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A Research on Existing R.C.C. Framed Building Condition Assessment and Evaluation of Seismic Activity With Etabs

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Abstract –

In this study, four G+3 reinforced concrete (R.C.C.) buildings' conditions are evaluated using the application of Rapid Visual Survey (RVS). A G+3 R.C.C., one of the examined buildings, was chosen for a comprehensive evaluation since it would also need to take into consideration a vertical extension that would add one or more stories. The present building's performance was assessed, and a simulation of the structure's response to seismic forces was conducted with the use ETABS, an advanced structural analysis and design program, to offer a thorough condition assessment of the seismic evaluation and performance and the structural integrity of an old structure. This study's main goals were to evaluate the building's existing state, detect problems with the structure, and create efficient retrofitting plans that would improve safety and conform to modern building requirements with respect to new IS building codes. Numerous important conclusions emerged from the investigation, including the possibility of seismic vulnerabilities, insufficient reinforcing, and overstressed columns. Customized retrofitting techniques such as column jacketing and the addition of shear walls are also designed and assigned in the software in accordance to IS 15988 : 2013

Key Words*: (Seismic Evaluation), (Condition-Assessment), (*ETABS), (Shear Wall), (Jacketing)

1.INTRODUCTION

Structures provide houses, places to live and work, and the infrastructure required for communication, transportation, and other essentials, which is why structures form the foundation of modern civilization. However, as these structures age, they become more susceptible to deterioration and harm from various earthquakes as well as other man-made and natural pressures. This poses a significant danger to the general safety of the town, the safety of its citizens, and the financial and social costs. Building owners, property managers, and the general public have serious concerns about preserving the integrity, safety, and long-term worth of structures. Seismic evaluation and building condition assessment are two essential parts of this work.

In accordance with the guidelines set out by the Indian Standard Code IS 15988:2013, the goal of this study is to provide a comprehensive review of the existing methodology and procedure for the condition assessment and seismic evaluation of buildings with reinforced concrete frames into the software. The research focuses on the particular challenges and issues associated with these structures, including their age, size, complexity, and variations in the way they are planned, constructed, and maintained.

The goal of earthquake evaluation, on the other hand, is to ascertain how resilient a structure is to seismic forces. This assessment is essential in earthquake-prone locations to prevent structure collapses that might have disastrous effects. A range of methods are employed for doing seismic assessments, from manual computations to sophisticated software modeling tools like as ETABS.

This research involves a case study of a real reinforced concrete framed building where the seismic assessment and condition analysis are conducted in accordance with new IS guidelines. The research includes a complete history of the building's design, construction, and upkeep as well as a summary of all the nondestructive tests that were performed on the structure. After the study's results are analyzed, recommendations are given to improve the building's seismic performance and safety by determining the location of any structural member problems. Earthquake evaluation and condition assessment work together to provide essential data that can extend a building's lifespan, improve its functioning, and increase safety. The current study aims to investigate the importance, methodologies, and outcomes of existing structure seismic evaluation and condition assessment, highlighting their respective roles in the larger picture of operation and preservation.

Assessing building structures and their ability to withstand seismic events has been an important area of research for many years. One of the most important topics has received a great deal of attention from many researchers but mostly the researches are done using some old programs and software such as Sap2000 and generally most of them are not conducted as per Indian standards. Therefore a thorough study is required as per Indian standards and with accordance to IS 15988 : 2013 to show proper retrofitting of the improper structural elements

Some of the following researches had provides an in-depth assessment of the studies and research efforts that have already been conducted on the condition analysis and seismic inspection of reinforced concrete framed buildings, along with the numerous tools and techniques used in this process, this researches had shown below in brief.

[1] Sameh A. El-Betar has conducted a seismic evaluation of Egypt's contemporary reinforced structures. He carried outtwo case studies were used. The second building that was chosen was likewise a school, built after 1990, while the first was an old school that was planned and built in the vicinity of1962. In contrast to the second building, which had a framed structure—a frame that could withstand a moment—the first building was merely intended for gravity loads. None of the buildings in this research had any planar or vertical irregularities. First, a FEMA P-154 form and score modifier were utilized for a rapid evaluation of these structures. instance 1 underwent a thorough review since the overall score for the second instance was higher than 2 and lower than 2 for the first. Axial and shear stresses in columns have been measured utilizing Tier 1 screening on Case Study 1. Using the traditional model of an old school building, all objects in Tier 1 of the method pass.

It does not meet the life safety performance target in all areas, however. It has been established that the model has several shortcomings. These are the short route's drawbacks:it has no redundancy and just one bay moment frame (less than two). The second drawback is that the height to thickness ratio of the corridor perimeters is excessively high (more than 2.5). The design expert can either share defectsand provide fixes, or they can take part in Tier 2, the second level. For Tier 2, the examination of shortcomings has to be done using the assessment standards listed in Tier 1. In this case, the as-built measurements, the soil report, the reinforcing requirements for each structural part, and core tests to determine the strength of the concrete are requiredfor the building study.

