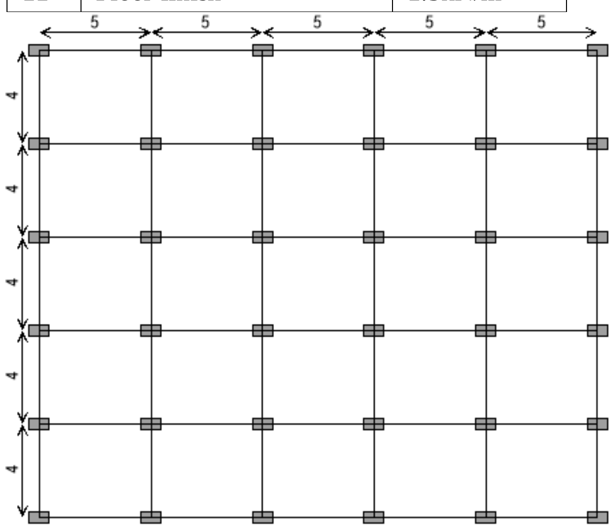

Fig. 1: Building Plan

C. Finite Element Model

A three dimensional finite element modelling of the structure was carried out using the ETABS 9.7.2. Beam and columns were modelled as frame elements .Whereas the slab was modelled as a thin shell element which combines both membrane and plate bending action. A rigid floor diaphragm constraint was provided so that all the constrained joint act as a planar diaphragm. Braces were modeled as truss element. Response Spectrum analysis was carried out to study the effect of location of bracings on the seismic behaviour of the above structure.

Volume 4 Issue VIII, August 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

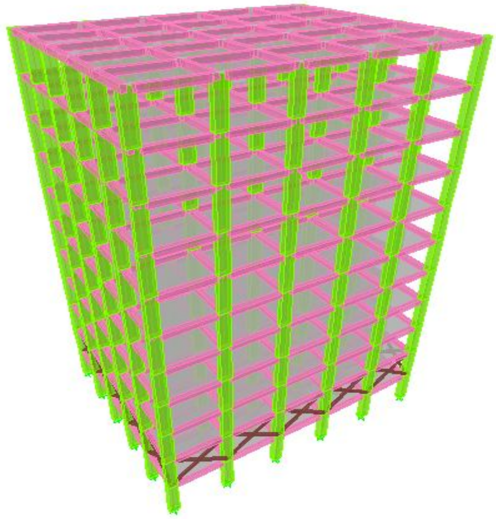

Fig. 2: 3-D Model of the Building

IV. RESULT & DISCUSSION

A. Bare Frame

The building is kept symmetric in both mutually perpendicular directions in plan to avoid torsional effects. The orientation and size of column is kept same throughout the height of the structure. The columns are oriented in such a way that the depth is along the longest span.

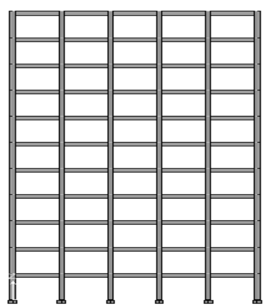

Fig. 3: Bare Frame

B. Optimum Level wise Location

To study the behavior of level wise bracing pattern 5 bay 12 storeyed structures are modeled and analyzed. A typical bracing pattern of this type is shown in Fig.3.

