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Non Destructive Test - A Tool in Structural Audit

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Abstract: ***Engineering structures with age greater than 30 years tends to detoriate due to reduced strength. Health examination of such concrete structure termed "Structural audit" becomes necessary. The current study aims at establishing the comparative strength of concrete member on concrete test specimen and RCC members at site. This will give an assessment of actual structural strength of concrete on the specimen tested in the laboratory and that actual used for concreting. Strength of specimen and structural member were tested using different Non Destructive Testig (NDT) methods like Rebound hammer and Ultrasonic Pulse Velocity(UPV) test to understand varying nature of the strength by different NDT test to arrive at optimum value of structural stability. The tests showed that the strength of concrete differed between Rebound hammer and UPV. Hence necessary decision for suitable measure for structural stability should be based on the further analysis from advanced non destructive testing instruments.***

Keywords: Structural Audit, Comparative strength, NDT, UPV, Structural stability

1. Introduction

A structure is a system of inter connected elements such as frames to carry loads safely to ground below earth. Structural strength reduces with age due to several factors and if such deteriorated structure is continued, it may collapse & endanger the lives of the occupants and surrounding habitation. The health examination of concrete building called as "Structural audit", is an overall health and performance check-up of building like a doctor examines a patient. It also suggests suitable Repair and Rehabilitation to increase the serviceability and life span of the building/ structure.

The damage or deterioration greatly depends on the quality of work at the construction stage. The impairment of building/ structure can be a result of many various factors which include damage due to fire , frost action, chemical attack, corrosion of steel etc during the life span of the structure.

2. Material and Methods

The current study comprise of conducting NDT at site and on test specimen at the GCOERC College labaoratory. The following methodology is adopted.

Non Destructive Testing comprising of use of
1) Rebound Hammer
2) Ultrasonic Pulse Velocity

M 20 grade concrete was used for construction of Beam, Slab and Column at a nearby construction site was used to prepare test specimen.12 cubes were casted of which 6 cubes from the material used for construction of slab and beam, and 6 cubes from the material used for construction of column was used to cast laboratory specimen. These cubes were cured for 28days

The quality of concrete with respect to the Rebound number is given in the table below,

Table 1: Quality of Concrete

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

3. Instrumentation

3.1 Rebound Hammer Test

The rebound hammer aids in non destructive testing of concrete. The extent of rebound of plunger is a measure of surface roughness which can be measured on graduated scale, and can be correlated to compressive strength of concrete which can be read from the graph available on the body of hammer.

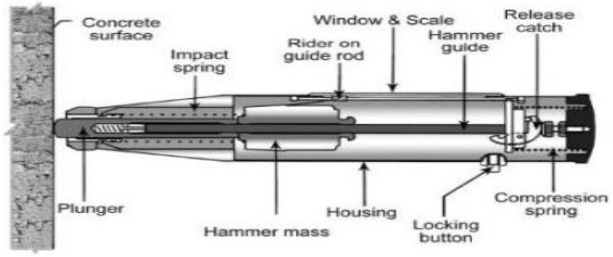


Figure 1: Section of Rebound Hammer[10]

3.2 Ultrasonic Pulse Velocity

UPV method relates concrete qualities with the compressive strength. The principle of finding the compressive strength depends on the expressing ultrasonic velocity waves as a function of the material density. Electronic timing circuits allows the transit time T of the pulse to be measured. Longitudinal pulse velocity (in km/s or m/s) is given by: V= L/T Where, V is the longitudinal pulse velocity, L is the path length, T is the time taken by the pulse to traverse that length.

Table 2: Quality of Concrete[8]

Concrete Quality based on the acoustic wave velocity	
Concrete Quality	V (M/S)
Excellent	>4500
Very Good	4000-4500
Good	3500-4000
Doubtful	3000-3500
Poor	2000-3000
Very Poor	<2000