[2] Tarek M. Alguhane, Ayman H. Khalil, M. N. Fayed, carried out an case study and research work , in this study aims to analyze the seismic performance of a five-story existing R.C.C. building in Madinah City that was built thirty years ago. With SAP2000, a building model was created. Four model systems have been taken into consideration: model I (no infill), model IIA (update from field test strut infill), model IIB (strut infill – ASCE/SEI 41), and model IIC (soft storey strut infill – ASCE/SEI 41). Inelastic material behavior for concrete, steel, and infill walls has been included into three-dimensional (3D) pushover analysis. On four models, displacement-controlled pushover studies were carried out. Buildings can be classified into two intermediate structural performance ranges and three distinct levels based on their structural performance. The three separate structural performance categories arestructural stability (CP), collapse prevention (CP), and immediate occupancy (IO)/life safety (LS). There are two levels of intermediate structural performance: the restricted safety range and the damage control range.Utilizing software results, the maximum base shear (Vb) and target displacement (δt) values for every one of the four models were calculated and compared.

[3] S Prasanth, Goutam Ghosh, and Ashwani Kulshrestha, describes in India, the most popular building construction method is filled walls with unreinforced masonry (URM) and reinforced cement concrete (R.C.C.). Because Indian regulations do not have codal requirements for the modeling of infills, the influence of infills is often disregarded. Infill modeling techniques are offered by certain international codes, such ASCE 41-06 and FEMA. Because of the infill-frame interaction, URM infills significantly alter the building's mode of failure. By acting in concert to absorb lateral pressures, infills contribute to the building's increased stiffness. Increased stiffness causes the time period to decrease, which has a major impact on the building's seismic behavior.

The study uses fragility curves to examine the seismic susceptibility of structures with and without infill panels. The seismic reactions of the buildings are ascertained by non-linear static pushover analysis and non-linear time historyanalysis. the research highlights the need of taking into account the interplay between RCC frames and URM infill panels when evaluating a building's seismic susceptibility. The study's conclusions highlight how URM in-fills negativelyimpact a building's ability to withstand earthquakes and advise that when designing RCC frame structures with URM in-fills, infill-frame interaction should be properly considered.

[4] H. AlWashali, Y. Suzuki observed that , many practicing engineers view brick infill walls as nonstructural since it might be challenging to evaluate their failure modes and interactions with the surrounding frame. They highlight the challenges in precisely determining the masonry infill's failure mechanism, shear strength, and deformation capacity, particularly in light of the wide range of material qualities and the quantity of structures already in place. Later the authors of this study also provided a comparison of current approaches with earlier experimental findings. It is also investigated how apertures affect the lateral strength of masonry infill walls. Based on earlier experimental results,the ductility of a R.C. frame with brick infill is examined. The F-index for masonry infill requires more investigation, and the information currently known about the factors influencing the deformation of masonry infill is deemed insufficient.

[5] Terala Srikanth, Ramancharla Pradeep Kumar conducted a case study and described that adequate building methodsand inadequate seismic knowledge have led to a substantial number of deaths during Indian earthquakes, and these issues were the focus of the research. The safety of pre-code revision structures must be taken into

consideration. . Representing a significant portion of the stock of vulnerable building. Although massive quakes are rare in India, each one is marked by high exposure, and it is impossible to ignore the consequences they have on society and the economy. For instance, the Indian Government estimates that the Jan. 26, 2001, earthquake in Bhuj, Gujarat, impacted 50% of the state's population either directly or indirectly. A total of 16,000 structures were surveyed for the case study of the cities of Gandhidham and Adipur. After the buildings were categorized according to their construction characteristics, it was found that a sizable portion of them were made of masonry. A review of the buildings' apparent quality revealed that many of them were of inadequate condition, necessitating more analysis and reinforcement. The study shows the significance of carrying out thorough seismic risk assessments and offers insights into the seismic susceptibility of structures in the cities of Gandhidham and Adipur. In comparable high-seismic zones, the findings can aid in the development of measures for reducing the danger of earthquakes and enhancing building safety.

2. METHODOLOGY

There will be a methodical approach used in order to guarantee a comprehensive assessment of the building's condition and seismic safety. This study attempts to provide important insights into the condition analysis and seismic evaluation of R.C.C. structures using a case study approach.

CHOOSING OF THE SAMPLE STRUCTURE : A suitable pre-existing R.C.C. framed building will be selected with care to function as the model building for the case study. Many factors were considered throughout the selection process, such as the kind of structure, age, structural composition, location, and ease of access to the necessary information.

CONDITION ASSESSMENT : A complete visual assessment of the selected building was conducted with the help of Rapid Visual Screening Form, paying particular attention to all structural components, including slabs, beams, and columns. To make sure every area is thoroughly examined, the examination is carried out methodically. Any obvious signs of pain, deterioration, or damage like cracks, spalling, uneven settlements, or rust, had been noted and document.

DATA COLLECTION OF SELECTED STRUCTURE :The consent of the authorities must be secured before proceeding with the following stages. To obtain full information, one G+3 building will be selected for detailed inspection and evaluation. Structural drawings, architectural plans, and construction records were obtained in order to get further insight into the original design and construction of the selected building. In addition, relevant historical data has been acquired, including construction methods, material properties, and maintenance records. To find out more information and understand the behavior of the structure along with detailed inspection with required NDT testing on the structure.

ASSESSMENT OF SEISMIC ACTIVITY : The structure has been represented mathematically through the use of structural analysis tools such as ETABS. The model for the structural aspects will include boundary conditions, geometric dimensions, and material properties along with actual loads on the existing structure. The IS standards or any relevant seismic evaluation standards must be followed while using seismic loads. To evaluate the building's performance, the computed answers will be compared to the acceptance standards established in the seismic assessment guidelines.

