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Health Monitoring of a Hospital Building Using NDT Technique Considering Seismic Load

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ABSTRACT

Seismic retrofitting is mainly done to meet the seismic safety requirements. The planning of modifications to existing buildings contrasts from new planning through a significant condition; the existing development must be taken as the premise of all planning and building activities. India is one of the most earthquake inclined nations on the planet and has encountered a few significant or moderate earthquakes during the most recent 15 years. Around 50-60 % of the absolute zone of the nation is defenseless against seismic movement of shifting forces. A live project (Hamidia Hospital old building) of G+2 existing old structure, structure is modelled and analyzed in Staad.Pro with existing strength determine from NDT and then providing extra columns, thickness and struts at places where strength is at failure. Comparative analysis is done in between the existing structure and the proposed structure which can easily overcome the failures seen by existing structure proven in the results of NDT. It is seen that with the procedure of retrofitting, the soundness of a structure can be recovered without disassembling the structure utilizing fortifying steady individuals.It is even seen that the retrofitting method can be 88.64% cost effective than destroying and developing another structure. Product examination and site test work can be joined for the advancement of the framework, as done in this investigation where we decided the quality of the structure utilizing NDT (Non-destructive testing) though displaying and checking quality improvement should be possible utilizing investigation apparatus staad.pro.

Keywords*: Retrofitting, NDT, Staad.Pro, Axial Force, Storey Displacement, Shear Force, Bending Moment.*

INTRODUCTION

Seismic retrofitting is mainly done to meet the seismic safety requirements. The planning of modifications to existing buildings contrasts from new planning through a significant condition; the existing development must be taken as the premise of all planning and building activities. India is one of the most earthquake inclined nations on the planet and has encountered a few significant or moderate earthquakes during the most recent 15 years.

Around 50-60 % of the absolute zone of the nation is defenseless against seismic movement of shifting powers. Many existing buildings don't meet the seismic quality necessity. The requirement for seismic retrofitting of an existing building can emerge because of a few reasons like: building not intended to code, consequent refreshing of code and configuration practice, resulting overhauling of seismic zone, crumbling of solidarity and maturing, alteration of existing structure, change being used of the building, and so on. Seismic retrofit is essentially applied to accomplish open wellbeing, with different degrees of structure and material survivability dictated by financial contemplations. Lately, an expanded direness has been felt to fortify the insufficient buildings, as

a feature of dynamic debacle relief, and to work out the adjustments that might be made to an existing structure to improve the auxiliary execution during an earthquake. In this proposed work we are considering a live project of G+2 existing old structure, structure is modelled in staad with existing strength determine from NDT and than providing extra columns, thickness and struts at places where strength is at failure.

Chiefly retrofitting depicts the measures taken in the assembling business to permit new or refreshed parts to be fitted to old or obsolete congregations (like edges to wind turbines).

The generation of retrofit parts is fundamental in make when the plan of a huge get together is changed or overhauled. In the event that, after the progressions have been actualized, a client (with an old adaptation of the item) wishes to buy a new part at that point retrofit parts and gathering procedures should be utilized so the reexamined parts will fit appropriately onto the more seasoned get together.

Retrofitting is a significant procedure utilized for valves and actuators to guarantee ideal activity of a mechanical plant. One model is retrofitting a 3-route valve into a 2-way valve, which brings about shutting one of the three openings to keep utilizing the valve for certain modern frameworks. Retrofitting can improve a machine or framework's general usefulness by utilizing progressed and refreshed hardware and innovation, for example, incorporating Human Machine Interfaces into more established production lines. Another case of this is vehicle altering, where more established vehicles are fitted with new advancements: control windows, voyage control, remote keyless frameworks, electric fuel siphons, and so forth.

Fig. 1. Retrofitting

OBJECTIVES

These following are the primary objective of our research work:

1) To determine the strength of an existing old structure using NDT (rebound hammer).
2) To determine the effect of composite member on an old structure strengthening.
3) To evaluate the present condition of Hamidia hospital block 2 using rebound hammer.
4) To evaluate seismic assessment impact on hospital building for Zone II using analysis tool.
5) To determine the weakest portion of the structure and propose suitable retrofitting technique

LITERATURE REVIEW

Disasters per se have been dealt by management experts, government and semi-government agencies in the past and the role of engineers has been mostly relegated to retrofitting and strengthening

post disaster. Most international codes have now started addressing the situation as disasters are occurring at a higher frequency across the globe. Traditionally declared disaster prone zones are ever expanding into new domains. Thus awareness among engineers, architects and equally among non-engineers has increased and resulted into various alternatives for mitigation and prevention aspects.

