SEISMIC EVALUATION AND RETROFITTING OF EXSTING BUILDING USING STEEL BRACING

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ABSTRACT

Retrofitting is a technique which upgrades the lateral strength of building. A large numbers of existing concrete structures in earthquake zones are not capable of earthquake action. In addition to this, the building also affected due to design deficiency, construction deficiency, additional lads etc. the point has become the subject of research for many civil engineers. Retrofitting of existing building plays a vital role in reducing energy consumption and emission of green house gases. Existing reinforced concrete structures, which are constructed in last twenty years, are not enough resistant t the seismic activities. Retrofitting using steel bracing among all techniques proves to be effective solution for enhancing seismic safety. The response of structure is evaluated using response spectrum method. The response spectrum method is preferred because; it provides the designer a simple basis for specifying the earthquake loading. Also this method is economical.

Keyword: - *Steel Bracing, Earthquake, Retrofitting, Response spectrum, RC frame, Storey Drift, Storey Stiffness, Lateral displacement, etc.*

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1. INTRODUCTION

Our ability to build seismically safe structures with adequate seismic resistance has increased significantly in the past two decades. One aspect of earthquake engineering which has received comparatively little attention is the seismic retrofitting of existing structures. Many reinforced concrete framed structures built in seismically active areas are expected to perform inadequately in a seismic event. Reconnaissance studies following major earthquakes have documented collapse or severe damage of numerous multistory reinforced concrete frames. For life safety and for economic reasons, structures expected to perform inadequately must be replaced or retrofitted. Steel bracing technique is known to be efficient structural system for building under high lateral loads such as seismic or wind loading the fact that the lateral resistance of a frame can be significantly improved by the addition of bracing system has led to idea of retrofitting seismically inadequate reinforced concrete frames with steel bracing system. In particular, the seismic rehabilitation of older concrete buildings in regions of high seismicity, which were designed prior to the advent of modem seismic design codes, is a matter of growing concern. Structures that may be vulnerable to damage must be identified and an "acceptable" level of seismic upgrade must be considered. The task of making such an assessment and establishing the level of seismic upgrading rests with the structural engineer who has limited analytical tools and code-based guidelines to carry out the task. While a performance-based criterion, both for the design of new construction and the retrofit of existing construction, is desirable, the process of developing such a guideline can be formidable. The optimal solution is a trade-off among a range of energy related and non-energy related factors, such as energy, economic, technical, environmental, regulations, social, etc.

1.1 METHODOLOGY

1) For evaluation of vulnerability of any buildings, some rapid visual methods and preliminary evaluation are to be carried out first.
2) On the basis of this study, derive a conclusion as to whether the building is safe or needs further detailed evaluation to assess its adequacy.
3) Provide guidelines such that not only the practicing engineers but also the common man who can broadly understand and note the absence or presence of seismic resistant features in the building and also the possibilities of seismic retrofit.
4) Also this project will include adequate details academicians, professionals, builders and owners to take a few major and positive steps to ensure that structures can be made adequately safe/ductile to save loss of life and property in case of earthquakes.
5) Compare the construction price of retrofitted buildings to the price of demolishing the existing and building a new building.

1.2 Response Spectrum Method

Response spectrum is a graph of (displacement, velocity or acceleration) of oscillators having different natural frequency. The resulting graph can be taken for the values of response of any linear system. The values taken from the response spectrum are used for correlation with seismic damage. Response spectra also can be used in assessing the response of linear system with multiple modes of oscillation (MODF). The main limitation of response spectrum method is that, they are only applicable for linear systems. Still response spectra can be generated for non-linear systems, but are only applicable to systems having same non-linearity.

1.3 Damping Factor

Damping is a phenomenon that makes any vibrating structure to decay in amplitude of motion gradually by means of energy dissipation through various mechanisms. Here in our case the damping factor is 0.05.
Re-scaling:
According to the ASCE7-05 ,
F_X or F_Y of RS max > 0.85 × calculated base shear i.e. E_X or E_Y
If it is not the re-scaling of the values can be done.
The formula for rescaling is:

$$\frac{I \times g}{R} \times 0.85 \times \frac{static\ base\ shear}{RS\ base\ shear}$$

2. MODELLING

In this study, G+10 RC building with steel bracing at different panels is analyzed using the response spectrum method based software ETABS. The displacement value of different storey level (storey drift), storey displacement and storey stiffness is obtained for all the structure. The various result obtained from the analysis are presented in this chapter.Destruction of building in earthquake has been seen in many past earthquakes, most building collapsed because of insufficient ductility or capacity or both. Most of the existing buildings in India are ordinary moment resisting frame. As mentioned in previous chapter, seismic code gives different methods to carry out lateral load analysis. Through, bracing are secondary structural members, they are of more importance when they tend to interact to frame, when the structures are subjected to lateral loads.

