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Seismic Analysis of G+12 Residential Building in Lucknow (Zone 3) Region and Study of RC Jacketing Technique for Retrofitting

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Abstract - *This research will give a brief presentation about earthquake resistant design and the methodology about seismic analysis and retrofitting of existing structures. It also provides certain aspects of computer software modeling against seismic loads and shows the necessity of seismic upgrading in a G+12 frame building of Shalimar One World Residential Building in Lucknow.*

Generally, the structural retrofitting of Columns by Reinforced Concrete Jacketing improved the seismic resistance of the building and it can be considered in the retrofit of G+12 frame structures to prevent the risk of structural collapse under the design load with much more confidence.

To prevent the storey mechanism during earthquakes, columns should never be the weakest components in the building structure. The response of a column in a building structure is controlled by its combined axial load, flexure, and shear. Therefore, column jacketing may be used to increase column shear and flexural strength so that columns are not damaged.

***Key Words*: Seismic Analysis, Column Shear, Retrofitting, Jacketing, Damping Ratio, Flexural Strength, Storey Mechanism**

1. INTRODUCTION

Seismic analysis is a subset of structural analysis and is the calculation of the response of a building (or non-building) structure to earthquakes. It is part of the process of structural design, earthquake engineering or structural assessment and retrofit in regions where earthquakes are prevalent.

Retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes. With better understanding of seismic demand on structures and with our recent experiences with large earthquakes near urban centres, the need of seismic retrofitting is well acknowledged.

Prior to the introduction of modern seismic codes in the late 1960s for developed countries (US, Japan etc.) and late 1970s for many other parts of the world (Turkey, China etc.), many structures were designed without adequate detailing and reinforcement for seismic protection. In view of the imminent problem, various research works has been carried out.

The aim is at:-

- Upgradation of lateral strength of the structure
- Increase in the ductility of the structure
- Increase in strength and ductility

1.1 Objective

The objectives of this research are:

i. To investigate the effects of earthquake forces on buildings and literature search on earthquake resistant design.

ii. To evaluate the feasibility of seismic evaluation of buildings and advantages of applying the retrofit measures developed for strengthening.

iii. To analyze performance based design and compare different seismic analysis method.

To model a real building with a structural analysis software i.e. Staad Pro v8i and investigate the earthquake effects with different analysis methods prescribed in codes & standards and propose appropriate rehabilitation methods in terms of the performance.

1.2 Methodology

- The methodology adopted to perform the seismic analysis of the G+12 residential building frame structure requires an understanding of the seismic zones of India and the knowledge of structural modeling software Staad Pro. v8i.
- An in depth knowledge of Staad Pro. v8i software is required as the Building Frame structure is analysed in Staad Pro v8i by defining the beams and column sizes and further assigning the supports and assigning load definitions to the respective building structure.
- The post analysis data was obtained after the analysis of the structure in Staad Pro. v8i.

- The members of the building structure were analysed with seismic analysis by defining the zone, area and the reduction factors and seismic loads were assigned as per the Indian code – IS 1893-2002 (Part-1).

- Suitable Retrofitting strategy that is reinforced concrete jacketing is proposed for the columns that are failing in shear and flexure due to the earthquake impact loads.

2. RESEARCH AND FINDINGS

2.1 Building Modeling and Analysis

- The structure is a 12-storey frame of reinforced concrete beams and columns in X and Y directions. All stories have a height of 3m.

- The total height of the building above grade is 36 m.

Table -1: Loading Conditions on the structure in Staad Pro v8i.

Loads	Types of Load	Areas of Loading	Value of Loads (in kN/m)
Dead Load	Self Weight	Full Structure	-1
	Member Load	Main Walls	-15
		Partition Walls	-7.5
		Parapet Walls	-3.75
	Floor Load	0 – 36 (Y-range)	-5
Live Load	Floor Load	0 – 36 (Y-range)	-2

➢ Negative sign denotes that load is acting in downward direction.

