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Performance of Different Bracing System on Displacement of First Soft Storied Steel Building under Seismic Load

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Abstract: Now a days in urban area open first story is being very popular due to commercial, residential and public building. It has continuous open space which gives very vulnerable condition because of getting long story height and reducing the stiffness of the lateral load resisting system in seismic zone. This paper highlights the seismic analysis of first soft storied building frames with different types of bracing system. Providing bracing in first soft story in different three arrangements is the alternative method to consist in the inserting of appropriate displacement reduction system. For this target, ETABS software has been used for analysis four identical six storied steel building with two load combination of each. The analysis result shows that that single diagonal barcing of eqivalent area gives better performance on reduction of horizontal displacement then other types of bracing system of steel building.
Keywords: Soft story, displacement, bracing, seismic load.

I. INTRODUCTION

A soft story building is a multi-story building in which one or more floors have windows, wide doors, large unobstructed commercial spaces, or other openings in places where a shear wall would normally be required for stability as a matter of earthquake engineering design. A typical soft story building is an apartment building of three or more stories located over a ground level with large openings, such as a parking garage or series of retail businesses with large windows. First soft-story buildings, so called for having first stories this much less rigid than the stories above, are particularly susceptible to earthquake damage because of large, unreinforced openings on their ground floors and in their typically wood-frame construction. These openings often accommodate parking spaces, large windows and expansive lobbies in residential and retail buildings. Adding strengthening material like bracing in first story column, such structures are more able to withstand the lateral forces (forces that push a structure side to side) that earthquakes generate. Once the first floor folds, the upper floors pancake down on top of it, crushing anything underneath. The importance of gravity load as well as lateral movement due to seismic effect on first soft story in steel building is becoming a general topic. In this study ground level was taken as fist soft story and by the analysis we observed that the performance of steel bracing (only in outer columns) is a drastically reduction of specified parameters which is dependent on the number of bracing installment. Some of the remarkable literatures on this topic are as follows:

Patil, et al. (2015) analyzed a comparison between RCC and composite structure soft storied building by ETABS 2013 software. Structures were located in the region of earthquake zone III on a medium soil. Equivalent static and response spectrum method was used for analysis where drift in soft storey was controlled by providing 1) Shear walls 2) Bracings 3) Stiffer column 4) Lateral load resisting system.

Joshi, et al. (2013) studied total 45 frames whose seismic analysis of soft storied building frames had been carried out considering 3 building plans, 15 soft storeys cases and 20 load combinations. All were done by STAAD.pro software where analysis was carried out on moment, storey displacements, shear force, axial force and story drift and this study shows that all these parameters were always maximum when first storey is soft for all types of buildings.

Banerjee, et al. (2014) concluded the effect of infill wall than a bare frame on some parameters such as floor displacement, storey drift, and base shear where modeling and analysis of the building were performed by nonlinear analysis program IDARC 2D and it was shows that lateral roof displacement and maximum storey drift is reduced by considering infill wall effect than a bare frame.

Ahmed, et al. (2014) modeled R.C.C. building for three cases - I) with no infill wall (Bare Model), II) with bottom story open, and III) with steel bracing system at bottom story, where the third model with steel braced system significantly contributed to the structural stiffness and reduced the maximum inter story drift and lateral displacement.

Setia, et al. (2012) analyzed seismic response of R.C.C building with soft storey. Parametric studies on displacement, inter storey drift and storey shear had been carried out using equivalent static analysis to investigate the influence of these parameter on the behavior of buildings with soft storey. The selected building analyzed through five numerical models by using the computer software such as STAAD. Pro 2006. Building having masonry infill in upper floors and with increased column stiffness of bottom story and building with shear wall in core has a small first storey displacement

In this study steel building is modeled and analyzed in two load combinations in four categories: model without bracing in first soft story, model with bracing Type-I (single diagonal bracing) in first soft story, model with bracing Type-II (double diagonal bracing) in first soft story and model with bracing Type-III (K bracing) in first soft story.

