Pushover Analysis of Reinforced Concrete High Rise Building with and without Bracing

Mohd Asad Khan[1], Md Tasleem[2] , Shariq Masood Khan[3]

[1]*M.Tech Student, Department of Civil Engineering, Integral University, Lucknow, India*
[2]*Assistant Professor, Department of Civil Engineering, Integral University, Lucknow, India*
[3]*Lecturer, University of Polytechnic, Integral University, Lucknow, India*

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Abstract - Bracings in RC structure are utilized on the grounds that it can withstand parallel burdens on account of seismic tremor, wind, and so forth it's one in everything about best techniques for horizontal burden opposing frameworks. This strategy gave to lessen the horizontal redirection of design. During this postulation 12 storey built up substantial casings is dissected for the square arrangement of 36x36 m and rectangular arrangement 54x24 m by thinking about Zone - V for soil type-II. The examinations were finished by utilizing the ETABS 2016 programming. During this paper the two models are analyzed for three unique sorts of propping, for example, Unbraced, Chevron and Diagonal supporting by setting Outer Edge, for the supporting point ISA 130x130x8. Results are acquired by considering the boundaries like maximum displacement and base shear by contrasting them agreeing with three distinct seismic codes ASCE 41-13, NTC – 2008, and EC-8.

Key Words: RC Frame, *Steel bracing system, Diagonal bracing, Chevron bracing, Storey displacement, Analysis using software ETABS-2016.*

1. INTRODUCTION

Bracing system is considered as an effective system to improve the rigidity and strength of reinforced concrete frame. It can have high lateral stiffness. The capacity of steel frames can be greatly enhanced under moderate to high magnitude earthquakes by increasing the energy absorption capacity of the structure and reducing the demand caused by seismic loads. Otherwise, connections and foundations that need to be reinforced will be affected by the use of brackets. In addition, it could not be better to change the original architecture of the building by using braces.

Due to its high efficiency and cost saving, RC Bracing Chassis System is widely used. The reinforced concrete brace system is effective if the braces are in the linear phase. The asymmetric response that develops when at the nonlinear stage begins while the lateral stiffness begins is declared. Previous studies have shown a limited redundancy of bracing reinforced concrete frames due to the concentration of seismic loads in a particular soil where phase strength and drift between highways are developed. .Plastic hinges begin to form in this soil and become vulnerable, resulting in the structure collapsing to the side. The frame beams must be sufficiently reinforced to resist the longitudinal shear forces developing from the concentric braces. To withstand seismic loads, steel bracing frames feature several bracing systems, such as concentric bracing, eccentric bracing, knee bracing, and mega bracing.

- External bracing
- Internal bracing

In external bracing, existing buildings are modernized by attaching local or global steel bracing to the exterior frames. Architectural concerns and the difficulty of providing proper connections between the steel bracing and the reinforced concrete frame are two of the shortcomings of this approach.

In the internal bracing method, buildings are modernized by incorporating a bracing system inside the units or individual panels of the reinforced concrete frame. The tie rod can be attached to the RC frame indirectly or directly.

1.1 TYPES OF BRACING

- Concentric Bracing System
- Eccentric Bracing System

Bracing system is concentric when the centerlines of brace elements intersect. The concentric bracing steel frame used in the structure consists of an X, a truss and a knee brace. X-braces are the most common type of bracing. The diagonal elements of the X and Chevron tie rods are subjected to tension and compression. The connections for the X-bracing are located at the beam-column joints. While the Chevron bracing elements are connected to the beam at the top and converge at a common point. The lateral stiffness of the frame is increased, resulting in increased natural frequency and reduced lateral deflection. The larger inertia force in the seismic zone is attracted due to the increased stiffness. Meanwhile, the axial compressive force in bracingly connected columns increases with decreasing bending moment and shear force in the column.

Eccentrically braced frames look similar to frames with Chevron were bracing. The difference between Chevron bracing and eccentric bracing is that the space between the bracing members at the highest gusset connection. In an eccentrically braced frame bracing members connect to separate points on the beam. The energy from the seismic activity through the plastic deformation is absorbed by the beam segment between the bracing members. The lateral stiffness of the system is reduced by eccentric bracing which improves the energy a dissipation capacity. Due to the eccentric connection of the braces to beams, the lateral stiffness of the system depends upon the flexural stiffness of the beams and columns, thus reducing the lateral stiffness of the frame. The vertical component of the bracing forces due to the earthquake causes the lateral concentrated load on the beams at the point of the connection of the eccentric bracing.