So in this study RC buildings G+10 with special moment resisting frame is consider in the analysis and building ‘X’ types of steel bracing is been provided.

Following data is considered for analysis:

1.Type of frame – Special Moment Resisting Frame
2.No. of Stories – 11
3.Zone (Z) – III
4.Importance factor (I) – 1
5.Response reduction factor (R) – 5
6.Slab thickness – 150 mm
7.Live load – 3 kN/m^2
8.Height of floor – 3.15 m
9Depth of foundation=1.5m
10.Type of building – Residential
11.Soil strata – Medium
12.Density of concrete – 25 kN/m^3
13.M-25 concrete and FE-415 steel is used.
14.The modulus of elasticity of concrete and steel are 25000 N/mm^2 and 2×10^5 N/mm^2 respectively.

2.1Model of building for X type of bracing system

The Eleven storey building is modeled as described in previous section. The Plan and elevation for the bare frame building is shown in Fig 4.1 and 4.2 respectively.

Criteria for selection of suitable steel bracing sections
In order to select the suitable section for the bracing various step were followed in the sequential manner listed below

1] The slenderness ratio of column and bracing was calculated for 1m member-

Size of concrete column- 250 $\times$ 900 mm

Size of steel bracing- 230 $\times$ 600 $\times$10 mm

Slenderness ratio = $\lambda = \frac{l}{r\min}$

For building column = $\frac{0.5 \times 1000}{173.20} = 2.5$

For steel bracing = $\frac{1 \times 100}{2.14} = 46.72$

2] Stiffness of concrete column and steel bracing calculated for 1m member- L^3

For concrete column = $K = \frac{12\,EI}{L^3}$

$$= \frac{12 \times 25000 \times 5.4 \times 10^9}{1000^3}$$

$$= 1.62 \times 10^6 \text{ N/mm}$$

For steel bracing = $K = \frac{AE}{L}\cos^2\theta$

$$= \frac{13.38 \times 10^2 \times 2 \times 10^5 \times \cos 36.86^2}{1000}$$

$$= 0.171 \times 10^6 \text{ N/mm}$$

The effective slenderness ratio of brace should be kept relatively low so that the brace are effective in compression as well as in tension. The suggested slenderness ratio (L/r) are 80 to 60 or even lower.

Modeling of building involves model configuration by forming grid, defining material properties of model, defining of section properties and assigning of it to model at specific location i.e. beam, column and slab. Loading and load combinations as per IS 1893:2002 (Part-I) and (IS 875-Part-I, II) are defined to model. Defining Time History function and Response Spectrum function as per analysis method used.

