

Survey Paper on Non-linear analysis of high rise steel frame structure with different bracing configuration

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Abstract - Steel is by far most useful material for building construction and in last decades steel structure has played an important role in construction industry. It is necessary to design a structure to perform well under seismic loads. In this study non-linear analysis is carried out for high rise steel frame building with different bracing configuration. Steel braced frame is one of the structural systems used to resist lateral deflection of the structures. In this project a steel building model is taken, this model is compared in different aspects such as Natural frequencies, fundamental time period, inter story drift and base shear etc. using different bracing configuration in different locations. After the numbers of trial the results of seismic analysis of high rise steel building with different pattern of bracing system which type of bracing at which location is more suitable would be selected for the structure.

Key Words: Time history analysis, high rise steel frame with different types of bracing, bracing pattern

1. INTRODUCTION

Steel buildings are more flexible than RCC building but they display lateral deflection than RCC building. A Bracing is a system that is provided to minimize the lateral deflection of structure. A Braced Frame is a structural system which is designed primarily to resist wind and earthquake forces. Braced frames are classified as concentric braced frames (CBF) or eccentric braced frames (EBF). Concentric braced frames are frames in which the center line of the member that meet at a joint, intersect at a point to form a vertical truss system which resists lateral forces. These frames provide complete truss action with member subjected to the axial forces in elastic range. Concentric braced frames (CBF) are used to resist wind forces. Bracing arranged concentrically in structure pose difficulties in preventing foundation uplift. Because one diagonal of an opposing pair is always in tension, possibility of brittle failure is present.

Eccentric braced frames(EBF) is a framing system in which the forces induced in the braces are transferred either to a column or to another brace through shear and bending in small segment of beam called link. The link in EBF act like structural fuses to dissipates earthquake induced energy in stable manner. EBFs represent an economically

effective way of designing steel structure for seismic loading. Due to eccentric bracings there is reduction in the lateral stiffness of the system and improve the energy dissipation capacity.

This study includes the structural behaviour of steel building for braced frame under static and lateral loading. The main aim of study has been to identify the type of bracing configuration which causes minimum displacement such contributes to greater lateral stiffness to the structure.

1.1 SCOPE AND OBJECTIVE

Following are the main objective of the present study:

- a) To investigate the seismic performance of a multi-story steel frame building
 - With different bracing configuration using Response Spectrum analysis and Time History analysis.
 - Under different earthquake loading and loading combinations

1.2 REVIEW OF LITERATURE

K.K.Sangle,K.M.Bajori,V.Mhalungkar.,2012,[1] Has done research work on "Seismic Analysis Of High Rise Steel Frame Building With And With Out Bracing" The Aim of study was to compare the results of seismic analysis of high rise steel building with different pattern of bracing system and without bracing system. By using time history analysis the result of the study shows that bracing element will have very important effect on structural behaviour under earthquake effect.

V.A. Choudhari, Dr. T. K. Nagaraj.,2015(2) The study shows that modeling of the G+4 steel bare frame with various bracings (X, V, inverted V, and Knee bracing) by pushover analysis results are obtained Comparison between the seismic parameters such as base shear, roof displacement, time period, story drift, for steel bare frame with different bracing patterns are studied. It is found that the X type of steel bracings significantly contributes to the structural stiffness and reduces the maximum drift of steel building than other bracing systems.

Mohammed Idrees Khan, Mr.Khalid Nayaz Khan, 2014(3), Presented paper on "seismic analysis of steel frame with bracings using pushover analysis". A typical 15th- story

regular steel frame building is designed for various types of concentric bracings like Diagonal, V, X, and Exterior X and Performance of each frame is carried out through nonlinear static analysis. Three types of sections i.e. ISMB, ISMC and ISA sections are used to compare for same patterns of bracing. It is found that the provision of bracing enhances the base shear carrying capacity of frames.

Juan Carlos Vielma, Reyes Herrera, Sigrit Perez, Alex Barbat, Ronald Ugel, 2012(4), Presented on "Seismic response of high-rise steel framed buildings with Chevron-braced designed according to Venezuelan codes". The object of this study is to determine the seismic response of regular high-rise steel buildings with Chevron-braced frames. Dynamic analysis is used to find parameters of ductility, over strength and maximum displacements. From these results they concluded that Chevron-braced frames presented a good overall performance and non V-braced frames show greater damage due to dynamic actions, validating nonlinear dynamic analysis as a very powerful tool to seismic-resistance design and Chevron-braced frames as a useful choice for improving the response of steel structures.

Chui-Hsin Chen., Jiun-Wei Lai., Stephen Mahin.2008(5) Presented on "Seismic response assessment of concentrically braced steel frame buildings". Improvement of performance based design and analysis procedure for better understanding of conventionally used concentrically braced frame and buckling restrained braced frames is discussed.

