

A Review on Seismic Response of Multi- Storied RC Building with Different Shear Wall and Bracing Systems

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ABSTRACT:From the history of mankind, uncountable deaths were occurred due to unplanned social system, as lesson learnt from disaster of Bhuj earthquake, thousands of people died and lakhs were injured. Present ground reality scenario of suffering people due to disasters, demands technical solutions, so it is necessity of following and implementation of Indian standards codes including national building codes, as a result structures performs as an seismic resistant and efficiently transfers lateral loads. During seismic shakes, designed structures should consist of lateral load transfer mechanisms such as shear wall and bracing systems which enhance the damping properties in addition to seismic vulnerabilities. This paper concerned with different study cases of RCC buildings which consist of dissimilar types of shear wall i.e. I, T, L etc. and bracing systems i.e. X, V, Knee etc., their effect on parameters like bending moment, shear force, lateral displacement, fundamental time period, seismic base shear, storey drift. This project work concluded performance of shear wall and bracings under exposed conditions covering various geometries and orientations through structure analysis using software research applications.

KEYWORDS:Disaster, Bhuj Earthquake, Earthquake Resistant Structure, Indian Standard Codes, Shear Wall, Bracing, Fundamental Time Period, Software Research Applications.

I. INTRODUCTION

Earthquake with 7.9 magnitude struck Gujarat on January 26, 2001 when people of India were preparing to celebrate their 52nd republic day, over 20,000 persons were reported dead and about 1.7 lakhs were injured [1]. It is the major turning point in India towards agenda of revised Indian standards codes and seismic risk reduction [2]. The basic requirement of seismic design of building mainly depends upon the type and location of structure and proper application on seismic criteria and design. To make the building more resistant to earthquake, various Indian standards codes should be properly implemented to survive through both direct and indirect actions of earthquakes, provides information related to basic design criteria, quality control, ductile detailing and seismic considerations for particular structure in specific seismic zones [19][20][21][22][23]. According to IS 1893 (PART 1):2002, dynamic analysis should be done for regular buildings greater than 40m in height in zones IV and V, and those greater than 90m in height in zones II and III, for irregular buildings greater than 12m in height in zones IV and V, and those greater than 40m in height in zones II and III. In the field of advance structure engineering, engineering software contribute vibrant part which is much faster and accurate combined process of analysis and design than conventional academic methods and capable to analyse advance structures having complex configurations allowed for varieties of building codes of different countries and its site conditions considered under software resembling STAAD.Pro, ETABS and MIDAS etc. [24][25][26].

Taller is the building, lower is the stiffness and higher the mass causes low natural frequency which is very vulnerable for tall buildings as it is easily available for resonance condition. So by adding shear wall and bracing, stiffness and damping properties increased. Almost all the structures carryover gravity loads but to perform as perform as earthquake

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resistant structures should propagate lateral loads as well. Structures must contain lateral load transferring mechanisms such as shear wall and bracing which enhances the energy absorption capacity of the structure under critical conditions. Every structure experience static and dynamic forces, dynamic forces which magnitude, direction and positions varies with time. Similarly, structure response to dynamic load, i.e. the resulting stresses and deflections also time varying or dynamic [27]. Horizontal forces in buildings, such as those produced by earthquake motion or wind action, are often resisted by structural elements called shear walls [28]. Shear wall should be top to bottom, aligned, parallel and free from offsetting. The minimum thickness of shear wall is 150mm. it is provided in different locations under various situations.

Bracing reduces stress concentrations and provides smooth passage of forces thus reduces lateral displacement by stiffness to structure. These are mainly used in steel structures and occupy less space. Eccentric bracing reduces lateral stiffness of building as it is helpful for energy dissipation during earthquake. Its property of providing lateral stiffness to the structure mainly depends upon stiffness of the flexural and compression members such as beams and columns as it exerts point load on it. Concentric bracing provides better lateral stiffness to structure succeeding with increased natural frequency. It also decreases bending moments and shear forces on adjacent members. These kind of above mentioned structural techniques resist the seismic shakes. Finally it is the necessity to implementation of new techniques to control the disaster in India [29].