Available literature examines individual aspects of each disaster. International guidelines describe the methodology that can be adopted for structural analysis and design for earthquakes, but there is no standardized protocol for other disasters. Thus it is difficult to truly handle the complex dynamics of real-time forces of earthquake, wind, fire or flood. Proprietary software on the other hand leave very little scope of flexibility to incorporate specific aspects of forces that could have disastrous effects. Once again the catch in available software is the modeling effort and the assurance of a robust model depicting the real life situation.

Thus both literature and software do not enable the engineer to have, on hand, a mechanism of finding a solution to his customized needs nor to study the effects in a post processor instead of tabulated or two-dimensional graphical outputs.

Besides, there has been no attempt at mirroring the outputs in a virtual environment which would show the actual behavior of the building in a real-life manner. Studies have thus been highly focused on addressing the structural aspects of various disasters.

The review of such available literature for the current research is presented here in nine major parts:

1) Pushover technique for performance based analysis of buildings.
2) Damage and retrofit options for seismic forces
3) Virtual reality in structural engineering
4) Structural aspects of mitigation of cyclonic wind.
5) Structural alternatives for mitigation of flood effects
6) Fire loads on structures
7) Damage and repair for Blasts and Tsunami
8) Structural alternatives for mitigation of flood effects

Previous Researches on the Performance of RC Structures

Premalatha and Lakshmipriya (2018) An analytical study on seismic retrofitting of a reinforced concrete Beam-column joint was performed using FEM modeling. The main objective of this study is to increase the shear capacity and load carrying capacity of the structures using retrofitting techniques.

In this study, the retrofitting was done by jacketing methods like carbon fibre reinforced polymer sheets (CFRP), Glass fibre reinforced polymer mesh, Sisalfibres along with crossed bars are carried out using the ANSYS Workbench. The wrapping of beam column joint was done by single, double, triple layer of CFRP, GFRP and Sisal fibres with different thickness.

During the analysis one end of the column were fixed. Cyclic loading was applied at the free end of the cantilever beam in Beam-column joint and Fixed load was applied at the top of the column. The load is applied up to the ultimate load to obtain the fatigue failure. This report discusses about the performance of the retrofitted beam column joint; and was compared with the conventional specimen.

