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Research Paper

"A Review on Design, Analysis and Cost Comparison of Steel and Concrete of A G+14 Multistorey Building W.R.T. Same Building with Different Bracing Patterns"

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Abstract:
Due to earthquake major losses can occurred it may give damages to structure and in worst Case it may collapse. For avoiding this damage of structure, bracings are provided to high rise buildings to provide strength and also for resist lateral load imposed by earthquake and wind. Bracing system is installed between column members to resist the lateral load. Bracing system is easy to installed, economical and occupies less space. Bracing system is provided for stiffness, strength and energy dissipation to resist the lateral load. Structural system development has evolved continuously to overcome the problems related to lateral stability and sway, there are many ways developed and adopted now these days to overcome this. One such structural system is bracing system. Structures are connected with various activities like sport, healthcare, transport, residence and power generation. All the structure posing adequate strength. The frame structure transfers 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.

The Bracing system has proved to be most promising structural system in resisting problem related to lateral stability and sway. The present study is conducted for G+14 storied high rise building with different kinds of Bracing patterns introduced in building outer periphery. High rise building with floor plan of 48m x 45m. Five types of models were decided to analyses the structure for all seismic Zones. Model Type I - For the reference base model, a regular reinforced concrete moment resisting bare frame model is considered. Model Type II – In base model introducing the Model with X-Bracing. Similarly Model Type III, Model Type IV & Model Type V – In base model introducing the Model with V-Bracing, Λ-Bracing & Single Diagonal -Bracing respectively. Static Earthquake analysis is carried out to study parameter's maximum storey displacement, Base shear, Base moment, Axial Force and Bending Moment to compare building with application of concrete outrigger at various position varying with the height of building and the software used for this analysis is Staad-pro V8i version. The load condition is applied as per IS 1893:2002. Bracing system improve the displacement capacity of the structure.

Key Words: *Multi-stories building, Bracing System, lateral stability, sway, Nodal displacement, Base shear, Base moment, Axial Force and Bending Moment.*

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I. Introduction

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. Strengthening of structures proves to be a better option catering to the economic considerations and immediate shelter problems rather than replacement of buildings. Moreover, it has been often seen that retrofitting of buildings is generally more economical as compared to demolition and reconstruction. Therefore, seismic retrofitting or strengthening of building structures is one of the most important aspects for mitigating seismic hazards especially in earthquake prone areas. Here we are going to study about the different bracing system (diagonal type, V type, inverted and X type) and arrangement of bracing system. To build the seismically safe structure with adequate lateral resistance. Bracing system is installed between column members to resist the lateral load. Bracing system is easy to installed, economical and occupies less space. The structure is analyzed for all Indian seismic zone with different types of bracing system and compared with the bare frame with the using of Staad-pro v8i software. The load condition is applied as per IS 1893:2002. Bracing system improve the displacement capacity of the structure. Seismic analysis is calculating the response of structure to the earth quake. Nowadays high-rise building is 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 to increase the lateral load resistance by bracing. There are many braced systems in RC structure like V, K and X. But concentric bracing mostly used by structure engineer. Structures are connected with various activities like sport, healthcare, transport, residence and power generation. All the structure posing adequate strength. The frame structure transfers 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.

II. LITERATURE REVIEW

This prospective comparative study on was carried out on Various researches, where observed on the present work but on different objective. This section describes the literature that were surveyed and studied for understanding the concept behind the present project work. These literatures were a helpful guide to accomplish the project objective to a great extent.

REVIEW OF LITERATURE:

The literature review is carried out in following major areas. These are:

- Research papers on response of buildings under seismic loading,
- Importance of Indian seismic design codes and their introduction in brief.
- Discussion about Building configuration.
- Literature based on behavior of structure under Seismic condition.

The first part of this chapter is devoted to a review of published literature related to behavior of building configuration under seismic loading.

The second half of this chapter is devoted to a review of design code perspective on Building configuration, Seismic analysis of structure using Equivalent Static Analysis and seismic effect on structure. This part describes different parameters used in analysis of structure and their importance, which will aid in framing the outcomes of analysis.

RESEARCH PAPERS:

The seismic response of flat slab and grid slab building had been the subject of numerous research papers. Following is a brief review of the work that has been done on topics which relates our study:

1. Review Paper on Seismic Behavior of RC Frame Structure with Different Types of Bracing System, 1Kartik prashar, et.al. 2018

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 members 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.

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 an 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 than other bracing system. Steel bracing can be used to retrofit the existing structure.

