Seismic Analysis of Steel Frame Building using Bracing in ETAB Software

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Abstract - *this paper compares seismic analysis of G+11 square building and L shaped building by using time history analysis in ETAB 17.01 software also compare displacement, base shear and pseudo acceleration and used different types of bracing systems and conclude which type of building and which type of bracing gives minimum displacement, base shear and pseudo acceleration*

Key Words: ETAB 17.01, steel structure2, displacement3, base shear4, pseudo acceleration5, bracing systems6, etc.

1. INTRODUCTION

One of the most devastating natural disasters that occur in the world is earthquakes that are generated due to the movement of tectonic plates that lie below the crust and also due to volcanic activity. They have different durations lasting from a few seconds to minutes and also of varying intensity. The ground experiences shaking under the effect of earthquakes which causes structures to experience high frequency movements induced by the inertial forces in the structure and its components, i.e., the structure's tendency to remain in its original position irrespective of ground movement. One of the main difficulties when a building is a seismically active zone is the lateral stability of the structure. This is due to external forces by the earthquakes that cause large deflections which in turn cause large internal forces in the structure. Any structure has its own displacement capacity, i.e., the amount of horizontal displacement induced is limited. This is addressed by using bracings that have large plastic deformation before failure and they are categorized into the eccentric, concentric and knee braced systems. This paper will consider only concentric braced systems.

The X bracing system is found to have the most reduction in lateral sway but it increases the axial load in columns. The pushover analysis, i.e., on a steel frame has found that there is a 70-80 % reduction in displacement of braced frames using, ISHB & ISMB sections as bracings. X Bracing is found to be the most effective in reducing sway at the top in low rise.. Diagonal bracings arranged in a diagonal pattern reduce bending moment, shear force and lateral displacement for high rise structures. High rise structures best reduction in displacement when using braced frames. Analysis of high rise structures using Y bracings in pushover analysis shows that the energy absorbing is higher when compared to conventional and unbraced frames. High rise

SMRF structure shows least sway in case of X braced concentric bracing and even inverted V type bracing system also showed promising values.

2. RESEARCH METHODLOGIES

The G+11 structure was modeled in ETAB 17.01 with base shear corresponding to zone II according to IS 1893(Part 1) and the base shear was calculated according to the Cl.6.4.2. Throughout the entire analysis the dimensions used for loads is Newton (KN) and for distances is meter (m). The geometric portion of the structure was modeled and the sections chosen were inputted into the software. The meshing of the element sections were given during the input of the sections. The material properties of steel such as Poisson's ratio, Young's Modulus and density are also given as input. Then the meshing of the structure is done and the assigning of the section property and material property along with the number of divisions is also specified. The loading conditions of the structure is then assigned according to Cl.6.4.2 IS 1893 (Part 1) and the base of the structure is fixed. The analysis is done for the unbraced structure and also for the braced structures. The following braced systems are used

i) X Bracings

ii) V Bracings

iii) Inverted V Bracings

iv) Diagonal bracing

3. AIM

The aim of this paper is to ensure that the displacement demand of a building is to be kept below its displacement capacity. This can mainly be achieved by reducing expected displacement demand of the structure during the strong motion or improving the displacement capacity of the structure

4. LITERATURE REVIEW

A Kadid [1] they said that recent earthquakes in Turkey (1999), Taiwan (1999) and Algeria (2003) demonstrated the catastrophic impact of such power upon urban cities. A great number of existing buildings in Algeria designed without

seismic design criteria and detailing rules for dissipative structural behavior suffered damages which were far worse than that for newer buildings designed and built according to the more stringent seismic code rules. Thus, it is of critical importance that the structures that need seismic retrofitting are correctly identified, and an optimal retrofitting is conducted in a cost effective fashion. Among the retrofitting techniques available, steel braces can be considered as one of the most efficient solution for seismic performance upgrading of RC frame structures. This paper investigates the seismic behavior of RC buildings strengthened with different types of steel braces, X-braced, inverted V braced, ZX braced, and Zipper braced. Static nonlinear pushover analysis has been conducted to estimate the capacity of three story and six story buildings with different brace-frame systems and different cross sections for the braces. It is found that adding braces enhances the global capacity of the buildings in terms of strength, deformation and ductility compared to the case with no bracing, and the X and Zipper bracing systems performed better depending on the type and size of the cross section