2. OBJECTIVE OF THIS PAPER

Following are the main objectives of the present study:

a) To investigate the seismic performance of a multi-story RC frame building (square and rectangle)with and without bracing arrangements (Unbraced, Diagonal bracing, Chevron bracing), using Nonlinear Static Pushover analysis methodby comparing them according to three different seismic codes ASCE 14-13, NTC – 2008, and EC-8.

b) To evaluate the performance factors for Unbraced frames with diagonal bracing and Chevron bracing.

3. METHODOLOGY

In the present study, G+12 storey rectangular and square buildings are analyzed with and without braces. The study is carried out for different types of bracing systems for both types of buildings using Pushover analysis.

Table -1: Description of the model

Sl.no	Model Description	
1	Type of building	Residential
2	No. of stories	G+12
3	Height of each Storey	3m
4	Plan of Square building	36mx36m
5	Plan of Rectangular building	54mx24m
6	Column size	600mmx600mm
7	Bracing	ISA 130x130x8
8	Beam size	300mmx650mm
9	Thickness of slab	150mm
10	Dead load	4.75KN/m2
11	Live load	4KN/m2
12	External wall thickness	230mm
13	Internal wall thickness	115mm
14	Seismic zone	V
15	Zone factor	0.36
16	Importance factor	1.5
17	Soil Type	II
18	outer Wall Load	12.5 kN/m
19	inner Wall Load	6.25 kN/m
20	Software used	ETAB 2016

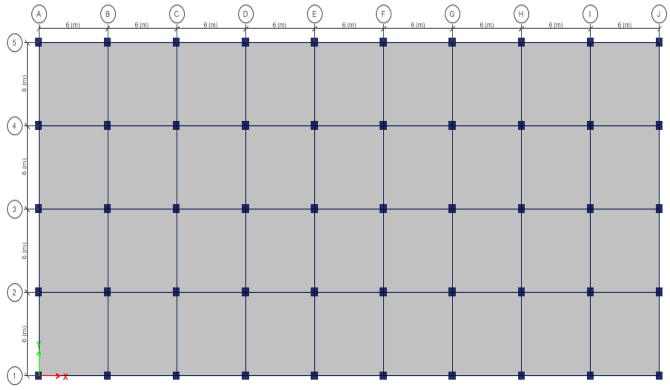

Fig. 1: Plan of rectangular building.