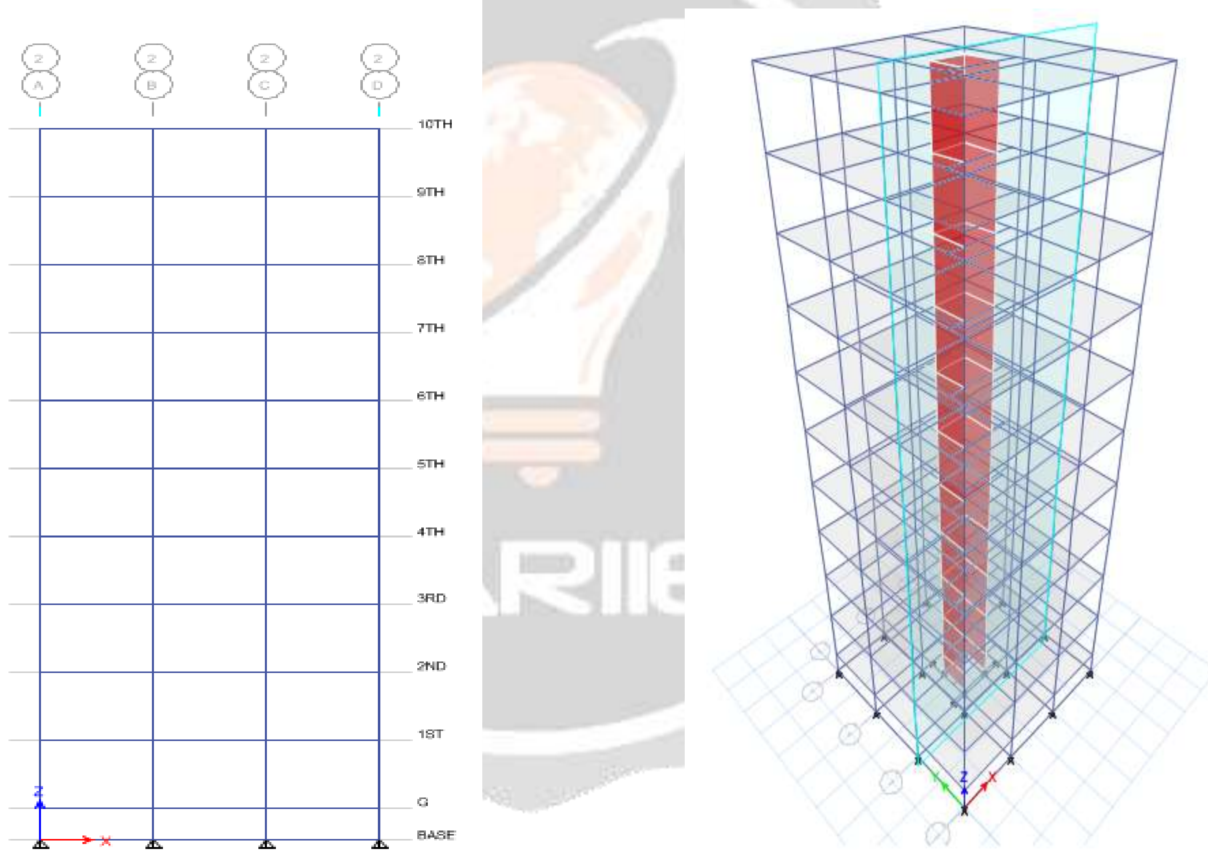

Fig1.
Elevation and 3D view of structure

3 cases of steel bracing in project

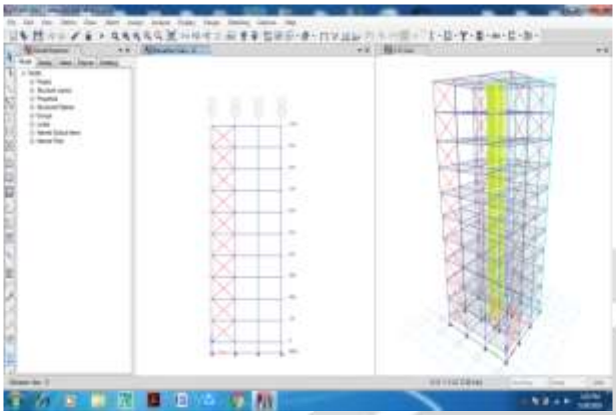

FIG2. TYPE 1 Steel bracing at left corner panel

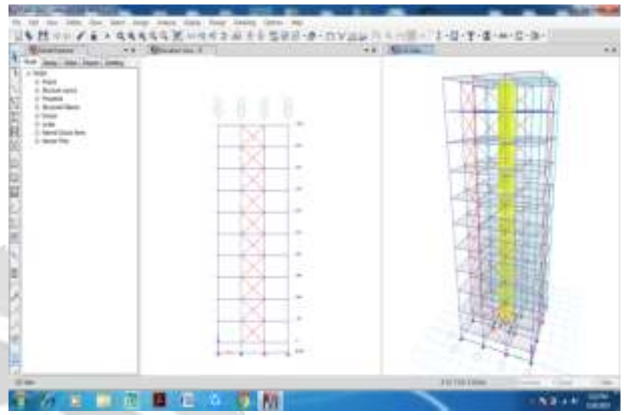

FIG3. TYPE 2 Steel Bracing at Mid panel

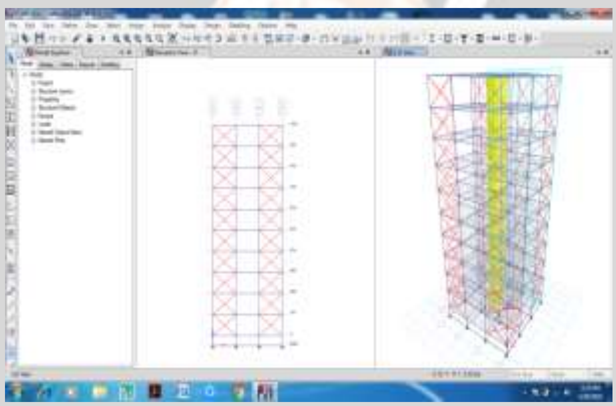

FIG4. TYPE 3 Steel Bracing at both the Exterior Panel

3. RESULT

1. LATERAL DISPLACEMENT

It is observed from the table that lateral displacement is reduced to very small extent for all type of bracing