

Review Paper on Seismic Behaviour of RC Frame Structure With Different Types of Bracing System

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Abstract:

In tall RC[reinforced concrete] building bracing system is provide for stiffness, strength and energy dissipation to resist the lateral load . The study about the different bracing system (diagonal type, V type ,inverted and k type) and arrangement of bracing system . To build the seismically safe structure with adequate lateral resistance .Bracing system is installed between column member to resist the lateral load. Bracing system is easy to installed , economical and occupies less space. The structure is analyzed for seismic zone V with different types of bracing system and compared with the bare frame with the using of ETAB software. The load condition is applied as per IS 1893 :2002. Bracing system improve the displacement capacity of the structure.

Keywords — **Earthquake strengthening, steel bracing system, seismic performance, analysis and lateral load .**

INTRODUCTION:

Seismic analysis is calculating the response of structure to the earth quake. Nowadays high rise building are constructed for the purpose of stiffness and lateral load resistance .Larger seismic waves strike the earth surface caused shaking the earth surface in all possible direction .In recent year growth of the cities have been on rise and any RC building depend on many factors like strength of material, used soil and amount of mass .Bracing are the most prominent method used by structural engineers .Increase the lateral load resistance by bracing .There are many braced system in RC structure like V,K and X. But concentric bracing mostly used by structure engineer .Structure are connected with various activity like sport, healthcare, transport, residence and power generation .All the structure posing adequate strength . The frame structure transfer the gravity load and lateral load to the foundation .Colum and beam distribute the gravity load in to the structure but there are not significant for stability of structure . They provide the different bracing system to transfer the seismic wave in to the structure .With the different method we analyses the structure. Steel bracing most used in RC structure .Steel bracing transfer the load to the frame.

India is fast developing country which demand hybrid structure or building with high seismic resistance .The multistory building require safety due to earth quake and wind forces. Damage to the RC building causes seismic waves of earthquake and low strength of material used. Bracing stable the multistory building .Steel bracing mostly used in that RC structure .Mostly seen that the retrofitting of building more economical then reconstruction or rebuilding. Most of structure collapse due to seismic waves. Strengthening the structure by bracing system or retrofitting for mitigating the seismic hazard in seismic zone area.

Literature review:

Mishra ,et al 2014 Presented the behavior of reinforced building with different bracing .In this study reinforced concrete frame considering with different bracing . Bracing resist the lateral load and wind load . Bracing system increase strength of building and Increase its resistance to seismic forces . Analyses reinforced concrete building with the using of STAAD PRO software . Different types of bracing system have been used . Analyze the bare frame to increase the lateral displacement and member force in the building . Bracing system effectively provide the stiffness to the structure . In this paper they compared of all the different bracing (x v inverted) with bare frame analysis to evaluate the seismic resistivity of the building .It concluded that bracing system effectively reduced the seismic forces.

Mohammed et al 2013 In this paper analyses the behavior of RCC multistory structure with different type bracing system .The main focus of this paper is to find out seismic responses of the braced structure and bare frame structure. Analyses the G+14 floor building with bracing and without bracing .They compared the result of bending moment ,shear force ,story drift and axial force with all types of structural system .It concluded that displacement of the reinforced concrete building reduce after the using of bracing system in RCC building . Cross bracing decrease the maximum lateral displacement of structure .RCC building with bracing system decrease the shear force and bending moment in columns . They found that Structure with bracing system transfer the lateral load through the axial action. They concluded that Steel bracing mostly used by the structure engineers .

Tanaji et al 2015 In this paper the analyses of G+13 storey building with different arrangement of concrete and steel bracing system with using of ETAB software. This paper presented the concrete braced and steel braced RCC building increase the strength and resistant to the lateral load. This is best retrofitting technique to overcome the deficiency of the structure .Different type of bracing system (X,V,K and inverted) studied .Bracing system improves the stiffness and displacement capacity of the structure. The storey displacement of the building effectively reduce by the X concrete bracing and combine v steel bracing .In this study X bracing found most effectively increase the seismic capacity of the structure. It show the effect of all side bracing and any two parallel side bracing on base shear in the column of building. In the result it increase the base shear of the building .The concrete braced and steel braced reduce the storey drift of the building.

