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Enhancing Structural Integrity: A Comprehensive Analysis and Retrofitting Approach for Strengthening Existing Residential Building

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ABSTRACT

Reinforced Concrete (RCC) buildings, though resilient, are subjected to degradation over time due to various factors such as environmental conditions, design deficiencies, and inadequate maintenance. To ensure their longevity and structural integrity, effective repair and retrofitting methods are essential. This abstract presents an overview of suggested approaches for repairing and retrofitting RCC buildings. Repair methods primarily address localized damages such as cracks, spalling, and corrosion of reinforcement. Techniques like epoxy injection, cementitious grouting, and polymer-modified mortars are commonly employed to restore the structural integrity of damaged elements. Furthermore, carbon fiber reinforced polymer (CFRP) wrapping and steel plate bonding are effective solutions for strengthening weakened members.

Keywords: Retrofitting, Structural Audit, NDT

INTRODUCTION

The structures or buildings may show some sign of distress during their service period and also under the effect of natural calamity like earthquakes, etc. The safety of these buildings is of great concern especially because the loss of most of the lives during collapse of buildings has been reported in the past. The most of the old buildings made of stone masonry/ brick masonry are in existence and require adequate maintenance. At present, most of the buildings are being constructed in Reinforced Cement Concrete, which is assumed to be more durable and stable. The new materials and techniques in the field of construction and maintenance are developed and adopted in strengthening of existing buildings so that the safety of public may be ensured. Many existing buildings do not meet the seismic strength requirements due to design inadequacy, material degradation over time or alteration carried out during the service life of the building. There may be some of the reasons for deterioration of buildings, e.g. the construction of the buildings is never exactly as per designer's specifications and a number of defects and uncertainties crop up during the construction; the quality of the material deteriorates with time and the assessment of an existing building becomes a time dependent problem. It is, however, most important to ensure the safety of such buildings against various loads including loads of natural disasters like earthquakes, floods, cyclones and landslides etc. by applying appropriate retrofitting techniques. The term 'retrofitting' is mainly used in context with the strengthening of weak buildings to make them strong enough to withstand seismic forces through various repairing methods. The main purpose of retrofitting (restoration) is to structurally treat the buildings with an aim to restore its original strength. The retrofitting may be adopted, if the cost of repair and strengthening of building is less than about 50% of the reconstruction cost.

METHODOLOGY

1 Introduction To Methodology

Earthquake around the world are single-handedly responsible for the destruction to life and property in large numbers. To moderate such perils, it is essential to join standards that will improve the seismic execution of structures. Such unserviceable structures require quick consideration. What's more, it was finished by utilizing the shear divider component in the product. Another technique for reinforcing and updating different kinds of solid structures is displayed. The upsides of the present strategy, over traditional retrofitting strategies, are talked about. A writing survey of existing retrofitted structures alongside exploratory works and different investigative and configuration approaches for fortified auxiliary part are presented. The achievability and the viability of the strategy are talked about.

In the current situation, concrete building deterioration is a global issue. There are numerous reasons for this, including the occurrence of natural hazards such as earthquakes, a lack of awareness of several critical and essential codal rules in construction, insufficient supervision, and so on. These factors result in structures that are weak. Overloading structures can result in significant deformations and corrosion, which require immediate treatment. Repair, retrofitting, and strengthening are periodically required actions in the construction business today to overcome all of these effects on reinforced concrete structures. Even newly constructed structures may require repair and strengthening in order to address faults caused by design or construction errors. Damaged structural elements caused by unexpected events such as fire, earthquake, foundation movement, impact, and overload require specialised strengthening, increasing the strength, and restoration techniques.

2. Structural Audit

Structural audits include a comprehensive check of buildings and premises, including: Verification of Load Conditions. Evaluation of the Structural System of the Building. Detection of Structural Defects, Damages, Distress, Deformation or Deterioration. Plan and Alignment Check. Residents and owners of building towards the health examination of existing concrete buildings called as Structural Audit. The need of structural audit is for maintenance and repairs of existing structures whose life has exceeded the age of 30 years to avoid any mishaps and save valuable human life.

