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# SEISMIC EVALUATION & RETROFITTING OF MULTI-STORIED RC FRAME BUILDING

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**Abstract-** Earthquake is the most dangerous and unpreventable natural occurrence, wreaking destruction on buildings, resources, and people's lives. Earthquake loading is extremely variable and is determined by the length, magnitude, and frequency of seismic waves. The number of stories, soil–structure contact, stiffness, mass of the structure, vertical, plan, and tensional disturbances and re–entrant corners are all variables that influence how structures respond to earthquakes. Retrofitting is the process of strengthening and improving the efficiency of defective structural components or the whole building. The aim of retrofitting is to improve a building's structural integrity after or before an earthquake to achieve a predetermined level of efficiency. A retrofitted building's seismic strength is comparable to that of the original structure. Complete restoration will be prohibitively expensive. The total cost of redeveloping the house will be significantly greater than the cost of retrofitting.
In the present study a G+6 storey Hospital building retrofitting is carried out which is located in Karimnagar city Telangana State. The building was located in low seismic zone II the analysis is carried out by using SAP 2000 software by Response spectrum method. The results like joint displacements, lateral loads, shear, bending, torsion, time period and frequency values are compared with existing structure and retrofitting structure.

**Key words**: **Earthquake, Retrofitting, Seismic strength.**

## I. INTRODUCTION

Now-a-days Retrofitting is very important to the historical, public and private structures which become old and week due to flow of time. It is one of the best options to make an existing building safe against future probable earthquake or other environmental forces.

Retrofitting is the process of addition of new features to the older buildings, bridges, heritage structures etc. It reduces the vulnerability of damage of an existing structure during earthquakes. It is the modification of existing structures to make them more resistant to seismic action, motion of ground, and failure of soil due to earthquakes or other natural disasters such as tornadoes, cyclones, and winds with high velocity caused by thunderstorm, snowfall, hailstorms etc.

Retrofitting is a pattern of building advancements that includes all systems and materials to manage the developing event and seriousness of cataclysmic events and their effect on structures. Most of the buildings are designed to protect the structure from seismic loading condition to make the earth quake resistant building model. As a result, retrofitting has become a basic segment of peril decrease.

The expression "restoration" is likewise used to portray retrofitting particularly for seismic tremor perils.

Repair, Restoration, and Retrofitting have acquired the accompanying definitions in tremor designing phrasing:

1. Repair: Actions taken to fix corrective blemishes and complete the work
2. Restoration: Action taken to re-establish underlying part's missing force.
3. Retrofitting: Efforts to improve the tremor strength of a constructed structure. Accordingly, it would be better in case of possible tremors.

*Jacketing of columns*

Jacketing of columns involves adding black-top to the first columns and building up them longitudinally and dynamically which is shown in the figure 1 below. The hub and shear strength of columns are expanded, albeit the flexural strength of the column and the strength of the pillar column joints stay unaltered. It has likewise been found that jacketing columns would not improve their malleability. A critical advantage of column jacketing is that it expands the building's horizontal burden ability in a more predictable and scattered way, killing the amassing of solidness that happens with shear dividers. This is the way enormous base building will be forestalled. Moreover, since there are no critical alterations in the first calculation of the building for this technique, the first reason for the building can be protected. The jacketing of columns is generally done in one of two different ways.

**1.** Reinforced concrete jacketing
**2.** Steel jacketing

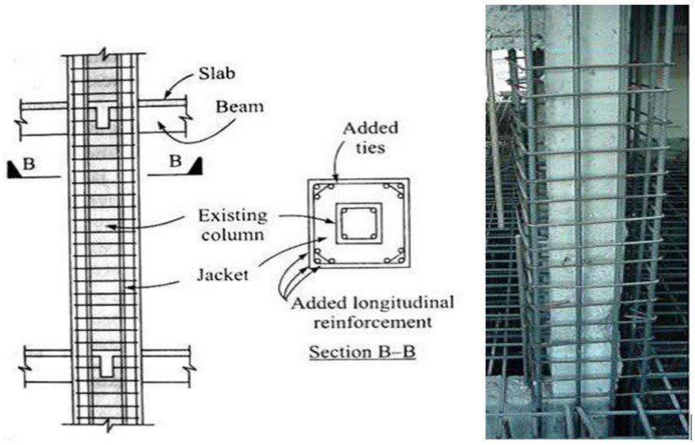



**Figure 1:** A jacketed column

## II. Methodology

The modular strategy, or mode superposition technique, is another name for this technique. It depends with the understanding that a building's response is a superposition of the responses of individual methods of vibration, with every mode reacting with its own twisted shape, recurrence, and modular damping.