H. Moghaddam, et.al [2] Author investigates the potentialities of the pushover analysis to estimate the seismic deformation demands of concentrically braced steel frames. Reliability of the pushover analysis has been verified by conducting nonlinear dynamic analysis on 5, 10 and 15 story frames subjected to 15 synthetic earthquake records representing a design spectrum. It is shown that pushover analysis with predetermined lateral load pattern provides questionable estimates of inter-story drift. To overcome this inadequacy, a simplified analytical model for seismic response prediction of concentrically braced frames is proposed. In this approach, a multistory frame is reduced to an equivalent shear building model by performing a pushover analysis. A conventional shear-building model has been modified by introducing supplementary springs to account for flexural displacements in addition to shear displacements. It is shown that modified shear-building models have a better estimation of the nonlinear dynamic response of real framed structures compared to nonlinear static procedures.

O. S. Bursi, et.al [3] Author presents the second part of the results of a study devoted to the analysis of heavy steel bracing connections, and to the effects of those connections on the behavior of braced frames subjected to static loads. The paper deals initially with the finite element analysis of one type of bracing connection, in which the structural fasteners such as bolted clip angles and fillet welds are modeled using the two-dimensional nodal interface element developed in a previous companion paper. Next, two series of full-scale tests of bracing connections subjected to tensile loading are described and the responses measured during the tests compared with the predictions. Good agreement was found between tests and predictions when the overall performance of the bracing connection is not strongly influenced by slip in the bolted fasteners. Lastly, one series of tests on beam-to-column connections made up of friction-bolted double clip angles is presented to validate the finite

element model for this type of connection. Once validated, the finite element analysis is used to derive fundamental bracing connection flexibilities and the relative strength interaction domain to be used in a companion paper.

5. System Development

5.1 Research Gap

The study of above research paper tells that work on "Seismic Analysis of steel Structure using Bracings" has been carried out in the past. but performance of different types of bracing in the different type of steel structure(G+11) by Response of steel frame structure under time history analysis were performed using ETAB 17 software this is not carried out previously hence in the next chapter(objectives) are design to fill the gap between past and present study.

5.2 Methodology

for the seismic analysis of steel structure using bracing we have to test the 4 different types of bracing on2 type of building (ie.L&rect building) by time history analysis were performed using ETAB and conclusion has to be made which type of bracing and in which type of building is most suitable and sustainable for earthquake vibration and effects
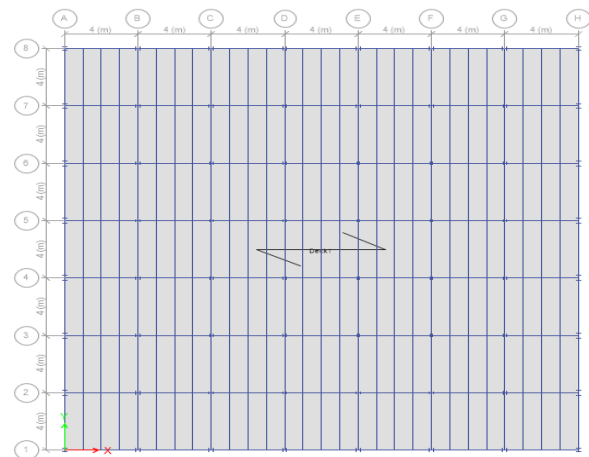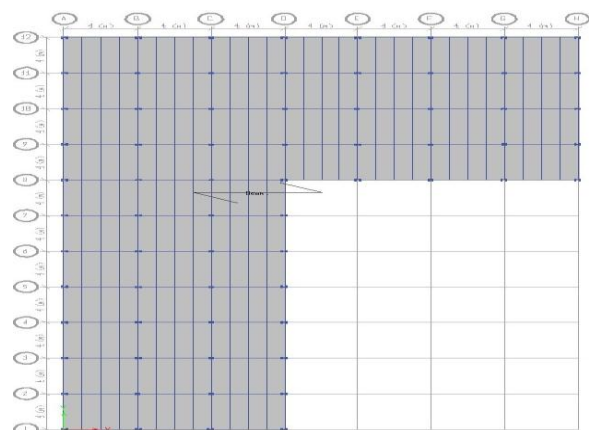

