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A STUDY ON SEISMIC BEHAVIOR OF DIFFERENT BRACED BUILDING

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ABSTRACT

Unexpected energy released due to the movement of tectonic plates or motion of rocks below ground surface is the main reason for Earthquake. According to Indian Standards there are four seismic zone based on their severity. So, to withstand the seismic forces the building must be equipped with Lateral Load Resisting System in which Bracings system (Concentric, Eccentric) is a part of it. Many literatures have concluded that installing optimum bracings system in building which are present in seismic zone can safeguard the structure from failure due to Lateral Displacement, Storey Drift and can reduce the cost in retrofitting process.

Keywords: Lateral Load Resisting System, Bracings System, Lateral Displacement, Storey Drift.

I. INTRODUCTION

Amongst the natural hazards, Earthquakes is more vulnerable to buildings which are present in seismic zones. Buildings are subjected to severe damages like Displacement, Storey Drift due to motion of ground caused by earthquake. To resist lateral forces like seismic & wind loads which cause possible lateral sway on the building, different types of bracing systems are introduced into the building to absorb more energy and has plastic deformation before collapse. So bracing system plays an important role in building which is subjected to lateral loads.

II. LITERATURE REVIEW

[1] P. V. Srivardhan, Dr. K. Harikrishna Studied the deflection of high raised concrete buildings with wind and Seismic loads for different shapes of Building plan (Rectangle, square, T ,Plus) in ETABS and providing lateral force resisting systems such as Shear Wall System, steel X-Bracings System and combination of Shear Wall and Bracing system which are placed in different location like core and corner of building and cost estimation of these systems are also obtained. The results are obtained with respect to the parameters like Storey Displacement, Storey Drift, Storey Stiffness, Storey Forces, Storey Acceleration. The increasing order of deflections is given by Square < Plus < Rectangle < T plan and Deflections for rectangular building is lesser than square building along short base and is high along long base dimension.

[2] D. Sirisha, M. Divya Tejaswi Studied deals with seismic analysis and design of multistoried RC (G+9) building in ETABS. considering Diagonal Bracings as lateral force resisting system induced in outer bay of building which is located in seismic zone II and has medium soil condition. Consisting of 4 models in which 2 are as per IS code and another 2 are as per EURO code (one is of bare frame & another is of Diagonal Bracings). Response Spectrum method is used for seismic analysis of the structure. The results are obtained with respect to the parameters like Storey Displacement, Storey Drift, Storey Shear. Displacements are reduced about 40% to 89% in plan and the displacement in EURO code is higher is more compared to IS code. Reduction of storey drift by 40% is observed when Bracings are provided to the structure.

[3] Sachin Metre, Shivanand C ghule, Ravi kiran made comparative study for analysis of different types of bracing system by placing it at different location of building in ETABS. Building is in seismic zone II & V and has medium soil condition. Providing (X, V, Diagonal) at outer edge, inner edge, centre of the building. Parameters like Storey Displacement, Storey Drift, Storey Shear are considered for comparison of results for different bracings. In both directions the displacement & Storey drift reduced when Inverted-V bracing is provided in inner edge. when height of the building increases, storey drift also increases & then decreases. Storey Shear increases for the X-bracing compared to inverted-V and Diagonal bracing.

[4] Lekshmi Soman, Sreedevi Lekshmi provides the comparative study of braced frame at core and shear wall at core of high rised building in ETABS without consideration of wind load. Outriggers are structural

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systems which connects the central core and the exterior columns of the building, provided at (top & middle), (top&3/4th height) of the building. Seismic analysis is done by a part of dynamic analysis i.e. Response Spectrum method. Parameters like Storey Drift, Base Shear are considered for output. The percentage reduction of RC shear wall compared to Braced Frame is 40% for Storey Drift. Outrigger placed at top&3/4th height the total height is good in terms of storey drift and base shear and a notable reduction was Observed.

[5] Bhargava Laxmi Goli, Himath Kumar Yerramasetty, Lingeshwaran Nagarathinam, Srujana Nandam deals with analytical study of buckling restrained braced for lateral loading. Providing Bracings (Diagonal, Zig-Zag, X, Inverted-V) at four corners of the building. considering zone III and medium soil condition. Modeling and Analysis of the structure have been done in ETABS by Response Spectrum method. Parameters like storey drift, storey forces, diaphragm drift, storey stiffness and storey acceleration are taken in account in both X&Y Directions. Diagonal & zig-zag bracing performs good in storey displacement and X & inverted v provide good stiffness.

[6] Mohammed Idrees Khan, Mr.Khalid Nayaz Khan studied the seismic analysis of steel frame with different bracings like (Diagonal, X, V). Considering steel sections like ISMB, ISMC, ISA for the bracings. Parameters considered are Base shear, joint displacement. ISMC Section reduces more displacement compare to Angel and ISMB section. X-Bracing provided in exterior bays reduced more displacement when comped to other bracings.