Tall buildings and unordinary buildings should be assessed utilizing the arrangement spectrum approach utilizing the math spectra appeared in Figure, as indicated by IS-1893(Part-l):2002. With regards to gauging floats and member powers in primary designs, the response spectra approach of seismic analysis gives major insightful advantages. Utilizing smooth spectra that are the amount of numerous quake developments, the framework just computes the most extreme estimations of the floats and part controls in every mode. There should be sufficient modes to get at any rate 90% of the building's taking an interest mass (in both of two symmetrical hypothesis flat headings) for the estimation to be legitimate. The response spectrum curve for 5% damping is shown in the figure 2 below. Utilizing given building attributes and ground movement spectra, the investigation is performed to decide the base shear for every mode. The Story pressing factors, speed increases, and floats for every mode are then estimated and measurably found the middle value of utilizing the CQC blend.

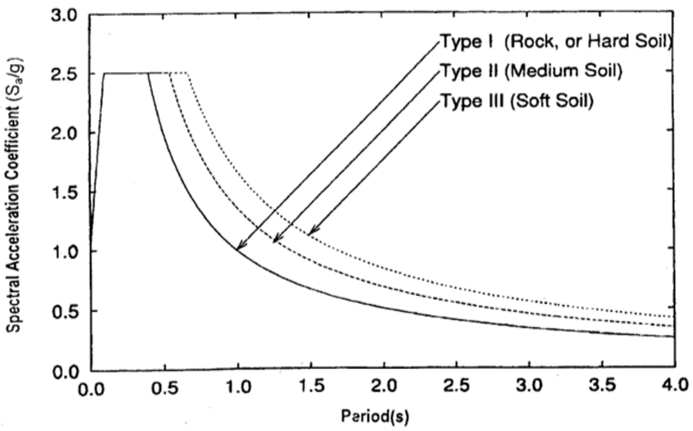



**Figure 2:** Response spectrum curve (IS 1893:2002 Code)

## III. Model specifications and Models in ETABS

The following are the basic data considered for analysis

| | | | |
|---|---|---|---|
| 1. | Height of typical Storey | = | 3 m |
| 2. | Height of ground Storey | = | 3 m |
| 3. | Length of the building | = | 79.2482 m |
| 4. | Width of the building | = | 17.67 m |
| 5. | Span in both the direction | = | 21 m |
| 6. | Height of the building | = | 120 m |
| 7. | Number of stores | = | 7 (G+6) |
| 8. | Wall thickness | = | 230 mm |
| 9. | Slab Thickness | = | 150 mm (for 1 to 4 floors) , 120mm(for 5 to 7 floors) |
| 10. | Grade of the concrete | | |
| a. | M 20 (for existing building) | | |
| b. | M40 (for retrofitting building) | | |
| 11. | Grade of the steel | | |
| a. | Fe 500 (for existing building) | | |
| b. | Fe 600 (for retrofitting building) | | |
| 12. | Support | = | Fixed |
| 13. | Column sizes | | |
| a. | 0.3mX0.3m, 0.65mX0.37m, 1mX0.37m ((for existing building) | | |
| b. | 0.4mX0.4m, 0.75mX0.5m, 1.2mX0.5m (for retrofitting building) | | |
| 14. | Beam size | | |
| a. | 0.27mX0.45m, 0.3mX0.35m, 0.37mX0.65m | | |
| 15. | Location of Building | = | Karimnagar City |
| 16. | Live load | : | 5 KN/$m^2$ |
| 17. | Dead load | : | 2 KN/$m^2$ |
| 18. | Density of concrete | : | 25 KN/$m^3$ |
| 19. | Seismic Zones | : | Zone 2 |
| 20. | Site type | : | II |
| 21. | Importance factor | : | 1.5 |
| 22. | Response reduction factor | : | 5 |
| 23. | Damping Ratio | : | 5% |
| 24. | Structure class | : | C |
| 25. | Basic wind speed | : | 44m/s |
| 26. | Risk coefficient (K1) | : | 1.08 |
| 27. | Terrain size coefficient (K2) | : | 1.14 |
| 28. | Topography factor (K3) | : | 1.36 |
| 29. | Wind design code | : | IS 875: 2015 (Part 3) |