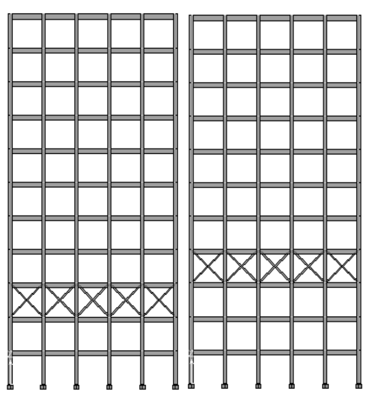

Fig. 4: Level Braced Frames

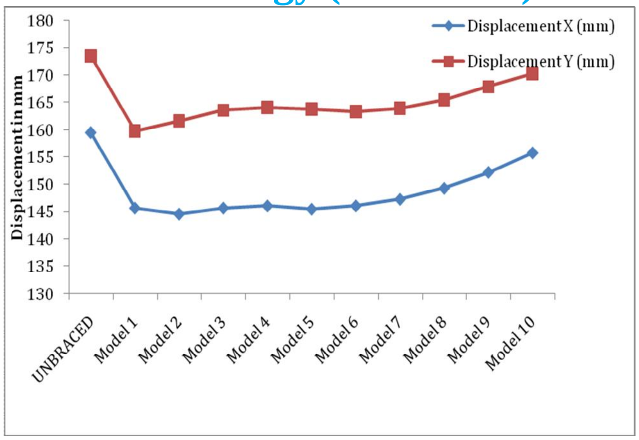

Chart 1: Variation of displacement

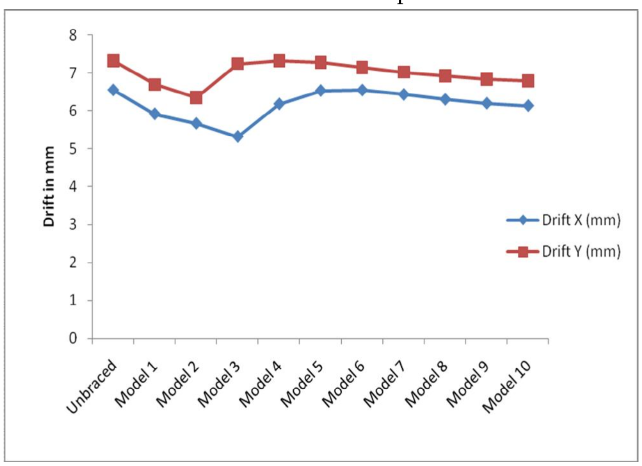

Chart 2: Variation of drift

When the position of the bracings changed from level 1 to level 10, the time period of the structure was found to increase. But minimum time period was observed when the bracings are provided at the second level. The drift was also seemed to be minimum at that level. The displacement and drift reduced considerably after providing bracings level wise. It was found to be minimum when bracings are provided in the second level along the transverse direction and third level along the longitudinal direction i.e. at the level where the drift was maximum when unbraced.

Aspect Ratio	Time Period sec	Displacement Y mm
1.925	1.3147	159.8
1.750	1.2153	146.3
1.575	1.0740	130.3
1.400	0.9346	114.1
1.225	0.7968	97.0
1.050	0.6608	84.5

Table 2: Time Period and Displacement for different Aspect Ratio

Volume 4 Issue VIII, August 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

From table 2, it is clear that, as the aspect ratio decreased, the time period and corresponding displacement found to decrease.

C. *Optimum Bay wise Location*

To study the behavior of baywise bracing pattern 5 bay 12 storeyed structures are modeled and analyzed numerically. A typical bracing pattern of this type is shown in Fig. 6