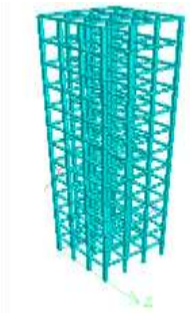

Figure -1: 3D Rendered View of the G+12 Structure in Staad Pro v8i

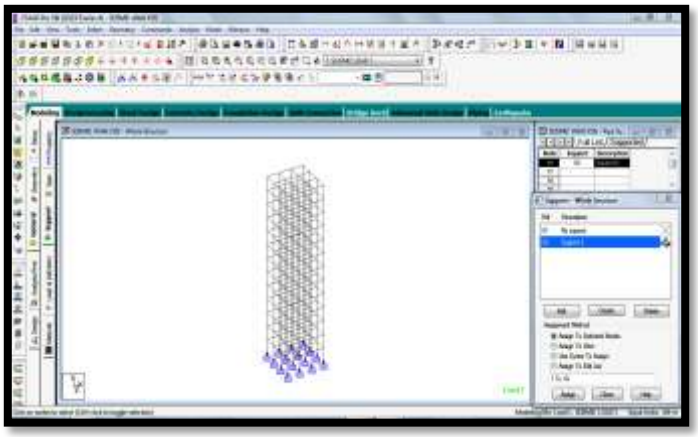

Figure -2: Defining Of Supports (Support Type: Fixed Support) of the G+12 Structure of Lucknow (Zone3) region in Staad Pro v8i

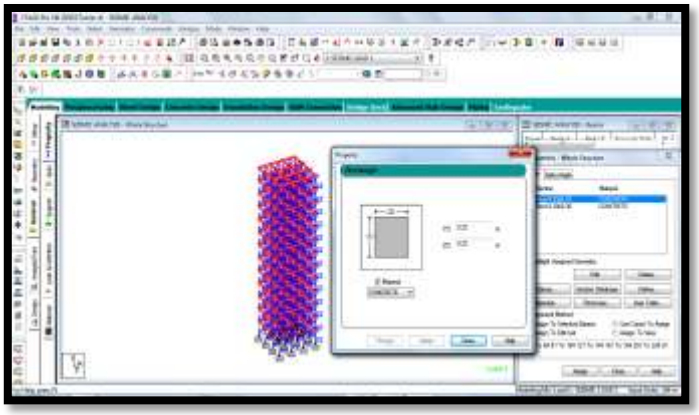

Figure -3: Defining of Property of the G+12 Structure of Lucknow (Zone3) region in Staad Pro v8i

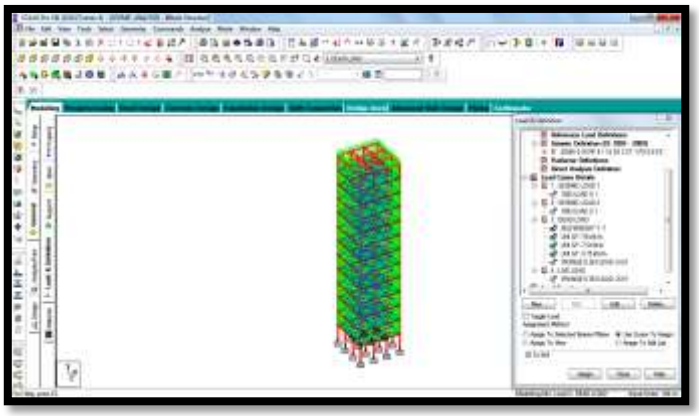

Figure -4: Imposing of Self Weight on the G+12 Structure of Lucknow (Zone 3) in Staad Pro v8i

