e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

DETAIL ASSESSMENT ON G+3 EXISTING RESIDENTIAL STRUTURE FOR REPAIR AND REHABILITATION

Ms. Bharati Kulkarni*1, Prof. Shashank U. Vanakudari*2

*1Post Graduate Student, Department Of Civil Engineering, Jain College Of Engineering, Belagavi Visvesvaraya Technological University, Belagavi, Karnataka, India.

*2Assistant Professor, Department Of Civil Engineering, Jain College Of Engineering, Belagavi Visvesvaraya Technological University, Belagavi, Karnataka, India.

DOI : https://www.doi.org/10.56726/IRJMETS45090

ABSTRACT

Concrete can be cracked or crushed into two or more portions, either entirely or partially. It is impossible to completely prevent concrete cracking, perhaps managed and mitigated. When a structure is subjected to a tensile stress that is exceeding the tensile strength of concrete, concrete, a material with a low tensile strength, is swiftly damaged. Building fractures are a global problem. If the component is held under more stress than it can handle, it will crack. Cracks are classified into two types structural cracks and non-structural cracks. Structural cracks endanger safety of building, while non-structural cracks disturb the aesthetic appearance of building. To analyze these cracks non-destructive tests like rebound hammer test and ultrasonic pulse velocity tests are conducted on the structure in this work. Also, various repair methods are studied depending on the nature of cracks. Suitable method that is routing and sealing is implemented for repair of cracks. Cost comparison is done between repair and rehabilitation and demolition and construction of new structure.

Keywords: Structural Cracks, Rebound Hammer Test, Ultrasonic Pulse Velocity Test, Repair Methods, Routing and Sealing.

I. INTRODUCTION

Buildings that have sustained damage have been repaired, while existing buildings have been strengthened and renovated. Designers and owners have had faith in the fixes and rehabilitation that have come about. There has been a mixed history of structures that underwent an earthquake, were strengthened after they were damaged by it, and then endured another earthquake. In other situations, the quake that followed the building's repair did not cause any damage. Detection, diagnosis, and repair are all involved in cracking. Cracks can be brought on by subsidence, temperature changes, shrinkage, and shoddy building techniques. Overloading, poor construction, and poor design all contribute to structural fissures. These might jeopardize a building's security. Non-structural fractures typically do not directly lead to structural weakness because they are caused by internally induced stresses in building materials. As concrete ages, cracks develop points of leakage and seepage, allowing hostile chemicals and gases like moisture, oxygen, chloride, and other to enter the concrete and seriously deteriorate the structure. Cracking is a warning sign that a building is about to fail. Concrete that is lighter will shrink more. Depending on crack width it is classified as Thin (less than 1 mm), Medium (1 mm to 2 mm), and Wide (more than 2 mm).

1.1 TYPES OF CRACKS

- Structural cracks
- Non-structural cracks

Structural cracks

The usual causes of structural cracks include poor design, poor construction, or overloading of the structure. The structural stability is impacted by these flaws, which could cause the building to collapse. An RCC beam with significant structural cracking is an example. Three different kinds of structural cracks are: flexural, shrinkage, and corrosion cracks in slabs; horizontal, diagonal, and corrosion cracks in columns; and corrosion, shear, torsional, and flexural cracks in beams.

Non-structural Cracks

The primary cause of non-structural cracks, which frequently do not immediately compromise the structure, is internally produced stresses in construction materials. However, on occasion, non-structural faults could lead

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

to the reinforcement corroding over time because of moisture leaking in via the gaps or weathering action, making the structure unsafe. When horizontal fractures develop in a lengthy compound wall because of shrinkage or temperature changes, this is known as non-structural cracking.

1.2 CAUSES OF STRUCTURAL CRACKS

1) Plastic shrinkage cracking
2) Plastic settlement cracking
3) Drying shrinkage crack
4) Concrete crazing
5) Steel corrosion induced cracking.

1.3 CAUSES OF NON-STRUCTURAL CRACKS

1) Moisture change.
2) Thermal movement.
3) Elastic deformation.
4) Creep.
5) Chemical reaction.
6) Foundation movement & settlement of soil.
7) Growth of vegetation.

