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Design & Analysis of Rcc Building with and Without Bracing by Response Spectrum Method - A Review

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Abstract:- *Concrete braced and steel braced reinforced concrete 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 concrete and steel bracing systems for strengthening seismically inadequate reinforced concrete frames is a viable solution for enhancing earthquake resistance. Concrete and steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness. In the present study, the seismic performance of reinforced concrete(RC) building rehabilitated using concentric RCC or steel Bracings is investigated. The bracing is provided in peripheral columns. The effect of the distribution of the steel bracing along the height of RC frame on the seismic performance of the rehabilitated building is studied. The performance of the building is evaluated in terms of global and storey drifts.*

Keywords:- *RC frame Structure, Bracings, Response Spectrum, forces, Storey drift.*

I. Introduction

To oppose lateral earthquake loads, shear dividers are normally utilized in RC confined structures, while, steel propping is the regularly utilized in steel structures. In the previous two decades, various reports have likewise demonstrated the compelling utilization of steel propping in RC outlines. Steel supporting of RC structures began as a retrofitting measure to fortify earthquake-harmed structures or to expand the heap opposing limit of existing structures.

Structures designed to resist moderate and frequently occurring earthquakes must have sufficient stiffness and strength to control deflection and to prevent damage. However, it is inappropriate to design a structure to remain elastic under severe earthquake because of economic constraints. The inherent damping of yielding structural elements can be advantageously utilized to lower the strength requirements, leading to a more economical design. This yielding provides ductility or toughness of structure against sudden brittle type structural failure. In steel structures, the moment resisting and concentrically braced frames have been widely used to resist earthquake loadings. The moment resisting frame possesses good ductility through flexural yielding of beam element but it has limited stiffness. It is necessary to design a structure to perform well under seismic loads. Shear capacity of the structure can be increased by introducing steel bracings in the structural systems. Bracing can be used as retrofit as well. There are n number of possibilities are there to arrange steel bracings. Such as D, K and V type Eccentric bracings.

Impact of the earthquake forces gets reduced because of this bracing and different location and types of bracing also have a good reduction in the displacement, shear and storey drift in the structure.

Strengthening Of RC Structures With Concrete And Steel Bracing Systems

Concrete bracing and Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A number of researchers have investigated various techniques such as infilling walls, adding walls to existing columns, encasing columns, and adding concrete bracing or steel bracing

to improve the strength and/or ductility of existing buildings. A bracing system improves the seismic performance of the frame by increasing its stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. Therefore, the use of steel bracing systems for retrofitting reinforced concrete frames with inadequate lateral resistance is attractive.

II. Literature Review

Krishnaraj R.Chavan et.al (2014) studied the seismic analysis of reinforced concrete (RC) buildings with different types of bracing (Diagonal, V type, Inverted V type, X type). The bracing is provided for peripheral columns. A seven-storey (G+6) building is situated at seismic zone III. The building models are analyze by equivalent static analysis as per IS 1893:2002 using Staad Pro V8i software. The main parameters consider in this paper to compare the seismic analysis of buildings are lateral displacement, storey drift, axial force, base shear. It is found that the X type of steel bracing significantly contributes to the structural stiffness and reduces the maximum inter storey drift of R.C.C building than other bracing system. The lateral displacement of the building is reduced by 50% to 56 % by the use of X Type steel bracing system, and X bracing type reduced maximum displacement. The steel braced building of base shear increase compared to without steel bracing which indicates that stiffness of building is increases.

M.G. Kalibhat et.al (2014) focused on the effect of a provision of concentric bracings on the seismic performance of the steel frames. In this paper study of two different types of concentric bracings (X and inverted V- type bracing) have been considered for the different storey levels. ETABS, Finite Element software has been used and the comparison between the performances of 1- bay X and inverted–V type and un-braced frames is made using pushover curves. Seismic performances of the frames are carried out the parameters such as Base shear, roof displacement and the number of hinges formed. Steel bracings can be used to strengthen or to retrofit the existing structure. The provision of bracing enhances the bases hear carrying capacity of frames and reduces roof displacement undergone by the structures. The lateral storey displacements of the building are reduced by the use of inverted-V bracing in comparison to the X bracing system.

M.I. Khan et. al (2014) in this paper nonlinear push over analysis is carried out for high rise steel frame building with different pattern of bracing system. The shear capacity of the structure can be increased by introducing Steel bracings in the structural system. 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. ISMC Sections reduces more displacement compare to angel and beam section for similar type of brace. It is shown that bracings have increased level of performance both in terms of base shear carrying capacity and roof displacement. ISMB Sections gives more stiffness compare to angel and channel sections for similar type of brace.