[7] Dr.Abbas Oda Dawoo, Ameen Ismael Atya studied the analysis of rigid steel frame with and without (X)bracings under wind load condition in Mayson Province. Parameters considered are base shear, base moment, drift ratio, torsion bending moment, axial stresses, bending stresses, shear stress, axial force, shear force and displacement. Base moment for unbraced structure is large by 5% than that of braced structure. Drift ratio and displacement for unbraced structure is large than that of braced structure by 20%. Max. bending moment in case of braced structure is in 11th storey & in 7th storey for unbraced structure.

[8] Jagadish J. S, Tejas D. Doshi presents the effect of different types of bracings in multi storied building (G+15). Modelling and analysis of the structure is done in STAAD.Pro software with (Diagonal, X, Double X, K, V) Bracings which are provided in corner & middle bay. Considering the loads acting on the building as gravity load and wind load in one direction. Parameters like Displacement, storey drift and storey shear, Axial force, weight of bracings are considered. D, X, Double-X Bracings reduced displacement and D and V has less storey drift when compared to others. Recommends bolted connections because of no deformation problem at the connections.

[9] Akhila Devi A Mariamol Kuriakose studied the seismic analysis of steel building (G+17) equipped with buckling restrained braced frame. Analysed by Time History method with consideration of only seismic loading. Considering (Diagonal, X, Inverted-V) Bracings of BRB core length (30,40,50,60,70%) which are provided at the outer corner & inner bays of building. BRB core length of 70% & 40% performs good and quite economical. Effective configuration of BRB is inverted V bracing and effective position of BRB is at the outer corners of the structure.

[10] K.K.Sangle, K.M.Bajoria, V.Mhalungkar studied the seismic analysis of high rise steel building (G+40) with Diagonal, X, K, knee Bracings and without bracings by Linear Time History method. Parameters like Base shear, displacement, time period is calculated. Bracings provided in both direction base shear increases up to 38%. Roof level Displacement with different bracing is reduces from 43% to 60%. Modal time period has reduced to 65%. Diagonal brace-B shows highly effective and economical when compared to other bracings.

[11] Bharat Patel, Rohan Mali, Prataprao Jadhav, G. Mohan Ganesh studied the Parameters like Base shear, storey displacement for buildings with and without bracings. Results showed that X-Bracing is effective and safe under lateral loading when compared with moment resisting frames & V-Bracing. The Shear in base increases for braced buildings when compared to building without bracing which implies that the stiffness of building increases. The percentage reduction of storey displacement of building is reduced upto **55% to 60%** by using XBF & VBF.

[12] Kafeel Hussain Ganaie, Birendra Kumar Bohara, Prasenjit Saha studied effects of Inverted-V bracing in Irregular RC building (G+3) where the Bracing are provided at corner of building. Considering Parameter like maximum story displacements, inter-story drift, base shear, capacity curves, and failure behaviors. Steel

bracing reduces the inter-storey drift and improves the ductile behavior of the structures. Steel Inverted V bracings increase the axial forces at base columns and decrease the column's moments. This helps the steel bracings in the retrofitting process. Steel bracings decrease the fundamental time period and increase the base shear of the structures.

[13] Sreelekshmi. S, Shilpa Sara Kurian provides the study of Outriggers system in high rised building. Considering Shear wall & Outriggers which are provided in different location of building and finding which is effective. Parameters such as storey displacement, storey drift and storey shear are considered. Double outrigger system effectively reduces the seismic response of the building.

[14] Dhananjay.S.Pawar, S.Abdulla U. Phadnis, Ravi.G.maske, Raju .S.Shinde studied the analysis of building in STAAD.Pro for (Diagonal, Cross) bracings provided at peripheral edges and has structure variation (G+5 to G+11) & bay variation (3,5&7). Considering Equivalent Static method, Zone III, parameters (Base shear, Lateral displacement). For both bracings axial force in penultimate column is reduced while compare to end column and this is observed for different height of the structure. Fully braced frames & optimum braced frames consisting of soft storey were found to be more flexible at intermediate level of the building than that of ground level. Cross bracing is economical for 1 bay when compared to Diagonal bracings for 1 bay.

[15] Raghavendra, Siddarth Bejgum, Siddarth S Udgir, Suryadev H Wagatti, Rajesh Harugoppa studied the analysis of five, seven, nine storey building which is resting on sloping ground and considering with irregularities. Lateral Load Resisting System such as bracings and shear wall and their combinations are considered and provided in core of the building. The parameters like lateral displacement, displacement reduction factor, base shear is obtained by response spectrum method. The displacement of roof of seven & nine storey building is 1.4 and 2.7 times the roof displacement of five storey bare frame. Stiffness of building is increased by addition of shear wall & bracing system. Shear wall performs good on roof displacement.

III. CONCLUSION

Bracing system forms an integral part in structural system to resist the lateral loads subjected to the building which is present under different seismic zones. Combination of braced core and outriggers effectively reduces the moments at base. To Obtain optimum bracings, bracings are provided at different location of building i.e.(plan or Height-wise), considering the percentage reduction of parameters like Storey Displacement, Storey Drift in both the directions. By providing bracing systems the structural elements are protected & are not easily damage by seismic forces. This saves human lives and design life of structure and reduces the cost of retrofitting after the occurrence of Earthquake. Present day software's are helpful in inducing the wind & seismic force in building and improving the design aspects of the building.

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