IJMRSETM

e-ISSN: 2395 - 7639

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING, TECHNOLOGY AND MANAGEMENT

Volume 9, Issue 5, May 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.580

+91 99405 72462 +9163819 07438 ijmrsetm@gmail.com www.ijmrsetm.com

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905004 |

A Review Study on Retrofitting of Reinforced Concrete Frame using Steel Bracing

Geeta Sharma, Monika Jakhar

M. Tech (Structural Engg.), MRIEM, Rohtak, India

MRIEM, Rohtak, India

ABSTRACT: The analytical usage of steel braces to reinforce low, medium, and rather highreinforced concrete frames are taken into account in this work. The reinforcedframe’s ultimate lateral-load capacity is estimated through load-controlledpushover analysis. Additionally, you can examine the pre-post-tension tension’seffects.Parameter work for this study's modification of the current R/C frame-structure to increase seismic lateral resistance provides the result. Using the steel X-brace brace system and the steel-frame enclosing the frame bay without fastening to the existing R/C frame-structure increases lateral-load capacity 20-fold. Appropriate C frame syntax. Height-to-width ratio determines this. “The relative success of this rehabilitation technique depends on the frame height to width ratio in the lateral-load direction. An increase in frame height at a given base thrust leads in a faster rate of change in the R/C support's axial load. It becomes smaller.Using the steel X brace and the steel-frame brace system surrounding it may boost the lateral-load capacity of a rebuilt R/C frame-structure by 2.5 times. Preload is applied to the brace system's vertical steel components to transmit the column's axial load. Preloading is beneficial as long as R/C column compression corruption mode prevails. As the failure mode moves from compression to tensile, increasing preload is deleterious.A steel X-bar with endmembers that aren't attached to the R/C frame is just as effective. Increase capacity. R/C couplings with big rebar need brace systems. It's a practical difficulty. This shows that the plan's toughest aspects may be reduced.

KEYWORDS: R/C frame, steel X-bar with endmembers, reinforced concrete

I. INTRODUCTION

The majority of reinforced concrete buildings were previously solely designed to withstand gravity. Furthermore, this structure is built to bear lateral forces that may be far lower than those permitted by the legislation at the moment. Inadequate lap joints of longitudinal reinforcements and a lack of confinement in the bent hinge zone can drastically diminish column strength and ductility. These flawed constructions can be shielded from seismic harm with the right repairs. As a result, scientists are currently studying and applying seismic repair to seismic structures.

Recent earthquakes have demonstrated how urgently structures with seismic flaws need to be fixed to function at acceptable levels. Current constructions' strength, stiffness, and ductility can be enhanced to accomplish this. In this field, research and development have advanced significantly. “Prior to selecting the best restoration strategy, it is important to carefully examine the status and seismic performance of existing structures. This can be done by employing linear static techniques, linear dynamic methods, nonlinear static methods (pushover analysis), and nonlinear dynamic methods.” Your best course of action for rehabilitation will depend on the results of a thorough building inspection. Most reinforced concrete structures were designed in the past merely to withstand gravitational stress. It is also built to withstand lateral forces that are considerably smaller than those permitted by current regulations. Inadequate lap joints of longitudinal reinforcements and a lack of confinement in the bent hinge zone can drastically diminish column strength and ductility. These flawed constructions can be shielded from seismic harm with the right repairs. As a result, scientists are currently studying and applying seismic repair to seismic structures.

Recent earthquakes have brought to light the need to repair seismically unsound structures in order to meet performance requirements. Current constructions' strength, stiffness, and ductility can be enhanced to accomplish this. In this field, research and development have advanced significantly. Before deciding on the optimal restoration method, the state and seismic performance of existing structures should be carefully assessed. One can evaluate the seismic performance of existing structures by using linear static techniques, nonlinear static methods (pushover analysis), linear dynamic methods, and nonlinear dynamic methods. Your best course of action for rehabilitation will depend on the results of a thorough building inspection. There are two sorts of rehabilitation therapies: Rehabilitation at the member and structural system levels [1]. Improved performance of some vulnerable elements, such as columns, walls and beams, is the aim of member-level hygiene. The application of steel jackets with fibre composites is an illustration of this tactic. As part of system-level renovation, the entire static system will alter globally [2]. The main advantage of this

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905004 |

method is that the underlying system won't need to be fixed. The gravitational load of existing structures is not greatly increased by the brace system because steel braces are frequently connected between existing members at vertical. It is anticipated that the modified frame would produce higher foundation force. However, the foundation needs to be assessed. under lateral-loads and increase the stress on the current foundation at the brace locations. In addition, the building is not significantly affected if an exterior steel system is installed.

