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Feasibility Study of Existing Distress Structure Using Non-Destructive Testing Methods

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Abstract

In this paper, we investigated the structural integrity of reinforced concrete structures through the application of Non-Destructive Testing (NDT) methods. Our focus was primarily on determining whether retrofitting measures are necessary to enhance the stability and safety of this structures. Two NDT techniques, namely the rebound hammer test and ultrasonic velocity test, were employed to assess the condition of the structures.

Based on the results obtained from these NDT tests, we analyzed the structural health of the reinforced concrete elements. If indications of distress or deterioration were identified, we explored various retrofitting techniques to address these issues. Retrofitting measures such as strengthening of structural components, application of protective coatings, and installation of additional support systems were considered based on the specific requirements of the structure.

Keywords: Non-Destructive Testing (NDT), retrofitting, Rebound hammer test and Ultrasonic pulse velocity test.

1. Introduction

The concrete is widely used as construction material. 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 last five to six-decade year during these periods, we have created a large number of infrastructure assets in terms of building, bridge, towers and other structure. Decoration of RCC is a natural phenomenon and has started exhibiting in large number of structures a systematic approach is needed in dealing with such problem identification of the case of deterioration and consequent repair strategy of optimum cost need and evaluation. The first step in repair and rehabilitation is the proper diagnosis for successful repair work. It deals with non-destructive evaluation techniques. Details of commonly used test for non-destructive evaluation (NDT) like Rebound hammer test, ultra- sonic pulse velocity and core test. Retrofitting of structure like building which include retrofitting, maintenance and strengthening of structure isnot only a need in construction and management in Urban are abut also a problem which arises to structural engineering in property management disciplines.

Retrofit in structures is done to increase the survivability functionality. The applications include different types offbridges, buildings, and industrial structures, transport structures in urban areas, earth retaining structures and marine structures. Retrofitting is the modification of strength of existing structures.

Strengthening of members that do not meet safety requirements must be strengthened, however there is often an underlying mistake that the strengthening of whole structural system is neglected. Strengthening of connection between members is quite influential to structural integrity. The benefits of retrofit existing structure includes; cost saving in long run by reducing the usage of energy and water by incorporating new technology, services or equipment; increasing the comfort level in a building by redesign the façade and interior to improve end users' productivity and satisfaction through.

2. Literature Review

A. Charles R Farrar et.al., (2007)"An introduction to structural health monitoring". Phil. Trans. R . Soc. A2007. In this paper the process of implementing a damage identification strategy for civil engineering infrastructure is referred to as structural health monitoring (SHM). In the most general terms, damage can be defined as changes introduced into a system that adversely affects its current or future performance. Damage identification is carried out in conjunction with five closely related disciplines that include SHM, condition monitoring, non-destructive evaluation, statistical process control and damage prognosis.

B. A.B.Mahadik et.al., Volume5,(2014) "Structural Audit Of Building". This paper deals to create awareness among the civil engineers, resident at owners of building towards the health examination existing concrete building. To find out the strength and durability of building so as to enhance its life duration or service life span.

C. Saiesh.L.Naik et.al., Volume: 04 Issue: 05, May(2017) "Structural Audit of RCC Building". This paper concludes that structural audit is generally recommended for older building. Structural audit help to improving the safety, efficiency and gives the idea about strength and durability of building. Structural audit is used to find out appropriate remedial measures can be recommended for all structure defect and damages so that to find out the damages non –destructive test isrequired. This method of testing's allows to test the material or component is without losing its usefulness.

D. John T. Petro et.al., (sep2011), "Detection of Delamination in Concrete Using Ultrasonic Pulse VelocityTest". In this test experimental study was perform to evaluate delamination in concrete using ultrasonic pulse velocity test. For this two slabs specimen are used having size 150mmand 300mm thickness consist delamination of varying size. For the test direct and indirect transmission methods were carried out to determine the characteristics of concrete.

