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Seismic Analysis for Zone III, IV, V of (G+14) Multistorey Building with Bracings System Using Staad Pro Software

Anamika Singh[1], Rajeev Singh Parihar[2], Abhay Kumar Jha[3], Barun Kumar[4], Rajesh Misra[5]
[1, 2, 3, 4, 5]*Department of Civil Engineering, Lakshmi Narain College of Technology, Bhopal (M.P)*

Abstract: This present study focuses G +14 Simple Building model In STAAD PRO software. With beam size 300 X 400 mm and column size 400 X 500 mm this reinforced concrete building having M30 grade of Concrete and Fe415 high density steel. To study the response of building with and without bracing system. The performance of the building is analyzed in Zone III, Zone IV, Zone V. Metallic braces is the easiest of simplest way of reducing response of building which gave rise to nine models for the analysis.Model1 in -BFB- Bare frame RCC Building.Model2 in -BX1-Framed building with Bracing at the exterior side along X-direction.Model3 in -BY2- Framed building with Bracing at the exterior side along Y-direction.Model4 in -BXY3- Framed building with Bracing at the exterior side along X and Y-direction.Model5 in-BEC4- Framed building with Bracing at the exterior side around the corners. This system of bracing is used because eccentric bracing systems consist of a link element that undergoes inelastic deformation for energy dissipation. This link is possibly beam element of frame structure which is more suitable for steel structures and not for reinforced concrete structures and a shear wall is a structural panel that can withstand the impact of lateral forces on it. Lateral forces are those parallel to the wall plane and are usually wind loads and seismic loads. This building has been modeled as 3D Space frame model with six degree of freedom at each node using STAAD PRO. software for stimulation of behavior under gravity and seismic loading.

Keywords: bracing, frame structure, STAAD PRO, seismic loads, wind loads, Lateral forces.

I. INTRODUCTION

Generally the purpose of high rise buildings is to transfer the primary gravity load safely. The common gravity loads are dead load, live load. Also the structure should withstand the lateral loads caused by earthquake, blasting, and wind depending on terrain category. The lateral loads reduce stability of structure by producing sway moment and induce high stresses. So in such cases stiffness is more important than strength to resist lateral loads. There are various ways of providing bracings to improve seismic performance of buildings. The different bracing configurations typically used are: Diagonal bracing, Cross bracing(X), Chevron bracing, and V-bracing. Each bracing configurations has its own merits and demerits as compared to other as shown in Figure: 1 Steel moment resisting frames are susceptible to undergo lateral displacement during earthquake. Horizontal (seismic/wind) load is the unreliable load that is coming on the structure. Any structure should be designed in such a way that, it should resist from both gravity and lateral loads. Gravity loads includes dead load, live load, dust load etc. Whereas lateral load includes seismic load, wind load and blast load. Due to this lateral loads, high stresses are produced which then leads to sway or vibration. So, every structure should contain strength to resist vertical (gravity) loads and stiffness to resist (horizontal). The present experimental investigation involves the analytical investigation of a Pre-Engineered building. Horizontal or lateral loading results in production of storey drift, overturning moment, storey displacement etc., which are responsible for failure of the structure. To inhibit these responses bracings and dampers are used for high-rise and important structures. Structures with bracings, dampers show better performance in reducing structural parameters (stress ratio) and systematic parameters (time period, base shear, lateral displacement). Dampers are more economical than bracings. Aspect ratio plays a vital role in performance of structure. As aspect ratio increases, there will be reduction in base shear carrying capacity and roof displacement of steel frame with aspect ratio 1. Arranged bracings to the structure should be of buckling resistant. Buckling restrained frames with special concentric bracings have effective performance than moment resisting and conventional frames. Based on the arrangement of bracing, there are concentric and eccentric bracings. Concentric bracing system is effective in reducing storey displacement, storey drift, and base shear than without bracing system. X-bracing avoids the instability and plastic hinging of floor beams and reduces storey displacement, inter storey drift, time period effectively. Eccentrically braced frames provide a unique combination of stiffness, strength and ductility.

Compared to X-bracing system, inverted-V bracing reduces lateral displacement. Steel frames with double Knee bracings have more lateral stiffness and shows effective behavior than eccentric bracings during earthquake. Knee bracing system increases ductility of structure and is economical for corner arrangement.

II. LITERATURE SURVEY

Chavan and Jadhav (2014) studied seismic analysis of reinforced concrete with different bracing arrangements by equivalent static method using Staad Pro. software. The arrangements considered were diagonal, V-type, inverted V-type and X-type. It was observed that lateral displacement reduced by 50% to 60% and maximum displacement reduced by using X-type bracing. Base shear of the building was also found to increase from the bare Page | 10 frame, by use of X-type bracing, indicating increase in stiffness.

