IJITCE

ISSN 2347- 3657

International Journal of Information Technology & Computer Engineering

Email : ijitce.editor@gmail.com or editor@ijitce.com

International Journal of Information Technology & Computer Engineering

ISSN 2347–3657

Volume 12, Issue 2, 2024

REPAIR AND REHABILITATION OF CONCRETE STRUCTURES

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ABSTRACT

Reinforced cement concrete (RCC) as a construction material has come into use for the last one century. In India, RCC has been used extensively in the last 50- 60 years. During this period, we have created a large number of infrastructural assets in terms of buildings, bridges, sports stadiums etc., which are lifelines for the civilized society. These have been created with huge investment of resources. We cannot even dream of recreating such assets out of limited national resources. It is therefore more essential to maintain them in functional condition. Since, deterioration of RCC is a natural phenomenon and has started exhibiting in a large number of structures, a systematic approach is needed in dealing with such problems. Identification of the causes of deterioration and consequent repair/rehabilitation strategy at optimum cost needs a scientific evaluation and solution.

As a result, the factors considered necessary for durability of RCC buildings are many times not given due importance during construction and/or during maintenance. In the international scenario also, deterioration of RCC had been drawing attention of the practicing civil engineers for quite some time. They have accordingly, made certain advancement in the field of protection, repairs, rehabilitation, strengthening and retrofitting of the existing RCC structures taking advantage of the advancement in the materials science, more particularly the polymer science. The knowledge in this area among the Civil Engineers in India is still at infancy stage and needs development and systemic dissemination.

Key words: RCC (Reinforced Cement Concrete), Deterioration, Maintenance, Rehabilitation, Durability, Retrofitting, Polymer Science.

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1. INTRODUCTION

Large stocks of existing structures and infrastructure are deteriorated with use and time and might have passed their design life and require retrofitting and rehabilitation. The cost of retrofitting various infrastructures is estimated in the lakhs of rupees. To overcome the ill effects caused by these deteriorated buildings Repair and Rehabilitation works are carried out from time to time. Many of the existing structures were designed to codes that have since been modified and upgraded. Change in use or higher loads and performance demands require modifications and strengthening of structural elements.

Concrete construction is generally expected to give trouble free service throughout its intended design life. However, these expectations are not realized in many constructions because of structural deficiency, material deterioration, unanticipated over loadings or physical damage. Premature material deterioration can arise from a number of causes, the most common being when the construction specifications are violated or when the facility is exposed to a harsher service environment than those expected during the planning and design stages. Physical damage can also arise from fire, explosion as well as from restraints, both internal and external, against structural movement. Except in extreme cases, most of the structures require restoration to meet its functional requirements by appropriate repair techniques.

The human body deteriorates upon aging. To a certain extent, the problem can be remedied by taking necessary preventive steps at the appropriate time. This is exactly the case with buildings. As time passes, the condition of buildings also becomes deteriorated. Unless corrective measures are taken, it may so happen that the safety of the building itself may be jeopardized.

There are other factors that necessitate renovation. These are accidents, environmental factors, alteration to structures, etc. The construction associated with already-constructed structures is called renovation. Some people call

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the process of rehabilitation "Forensic Engineering." The role of the engineer is just like that of a doctor trying to diagnose the disease of a patient and then recommending corrective treatment. Maintenance of constructed structures includes preventive care, repairs, and rehabilitation.

2. LITERATURE REVIEW

Chris Ppantelides, Chandra Clyde, Lawrence D Reaveley: Reinforced concrete buildings that were built in the 1960's do not meet current design criteria and behave in a non ductile manner. In this paper, beam column joints of such non ductile buildings are investigated. Half scale R/C corner joints were tested for the purpose of investigating their behavior in a shear type of failure due to diagonal tension. In addition the as is specimens, an identical corner joint was retrofitted with FRP composites to determine the improvement in ductility and joint shear capacity that could be achieved. The proposed method of strengthening the beam column joints with FRP composites jacket is relatively new; existing techniques include R/C jackets, glued steel plates and X shaped prestressed collars.