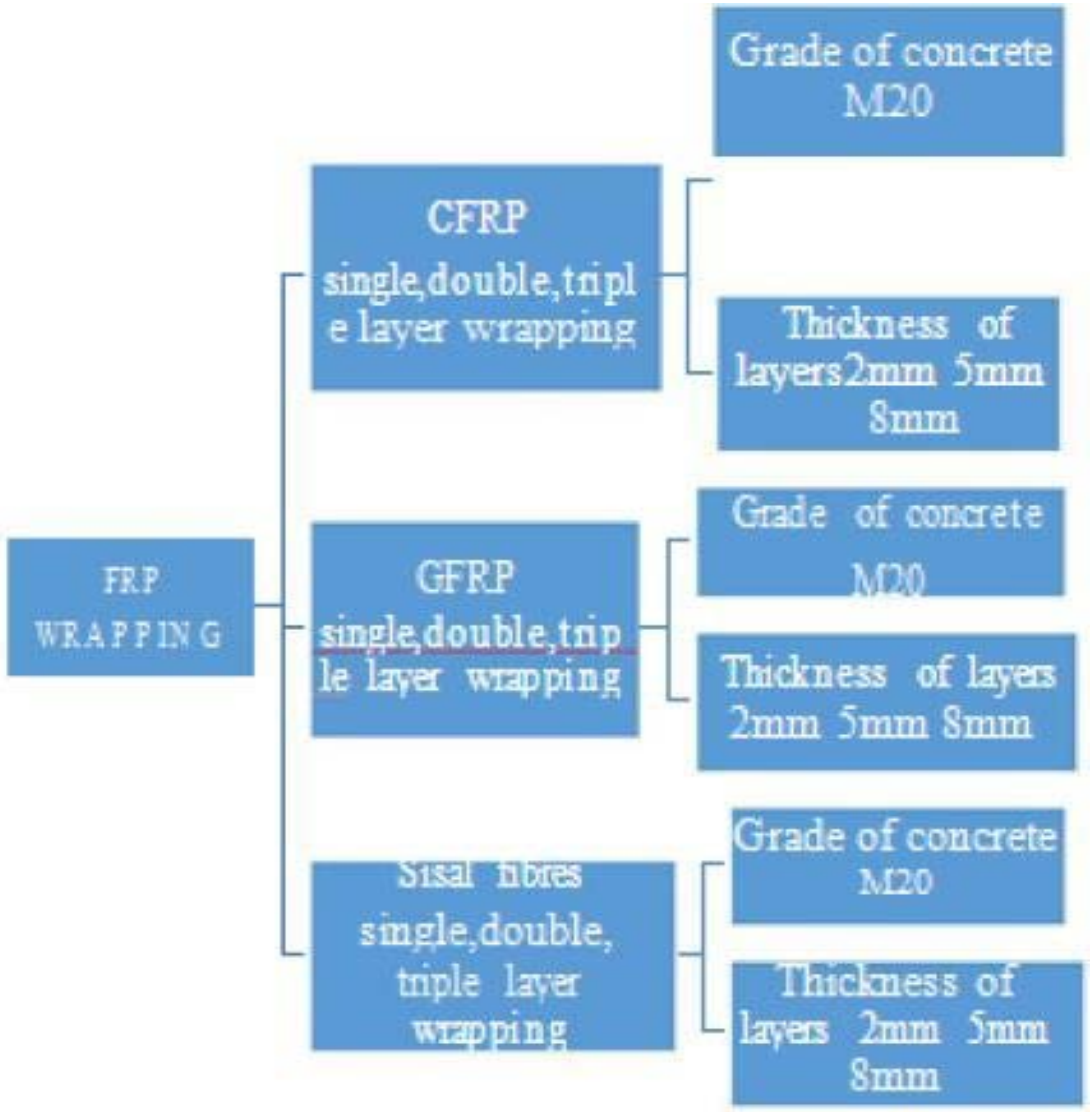


Fig. 2. Flow Chart of Modeling using FRP Wrapping

S.no	Specimen	No. of layers	Thickness (mm)	Ultimate Load (kN)	Deflection (mm)
1	Conventional	-	-	380	67.613
2	Conventional with Cross bars	-	-	395	59.028
3	CFRP	1	3	389	59.205
4	GFRP	1	3	385	67.188
5	Sisal Fibres	1	3	383	68.125
6	CFRP	2	5	401	58.677
7	GFRP	2	5	394	67.305
8	Sisal Fibres	2	5	389	67.602
9	CFRP	3	8	418	58.109
10	GFRP	3	8	403	66.449
11	Sisal Fibres	3	8	396	66.012

According to the analytical study and FEM modeling of RCC Beam-column joint with CFRP, GFRP, Sisal fibres wrappings along with cross bars using ANSYS software described in this study, the following conclusions are drawn:1. The FEM modelling of RCC Beam-column joint with FRP wrapping along with cross bars was developed using ANSYS software. 2. The Ultimate load carrying capacity is increased up to 15% after the utilization of the FRP wrapping. 3. Significant increase in strength was observed with increase in thickness of the FRP sheets. 4. When compared with the conventional beam column joint, its stiffness was increased by providing CFRP wrapping.

Tsige and Zekaria (2018) broke down an office medium ascent building for earthquake power by thinking about three kind of basic framework. for example Exposed Frame framework, in part infilled and completely Infilled outline framework. Viability of workmanship divider has been was contemplated with the assistance of five unique models. Infills were displayed utilizing the equal swagger methodology. Nonlinear static examinations for sidelong loads were performed by utilizing standard bundle ETABS, 2015 programming. The correlation of these models for various earthquake reaction parameters like base shear versus rooftop relocation, Story uprooting, Story shear and part powers are done, discovered that the seismic interest in the uncovered casing is impressively more when infill firmness isn't taken with bigger removals. It has been inferred that completely infilled outline is around 15% more contrasted with exposed casing model; outline with 25% brick work divider diminished is almost 10% more contrasted with the uncovered casing; outline with half of the workmanship divider diminished is about 8% more contrasted with the uncovered edge and edge with 75% of the stone work divider diminished is about 5% more contrasted with the uncovered casing. This is on the grounds that the exposed edge models don't account the solidness rendered by the infill board, it gives essentially longer timespan.

Mayorca *et. al.* (2004) Seen that Masonry structures are generally utilized because of its minimal effort and development effortlessness particularly in creating nations. Regardless of the endeavors to give rules to the development of sound earthquake safe houses, each year setbacks due to falling stone work houses during earthquakes are accounted for. Despite the fact that plainly retrofitting the existing lodging stock is pressing, effective crusades situated toward this path are rare or inexistent. To defeat this circumstance, retrofitting strategies including modest development materials accessible in remote locales and low-expertise work just as forceful instructive crusades are required. This paper displays an imaginative retrofitting technique for brick work houses, which comprises of utilizing polypropylene groups masterminded in a work style and implanted in a mortar overlay. These groups, which are normally utilized for pressing, are safe, reasonable, sturdy and worldwide accessible. So as to confirm the reasonableness of the proposed strategy, a progression of brick work dividers, with and without retrofit, were tried under in-plane burdens. Despite the fact that the retrofitted divider top quality was nearly equivalent to that of the exposed divider, its post-top quality was bigger and continued for sidelong floats over 2%. So as to research the proposed retrofitting highlights for various material properties and work setups, numerical reproductions dependent on a discrete demonstrating approach were performed. The impacts of the band work pitch and

association circulation joined with various stone work types were inspected.