Chadhar et al 2015 They analyses the G+15 storey building with different arrangement of bracing the building situated at seismic zone 4 analyzed by STAAD pro software . The main focus of this paper analyze the reinforced concrete building with different bracing arrangement of the building .They adopted the linear static method. Seismic loading is applied according to IS1893-2002.Analyze the building and the result shown in the form of graphs. Analysis of RCC building used the v and inverted v bracing system . In this paper the steel bracing effectively reduce the bending moment and shear force. RCC building with inverted braced system decrease the storey drift and node displacement .This paper presented the different types of arrangement have been used for bracing member doubled angle section ISMC and ISMB have been used. It shown that doubled angle section effectively decrease the lateral displacement

Velmurugan et al 2017 Investigated the behavior of the RCC building with using of bracing system .Bracing system got the structural importance specially in the RCC building .It concluded that building has to go through many regular motion at its base caused damage to the structure . It is necessary to provide lateral stability to the structure . In this paper mainly cross bracing

has preferred . In this study analyses of RCC G+9 floors structure situated in seismic zone IV with using of Sap 2000 software .They compared the bending moment shear force axial load and lateral displacement for all type of structure system that is braced and without braced structural .It observed that X bracing system most effective type of bracing system which reduced the lateral displacement and moment in the structure. Result are compared bracing structure and without bracing structure.

Youssef et al 2007 In this paper proven the steel bracing is one of the most effective system to resist the seismic load. This paper experimentally evaluated the braced RC frame .They experimentally investigated the use of concentric internal bracing .Moment frame were design on the bases of current seismic codes . It show that lateral stiffness of braced frame was double . Its experimentally proved that seismic performance of the braced frame is higher then moment frame .They represented the brief detailing of the RC according to the seismic design code. Comparing the result of behavior of RC frame and conventional moment frame . Adopt the rational method to design the braced RC frame.

Patil et al 2015 have studied the seismic evaluation of RC building by using braced ductile shear panel .The main focus of this paper suitability of BDSP system in RCC building during earth quake ground motion. They carried out the analysis of G+4 and G+10 storey buildings situated at seismic zone .The load condition applied as per is 18932002 .They adopted the response spectrum method with the using of ETAB software . They found the building with x bracing has reduced the drift as well as time period .But in BDSP modal system has more values then X braced model . They compare result of the X bracing model and BDSP model system .

Manjunath et al 2016 Presented the behavior of the RC structure on sloping ground with different bracing system . In this paper evaluate the response of the multistory building the sloping ground subjected the lateral load .They found that hilly region multistory building suffer the more damage .Twelve building model have been selected and analyses of building model performed by ETAB software .The response of the model each captured in the form of base shear lateral displacement and story drift using of response spectrum method equivalent static method and time history method .They investigate the behavior of the building with different bracing X, inverted ,V and diagonal using non linear static push over analysis and time history analysis .In the result the model frame with inverted V bracing are found effectively reduce the seismic loading.

Kumar et al[9] 2017 Investigated the effective behavior of steel bracing in RCC structure.RCC structure require the seismic retrofitting .So the bracing system has been used to resist seismic force . In this paper various system analysis by the STAAD PRO and ETAB software . Analyze the various steel section change the seismic strength of the structure.G+10 storey building analyze with using of STAAD and ETAB software .They have studied the behavior of RCC buildings with different bracing system X and inverted V .They compare the lateral displacement storey drift of various bracing building .They found X steel bracing system for RCC building effective retrofitting technique.

Kadid et a 2011 They study the seismic assessment of braced frame .They found that steel bracing is considered one of the effective retrofitting technique .They investigate the seismic behavior of building with different bracing system .They adopted the static non linear method to estimate the capacity of three storey and six storey building with different bracing X ,V ,Z and zipper braced .G+2 and G+6 storey building situated at high seismic zone area .They concluded that steel bracing reduced the level of damage of the structure. They have found that Z ,X and

zipper bracing system are to be most efficient .This bracing system seen globally influence the deformation and ductility capacity of the building .