2. Comparison study of RC structure with different arrangement of rcc bracing system, Mr. Mehul M. Kanthariya 1 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.

3. Analysis of Reinforced Concrete Building with Different Arrangement of Concrete and Steel Bracing system Prof. Bhosle Ashwini Tanaji, 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.

4. Behavior of moment resisting reinforced concrete concentric braced frames (rc-mrcbfs) in seismic zones E.A. Godínez-Domínguez, et.al. 2008
This paper presents the results of a study devoted to evaluate, using nonlinear analyses, the behavior of ductile moment-resisting reinforced concrete concentric braced frames structures (RC-MRCBFs) using steel bracing. RC-MRCBFs were designed for lakebed region of Mexico City. It is possible to conclude from the results obtained in this study the need to improve current guidelines in the Mexican building code in order to warrant a ductile behavior for this structural system and to achieve the expected collapse mechanism.
Currently, there are shortcomings in many international codes to design ductile RC- MRCBFs. Many building codes extrapolate recommendations developed for RC moment- resisting frames to design MRCBFs, which is an incomplete strategy. From the results obtained in this study, it seems that the capacity design methodology used by the authors is successful to design ductile RC-MRCBFs when the columns of the moment frames resist at least 50% of the total seismic shear force, supporting with numerical evidence this proposed strength balance established in MFDC-04. However, the optimal strength balance between the RC frame and the steel bracing system seems to vary depending on the building height, so the authors are currently studying this possibility designing buildings with 20 and 24 stories.
It was found a notorious difference between the assessed over strength factors (R) and the proposed values in MFDC-04. A relationship seems to exist between the assessed R factors and the shear strength contribution for the columns to resist lateral loads, so a new expression could be developed to define the R factor for RC-MRCBFs in Mexican codes in order to improve their design.

5. "Strengthening of reinforced concrete and steel Structure by using steel bracing systems" Soundarya n. Gandhi1, et.al. -2017
Due to earthquake major losses can occurred it may give damages to structure and in worst case it may collapse. For avoiding this damage of structure steel braces provided to high rise building to provide strength

and also for resist lateral load imposed by earthquake and wind. There are 'n' numbers of possibilities to arrange steel bracings such as X, V, Inverted V. A building is situated at seismic zone V. The building models are analyzing as per IS 1893:2002 using software ETABS. The main parameters consider is to compare the seismic analysis of buildings for lateral displacement, storey drift, base shear etc. From analysis of 15 storied RC & Steel building with provision of Bracing for different types, following conclusions are drawn.

1. The seismic responses in X and Y direction namely base shear for 15 storied RC structure with X bracing gives maximum result for base shear as compare to without bracing.
2. For structure with bracing X have minimum storey displacement. Storey displacement is uniformly increasing when structure unbraced and it is maximum at top floor of the structure.
3. For structure with bracing have minimum storey drift compared to structure without bracing respectively. Structure with inverted V Bracing gives minimum Storey drift as compare to other X, V. The values of storey drift for all the stories are found to be within the limits i.e., 0.004 times to storey height according to IS 1893:2002 (Part I)
4. Building with bracing leads to minimum displacement, maximum base shear and minimum storey drift compared to building without bracing.
5. Structure with X Bracing is suitable for G+14 RC and Steel frame the effect of earthquake load on the seismic performance.

6. Effect of Steel Bracings on RC Framed Structure Anes Babu1, Dr. Chandan Kumar et.al. 2017

Earthquake is the natural calamity known to mankind from many years, from the antiquated time researchers looked into numerous approaches to secure the structures. There was a need to control the damage caused by earthquake to the existing buildings. Many strengthened solid structures need retrofit to overcome inadequacies to oppose seismic loads. Bracing was the best technique which can be used to existing reinforced concrete buildings. Steel bracing is economical, simple to erect, involves less space and has adaptability to plan for meeting the required strength and stiffness. The present work deals with study of effect of steel bracings on RC framed structures. For the purpose of this study, reinforced concrete framed building (G+9) was modelled and analyses in three parts 1) Model without steel bracings and shear wall 2) Model with different bracing system 3) Model with shear wall. Bracings and shear walls were placed at the middle bays and all these models were analysed for seismic forces at different seismic zones using E tabs 2015 software. To find out seismic performance of steel bracing and shear wall to RCC building, parameters as Lateral displacement, Story shear and Story drift must be studied. It was found that the chevron type of steel bracing was found to be more efficient in zones II & III and X type of bracing was found to be more efficient in Zones IV & V further steel braced building significantly reduces the lateral drift when compared with shear wall building.