U.Akguzel *et. al.* studied thatthe latest research findings into the effects of multiaxial loading on the seismic performance of as-built and FRP retrofitted three-dimensional (3D) beam-column joints with and without floor slabs are presented. For this purpose, the experimental results of four 2/3 scale, deficient RC beam-column joints are presented and conclusions are drawn on the basis of observed global and local performance. Special emphasis is given to the feasibility and efficiency of a retrofitting intervention using glass fibre reinforced polymer (GFRP) composites. A performance-based retrofit approach is adopted with attention given to the targeted specific limit states or design objectives. In addition, a numerical study is presented to calibrate and develop versatile finite element (FE) model, based on microplaneconcrete, to simulate the response of the 3D corner as-built joint under bidirectional loading with concurrent varying axial load and compared with the experimental results.

AmlanK.Sen Gupta et. al. studied live case of three storeyed building and provided shear walls, infills bracings etc to enhance structure strength and determined that all these global retrofitting techniques are improving structure stability.

The behavior of beam-column joints in plane frames under seismic loading has been extensively investigated by experimental testing since the 1960`s. Most of these studies were undertaken with the aim of verifying the design of new space frame joints, whilst there has been far less experimental investigation into the behaviour of under-designed (*e.g.* following older code of practice when compared to current one and prior to capacity design principles were introduced) beam column joints in space frames either in as-built or retrofitted configurations

Methodology
Proposed steps are as followings:

Step 1: Selection of the geometry of superstructure by using coordinate system in STAAD Pro or plot over the AUTO CAD, which can be import in Staad-Pro as per dimension of beams, c/c distance of columns, expansion to expansion distance and no. of diaphragm etc. Schematic sketch of the superstructure.

Step 2: building as per existing strength is modelled and one model with retrofitting is prepared of same dimension and same loadings as per Indian standards. Finite element modeling of the model considering the above parameters.

Different types of cases considered are as follows:
Existing Building

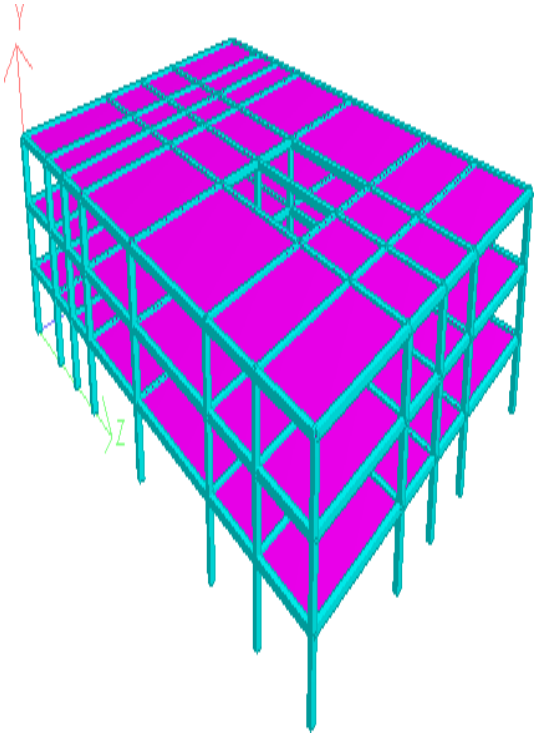


Fig. 3. Existing Building

Retrofitted Building

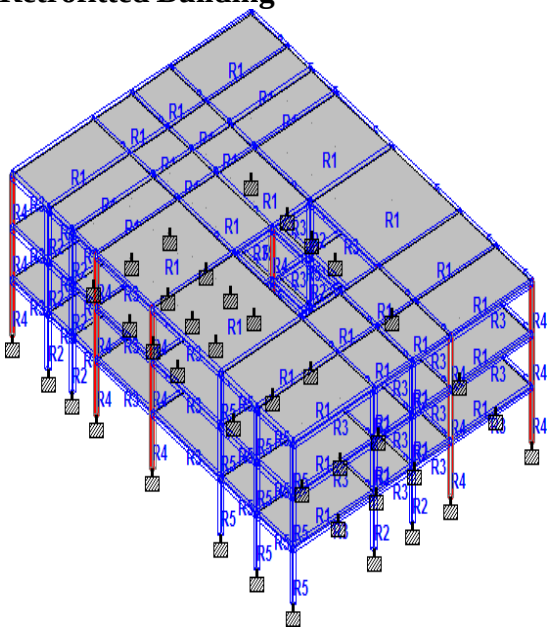


Fig. 4. Retrofitted Building Structure

In retrofitting technique we are assigning composite steel tubular sections for strengthening the existing weak structure.