30. RCC design code : IS 456:2000
31. Steel design code : IS 800: 2007
32. Earth quake design code : IS 1893 : 2016 (Part 1).

*2D Floor plan*

The below figure 3 shows the typical floor plan for the G+6 storey apartment building structure which is located in Karimnagar city, Telangana.

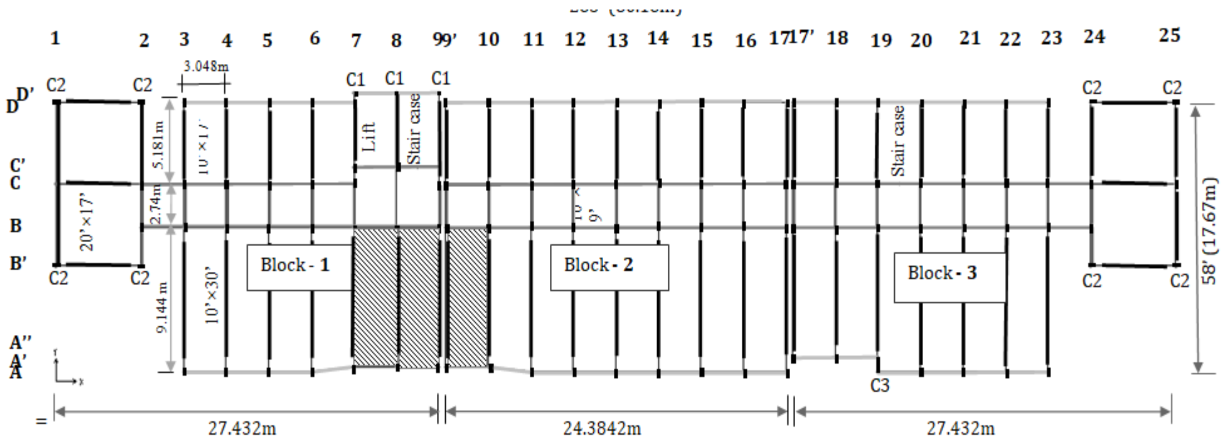



**Figure 3:** G+6 floors Building plan

*3D Model IN SAP 2000 Software*

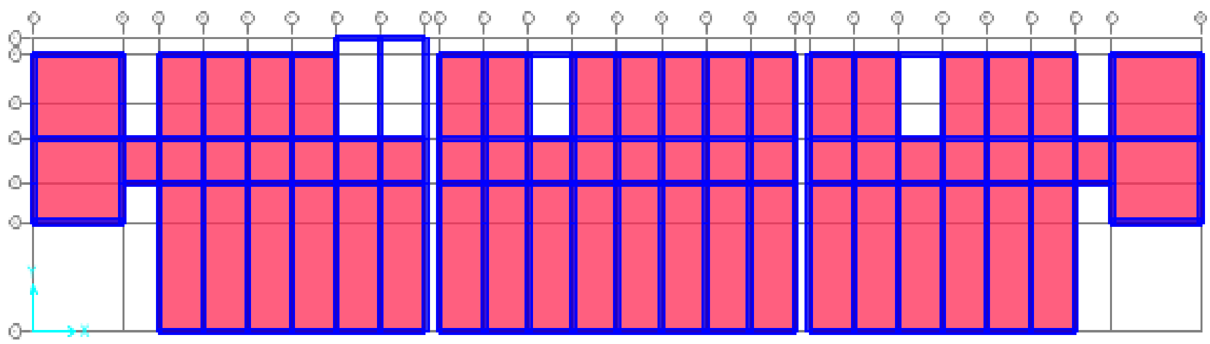


**Figure 4:** Top view of G+6 Building in SAP 2000 Software

The above figure 4 shows the top view of G+6 hospital building which is modeled in SAP 2000 software