7. Analysis of RC Building Frames for Seismic Forces Using Different Types of Bracing Systems Rishi et.al. 2014

In this study, seismic analysis of high-rise RC building frames has been carried out considering different types of bracing systems. Bracing systems is very efficient and unyielding lateral load resisting system. Bracing systems serves as one of the components in RC buildings for increasing stiffness and strength to guard buildings from the incidence caused by natural forces like earthquake force. In proposed problem G+ 10 story building frame is analyzed for different bracing system under seismic loading. STADD-Pro software is used for analysis purpose. The results of various bracing systems (X Bracing, V Bracing, K Bracing, Inverted V Bracing, and Inverted K Bracing) are compared with bare frame model analysis to evaluate the effectiveness of a particular type of bracing system in order to control the lateral displacement and member forces in the frame. It is found that all the bracing systems control the lateral displacement of frame very effectively. However Inverted V bracing is found to be most economical. Salient conclusions of the study are, the concept of using steel bracing is advantageous to resist the seismic forces. The bracing system effectively reduces the lateral displacement (up to 80%) of the structure compared to bare frame. Steel bracings the number of forces in members significantly reduces. Bracing system proves as an effective member to control the story drift (up to 56%) in structures as compare to Bare frames. After using bracing member as a resistive member margin of safety against collapse increased.

8. Seismic Behavior of Different Bracing Systems In High Rise RCC Buildings, Bharat Patel, 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 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 behave buildings. Also, three structural configurations used in this paper are Moment Resisting Frames (MRFs), X storey (G+10) building. The bracing systems provided on periphery of the column. The frame models are

analyzed as per IS: 1893 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 safer at time of earthquake when compared with moment resisting frames and V-braced frames.
In this paper the different braced buildings are studied and the seismic parameters in terms of base shear and storey displacement are compared. The following conclusions are summarized based on analysis: In high rise buildings, the parameters like strength and stiffness are more important. So, for this purpose bracing system are adopted to enhance both these parameters. MRF buildings showed higher storey displacement that it is weak as compared other braced buildings, so prone to excessive damage in earthquake. The base shear of braced buildings increased as compared to building without bracing which indicates that the stiffness of building increases. The storey displacement of the building is reduced by 55% to 60% by using XBF and VBF. The performance of XBF has more margin of safety when compared to VBF. The RC bracing has one of advantage that it can be used to strengthen the existing structure.

SEISMIC CODES BY BIS.

Indian Seismic Codes

Seismic codes are unique to a particular region or country. They take into account the local seismology, accepted level of seismic risk, building typologies, and materials and methods used in construction. Further, they are indicative of the level of progress a country has made in the field of earthquake engineering. The first formal seismic code in India, namely IS1893, was published in 1962. Today, the Bureau of Indian Standards (BIS) has the following seismic codes:

- IS 1893 (Part I), 2002, Indian Standard Criteria for Earthquake Resistant Design of Structures (5th Revision)
- IS 4326, 1993, Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Buildings (2nd Revision)
- IS 13827, 1993, Indian Standard Guidelines for Improving Earthquake Resistance of Earthen Buildings
- IS 13828, 1993, Indian Standard Guidelines for Improving Earthquake Resistance of Low Strength Masonry Buildings
- IS 13920, 1993, Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces
- IS 13935, 1993, Indian Standard Guidelines for Repair and Seismic Strengthening of Buildings

The regulations in these standards do not ensure that structures suffer no damage during earthquake of all magnitudes. But, to the extent possible, they ensure that structures are able to respond to earthquake shakings of moderate intensities without structural damage and of heavy intensities without total collapse.

IS 1893: 2002

IS 1893 is the main code that provides the seismic\zone map (Figure 1) and specifies seismic design force. This force depends on the mass and seismic coefficient of the structure; the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests, and its ductility. For example, building in Bhuj will have 2.25 times the seismic design force of an identical building in Bombay. Similarly, the seismic coefficient for a single-storey building may have 2.5 times that of a 15-storeybuilding. Over 70% of India's land under seismic zones III, IV and V. The revised 2002 edition, Part 1 of IS1893, contains provisions that are general in nature and those applicable for buildings.
The other four parts of IS1893 will cover:

- Liquid-Retaining Tanks, both elevated and ground supported (Part 2);
- Bridges and Retaining Walls (Part 3);
- Industrial Structures including Stack- Like Structures (Part 4);
- Dams and Embankments (Part 5).