Step 3: Computation of existing culvert strength by N.D.T. rebound hammer method to determine its present condition

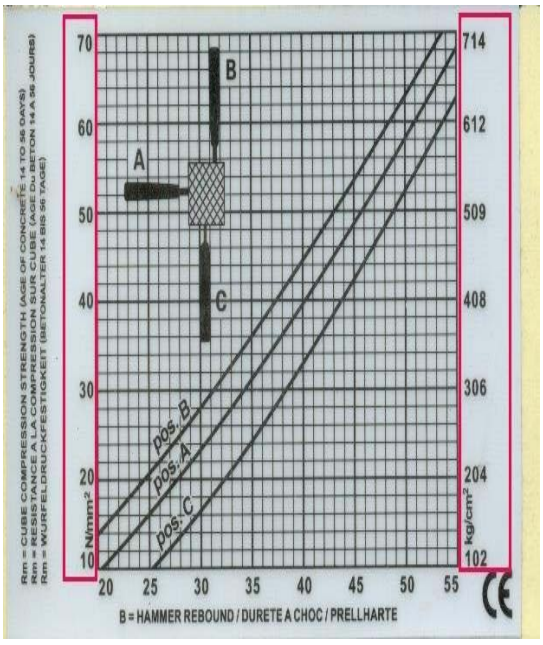


Fig. 5. Rebound Hammer Graph

Step 4: Modelling in staad for same strength and apply the material property, after that support condition has been considered at the bearing locations of the superstructure which is pinned / hinged

Step 5: After apply the support condition, now the next step to be considered for the Dead Load of the superstructure i.e. “self weight”.

Step 6: After apply the Dead Load, now the next step to be considered for the **Superimposed load**.

Step-7 Selection of Seismic zones (Zone II) and medium type soil as per IS- 1893(part I) -2016.

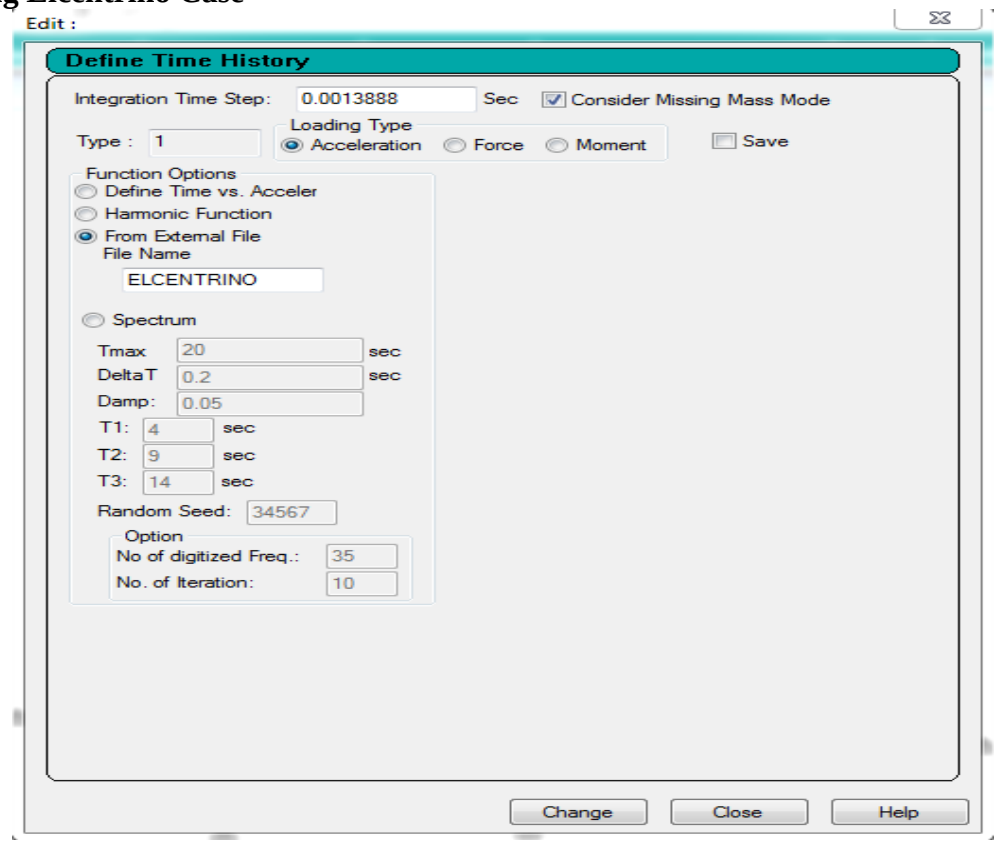
Step-8 load combination as per 875-part-V