E. Mostafa Kazemi et.al. "Compressive strength assessment of recycled aggregate concrete rebound hammer test". In this study estimate the compressive strength of recycled aggregate concrete by using rebound hammer test. Rebound hammer test helps to identify relative surface weakness in cover concrete and to determine relative compressive strength of concrete. Casting cubes were tested under the controlled condition

3. Methodology

- The steps involved in assessing the feasibility of a structure are as follows:
- Measurement of dimention of the building To prepare the layout of a building, dimensions of different RC members are measured. This dimentional measurement will be usefull in design of the additional . floor .
- Physical observations (if any).

- Physical observations are made to know the distress in building if any like any damage, cracks, settlement of foundation."
- Conducting Non-destructive test for different structural members.
- NDT Tests carried out at site NDT tests are carried out for structural members to know the quality, strength, reinforcement details, corrosion of steel etc. Following are instruments used to conduct non-destructive test
- Rebound hammer test.
- Ultrasonic pulse velocity test.
- Analyzing the structure from the data obtained from NDT Techniques using e-tab or staad-pro software.

4. Aim of the Study

- Retrofitting serves to improve strength, resistivity. The basic aim behind retrofitting or repair works is to extend the service
- life, enhance the performance of the structure or increase the load-bearing capacity. The major approach to any retrofitting
- work is to keep into consideration that the main reason of the damage along with the symptoms.

1. To enhance the life of the building after retrofitting.
2. To make reduction cost of new construction,
3. To improvise stability and sustainability in the structure
4. To prepare the building to withstand different weather conditions
5. Strengthening growth and enhancement of the structure

5. Objectives of Project

- To understand the real condition of the building.
- Protect the life of human being and animal froawarm structural failure.
- To know the Current Health of building and to protect the future life.
- To identify any signs of material deterioration.
- Awareness of resident to under the seriousness of the problem and the suggest the remedies to the structure

6. NDT Tests

NDT typically stands for "Non-Destructive Testing," a method used in science and industry to evaluate the properties of a material, component, or system without causing damage. It's commonly used in fields like engineering, manufacturing, and aerospace to ensure the quality and integrity of materials and structures. Astronomer Neil deGrasse Tyson also goes by the initials NDT.

Types of NDT Techniques

A. Rebound Hammer test

Rebound Hammer Test is a quick method to evaluate the quality of concrete based on surface hardness of the existing structure. The rebound number gives the average surface compressive strength of the concrete. Rebound Hammer Test was carried out on all accessible locations of R.C. slab panels, beams, and columns in order to assess the surface hardness / quality of in-situ concrete. Initially the surface was prepared by

removing the Plaster and dusting the surface to get better results. The test was conducted by using 'Schmidt Rebound Hammer' .

- Quality of Concrete for different values of rebound number

Average Rebound Number	Quality of Concrete
>40	Very good hard layer
30 to 40	Good layer
20 to 30	Fair
< 20	Poor concrete
0	delaonation

B. Ultrasonic pulse velocity test.

UPV is the important NDT method used for testing concrete. This method has gained considerable popularity all over the world. This method involves a measurement of travel time over a known path length pulse of ultrasonic compressional waves. The pulses are generated by use of pulse generator circuit. The pulse generator circuit consists of electronic circuit for generating pulses and a transducer. The pulses are introduced into concrete by a piezoelectric transducer and similar transducer acts a receiver to monitor the surface vibration cause by the arrival of the pulse. A timing circuit is used to to measure the time for the pulse to travel from the transmitting to receiving transducers. The path length between the transducer divided by time of travel gives the average velocity of wave. The pulse velocity is determined by the equation. Pulse Velocity = Transit Path Time Length Generally, the higher the pulse velocity, the higher the quality and durability of concrete or lower quality concrete is by lower velocity sample template format ,Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