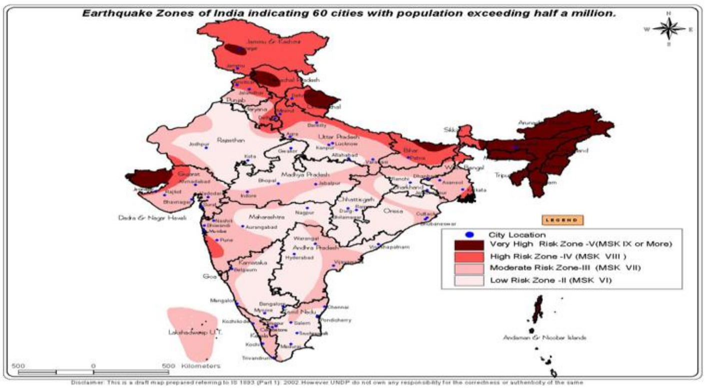

Figure 2.2: Map of India showing area covered under different Seismic zones.

These four documents are under preparation. In contrast, the 1984 edition of IS1893 had provisions for all the above structures in a single document.
Provisions for Bridges Seismic design of bridges in India is covered in three codes, namely IS 1893 (1984) from the BIS, IRC 6(2000) from the Indian Roads Congress, and Bridge Rules (1964) from the Ministry of Railways. All highway bridges are required to comply with IRC 6, and all railway bridges with Bridge Rules. These three codes are conceptually the same, even though there are some differences in their implementation. After the2001 Bhuj earthquake, in 2002, the IRC released interim provisions that make significant improvements to the IRC6 (2000) seismic provisions.

IS 4326:1993

This code covers general principles for earthquake resistant buildings. Selection of materials and special features of design and construction are dealt with for the following types of buildings: timber constructions, masonry constructions using rectangular masonry units, and buildings with prefabricated reinforced concrete roofing/flooring elements.

IS 13827: 1993 and IS 13828: 1993

Guidelines in IS 13827 deal with empirical design and construction aspects for improving earthquake resistance of earthen houses, and those in IS 13828 with general principles of design and special construction features for improving earthquake resistance of buildings of low-strength masonry. This masonry includes burnt clay brick or stone masonry in weak mortars, like clay-mud. These standards are applicable in seismic zones III, IV and V. Constructions based on them are termed non-engineered, and are not totally free from collapse under seismic shaking intensities VIII (MMI) and higher. Inclusion of features mentioned in these guidelines may only enhance the seismic resistance and reduce chances of collapse.

IS 13920: 1993

In India, reinforced concrete structures are designed and detailed as per the Indian Code IS 456(2002). However, structures located in high seismic regions require ductile design and detailing. Provisions for the ductile detailing of monolithic reinforced concrete frame and shear wall structures are specified in IS 13920 (1993). After the 2001 Bhuj earthquake, this code has been made mandatory for all structures in zones III, IV and V. Similar provisions for seismic design and ductile detailing of steel structures are not yet available in the Indian codes.

IS 13935: 1993
These guidelines cover general principles of seismic strengthening, selection of materials, and techniques for repair/seismic strengthening of masonry and wooden buildings. The code provides a brief coverage for individual reinforced concrete members in such buildings, but does not cover reinforced concrete frame or shear wall buildings as a whole. Some guidelines are also laid down for non-structural and architectural components of buildings.
Countries with a history of earthquakes have well developed earthquake codes. Thus, countries like Japan, New Zealand and the United States of America, have detailed seismic code provisions. Development of building codes in India started rather early. Today, India has a fairly good range of seismic codes covering variety of structures, ranging from mud or low strength masonry houses to modern buildings. However, the key to

ensuring earthquake safety lies in having a robust mechanism that enforces and implements these design code provisions in actual constructions.

III. Conclusion

This chapter gives a broad note on the literatures reviewed and studied to gather information and learn the present study and form a better comparison. In this chapter papers of different authors of similar objective are chosen and abstracted here in short to understand the objective of present study and furthermore gather information in future studies. After observing these literature papers adopted some of objectives for my research work. The primary objectives of this plan can be shortening as follows:

1. To carry a relevant literature review by going through journal papers conference proceedings, text/reference books, Standard handbooks, BIS publications etc.
2. To identify the suitable bracing system for resisting the lateral loads efficiently.
3. Establishing a comparison between the two types of structure with & without Bracings and analyzing the result and establishing a needful similarity with effectiveness in tabular & graphical form.
4. To compare the Staad- pro. Results for the following parameters- Nodal displacement , Maximum axial forces , Maximum bending moments , Maximum Base shear , Maximum Base Moments & Rate Analysis of all model Structures.

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