ANALYZING THE OUTCOMES : After the assessment of model I'll look over and review the data acquired from the seismic assessment from the software , detailed inspections, and visual inspection. The findings of the seismic evaluation and the condition assessment's findings will be compared to look for patterns and validate the assessment methodology. The effectiveness of the recommended retrofitting options in enhancing the building's seismic performance and structural integrity will be evaluated. The analysis and interpretation step will help to clarify the building's condition and seismic susceptibility as well as the practicality of potential retrofitting methods.

In light of the results, suggestions will be given on potential retrofitting methods to improve the strength and earthquake resistance of similar structures. In the end , this study will expand our knowledge of condition assessment and seismic activity of historic R.C.C. framed buildings by providing thoughtful analysis and useful recommendations for the preservation and retrofitting of these structures.

3. CONDITION ASSESSMENT OF THE STRUCTURE

The primary method for assessing the condition of the building's components, systems, and finishes is visual inspection. It should be done by qualified personnel with knowledge of construction materials, methods, and defect identification. It is necessary to thoroughly inspect all relevant areas, including the structural elements, walls, roofs, floors, and finishes. The aim is to identify any evident defects, deterioration, damage, or distress indications that might compromise the building's safety and operation.

IS 15988:2013 provides a list of things to consider while doing the visual evaluation. One of these requirements is the structural integrity, which includes any cracks, settling, deformations, or corrosion. decay or damage to building materials like steel, concrete, masonry, or wood. the efficiency of the building's plumbing, electrical, HVAC, and fire protection systems. condition of every finish, including walls, ceilings, floors, and coatings. identifying any telltale signs of danger that may be visible.

A comprehensive report based on the findings of the visual inspection should be prepared to explain the condition of the building. An assessment of the parameters, a detailed description of any defects discovered, and an outline of the inspection process must all be included in the report. Recommendations for further investigation, maintenance, or repairs should be made in light of the issues discovered. The report should also address any dangers or ongoing safety hazards associated with the faults discovered.

3.1 VISUAL EXAMINATION OF THE STRUCTURE

Rapid visual screening (RVS) of buildings for seismic susceptibility is a preliminary evaluation approach used to identify structures that may be vulnerable in the event of an earthquake. During this process, key structural elements are visually examined, and knowledgeable specialists quickly assess the site to look for characteristics that can indicate a building's vulnerability to seismic damage. RVS often uses standardized forms and checklists to assess factors such building age, construction type, geometry, and condition. Establishing a building's priority for a thorough inspection and refit is made easier using this strategy, which prioritizes the structures that require the greatest attention and resources. One method that RVS lowers risks and increases community resilience to seismic catastrophes is the rapid construction identification of potentially sensitive structures.

RSV method have a chart of an estimate of the potential damage based on RVS score. Therefore, it should be acknowledged that the real injury will depend on a number of factors not addressed by the RVS approach. As a result, this database should only be used as a reference to determine if the buildings require a simplified vulnerability assessment. These data can also be used to identify whether modifications to structures are necessary when a more comprehensive risk assessment may not be feasible.

A complete visual evaluation was performed on about 4–5 G+3 (ground floor plus three storeys) RCC (Reinforced Concrete) buildings. The primary objective of the examination was to evaluate these buildings' overall condition and usefulness. Based on the measurements and observations recorded in the RVS form, a score was produced. This score influenced subsequent decision-making processes and provided a quantifiable assessment of the building's condition.

BUILDING-1 :

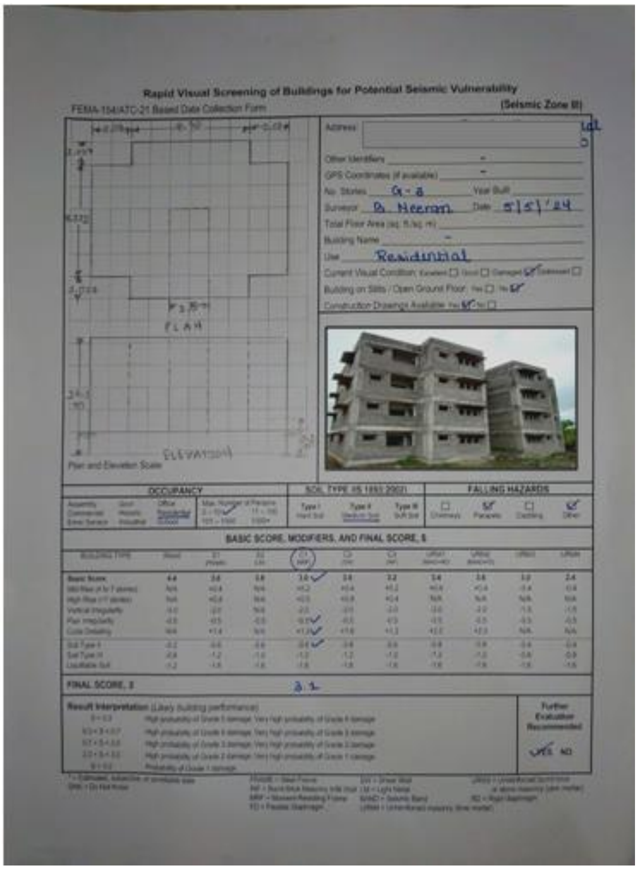

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability
FEMA 154/ATC-21 Based Data Collection Form
(Seismic Zone III)

Fig -1: Building-1 RVS Form

The structure was built in 2012 or 2013. The outside of the structure is not properly plastered. Vegetation is growing up close to the structure. The masonry walls have some fractures in them. There is an obvious separation fracture in the center of the wall and column where the walls are detaching from the columns. Leakage issues are seen on higher floors.