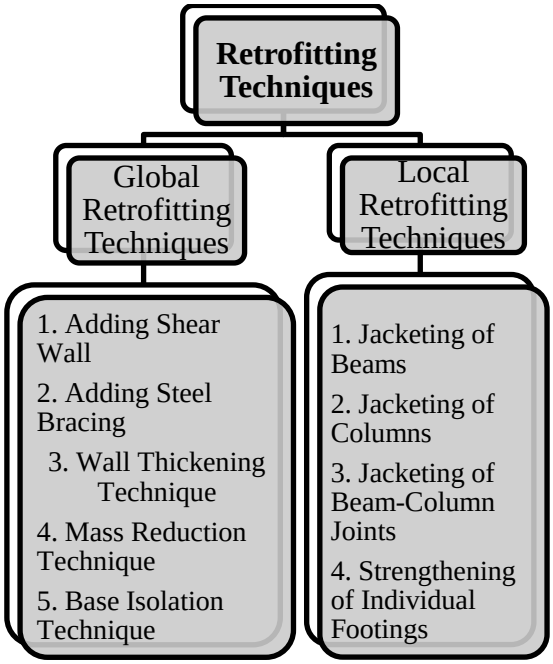
- Quality of Concrete for different values of Ultrasonic pulse velocity test.

Ultra Sonic Pulse Velocity Km/s	Quality Of Concrete
Below 3.0	Doubtful
3.0 to 3.5	Medium
3.5 to 4.5	Good
	Excellent

7. Purpose of Retrofitting

As time passes many environmental factors going on around impact the structure. Out of all these factors, the most damaging is an earthquake that disturbs the internal structure of the building, and thus gradually building starts losing its strength and stability. As a result, the structure becomes unsafe for future use and might cause massive loss.

The level of deterioration caused to the concrete element structure is occurring at an alarming rate. It has been confirmed that even if all the specific building code is followed still there is a high risk of deterioration of concrete element and corrosion of reinforcement.



Methods of Local Retrofitting of Building

1. Jacketing Method

- There are 3 types of jacketing, they are, Reinforced Concrete Jacket, Steel Jacket, Fiber Reinforced Polymer Composite Jacket (FRPC).
- It is utilized for increasing bearing load capacity following an alteration of the structural design or to reestablish structural design integrity because of a disappointment in the structural member.
- This retrofitting techniques for RCC buildings is utilized on vertical surfaces like walls, columns and different combinations, for example, beam sides and bottoms.

- In this process an existing structural member section is reestablished to the original dimensions or expanded in size by encasement utilizing reasonable materials.
- In this type of retrofitting techniques for RCC buildings, a cage like design made of steel reinforcement or a composite material wrapping is constructed around the deteriorated section onto which cast-in-place concrete or shotcrete is placed.
- Jacketing is especially utilized for the repair of crumbled columns, piers and piles and may effortlessly be utilized in underwater applications.

Fig No

8. Result

Readings of Rebound hammer test

Floor	Reading 1	Reading 2	Reading 3	Reading 4	Average	Compressive Strength
COLUMN 1						
GF	**31**	**34**	**26**	**29**	**29.75**	**20**
$_1$ST	**29**	**29**	**30**	**28**	**29**	**19**
$_2$ND	**32**	**29**	**26**	**34**	**30**	**20**
COLUMN 2						
GF	**30**	**28**	**30**	**30**	**29.5**	**20**
$_1$ST	**22**	**22**	**23**	**22**	**22.25**	**12**
$_2$ND	**29**	**28**	**26**	**27**	**27.5**	**17**
COLUMN 3						
GF	**34**	**40**	**30**	**24**	**32**	**23**
$_1$ST	**28**	**24**	**24**	**30**	**26.5**	**15.5**
$_2$ND	**28**	**28**	**26**	**28**	**27.5**	**17**
COLUMN 4						
GF	**32**	**23**	**43**	**33**	**32.75**	**24**
$_1$ST	**24**	**24**	**22**	**22**	**23**	**12**
$_2$ND	**40**	**43**	**38**	**42**	**40.75**	**36**