2.1. Visual inspection

- A visual inspection is an examination of concrete to identify and define many of the various conditions concrete may exhibit during its service life. The visual inspection is typically limited to the surfaces of the concrete structure that are visually accessible.
- It is important that the inspector properly document any observations related to environmental and loading conditions. Inspections are often supplemented with nondestructive tests, destructive tests, and other investigations, especially when distress and deterioration is observed and information regarding the internal condition of the concrete is needed.
- It is important that the inspector properly document any observations related to environmental exposure (effects from physical loads, deformations, defects, imperfections, and distress), durability, and performance. Concrete material records and construction practices should be collected and reviewed.
- The checklist includes items that might have a bearing on the durability and performance of the concrete. Individuals making the survey should not limit their investigation to the items listed, but should review any other contributing factors. Following the guide does not eliminate the need for intelligent observations and the use of sound judgment.

3. NDT Tests

NDT TESTS FOR COCRETE:-
1. Rebound hammer method.
2. Ultrasonic pulse velocity method.

1.Rebound hammer method:- Schmidt Hammer (or Rebound Hammer) Method Once calibrated, a spring release mechanism is used to activate a hammer which impacts a plunger to drive into the surface of the concrete. After impact, the plunger is locked in its retracted position and a rebound number is recorded (the numbers can range from 10-100). Rebound Hammer test is a Non-destructive testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. The rebound hammer is also called as Schmidt hammer that consist of a spring

controlled mass that slides on a plunger within a tubular housing. The operation of rebound hammer is shown in the fig.1. When the plunger of rebound hammer is pressed against the surface of concrete, a spring controlled mass with a constant energy is made to hit concrete surface to rebound back. The extent of rebound, which is a measure of surface hardness, is measured on a graduated scale. This measured value is designated as Rebound Number (rebound index). A concrete with low strength and low stiffness will absorb more energy to yield in a lower rebound value.

Principle of Rebound Hammer Test

Rebound hammer test method is based on the principle that the rebound of an elastic mass depends on the hardness of the concrete surface against which the mass strikes. The operation of the rebound hammer is shown in figure-1. When the plunger of rebound hammer is pressed against the concrete surface, the spring controlled mass in the hammer rebounds. The amount of rebound of the mass depends on the hardness of concrete surface. Thus, the hardness of concrete and rebound hammer reading can be correlated with compressive strength of concrete. The rebound value is read off along a graduated scale and is designated as the rebound number or rebound index. The compressive strength can be read directly from the graph provided on the body of the hammer.

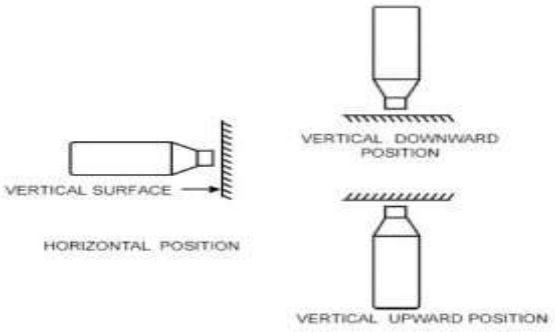

Fig no.1

Fig no 2

2.Ultrasonic pulse velocity method:- Ultrasonic pulse velocity test is a non-destructive testing technique. It can be used to approximately evaluate the internal structural of a material. With rise in the pulse velocity, it can be ascertained that the internal structure of a material is good, well compacted.
Procedure to determine strength of hardened concrete by Ultrasonic Pulse Velocity.:-
i) Preparing for use: Before switching on the 'V' meter, the transducers should be connected to the sockets marked "TRAN" and " REC".

The 'V' meter may be operated with either:
a) the internal battery,
b) an external battery or
c) the A.C line

ii) Set reference: A reference bar is provided to check the instrument zero. The pulse time for the bar is engraved on it. Apply a smear of grease to the transducer faces before placing it on the opposite ends of the bar. Adjust the 'SET REF' control until the reference bar transit time is obtained on the instrument read-out.
iii) Range selection: For maximum accuracy, it is recommended that the 0.1 microsecond range be selected for path length upto 400mm.

iv) Pulse velocity: Having determined the most suitable test points on the material to be tested, make careful measurement of the path length 'L'. Apply couplant to the surfaces of the transducers and press it hard onto the surface of the material. Do not move the transducers while a reading is being taken, as this can generate noise signals and errors in measurements. Continue holding the transducers onto the surface of the material until a consistent reading appears on the display, which is the time in microsecond for the ultrasonic pulse to travel the distance 'L'. The mean value of the display readings should be taken when the units digit hunts between two values.