BUILDING-2 :

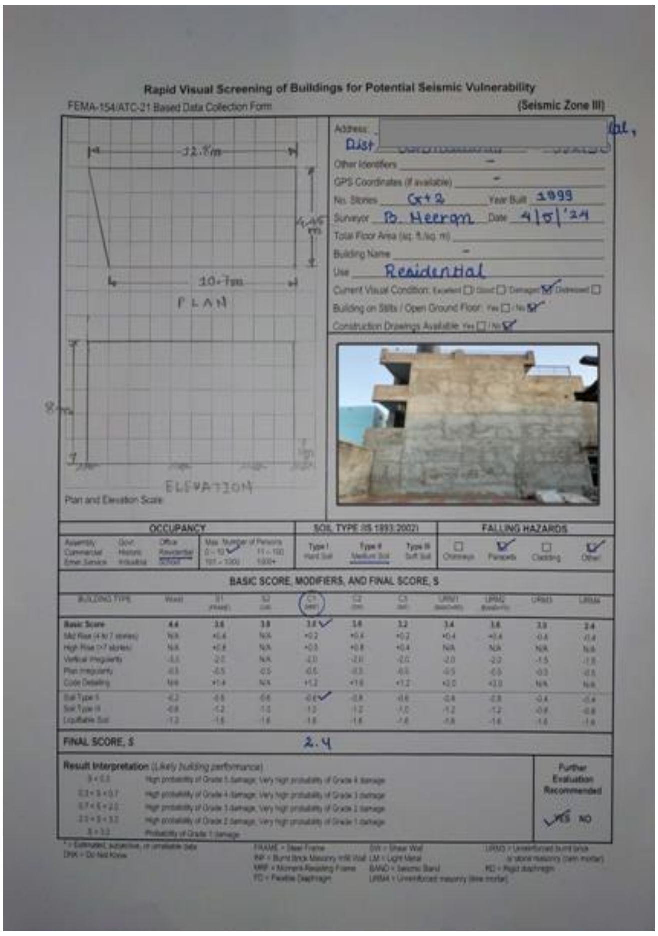

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability
FEMA-154/ATC-21 Based Data Collection Form (Seismic Zone III)
Address:
Dist
Other Identifiers
GPS Coordinates (if available)
No. Stories G+2 Year Built 1999
Surveyor B. Heeron Date 4|5|'24
Total Floor Area (sq. ft./sq. m)
Building Name
Use Residential
Current Visual Condition
Building on Stilts / Open Ground Floor
Construction Drawings Available
PLAN
ELEVATION
Plan and Elevation Scale
OCCUPANCY
SOIL TYPE (IS 1893:2002)
FALLING HAZARDS
BASIC SCORE, MODIFIERS, AND FINAL SCORE, S
FINAL SCORE, S 2.4
Result Interpretation
Further Evaluation Recommended
YES NO

Fig -2: Building-2 RVS Form

The next structure was constructed in 1999. The building's brick walls are cracked. The brickwork extremely close to the columns has fractures in it. The building's two exterior walls are not plastered, allowing weathering to affect them. Leakage issues are present at the building's terrace. Inside the structure, there are fissures in the beams. The slabs are causing the plaster to spall. The structure wasn't constructed according to Indian requirements.

The following basic data about every surveyed building is provided in the RVS form:

RVS Score	Damage Potential
S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

Table -1: RVS Damage

3.2 DETAILED INSPECTION OF BUILDING-1

The building that was previously stated consists of three upper storeys and a ground floor level. The structure, which is between 12 and 13 years old, was constructed with regard for previous earthquake regulations. The building's primary issues are the tiny cracks in the beam-column frames, the broken water tank, and the incorrect plastering on the outside of the walls. Masonry work has been done using bricks. The window shades are shattered in many places. There is an increase in vegetation and issues with water blockage in the building's environs. Moreover, there are locations where it is discovered that the masonry and the columns, as well as the masonry and the plinth, are separated.

Throughout the inspection process, measurements are made of the sizes of various building elements, such as walls, columns, and beams. While I was there, I also took some photos of some of the building's parts.

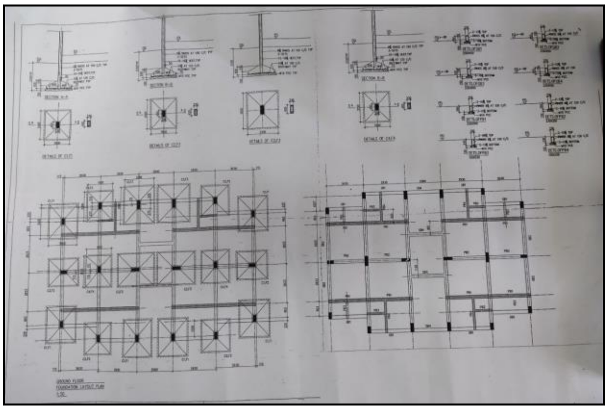
Fig -3: Site Visit Images

Later on the Rebound hammer test is carried out during the site visit. The rebound hammer test on this structure provided information on the concrete's surface hardness and expected compressive strength. The results demonstrated that the structure's various components had varying rebound values, indicating the heterogeneity and condition of the material after years of usage. While the test revealed that certain parts had sufficient strength, some areas had lower rebound values, which might suggest that there was insufficient compaction or deterioration during the original building phase.