K.G.Vishwanath, presented on "Seismic response of Steel braced reinforced concrete frames" in International journal of civil and structural engineering 2010 (6) A four storey building was taken in seismic zone 4 according to IS 1893:2002 . The performance of the building is evaluated according to story drift. Then the study is extended to eight story and twelve story. X type of steel bracing is found out to be most efficient.

Ghobarah A. et al., 1997(7) The study shows that the inter story drift can also be considered as a means to provide uniform ductility over the stories of the building. A story drift may result in the occurrence of a weak story that may cause catastrophic building collapse in a seismic event. Uniform story ductility over all stories for a building is usually desired in seismic design.

Christopoulos et al., 2008(8) an advanced cross bracing system has been used in University of Toronto called (SCEDs) Self centering energy dissipating frames. Alike, Special moment resisting frames and Buckling reinforced braced frames, they also dissipate energy, but they have self-centering capabilities which reduce residual building deformation after major seismic events.

kalugotla naga bhushanam *, dr. h. sudarsana rao, december, 2015(9) presented on "optimized modeling and design of steel frames in different seismic zones using etabs software". In the Present analysis, a steel framed building with 15 floors (each story is 4m height) is analyzed and designed in all seismic zones by using software "ETABS" an engineering software product that caters to multi story building analysis and design. The project consists of design based on a set of user specified load combinations. The design involves calculating story drift, story shear, displacements in all seismic zones and comparing the results. Optimization is an act, process, or methodology of making something as fully perfect, functional, or effective as possible. In steel structures best way of modeling can be possible by effective placing of steel braces to counter the lateral forces acting on the structure. Lateral forces always try to overturn the structure so effective placing of braces is required. Diagonal braces can be placed in interior elevations of the building. The intent of the braced frame at this location was to provide resistance to lateral loads in both shear and overturning. The horizontal truss elements at the roof and mid-height of the building are transfer trusses to help distribute overturning forces from the interior braces to the building exterior

2. Methodology

- a) A thorough literature review to understand the basic concept of the topic like seismic evaluation of building structures, Response Spectrum analysis, and linear Time History analysis by referring books, technical papers or research papers.
- b) Data collection.
- c) Seismic behavior of steel frames with various bracings bracing configuration.
- d) Modeling the steel frame with various bracing configuration by computer software ETABS2013.
- e) Carry out Equivalent Static analysis, Response Spectrum analysis and linear Time History analysis on the models
- f) Interpretation of results & conclusion

2. Theoretical Content

Steel frame is a building technique with a "skeleton frame" of vertical steel columns and horizontal I-beams, constructed in a rectangular grid to support the floors, roof and walls of a building which are all attached to the frame. The Steel buildings are used for a variety of purposes including High rise buildings Industrial buildings Warehouse buildings Residential buildings, Temporary Structures because of its strength, low weight, speed of construction, its

ability to create large span spaces at low cost, quick to set up and remove.

In this frame system, bracing are usually provided between beams and columns to increase their resistance against the lateral forces and sideways forces due to applied load. Bracing is usually done by placing the diagonal members between the beams and columns. This frame system provides more efficient resistance against the earthquake and wind forces. This frame system is more effective than rigid frame system. Braced framed are classed as concentric braced frame or eccentric braced frame.

Concentrically Braced Frames (CBFs) are a class of structures resisting lateral loads through a vertical concentric truss system, the axes of the members aligning concentrically at the joints. CBFs tend to be very efficient in the resisting lateral forces since they can provide high strength and stiffness. These characteristics can result in less favorable seismic response, such as low drift capacity and higher accelerations. CBFs are a common structural steel or composite system in areas of any seismicity. Special Concentrically Braced Frames (SCBFs) are a special class of CBF that are proportioned and detailed to maximize inelastic drift capacity.

A frame whose centerline braces are offset from the intersection of the centerlines of the columns and beams are nothing but eccentric braced frame. Eccentric bracings reduce the lateral stiffness of the system and improve the energy dissipation capacity. Due to eccentric connection of the braces to beams, the lateral stiffness of the system depends upon the flexural stiffness of the beams.

3. CONCLUSIONS

The result of the present study shows that bracing element will have very important effect on structural behavior under earthquake effect. If a structure is provided with Bracings though it may concentric or eccentric then it gives more resistance to lateral deflection. The provision of bracing enhances the base shear carrying capacity of frames. Chevron-braced frames as a useful choice for improving the response of steel structures. It is found that the X type of steel bracings significantly contributes to the structural stiffness and reduces the maximum drift of steel building than other bracing systems.

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