Table 1. Number of Load Cases Details

Load Case No.	Load cases
1	D-L
2	L-L
3	EQ_X +ve
4	EQ_Z +ve
5	EQ_X-ve
6	EQ_Z-ve
7	1.5(D-L+L-L)
8	1.5(D-L+E.Q._X)
9	1.5(D-L-E.Q._X)
10	1.5(D-L+E.Q._Z)
11	1.5 (D.L-E.Q._Z)
12	1.2(D.L+L.L+E.Q._X)
13	1.2 (D.L+L.L-E.Q._X)
14	1.2 (D.L+L.L+E.Q._Z)
15	1.2 (D.L+L.L-E.Q._Z)
16	0.9 D.L. + 1.5 E.Q.
17	0.9 D.L. – 1.5 E.Q

Step-9: Analysis of building frames considering Time history Analysis (ELCENTRO CASE) method for seismic forces in X & Z direction and gravity load as shown in figure below.

Defining Elcentrino Case



Assigning Time History (Elcentrino)

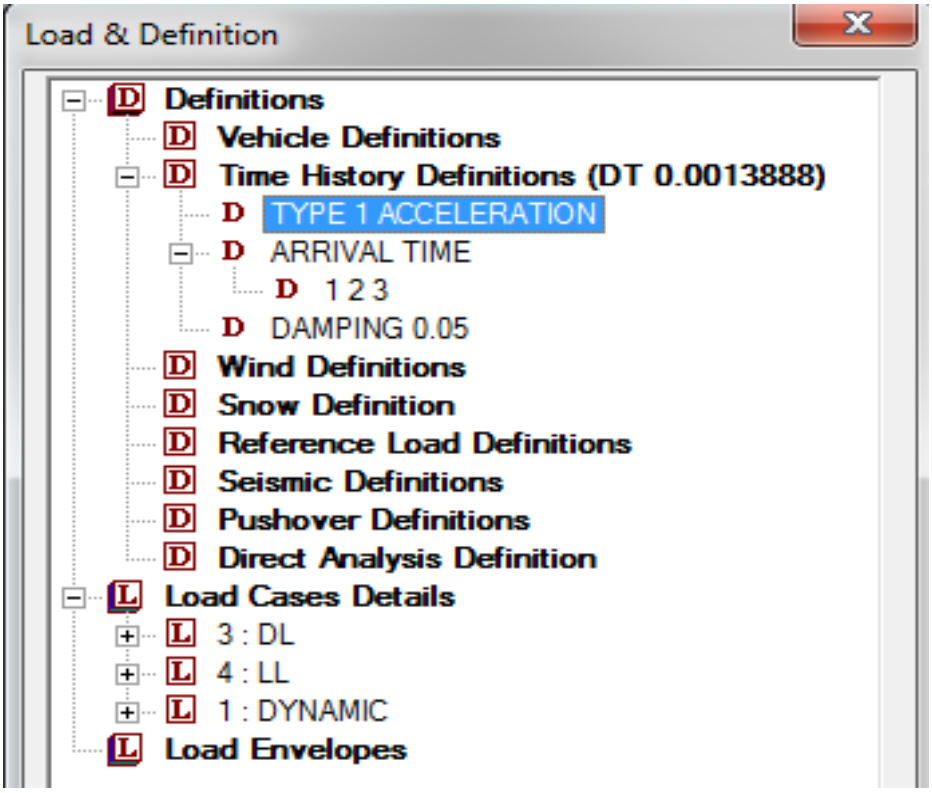


Fig. 6. Schedule of Rates as per M.P.P.W.D. 2019

Step-10: Cost analysis of material quantity i.e. concrete in cubic meter and Steel casing in Kg using S.O.R. M.P.P.W.D. 2014.

Material	S.O.R. Rate	Quantity	Total Rate
Steel Casing	68/kg	2200 kg	1,49,600/-
Concrete	5091/cu.M	56/ cu.M.	2,85,096/-

Step 11: After applied all the boundary condition and forces, now the model has to be "Analyze" for getting the results *i.e.* axial force, shear force, deflection and support reactions *etc*.