COLUMN 5

GF	34	46	28	42	36	29
$_1$ST	30	32	32	30	31	22
$_2$ND	26	24	26	24	25	14

COLUMN 6

GF	34	31	31	30	31.5	22.5
$_1$ST	28	30	28	26	28	18
$_2$ND	29	26	26	30	27.75	18

COLUMN 7

GF	38	37	37	30	35.5	28
$_1$ST	40	34	36	34	36	29
$_2$ND	31	28	24	25	27	16

COLUMN 8

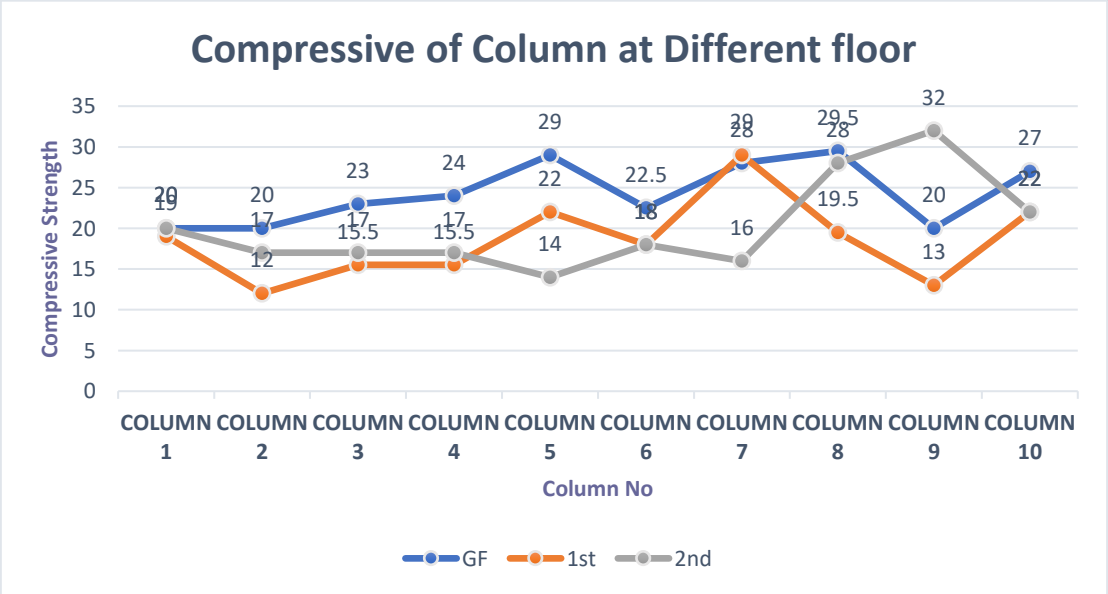
GF	35	39	35	37	36.5	29.5
$_1$ST	28	32	26	32	29.5	19.5
$_2$ND	26	34	42	40	35.5	28