Montuori (2014) Perform analysis on high rise steel diagrid building of 351 m high with H/B ratio of 6.62. Analytical model has floor dimension of 53 m x 53 m with steel framing members as per euro steel table. Model was prepared on SAP 2000 software and analyzed for three different brace angles 600 , 700 & 800 with and without secondary bracing system. Analysis shows need of secondary bracing system in steel diagrid building. Local inter-storey drifts are found lowest for 600 angle bracing system.

Gowardhan et al. (2015) reviewed on comparative seismic analysis of steel frame with and without bracing by using software. This research has depended upon the affectivity of steel bracings in steel structures. A comparison has been deliberated between structure with and without steel bracings resistant to seismic effects. It has been found that seismic bracings increase the stiffness against lateral loadings and it might be a good practice to use bracings as retrofitting scheme.

Bhosle et al. (2015) 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 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) is studied. The bracing is provided for peripheral columns and any two parallel sides of building model. A thirteen-storey building is analyzed for seismic zone III as per IS 1893: 2002 using ETAB software. The percentage reduction in storey displacement is found out. It is found that the X type of concrete bracing significantly contributes to the structural stiffness and reduces the maximum storey drift of the frames. The bracing system improves not only the stiffness and strength capacity but also the displacement capacity of the structure.

Akbari et al. (2015) assessed seismic vulnerability of steel X-braced and chevron-braced Reinforced Concrete by developing analytical fragility curve. Investigation of various parameters like height of the frame, the p-delta effect and the fraction of base shear for the bracing system was done. For a specific designed base shear, steel-braced RC dual systems have low damage probability and larger capacity than unbraced system. Combination of stronger bracing and weaker frame reduces the damage probability on the entire system. Irrespective of height of the frame, Chevron braces are more effective than X-type bracing. In case of X-type bracing system, it is better to distribute base shear evenly between the braces and the RC frame, whereas in case of Chevron braced system it is appropriate to allocate higher value of share of base shear to the braces. Including p-delta effect increases damage probability by 20% for shorter dual system and by 100% for taller dual systems. The p-delta effect is more dominant for smaller PGA values

Atif1 et al. (2015) research work focuses on comparison of seismic analysis of G+15 building stiffened with bracings and shear wall. The performance of the building is analyzed in Zone II, Zone III, Zone IV and Zone V. The study includes understanding the main consideration factor that leads the structure to perform poorly during earthquake in order to achieve their appropriate behavior under future earthquakes. The analyzed structure is symmetrical, G+15, Ordinary RC moment-resting frame (OMRF). Modelling of the structure is done as per staad pro. V8i software. Time period of the structure in both the direction is retrieve from the software and as per IS 1893(part 1):2002 seismic analysis has undergone. The Lateral seismic forces of RC frame is carried out using linear static method as per IS 1893(part 1) : 2002 for different earthquake zones. The scope of present work is to understand that the structures need to have suitable Earthquake resisting features to safely resist large lateral forces that are imposed on them during Earthquake. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing Earthquake damage in structure. Also the braced frames can absorb great degree of energy exerted by earthquake.. The results of the performance and the analysis of the models are then graphically represented and also in tabular form and is compared for determining the best performance of building against lateral stiffness by arrangement of three different types of bracings with three different orientation of bracings and shear wall. A comparative analysis is done in terms of Base shear, Displacement, Axial load, Moments in Y and Z direction in columns and shear forces, maximum bending moments, max Torsion in beams.

Kanthariya et al. (2016) In this paper from the table and chart I am conclude in a double diagonal system more effective to compare single diagonal bracing system. Both bracing systems are increase base shear in building and provide more stiffness compare to without bracing system structure. In a earthquake resistant system bracing system more effectively and provide more resistance during a earthquake. Bracing system is less costly and complex compare to damping system and other earthquake resistant techniques. When establishing a Comparison of bending moment of both bracing systems. From the Table-1 and chart-1 is represented deflection in single and diagonal bracing systems. Deflection in single diagonal system deflection is more compare to double diagonal bracing system and produce jerk in single diagonal system. From the table-1 and chart-1 is represented shear force in single and diagonal bracing systems. In this chart shown very clearly base shear is high in top in single diagonal bracing system and average decrease to floor to floor. Now in double diagonal bracing system shear force is increase to respect of floor height and becoming to near equal to single diagonal bracing. From the table-1 and chart-1 is represented bending moment diagram in single and diagonal bracing systems.

