

# Repair, Rehabilitation and Retrofitting of Reinforced Concrete Structures

## By using Non Destructive Testing Methods

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**Abstract**— Repair, rehabilitation is very important in any construction of structure. Due to aging and life increasing of the structure, it is subjected to repairs. Repairs leads to damage and failure of structure. So, in order to prevent damages and repairs in the structures these are very useful. These are achieved by selection of suitable methods and proper construction and maintenance of the structure. By using suitable retrofitting methods, we can minimize the losses and damages in the construction of reinforced cement concrete structures. Proper supervision is required for maintenance. Regular inspection and periodical inspections are plays very good role in strengthening of the structure. Repairs are done by using suitable methods. These are used to increase the durability of the structure but not in the form of strength aspects. Rehabilitation done before construction of structure to strengthening of structural elements. Retrofitting is done after construction of the structure to strengthening the structure. These are used to prevent and withstand the upcoming defects like earthquakes etc. these are used to improve strength at during construction stage and as well after construction stages. The minor defects are fixed easily by using resin injection or grouting or any other suitable methods and the main problem is to deal the major defects. It takes more time to set. So, repair and rehabilitation and retrofitting of structures are needed for every structure to continue the structure in economical point of view and prevent damages. It is also helping to maintain a structure in good condition and good performance as well. To improve strength aspect and as well as performance aspect and functional utility of structure.

**Keywords**— Renovation, Re design, Demolition, Cracks, Corrosion, Concrete, strength.

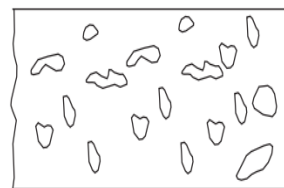
### I. INTRODUCTION

Every structure is important for any purpose in daily life. After using of the structure, some days it is subjected to several damages and various repairs. So, the main important of using these methods to improve the strength and durability and to make an impervious layer to the reinforced concrete structures to avoid the repairs. Now a days this importance is going to increase worldwide. The results are also good and acceptable for the reinforced concrete structures. In this paper explains the importance of rehabilitation and also explains about some important retrofitting methods for the reinforced concrete structures. In this one thing is clearly understand about concrete is a universal material used for construction in reinforced

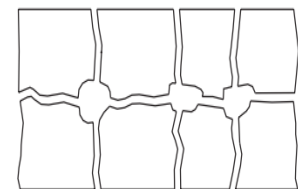
concrete structures. day by day the usage of concrete in reinforced structures are increases. The main important thing we can understand about concrete is it is not a maintenance free material. so, the concrete structures are requiring regular inspections and maintenances to achieving more life span to the structures.

### II. LITERATURE REVIEW

The strength of structures is depending on size and shape of the concrete. The amount of concrete is placed in structures based on suitable mix proportions in the reinforced concrete structures. in this one thing is understand that concrete is porous and it is subjected to some voids. Due to filling of that voids with water and reaction of water in the reinforcement concrete structures leads to formation of corrosion in the concrete structure. It may lead to severe damage in reinforced concrete structures.



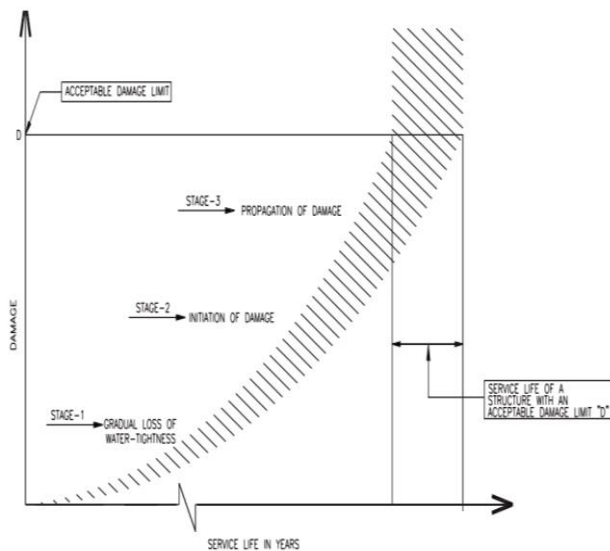
a) POROUS BUT IMPERMEABLE STRUCTURE - DURABLE



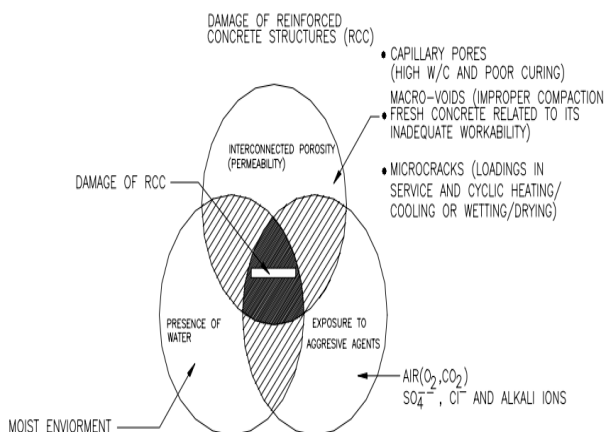
(b) POROUS BUT PERMEABLE MATERIAL - NON-DURABLE

In this above figure we can clearly understand that pores are present in the concrete structures. for the most durable concrete structures voids or pores are minimum and it is also subjected to impermeable. In the first figure we can understand that concrete is porous and also it is impermeable. So, this type of concrete is very good and durable in concrete structures. in the second figure we can understand that the concrete is also porous and it is not permeable. So, this type of concrete is not good and non-durable for concrete structures.