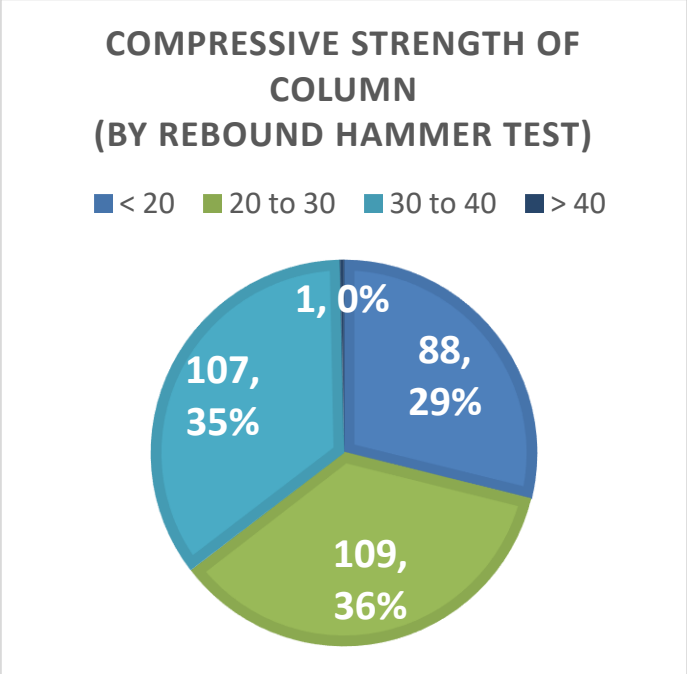
COLUMN 9

GF	34	33	27	26	30	20
$_1$ST	28	20	26	23	24.25	13
$_2$ND	38	36	39	39	38	32

COLUMN 10

GF	39	38	30	36	35.75	27
$_1$ST	22	22	23	22	31.5	22
$_2$ND	33	33	28	29	30.75	22





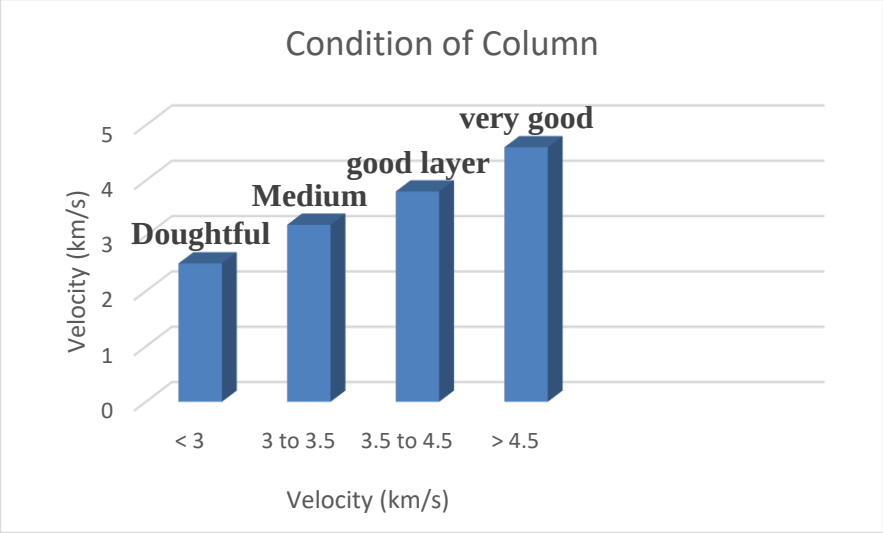
No of Column	Compressive Strength of Column
88	< 20 N/mm^2
109	20 to 30 N/mm^2
107	30 to 40 N/mm^2
1	>40N/mm^2

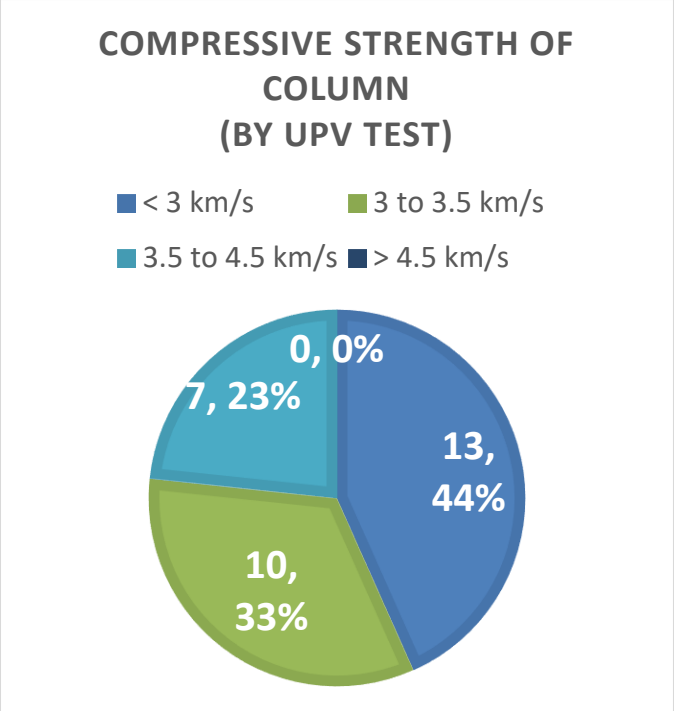
- **Condition of Column**

29 %	**Poor Concrete**
36%	**Fair Concrete**
35%	**Good Layer of Concrete**
0%	**Very Hard Layer of Concrete**

