Time History Analysis of G+11 Steel Frame Building using Bracing in ETAB Software

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Abstract— Lateral stability is important for the steel structures in the seismic zones. Effective way to increase the lateral strength is by means of bracing system. An attempt is made to analyze the effect of seismic force on 'C' shape and hollow circular Steel framed high rise building with different bracing system and also to find the best bracing system. The building is modeled and analyzed using ETABS and sections are selected based on their capability to control the maximum lateral storey displacements. The Zone II as per IS 1893-2016 is selected for the study. Analysis is carried out by time history Method. Various parameters such as, displacement and base shear were studied.

Keywords: Time history analysis ETAB 17.01, steel structure, displacement, base shear, pseudo acceleration, bracing systems

I. INTRODUCTION

The earthquake in Japan by name Kobe and in the USA by name Northridge were two clear illustrations where we came to know the important of lateral stability in structures constructed using steel. This problem has been a significant subject of consideration for investigators. Finally researchers gave an effective idea of using bracing systems like concentric, eccentric and knee bracing systems. The bracing system provides the structure more capacity to soak up energy while it is under seismic excitation. Steel Structures in tectonic prone zones are needed to be designed such that they resist considerable horizontal loads. The designs of structures require a good amount of balance between strength, stability, and energy Dissipation.

Steel has become the predominate material for the construction of bridges, buildings, towers and other structures. Its great strength, uniformity, light weight and many other desirable properties makes it the material of choice for numerous Structures such as steel bridges, high rise buildings, towers and other structures. Bracing element in structural system plays vital role in structural behaviour during earthquake. Steel bracing is an effective and economical solution for resisting lateral forces in a framed structure.

In the present study, response of the'C' shape and hollow circular shape steel braced frame under time history analysis were performed using computer software ETABS 2017.

II. RESEARCH METHODOLOGIES

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 analysis is done for the unbraced structure and also for the braced structures. The following braced systems are used:

1) X Bracings
2) V Bracings
3) Inverted V Bracings
4) Diagonal bracing

III. AIM

Aim of this paper is to compare the two steel frame building ('C' & 'hollow circular' shape) by using the time history analysis using different types of bracing and calculate displacement, base shear, pseudo acceleration & story drift. and conclude which type of building and which type of bracing gives minimum values and maximum value.

IV. LITERATURE REVIEW

Hendramawat A Safarizkia[1] They said that the aim of this paper is to evaluate the possible improvement of seismic performance of existing reinforced concrete building (the 5th Building of UNS Engineering Faculty) by the use of steel bracing. Three methods of seismic evaluation are employed for the purpose of the study, Improvement of Nonlinear Static Pushover Displacement Coefficient Method as described in FEMA 440 and dynamic time history analysis following the Indonesian Code of Seismic Resistance Building (SNI 03-1726-2002) criteria. The results show that the target displacement determined from nonlinear pushover analysis of the existing building in X direction is 0.188 m and in Y direction is 0.132 m. The performance of this building could be categorized in between Life Safety (LS) - Collapse Prevention (CP) and plastic hinges occur in columns. It is also indicated that the story drifts in Y direction exceed the serviceability limit criterion when the recorded El Centro accelerogram was used for dynamic time history analysis. The performance of the existing building could be improved if steel bracings are utilized for seismic retrofitting. It is shown from the nonlinear pushover analysis that target displacements in both directions are reduced by 16%-55% if the proposed steel bracings are used. Furthermore, dynamic time History analysis points out that the story drifts of the retrofitted building are within the limit criteria. Meanwhile, the size of steel bracing elements does not significantly affect the seismic Performance of retrofitted building. This study does not clearly show the effect of steel bracing size in improving seismic performance of the structure under consideration.

Ahmet Kuşyılmaz et.al [2] they reports an analytical study on the design over strength of steel eccentrically braced frames (EBFs). The study aimed at examining the influence of geometrical factors and seismic hazard on the design over strength of EBFs. Pursuant to this goal a computer program which facilitates EBF designs was developed. The algorithm of the program adopts the lightest uniform frame design and library of link-beam-brace sub-assemblages concepts. The design output from the program was compared with published solutions and the results indicate that the algorithm developed as a part of this study is capable of providing lighter framing solutions. A parametric study was conducted using the developed computer program. The results indicate that the frames considered in this study have on average higher over strength values when compared with the codified value even without considering potential increases due to material over strength and strain hardening. The design over strength was found to be influenced primarily by the link length to bay width ratio and the bay width, and secondarily by the building height and seismic hazard level.

Future research should consider quantifying structural over strength using response spectrum analysis of EBFs as it is the most accurate way of determining this factor. This analysis inherently includes the strain hardening effects produced by different link lengths.

Sina Kazemzadeh Azad et.al [3] they conducted research on steel eccentrically braced frames (EBFs). Both component level and system level responses for such braced frames are treated and discussed. For the component level response, a thorough review of the investigations on links, which are the primary sources of energy dissipation in EBFs, has been presented. The results of experimental and numerical studies on strength, rotation capacity, and over strength of links are discussed. Furthermore, studies on the effects of axial force, the presence of a concrete slab, the loading history, compactness, link detailing, and the lateral bracing on link behavior are summarized.