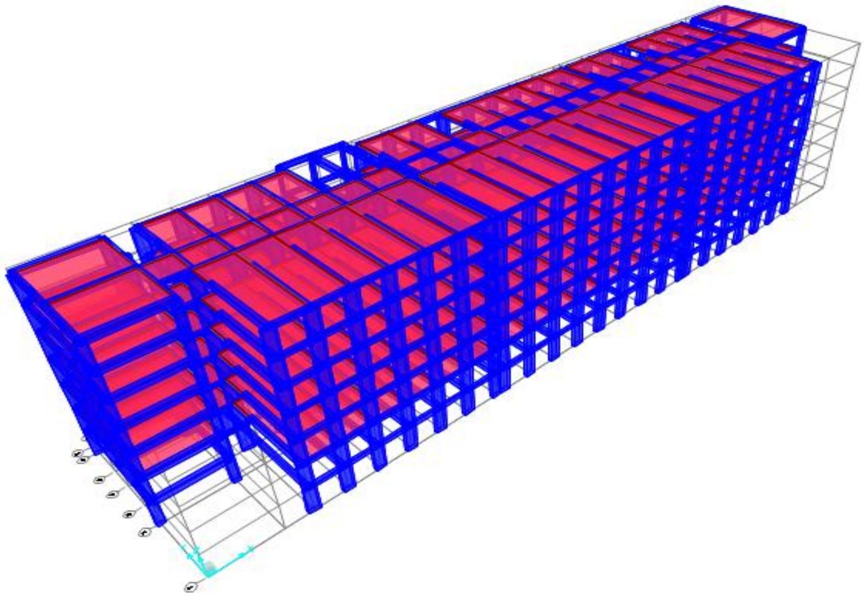
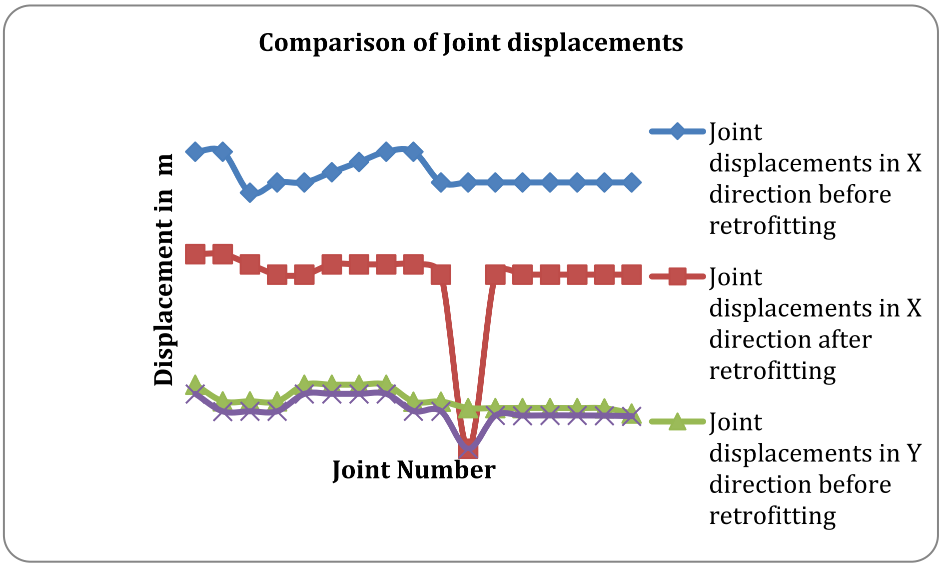


**Figure 5:** 3D Model in SAP 2000 Software

The 3D model of G+6 hospital building is shown in the above figure 5 which analyzed by using response spectrum analysis in SAP 2000 software package.

