REVIEW ON SEISMIC ANALYSES OF RC FRAME STRUCTURE BY USING BRACING SYSTEM

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Abstract - *In all type of building bracing systems are used to provide strength, stiffness and energy dissipation to resist different types of load act due to earthquake. This research works focus on review of seismic analysis of the RC frame structure by using bracings by ETAB17.01 software by the response spectrum method. In this research we are comparing 4 types of structure (ie.L, C,O&rect building) by providing 4 types of bracing in each by keeping the constructed area of each building same. Every structure is the institutional building (G+11).the comparison of different type of building with different bracing system is analyze will have to be done in future scope of this research work. In this research work story shear, story displacement, story stiffness etc. Structural performance of all the systems is significant but their effect unequal variations and behavior against earthquake loads.*

Key Words: seismic analysis, RC frames structure, response spectrum, story shear, story drift, 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.

High-rise buildings are closely related to the city, they are a natural response to dense population concentration, scarcity of land, and high land cost. Our country is a developing country; so many residential and other public buildings are needed for social, ecological, economical and public demands. The structural elements of the building are subjected to Gravitational forces, meteorological loads, seismological force and other man made forces. Therefore the structural elements must be designed to resistance. In addition, the structural engineer should be able to analyze three basic aspects of structural behavior

1) Stress, strain and deflection characteristics under static loading condition.

2) Response and vibration characteristics under dynamic loading condition.

During earthquake motions, deformations take place across the elements of the load-bearing system as a result of the response of buildings to the ground motion. As a consequence of these deformations, internal forces develop across the elements of the load-bearing system and displacement behavior appears across the building. The resultant displacement demand varies depending on the stiffness and mass of the building. In general, buildings with higher stiffness and lower mass have smaller horizontal displacements demands. On the contrary, displacement demands are to increase. On the other hand, each building has a specific displacement capacity. In other words, the amount of horizontal displacement that a building can afford without collapsing is limited. The purpose of strengthening methods 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.

Steel braced frame is one of the structural systems used to resist earthquake loads in multistoried buildings. Many existing reinforced concrete buildings need retrofit to overcome deficiencies to resist seismic loads. The use of steel bracing systems for strengthening or retrofitting seismically inadequate reinforced concrete frames is a viable Steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. In the recent past earthquake several RC buildings which are designed for only gravity loads and Buildings with non-ductile detailing are suffered moderate to severe damages. The non-ductile behavior of RC frames is due to inadequate transverse reinforcement in beams, columns and joints. Therefore, it is necessary to provide special mechanism or mechanisms that improve lateral stability of the structure. One of the main strengthening approaches is installing new structural element, such as steel braces to upgrade the seismic performance of structures by using concentric and eccentric steel bracing techniques. Although it is common to employ steel braces in steel frames and use shear walls in RC structures; in recent years, there have been several studies on use of steel braces in RC buildings.

A large portion of India is susceptible to damaging levels of seismic hazards. Hence, it is necessary to take in to account the seismic load for the design of structures. In buildings, the lateral loads due to earthquake are a matter of concern. These lateral forces may produce critical stresses in the structure, induce undesirable stresses in the structure, induce undesirable vibrations or cause excessive lateral sway of the structure. Sway or drift is the magnitude of the lateral displacement at the top of the building relative to its base. Traditionally, seismic design approaches are stated, as the structure should be able to ensure the minor and frequent shaking intensity without sustaining any damage, thus leaving the structure serviceable after the event. The structure should withstand moderate level of earthquake ground motion without structural damage, but possibly with some structural as well as non-structural damage. This limit state may correspond to earthquake intensity equal to the strongest either experienced or forecast at the site. In present study, the results were obtained for pushover analysis. The main parameters considered in this study to compare the seismic performance of a structure with and without steel braces. Seismic Analysis is a subset of structural analysis and is the calculation of the response of a structure to earthquakes.[5] A reinforced concrete building should be designed to have a capacity to carry combined loads at certain safety level and at certain degree of reliability so, when this design is finally executed in the construction process, the expected performance of the structural building should come into satisfaction. However, this ideal condition is not always realized. Performance of structural building could be below the expected criteria in term of safety level and service life due to a variety of causes. There are several technologies that could be chosen for this purpose such as bracing, shear walls etc.

1.1Method of analysis

1.1.1 Response Spectrum Method

This is the most widely used method in seismic analysis. In this method, a multi-storey structure is idealized as multi storey shear building by assuming the mass is lumped at the floor and roof diaphragm levels, that the diaphragms are infinitely rigid and the columns are axially in extensible but laterally flexible. The dynamic response of the system is represented by the lateral displacements of the lumped masses with the number of degrees of dynamic freedom or modes of vibration „n' being equal to the number of masses.

This concept provides a conceptual basis for using response spectra based on single mass system for analyzing multi storey buildings. Given the period, mode shape and mass distribution of a multi-storey building, we can use response spectra of a single degree of freedom system for computing the deflected shape, storey accelerations, forces and moments.

The combination method include,

i. Absolute - peak values are added together.

ii. SRSS method. And iii.CQC method.

1.2 Types of Bracings

There are two types of bracing systems 1) Concentric Bracing System and 2) Eccentric Bracing System

1) 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. Concentric braced frames do not have extensive requirements regarding members or connections, and are frequently used in areas of low seismic risk. Most braced frames are concentric. This means that, where members intersect at a node, the centroid of each member passes through the same point.

2) Eccentrically braced frames (EBFs) are a relatively new lateral force resisting system developed to resist seismic events in a predictable manner. Properly designed and detailed EBFs behave in a ductile manner through shear or flexural yielding of a link element. The link is created through brace eccentricity with either the column centerlines or the beam midpoint. The ductile yielding produces wide, balanced hysteresis loops, indicating excellent energy dissipation, which is required for high seismic events.

2. AIM

The purpose 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

3. LITERATURE REVIEW

1. Extensive literature of the subject reveals that many successful applications of bracing system made. Some of the literatures referred as follows:-

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 i.e. Nonlinear Static Pushover Displacement Coefficient Method as described in FEMA 356,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.

A Kadid[2] 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 typeand size of the cross section

H. Moghaddam, et.al [3] 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.

Ahmet Kuşyılmaz et.al [4] 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 [5] 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.

O. S. Bursi, et.al [6] 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.

4. System Development

4.1 Research Gap

The study of above research paper tells that work on "Seismic Analysis of RC Structure using Bracings" has been carried out in the past. but performance of different types of bracing in the different type of RC structure(G+11) by Response of steel braced RC frame structure under response spectrum 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.

4.2 Methodology

for the seismic analysis of RC structure using bracing we have to test the five different types of bracing on four type of building (ie.L, C,O&rect building) by response spectrum 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

5. OBJECTIVE

1. Response of steel braced frame RC structure under response spectrum 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 RC building and also determine which bracing gives the less lateral displacement among the consider one.

b. In this we have to considered 4 type of building by keeping the area of all the building same

c. Also calculate which bracing system gives more stiffness to the structure and which bracing system gives less stiffness to the structure.

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.

f. Also calculate which bracing system subjected to maximum and minimum stress and strain

6. CONCLUSIONS

By studying the above review it is concluded that:

1) By using bracing system, the lateral displacement and deflection of the building reduces.

2) The system of using concrete bracings is more useful which can use to strengthen or retrofit the existing structure.

3) The lateral displacement of the building reduced by the use of bracing system.

4) In medium high rise buildings (>10storeys) provision of SW is found to be effective in enhancing the overall seismic capacity characteristics of the structure.

5) ESA and RSA methods are more accurate than IS code method, as it reduces the natural time period.

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