### III. METHODOLOGY



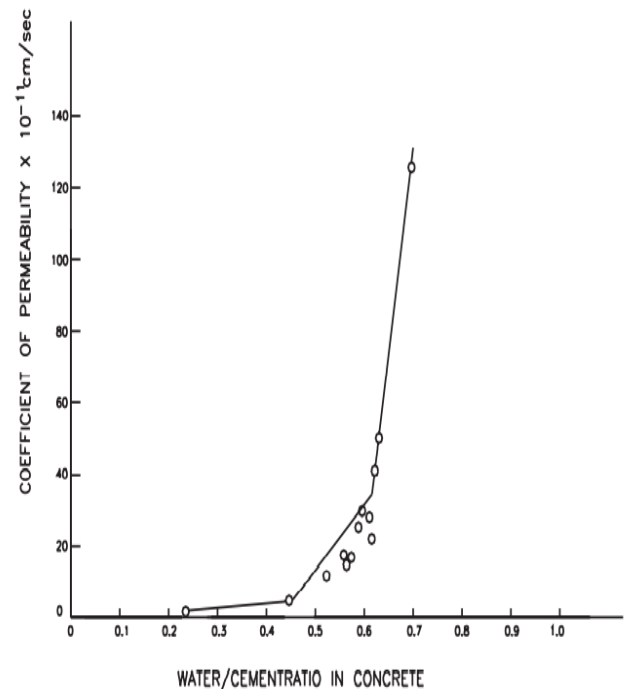
In the above figure we can understand about damages to the concrete structures with respect to the service life in years. In this there are three important zones with respect to damages. These are three zones which are mostly used for analysis. In the first stage the structure is subjected to damage due to water. By passing of water into the concrete structures it may leads to formation of corrosion in the concrete structures. in the second stage damages are started and subjected to problems in the reinforced concrete structures. in the stage three the damages are increased rapidly and finally structure is subjected to major damages and repairs. In order to prevent this type of damages in concrete structures we can identify the problem in early stage and solve it by using suitable repair materials. If we are not identifying the damages in early stage which results increasing of damages in each zone with respect to the service life of the reinforced concrete structures.



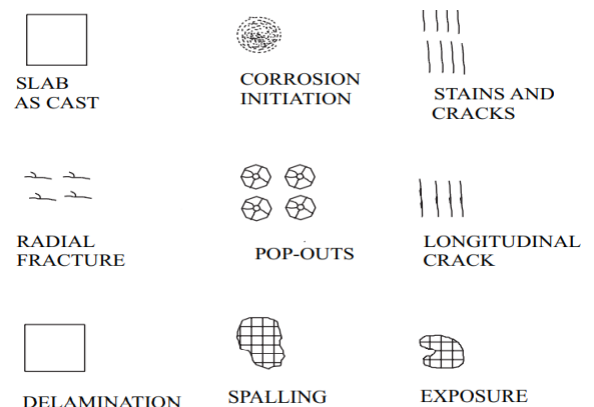
### IV. REASONS FOR REPAIRS

- Permeability
- Curing
- Hydration
- Water cement ratio
- Air voids

- Improper compaction
- Over loading
- Over stresses
- Poor quality works
- Improper design



From the above figure we can understand that coefficient of permeability of concrete with respect to water cement ratio in the concrete. If the amount of water cement ratio increases which results in increasing in coefficient of permeability in the concrete structures and then decreases the strength of the concrete as well. If amount of moisture increases in concrete surface which results concrete become loose and lost its strength and durability and it can be weak compared to normal strength of the concrete.



### V. TESTS USED

There are number of tests are available for repairing the reinforced cement concrete structures. in this we have mainly discuss on NDT tests. By using these tests, we can clearly identify damages and location of damage surfaces in the structure and also examined type of damage and severity of the damages in the reinforced concrete structures. most of tests are gives acceptable and good results. By following

details gives an idea about tests and its uses and details as well.

S.No.	Tests	Details
1.	Rebound Hammer	A Qualitative field test to measure surface hardness of concrete
2.	Ultrasonic Pulse Velocity	A Qualitative field test to measure surface integrity and homogeneity of concrete structures
3.	Windsor Probe	Field test to measure strength of concrete
4.	Pull out	To Determine the compressive strength of concrete
5.	Pull off	To Determine the tensile strength of concrete

In the above figure we can understand about damage of reinforced concrete structures with respect to water content and environmental exposure conditions etc. due to permeability and moisture content and environmental agents are leads to formation of damages in the reinforced concrete structures. the chemical reactions are playing an important role in leading damages in concrete structures.