## IV. RESULTS AND ANALYSIS

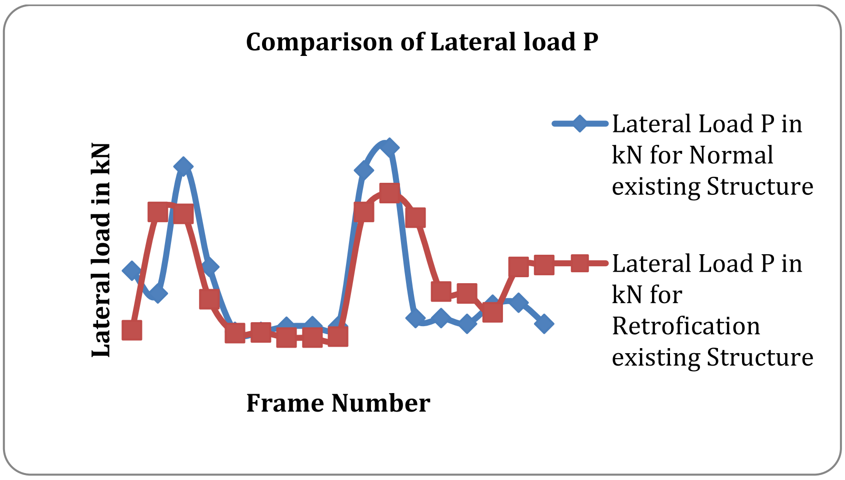
*Joint displacements*




**Graph 1:** Comparison of joint displacements

Joint displacement for G+6 hospital building with and without retrofitting in X direction and Y direction is shown in the above graph 1 from the graph it was observed that the seismic loading action is high in case of X direction than Y direction due to that reason the joint displacement is higher in X direction where in case of Y direction the seismic loading action rate is less for with retrofitting than without retrofitting.

*Lateral Load P*

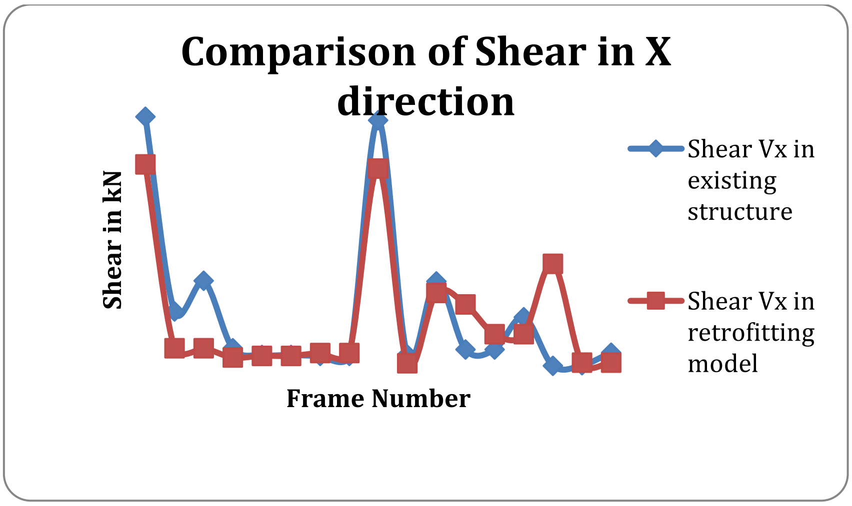



**Graph 2:** Comparison of Lateral load P

Lateral loads are live loads that are applied parallel to the ground; that is, they are horizontal forces acting on a structure. They are different to gravity loads for example which are vertical, downward forces. The most common types are wind load, seismic load and water and earth pressure. The above graph 2 shows the comparison of lateral loads for both with and without retrofitting building models, the loading rate is some higher in case of normal existing structure than retrofitting building model for G+6 hospital building.