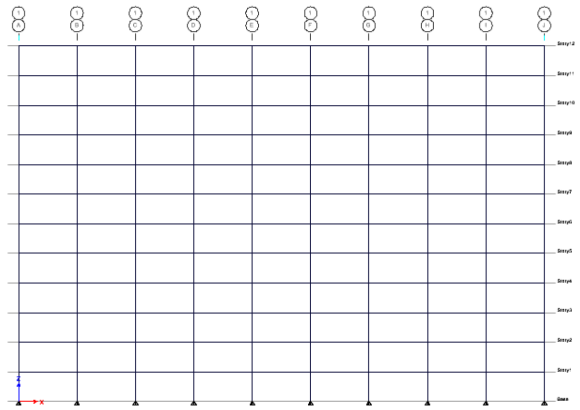

Fig 2: Unbraced Elevation

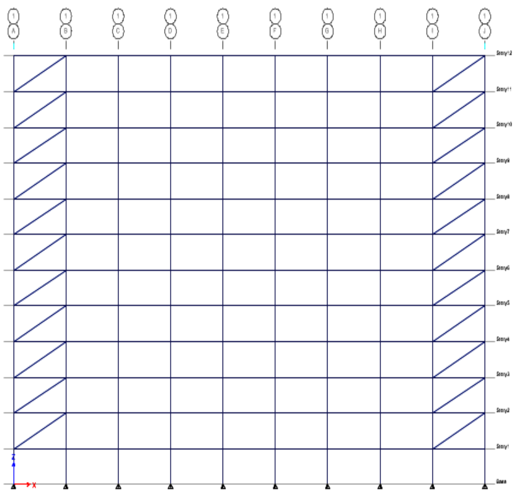

Fig 3: Diagonal bracing Elevation

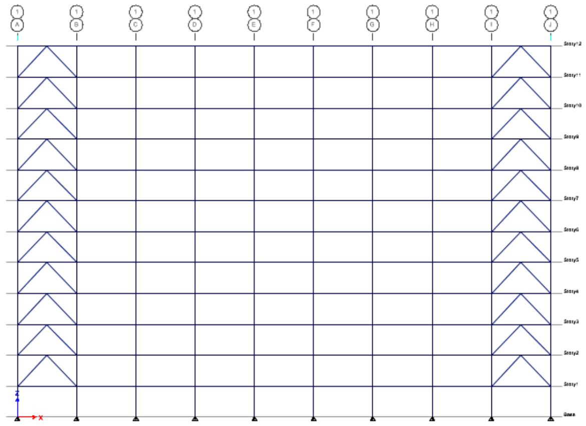

Fig 4: Chevron bracing Elevation

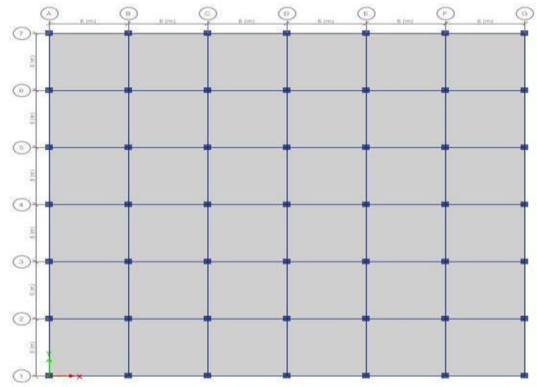

Fig. 5: Plan of square building.

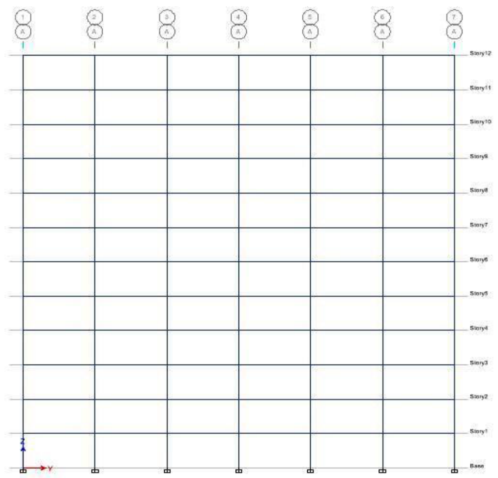

Fig 6: Unbraced Elevation

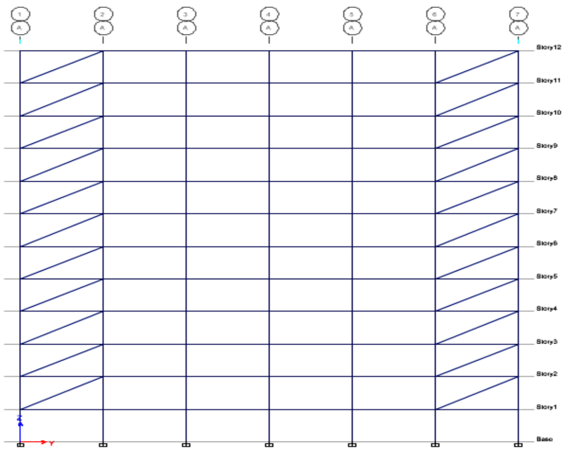

Fig 7: Diagonal bracing Elevation

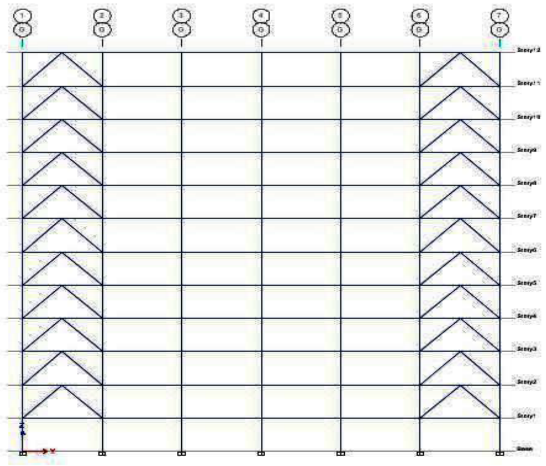

Fig 8: Chevron bracing Elevation

4. RESULT AND DISCUSSIONS:

4.1 RESULTS FOR DISPLACEMENTS:

Table -2: Target displacement for rectangular building

Bracing	Target Displacement mm		
	ASCE 41-13	NTC-2008	EC-8
Unbraced	384	265	263
Diagonal bracing	357	199	252
Chevron bracing	334	146	244