1.4 REPAIR

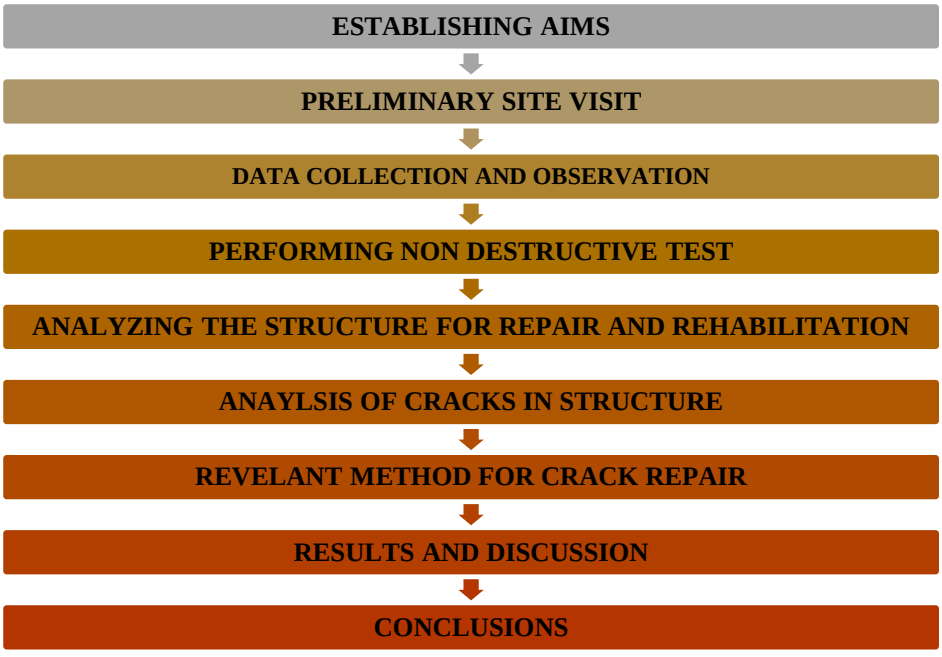
The major goal of restorations is to restore the structure original architectural form so that all services can rapidly recommence to operate. Repair can be very misleading for satisfying the strength standards because it makes no attempt to increase the building structural stability.

Repair should aim to build rehabilitation, which is defined as a relatively inexpensive repair that lasts for the duration of its intended life and function without suffering from premature deterioration or distress. To accomplish this, it is required to consider the elements influencing the longevity of a restored structural system entirely or as component of composite system.

1.5 REHABILITATION

In structural rehabilitation, the key concepts on a building is upgraded or altered to accommodate modifications to the building's owners, usage, design objectives, or legal requirements. In every instance, it is found to be less expensive to renovate the building and make the necessary changes rather than torn down and build a new structure in the designated area.

II. METHODOLOGY



e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

2.1 OBJECTIVES

- To locate an existing residential building.
- Determining stability of the structure with the help of non-destructive tests like Rebound hammer test and Ultrasonic pulse velocity test.
- To investigate property of the existing structure which is compressive strength.
- To analyze whether the structure requires repair and rehabilitation based on compressive strength of the structure.
- To identify cracks, present in the building with the help of visual inspection.
- To study the types and causes of cracks present.
- Studying various repair methods for cracks.
- Implementing relevant method to repair the cracks analyzed.

2.2 PURPOSE OF NON-DESTRUCTIVE CONCRETE TESTS

1. Estimating the in-situ compressive strength.
2. Estimating the uniformity and homogeneity.
3. Estimating the quality with respect to standard requirement.
4. Identifying areas of lower integrity in comparison to other parts.
5. Detection of cracks, voids and other imperfections.
6. Monitoring changes in the structure that could appear after some time.
7. Identification of reinforcement profile and measurement of cover, bar diameter, etc.
8. Condition of pre-stressing/reinforcement steel related to corrosion.
9. Chloride, sulphate, alkali contents or degree of carbonation.
10. Measurement of Elastic Modulus.