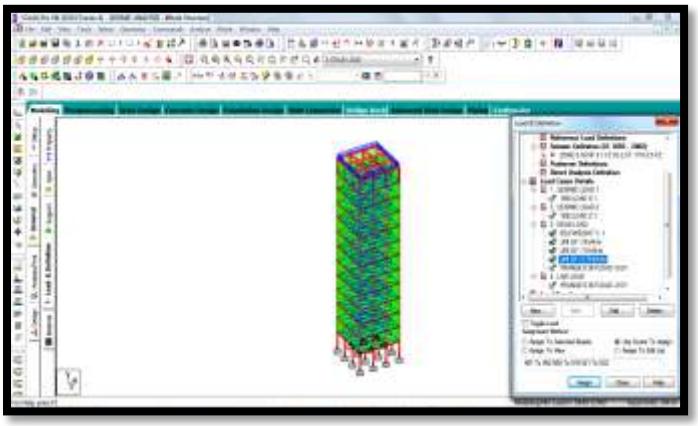

Figure -5: Imposing of Loading Conditions including Dead Loads, Live Loads, and Floor Loads on the G+ 12 Structure of Lucknow (Zone 3) region in Staad Pro v8i

Table-2: Seismic Loading Conditions on the G+12 Structure of Residential building of Lucknow (Zone 3) Region in Staad Pro v8i.

Type of Load	Seismic Load
Seismic Definition	IS 1893-2002
City	Lucknow
Building Type	Important Building
Soil Type	Medium Soil
Structure Type	RC Frame Building
Damping Ratio	5% (For Concrete)

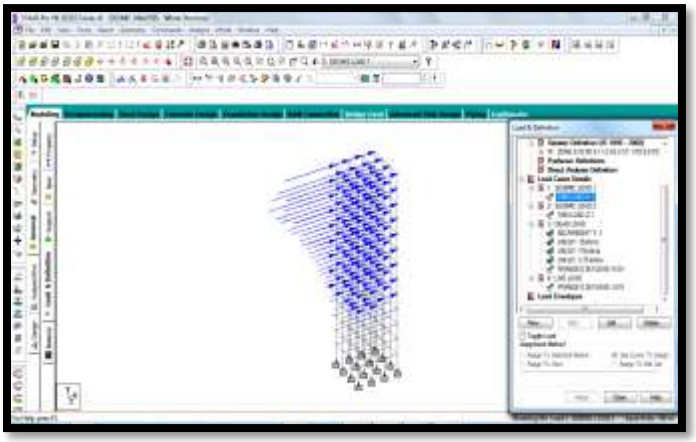

Figure -6: Seismic Load in X1 Direction on the G+12 Structure in Lucknow (Zone 3) in Staad Pro v8i

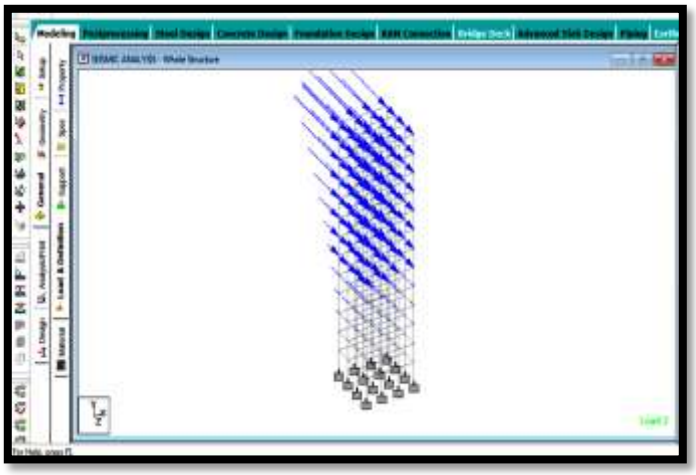

Figure -7: Seismic Load in Z1 Direction on the G+12 Structure in Lucknow (Zone 3) region in Staad Pro v8i

Initially the analysis was started by firstly designing the G+12 Residential Building frame structure of Lucknow (Zone 3) region on Staad Pro v8i, with 12 floors having height of 3m apart. Then defining of the property of the respective columns and beams in X,Y and Z direction was done by giving (0.23m*0.23m)cross section of beam for X and Z direction and (0.3m*0.3m) for Y direction that is the columns. Then further defining of Supports was done and fixed support was provided as foundation of the building structure.

