

Damage Assessment and Economical Repair Methodologies for Residential RCC Structures

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Abstract— In this study damage assessment and economical repair methodologies have been accessed for some types of RCC residential buildings located in various areas of Bhopal by using rebound hammer testing. This study gives the noticeable results in finding the economical methodologies of reinforced concrete repairing methodology.

Key words: Damage Assessment, Repair Methodology, RCC Structures, Non-Destructive Test, Economical Repair Techniques, Compressive Strength

I. INTRODUCTION

In this research paper, the detailed information about the work done i.e. all types of damage assessment and technological analysis of repair methodologies are given. The damage in buildings and structures are found on the basis of visual inspection and by the application of NDT. Also the NDT test is applied on the respected area surrounded to inspected damage to measure its strength. The assessment of damage tells about the availability of repair methodologies that can be applied on the found damage. I have analyzed the available methodologies of repairing and then decided to find a manner of repairing technique that is economic, specific and generalized for the inspected damage.

Here, following are the major objectives of the study

- 1) To find out the damages in residential buildings and assessment of damages by performing NDT.
- 2) Finding out a manner of economic repairment of damages that is convenient and easily applicable in residential areas.
- 3) To testify and analyse the results of strength calculated after the repairment by NDT.

Yasar Ayaz, Adnan faith kocamaz, Mehmet Burhan Karako (2015), suggested that compressive strength and UPV parameters are the techniques that are utilized to decide high-volume mineral admixture concrete quality. In any case, tests for all levels of these parameters are costly, troublesome and tedious

M. Ghasemi Naghibdehi, M.K. Sharbatdar (2015), studied on that there are a several strengthen methods for restoration of RC structural components. The proficiency of these strategies has been shown by numerous scientists. Because of their mechanical properties, utilizing sinewy materials as a part of restoration applications is developing quick. Accordingly, this study presents restoration of pieces in a manner that plain concrete layers on top, on base, on the whole cross area are supplanted by fortified concrete layers. With a specific end goal to fortify the concrete, Polypropylene (PP) and steel strands were utilized by 0.5%, 1% and 2% fiber volume parts.

Ramazan Demirboga, Fatma Karagol (2014), concentrated on the utilization of urea to the cool climate

concreting. One of the benefits of this strategy is to improve curing after concrete position at low temperatures; just a hostile to vanishing sheet is important to keep new concrete wet until completing of concrete curing.

Method, Urea is utilized at level of 6% by weight of concrete dose in the blends. Subsequent to throwing, one gathering of concrete examples were cured in the diverse profound stops at - 5, - 10, - 15, - 20 °C for 7, 14 and 28 days and after that the same specimens were cured in water for 7, 14 and 28 days as per ASTM C 192. Compressive quality of concreted concrete was resolved by C 39.

Taraka Ravi Shankar Mullapudi, Di Gao (2013), reported that researched concrete is the most broadly made development material. The expansion of carbon nano-fibres (CNFs) to concrete has numerous points of interest as far as mechanical and electrical properties (e.g. higher quality, higher Young's modulus and enhanced weariness resistance) and self-checking conduct because of the high rigidity and high conductivity.

M. K. D. Khan and M. Wamiq (2008), explained the impact of concrete breaking on the lateral reaction of building structures. The examination business related to the investigation of impact of concrete splitting on its firmness has been overviewed. The debates in the declarations of the prime parameter identified with the breaking of the fortified cement are likewise talked about.

II. METHODOLOGY

Methodology provides detailed information about the procedure I have applied for application of repair techniques for damaged reinforced concrete structure. Survey of damaged residential structure and proposed repair techniques are also included in this. The result of the repairing application depends upon the methodology used.

A. Steps Involved in Methodology

- Finding out the damaged or deteriorated residential buildings in the areas of Bhopal in MP Nagar, Ayodhya Nagar, Kasturba Nagar.
 - Identification of the types of damaged concrete structure by visual inspection.
 - Selection of various types of damaged structures from all structures.
 - Detailed survey on damaged concrete structures named damage assessment.
 - Study of all the possible repair techniques which can be applicable for repairing
 - Selection of an economical repairing method for application which depends on
- 1) Availability of material and equipments used in the technique near the site or area.
 - 2) The cost of the equipments and material used.
 - 3) Need of skilled or non-skilled labor at site.

- 4) Time taken in repairing application.
- 5) The weather and environment condition of the area.
 - Making the strategies of economic repair techniques.
 - Application of economic repairing techniques.
 - Post repair works like curing and safety measures.

The survey is done in various areas in Bhopal for selecting the appropriate site. The sites selected are Kasturba Nagar, Ayodhya Nagar and BHEL area. Here, we observed that damages are found in various buildings and houses. The reason came into consideration is the houses and buildings constructed in these areas are in between the period 1970 to 2000.