II. OBJECTIVE OF THE STUDY

The main objective of this paper is to analyze and compare the seismic performance of different types of braced and non-braced steel frame models in terms of horizontal displacement in first soft story and total building displacement. Equivalent static load method is used for analysis of all models by a commercial finite element analysis software (ETABS 2015).

III. STRUCTURAL MODELING

Following four categories of steel frame are analyzed

(i) Non-braced, (ii) Single diagonal braced (Type-I), (iii) Double diagonal braced (Type-II) and (iv) K braced (Type-III)

In this study section of different types of bracing system is consider in such way that in a single bay total steel quantity is same and depth, width of that section is consider as available in marcket.

A typical building 3D and plan for the analysis without bracing is shown in Fig.1. Fig.2, 3 and 4 represents the side views of model with bracing Type-I, Type-II and Type-III respectively. It has five bays in the x direction with 4.57 m spacing and three bays in the y direction at 6.1 m spacing. Structural models for the three categories are shown in Fig.3 to 5. Table 1 and Table 2 shows the modeling parameter and bracing details respectively.

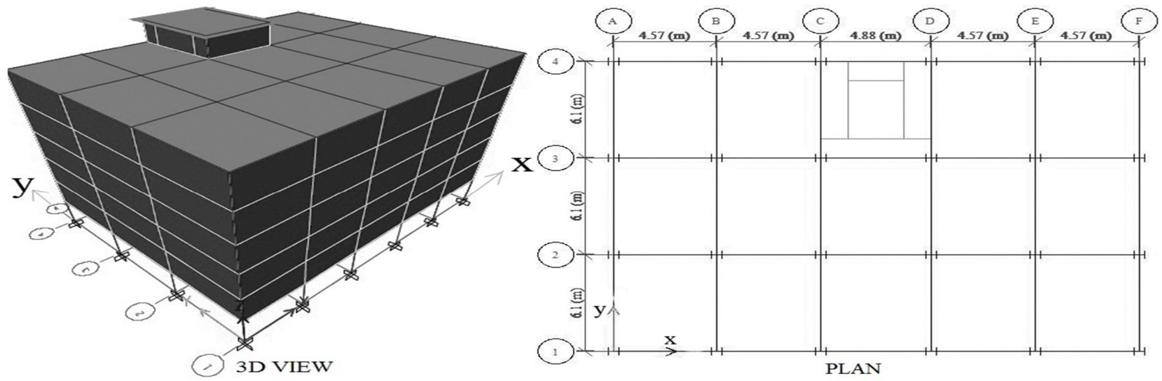

Figure 1: 3D view and plan of six storied steel building without bracing

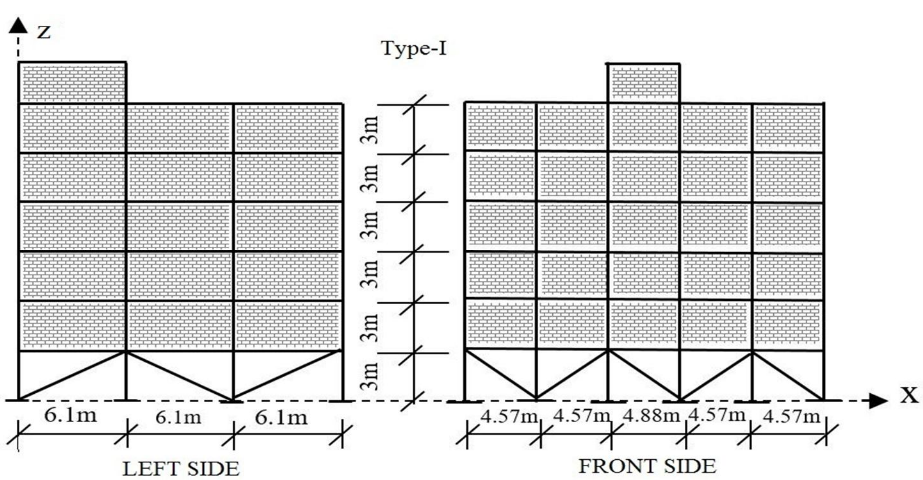

Figure 2: Elevation of first soft story in six storied building with bracing Type-I (single diagonal)