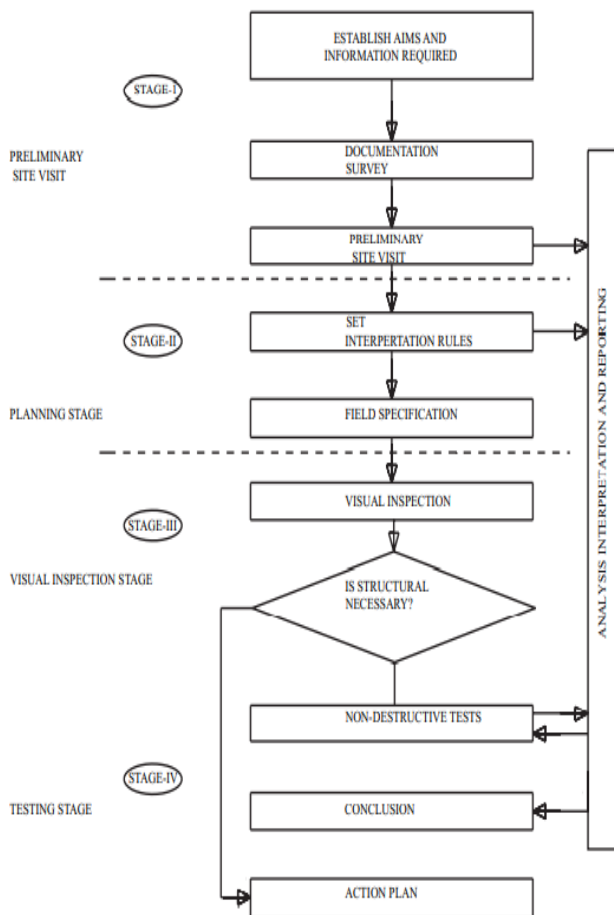


Fig. Visual Inspection

## VI. RETROFITTING METHODS

These are the important methods and it can be used to improve the structural capacity and structural strength and as well as increase the structural durability. The main aim of this is to reduce the damages and to make an impervious or non-absorbing layer or surface to the concrete structures. in this paper we can discuss some of the important techniques and uses in the concrete structures.



Fig. Resin Injection



Fig. Stitching



Fig. Routing





Fig. Damaged structure



Fig. Guniting

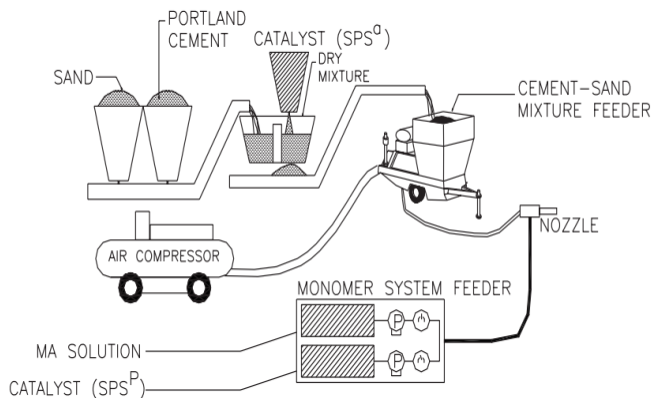
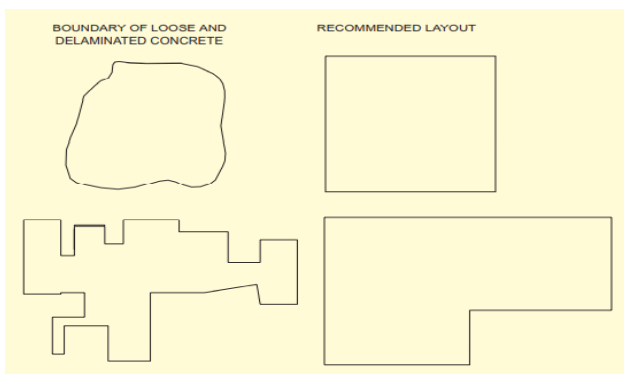


Fig. Polymer Modified Concrete

## VII. RECOMMENDED AREA OUTLET



For proper repairing of any damages area outlet also plays an important role to repair the damages. If the area of layout is in regular or linear manner then the repairing of reinforced concrete structure is easy. if the area of layout is irregular and non-uniform then the repairing of damages is complex compared to uniform structures. so, it is indirectly placing an important role for concrete structures.

## VIII. CONCLUSION

To ensure a structure in safely and in order to prevent damages repair and rehabilitation of concrete structures are necessary. There are lot of researches is going on repairing methodologies and development of strength in the concrete structure. It can be used to reduce the risks and with stand the environmental effects to the reinforced concrete structures. the study of repair and rehabilitation is most useful to gain knowledge on concrete structures and its repairs.

## ACKNOWLEDGMENT

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