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Repair and Rehabilitation of RCC Structures Using NDT Techniques

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***Abstract*: In this paper discusses about the review of repair and rehabilitation of RCC building by using non -destructive techniques. We have inspected "school building" at chidambaram to check the building component for the purpose to find out current structural condition and its strength properties. This paper brings out the present state of G+2 storied of RC framed structure as the intensity and damage is indicatively severe and exhibits. As the extended movement corrosion of the steel reinforcement take place. Overall structural condition of the building does not look to satisfactory since the building elements are to be analyzed and some recommendations are to provide for the rehabilitation work. The determination of work can be executed in the field of school building.**

***Keywords*: Carbonation, Non-destructive resting, Polymers, Reinforcement corrosion.**

1. Introduction

The crack and damages in building can be restoring by using repair and rehabilitation techniques. This technique can be analyses the cracks and test results to determine the material used for repair work. This technique is used for the rehabilitation of structure restoring its original function and structural strength. Normal determination due to the shrinkage of cracks and carbonation effects. Corrosion reinforcement leads to the spalling of cover concrete thus reduces the strength of the structure.

In this techniques carried out to identify the cracking, spalling (or) any other by the structural and Non-structural members. The structural cracks are plays major role due to improper design, fault construction or overloading and these may endanger the safety of a building and their inmates. The non-structural cracks are like creep, vegetation, settlement, etc. these are formed by many aspects.

The repair and rehabilitation of structure include the following stages:

- Investigation of cracks
- Monitoring
- Testing and analysis
- General repair
- Concrete durability

A. Literature review

Dennis L Bean (1985): Submitted a report on how to use epoxy resins as grouting material. In his findings he said that it is possible to restore the tensile strength of cracked concrete structural elements by injection of an adhesive material through injecting it into the cracked concrete.

Ying Luo, Ziping Wang, Baiqiaing Xu (2012): Conducted his findings in accordance with Stack Migration Imaging Technology which is an advanced imaging technique used in geophysical exploration. Ultrasonic transducers were utilized as both actuators and sensors to generate and receive stress waves in the concrete.

2. Preliminary investigation

To determine the sign of damage and its age and to observe the type of loading and design of structure. Further classify the what kind of tests are to carried out for the building based on the type of cracking under visual inspection.

The preliminary investigation plays important role in analysis of type of failure and how it happens, loading condition of building, carbonation depth in concrete, permeability of affected concrete, causes of dampness, etc. are to analyzed under preliminary investigation.

3. Detailed investigation

Detailed investigation will be carried out the width of crack and its causes like carbonation, temperature changes, corrosion of reinforcement, alkali aggregate reaction, sulphate attack, etc.

A. Carbonation effect

Carbonation effect of concrete is associated with the corrosion of steel reinforcement and with shrinkage. However, it also increases both the compressive strength and tensile strength of concrete, so not all its effects on concrete are bad.

B. Alkali aggregate reaction

Alkali aggregate reaction is a term mainly referring to a reaction which occurs over time in concrete between the highly alkaline cement paste and non-crystalline silicon dioxide, which is found in many common aggregates.

4. Testing method using NDT

A. Rebound hammer test

It helps to determine the average compressive strength of concrete by the NDT technique. It determines the quality of concrete in standard requirement. It assessing the quality of concrete and uniformity of concrete.

Application of surface hardness measurement:

a) Checking the uniformity of concrete**.**
b) Comparing a given concrete with a specified requirement.
c) Approximate estimation of strength by using laboratory calibrated graphs**.**
d) Abrasion resistance classification.

Interpretation of results:

Results will not be the same in case of internal micro-cracking or heterogeneity across the cross section. The probable accuracy of concrete strength in a structure is +/- 25%. The accuracy of results and confidence are greatly increased if the relationship between rebound index and compressive strength is obtained from the structure and standard specimen like concrete cubes.

Table 1
Quality of cover concrete from rebound hammer

Sr. No.	Average Rebound Number	Quality of Concrete
1	Above 40	Very good hard layer
2	30 to 40	Good layer
3	20 to 30	Fair layer
4	Below 20	Poor layer
5	0	Delaminated

B. Ultrasonic pulse velocity (UPV) test

It is carried out in electromagnetic acoustic transducer (EMAT). It diagnosis the signal with amplitude representing the intensity of the reflection and distance. It representing time of the reflection and transmitting of frequency.

Three possible way of measuring pulse velocity are

a) Direct transmission
b) Indirect or surface transmission
c) Semi-direct transmission.

Interpretation of result:

The Homogeneity of the concrete, the presence of cracks, voids and other imperfections, changes in the structure of the concrete which may occur with time, the quality of the concrete in relation to standard requirement, the quality of one element of concrete in relation to another and concrete quality can be assessed by UPV test.