Fig:-plan for square building

Fig: - plan for L shape building

6. OBJECTIVE

1. Response of steel braced frame steel structure under time history analysis were performed using ETAB

a. Using different types of bracing on different type of building we have to calculate the story displacement for the steel building and also determine which bracing gives the less displacement among the consider one.

b. In this we have to considered 2 type of building by keeping the area of all the building same

d. To calculate which bracing system gives more base shear and also less base shear on different type of considered building.

e. Also compare the response of braced frame with unraced frame.

7. ANALYSIS

A. Data assumed for G+11 Building

1. No. Of storeys=G+11

2. Plan Area of Structure= m2 (C/C d/s)

3. Seismic Zone Area=II (Aurangabad)

4. Dimensions of beam =ISMB 175

5. Dimensions of Column= ISWB 600

6. Dimensions of Bracings=ISHB 225

7. Height Of storey= 3m

8. Length of Bay=3.5m

9. No. Of bays= 12

B. Load Conditions

1. Self-weight of the components

2. Live load of 2 KN/m as per IS 1893 (Part II)

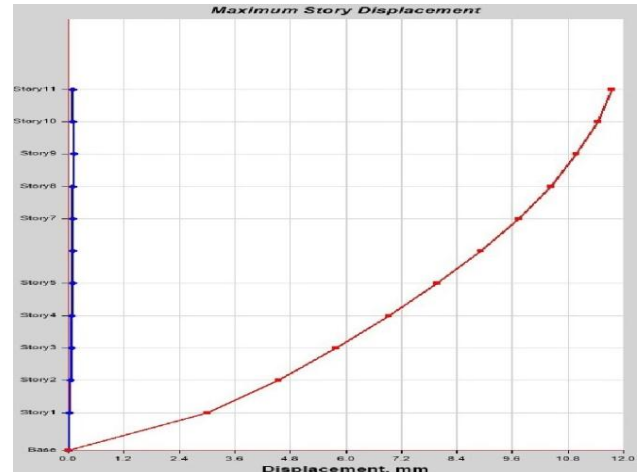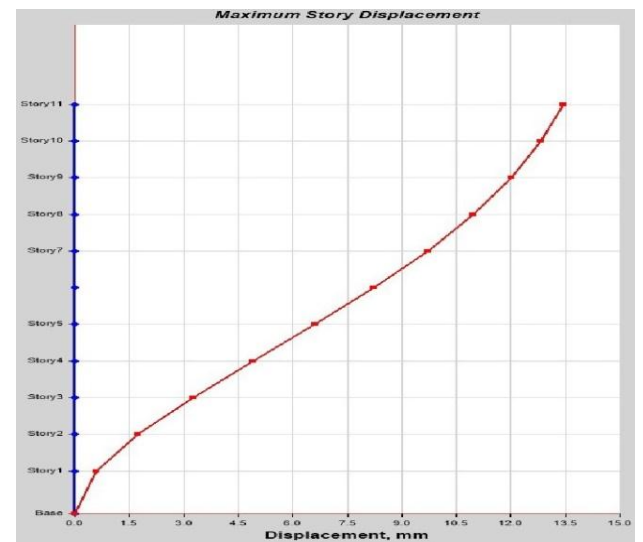3. Base shear as per CL 6.4.2 IS 1893 (Part I)