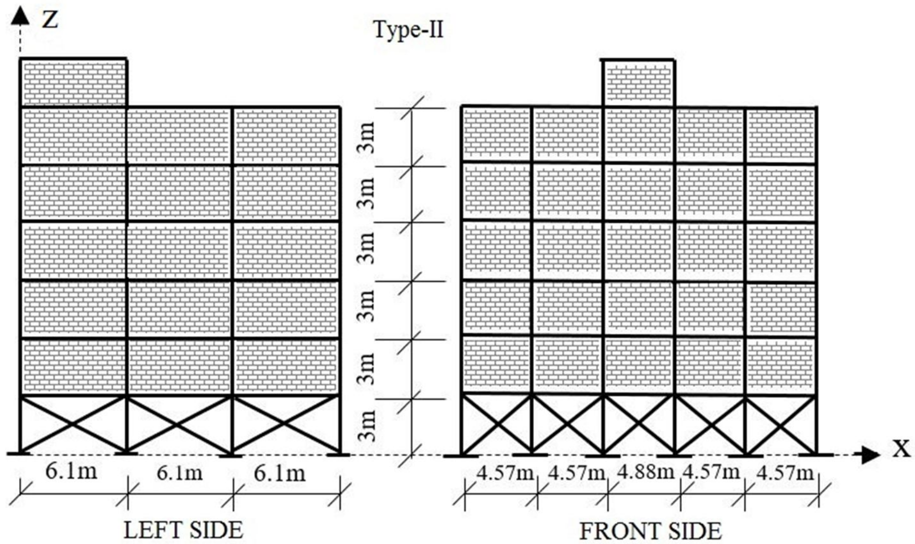

Figure 3: Elevation of first soft story in six storied building with bracing Type-II (double diagonal)

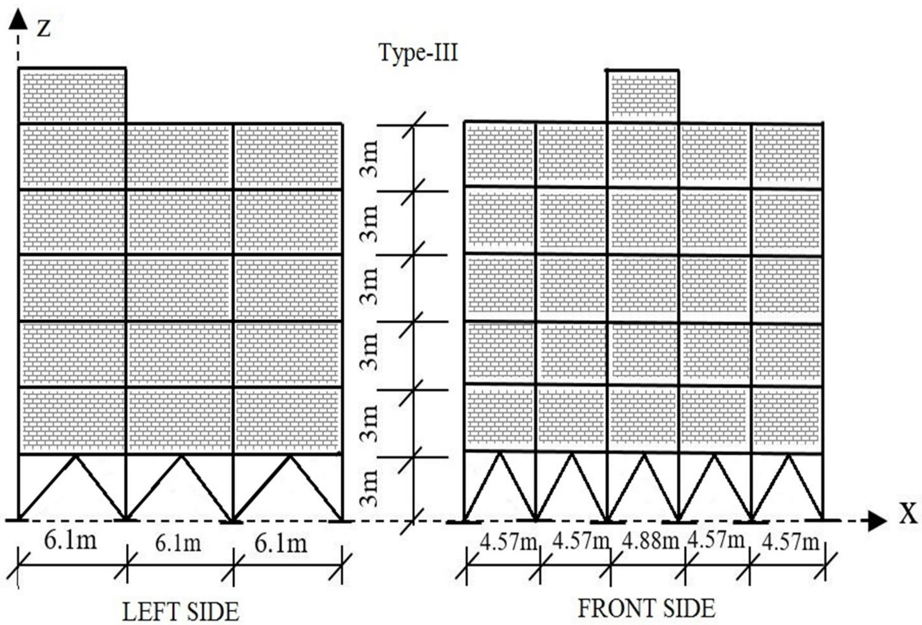

Figure 4: Elevation of first soft story in six storied building with bracing Type-III (K)