*Storey Shear:*

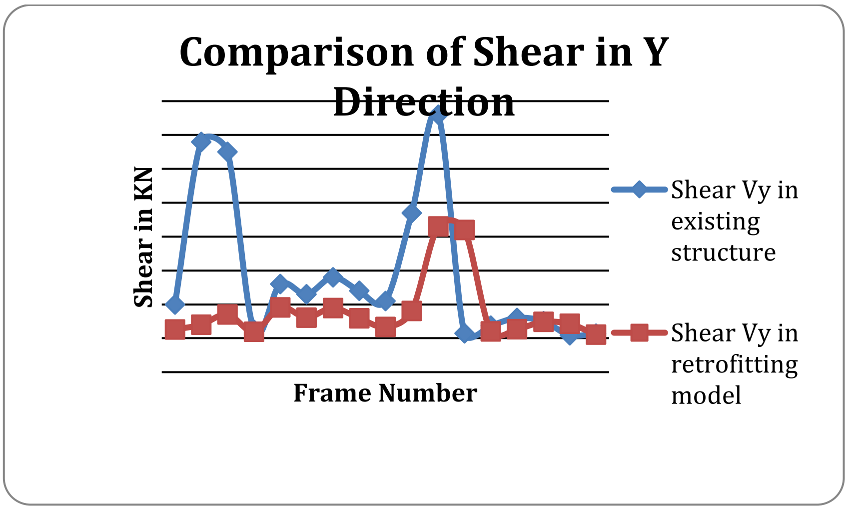
*X Direction*




**Graph 3:** Comparison of shear in X direction

A shear force is a force applied perpendicular to a surface, in opposition to an offset force acting in the opposite direction. This results in a shear strain. In simple terms, one part of the surface is pushed in one direction, while another part of the surface is pushed in the opposite direction. The graph 3 shows the shear in X direction for existing building and retorting building models it has almost same values for both the cases for frames 1 to 17.

*Y Direction*

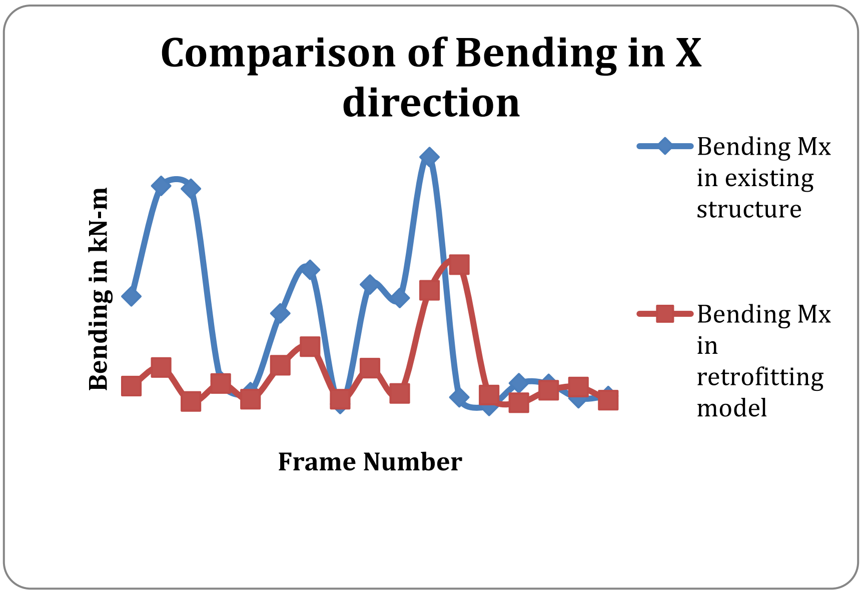



**Graph 4:** Comparison of shear in Y direction

The comparison of shear in Y direction is shown in the graph 4 from these results it was concluded that the Shear force has higher values in Y direction for the existing building than the retrofitting building model for G+6 hospital structure.