II. OBJECTIVE

1. To show the importance of building codes for seismic resistant structures.
2. Reflecting advances in structural engineering based on various study cases of shear wall and bracing systems.
3. To compare braced and shear wall frames.
4. To represent various research work methodologies taken up by researches.
5. To show new advance researches, its necessities to implement on ground reality by construction and its organisations.
6. Give message to aware people about problem of disasters, its elated issues and lesson learnt. Furthermore importance and implementation of structure drawings through structure designers only.

III. LITERATURE REVIEW

Anes B et al. (2017), deal with effect of steel bracings on RC framed structures. Reinforced concrete building (G+9) was shaped and analysed in three parts comprising model sans steel bracing and shear wall, with dissimilar bracing systems, with shear wall. Bracings and shear wall were positioned at the middle bays and all these simulations were analysed for seismic forces at seismic zones II, III, IV and V using ETABS 2015. As per conclusion chevron category of steel bracing was originate to be more effectual in zones II and III, X type bracing was originate to be more effective in zones IV and V. Steel braced building significantly decreases the lateral drift when associated with shear wall building.

Rakshith (2017), examined effect of bracings on Multi-Storied RCC building under dynamic loading. RCC building (vertical regular and vertical irregular) having (G+9) stories with different bracing systems were analysed by response spectrum method using ETABS. Outcomes corresponded to displacement, storey drift and storey shear was compared. In this research , researchers concluded that both regular and irregular RCC frame structures X- bracing gives less displacement, storey drift and base shear. Regular frame bears more stiffness than irregular frame. Steel bracing were used to strengthen and retrofit existing structures.

Mohammad A. et al. (2016), donea numerical approach to show dissimilarity between shear wall and steel bracing systems. The new methodology of this research was to strengthened lateral force resisting system via steel bracing. A measured has been done step by step to show understandable contrasts between systems. The overall investigation has been carried out by response spectrum using ETABS 9.7 that is of six case studies. It is coherent that model 1 (shear wall at core) is the safest among six models assessed in the research tenacity. Positioning of shear wall is a principal point. Besides, the orientation in floor bracing is of less significant dissecting with the vertically oriented bracing systems. Further modification in floor bracing will escort good formulation as seismic force resisting system.

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Priyanka et al. (2016), carried analysis of Multi-Storied buildings with different heights and shear wall locations. Buildings having (G+10), (G+20) and (G+26) were modelled and analysed in zone II with considering all loads included dead load, live load, wind load and seismic load as per Indian standards with different shear wall locations by means of STAAD.Pro software. Parameters studied were inter-storey drift, base shear and lateral displacement. Researchers concluded that (G+10) building generated less value of deformations and stresses at location 1 as compared to location 2. Also, concluded that (G+20) building generated less value of stresses and deformation on location 2 than at location 1. Also location 2 shear wall decreased efficiency of structure.

Kasliwal N.A et al. (2016), studied seismic analysis of reinforced concrete building with unrelated positions and numbers of shear wall. The reinforced concrete building having (G+9) stories with seismic zone V is analysed by using response spectrum method as per IS 1892 (PART 1):2002. Dynamic analysis has been done to know base shear, storey drift and displacement using ETABS. In this research, they concluded that building with complete shear wall shows lesser lateral displacement as compared to other frames. Also frame with shear wall from first storey carried good results and corner shear wall is good with low cost type.

Patil S.P. et al. (2016), studied comparison of shear wall and bracing in RCC framed structure with different locations. Fifteenth storey balanced RC frame is comprehensively deliberated for seismic loading under response spectrum method. The base shear, frequency, period and displacement were calculated. When shear wall is delivered, displacement and storey drift reduced, storey shear and base shear raised. As thickness and width of shear wall increases, displacement and storey drift decreased, storey shear and base shear up surged, when it is balanced and well distributed along periphery displacement decreased. Steel bracing declined flexure and shear mandate on beams and columns, transfers lateral loads through axial load mechanism.

Amey (2016), RCC building of dissimilar heights and different typical plan shapes but equivalent area placed in solapur subjected to earthquake loading in zone III were deliberated. An earthquake load was calculated seismic method using 1893 (PART 1):2002 and detailed as per IS 13920:1993. These analyses were performed using ETABS 2013. A study has been carried out to regulate effect of RC shear wall on earthquake resistance of a multi-storied building by changing shear wall location. Different cases of shear wall locations of diverse heights and plan have been analysed. Also optimum percentage of shear wall is resolute with respect to perimeter of buildings. All rectangular shaped buildings i.e. (G+30), (G+35) and (G+40) were deliberated, it is detected that R/40/20/2 permutation gives more stable fallouts to structure along with optimum results.