Table -3: Target displacement for square building

Bracing	Target Displacement mm		
	ASCE 41-13	NTC-2008	EC-8
Unbraced	346	345	401
Diagonal bracing	289	208	354
Chevron bracing	274	203	291

The maximum displacement obtained from rectangular and square building as per ASCE 41-13 code as mentioned in table 2 and table 3. Below are the compared bar-charts:

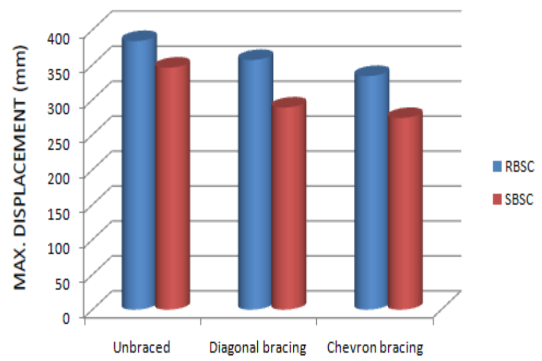

Fig 9: Comparison on displacement for ASCE 41-13

The maximum displacement obtained from rectangular and square building as per NTC-2008 code as mentioned in table 2 and table 3. Below are the compared bar-charts:

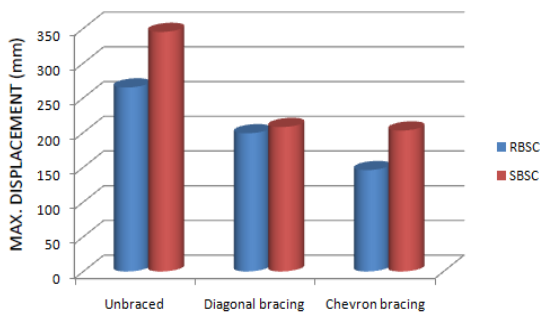

Fig 10: Comparison on displacement for NTC-2008

The maximum displacement obtained from rectangular and square building as per EC-8 code as mentioned in table 2 and table 3. Below are the compared bar-charts:

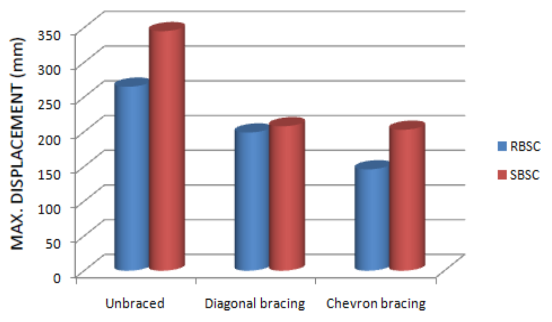

Fig 11: Comparison on displacement for EC-8

DISCUSSIONS FOR DISLACEMENT:

From the comparison values in fig 9, fig 10, fig 11, it can be clearly found that due to introduction of bracing in both (rectangular, square) structures the displacement have been reduced by 14% in SBSC using ASCE 41-13 code for unbraced plan, 23% reduce SBSC as compared to RBSC using ASCE 41-13 code for diagonal bracing, 22% reduce SBSC as compared to RBSC using ASCE 41-13 code for chevron bracing, 23% reduce RBSC as compared to SBSC using NTC-2008 code for unbraced plan, 4% reduced RBSC as compared to SBSC using NTC-2008 code for diagonal bracing, 28% reduced RBSC as compared to SBSC using NTC-2008 code for chevron bracing, 34% reduce RBSC as compared to SBSC using EC-8 code for unbraced plan, 28% reduce RBSC as compared to SBSC using EC-8 code for diagonal bracing, 16% reduce RBSC as compared to SBSC using EC-8 code for chevron bracing.

