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Analysis of G+4 building structure for Seismic Retrofitting using Cross Bracing

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Abstract
As the earthquakes are an inconsistent phenomenon they may or mostly may not occur in entire lifespan of building, Designing abuilding structure to sustain during an earthquake makes it very uneconomical, Hence a Structural model is going to be used for comparison in between building structure models with seismic retrofitting techniques such as Steel Bracings. In this paper a G+4 building structural model is analysed in zone III and zone IV by using Arduino Earthquake Detector Alarm with Seismic Graph using Accelerometer. Various characters like consistency, lateral displacement and storey drift will be studied. The main aim of this paper is to compare the differences in Structural model without Steel Bracing and Structural model with Steel Bracings with help of different levels applied to the model with increase in force applied from zone III to zone IV.

Keywords: *Structural Model, Arduino Earthquake Detector Alarm, Accelerometer, Seismic Graph.*

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I. INTRODUCTION

In the past thirty years, moderate to severe earthquakes occurs around the world every year. Such events lead to damage to the concrete structures as well as failures. Thus, the aim is to Focus on a few specific procedures which may improve the practice for the evaluation of seismic vulnerability of existing reinforced concrete buildings of more importance and for their seismic retrofitting by means of various innovative techniques such as base isolation and mass reduction. So Seismic Retrofitting is a collection of mitigation technique for Earthquake engineering. It is of utmost importance for historic monuments, areas prone to severe earthquakes and tall or expensive structures. The existing building stock poses a much more serious and complex seismic safety problem when compared to safe earthquake design of new construction. The vast majority of structures located in seismic areas exhibit deficiencies in their resistance to earthquake loads due to a number of reasons, highlighted below.

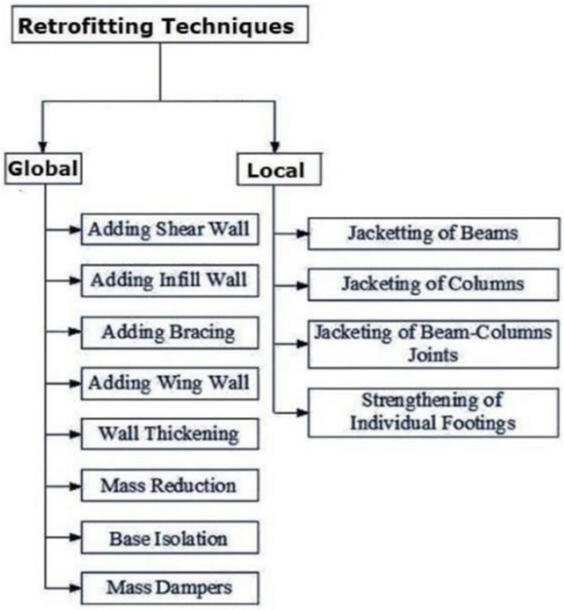
Older construction, designed according to earlier codes, may not comply with current seismic regulations since focus used to be primarily on warranting sufficient capacity for gravity loads alone. Moreover, the past thirty years have witnessed such a significant increase of knowledge in the field of earthquake engineering that even relatively modem structures may no longer meet the prerequisites of constantly-developing regulations. As a result, several shortcomings can be found in existing buildings such as irregular structural configuration, inappropriate member detailing for ductility and insufficient lateral stiffness, amongst others.All the above considered, it seems clear that repair and strengthening of both old structures designed according to outdated codes and new but defective earthquake-resistant construction, is urgently needed. This requirement also arises where existing structures must comply with more recent code stipulations, or when these structures are to be reassessed for higher loads.

1.1 Seismology

Seismology is the scientific study of earthquakes and the propagation of elastic waves through the Earth or through other planet-like bodies. The field also includes studies of earthquake environmental effects such as tsunamis as well as diverse seismic sources such as volcanic, tectonic, glacial, fluvial, oceanic, atmospheric, and artificial processes such as explosions. A related field that uses geology to infer information regarding past earthquakes is paleo-seismology. A recording of Earth motion as a function of time is called a seismogram. A seismologist is a scientist who does research in seismology.

National Centre for Seismology (NCS) is the nodal agency of the Government of India for monitoring earthquake activity in the country. NCS maintains the National Seismological Network of more than 150 stations each having state of art equipment and spreading all across the country NCS monitors earthquake activity all across the country through its 24x7 around-the-clock monitoring centre. NCS also monitors earthquake swarm and aftershock by deploying a temporary observatory close to the affected region

1.2 Classification



Above mentioned are various types of Seismic Retrofitting Techniques used both locally and on Global level. Seismic Retrofitting Techniques are required for concrete constructions which are vulnerable to damage and failures by seismic forces. In the past thirty years, moderate to severe earthquakes occurs around the world every year.Thus the aim is to Focus on a few specific procedures which may improve the practice for the evaluation of seismic vulnerability of existing reinforced concrete buildings of more importance and for their seismic retrofitting by means of various innovative techniques such as base isolation and mass reduction. It is of utmost importance for historic monuments, areas prone to severe earthquakes and tall or expensive structures. In this project we will be dealing with the most commonly used Seismic Retrofitting technique known as Cross Bracing.