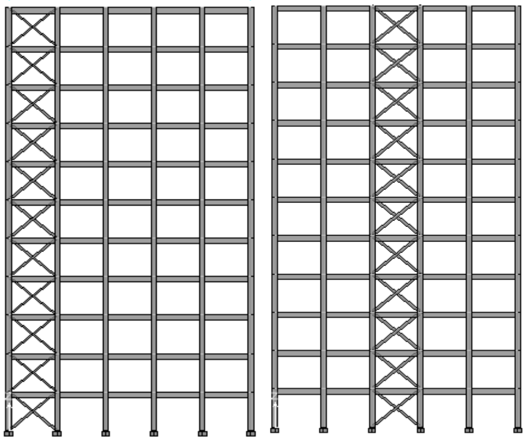

Fig. 5: Bay Braced Models

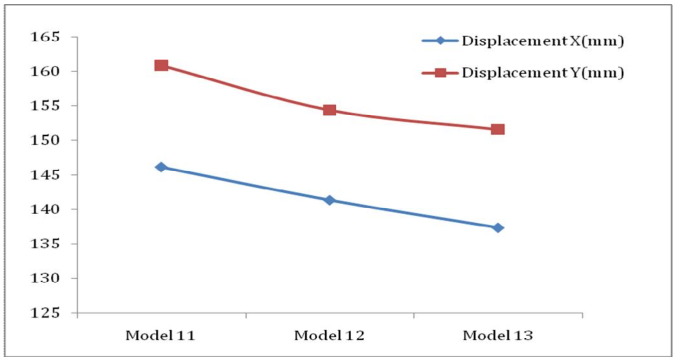

Fig. 6: Variation of displacement

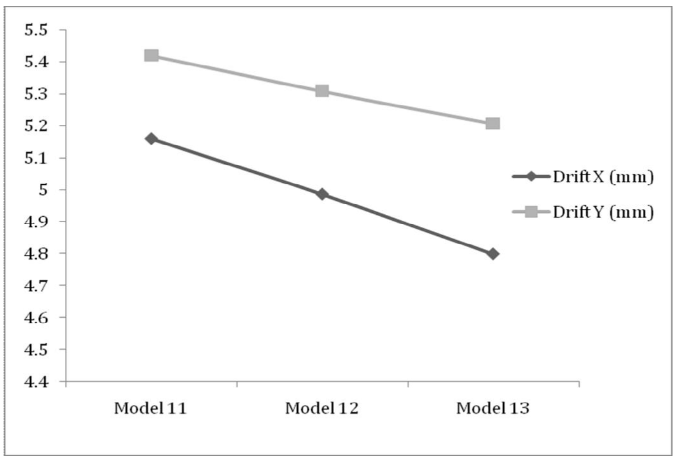

Fig. 7: Variation of drift

When bracings position is changed from first bay to the third bay, the time period of the structure tend to decrease. The bracings provided in the third bay was found to be effective in controlling the roof displacement and the maximum inter storey drift.

Volume 4 Issue VIII, August 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Aspect Ratio	Time Period sec	Displacement Y mm
1.925	1.2417	151.5
1.750	1.1531	141.4
1.575	1.0267	125.3
1.400	0.9023	110.7
1.225	0.7799	95.2
1.050	0.6597	82.5

Table 3: Time Period and Displacement for different Aspect Ratio

Table 3, shows the variation of time period and displacement for different aspect ratio. The time period and corresponding displacement was found to be minimum for the least aspect ratio..

D. Partially Braced Frames

The logic of placing the braces bay wise and level wise share the algorithm which allows for combining them evolving a "braced frame with outrigger" i.e. a partially braced frame which results in the new combination of above two scenarios. To study the behavior of such outrigger frames, 5 bay 12 storey structures are modeled and analyzed. A typical frame of this type is shown in Figure below

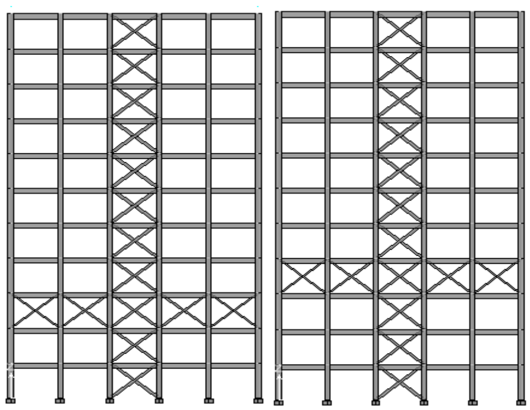

Fig. 8: Level and bay braced models

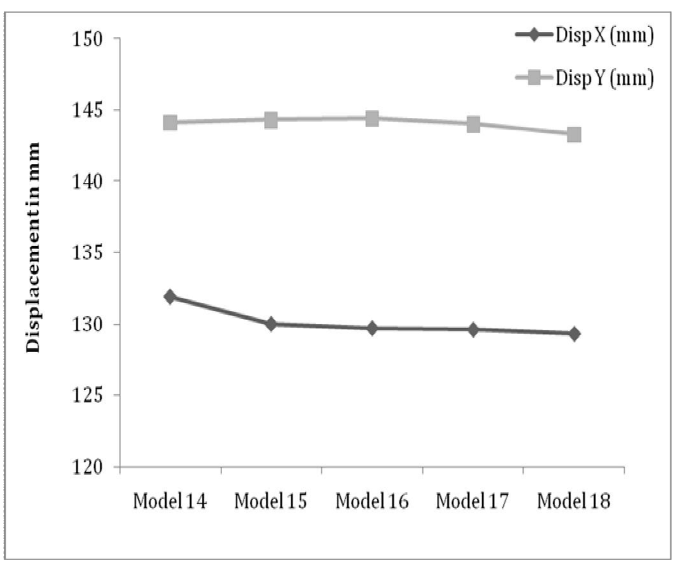

Fig. 9: Variation of displacement

Volume 4 Issue VIII, August 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