A detailed table is prepared for different structural members show the mean rebound values and co-related compressive strength of the members in the report. Generally during the reviewing the structural detailing plans it is mentioned that all the elements are of M20 and the grade of column is M25. But after testing and it is found that most of the columns have a little lass strength as compared to the mentioned into the detailing plans , so while designing and modeling into the software it will be taken as M20 grade for the better result of the existing building.

These findings highlight the necessity of doing a more comprehensive evaluation of the building's structural integrity. Areas with low rebound values would need to be further studied using more comprehensive non-destructive testing procedures or core samples in order to determine the extent of any damage. Consequently, the historic building's preservation and restoration process has been driven by the rebound hammer test, which has shown to be a helpful first evaluation tool.

4 DETAILED EVALUATION OF BUILDIND-1 (G + 3) :



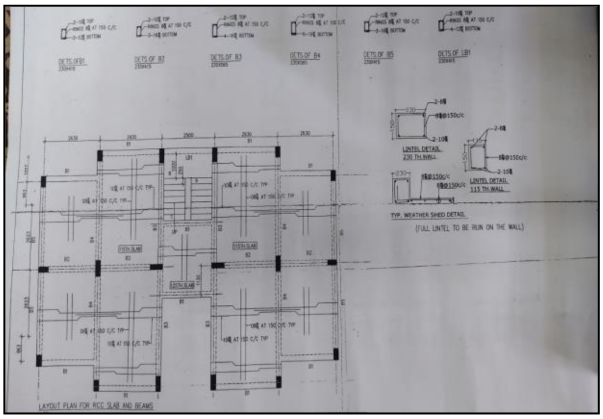


Fig -4: Detailing plan of building-1

IS: 1893:2016 earthquake load calculations are considered and performed. The existing structure is constructed as per IS: 1893:2002.

Earthquake load parameters taken into consideration are Considering that every frame is regarded as an ordinary moment-resistant frame, the response reduction factor (or "R") used in earthquake analysis is 5. Since the building is situated in Zone 3, the zone factor "z" equals 0.16. The importance factor "I" is valued at 1.0. The aforementioned parameters are used to construct two load scenarios, EQ X and EQ Z.

All the loads such as Dead load, Live load on the slab and wall loads on the beams are considered as per the existing building loads.

Size of the components :

Sr.no.	Structure	Designation	Size in mm
1.	Column	C1,C2,C4	230X450
		C3	230X600
2.	Beam	B1,B2,B5,LB1	230X415
		B3,B4	230X565
3.	Slab	SLAB-1	115
		SLAB-2	125
		STAIR SLAB	150

Table -2: Size of the Components

4.1 DESIGNING AND MODELING IN SOFTWARE (G + 3) :

All the members are designed as per the detailing plan of the existing building. At first the beams and columns are defined

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to be designed for checking the required reinforcement. Later the columns are designed with respect to sizing and reinforcement details as per the detailing of the existing building. So the accurate results of the column-beam framing con be obtained

The loading to the structural members are defined and assigned separately.