Qiu and Zhu (2016) investigated seismic-resisting, multi-story steel frames with self-centering braces (SCBs) numerically through pushover and incremental dynamic analyses. The seismic performance of self-centering braced frames (SC-BFs) is systematically compared with that of buckling-restrained braced frames (BRBFs), with emphasis on high-mode effect. The concentration of inter-story drift in the upper part of the buildings is more significant in SC-BFs than in BRBFs as a result of this effect. This high-mode effect strengthens with the increasing intensity of ground motions. Parametric studies indicate that increasing the post-yield stiffness ratio and/or energy dissipation capacity can successfully improve the seismic performance of SC-BFs, particularly in terms of limiting the high-mode effect. SC-BFs with enhanced post-yield stiffness and energy dissipation capacity exhibit relatively uniform inter-story drift ratios and reduced record-to-record variability in seismic performance.

Pathak et al. (2016), considered and examined G+9 steel mounts with a diverse variety of bracing configuration and altered combination of soft-story by means of software STAAD Pro. Result of these altered bracings on the soft story is planned for unlike constraints like column shift, determined deflection, story drift, maximum bending moment, maximum axial force and maximum shear force. Nitin Bhojkar and Mahesh Bagade (2015), considered the seismic appraisal of elevated- rise construction by means of steel bracing system. For the seismically insufficient reinforced concrete mounts, the use of steel Vol-7 Issue-5 2021 IJARIIE-ISSN(O)-2395-4396 15245 www.ijariie.com 92 bracing systems is prepared for solidification. In this investigation, diverse varieties of bracing structures are used and seismic examination is completed for seismic region III as per IS1893:2002. Adjacent movement, story drift, axial force, and base shear are the key constraints which are considered. It was perceived that the mechanical toughness was supplementary by the X type of steel bracing and extreme inter-story drift of the casings also grows condensed. The bracing system gives best outcomes in lateral rigorousness, power aptitude as well as in movement capacity. They determine that a decline in lateral movement of the assembly happens up to 65% by the use of X kind of bracing arrangement. Story drift becomes less in X type of bracing system. There was an upsurge in axial force for X bracing system up to 22%.

Srivardhan et al. (2016) A typical 20 and 30 storeyed buildings are considered with four distinct plan shapes such as square, rectangle, plus and a T shape within an area of 40m x 40m having a span of 4m. Each building is analysed for Wind and Earthquake loads using the load combinations provided in IS code book. Three bracing types, a concrete shear wall system, steel X-bracing system and a combination of both shear wall and X-bracing for lower and upper half of the structure are used A deflection for rectangular building is lesser than square building along shorter base dimension and is higher along longer base side

Pate et al. (2017) The high-rise buildings that are made of RCC frame, the greater importance is given to make structure safe against lateral load. These loads are produced due to wind, earthquakes etc. To resist lateral load acting on building different types of steel or RCC bracing systems are provided.

The use of RCC bracing has potential advantage than other bracing like higher stiffness and stability. This study aimed the comparison of different RCC bracing system under seismic behavior in high rise buildings. Also three structural configurations used in this paper are Moment Resisting Frames (MRFs), X-Braced Frames (XBFs), V-Braced Frames (VBFs) for 11 storey (G+10) building. The bracing systems provided on periphery of the column. The frame models are analyzed as per IS: 1893-2000 using STADD.ProV8i and ETABs software’s. The parameters which are considered in this paper for comparing seismic effect of buildings are base shear and storey displacement. The results showed that X-braced frames are more efficient and safe at time of earthquake when compared with moment resisting frames and V-braced frames.