Abhijit Mukharji, Mangesh Joshi: Cement concrete reinforced with steel bars is an extremely popular construction material. One major flaw, namely its susceptibility to environmental attack, can severely reduce the strength and life of these structures. External reinforcement using steel plates have been used in earlier attempts to rehabilitate these structures. The most important problem that limited their wider application is corrosion. Recent developments in the field of fiber reinforced composites (FRCs) have resulted in the development of highly efficient construction materials. The (FRCs) are unaffected by electromechanical deterioration and can resist corrosive effects of acids, alkalis, salts and similar aggregates under a wide range of temperatures.

M.C. Baker: The building envelope provides the separation between inside and outside environments and controls flows of mass and energy. Rehabilitation of buildings usually involves new interior

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conditions that will normally impose a more severe service environment for the building envelope than existed in the original building. The walls and roofs have to be designed to maintain the separation of the two dissimilar environments without deterioration and this should take precedence over restoration considerations. The paper deals with the upgrading of walls and roofs to increase air tightness, reduce rain penetration and conserve energy use. It discusses the effect of insulation on the envelope performance and the types of wall and roof modification that are possible. Exterior cladding and insulation on the exterior of walls, controlled buffer spaces for walls and exposed insulation in the protected membrane mode for the roof is considered.

Prof. R.G. Limaye and Devendra Limaye : Repairs and rehabilitation is a cause of concern to the structural designer and owners . Being a heterogeneous combination of old and new material, affected farther by bonding between old and new materials ,standard NDT technique are not directly applicable to assess the strength gain for the structural members .Using various NDT methods , this paper intends to highlight typical methods used to insure execution of repairs and rehabilitation to deliver assured quality. In addition ,the paper analyzes the root causes of quality

issues , methods to overcome the same ,use of the latest computing and mobile technology for mass adoption.

3. DIFFERENT TYPES OF REPAIRS AND REHABILITATION WORKS FOR DIFFERENT STRUCTURAL COMPONENTS:

Repair for Plaster of walls:

It is usually better to go in favor of repairing plaster walls, regardless of what they look like. But honestly, this is not always possible. Basically, if:

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- There is more than 1 large hole per 4 x 8 Sq. ft
- There are more than 3-4 cracks in 100 Sq. ft,
- The cracks are more than 1/4"

Then replace the section of wall. It

will take more time and failed attempts to repair this wall than it is worth. Old plaster should be cherished. sand more sound proof than current walls made of gypsum board or sheetrock.

Plaster Damage (Non-Structural Problems)

Plaster is pretty tough stuff, but like any wall, it's going to get banged or gouged, and age will take its toll.

Impact Damage can be serious problem in an old house. Over the years, the walls are going to get banged and dented as shown in the figure. Generally, we have to replace the plaster 6-12" from the visible hole to reach plaster that is still keyed to the lath tightly.

For repair of minor cracks, use fiberglass mesh tape then go over with a wide trowel and joint compound. There are also plaster patch compounds available that are excellent.

Plaster damage of wall

For larger cracks and holes, we need to remove all the debris and enlarge the crack until we reach solid plaster and fill the crack with joint compound

Repair for Cracks in Structure:

Crack: A line on the surface of something along which it has split without breaking apart. If crack is not properly treated, it will affect the strength of wall/slab which ultimately leads to failure of that component.

4. METHODS OF REPAIR & REHABILITATION FORSLAB/WALL CRACKS:

Stitching:

Stitching involves drilling holes on both sides of the crack and grouting

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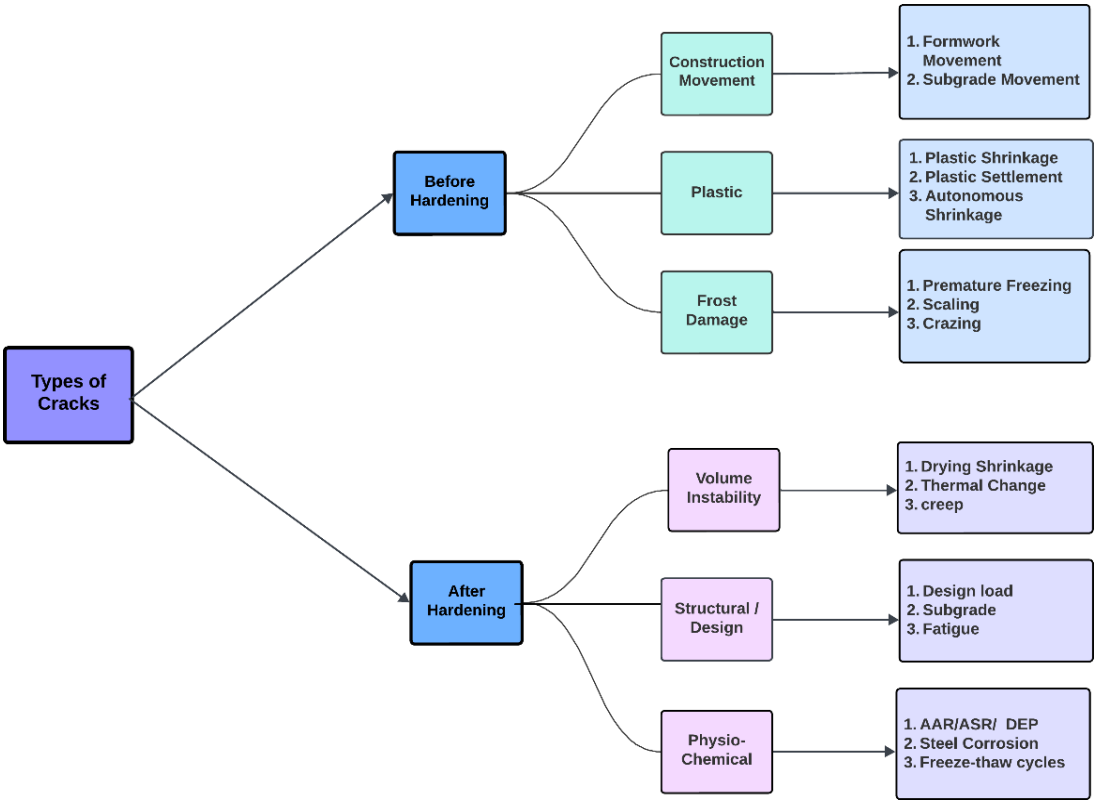
in U- shaped metal units with short legs (staples or stitching dogs) that span the crack as shown in figure.

Repair of Wall Crack using Stitching

Stitching may be used when tensile strength must be reestablished across major cracks. The stitching procedure consists of drilling holes on both sides of the crack,



cleaning the holes, and anchoring the legs of the staples in the holes, with either a non-shrink grout or an epoxy resin-based bonding system. In this technique, the crack is bridged with U-shaped metal units called stitching dogs before being repaired with a rigid resin

material. A non- shrink grout or an epoxy resin-based adhesive should be used to anchor the legs of the dogs. Stitching is suitable when tensile strength must be reestablished across major cracks. Stitching dogs should be of variable length and orientation.

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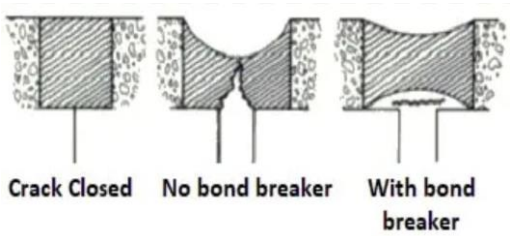
Routing and Sealing:

Routing and sealing of cracks can be used in conditions requiring remedial repair and where structural repair is not necessary. This method involves enlarging the crack along its exposed face and filling and sealing it with a suitable joint sealant as shown in the figure. This is a common technique for crack treatment and is relatively simple in comparison to the



procedures and the training required for epoxy injection. The procedure is most applicable to approximately flat horizontal surfaces such as floors and pavements. However, routing and sealing can be accomplished on vertical surfaces (with a non-sag sealant) as well as on curved surfaces (pipes, piles and pole).

Routing and sealing are used to treat both fine pattern cracks and larger,

isolated cracks. A common and effective use is for waterproofing by sealing cracks on the concrete surface where water stands, or where hydrostatic pressure is applied. This treatment reduces the ability of moisture to reach the reinforcing steel or pass through the concrete, causing surface stains or other problems.

PROCEDURE:

The procedure consists of preparing a groove at the surface ranging in depth, typically, from 1/4 to 1 in. (6 to 25 mm). A concrete saw, hand tools or pneumatic tools may be used. The groove is then cleaned by air blasting, sandblasting, or water blasting, and dried. A sealant is placed into the dry groove and allowed to cure. A bond breaker may be provided at the bottom of the groove to allow the sealant to change shape, without a concentration of stress on the bottom

groove to allow the sealant to change shape, without a concentration of stress on the bottom.