Relevant available research on link-to-column connections is revisited. Different approaches for the numerical modeling of links are also given. For the system level response, characteristics of EBF systems are discussed in light of the capacity design approach. Findings of numerical studies on the seismic performance of EBFs are discussed to provide insight into suitable response factors utilized in the design of these systems. Additionally, special topics and emerging applications of EBFs, such as replaceable links, are provided. The impact of research findings on the design of EBF systems is demonstrated considering the AISC Seismic Provisions for Structural Steel Buildings. Finally, future research needs for improvement of EBF design and application are identified and presented.

V. SYSTEM DEVELOPMENT

A. Research Gap

The study of above research paper tells that work on "Time history analysis of G+11 steel frame building using ETAB software" 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.

B. 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.'C' & hollow circular shape 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

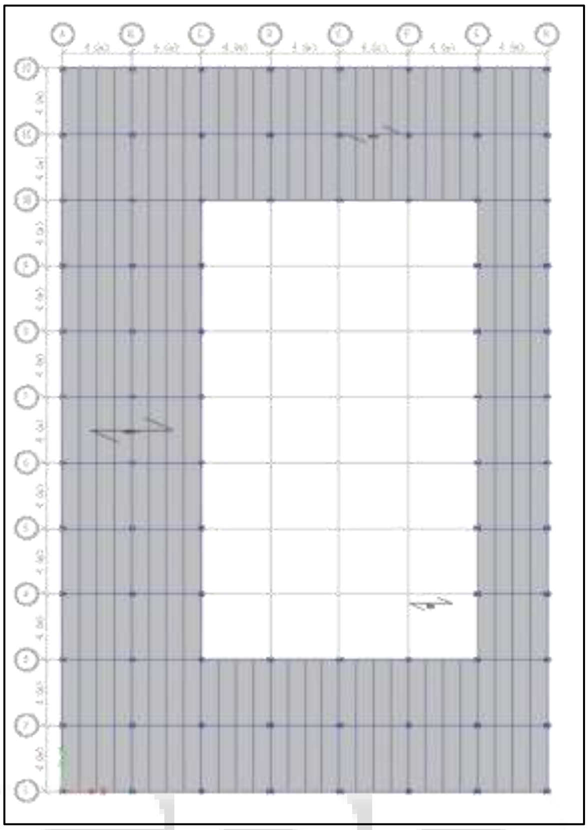

Fig. 1: plane of hollow square building

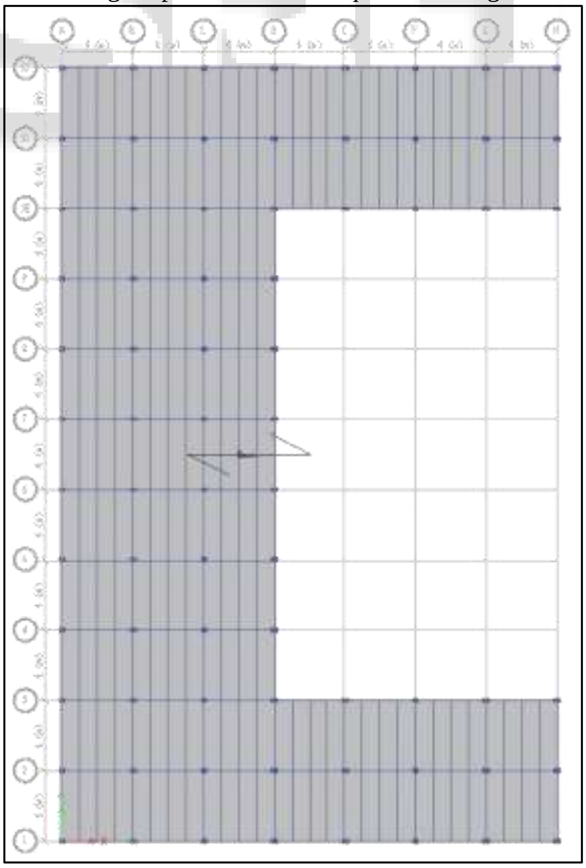

Fig. 2: plane of C building

VI. 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
c) To calculate which bracing system gives more base shear and also less base shear on different type of considered building.
d) Also compare the response of braced frame with unraced frame.

VII. 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 =
5) Dimensions of Column=
6) Dimensions of Bracings=
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)