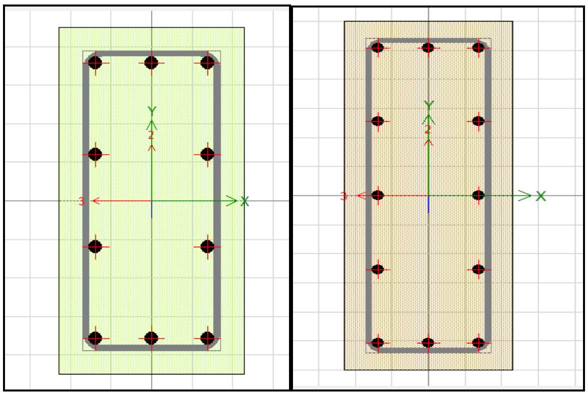

Fig -5: Designed Column Section

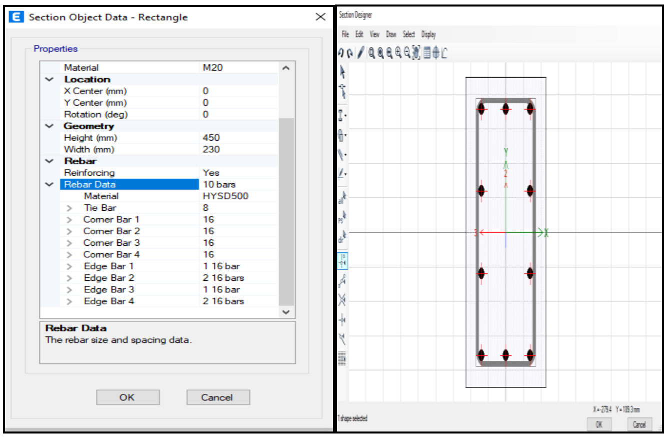

Fig -6: Column Section Details

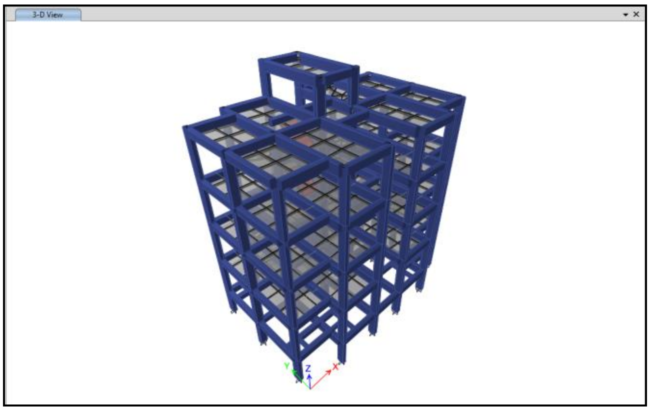

Fig -7: 3D Excluded View (G+3)

5. RESULTS AND DISCUSSIONS (G+3) :

After the performing geometrical check, it reported that the model is designed perfectly and passes the design check. It checks to make sure all of the structural components beams, columns, and slabs are joined correctly at joints and intersections. It also confirms that the dimensions and features of each mentioned section—such as its beams and columns match the actual construction requirements.

It also confirms that all pertinent members are appropriately assigned the loads.

CHECKING THE REINFORCEMENT OUTCOMES :

Engineers may improve the building's safety and longevity by ensuring that the structural parts are sufficiently reinforced by methodically testing the reinforcement in ETABS. This procedure is essential for both the assessment and renovation of existing buildings as well as for new development.

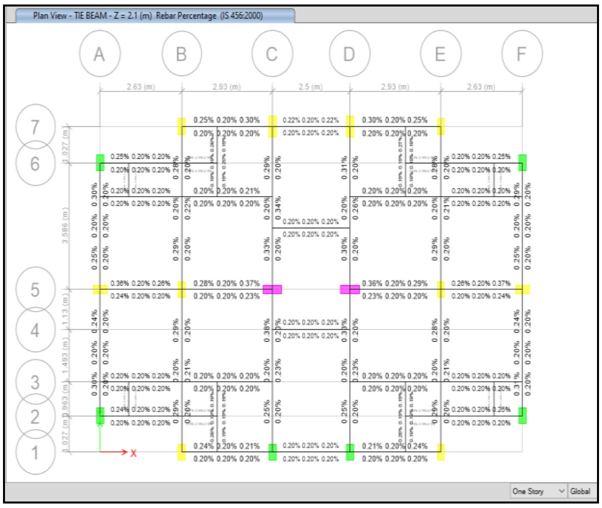

Fig -8: Design Check

The above picture is of Tie-beams of building which shows the required reinforcement in it. A table is prepare to check the deficiency in the beams. The table is prepare between the actual reinforcement in the beams of existing building and reinforcement required from the results of the software.

BEAM DESIGNATION	BAR POSITION	% REINFORCEMENT PROVIDED	% REINFORCEMENT IS LESS THAN REQUIRED
GB1	TOP	0.219	O.K.
	BOTTOM	0.583	O.K.
GB2	TOP	0.328	O.K.
	BOTTOM	0.971	O.K.
GB3	TOP	0.437	O.K.
	BOTTOM	0.874	O.K.
GB4	TOP	0.152	0.2
	BOTTOM	0.437	O.K.
PB1	TOP	0.195	0.2
	BOTTOM	0.421	O.K.
PB2	TOP	0.281	O.K.
	BOTTOM	0.500	O.K.
PB3	TOP	0.291	O.K.
	BOTTOM	0.656	O.K.
PB4	TOP	0.455	O.K.
	BOTTOM	0.656	O.K.

Table -3: R/f details of Tie-beams

So from this check it is reported that two beams that have improper reinforcing at the top position are GB4 and PB1. The appropriate actions should be taken in accordance with the design criteria, and these beams should be inspected and altered in order to meet the exact reinforcing requirements. The remaining beams have the required proportions of reinforcement. This deficiency is may be due to the requirement of extra cut bars in the compression area.

While examining the Ground Floor beams the reinforcement design check, it is reported that some of the beams have insufficient reinforcement in top portion same as Tie-Beams.

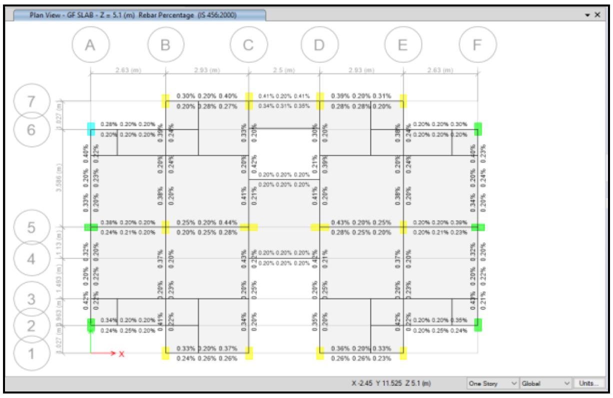

Fig -9: Design Check G.F.