4. 2 STOREY MAX/AVG DISLACEMENT

Suggested maximum drift at the highest point of buildings vary between H/50 and H/2000 Where H is that the height of the building. A limiting value for the most displacement within the elastic limits was obtained as a function of the peak of a story, the stiffness of a story, number of stories, effective depth d of a shear wall, the yield strain of steel εy and so the most allowable concrete strain εc. However, the worth H/50 suggested by UBC97 and IBC 2006 generates large strains at the underside of a shear wall.

Hence for story 12, H=36m.

Limiting displacement = $H/50 = 36000/50 = 720mm = 0.72m$

Therefore, obtained values are within limits. Below figures are curves Max. Displacements vs. Story levels for Push X.

Maximum storey displacement for rectangular and square building due to PUSH X.

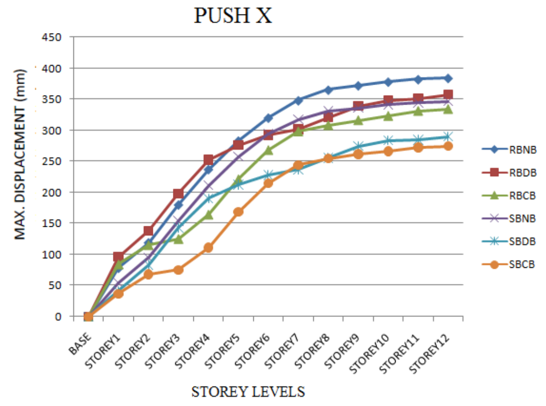

Fig 15: Comparison Maximum storey displacements ASCE 41-13 code.

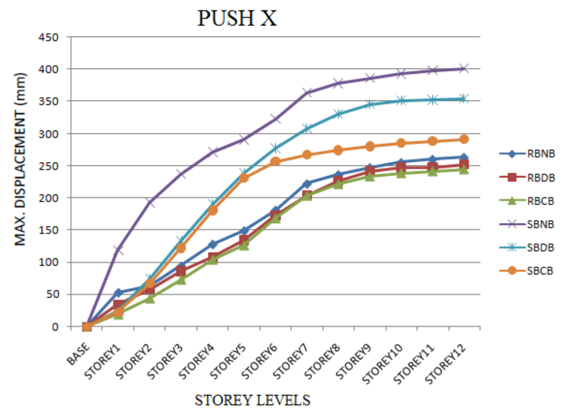

Fig 16: Comparison Maximum storey displacements NTC-2008 Code

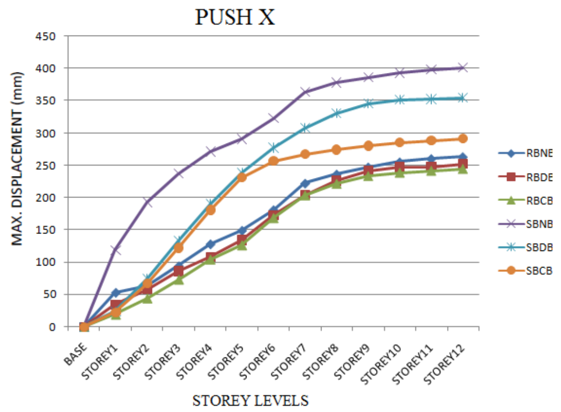

Fig 17: Comparison Maximum storey displacements EC-8 code

4. CONCLUSIONS

From the results discussed with respect to the building models considered, leads to the following conclusions:

After the analysis of both structures with different types of Bracing, it has been concluded that the Storey Displacement and Storey Drift and Natural Time Period of the structure decreases after the application of bracing system.

The maximum reduction in the storey displacement occurs after the application of Chevron bracing system in Rectangular building.

The maximum displacement of the rectangular building is reduced by 28% with the use of Chevron bracing when compared with square building for NTC-2008 code.

In both buildings the maximum displacement and storey drift decreases for diagonal and chevron bracing system used compared to without bracings and the base shear increases for diagonal and chevron bracing as compared to unbraced frame structures.

The base shear of the rectangular building is increased by 8% with the use of Chevron bracing when compared with square building for ASCE 41-13.

It is observed that rectangular buildings are performing well as compared to square building.

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