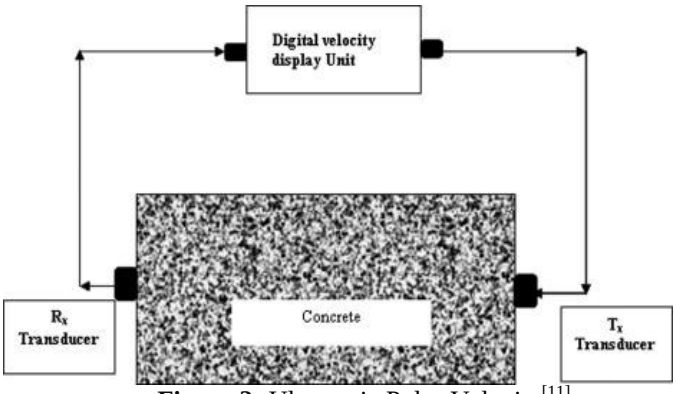
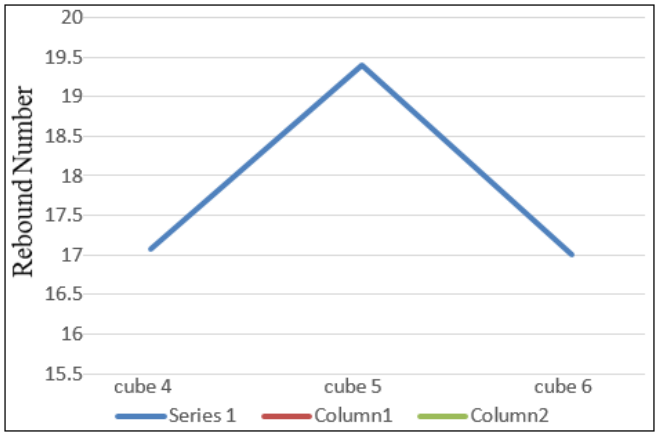
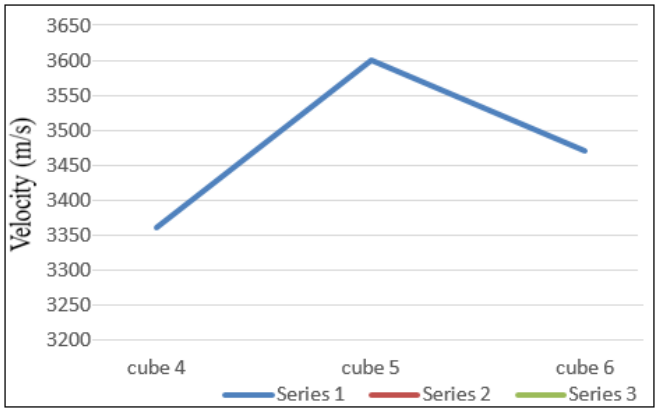


Figure 2: Ultrasonic Pulse Velocity[11]

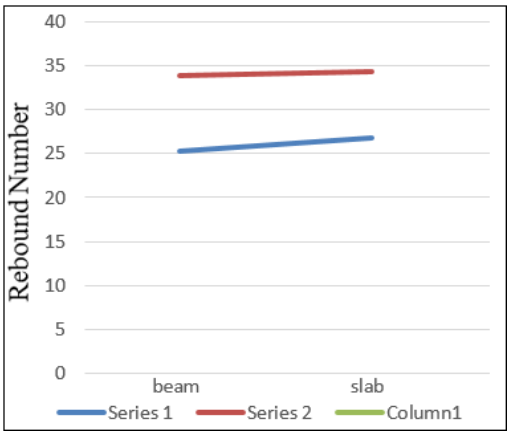
4. Results and Discussion



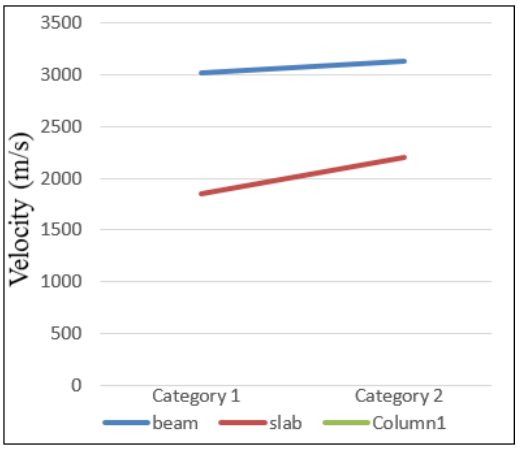
Graph 1: In Lab Testing (Slab & Beams) Cube Tested By Rebound Hammer



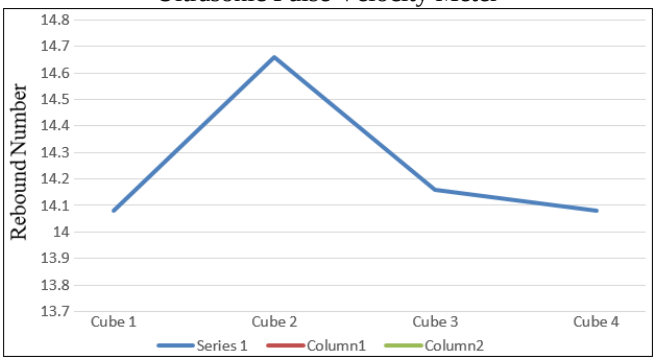
Graph 2: In Lab Testing (Slab & Beams) Cube Tested By Ultrasonic Pulse Velocity Meter



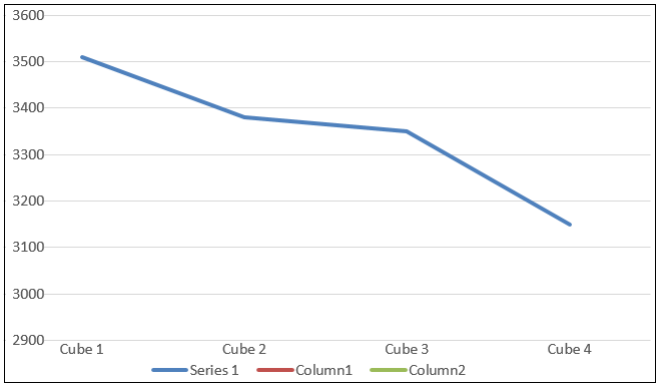
Graph 3: Onsite Testing (Slab & Beam) Tested By Rebound Hammer