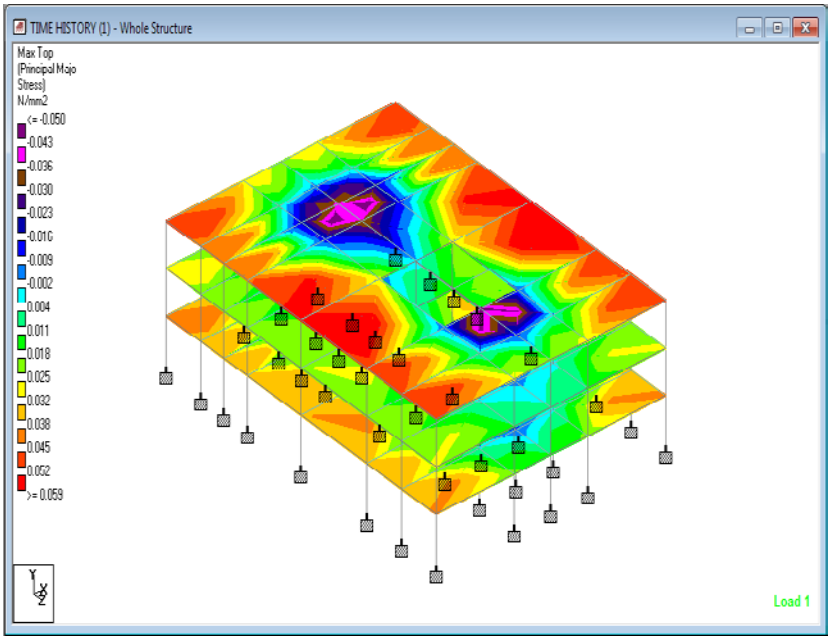


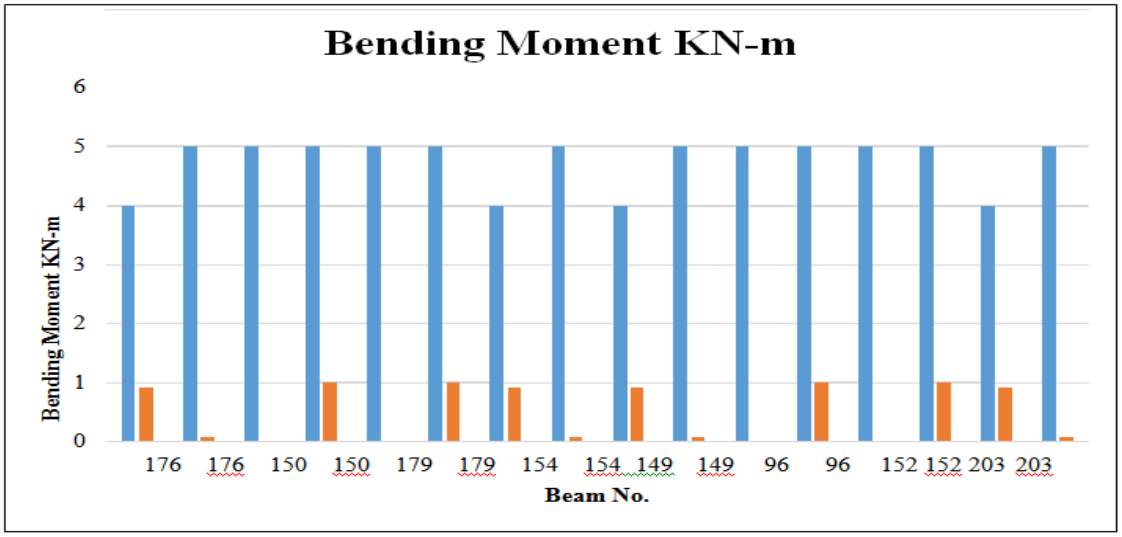
Fig. 7 Stress Distribution

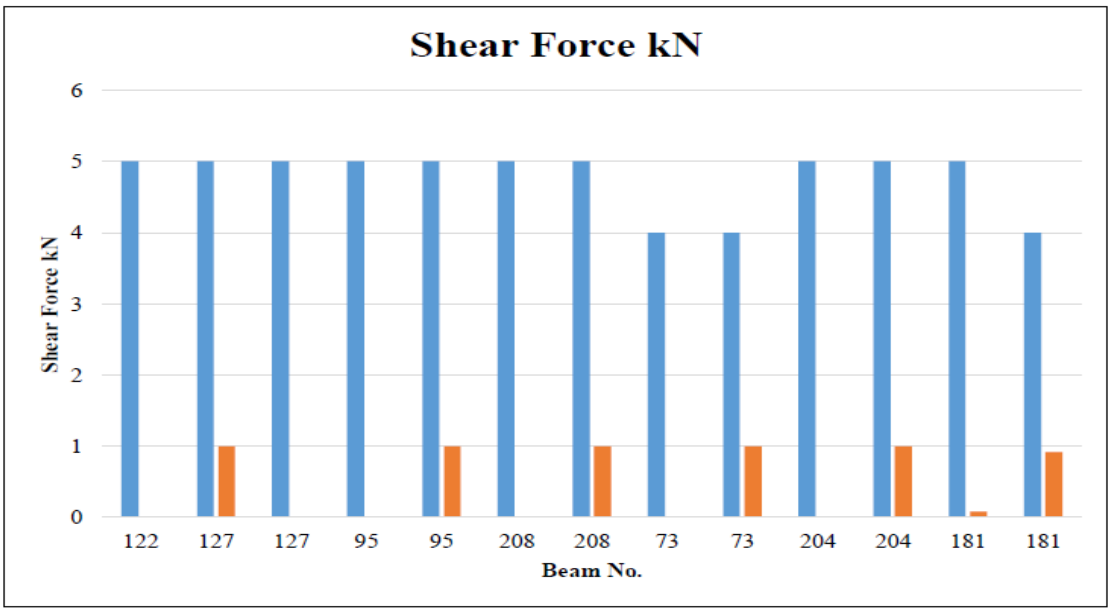
Step 12: After optimization process comparative results are drawn in all cases to determine the best one with the help of graph using M.S. Excel. The geometric parameters of existing/proposed structure are shown in Table 4.1.