S.N.Tande et.al (2014) this paper provides an introduction and overview of the design and behavior of seismic-resistant eccentrically braced frames (EBFs). EBF‘s have become a widely recognized lateral load resisting system for steel building in areas of high seismicity. In general, braces are the members that resist against lateral forces in a steel structure while the structures are under seismic excitation. In this paper six frames were exerted which were braced with three different eccentric braces (V, Inverted-V and Diagonal) in two different heights (4 and 8 storey). Then the frames were assessed by nonlinear static (pushover) analysis mainly based on FEMA 440. As a result of these frame analysis, it can be observed that the plastic hinges firstly occur at the fuse section of braces and then at the compressive members of the eccentric braces. The primary purpose of this paper is to present the best suitable bracing system up to 8 storey level in performance point of view and also economy point of view.

Kiran Kamath et.al (2015) studied the effect of different aspect ratios i.e. H/B ratio, where H *is the total height of the building frame and B is the base width of the building frame, on the seismic performance of the steel frame structures. In the present study, seven different aspect ratios ranging from 1.0 to 3.75 have been considered for the ten storey steel frame building with concentric bracing i.e. X bracing and without bracing system. For this analytical study, ETABS is used and the comparison between the performances of bare frames with different aspect ratios is made using pushover curves. Roof displacement, base shear carried and performance point are the parameters used to identify the seismic performance of the frames. It is shown that provision of bracings to the frame structure increased the base shear carrying capacity, performance point and reduced the roof displacement for all types of aspect ratios considered. As aspect ratio increases, base shear carrying capacity decreases for both type of section considered in this paper. Steel frame with aspect ratio 1.0 and two bays X braced frame showed better performance.*

Viswanath K.G et al. (2010) studied on seismic analysis of steel braced reinforced concrete frames. He studied the seismic performance of reinforced concrete (RC) buildings rehabilitated using concentric steel bracing. For peripheral columns the bracings were provided. A 4story building was analyzed for seismic zone IV as per IS 1893: 2002 using STAAD Pro software in his paper. It was examined the effectiveness of various types of steel bracing in rehabilitating a 4story study. The seismic performance of the rehabilitated building was studied on the effect of the distribution of the steel bracing along the height of the RC frame. In terms of global and story drifts the performance of the building was evaluated. His result shows the reduction of percentage in the lateral displacement. Then he concluded that the X type of steel bracing significantly contributed to the structural stiffness and reduces the maximum inter story drift of the frames.

Madhusudan et al. (2014) had studied on the effect of a provision of concentric bracings on the seismic performance of the steel frames and in the study they considered the two different types of concentric bracings (viz. X and inverted V type bracing) for the different story levels.

Nauman Mohammed et al. (2013) studied on Behavior of Multistory RCC Structure with Different Type of Bracing System (A Software Approach). They aims to evaluate the response of braced and unbraced structure subjected to seismic loads and to identify the suitable bracing system for resisting the seismic load efficiently. A G+14 floors building were analyzed using STAAD V8i software for special moment resisting frame situated in zone 4.The RCC G+14 structure was analyzed for both without bracings and with different types of bracings system. For all type of structural systems i.e. braced and unbraced structural system bending moments, shear forces, story shears, story drifts and axial forces was compared. They had been concluded that the displacement of the structure decreased after the application of the bracing system. After the application of cross bracing system the maximum reduction in the lateral displacement occurs. In the columns bracing system reduces bending moments and shear forces. The paper also states that the execution of cross bracing system was better than the other specified bracing systems.

To retrofit the existing structure steel bracings were used. Significantly after the application of the bracings, total
weight of the existing structure will not be changed.

III. Methodology

In this study, the seismic analysis of reinforced concrete (RC) buildings with different types of bracing (Diagonal, V type, Inverted V type, Combine V type, K type, X type) studied. The bracing is provided for peripheral columns and any two parallel sides of building model. A fifteen-storey building is analyzed for seismic zone V as per IS 1893: 2016 using STAAD and ETAB software. The percentage reduction in storey displacement will be calculated as per response spectrum method and the type of bracing system which will be better and gives good stiffness and good strength capacity in displacement and base shear will be applied. The evaluation of the results will be in terms of storey drift and graphical comparison will be done and the maximum inter storey drift of the frame as per the different types of bracings which contributes to the structural stiffness of the frame.

IV. Conclusion

1. The steel bracing system has not only improved displacement capacity of reinforced concrete structures, but also the lateral stiffness and strength capacity of the structures by increasing its shear capacity. Story drift should be limited because deflection must be limited during the earth quake to protect the damage of structural elements, especially non -structural elements, and hence the provisions of steel bracing for the RC structure give adequate stiffness for the structure and bracing given better result in reduction of story drift.
2. The base shear capacity of steel braced frame is increased as compared to bare frame (without bracing) building which indicates that the stiffness of building has increased. The base overturning moment of RC frame has increased after the application of all bracing systems.

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