Brace systems are divided into groups based on whether they are within or outside the reinforced concrete frame and how they are connected (eccentric or concentric brace system). Steel trusses are installed on the building's exterior frame as part of the external brace system. On 23 scale models, Bush, Jones, and Jirsa [3] conducted periodic loading trials. models with a variety of constructions and external braces. Figure 1.1 theoretically depicts the brace system. The deep, robust balustrade girder and the short, flexible support, which tended to give way under lateral-loads, made up the main frame. The original structure's exterior was reinforced using epoxy cast dowels and an X-brace system made of steel. Framework design Three-level, two-span buildings were subjected to static periodic lateral-loads. Only 40% of the column's bending strength and 30% of the beam's bending strength were attained during the lateral-load test before the column's nominal shear strength was exceeded.

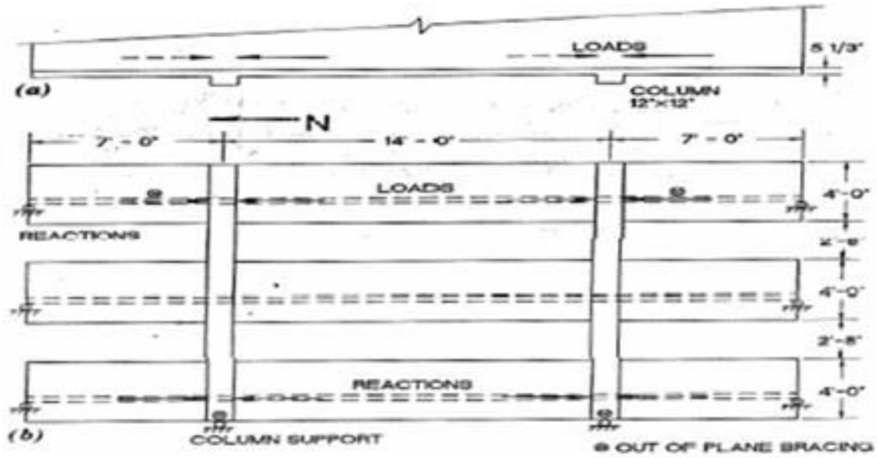

Figure 1.1: Schematic of 2 3 scaled frame model: (a) Plan, (b) Elevation. [3]

The X brace that was utilised in the model brace had two stories. The brace model's schematic diagram is shown in (Figure 1.2).

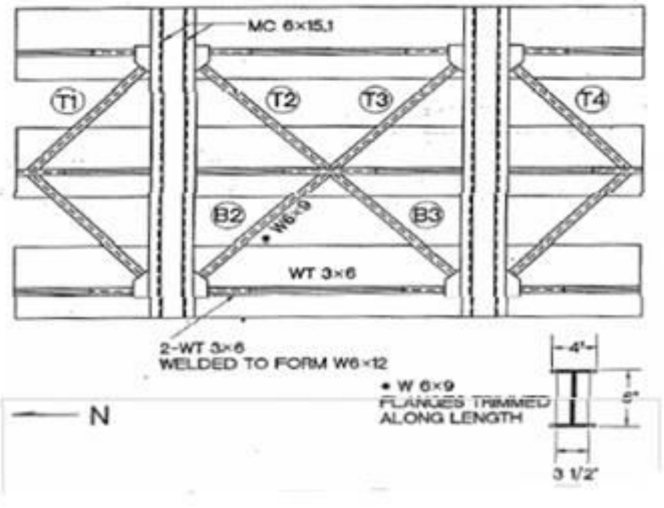

Figure 1.2: Schematic of the model bracing scheme. [3]

The mainframe's load was below the estimated fracture capacity that based-on the shear cracks of two pillars, therefore the reinforced-frame originally had roughly 1.5 times the stiffness of the original crack-free construction. The test's findings revealed a noticeably higher level of lateral stiffness and strength. The highest point of the braced frame was

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subjected to a projection force that was over six times greater than that of the original structure. Additionally, this load was 2.24 times greater than the reinforced frame's estimated design capability. The shear resistance of the concrete column has been greatly increased by brace system components positioned on the sides of the column. The reinforced frame's ability to support lateral-loads was tested through column shear failure, column buckling, and final connection failure. The behaviour of RC frames with additional outside columns was examined by Badoux and Jirsa [4] using numerical analysis. For two reasons, according to researchers, the lateral resistance of the current frame-structure is insufficient. First, they are negatively vulnerable to failure due to the outer frame's frail and short support. Second, it's possible that code requirements have improved significantly after construction, leading to higher current seismic design loads than the initial projections. The weak short columns were investigated analytically to determine their causes. The subassembly and its analytical model are depicted in (Figure 1.3).