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5. RCC STRUCTURES REPAIRS:

Shotcreting/ Guniting:

Shotcrete is the process of pneumatically applying concrete onto various surfaces at high velocity is as shown in the figure There are two primary application methods: the wet process pumps mixed concrete through a hose to the nozzle where compressed air is added to provide high velocity for placement and consolidation; the dry process, commonly known as gunite, uses compressed air to blow pre-blended dry materials through a hose at high velocity to the nozzle, where water is added. The effects in most cases are almost identical.

RCC Jacketing

Reinforced concrete jacketing increases the member size significantly. This has the advantage of increasing the member stiffness and is useful where deformations are to be controlled. If columns in a building are found to be slender, RC jacketing provides a better solution for avoiding buckling problems as shown in the figure below.

Design for strengthening/repair work is based on composite action between the old and the new work. Strain compatibility calculations may have to be carried out carefully giving due accounts to factors such as creep. As the new jacket is to behave compositely with the parent member, the new jacket can take additional loads only with the increase in the stresses & strains in the old one. The problem arises if the;

- Old concrete has reached limiting strain and is not likely to sustain any more significant strain.
- Old concrete is weak and

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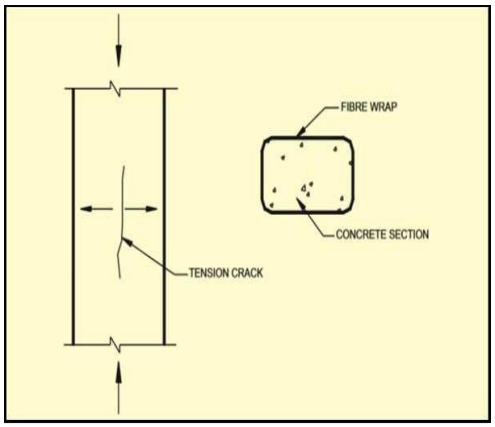
porous and started deteriorating due to weathering action and corrosion of reinforcement.

The question then arises as to whether the composite action should be abandoned and the new jacket (plate or RC) designed to carry the entire load. It is perhaps best to design the strengthening in this manner, but detailing must be right to ensure transfer of load to the new jacket, if the old concrete fails. It is however, necessary to ensure perfect bond also between the old and new concrete by providing shear keys and effective bond coat with the use of epoxy or polymer modified.

Fiber Wrap Technique

The fiber wrap technique, also known as Composite Fiber System is an on-intrusive structural strengthening technique that increases the load carrying capacity (shear, flexural, compressive) and ductility of reinforced concrete members without causing any destruction or distress to the existing concrete.



FOUNDATION REHABILITATION METHODS:

The methods to repair and rehabilitate a structure having foundation distress generally involve shoring & underpinning work for structures that are out of plumb, or are sensitive to effects of small settlement etc.
Methods of rehabilitation:

1) Shoring
2) Under Pinning

Shoring:

Shoring means support or propping. Before any shoring work is commenced, the building should be

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carefully surveyed & record of levels, cracks & tilts kept. The observations should be continued throughout the period of shoring under pinning and till the time when detectable measurements have ceased.

Repair of damaged foundation

Underpinning:

Underpinning is the process of strengthening and stabilizing the foundation of an existing building or other. Foundation underpinning is a means of transferring loads to deeper soils or bedrock. Figures below shows the supporting of walls of structure and then repairing the foundation.

Purpose of under pinning:

- To obtain additional foundation capacity.
- To modify the existing foundation system.
- To create new foundations through which the existing load may be wholly or partially transferred into deeper soil
- To arrest the excessive settlement.
- To improve the future performance of the existing foundation

Underpinning supporting walls

- Construction of a new project with deeper foundation adjacent to an existing building.
- Change in the use of structure.
- The properties of the soil supporting the foundation may have changed or was mischaracterized during planning.
- To support a structure this is sinking or tilting due to ground subsidence or instability of the super structure.