Mohammad A. et al. (2015), done comparative analysis of reinforced concrete frame building with bracing and shear wall. The reinforced concrete building (OMRF) having (G+15) storied were analysed in seismic zones II to V by using linear static method as per IS 1893 (PART 1):2002 in STAAD.Pro V8i. In this research, researchers concluded that shear wall element resist more lateral deflection than braced frame and bare frame. Also location of shear wall and bracings has significant effect on performance of the building. X bracing showed minimum possible bending moments comparison to other forms of bracings, reduced 35% to 45% lateral displacement of the building.

Prof. Bhosle et al. (2015), studied analysis of RCC building with different arrangements of concrete and steel (ISA110X110X10) bracing systems, various types of bracing (Diagonal, V, Inverted V, Combined V, K and X). Reinforced concrete building (G+12) located in zone III and analysed as per 1893 (PART 1):2002 using ETABS. Amount of displacement reduction has been found out and concluded that X-type of concrete bracing was found to most efficient for storey overturning moment, better resist lateral displacement which improves strength, stiffness of structure and capacity of building.

Suchita et al. (2015), analysis has been done on Multi-Storey building for optimum location of shear wall using Genetic Algorithm. Six study cases were taken up to identify optimization of shear wall with Genetic Algorithm, which is coded in MATLAB and objectives were analysed by ETABS 2015. Constraints like lateral displacement are determined by using equivalent static method [IS 1893 (PART 1):2002]. Finally it is concluded that, genetic algorithm provides good path to structural analysis techniques, best clarification among numerous solutions, model-2 demonstrated finest place of shear wall in (G+10) building. By providing shear wall to high rise building, structural seismic behaviour performs better, also stiffness and strength of building was increased.

Biradar et al (2014), studied on seismic response of RC structure by using different bracing systems. The seven models have been made and behaviour of all cases was determined by linear static and dynamic analysis, non-linear static and dynamic analysis using ETABS. Results comprised fundamental time period, base shear, storey drift has

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been evaluated and equated with bare frame. The conclusion is that cross bracing giving less seismic response leading to serviceable and stiff model, base shear obtained from IS code is not on a good agreement with values obtained from equivalent static and response spectrum analysis.

Thorat et al (2014), had investigated seismic behaviour of RC Multi-Storied building with different shear wall versus bracing systems. The elastic dynamic method, response spectrum method was used to find out lateral displacement collaborated STAAD.Pro V8i. Comparison of floor displacement and axial force in members were done. Seismic zone III was considered for analysis. They come to the point that centrally situated shear wall and bracing elements resisted lateral displacements very efficiently as when shear wall is provided at core of the building reduced action of forces, lateral deflection or displacement and drift.

Anshul S. et al. (2014), calculated effect of shear wall on seismic response for RC moment resisting frame. The different locations were adopted to find out seismic reaction of structure. Four different types of shear wall that core, symmetrically external bays (centrally) and adjacent exterior bays. These frames were analysed under load combinations recommended by IS 1893 (PART 1):2002, concluded that frame with shear wall at core gives less reduction in lateral displacement, bending moment and shear force, also determined that shear wall at core gave minimum lateral displacement than centrally placed.

Patil S.S. et al. (2013), studied linear dynamic analysis for performance of high rise building through STAAD.Pro. Response spectrum analysis was considered for RC moment resisting frame having (G+14) situated in zone IV as per IS 1893 (PART 1):2002. The different study cases were taken to find out lateral displacement, base shear, storey shear, Storey drifts and time period. Three cases was performed i.e. pure frame or RC bare frame, braced frame and shear wall frame systems and concluded that both brace and shear wall configurations give less reduction in lateral displacements and building with short time period tends to suffer higher accelerations but lesser displacements.