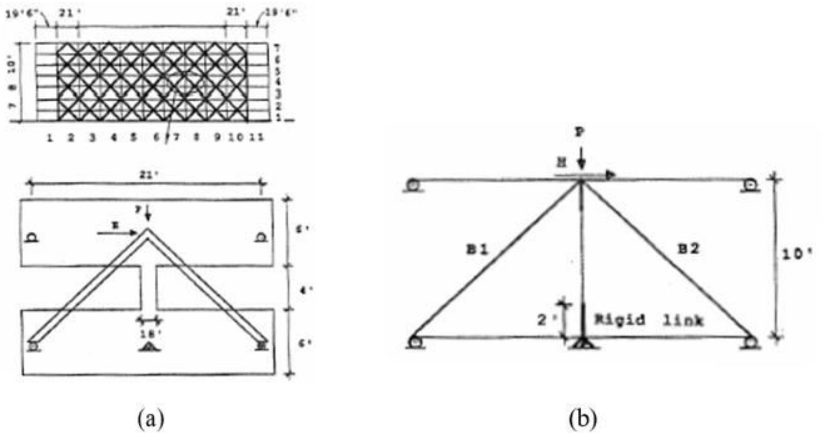

Figure 1.3: (a) Subassemblage, (b) Analytical model of subassemblage. [4]

The inflexible clipping of the brace has an impact on the inelastic periodic behaviour of the brace frame. By utilising struts that collapse under stress or by elastically buckling with light axial loads, instability can be prevented. The frame's ductility, stiffness, and strength have all increased thanks to the brace system. When the column shear failed in their investigation, the brace system tuned the behaviour, and the tensile brace provided the majority of the lateral resistance. According to Umehara and Jillsa's experiment [5], power loss in one direction causes power loss in the other. By altering the kl/r ratio, we looked into how strut aspect ratios affected subassembly behaviour. For all values of kl/r, the brace system's elastic capacity remained constant. We contrasted the subassembly reactions of 40 and 120 kl/r. Because the buckling parameters impacted both buckling and hysteresis behaviour of the bracing system, the hysteresis loop was more evenly balanced at kl/r = 40. However, keeping the device thin enough is frequently impossible. Making use of elastic braces, such as: B. Cable to stop inflexible buckling. Instead of steel pieces for the stanchions, they advised using cables to prevent buckling and increase the ductility of the structure. Based on their research, Badoux and Jirsa advise designers to consider the original frame's lateral distortion as a potential failure mechanism. The frame's rigidity and strength can be improved via the brace system;however, the break mode cannot be altered. Instead of using a weak support and strong beam framework, which results in undesirable failure modes, utilise a strong support and weak beam structure. You can accomplish this by making the beam weaker or adding more support. The first choice is practical but pricey. However, The ease of weakening the beam makes it appealing. The weakening is intended to reduce the beam's bending strength until it can hinge when subjected to lateral pressure without causing the column to collapse. The joists can be chopped or gutted to do this. The ductility of deflection caused the lateral strength to either improve or slightly increase. Damage to the support is avoided, and the frame's capacity for dissipating energy is increased, by moving the inelastic behaviour from the support to the beam.

1.1 InternalBracingSystem

Steel strings or other brace components are added to the open area between columns and beams in the reinforced concrete frame as part of the internal brace system. The viability of replacing internal steel beams in reinforced concrete frames that already exist has been extensively researched. They assert that this method enables retrofitting of existing structures. Internal brace elements are favoured over internal steel beams, claim Maheri and Sahebi [6]. The details of the investigation's tests, which were run in several model frames, are displayed in Figure 1.4.