Viswanath et al 2010 Presented the behavior of the structure with concentric steel bracing .They investigated seismic performance of the structure with using of concentric bracing system . Analyze the structure with using of STAAD PRO software .They found that seismic performance of the structure evaluated in term of globally and story drift .G+4 storey building situated in seismic zone IV and analysis in pro software .It observed that maximum lateral displacement reduced due to bracing system .They compared the result of different floors level of building .Steel bracing system effectively improve seismic performance of the structure.

Kumar et al[12] 2017 In this paper they have study of steel braced RC frame with different arrangements .Steel bracing is the most used and effective retrofitting technique for resisting the horizontal forces like seismic and wind .They adopted the seismic coefficient method to estimate the planning of bracing member in the building frame .In this paper raise the seismic performance of the structure. G+15 storey building with X bracing provided on different position of building analyzed for seismic load. Load has applied as per recommendation of IS 1893-2002 with the using of STAAD PRO software..Building is situated at seismic zone IV on medium soil condition. Different types of steel profile used ISA and ISMC. They found that the shear force and bending moment reduced for bracing system when compared with bare mode .The graph shown that angle type bracing system significantly reduces the shear force and bending moment. Steel bracing system represented the bracing system reduce the bending moment and shear force.

Siddiqi et al[13] 2014 Presented the comparison of different bracing system for tall buildings. In this paper they analyzed the sixty storey regular shaped building for wind and gravity load combination along both major and minor axes .Bracing is economical method of resisting lateral forces in the frame structure .They investigated the five different types diagonal, double diagonal, k storey height knee and v bracing system used in tall building to provide the lateral stiffness and lesser lateral displacement .Analyzed the building with five different bracing at different bays level .Compared the different bracing along minor and , major axis .it concluded that minimum displacement obtained in case of K bracing system and when column are braced along major axis lateral displacement values go beyond limit .But in case of double bracing system it enhance the lateral stiffness of structure.

Raj C et al[14] 2016 They investigated the analytical study on seismic performance of hybrid structure subjected to seismic load .in this paper steel braced frame used to resist the earthquake loads in multistory buildings. Building are analyzed for seismic zone V as per IS 1893:2002 using SAP 2000 software .Analyzed the six ,twelve and eighteen storey building with bracing , without bracing and X type bracing for seismic zone V .The result are compared with various type of bracing .It observed that maximum displacement reduced in case of X bracing system then diagonal one .it conclude that the bracing in bare frame increases the overall stiffness of the structure .

Biradar et al[15] 2016 Presented the seismic performance of the structure with different bracing system to resist the lateral load. Bracing system got the structural impotence in reinforced concrete building. Seven RC modeled have been analyzed by using of ETAB software .In this paper the time period decrease by different bracing system .They found that the displacement within the limit in linear static method ,linear dynamic and non linear dynamic method .X bracing shown the good performance in x and y direction .the effect of different bracing system provided in the building the storey drift and lateral displacement get reduced leading to safe and stiff.

Patel et al[16] 2017 This paper represent the different RCC bracing system under seismic behavior of high rise building .Analyzed the G+10 storey building with different types of bracing system .Bracing has provided on periphery of the column. This frame model has analyzed as per IS 1893:2000 using STAAD PRO software and ETAB software. This paper shown that X braced model gives the higher value of base shear while compared with the V and moment resisting frame. It observed that the X bracing system model reduced the maximum displacement while displacement is maximum for without braced frame model.

Conclusion :

Steel bracing system is an efficient and effective lateral load resisting system. Steel braced RC frame as the lateral load resistance system for reinforced concrete structure is a effective technique. Structure with different types of bracing system reduce the storey drift and displacement of the structure .Out of various arrangements of bracing X bracing system are more effective in increasing lateral load capacity of structure. Bracing system reduce bending moment and shear force in the column .Steel bracing transfer the lateral load through axial action. The performance of the steel cross bracing is better then other bracing system. Steel bracing can be used to retrofit the existing structure.