systems, while the displacement is maximum for the system without bracing. The displacement are reduced sequentially for bracing type 1, and 3. These pattern are observed due to increased stiffness provided by the respective bracings.

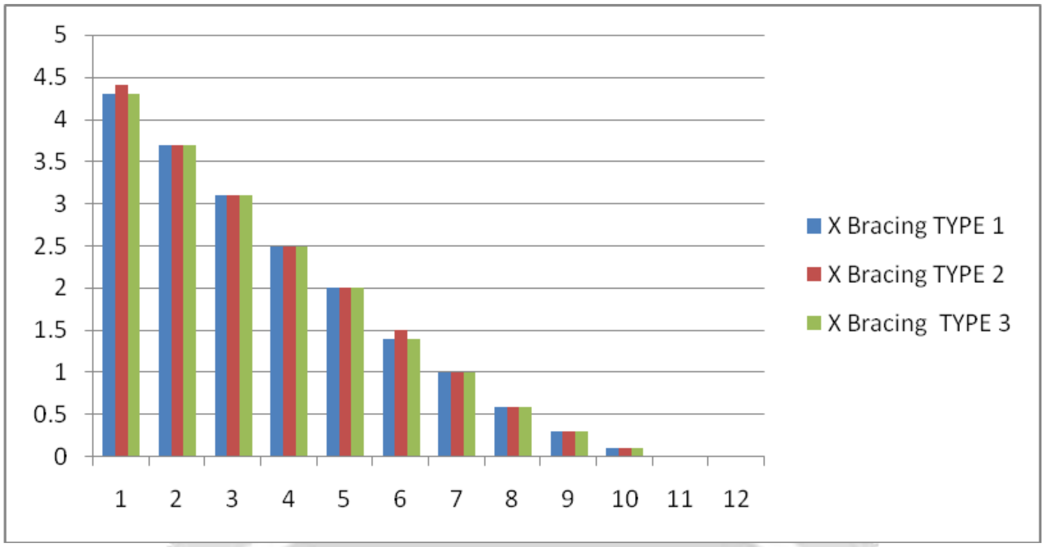

Fig5：Maximum Lateral Displaement in Y direction

2. STOREY DRIFT

It can be observed from the Table and graph that the story drifts are reduced to smallest extent from type 1 to type 3 bracing systems, while these are maximum for the system without bracing.