Reading of Ultrasonic pulse velocity test

ColumnNo	Pulse	Velocity km/s	Width of Column
11	**366.3**	**2.928**	**0.38**
12	**291.5**	**1.234**	**0.38**
13	**110.6**	**3.345**	**0.38**
14	**304.5**	**3.114**	**0.38**
16	**630**	**3.571**	**0.36**
18	**263.8**	**1.364**	**0.36**
19	**288.4**	**1.317**	**0.38**
21	**549.5**	**0.655**	**0.38**
22	**422.6**	**3.204**	**0.38**
23	**184.8**	**1.889**	**0.38**





No of Column	Velocity km/s
13	< 3 km/s
10	3 to 3.5 km/s
7	3.5 to 4.5 km/s
0	>4.5 km/s

- **Condition of Column**

44 %	**Poor Concrete**
33%	**Good Concrete**
23%	**Good Layer of Concrete**
0%	**Very Hard Layer of Concrete**

9. Applications

- To measure the uniformity of concrete.
- To discover the development of cracks in various concrete structures
- To check deterioration due to frost action or chemical action.
- To find out the voids or honeycomb in concrete structure.
- To determine the strength of concrete.
- To measure the thickness of concrete slabs and concrete roads.
- To measure elastic modulus.
- It is useful for studies conducted on the durability of concrete.
- It is used for strength development monitoring.
- It is also useful in pre-casting and also in deciding the removal of formwork.

8. Conclusion

- The damages are identified through visual inspection. NDT tests were conducted to assess the cause of crack. During this investigation, quality of concrete has been determined using rebound hammer and UPV tests.
- Class of damage has been determined and recommendations for the repair work have been identified.
- The strength of concrete in the tested RC columns is found to be 25kN/mm2, 20kN/mm2 and 30kN/mm2 Respectively.
- Feasibility study of existing RCC structure is done by using NDT test such as Rebound Hammer test and Ultrasonic pulse velocity test , Based on these NDT test Results maximum number of column of that RCC structure are in good condition , There are 45 % column of total column of building are good in condition.
- As per Results , there are 55 % column of that building have shown deficient results . hence Condition of that column are poor so, for enhancing the strength of column the retrofitting techniques are to be adopted. So, the Column Jacketing technique can be used

9. References

1. Prof.Dr.D.K.Kulkarni's "Health assessment of Reinforced Concrete structures-A Case study".
2. Pankaj Sharma, Murari Ratnam's "Correlation between Pulse Velocity and Compressive Strength of Concrete" in 2011.
3. Samia Hannachi, Mohamed Nacer Guetteche's " Application of the Combined Method for Evaluating the Compressive Strength of Concrete on Site".
4. Lawson, K.A. Danso, H.C. Odoi, C.A. Adjei, F.K. Quashie, I.I. Mumuni and I.S. Ibrahim's "Non-Destructive Evaluation of Concrete using Ultrasonic Pulse Velocity"
5. Kaushal Kishore "Non-destructive Testing Of Concrete By Rebound Hammer"

6. Mr . K. N. Vishwanath's "Strength Assessment And Restoration Of Rc Structures By Structural Health Evaluation - Case Study"
7. A.R.Patel and N.R.Patel study on"Non destructive technique advantages and limitations"
8. Francesco NUCERA* and Raffaele PUCINOTTI* study on "destructive and non-destructive testing
9. onreinforced concrete structure: the case study" Lawson, K.A. Danso, H.C. Odoi, C.A. Adjei, F.K. Quashie, study on "Non-Destructive Evaluation of Concrete using Ultrasonic Pulse Velocity"