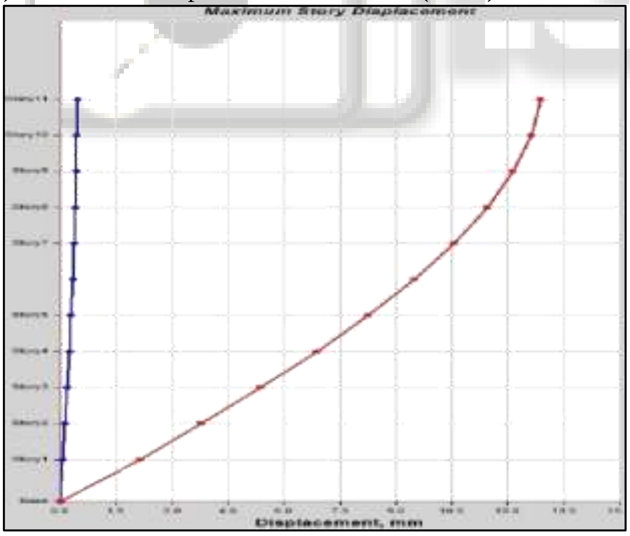

Fig. 3: displacement of hollow sq. building with X bracing

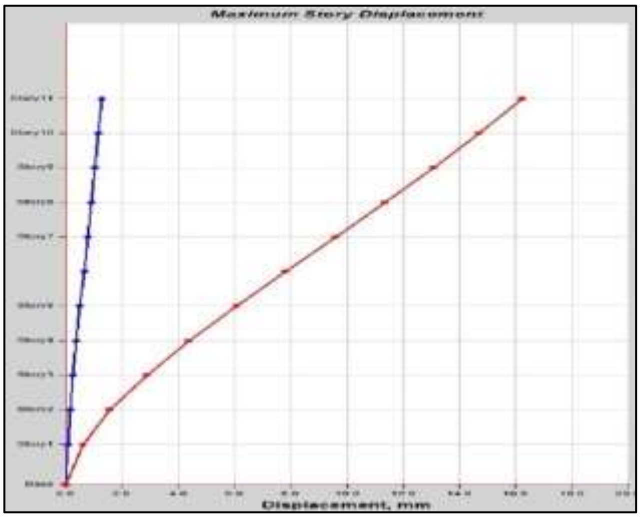

Fig. 4: displacement of C building with X bracing

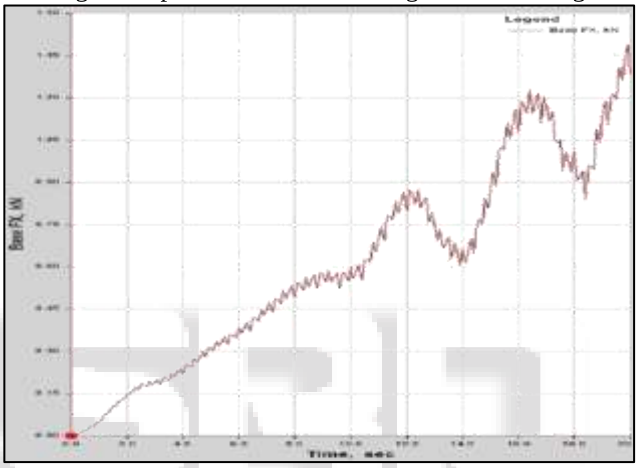

Fig. 5: base shear of the C building with X bracing

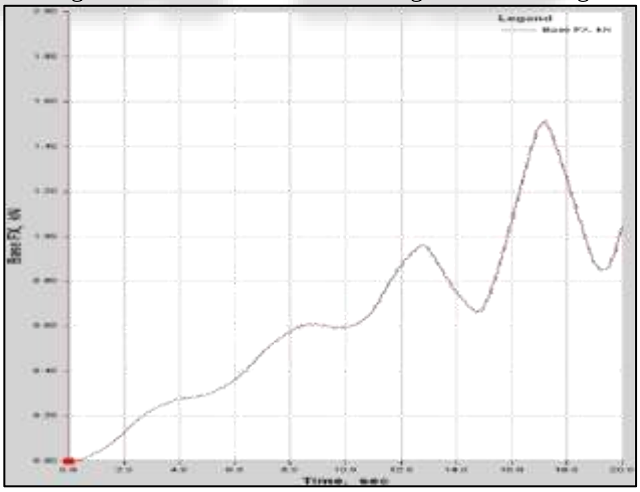

Fig. 6: base shear of the hollow sq. building with X bracing

VIII. RESULTS & DISCUSSION

SR. NO.	Type of bracing	DISPLACEMENT (mm)	BASE SHEAR E5 KN	PSEUDO ACCELERATION(mm/sec2
1	Without bracing	16.23	1.343	319.077
2	X bracing	11.42	1.3	357.81
3	V bracing	11.49	1.343	319.09
4	Invert V bracing	11.49	1.343	319.09
5	Diagonal bracing	11.80	1.39	320.02

Table 1: "C" Building

SR. NO.	Type of bracing	DISPLACEMENT (mm)	BASE SHEAR E5 KN	PSEUDO ACCELERATION(mm/sec2
1	Without bracing	15.83	1.513	526.518
2	X bracing	12.83	1.482	393.518
3	V bracing	15.39	1.5	854.34
4	Invert V bracing	15.84	1.477	1183.39
5	Diagonal bracing	15.76	1.483	422.14

Table 2: Hollow SQURE Building

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

From the above data it is clear that base shear of the ‘C’ shaped building with ‘X’ bracing system is minimum among all the type of bracing when comparing the ‘hollow square’ and ‘C Shaped building

IX. Conclusion

By performing the time history 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. hollow square & C shaped building
2) for comparing the shape of building “C” shaped building gives minimum displacement with “X” bracing
3) for the base shear C shape building gives minimum base shear with “X” type of bracing

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