Then imposing of the various different loading conditions was defined that includes the Dead Load, Live Load and Floor loads over the Main Walls, Partition Walls and the Parapet Walls of the respective building structure was done as per the values given in the Table-1.

Then Seismic Load was imposed as per IS 1893-2002 (Part-1) for the Medium type of soil and with a damping ratio of 5%(for concrete) which was in the X1 direction and Z1 direction of the building structure for Lucknow (Zone 3) region with values defined as per Table-2. At last Concrete design was done.

Finally the seismic analysis was carried out with that included analysis of all the members of the structure, their behaviour in shear and flexure.

3. RESULTS

After the seismic analysis, the results clearly indicated that most of failures are occurring on the columns of the building due to the horizontal displacement of the building and the building has an insufficient strength and displacement of the columns against the earthquake loads.

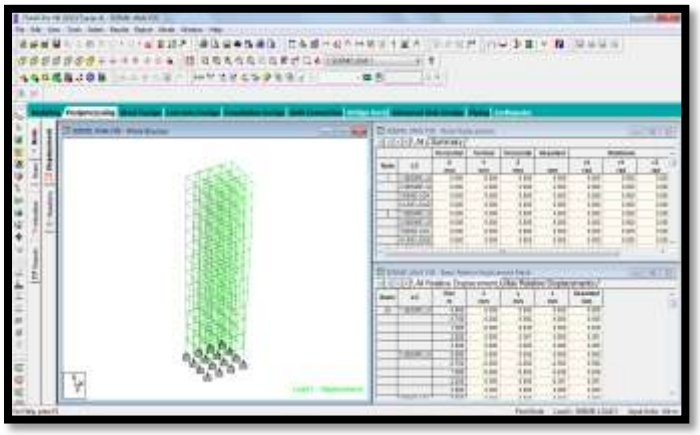

Figure -8: Results depicting the displacement of the G+12 Structure in Lucknow (Zone 3) region in Staad Pro v8i

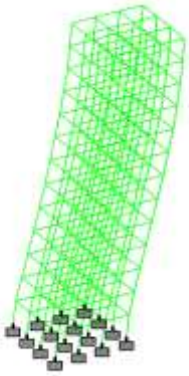

Figure -9: Lateral displacement of the G+12 Structure in Lucknow (Zone 3) region due to seismic load

3. CONCLUSIONS

The analysis on Staad Pro v8i plays a very important role for knowing the failures caused on the columns and beams due to shear and flexure. As in the analysis with defining of the dead loads and live loads, seismic loads are also defined according to IS 1893:2002(Part-1). So, in the results it shows that the columns of the G+12 residential building frame structure will face failures due to the lateral displacement and shear and flexure, as initially cracks are generated over the columns and further the column shall fail due to the seismic forces that are acting over the building. In order to overcome these failures in the column, we shall provide RC jacketing technique of retrofitting in the columns of the respective building that we have analysed.

Generally, the structural retrofit improved the seismic resistance of the building and it can be considered in the retrofit of moment frame structures to prevent the risk of structural collapse under the design load with much more confidence. This study shows how the RC jacketing can be used in order to reduce the failure of columns of the respective building. One of the most significant advantages of RC jacketing is that it makes the building resistant to high magnitude earthquakes and can give valuable information about performance of building in expected future seismic events.

RC jacketing is a compulsory retrofitting technique to be provided in the building so as to resist the loads due to earthquake on the columns of the respective building of *G+12 Residential Building of Shalimar One World, Lucknow.*

Figure -10: Depiction of RC Jacketing of Column as necessity for preventing the failure of columns in the building

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