1.3 Cross Bracing

Bracing is a very effective global upgrading strategy to enhance the global stiffness and strength of steel and composite frames (Fig 02). It can increase the energy absorption of structures and/or decrease the demand imposed by earthquake loads. Structures with augmented energy dissipation may safely resist forces and deformations caused by strong ground motions. Generally, global modifications to the structural system are conceived such that the design demands, often denoted by target displacement, on the existing structural and non-structural components, are less than their capacities (Fig 02). Lower demands may reduce the risk of brittle failures in the structure and/or avoid the interruption of its functionality. The attainment of global structural ductility is achieved within the design capacity by forcing inelasticity to occur within dissipative zones and ensuring that all other members and connections behave linearly.

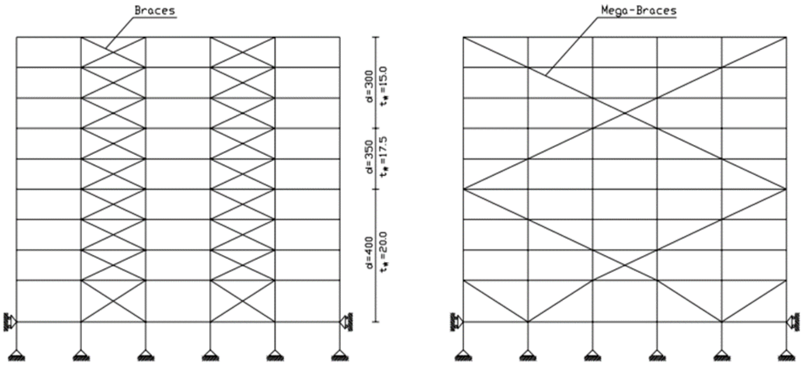


Figure 1:Layout of braced frames: concentrically- (left) and mega-braced (right) frames.

There are different types of Cross Bracing Techniques which are as follows:
1) Concentric based frames (CBFs)
2) Eccentric based frames (EBFs)
3) The novel knee-base frames (KBFs)

Concentric based frames are further classified in following types:
(i) V – Type Cross Bracing
(ii) X – Type Cross Bracing
(iii) K – Type Cross Bracing
(iv) Opposite V – Type Bracing
(v) Diagonal Bracing
(vi) 2 Storey X – Bracing.

In this project we will be dealing with V – Type and X – Type Cross Bracing.

1.4 Seismic Zones
Different Seismic Zones in India
(i) Seismic Zone II: Zone II is classified as the low-damage risk zone.
(ii) Seismic Zone III: Seismic Zone 3/III is classified as the moderate-damage risk zone.
(iii) Seismic Zone IV: Zone IV is considered the high-damage risk zone.
(iv) Seismic Zone V: Zone V has the highest risk of damaging earthquakes.

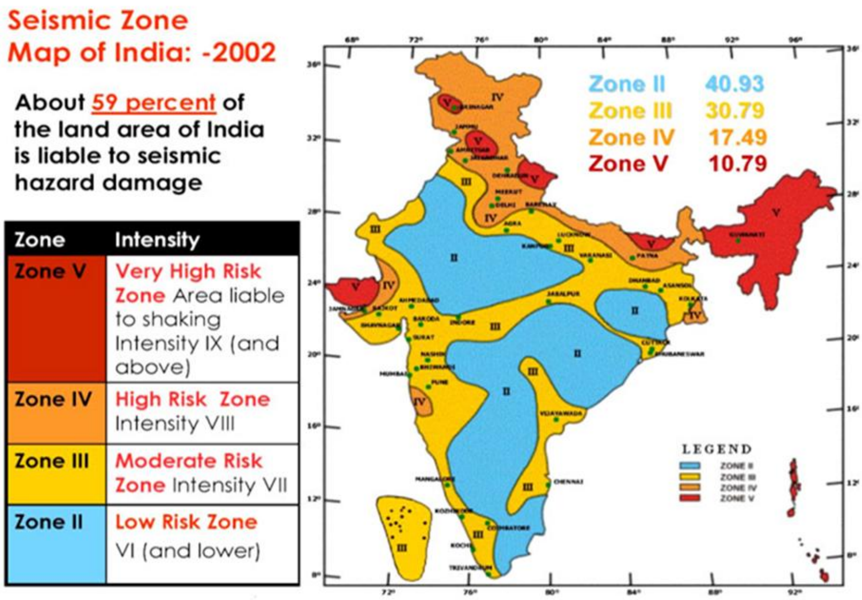


Figure 2: Seismic Zone Map of India

According to the seismic zoning map of the country, India is divided into four seismic zones. Also known as earthquake zones, these seismic zones are formed on the basis of scientific inputs related to the following:

(i) The Seismicity or the Frequency of Earthquakes in a Region
(ii) Earthquakes That Have Hit the Country in the Past The four zones of earthquake in India, as discussed below:
(iii) Seismic Zone II: Zone II is classified as the low-damage risk zone. This is the least seismically active zone, meaning the areas that fall under these zones in India have a low chance of having an earthquake. Zone II covers earthquake-prone areas, which are 41% of India. Here, the Indian Standard (IS) Code allots a zone factor of 0.10.
(iv) Seismic Zone III: Seismic Zone 3/III is classified as the moderate-damage risk zone. Here, the IS Code allots 0.16 to this zone. Zone III, or moderate earthquake zone, covers 30% of India.
(v) Seismic Zone IV: Zone IV is considered the high-damage risk zone. The IS Code allots 0.24 to this zone. Moreover, 18% of the total area of the country belongs to Zone IV.
(vi) Seismic Zone V: Zone V has the highest risk of damaging earthquakes. The IS Code has assigned a factor of 0.36 for this very high-risk damage zone. Around 11% of India falls under Zone V.
Note: There are no cities in India which fall under Seismic Zone I

The above-mentioned list of earthquake zones in India gives a comprehensive knowledge of the different zones and total areas they cover. Let us now take a look at the top 10 cities prone to an earthquake.

Table 1: Magnitudes & Intensity of Earthquake Globally

Magnitude	Description	Intensity (Mercalli)	Average Frequency of Occurrence Globally
1.0 – 1.9	Micro	I	Several Million Per year
2.0 – 2.9	Minor	I to II	Over one million per year
3.0 – 3.9		III to IV	Over 1,00,000 per year
4.0 – 4.9	Light	IV to VI	10,000 to 15,000 per year
5.0 – 5.9	Moderate	VI to VII	1,000 to 1,500 per year
6.0 – 6.9	Strong	VIII to X	100 to 150 per year
7.0 – 7.9	Major	X or greater	10 to 20 per year
8.0 – 8.9	Great	X or greater	One per year
9.0 & greater		X or greater	One per 10 to 50 years

1.5 Satara District Seismic Zones

(i) As Satara District comes under earthquake prone areas it mainly gets divided into two different zones.
(ii) It gets divided into Zone III and Zone IV respectively.
(iii) As Zone III is also called as Very strong intensity zone its intensity on MMI scale is around "VII".
(iv) As Zone IV is called as Severe Intensity zone its intensity on the MMI scale is around "VIII".
(v) Hence, as for Satara District region the typical MMI (Modified Mercalli Intensity) is around VII & VIII.
(vi) Which then comes under the Magnitude of Earthquake as in 6.0 to 7.0.

Table 2: Magnitude vs. MMI Scale

Magnitude	Typical MMI
1.0 – 2.9	I
3.0 – 3.9	II – III
4.0 – 4.9	IV – V
5.0 – 5.9	VI – VII
6.0 – 6.9	VII – IX
7.0 & higher	VIII or higher

III. OBJECTIVES

2.1 To Develop G+4 Building structure model with Cross Bracing.
2.2 To apply different levels of magnitudes to all models.
2.3 To compare between Building Structure models of both buildings with Cross Bracing and without Cross Bracing.
2.4 To Obtain result and conclusion based on testing, that demonstrates the validity of the designed technique.

IV. METHODOLOGY

As the earthquakes are an inconsistent phenomenon they may or mostly may not occur in entire lifespan of building, Designing a building structure to sustain during an earthquake makes it very uneconomical, Hence a Structural model is going to be used for comparison in between building structure models with seismic retrofitting techniques such as Steel Bracings. In this paper a G+4 building structural model is analysed in zone III and zone IV by using Arduino Earthquake Detector Alarm with Seismic Graph using Accelerometer. Various characters like consistency, lateral displacement and storey drift will be studied. The main aim of this paper is to compare the differences in Structural model without Steel Bracing and Structural model with Steel Bracings with help of different levels applied to the model with increase in force applied from zone III to zone IV.