Table 2 Geometric Parameters of Existing/Proposed Structure

S. No.	Description	Value
1	Area of building	$408m^2$
2	Length	24 m
3	Breadth	17 m
4	Storey height	3.5 m
5	Height of the column below plinth level	1.5 m
6	Size of the column	300 mm x 300 mm
7 (a)	Size of beam for 5m span	200 mm x 500 mm
7 (b)	Size of beam for 4m span	200 mm x 400 mm
8	Thickness of slab	150 mm
9	Thickness of outer walls	200 mm
10	Thickness of inner walls	100 mm
11	Support condition	Fixed

ANALYSIS RESULTS





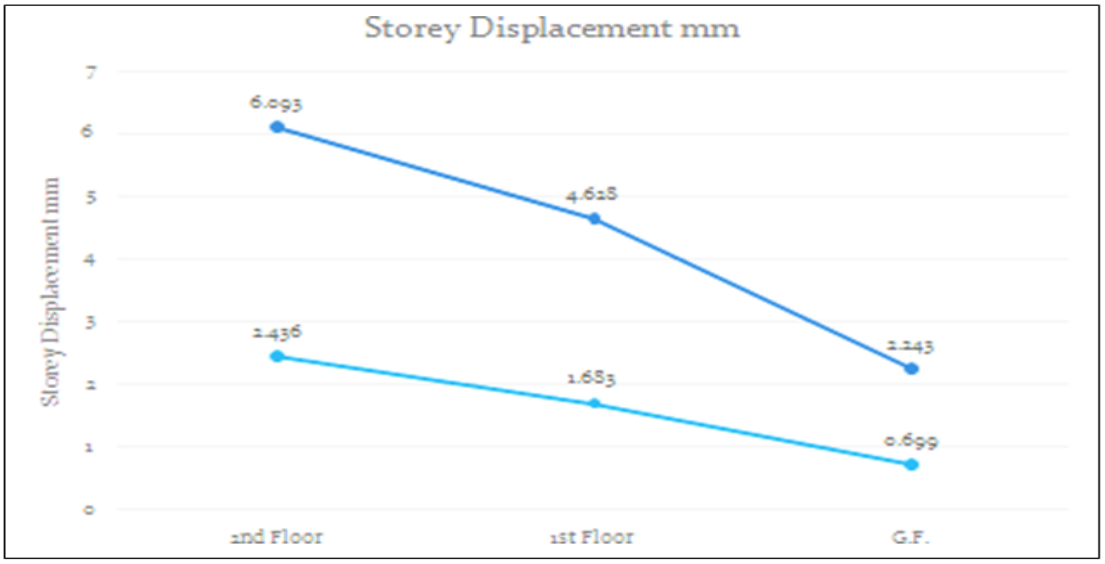


Table 3: Cost

Material	S.O.R. Rate	Quantity kg	Total Rate
Steel Casing	40 / kg	35953	14,38,120/-
Concrete	5091 / cu. M.	5.0208	25560/-

CONCLUSION

Following are the ends according to the examination

1) In this investigation, it is seen that with the procedure of retrofitting, the soundness of a structure can be recovered without disassembling the structure utilizing fortifying steady individuals.
2) It is seen that the retrofitting method can be 88.64% cost effective than destroying and developing another structure.
3) It can be reasoned that product examination and site test work can be joined for the advancement of the framework, As we did in this investigation where we decided the Quality of the structure utilizing NDT (Non-destructive testing) though displaying and checking quality improvement should be possible utilizing investigation apparatus staad.pro.

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