Methods for underpinning:

- Pit Underpinning
- Push Piers System
- Helical Pier System
- Pile Underpinning

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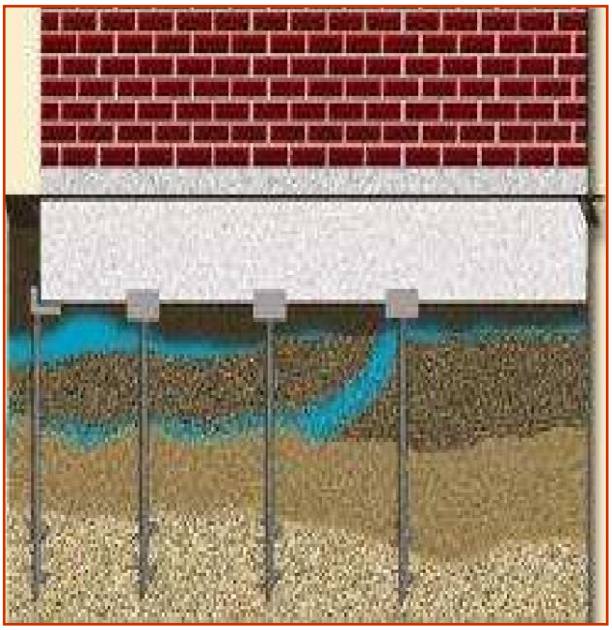
- Other Methods
- Micro-piles
- Chemical Methods
- Micro-fine grouting

Helical Pier System Repairing:



Helical Pier System-Repaired Foundation

- Helical piers, also known as anchors, piles or screw piles, are deep foundation solutions used to secure new or repair existing foundations.
- Due to their design and ease to install, they are most commonly used whenever soil conditions prevent standard foundation solutions.
- Helical piers have a higher cost than concrete piers and steel piers
- Helical pile designers will estimate a lifespan of approximately 150 years.
- Round shaft piers are best used in compression applications. These piers have a greater load capacity and lateral strength.

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6. CONCLUSION

- Each and every problem should be properly analyzed and then the appropriate repair methods undertaken.
- Each repair technique is suitable only for the particular application for which it is meant for.
- Cost should not be significant planning factor in rehabilitation though it is a deciding factor.
- Due to moisture, walls get patch off and brick walls losses its strength, so the mentioned repair works for bricks and plaster of walls should be done.
- Due to some adverse conditions cracks will form in walls and slab which disturbs the functioning of structure, so the earlier mentioned methods are very useful for repair of cracks and rehabilitation of structure.
- RCC structures gets deteriorated due to corrosion of steel which ultimately results in improper functioning, so above mentioned methods like RCC jacketing, Guniting/Shortcrete etc., are very useful in rehabilitation of structures.
- Due to improper settlement of underlying soil the foundation damaged by which all the overlying structure may get disturbed, so for the repairs of foundations methods like Shoring and Underpinning are recommended.

7. REFERENCES

1. Handbook On Repair and Rehabilitation of RCC Buildings Published by Director General (Works), Central Public Works Department, Government of India, Nirman Bhawan.
2. International Journal of Engineering Sciences & Research Technology on Repair and Rehabilitation of Structures (2014).
3. Journal On “Repair and Rehabilitation of RCC Structures” By P P Ambedkar M.E, Civil
4. S N Sinha, RCC Design, Tata McGraw-Hill Publications Ltd-2002.
5. Sivananda “Rehabilitation Indian Concretional”, December-2002, Vol 76.
6. Allen R.T.C, Repair of

ISSN 2347–3657

Volume 12, Issue 2, 2024

Concrete Structures.

7. Broomfield, J.P., "Corrosion of Steel in Concrete: Understanding, Investigation and Repair," E & FN Spon, 1997.
8. Neville, A.M., "Properties of Concrete," Longman, 2011.
9. Mehta, P.K., and Monteiro, P.J.M., "Concrete: Microstructure, Properties, and Materials," McGraw-Hill Education, 2006.
10. Emmons, P.H., "Concrete Repair and Maintenance Illustrated: Problem Analysis, Repair Strategy, Techniques," R.S. Means Company, 1993.
11. Ghosh, S., "Repair and Rehabilitation of Steel and Concrete Structures," S.K. Kataria & Sons, 2010.
12. Alexander, M.G., and Bauhausian, H.D., "Durability, Design, and Construction Quality of Concrete Structures," CRC Press, 2019