Fig:-1

Fig 2

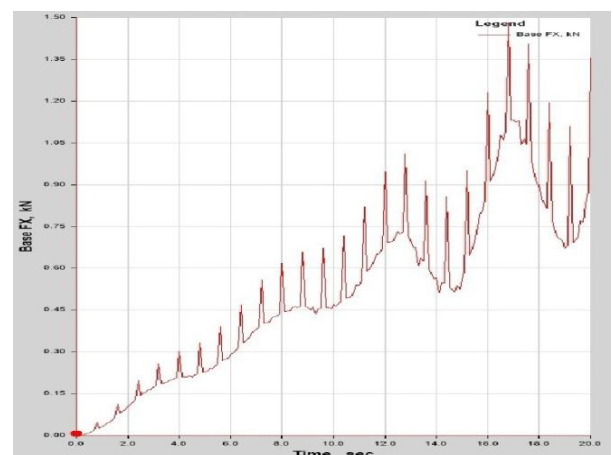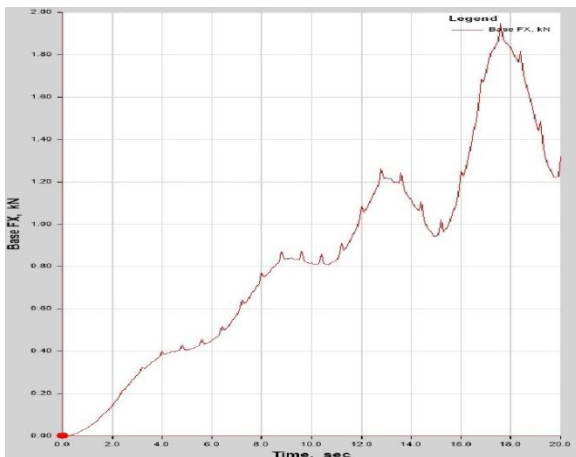

Fig 3

Fig4

Fig 1 shows displacement of 'L' shaped building with X bracing

Fig 2 shows displacement of 'squre' shaped building with X bracing

Fig3 shows base shear of 'squre' building with x bracing

Fig4 shows base shear of 'L' building with x bracing

8. RESULTS AND DISCUSSION

TABLE NO 1:- "L"BUILDING

SR. NO.	Type of bracing	DISPLACEMENT (mm)	BASE SHEAR E5 KN	PSEUDO ACCELERATION (mm/sec2)
1	Without bracing	15.71	1.948	691.28
2	X bracing	11.75	1.8	555.35
3	V bracing	15.40	1.827	676.928
4	Invert V bracing	15.44	1.826	699.83663

TABLE NO 2:- SQURE BUILDING

SR. NO.	Type of bracing	DISPLACEMENT (mm)	BASE SHEAR E5 KN	PSEUDO ACCELERATION(mm/sec2)
1	Without bracing	15.64	1.412	631.71
2	X bracing	13.44	1.453	398.03822
3	V bracing	15.26	1.519	368.28893
4	Invert V bracing	16.014	1.404	1530.08
5	Diagonal bracing	15.63	1.527	947.13

From the above data it is clear that deflection of the 'L' shaped building with 'X' bracing system is minimum among all the type of bracing when comparing the 'square' and 'Shaped building

From the above data it is clear that base shear of the 'squre' shaped building with 'X' bracing system is minimum among all the type of bracing when comparing the 'square' and 'L'Shaped building

From the above data it is clear that pseudo acceleration of the 'squre' shaped building with 'X' bracing system is minimum among all the type of bracing when comparing the 'square' and 'Shaped building

9. CONCLUSION

By performing the seismic analysis of G+11 steel structure we conclude the following points

1. Among all the 4 types of bracing displacement of "x Bracing" is found to be minimum in the both types of building eg. squre & L shaped building

2. For comparing the shape of building "L"shaped building gives minimum displacement with "X" bracing

3. For the base shear squre shape building gives minimum base shear with "X" type of bracing

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