BEAM DESIGNATION	BAR POSITION	% REINFORCEMENT PROVIDED	% REINFORCEMENT IS LESS THAN REQUIRED (EDGE-REINFORCEMENT)
B1	TOP	0.165	0.21
	BOTTOM	0.355	O.K.
B2	TOP	0.165	0.21
	BOTTOM	0.632	O.K.
B3	TOP	0.174	0.22
	BOTTOM	0.619	O.K.
B4	TOP	0.174	0.2
	BOTTOM	0.928	O.K.
B5	TOP	0.237	O.K.
	BOTTOM	0.632	O.K.
LB1	TOP	0.165	0.22
	BOTTOM	0.474	O.K.

Table -4: R/f details of G.F. beams

The beams B1, B2, B3.B4, and LB1 that have been reported to have incorrect reinforcing at the top position. These beams should be inspected and modified to meet the precise reinforcing requirements, and the necessary operations should be performed in compliance with the design standards. The remaining beams are reinforced to the necessary ratios.

After inspected the upper floor results. It is found out that mostly upper structural components shows good results along with different story plots. The minor problem is that some of the beams shows some reinforcement deficiency in the compression area at bottom storeys of the building.

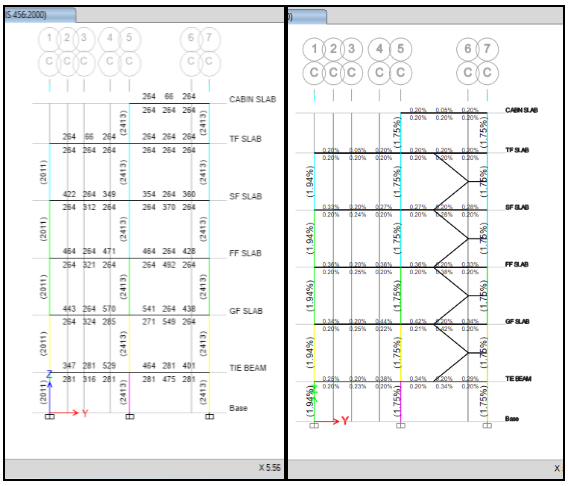

Fig -10: Column Check

While examining the columns the findings indicated that several of the columns on the first and ground floors, especially those in the middle, had somewhat higher weights than the others, they nevertheless passed the design examination.

It is discovered that every column passes the IS 456 design check after examining the reinforcement data in each column. It is confirmed that the design specifications and code requirements are met by the longitudinal and transverse reinforcement details.

Also it is verified that the cross-sectional measures of the columns comply with the design specifications. confirmed that the applied loads, including axial loads, moments, and shear forces, are accurately reflected in the model.

6. DESIGNING AND MODELING FOR FUTURE EXPANSION (G + 5)

whether the owner of this old residential building plans to construct two more storeys to his current Ground + three-story property. Before moving on with the expansion, it is necessary to guarantee the building's structural integrity and safety, which is why ETABS is used to do a thorough structural study. The purpose of this study is to assess the building's state, spot any possible flaws, and quantify the amount of retrofitting that will be needed to properly sustain the new expansion.

The purpose of utilizing ETABS to analyze the existing building is to make sure that the proposed extension is safe, legal, and sustainable so that it can serve as a strong base for the two extra storeys that are being planned.

As an outcome of the structural analysis and design assessment carried out in ETABS, several of the columns in the existing building model are under greater stress than they can sustain (the red colored columns). This exceeds indicates that the columns are overstressed and would not be able to support the imposed loads effectively, especially during seismic occurrences.

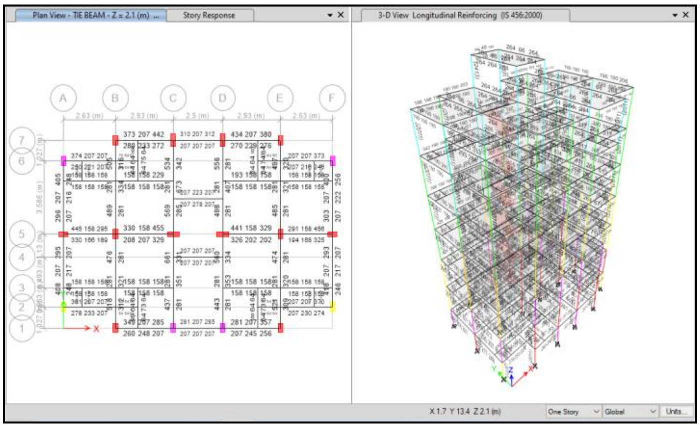

Fig -11: Outcomes of G+5

It seen in the above mentioned picture that 12 to 13 columns failed the design check in first 2 storeys. The design check reveals an overabundance of O/S capacity ratio mistake, which might be caused by smaller section sizes. Many of the columns' stress capacities are exceeded, which represents a major risk to the building's structural integrity and safety. Enhancing and upgrading the structure is necessary to address the weaknesses and ensure that it can support loads in the future, including seismic activity

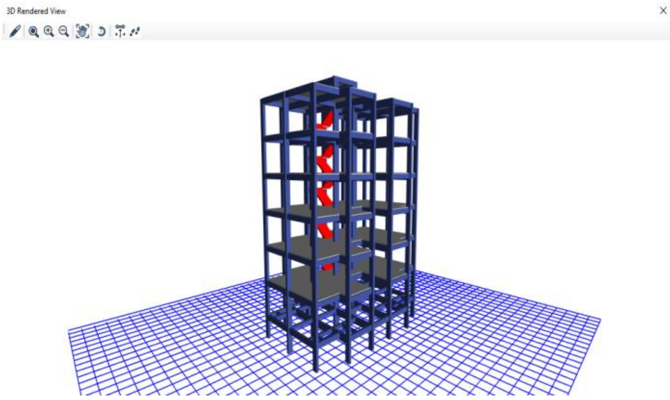

Fig -12: 3D rendered view (G+5)

7. RETROFITTING OF BUILDING-1 (G + 5)

The designing of Column jacketing is completed in compliance with the guidelines provided by Indian Standard Code IS 15988 (2013).