2.3 DIFFERENT METHODS OF NON-DESTRUCTIVE TEST ON CONCRETE:

1. Penetration method
2. Rebound hammer method
3. Pull out test method
4. Ultrasonic pulse velocity method
5. Radioactive methods

2.4 VARIOUS METHODS EMPLOYED FOR CRACK REPAIR

The crack-repair procedures include the following:

- **EPOXY RESIN METHOD**
- **STITCHING METHOD**
- **GROUTING PROCESS**
- **ROUTING AND SEALING**
- **POLYMER IMPREGNATION**
- **DRILLING AND PLUGGING**
- **SEALING CRACKS WITH GRAVITY FILLING**
- **DRY PACKING**

III. MODELING AND ANALYSIS

The examination of SAI DARSHAN APARTMENT located in Somwar peth, Tilakwadi Belagavi.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Fig.1: Sai Darshan Apartment

Two types of non-destructive tests are conducted in this project.

3.1 REBOUND HAMMER TEST

Objective:

It is used for:

- To estimate the expected compressive strength of concrete using appropriate correlations between the rebound index and compressive strength
- Uniformity of concrete is evaluated.
- Comparing concrete quality to industry standards and estimating concrete quality in relation to other concrete components.

Principle:

The length of the spring-controlled mass rebound when the plunger of it is forced against the surface of concrete is obtained by hardness of concrete at the surface. It is considered that rebound and surface hardness are proportional to compressive strength. The number obtained or rebound index is used for reading rebound along a graduated scale.

Fig. 2: Schmidt hammer

3.2 ULTRASONIC PULSE VELOCITY TEST

The fundamental concept is to investigate the relationship between compressive strength, material density and ultrasonic velocity waves. Electro-acoustical transducer which is in contact with one surface of the concrete being tested generates a pulse of longitudinal vibrations. Through concrete, a complicated system of stress waves that includes both longitudinal and shear waves forms. The longitudinal waves are the first waves to encounter the receiving transducer; a subsequent transducer transforms them into an electrical signal. The transit time T of the pulse can be monitored with the help of electronic timing circuits.

Longitudinal pulse velocity (in km/s or m/s) is given by:

$$V = L/T \text{ in} \ldots\ldots\ldots\ldots \text{ km/sec}$$

Were,

V is the longitudinal pulse velocity,

L is the path length,

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

T is the time taken by the pulse to traverse that length.

Fig. 3: Ultrasonic pulse velocity test

3.3 ANALYZATION OF CRACKS IN BUILDING

Cracks in ground floor.

 **Fig. 4:** Structural crack on ground floor	Crack type : Structural crack observed on floor slab dry packing method is used to treat crack. Width of crack : 5 cm Length of crack : 120 cm Probable Cause of crack : Foundation movement and settlement of soil. It could be due to thermal variation.
 **Fig. 5:** Structural crack on column	Crack type : Horizontal crack on column, crack observed slightly below window sill. (structural crack) Width of crack : 1 mm Length of crack : 40 cm Depth of crack : 10.95 mm Probable Cause of crack : Settlement of soil, overloading or shrinkage
 **Fig. 6:** Vertical crack on wall	Crack type : Vertical crack on wall (non structural crack) Width of crack :1mm Length of crack : 120cm Depth of crack : 10 mm Probable Cause of crack : Due to contraction between two walls
 **Fig. 7:** Vertical crack on compound wall	Crack type : Non-Structural crack observed on compound wall Width of crack : 2 mm Length of crack : 150 cm Depth of crack : 39.95 mm Probable Cause of crack : Foundation settlement, or growth of surrounding vegetation

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

 **Fig.8:** Structural crack on at ground floor	Crack type : Structural crack observed on floor slab Width of crack : 2 mm Length of crack : 210 cm Depth of crack : 39.65 mm Probable Cause of crack : Thermal variation or overloading
 **Fig. 9:** Structural crack on beam	Crack type : Structural crack observed on Beam Width of crack : 1 mm Length of crack : 50 cm Depth of crack : 11.25 mm Probable Cause of crack : Due to overloading or corrosion of steel reinforcement.
 **Fig. 10:** Structural crack on Slab	Crack type : Structural crack observed on roof slab (diagonal crack) Width of crack : 2 mm Length of crack : 213.5 cm Depth of crack : 38.77 mm Probable Cause of crack : Plastic shrinkage crack.