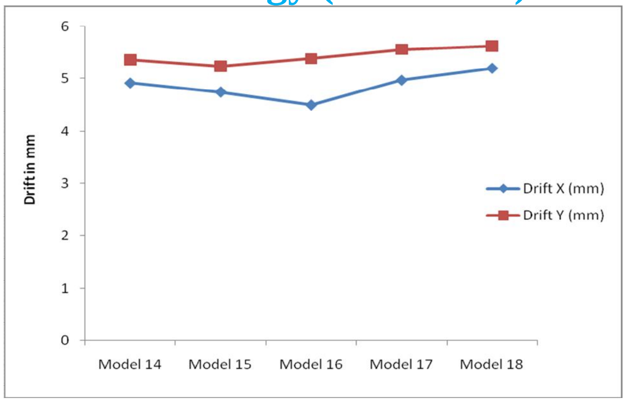

Fig. 10: Variation of drift

Aspect Ratio	Time Period sec	Displacement Y mm
1.925	1.1348	144.3
1.750	1.0476	131.7
1.575	0.9241	116.9
1.400	0.8038	100.5
1.225	0.6875	89.1
1.050	0.5766	72.7

Table 4: Time Period and Displacement for different

Aspect Ratio

Bracings are provided as combinations of level and bay. The bay position is kept as constant changing the level position. The third bay is braced and the level position changed from first to fifth. The time period initially decreased then increased. The minimum time period was obtained when second level was braced along with the third bay.. The drift was also found to be minimum when bracings are provided in the second level and third level in the transverse and longitudinal direction respectively. The reduction in displacement was around 20%.

The variation of time period and displacement with respect to aspect ratio is shown in table 4. A drastic decrease in displacement was observed for the model with the least aspect ratio.

V. CONCLUSIONS

A. A significant amount of increase in the lateral stiffness has been observed in all models of braced frame compared to bare frame.
B. Time period was found to be decreasing when bracings are provided in the lower levels.
C. Usage of bracings increase the base shear on the buildings
D. It was found that more effective configuration is obtained when bracings are placed in that level which is subjected to high lateral drift when unbraced.
E. Bracings seemed to be not much effective when placed at higher levels.
F. Maximum reduction in displacement and drift was observed when third bay and second level in case of transverse direction and third bay and third level in case of longitudinal direction is braced.
G. The time period and top storey displacement of the building changed with the aspect ratio. Maximum reduction in the response was

obtained for the least aspect ratio.

REFERENCES

[1] Ashik S. Parasiya and Paresh Nimodiya (2013), "A review on comparative analysis of brace frame with conventional lateral load resisting RC frame using software", International Journal of Advanced Engineering Research and Studies, Vol. 3, Issue I, pp.88-93

[2] Banihashemi and et al (2015), "Performance-based plastic design method for steel concentric braced frames", International Journal of Advanced Struct Eng, Vol. 7, Issue 3, pp.281–293

[3] Chandurkar P.P (2013), "Seismic analysis of RCC Building with and without Shear wall-A literature review on experimental study, International Journal of Modern Engineering Research (IJMER), Vol. 3, Issue. 3,pp. 1805-1810

[4] Ghadge .S.A, Prof. Patil S.S., Prof. Konapure C.G. (2013), "Equivalent Static Analysis of High-Rise Building with Different Lateral Load Resisting System", International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 1, pp.1-9

[5] Hussain Imran K.M and Sowjanya G.V (2014), "Stability Analysis of Rigid Steel Frames With and Without Bracing Systems under the Effect of Seismic and Wind Loads", International Journal of Civil and Structural Engineering Research, Vol. 2, Issue 1, pp.137-142.

[6] Khaloo A. R & M. Mahdi Mohseni, (2008) "Nonlinear Seismic Behaviour of RC Frames with RC Braces", Asian Journal of Civil Engineering, Vol. 9, No. 6, pp.577-592.

[7] Kulkarni J. G., Kore P. N, Tanawade S. B, (2013) " Seismic Response Of Reinforced Concrete Braced Frames", International Journal of Engineering Research and Applications (IJERA) ,Vol. 3, Issue 4, pp.1047-1053

[8] Kulkarni J. G and Kore P. N and Swami P. S.(2015), "Seismic Response of Cell wise Braced Reinforced Concrete Frames", International Journal of Current Engineering and Technology, Vol.5, No.2, pp.785-793.

[9] Maheri M.R , R. Kousari, M. Razazan (2003), "Pushover tests on steel X-braced and knee-braced RC frames", Journal of Engineering Structures ,Vol. 11, Issue 6, pp. 1697–1705

[10] Mahmoud R. Maheri and Akbari R. (2003), "Seismic behaviour factor, R, for steel X-braced and knee-braced RC buildings", Journal of structural engineering, Vol. 25, No. 12, pp.1505–1513