Table 2
Quality of concrete from UPV

S. No.	Avg. Velocity	concrete Quality
1	Above 4.5 km/sec	Excellent
2	3.5-4 .5 km/sec	Good
3	3.0-3.5 km/sec	Average
4	Below 3.0 km/sec	Doubtful

5. Experimental study

A. Rebound hammer test

A minimum of 10 reading is compared and each reading should not differ by more than 7 units'. The average of remaining readings is determined for evaluating the strength. If more than two reading differ from the average by 7 units.

Around each point of observation, six readings of rebound indices are taken 2nd average of these readings after deleting outliers as per IS 8900: 1978 becomes the rebound index for the point of observation.

Fig. 1. Rebound Hammer Test

Table 3
Test result from rebound hammer

S. No.	Member and level	Test on location member	Rebound hammer result with direction
1	C1- G	MID-C	HOR -31
2	C2- G	MID-C	HOR-26
3	C3- G+1	MID-C	HOR-34
4	C4- G+1	MID-C	HOR-24
5	C5- G+1	MID-C	HOR-26
6	C6- G+1	MID-C	HOR-19
7	S1- G+1	EDGE-S	VUP-25
8	S2- G	EDGE-S	VUP-35
9	B1- G	END-B	HOR-18
10	B2- G+1	END-B	HOR-34

Note: S-slab, B-beam, C-column, G-ground floor, G+1- first floor, HOR-horizontal to direction, VUP- vertically upward direction.

B. Ultrasonic pulse velocity (UPV) test

The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformity is good.

In case of poorer quality, lower velocities are obtained. If there is a crack, void or flaw inside the concrete which comes in the way of transmission of the pulses, the pulse strength is attenuated and it passes around the discontinuity, thereby making the path length longer.

Fig. 2. UPV Test

Note: S-slab, B-beam, C-column, G-ground floor, G+1- first floor.

Table 4
Test result from UPV

S. No.	Member	Test on location member	Ultrasonic pulse velocity result (km/sec)
1	C1-G	MID-C	3.7(Good)
2	C2-G	MID-C	3.28(Average)
3	C3-G	MID-C	3.7(Good)
4	C4-G	MID-C	3.23(Average)
5	C5-G	MID-C	3.4(Average)
6	C6-G	MID-C	2.5(Doubtful)
7	S1-G	EDGE-S	3.3(Average)
8	S2-G	EDGE-S	3.7(Good)
9	B1-G	END-B	2.1 (Doubtful)
10	B2-G	END-B	3.67(Good)

6. Result and recommendation

The rebound charts are to provide to find the compressive strength of concrete based on rebound number values, and the recommendations are provided.

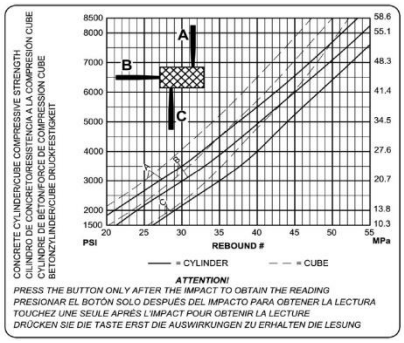

Fig. 3. Rebound chart for compressive strength of concrete

Rehabilitation material for cracks:

- Epoxy Resin.
- Cement Mortar.
- Polymer Concrete.

Techniques used for cracks in field:

1. Epoxy Injection
2. Routing and Sealing
3. Stitching method (for reducing widening of crack).

A. Epoxy Injection


Fig. 4. Epoxy injection to column

Epoxy injection is an economical method of repairing non-moving cracks in concrete walls, slabs, columns and piers as it is capable of restoring the concrete to its pre-cracked strength. The technique generally consists of establishing entry and venting ports at close intervals along the cracks, sealing the crack on exposed surfaces, and injecting the epoxy under pressure.

B. Routing and Sealing

In this method, the crack is made wider at the surface with a saw or grinder, and then the groove is filled with a flexible sealant. This is a common technique for crack treatment and it is relatively simple in comparison to the procedures and the training required for epoxy injection. It can be done on vertical surfaces and curved surface.

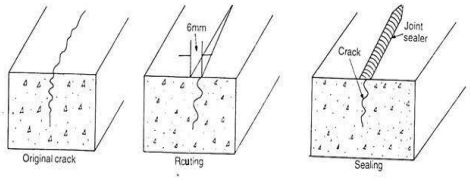

Fig. 5. Routing and sealing in cracked surface

C. Stitching

This method is done to provide a permanent structural repairs solution for masonry repairs and cracked wall reinforcement. It is done by drilling holes on both sides of the crack, cleaning the holes and anchoring the legs of the staples in the holes with a non-shrink grout.


Fig. 6. Stitching of cracks

7. Conclusion

Though it is impossible to guarantee against cracking yet attempts can be made to minimize development of crack. In case of existing cracks, after detail study and analysis of crack parameters, most appropriate method of correction should be adopted for effective and efficient repair of crack.

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