The column-1 is designed in accordance to IS 15988 with the minimum thickness consideration. therefore the size of Column-1 is similar to the size of column-2 and column-4, this are also designed in the same way. The shear wall is also design and assigned in accordance with the same IS code.

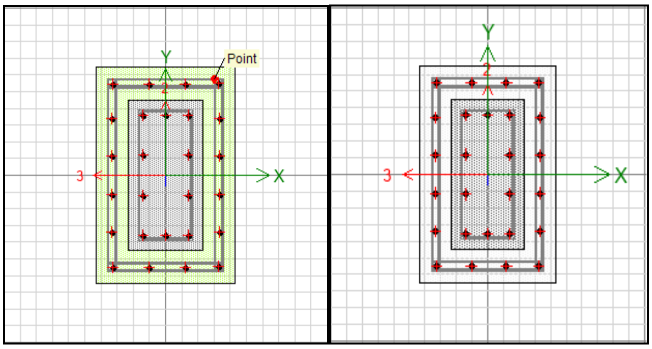

Fig -13: Column Jacketing

The shear wall is defined once the columns are. As the Shear walls are a crucial retrofitting component that may be used to increase an older structure's seismic resistance and structural stability. Shear walls are vertical elements designed to absorb lateral pressures such as those brought on by wind or earthquakes in order to prevent excessive structural sway and potential collapse

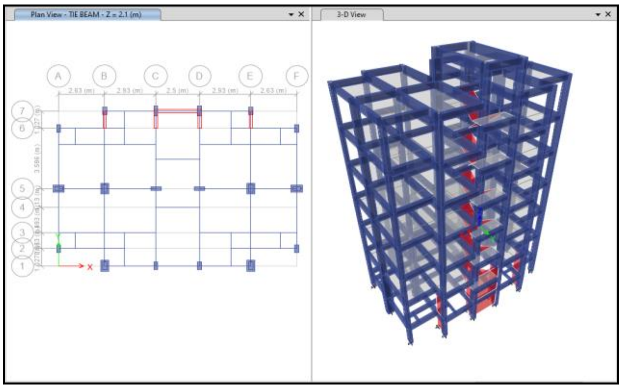

Fig -14: Assigning the components (G+5)

The designated wall portions and column jacketing are displayed in the photo indicated above. To preserve the outcomes, these components' locations might be altered. It is found that when the components are assigned to different locations, the results are consistently consistent. But all section passes the design checks.

8. RESULTS AND DISCUSSIONS (G+7)

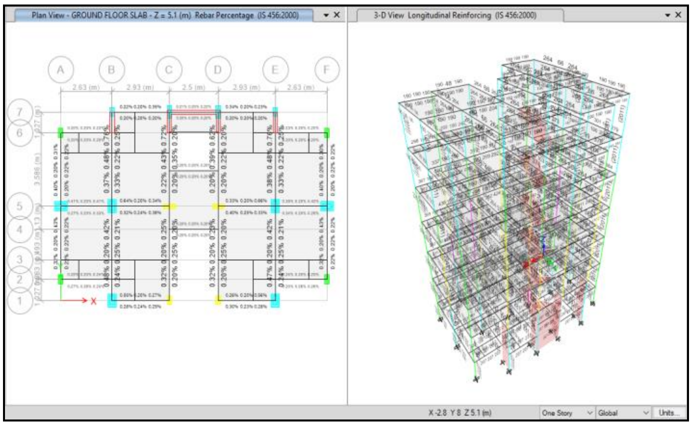

Fig -15: G+5 Outcomes

Upon structural analysis, it was discovered that some columns in the Ground + 5 building were overstressed and did not follow the required safety rules. In order to ensure structural integrity and enhance load-bearing capabilities, wall sections and column jacketing were developed and used. This validates that the updated columns and walls now meet the necessary design standards and evaluates how well column jacketing and wall sections functioning.

The retrofitted columns have all successfully completed the design examinations, proving that the column jacketing has sufficiently fixed the original structural defects. The columns that were previously failing were found to have passed the design inspection after the column jacketing and wall sections was assigned to the ground level and Tie-Beam level. The other result of this G+5 building verifies all the necessary requirements such as drifts, displacement and othe loads on the structure according to the Indian standards.

9. CONCLUSION

In summary, the application of ETABS to the analysis of the old existing structure has shown to be a useful tool for identifying structural problems and directing required repairs. After implementing the retrofitting to some of the components and the shear wall, the analysis's findings will render it easier to safely and effectively expand the structure while maintaining its structural integrity and resistance against loads and seismic incidents in the future. This procedure emphasizes how crucial it is to protect and enhance the safety and performance of old structures by utilizing cutting-edge structural analysis methods. In the end, the building's safety, resilience, and durability have been confirmed by the ETABS investigation and focused retrofitting efforts, establishing it for future expansions and external forces.

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