These areas are located in the dense area of Bhopal, where some chemical industrial plants are also located. This may incur the reason of damages in buildings due to chemical causes.

Damages found in the houses and buildings of Kasturba Nagar, BHEL area and Ayodhya Nagar are mainly focused in this proposed work.

S. No.	Area	How old is construction	Damages found
1.	Kasturba Nagar	40 years	Spalling of concrete, Cracks in column, Corrosion of Steel bars in Slabs, Exposure of steel bars in Structure, Seepage in Slab
2.	Ayodhya Nagar	15-20 years	Hair cracks in Concrete, Cracks due to foundation settlement, Seepage in Slab
3.	M.P.Nagar	10 years	Hair line cracks, defects due to moisture.

Table 1: Damages found at different locations

B. Damage Assessment and Method of Testing Preferred

There are basically two Methods for the Testing of Concrete Structures i.e.

- Destructive Testing
- Non Destructive Testing

Destructive testing is the method in which the testing is mainly done in lab, where the concrete, which is to be tested, is broken or test is applied on the concrete up to the extent at where the compressive strength is calculated. Hence this method is generally used in labs, and for the purpose of this report the testing technique which is followed is non destructive testing. The NDT can easily be done in the residential buildings without destroying or breaking any concrete structure. So this type of testing is done in the procedure of damage assessment.



Fig. 1: NDT of damaged structures

C. Selection of Economic Techniques for Repairmen

There is various techniques which are available for repair, but the selection of technique is done in such a manner that the technique is economic, convenient and less time taking technique.

- Injection method
- Plastering on concrete
- Strengthening by chicken mesh
- Gravity filling of mortar
- Dry pack method for cavities
- Surface protection by sealing coats
- Water proofing in slabs with help of fixit

D. Repairment of Damaged Structures

Placing of repairing material and concrete is carried out in this order firstly, surface cleaning and removing of dead concrete is done by the hard brushes. As strengthening material, Chicken mesh is utilized for building inner and outside design, particularly in putting work. And Dr.Fixit is mixed with water and after properly mixing the mixture is placed at the seepage point on wall. So in the repairing procedure, we used this mixture of mortar and Dr.fixit for stopping the seepage problem. Iron crushes strengthen the mixture of mortar .It is placed on walls where damages are found. We have taken 10% of iron crushes in place of fine aggregate and then this mixture is placed on damaged surface.



Fig. 2: Mortar preparation and adding Dr. Fixit in mixture



Fig. 3: Repairment by chicken mesh and major cracks filling

III. RESULT AND DISCUSSION

The work done in the procedure of damage assessment and economic repairment is gone through various aspects and steps of damage assessment, selection of appropriate repairment technique, analysis of particular selected technique.

A. Here spalling in column is observed and repairment is done by applying concrete with chicken mesh

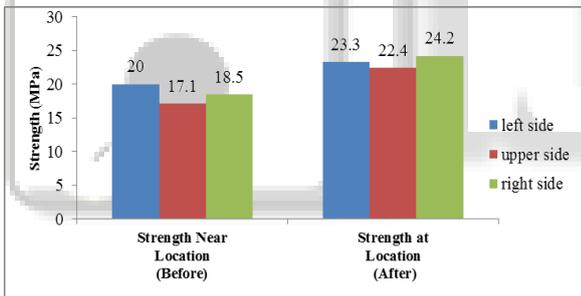


Fig. 4: Graph of compressive strengths observed at the damaged location (H. No. C48)

$$\text{Strength Corresponding Near Location} = \frac{(18.53-23.4)}{18.53} \times 100 = 26.28\% \text{ (More than surrounding)}$$

- Overall strength increased of column because the use of chicken mesh.
- Plaster settled strongly

B. Here seepage is occurring from roof and affecting ceiling because of cracks then repairment is done by dr. fixit with mortar for cracks filling

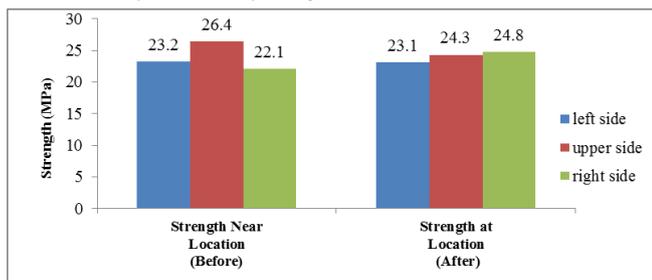


Fig. 5: Graph of compressive strengths observed at damaged location (H. No. D 55)

$$\text{Strength Corresponding Near Location} = \frac{(23.9-24)}{23.9} \times 100$$

$$= 0.41\% \text{ (More than surrounding)}$$

- Overall strength is more than M20 (original concrete).
- Cracks are filled properly.
- Seepage is not taking place because we use Dr. Fixit as water proofing Agent.