3.4 METHOD USED FOR CRACK REPAIR

The cracks observed are sealed with suitable crack filling paste (Dr. Fixit crack X paste)

The crack repair process is done in five steps.

Step 1: Surface Preparation

The cracks observed were thoroughly cleaned leaving behind no dirt or dust particles.

Surface cleaning of cracks is necessary before any other step so that the liquid used for filling the cracks accumulates in the depth of crack without any dust or dirt particles. Also, the vegetation growth is thoroughly cleaned.

Step 2: Cracks Are Moisturized.

Some amount of water is added to cracks to slightly wet them, so that if sought of dust and dirt particles remaining can be washed out and the flow of crack filling liquid becomes easy.

Step 3: Applying Crack Filling Paste

The crack filling paste here used is Dr. Fixit crack X paste, which has good efficiency of filling the crack and stop penetration of water through them. The surface must be free from oil, dust, grease, and any other loose material. Cracks are widened up to 1mm with the help of scrapper and putty knife. Primer coat is applied if the

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

surface is porous and prepared solvent Dr. Fixit crack x-paste and water in a 1:1 ratio. Prepared solvent is applied to fill the crack. Formation of cavities should be avoided during application. It is settled for 24 hours to completely dry.

Step 4: Application of Waterproof Chemical

Once the crack filling paste is completely dried for 24 hours, application of waterproof chemical is done with one coat.

Step 5: Application of Waterproof Paint

Waterproof paint is applied, here Asian paints waterproof paint is applied when the surface is completely dried.

IV. RESULTS AND DISCUSSION

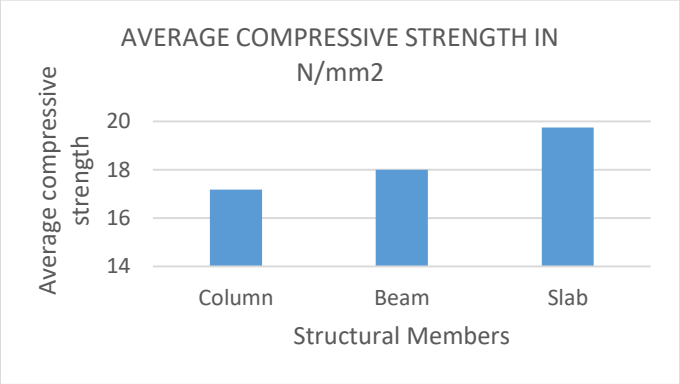


Fig. 11: Rebound hammer test results for Flat 002

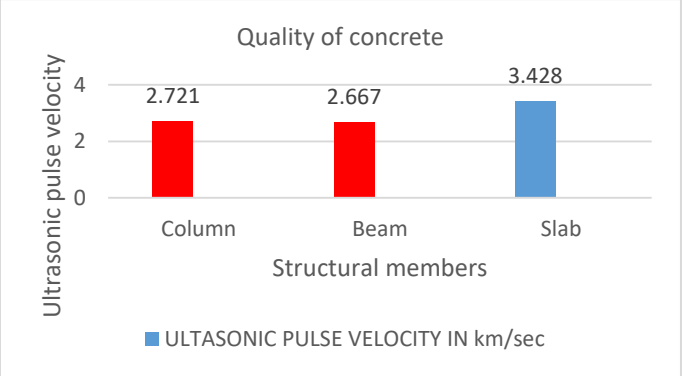


Fig. 12: Ultrasonic pulse velocity test results for Flat 002

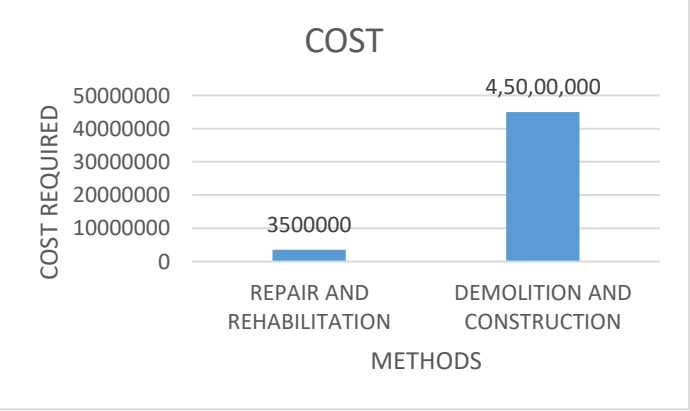


Fig. 13: Comparison between Repair and Rehabilitation and Demolition and Construction for Cost