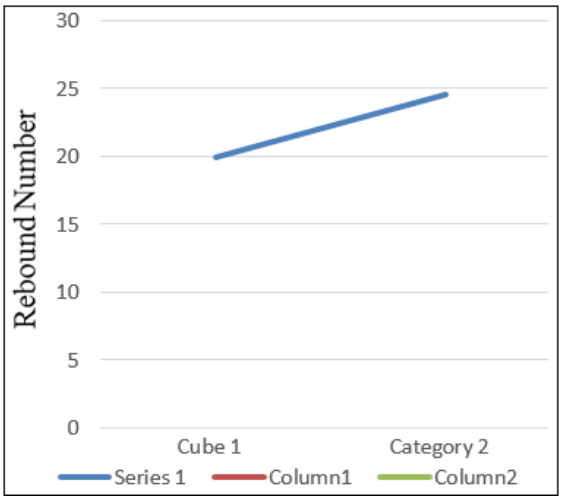
Graph 4: Onsite Testing (Slab & Beam) Tested By Ultrasonic Pulse Velocity Meter



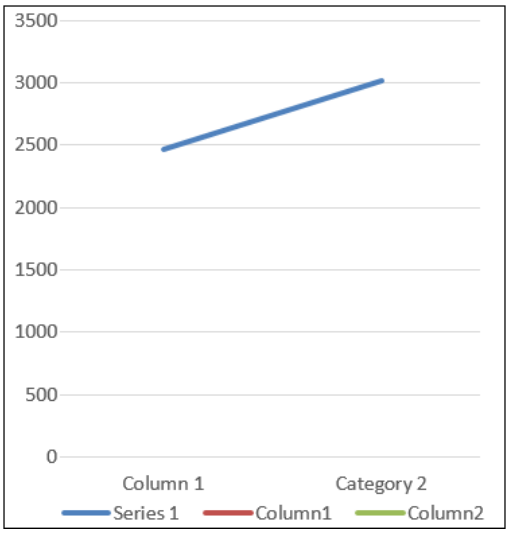
Graph 5: In Lab Testing (Column) Cube Tested By Rebound Hammer



Graph 6: In Lab Testing (Column) Cube Tested By Ultrasonic Pulse Velocity Meter



Graph 7: Onsite Testing (Column) Tested By Rebound Hammer



Graph 8: Onsite Testing (Column) Tested By Ultrasonic Pulse Velocity Meter

The 28 days Cube test on the laboratory specimen of slab & beam using rebound hammer using M20 showed average rebound number variation between 19.4 to 17(Graph 1). The On site ND testing of the beam 1&2 showed that the average rebound number varied between 25.25 and 26.75(graph3). The average rebound number for slab 1 &2 varied between 33.83 and 34.33 (graph3).

The 28 days cube strength assessment for the laboratory specimen carried out for slab & beam material using UPV for showed variation of pulse from 3600 m/s to 3360 m/s (graph2).

The 28 days cube strength assessment for the onsite beam 1&2 carried out using UPV showed 3010 m/s which reduced to 3130 m/s (graph4).Similarly The 28 days strength assessment for the on site slab 1&2 carried out using UPV for showed a pulse rate of 2200 m/s which reduced to 1852 m/s (graph4)

The 28 days cube assessment for the laboratory specimen of column material using rebound hammer showed average rebound values varying between 14.08 and 14.66(graph 5). While the onsite rebound hammer test on column gave average rebound no varying between 19.91 and 24.58 (graph 7).

UPV test on column material was carried at laboratory and on site. The laboratory specimen gave values between 3150m/s and 3510 m/s(graph 6).While the onsite UPV test on column1 gave value of 2460 m/s and column 2 gave value of 3020m/s(graph 8)

5. Conclusion

The test to assess the quality of concrete which was to be used for the construction activity was made. Rebound hammer and UPV was used to assess the qaulity. It was observed that concrete material tested both at laboratory and on site using rebound hammer showed the quality of concrete was poor. UPV results for the same showed quality of concrete to vary between good to doubtful. The Rebound Hammer test conducted at the site showed the Quality of concrete used for beam and slab varied between fair to good. However to UPV test showed poor quality of concrete for the same. Hence it can be concluded from present study the quality of concrete for construction or assessment of strength of existing structure cannot be decided by results obtained from rebound hammer or UPV only, for better assessment the results should be checked with the results from other advanced instruments.

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[11] 11.https://www.google.com/search?q=ultrasonic+pulse+velocity&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiBzpy67eDgAhWIQo8KHeK1DjMQ_AUIDigB&biw=1366&bih=657#imgrc=AoQCoia0jkip2M:

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