Bracing play important role in keeping structure stable. Earthquake produces inertial forces in structure. These inertial forces act in the form of base shear on structure. Base shear is distributed to different floor along the height of the building. This force produces later displaces in structure. For high rise building, lateral displacements are common due towing loading. But if the earthquake is of high intensity, it can be disastrous. Bracings play important role in distributing this force in columns and beams. In this project we have analysed unbraced structure with structures having different bracings.

X-bracing system has shown good results when it comes to reducing lateral displacements. Base shear values are same in both directions. Since number of bracings along X-directions were more, bracings shown good performance in lateral displacements along X-axes. Diagonal bracing shows overall good performance considering maximum bending moment. V-bracing has shown good performance considering Maximum support Reactions. Weight of the structure remains almost same. Not more than 2 percent change in weights of structure. Since base shear is dependent on weight, base shear also remain similar.

V. TESTING AND CONVERGENCE

1. As for Amplitudes regarding in the application in Project Model.
2. There will be levels used for change in amplitude of earthquake.
3. i. 1 Hz to 20 Hz in 30 seconds amplitude 0.50 as for the Shake in Platform Level 1, we will be using Total Shake.
   ii. Level 2 - 0.75 amplitude change in every 30 seconds from 20 Hz to 40 Hz.
   iii. Level 3 – 1.00 amplitude change in every 30 sec.
4. We will also be adding pulse motions for sudden jerks in the structural model.
5. Then we will be increasing the amplitudes on the shake table till the building with no bracing collapse.
6. After the collapse of the building with no bracing, we will be taking results from the other two building structures.
7. We will take different results for both building structure models with X-Type and V-Type bracing to check its durability with increase in the amplitudes simultaneously.
8. As the project model is based on the Satara district seismic zone, the earthquake zones will be Zone III and Zone IV.
9. Hence, we will need to take results up to the magnitude of amplitude level 7.5 to 8.0 as per the severe intensity zone in the MMI scale.

VI. CONCLUSION

Lateral forces are distributed to beams and columns by bracings. In this project a comparative analysis of unbraced structure with structures having different bracings. With parameters such as Bending Moments, Lateral displacements, support reactions. X-bracing system has shown good results when it comes to reducing lateral displacements.

On the basis of the present study, following conclusions are made:

- As per displacement criteria, bracings are good to reduce the displacement and in case of X and V-bracing, the displacement is higher than without bracing because of irregularity in shape of the structure.
- The reactions and weight of the structure are more in different types of bracing structures when compared to un braced structure with same configuration of the structure.
- It is also seen that as there are different bracing systems employed the displacement and storey drifts, may increase or decrease for the braced buildings with the same configurations.

- The braced buildings of the storey drift either increases or decreases, as compared to un braced building with the same configuration for the different bracing system.

VII. FUTURE SCOPE

This project primarily focused on concentric bracings. There are so many different types of concentric bracings. In this project only four of them are utilized. There are various types of eccentric bracings too. Eccentric bracings can useful when lateral loads are of know directions. In future works this analysis can be utilized as a source of data for further analysis. There could be multiple arrangements. Here we have only focused on only one type of arrangements. This work can be further carried out with different arrangements. Bracing types can be compared by using many more parameter

This project can also be tested for dynamic loading, wind loads. Work is done on static coefficient method. It can be redone using Response spectra method, Time history analysis. This is a symmetrical structure. Further projects can be done on irregular structures. Irregularity can induce unexpected forces in structure.

REFERENCES

[1]. The Mexico Earthquake of September 19, 1985 – Typical Cases of Repair and Strengthening of Concrete Buildings M. Jara, C. Hernandez, R. Garcia, and F. Robles Earthquake Spectra, Vol. 5, No. 1, 1989

[2]. Ashimbayev M.U., Itskov I.E., LobodrygaT.D.,living with natural and technological hazards, topic : reducing vulnerabilities in existing building and life lines

[3]. Forced Vibration Studies of an RC Building Retrofit with Steel Bracing. Keith D. HJELMSTAD, Douglas A. FOUTCH, Enrique DEL VALLE, Ruth. DOWNS. Proceedings of Ninth World Conference on Earthquake. Engineering, Tokyo-Kyoto, Japan (Vol. VII)

[4]. Seismic Retrofit of a RC Building: A Case Study. Enrique DEL VALLE CALDERON, Douglas A. FOUTCH, Keith D. HJELMSTAD, Eduardo FIGUEROA – GUTIERREZ and Arturo TENA – COLUNGA. Proceedings of Ninth World Conference on Earthquake Engineering, Tokyo-Kyoto, Japan (Vol. VII)