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

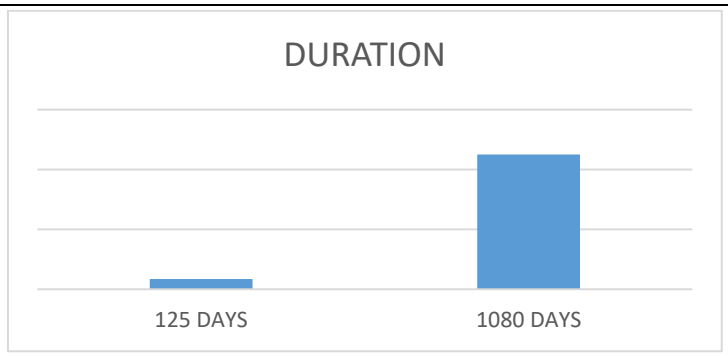


Fig. 14: Comparison between Repair and Rehabilitation and Demolition and Construction for Duration

V. CONCLUSION

- Repair and Rehabilitation is important for structure to avoid future deterioration of structure.
- The tests conducted on the structure were Rebound Hammer test and Ultrasonic Pulse velocity test to determine compressive strength of structure. The graph plotted from rebound hammer test indicates average compressive strength of the structure is less than 20 N/mm^2. It ranges between 15 N/mm^2 to 20 N/mm^2, which is low for existing structure.
- The graph plotted from Ultrasonic pulse velocity test indicates that the pulse velocity of the structure is below 3 km/sec, which indicates poor quality of concrete.
- The lower compressive strength of concrete is due to high permeability of concrete which leads to ingress of harmful agents like carbon-di-oxide and chlorides.
- From the graph plotted above it can be clearly seen that repair and rehabilitation of structure is much more effective than demolition and reconstruction of the building.
- The duration required to complete the repair and rehabilitation process is around 125 days where as demolition and reconstruction of the structure requires almost 1080 days.
- The cost required for entire repair and rehabilitation process is 35 lakh rupees and new construction needs almost 4.5 crore.
- With the method of repair and rehabilitation 93 percent of cost can be saved.
- It also increases the aesthetic appearance of building and much skilled labors are not required. The method is not effective to improve compressive strength of the structure, but has an assurance of almost 5 years for crack filling paste and the interior and exterior paint application.

VI. REFERENCES

[1] "Assessing the Performance of Concrete Structure Based on the width of the Crack using UPV", Journal of Engineering Science and Technology Special Issue on ISSC'2016, April (2017) 17 - 25 © School of Engineering, Taylor's University.

[2] "A Systematic Approach Towards Restoration of Heritage Buildings- A Case Study", International Journal of Research in Engineering and Technology ISSN: 2319-1163.

[3] "Causes of Cracks on Concrete Structures and Repair Methods", International Journal of Latest Engineering Research and Applications (IJLERA) Volume – 07, Issue – 09, September 2022.

[4] "Methodology for Prevention and Repair of Cracks in Building" GRD Journal for Engineering, Volume 3, Issue 3, February 2018.

[5] "Repair and Rehabilitation of R.C.C Structures: A Case Study", GRD Journals, Global Research and Development Journal for Engineering. Recent Advances in Civil Engineering for Global Sustainability, March 2016.

[6] "Repair and Rehabilitation of a Building", International Research Journal of Engineering and Technology (IRJET) Volume 6, Issue 4, Apr 2019.

[7] "Repair and Rehabilitation of R.C.C Structures", International Journal of Innovations in Engineering and Technology (IJIET).

[8] "Review on Repairs and Rehabilitation of Civil Structures", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 8, Issue 12, December 2019.