*Storey Bending:*

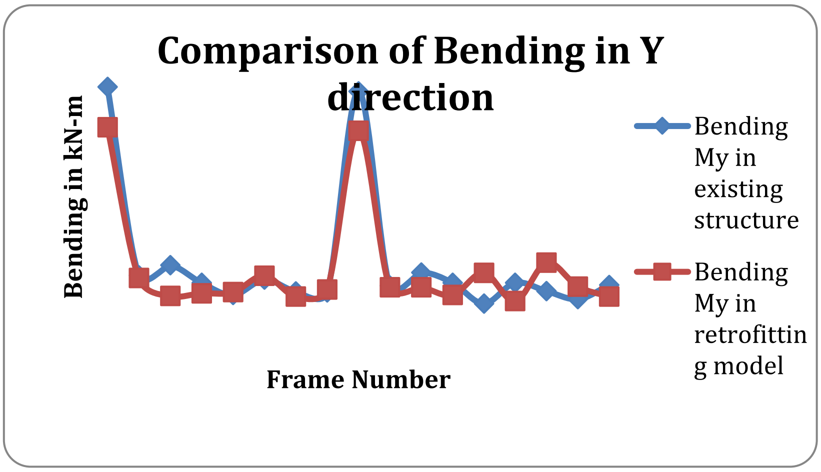
*X Direction*




**Graph 5:** Comparison of Bending in X direction

The force or load applied that tends to bend floor joists. The bending moment cannot induce stress in the floor joists that exceed the strength of the floor joists or they will fail. The comparison of bending in X direction is shown in the graph 5 from these observations it was concluded that in X direction the existing building structure has higher values of bending for existing model than retrofitting building model.

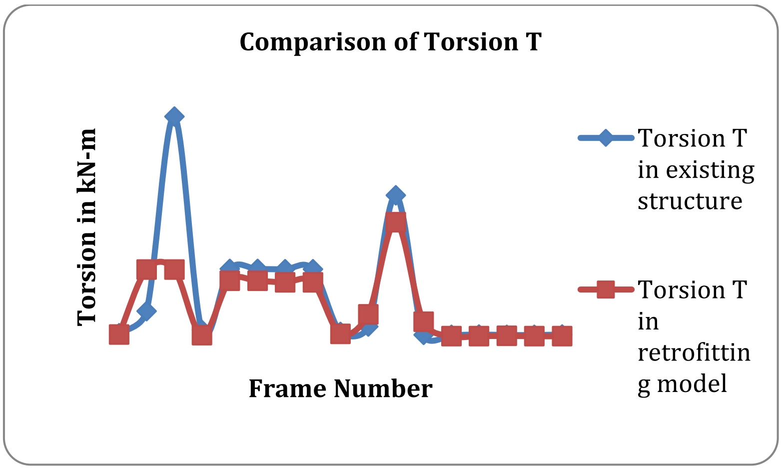
*Y Direction*




**Graph 6:** Comparison of Bending in Y direction

The comparison of bending in Y direction is shown in the above graph 6 from this graph it was observed that the bending in Y direction has same values for the two cases which is related to the existing model and reroofing building model for G+6 hospital structure.