References:

- [1] Rishi Mishra , Dr Abhay Sharma, and Dr Vivek garg , “Analysis of RC building frame for seismic forces using different types of bracing systems”, International Journal of engineering research & technology (IJERT) vol. 3, Issue 7, July 2014 ,ISSN 2278-0181
- [2] Nauman Mohammed and Islam Nazrul “Behavior of Multistory RCC Structure with Different Type of Bracing System”, *IJIRSET*, Vol. 2 Issue 12, Dec 2013,ISSN 2319-8753
- [3] Prof.Bhosle Ashwini Tanaji and Prof.Shaikh A.N “Analysis of Reinforced concrete Building with Different Arrangement of Concrete and Steel Bracing system”, Journal of Mechanical and Civil Engineering Vol.12 Issue 5, Sep 2015 ,PP 08-12
- [4] Shachindra Kumar Chadhar and Dr. Abhay Sharma “Seismic Behavior of RC Building Frame with Steel Bracing System using various Arrangements” International Research Journal of Engineering and Technology Vol.02 ,Issue 5, Aug-2015 , ISSN 2395-0056
- [5] S. Velmurugan, B. Preethiwini and A.Nisha Devi “Behavior and Model of Earthquake Resistant Structure using Steel Bracing “International Journal of Engineering Research and Modern Education “ Special Issue, April, Page Number 176-180,2017,ISSN 2455-4200
- [6] Youssef M. A., Ghaffarzadeh H. and Nehdi M. “Seismic performance of RC frames with concentric internal steel bracing”, *Eng. Struct.*, 29, 1561- 1568, 2007
- [7] Patil S.S., Aland S.S., Kore P.N. "Seismic Response of Concentrically Braced Reinforced Concrete Frames", International Journal of Scientific and Engineering Research, Volume 4, Issue7, July 2013 Edition
- [8] Manjunath C S and Siddu karthik C S “ Seismic Performance of RC Building on Sloping Ground with Different Types of Bracing System” International Journal of Research in Engineering and Technology, Vol.5,Issue2, Feb 2016 ,ISSN 2319-1163
- [9] Surrender Kumar ,Hakam Singh and R.S Bharj “A Seismic study of Steel Braced RC Frame with different Arrangements” International Journal of Research in Management ,Science &Technology ,Vol.5,No.1,Pages 1-6, April 2017,ISSN 2321-3264
- [10] A Kadid1, D.Yahiaoui Department of Architecture, LARHYA, University of Batna, Algeria. Seismic Assessment of Braced RC Frame: science direct, Procedia Engineering 14

(2011) 2899–2905 The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction

[11] Viswanath K.G., Prakash K.B. and Anant Desai, “Seismic analysis of steel braced RC frame” International Journal of Civil and Structural Engineering Volume 1, No 1, and 2010.

[12] Ayush Kumar , Urja Singh Vaishali Vishnoi, Parthivee Choudhary and Swapnii Dwivedi “A study on the Effectiveness of Steel Bracing in RCC Structure” International Journal of Engineering Technology Science and Research ,Vol.4,Issue 7,July-2017,ISSN 2394-3386

[13] Z.A. Siddiqi, Rashid Hameed and Usman Akmal “ Comparison of Different Bracing System for Tall Building” *Pak. J. Engg. & Appl. Sci. Vol. 14, Jan., 2014 (p. 17-26)*

[14]Nabin Raj .C and S.Elavenil “Analytical Study on Seismic Performance of Hybrid Structural System subjected to Earthquake” International Journal of Modern Engineering Research Vol.2 ,Issue 4, July-Aug. 2012 pp-2358-2363 ISSN: 2249-6645

[15] Umesh. R .Biradar, Shivraj Mangalgi —Seismic Response of Reinforced Concrete by using different Bracing Systems International Journal of Research in Engineering and Technology (IJRET) Vol. 3, Issue 09 Sept. 2014 ISSN: 2319-1163 ISSN: 2321-7308

[16] Aparna S. Patil, G.R.Patil Seismic Evaluation of RC building by using Steel bracings Sachin Dhiman, Mohd. Nauman Behaviour of multi storey steel section with different types of bracings

[17] Bush TD, Jones EA, and JIRSA JO (1991). Behaviour of RC frame strengthened using structural steel bracing . Proc. ASCE, J. Struct. Engng. No. 4,1171115-1126

[18] Dhanaraj M. Patil and Keshav K. Sangle, Seismic Behavior of Different Bracing Systems in High Rise 2D Steel Buildings, Science Direct, Structures vol 3, 2015, pp 282 –305.