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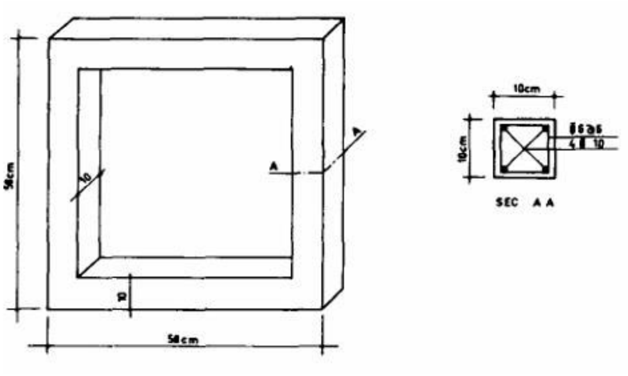

Figure 1.4: Detail of typical test model. [6]

The goals of test programme are to evaluate the effectiveness of various transverse braces to increase some lateral-load bearing existing capacity concrete frames and to monitor how tension and compression braces interact. was. These tests were conducted with conventional diagonal X bracing. Four concrete frames—one without braces, one with diagonal tension struts, one with diagonal compression struts, and one with X braces—were chosen as the model frame. The two diagonal struts were additionally joined together at the intersection by steel plates to reduce the propensity for the X-strut system's compression struts to buckle. The stanchions are connected to the frame by laterally welding them to steel plates that are prefabricated at the corners of the frame and welded at the same angle. The specifics of the connection information are shown in (Figure 1.5).

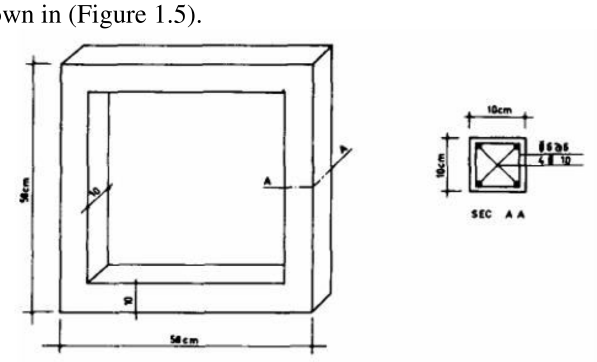

Figure 1.5: Connection detail of; (a) the steel brace to concrete frame, (b) the steel cross braces to each other. [6]

II. COMPUTER MODELING

The SAP 2000 combined programme for organizational examination and design was used to model the frame [14]. Three fundamental groups of structural elements make up each model. The steel X brace system that attaches to the reinforced concrete tube frame in each bay is one of them, as is the inner steel-frame, the steel-frame inserted the frame-bays, and the steel-frame that is placed inside the frame. In order to mimic the impacts of earthquakes on structures, load-driven pushover studies were carried out utilising the lateral-load distribution of inverted triangles. Each model of the finished structure was examined using the SAP 2000 stage analysis feature. The modelling of reinforced concrete tubular frames, the addition of steel elements, their prestressing at a specific ratio to the existing axial loads of nearby reinforced concrete columns, the addition of steel elements to beams and columns, and additional lateral-loads are the main phases of phase analysis. Steel beams for progressively adding model brace and pushover analysis. Since rebar rehabilitation procedures could be used on this structure in reinforced of the concrete frame construction, regardless of the number of floors, spans, compressive Ness of strength of the concrete, column size, etc., many parameters were taken into account in this research. The building stock in Turkey is taken into account when choosing these properties.

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III. CONCLUSIONS

In this paper, there is consideration given to the analytical application of steel braces as a means to reinforce low, medium, and rather high reinforced concrete frames. The load-controlled pushover analysis provides a method for estimating the ultimate lateral-load capacity of the reinforced frame. In addition to this, you can investigate the effects that the pre-post tension had. In the first chapter, a comprehensive literature review is carried out on the steel brace system, which is one of the techniques for system-level rehabilitation that is frequently employed. In the current frameworks, linking to columns is a proposed approach as opposed to the generally recommended methods. This is because there is no beam connection between the steel braces and the reinforced concrete frames, and the steel components have not been prestressed. is the key advantage that it offers. The lack of lateral rebar and lap joints with insufficient connection lengths in place in the majority of existing constructions frequently results in problems with beam-column connections. "The prestressed steel profile next to the existing reinforced concrete frame columns helped to reduce their axial compressive load." As a consequence of these flaws, the interaction between the beam and the column is diminished. With this type of restoration, the steel beam and the frame are not connected. Instead, the already-existing reinforced concrete frame is allowed to remain in its place at these essential points. In Chapter 2, a fundamental mathematical model of the framework is described. This model was studied and constructed with the help of the SAP 2000 statics and design application. Each model is comprised of the following three core groupings of structural elements: The inner steel-frame, which is placed within the frame, the steel-frame that is placed within the frame, and the steel X brace system that is attached to the reinforced concrete tube frame in each bay are some of the components that make up the frame. Studies using load-driven pushover with the lateral-load distribution of inverted triangles were carried out so that the effects of earthquakes on structures could be simulated. In order to evaluate each model of the finished structure, the stage analysis functionality of SAP 2000 was utilised. The relative lateral-load capacity of the refurbished structure is calculated, and then graphically displayed in relation to the load capacity of the existing shell structure. "The final lateral-load capacity controlled by the present R/C frame-structure is computed in Chapter 3 after these model structures have been analysed and the design has been confirmed for the selected parameters,"