Table 1: Modeling parameters

Particulars	Value	Particulars	Value	Particulars	Value
Building Height	20 m	Dead Load, D	2 kN/m^2	Seismic Zone	III
Normal Beam Dimension	W18×35	Floor Live load, L_f	2 kN/m^2	Damping ratio	5
Column Dimension	W18×150	Roof Live Load, Lr	2 kN/m^2	Importance Factor (I)	1
Number of bay in x direction	5	Live Load on Corridor & Stair	3 kN/m^2	Seismic zone factor (Z)	0.36
Number of bay in y direction	3	Density of Concrete	23.5 kN/m^3	Response Reduction Factor (R)	5
Slab Thickness	0.13 m	Grade of Steel (f_y)	50 MPa	Type of structure	Steel Structure

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Table 2: Bracing Details

Particulars	Total Depth (mm)	Top Flange Width (mm)	Top Flange Thickness (mm)	Web Thickness (mm)	Top Flange Width (mm)	Top Flange Thickness (mm)	Area (cm^2)
Bracing Type-I	304.8	254	19.1	12.7	254	25.4	146
Bracing Type-II	228.6	177.8	15	10	177.8	15	73.2
Bracing Type-III	304.8	228.6	18	12.7	228.6	18	116.4

IV. MODEL ANALYSES AND RESULT DISCUSSION

Here two different load combinations $1.2D+1.5E_x+0.5L_f$ and $1.2D+1.5Ey+0.5L_f$ (BNBC, 1993) are used for analysis of four categorized building. Analyzed result is presented graphically for horizontal displacement of first soft story and maximum building displacement and shows seismic effect on mainly in x-direction for load combination $1.2D+1.5Ex+0.5L_f$ (denoted by LC-1) and seismic effect on mainly in y-direction for load combination 1.2D+1.5Ey+0.5Lf (denoted by LC-2).