C. Here Spalling of Plaster in Column, Repairment is done by Iron Crumps as Admixtures

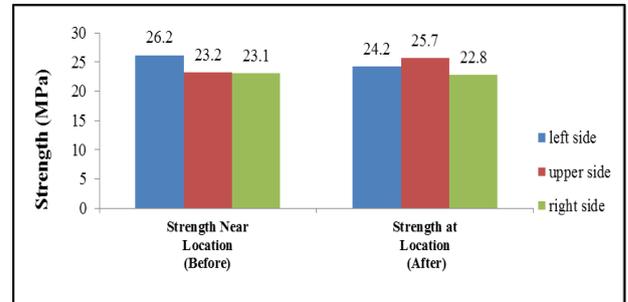


Fig. 6: Graph of compressive strengths observed at damaged location (Rajvihar 3)

$$\text{Strength Corresponding Near Location} = \frac{(23.8-24.2)}{23.8} \times 100 = 1.68\% \text{ (More than surrounding)}$$

- Overall strength is more than M20 (original concrete).
- Concrete settled properly on damaged structure

D. Here broad cracks are found in beam and column and repairment is done by only mortar

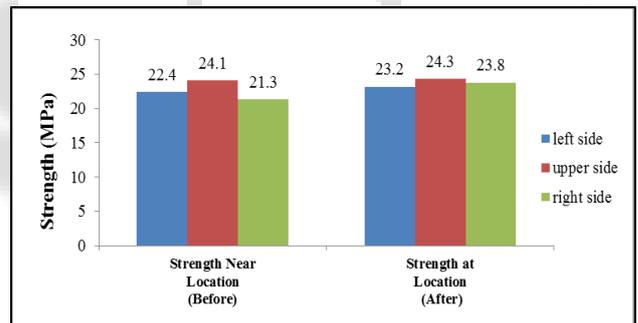


Fig. 7: Graph of compressive strengths observed at damaged location (H. No. D/10)

$$\text{Strength Corresponding Near Location} = \frac{(23.3-24.5)}{23.3} \times 100 = 5.1\% \text{ (More than surrounding)}$$

- Cracks are filled properly.
- Mortar settled properly between cracks.





Fig. 8: Structures before and after repairment

E. Economics of Repairing

Here the detailed data of all repairing techniques which are used to repair RCC structures is given. These repairing techniques are selected on the basis of their convenience, simplicity to use and economic characteristics.

The expenditure in repairing while applying the convenient repairing technique is given in the table:

S. No.	Damages Found	Applied technique	Cost of Repair (Expenditure)	Remark
1.	Spalling of concrete in Slab (Area 2 m ²)	By Cement Mortar	Labour charge=Rs. 500 Material cost=Rs. 600	Strength increased
2.	Cracks in Beam (Minor cracks in 1m ²)	Injection method	Labour charge=Rs. 100 Material cost=Rs. 200	Cracks filled properly
3.	Spalling of concrete in Column (Area 0.5 m ²)	Using Chicken mesh	Labour charge=Rs. 300 Material cost=Rs. 400	Strength increased
4.	Spalling of plaster in Column (Area 0.5 m ²)	Using Iron crumps in mortar	Labour charge=Rs. 300 Material cost=Rs. 250	Strength comparable to surrounding
5.	Minor cracks in Beam (Area 1 m ²)	Using white cement	Labour charge=Rs. 300 Material cost=Rs. 350	Cracks filled properly
6.	Seepage from Roof (Area 4 m ²)	Using water proofing agent	Labour charge=Rs. 700 Material cost=Rs. 600	Seepage not taking place

Table 2: Detailed data of applied techniques

IV. CONCLUSION

Here it is noticeable that the observations are mainly done by the NDT testing. Salient features of conclusion are:-

- Results obtained from NDT testing. Basically NDT is done in those areas where the destructive type of testing can't be applied. The area of this thesis work includes the strength calculation at damaged site of residential buildings. So the applicability of NDT is essential and convenient.
- It may be concluded that after repairing of damage, the strength calculated is nearly same as the strength of the area which surrounds the damaged point.

When chicken mesh is used in repairment the strength obtained is quite good .And also this method is economical.

When the iron crams are used in place of sand, the strength of repaired concrete structure is obtained well than by using sand. We used 10% of iron crumps in mortar and it gave more strength to concrete structure.

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