REFERENCES

1. Anindya Dutta, Ph.D, S. E, "Design of Concentrically Braced Frames," April 2008.
2. Godínez-Domínguez E. A, Tena-Colunga. A, "Behavior of Moment Resisting Reinforced Concrete Concentric Braced Frames (RC-MRCBFs) in Seismic Zones," The 14th World Conference on Earthquake Engineering, Beijing, China, October, 2008.
3. Viswanath K.G, Prakash K. B, Anant D, "Seismic Analysis of Steel Braced Reinforced Concrete Frames," International Journal of Civil and Structural Engineering, Integrated Publishing services Volume 1, No 1, 2010.
4. Chinwuba. A, Akinloye. A, "Comparison of Wind-Induced Displacement Characteristics of Buildings with Different Lateral-load Resisting Systems," doi:10.4236/eng.2011. Published Online, March 2011
5. Siavash. K, "Optimal Conceptual Design of High-Rise Office Buildings," A thesis presented to the University of Waterloo in fulfilment of the thesis requirement for the degree of Doctor of Philosophy in Civil Engineering, Waterloo, Ontario, Canada, 200.
6. Karthik. K. M, Vidyashree. D., "Effect of Steel Bracing on Vertically Irregular R.C.C Building Frames under Seismic Loads," IJRET: International Journal of Research in Engineering and Technology, pISSN: 2321-7308, Volume 04, June-2015
7. Umesh. R. B, Shivaraj M, "Seismic Response of Reinforced Concrete Structure by Using Different Bracing Systems," International Journal of Research in Engineering and Technology, pISSN: 2321-7308, Volume: 03, Sep-2014.
8. Viswanath. K.G, Prakash. K.B, Anant. D, "Seismic Analysis of Steel Braced Reinforced Concrete Frames," International Journal of Civil and Structural Engineering, Integrated Publishing services, Volume 1, 2010.
9. Massumi. A, Tasnimi. A. A, "Strengthening of Low Ductile Reinforced Concrete Frames Using Steel X-Bracings with Different Details," The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.
10. Keyvan. R, "Seismic Behavior of Steel Off-Diagonal Bracing System (ODBS)
11. Utilized in Reinforced Concrete Frame," Journal of Structures, HindawiPublishinCorporation,Volume 2014, April 2014.
12. Maheri. M.R, Akbari. R, "Seismic behaviour factor, *R*, for steel X-braced and knee-braced RC buildings," Engineering Structures 25 (2003) 1505–1513, May 2003.
13. Maheri. M. R, "Internal Steel Bracing of RC Frames," 3rd International Conference on Concrete & Development.

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 5, May 2022 |

| DOI: 10.15680/IJMRSETM.2022.0905004 |

14. Maheri M. R, Ghaffarzadeh. H, "Seismic Design Basis for Internally-Braced RC Frames," The 14th World Conference on Earthquake Engineering, October 12-17, 2008, Beijing, China Comparative study on the response of RC frame-structure braced with different steel bracing systems (AAU/AAiT,SCEE MSc Thesis) ,2016 77
15. Ghaffarzadeh. H, Maheri M. R, "Cyclic Tests on the Internally Braced RC Frames" JSEE: Fall 2006, Vol. 8, No. 3.
16. Prof. Sarita Singla, Megha Kalra., Rahul Kalra, and Taranjeet Kaur, "Behaviour Of RC Framed Building With Different Lateral Bracing Systems," Proc. of Int. Conf. on Advances in Civil Engineering 2012.
17. Madhusudan G. Kalibhat, Kiran K, Prasad S. K., Ramya R. Pai, "Seismic Performance of Concentric Braced Steel-frames From Pushover Analysis," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 67-73.
18. Nauman Mohammed1, Islam Nazrul, "Behavior of Multistory RCC Structure with Different Type of Bracing System (A Software Approach)," International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, December 2013.

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