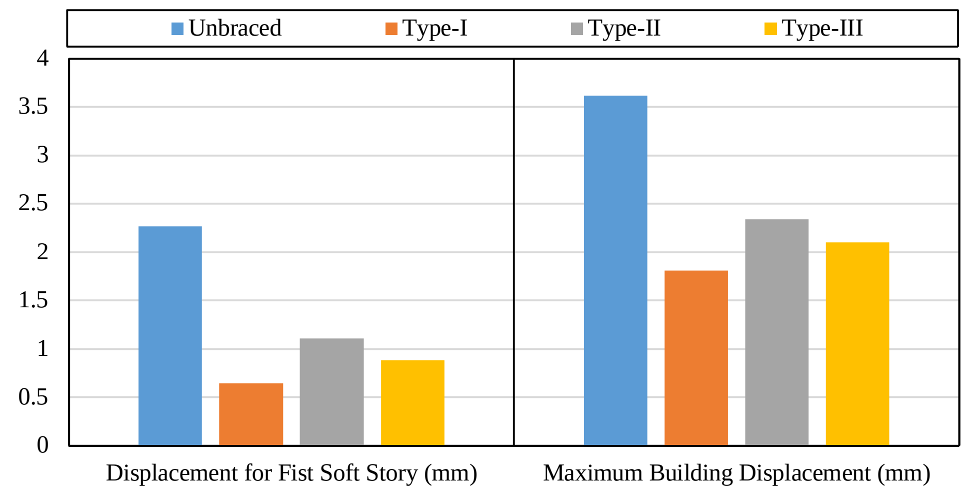

Figure 5: Variation of horizontal displacement on x-direction considering LC-1

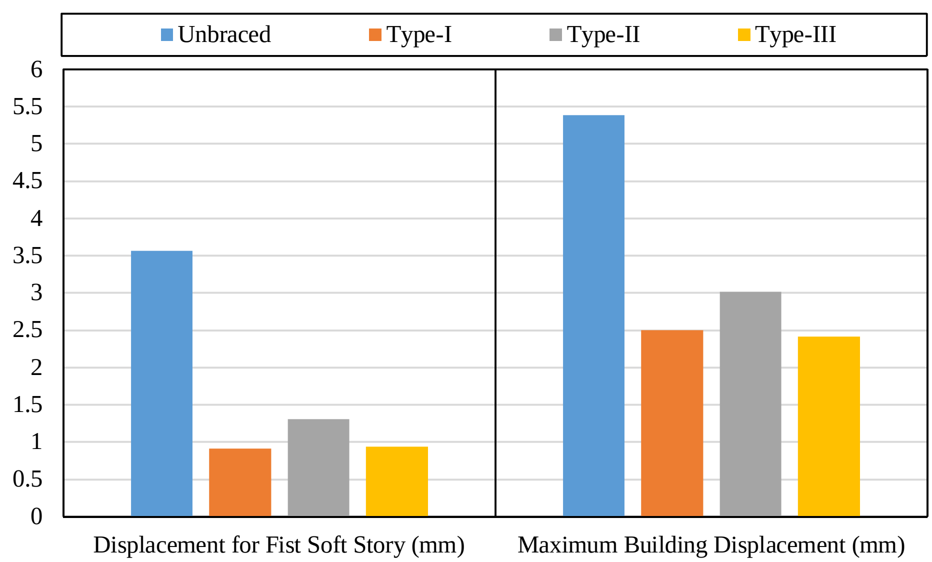

Figure 6: Variation of horizontal displacement on x-direction considering LC-1

Figure 5 and 6 shows the bracing performance on the parameter of horizontal displacement considering LC1 and LC2 in both x and y direction. From these two graphs it is observed that the bracing type-I give more better performance. Table 3 shows the percent of horizontal displacement reduction for different types of bracing system.

Table 3: % reduction of horizontal displacement for different types of bracing system

Considering Portion	For LC-1 % of Displacement Reduction			For LC-2 % of Displacement Reduction		
	Bracing Type-I	Bracing Type-II	Bracing Type-III	Bracing Type-I	Bracing Type-II	Bracing Type-III
Fist Soft Story	72%	51%	61%	74%	63%	74%
Total Building	50%	63%	42%	54%	44%	55%

V. CONCLUSION

The seismic effect on soft first story in steel building acts very vulnerable situation which is need to recognize and take necessary step to improve the reduction on some definite parameters for this destructive condition. The open first storey cannot be eliminated because of its important functional requirement of almost all the urban multi-storey buildings. It may improve by different way where this paper explain a method to increase the stiffness of first story column by installing different arrangement of steel bracing. The number of bracing used in Type-I is greater than Type-I which is introduced a better solution to reduction on horizontal displacement, rotational displacement. The percentage of reduction around maximum 74% is observed. From the above expplaination it is conclude that single diagonal barcing of eqivqlent area gives better performance then other types of bracing system.

REFERENCES

[1] Patil, U. P. and Suryanarayana, M. (2015). Analysis of G+15 RCC and Composite Structure Having A Soft Storey at Ground Level by Response Spectrum and Equivalent Static Methods Using ETABS 2013. International Research Journal of Engineering and Technology (IRJET). 02, 59-64.
[2] Ahmed, S. Z., Ramana, K.V. and Kumar, R. P. (2014). Seismic Response of RC Frame Structure with Soft Storey. International Journal of Research in Engineering and Technology. 03, 108-186.
[3] Arora, A. (2015). Alternative Approach to Soft Storey in Seismic Analysis of R.C.C Building Structures. International Journal of Civil Engineering (SSRG-IJCE). 40-45.
[4] Joshi, G., Pathak, K.K. and Akhtar, S. (2013). Seismic Analysis of Soft Storey Buildings Considering Structural and Geometrical Parameters. Journal on Today's Ideas –Tomorrow's Technologies. 01, 73–84.
[5] Banerjee, S., Patro S. K. and Rao P. (2014). Inelastic Seismic Analysis of Reinforced Concrete Frame Building with Soft Storey. International Journal of Civil Engineering Research. 05, 373-378.
[6] Arlekar, J. N., Jain, S. K. and Murty C.V.R. (1997). Seismic Response of RC Frame Buildings with Soft First Storeys. CBRI Golden Jubilee Conference on Natural Hazards in Urban Habitat, New Delhi.
[7] Bangladesh National Building Code (1993). Housing and Building Research Institute.
[8] Selna, R. (2008). S.F. leaders ignore weak buildings quake risk. San Francisco Chronicle.
[9] Kwong & Jessica (2010). Prop. A seismic retrofit bond would aid some. San Francisco Chronicle.