Shaik K. M. A et al. (2013), studied structural behaviour of Multi-Storied RC framed building with shear wall. Contrary arrangements for the same were considered for evaluation of seismic performance of building. All models were analysed by elastic response spectrum method and inelastic pushover analysis using ETABS. Comparison of simulations was done on the basis of strength, stiffness and damping characteristics. Study resolved that shear wall in the outermost RC moment resisting frame gave superior seismic management, also influence of shear wall significantly upsurgs damping properties and period at the performance point of tall buildings.

Viswanath et al (2010), evaluates seismic response of steel braced reinforced concrete frames. The different bracing systems were used in RC frame, the cross (X) bracing and diagonal bracing with different regular stories were used to resist structure or frame. Numerous cases i.e. four, eight, twelve and sixteen storied buildings were considered, where four storey building was analysed for rehabilitation purposes and other three for displacement. These structures were performed by means of STAAD.Pro and IS 1893 (PART1):2002. The response of dissimilar cases are determined in zone IV and concluded that steel bracing reduces shear and flexure demands on beam and columns.

IV. CONCLUSION

To make the structure safe to environmental forces and human errors, hence for that time to time new technologies has been discovered to minimise the impact of disasters, also advances in structural engineering, revised building codes comes into existence for safe, economic, stiffer, durable and seismic resistant structures by symmetrically transfers loads (whether dynamic or static) from one to another member. There are many significant observations in the field of research related to load transferring mechanisms (gravity and horizontal) through structure components i.e. the arrangements of shear wall and bracing by structure designer.

Following are the outcomes consist of technical merits listed from the remarks of researchers:-

1. Building with shorter time period tends to admit higher acceleration but smaller displacement.
2. Shear wall has more significant influence on lateral strength in taller buildings except for shorter height buildings while it has more potency on lateral stiffness in case of shorter buildings besides taller buildings.
3. Inter storey drift being critical for columns got reduced with provision of shear wall.
4. Position of shear wall has effective role on the performance of buildings that von-misses stresses got reduced simultaneously, as centrally located shear wall and brace components were best observed.

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5. Genetic algorithm has convenient manner for optimization amongst several solutions and structure analysis, which can be handily used by professional designers.
6. Confined configuration in plan extended high stability but it does not cause any perceivable change in base shear. Column axial force induced in brace frame is more as equated to shear wall frame.
7. Steel bracing can be used as an alternative to other retrofitting techniques, in addition total weight of existed building will not change significantly. Steel bracing usage reduced tension forces, bending moment, shear demands on beams and columns.
8. Lateral displacement of building got miniaturized maximum by the use of X- type of bracing system. Bracing incorporated building showed storey drift within limit as specified in IS 1893 (PART 1):2002.
9. Bracings X, combined V added on base shear by 60% to 65%, indicates that stiffness of the building has increased. Concrete bracing enhances overturning moment by 61% to 65%, whereas steel bracing by 48% to 53%.
10. RSA exhibits very much non-linear behaviour and simulating to practical situation which then helps designers to choose proper analysis procedure.