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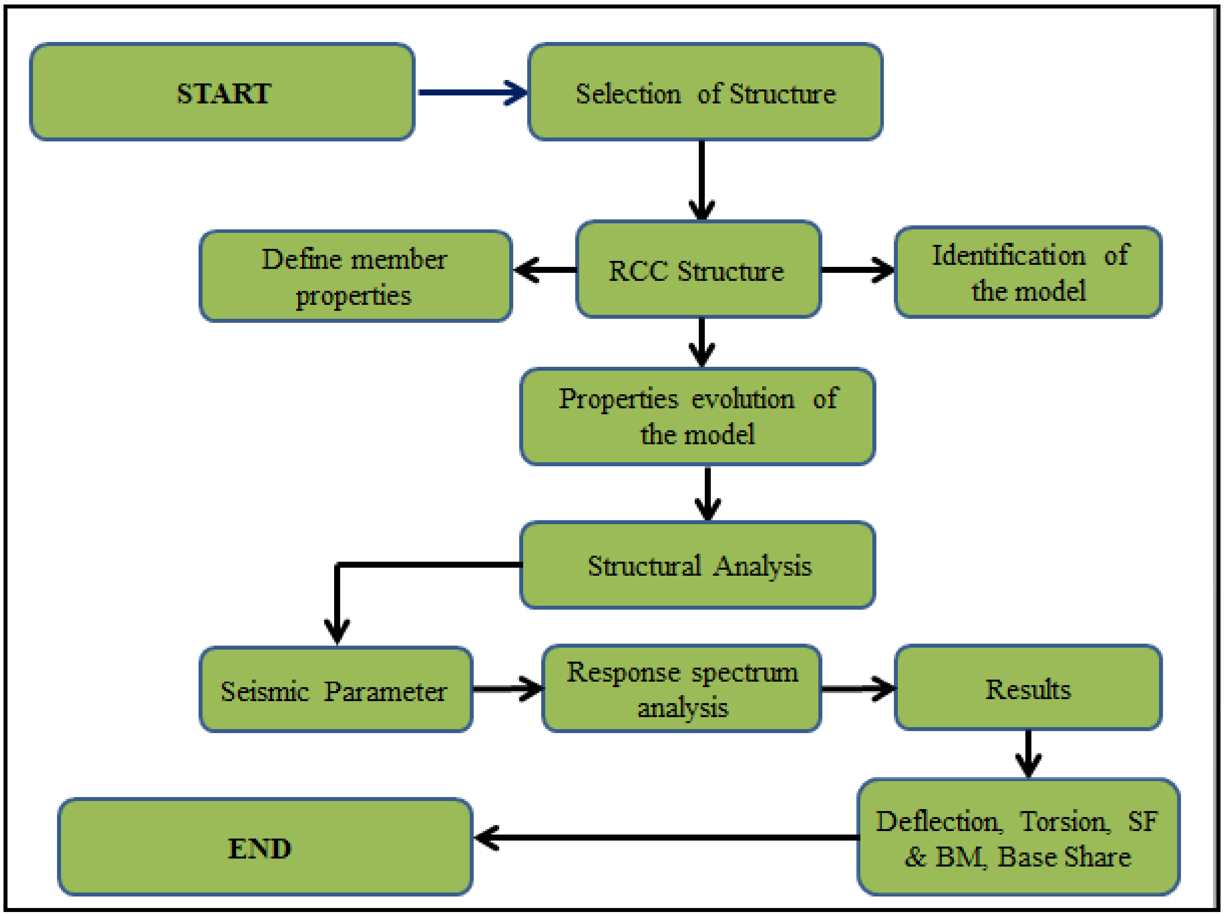
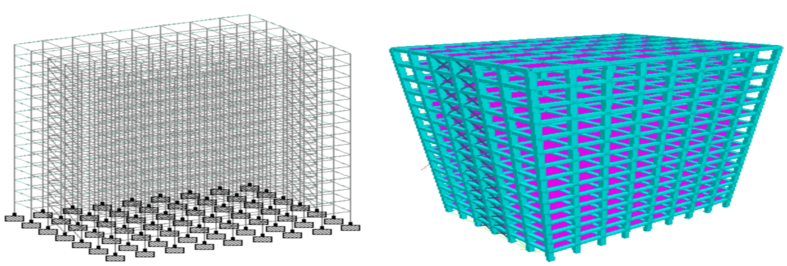
III.STRUCTURAL MODELLING

In this study comparison of the different bracing systems in zone IV and zone V with a conventional non-braced structure under seismic as well as gravity loading is worked out, and behavior and concept of the bracing system are studied. The various models are prepared in the STAAD-PRO software. Bracing system and conventional non-braced structure are modelled for the analyses are presented in this section. Various loading specification and their combination which are subjected to braced structure and non-braced structure are discussed here in this section. Design specification and methods for the analysis of the bracing system are also presented here. To achieve the objective of this study, the following methodology is



IV.METHODOLOGY

For braces angle section ISA 60 X 40 X 6 is used. There are four trial locations in the building where braces are placed and analyzed for their effect on lateral stiffness. Braces are modeled as axial force members having pinned end connections. Bracings are of X-type modeled throughout the height of the building.



Elevation & 3D in X-Z Plane

V. CONCLUSIONS

A. Base shear is same for zone III, zone IV, and zone V as it depends upon height of the structure. As height is increasing base shear is also increasing in same zones.
B. Lateral displacement is minimum for BEC4 for zone III, IV and V. This type of bracing BXY3 is suitable for zone III, IV and V.
C. The minimum axial force found in BX1, BXY3 and BEC4 in zone III , for zone iv BX1, BXY3 and zone VBX1 is economical.
D. The minimum bending moment occurs in zone III, IV and Zone V for BXY3 system.
E. Torsion Increases owing to bracing.
F. The shear force is found out by zone III, IV and Zone V increasing.
G. The maximum bending moment reduces to BX1 frame in zone III ,IV in ZONE V it reduces. BX1 Frame is more effective in resisting maximum bending moment and is more economical.

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