Pulse velocity=(Path length/Travel time)

v) Separation of transducer leads: It is advisable to prevent the two transducer leads from coming into close contact with each other when the transit time measurements are being taken. If this is not done, the receiver lead might pick-up unwanted signals from the transmitter lead and this would result in an incorrect display of the transit time.

Fig no 3

Pulse Velocity (km/second)	Concrete Quality (Grading)
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful

Table no 1

Fig no 4

RESULT

Interpretation of results and suggestion of retrofitting

1. Visual Inspection of residential building (Gawade Chambers)

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Visual inspection detailed report and suggestions for NDT tests.

CONCLUSION

Jacketing and carbon fiber wrapping offer promising solutions for reinforcing and enhancing the structural performance of residential buildings. Jacketing, typically involving the addition of reinforced concrete or steel plates to the existing structural elements, provides increased strength and stiffness, thereby improving the building's resistance to lateral loads such as wind and seismic forces. This method is particularly effective in addressing deficiencies in the building's lateral load-resisting system, enhancing its overall stability and resilience.

REFERENCES

[1]. Steel Angles and Strips Jacketing of Existing RC Columns: A State of Art Farjana Akter, Md. Hasnul Habib. International Advanced Research Journal in Science, Engineering and Technology Vol. 6, Issue 5, May 2019.

[2]. SEISMIC RESISTIVITY AND RETROFITTING OF RC FRAME BUILDING Mohd. Ikam Ansari, Prof. Rachana Bajaj. Mar.2022 International Research Journal of Engineering and Technology (IRJET) Volume: 09 Issue: 03 | Mar 2022.

[3]. Retrofit of Square Concrete Columns with Carbon Fiber-Reinforced Polymer for Seismic Resistance byRicharD.Iacobucci.ACI StructuralJournal/November-December 2003.

[4]. Art-of-review on CFRP Wrapping to Strengthen Compressive and Flexural Behavior of Concrete Hemanth Kumar Reddy. Revue des Composites et des Matériaux Avancés Vol. 29, No. 3, June, 2019, pp. 159-163.

[5]. Hemanth Kumar Reddy(2019) Art-of-review on CFRP Wrapping to Strengthen Compressive and Flexural Behavior of Concrete [2019] . Revue Composites et des Matériaux Avancés Vol. 29, No. 3, June, 2019, pp. 159-163.

[6]. Richard D. Iacobucci, Shamim A. Sheikh, and Oguzhan Bayrak(2003) Retrofit of Square Concrete Columns with Carbon Fiber-Reinforced Polymer for Seismic Resistance ACI Structural Journal/November-December 2003.

[7]. Mohd. Ikam Ansari, Prof. Rachana Bajaj (2022) SEISMIC RESISTIVITY AND RETROFITTING OF RC FRAME BUILDING International Research Journal of Engineering and Technology (IRJET) Volume: 09 Issue: 03 | Mar 2022.

[8]. S. Sirimontree, S. Keawsawasvong(2021) Experimental Investigations on Strengthened Reinforced Concrete Columns under Monotonic Axial Loading. IJE TRANSACTIONS B: Applications Vol. 34, No. 05, (May 2021) 1124-1131

[9]. M C GRIFFITH And A V PINTO(1999) SEISMIC RETROFIT OF REINFORCED CONCRETE BUILDINGS - A REVIEW AND CASE STUDY ACI Structural Journal, Vol. 92(5), pp. 597-609.

[10]. Improving the Strength of Existing Building Using Retrofitting Techniques Mr.S.MAHESH1 , Mr.CH.SANDEEP REDDY2, Mr.P M B RAJ KIRAN NANDURI3, Mr.P. BIKKU UGC Care Group I Journal Vol-12 Issue-08 No. 07 August 2022.