REFERENCES

- [1] Dr.Alok G (2001), "The Great Gujarat Earthquake 2001- Lesson Learnt", 22nd Asian conference on remote sensing organised under CRISP, SISV and AARS, National university of Singapore.
- [2] Sudhir K. J. (2004), "Implications of 2001 Bhuj Earthquake for Seismic Risk Reduction in India", 13th world conference on earthquake engineering, paper no. 3244, B.C., Canada.
- [3] Anes B, Dr.Chandan K, Patnaikuni, Dr.Balaji, Santhosh K (2017), "Effect of Steel Bracings on RC Framed Structure", International Journal of Mechanisms & Solids, Volume 9, No. 1.
- [4] Rakshith K L, Smitha (2017), "Effect of Bracing on Multi-Storey RCC Frame Building under Dynamic Loading", International Journal of Advance Research, Ideas and Innovations in Technology, Volume 3, Issue 4.
- [5] Mohammad. A, Syed H (2016), "Comparative Study of Seismic Analysis of Multi-Storey Building with Shear Wall and Bracing Systems", International Journal of Advanced Structures & Geotechnical Engineering, Volume 5, No. 3.
- [6] Priyanka S, Purushottam L.T, Vikky K, (2016), "Structural Analysis of Multi-Storeyed Building of Different Shear Wall Location and Heights", International Journal of Engineering Trends and Technology, Volume 32, Issue 1.
- [7] Kasliwal N.A, Rajguru R. S (2016), "Effect of Numbers and Positions of Shear Wall on Seismic Behaviour of Multi-Storeyed Structure", International Journal of Science, Engineering and Technology Research, Volume 5, Issue 6.
- [8] Patil S.P, Desai R.M., Khurd V.G (2016), "Comparison of Shear Wall and Bracing in RCC Framed Structures", International Journal for Research in Applied Science & Engineering Technology, Volume 4, Issue 12.
- [9] Amey D. K. (2016), "Assessment of Location and Optimum Percentage of Shear Wall for Typical Plans", International Journal of Engineering Development and Research, Volume 4, Issue 3.
- [10] Mohammad A, Prof. Laxmikant V, Vikrant N (2015), "Comparative Study on Seismic Analysis of Multi-Storey Building Stiffened with Bracing and Shear Wall", International Research Journal of Engineering & Technology, Volume 2, Issue 5.
- [11] Prof. Bhosle A.T, Prof. Sheikh A.N. (2015), "Analysis of Reinforced Concrete Building with Different Arrangement of Concrete and Steel Bracing System", IOSR Journal of Mechanical & Civil Engineering, Volume 12, Issue 5.
- [12] Suchita T, Fernandes (2015), "Optimum Location of Shear Wall in a Multi-Storey Building Subjected to Seismic Behaviour using Genetic Algorithm", International Research Journal of Engineering And Technology, Volume 2, Issue 4.
- [13] Biradar and Mangalgi S (2014), "Seismic Response of Reinforced Concrete Structure by using Different Bracing Systems", International Journal of Research in Engineering and Technology, Volume 3, Issue 9.
- [14] Thorat S.R. and Salunke P.J. (2014), "Seismic Behaviour of Multi-Storey Shear Wall Frame versus Braced Concrete Frames", International Journal of Advanced Mechanical Engineering, Volume 4, No. 3.
- [15] Anshul S, Raghav S.S, Poonam (2014), "Effect of Different Shear Wall Configurations on Seismic Response of a Moment Resisting Frame", European Scientific Journal, edition ISSN: 1857-7881 (print) e – 1857-7431.
- [16] Prof. Patil S.S., Miss. Ghadge S.A., Prof. Konapure C.G., Prof. Mrs. Ghadge C.A. (2013), "Seismic Analysis of High Rise Building by Response Spectrum Method", International Journal of Computational Engineering Research, Volume 3, Issue 3.
- [17] Shaik K. M. A, Vinod H (2013), "Seismic Performance Evaluation of Multi-Storeyed RC Framed Buildings with Shear Wall", International Journal of Scientific and Engineering Research, Volume 4, Issue 1.
- [18] Viswanath K. G, Prakash K.B., Anant D (2010), "Seismic Analysis of Steel Braced Reinforced Concrete Frames", International Journal of Civil And Structural Engineering, Volume 1, No. 1.
- [19] IS 1893 (PART 1):2002. "Indian Standard Criteria of Practice for Earthquake Resistant Design of Structures", Bureau of Indian Standards, New Delhi, India.
- [20] IS 4326:1993, "Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings", Bureau of Indian Standards, New Delhi, India.
- [21] IS 13920:1993, "Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces", Bureau of Indian Standards, New Delhi, India.
- [22] IS 456:2000, "Indian Standard Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi, India.



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- [23] National Building Codes, Bureau of Indian Standards, New Delhi, India.
- [24] Technical Reference Manual of STAAD.Pro (2016), a Bentley Trademark.
- [25] User's Guide Manual of ETABS 2016, a CSI Trademark.
- [26] Civil Manuals of Midas (2016), Midas Information Technology Co., Ltd.
- [27] Ray W. C & Joseph P (1995), "*Dynamics of Structures*", Objectives of Structure Dynamics, Page No.1, 3rd edition, Computer & Structures, Inc., USA.
- [28] Mario P (2004), "*Structure Dynamics*", 2nd edition, Page No. 132, CBS Publishers & Distributers Pvt. Ltd., New Delhi, India.
- [29] Book of Disaster Management India (2017), Government of India.