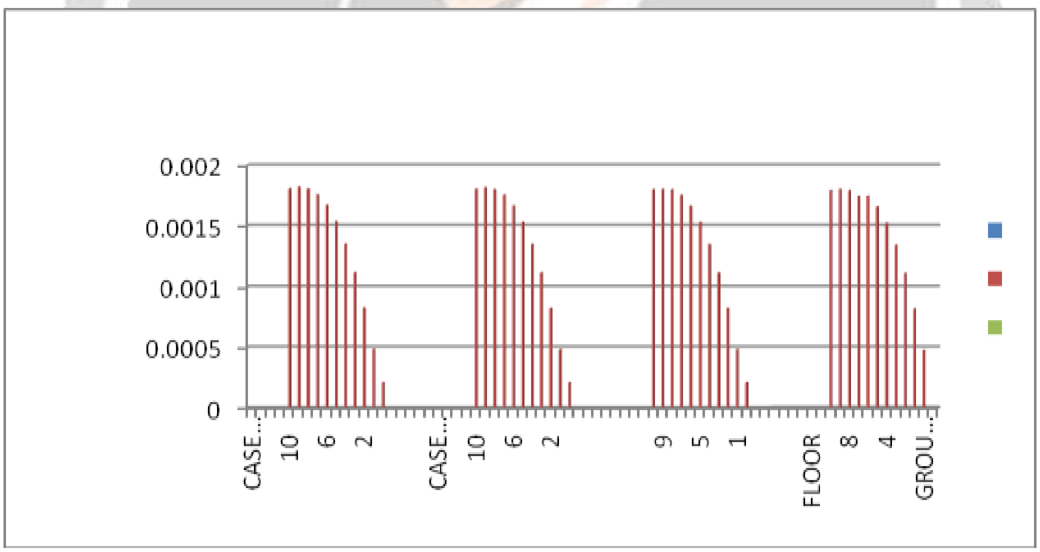

Fig 6: Storey drifts (m) in Y Direction for G + 10 building model

3. STOREY STIFFNESS

It is concluded from the graph and table that storey stiffness has increased slightly from type 1 to type 3. Also it can be seen that stiffness of the braced building has raised than, the stiffness of unbraced building.

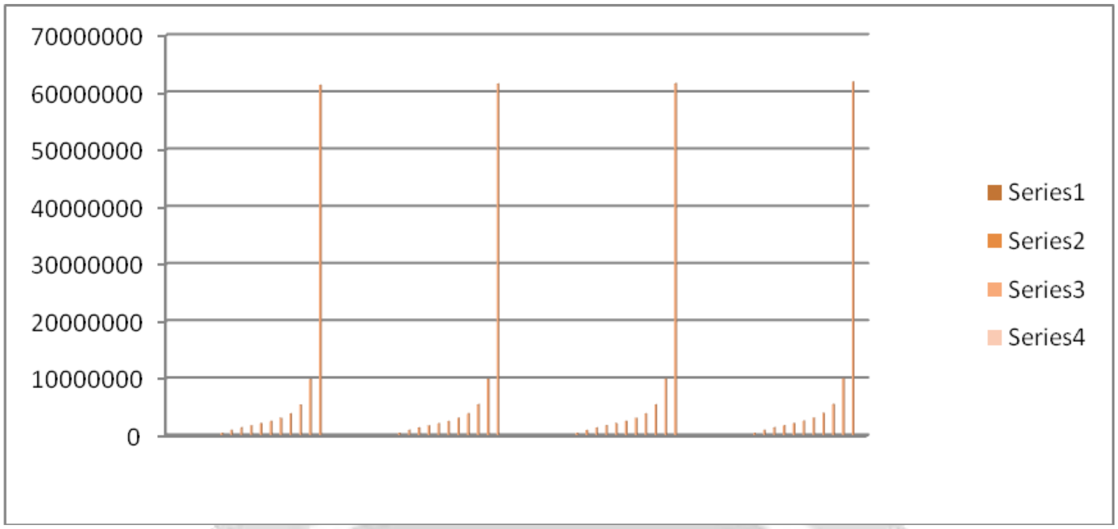

Fig7:Storey Stiffness in Y direction for G+10 building model

4. CONCLUSIONS

Analysis of RC multistoried building is carried out by using response spectrum method. Following conclusions are drawn based on present study.

1. The lateral displacement of building is reduced by the use of X type bracing system. But the variation in lateral displacement is not so far.
2. The displacement of the storey is gradually decreasing up to 8^{th} storey and then sudden decrease in displacement is observed in both the cases i.e. frame with bracing and frame without bracing.
3. Maximum storey drift is observed in building frame without steel bracing. And minimum storey drift is observed in third type bracing system i.e. bracing at both exterior panel. The difference of storey drift is 2.48%.
4. Storey stiffness has increased from type 1 to type 3. It is observed that storey stiffness has been increased from unbraced building to frame with bracing at two exterior panel. And the percentage of increment is 1.69%.
5. “Therefore finally it is concluded that the framed building with steel bracing at both the exterior end panels is having more strength than others and is preferable”

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