[19] Kulkarni J. G and Kore P. N, Seismic response of reinforced concrete braced frames, IJERA, Vol.3, Issue 4, 2013, pp-1047-1053.

[20] Karthik K. and Vidyashree D, Effect of Steel Bracing on Vertically Irregular R.C.C Building Frames Under Seismic Loads, IJRSET, Karnataka, India, 2015, pp 90-96

[21]A.Ghobarah , H. Abou Elfah , Rehabilitation of reinforced concrete frame using eccentric steel bracing , sciencedirect, Engineering Structure , (2001) 745-755

[22] Verma S.k, Raman Kumar, “Seismic Response of RC Building.”(IJCSE) volume 4,No 4,2014 ISSN 0979-4399

[23] P.P .Chandukar and Dr . P.S . Pajgade (2013) , “ Seismic Analysis of RC Building with or without Shear wall “ . (IJMER) ,.2.3,Issue.3,pp-1805-1810,ISSN: 2249-6645, May-June 2013

[24] Vani Prasad , Nivin Philip “Effectiveness of Inclusion of Steel Bracing in Existing RC Framed Structure “ , International Journal of Research in Engineering & Technology , Vol .2 Issue 9, sep 2014(P. 81-88).

[25] Y.Singh, phani Gade “Seismic Behavior of Building Located on Slopes –An Analytical Study and Some Observation From Sikkim Earthquake of September 18” , 2011,15WCEE-LISBOA 2012.

[26]Madhusudan G. Kalibhat, Arun Kumar Y,M, Kiran Kamath, Prasad.S.k, Shrinath Shet, Seismic Performance of RC Frame with Vertical Stiffness Irregularity from Pushover Analysis “ IOSR Journal of Civil Engineering (IOSR-JMCE),E-ISSN: 2278-1684, P-ISSN :2320-334X Pp 61-66.

[27] Desai J. P., Jain A. K. and Arya A. S., “Seismic response of R. C. braced frames”, Computers and Structures Volume 29 No.4, pp 557-568, 1988.

[28] Manish S. Takey and S.S.Vidhale,“Seismic response of steel building with linear bracing system (A software approach)”, International Journal of Electronics, Communication and Soft Computing Science and Engineering, 2(1), pp 17-25, 2012.

- [29] Mahtab M. and M. Zahedi, "Seismic Retrofit of steel frames using steel plate shear walls". Asian Journal of Applied Sciences. 1(4), pp 316-326, 2008.
- [30] Marc Badoux and James O. Jirsa, "Steel bracing of RC frames for seismic retrofitting", Journal of Structural Engineering, Vol. 116, No. 1, January, 1990.
- [31] Kevadkar M.D. and Kodag P.B., (2013) "Lateral load analysis of R.C.C. building" International Journal of Modern Engineering Research (IJMER) Vol.3, Issue.3, pp. 1428-1434
- [32] Massumi A. and Tasnimi A.A. (2008) "Strengthening of low ductile reinforced concrete frames using steel x-bracings with different details" The 14 World Conference on Earthquake Engineering October, Beijing, China pp. 12-17
- [33] Ozel A. E. and Guneyisi E. M. (2010) "Effects of eccentric steel bracing systems on seismic fragility curves of mid-rise R/C buildings: A case study" Structural Safety 33 pp.82-95
- [34] Parasiya A. S and Nimodiya P. (2013) "A review on comparative analysis of brace frame with conventional lateral load resisting frame in RC structure using software" International Journal of Advanced Engineering Research and Studies pp.88-93
- [35] S. I. Khan, Prof. P. O. Modani "Seismic Retrofitting of RC Building by Using Different Bracing Systems" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 7, July – 2013