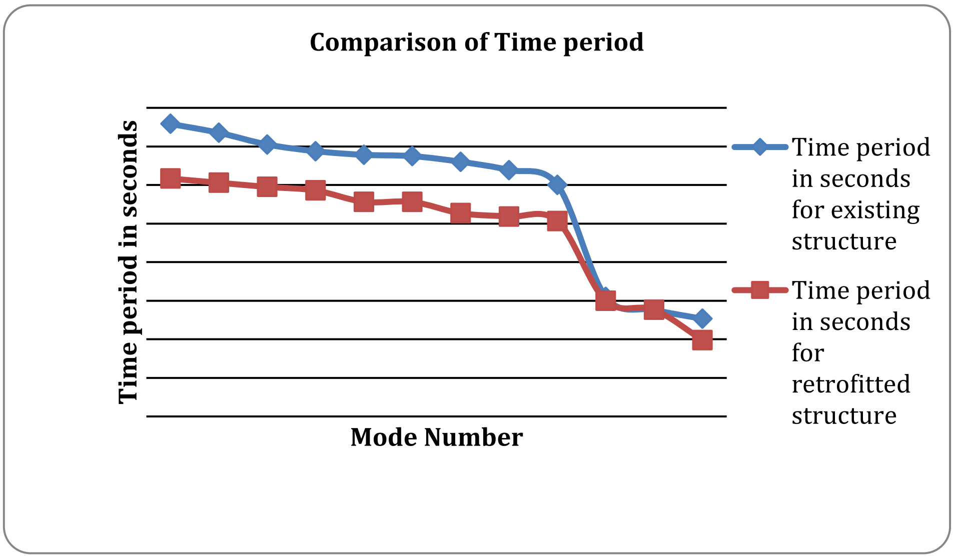
*Building Torsion*




**Graph 7:** Comparison of Torsion

Torsion is the state of strain in a material that has been twisted by an applied torque. It will occur whenever a structural element is subject to a twisting force. Torsion can be seen in a circular-section rubber bar inscribed with rectangles and which is held at each end, with one hand twisting in relation to the other: the rectangles become skewed or distorted. The state of strain that has distorted the rectangles is called torsion and consists of pure shear. The analysis results for building torsion is shown in the above graph 7 from this comparison it was concluded that torsion for existing building model is high when we compared with retrofitting building model.

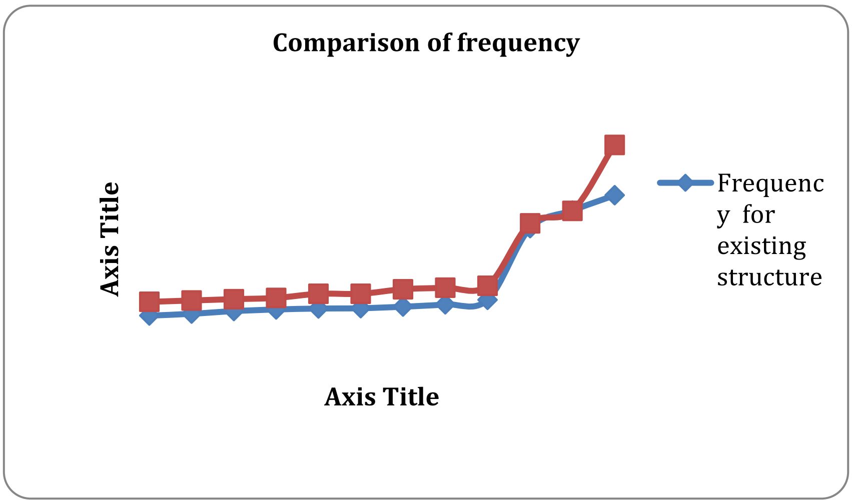
*Time Period*




**Graph 8:** Comparison of Time period

Time period plays an important role in design of earthquake resistant structures. As per the codes such as Indian code (IS), United States (US) and Egyptian codes and as per the recommendations provided in many researches, the fundamental period of vibration is estimated by considering the overall height of the building or by the number of stories. From the above graph 8 it was conclude that for the existing building model the time period values is high when we compared with retrofitting structure.

*Frequency*




**Graph 9:** Comparison of frequency

Natural frequencies and modal damping ratios of buildings for vibration tests or vibration observations are important to grasp, and those various behaviors are also significant. The evaluation methods of natural frequencies are almost established; however the modal damping ratios cannot be evaluated accurately in these days. The comparison of frequency values for both existing structure and retrofit structure is shown in the above graph 9 the frequency values are increasing from node 1 to node 12 for both the cases and it has higher values for retrofit model.

## V. CONCLUSIONS

1. After a thorough bibliographical analysis and modification of numerous Indian engineering projects for structure retrofit, it very well may be induced that there are a few diagrams that aid the plan of a construction retrofit conspire utilizing concrete jacketing, subjectively as well as quantitatively.
2. Retrofitting such associations with built up concrete (RC) jacketing is a practical alternative. The utility of the RC jacketing procedure for reinforcing delicately fortified pillar column joints is tried tentatively in this article.
3. A full-scale delicately supported solid shaft column subassembly was improved by projecting a RC coat outside the column and the joint, and the expansion in the cyclic response of the example achieved by the retrofitting procedure was tentatively tried.
4. Response spectrum analysis is utilized in the re-enactment of the G+6 house, which is performed utilizing SAP 2000 programming.
5. As contrasted with the old medical clinic house, the uprooting, shear, bowing, twist, and time cycle esteems are lower when utilizing the retrofitting interaction.

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