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TO STUDY THE EFFECT OF AGE ON COMPRESSIVE STRENGTH OF VARIOUS RCC MEMBERS USING THE REBOUND HAMMER TEST

MR. KASHINATH N. ZAMARE, PROF. A. R. GUPTA
College of Engineering & Technology, Akola

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Abstract – Concrete compressive strength is one of the most important concrete requirements that can be used to decide if the concrete is structurally acceptable or not. In several cases there is a need to estimate the concrete compressive strength on the site during construction or later on during the life of concrete. Testing and quality checkup are important at different stages during the life of a structure. To properly maintain the civil infrastructures, engineers required new methods of inspection. Better inspection techniques are needed for deteriorating infrastructure. The traditional method of evaluating the quality of concrete in civil structures is to test specimens casted simultaneously for compressive, flexural, and tensile strengths; these methods have several disadvantages such as results are not predicted immediately, concrete in specimens may differ from actual structure, and strength properties of a concrete specimens depend on its size and shape; therefore to overcome above limitations several NDT methods have been developed. NDT methods depend on the fact that certain physical and chemical properties of concrete can be related to strength and durability of structures. Now in the present century NDT has become more sophisticated. There are several methods used for this purpose, among the mostly used methods are the Ultra sonic pulse velocity and the Schmidt rebound hammer. Concrete is a basic material used for the great amount of engineering projects. The concrete performance is influenced by some building variables, such as: the water/cement ratio, the aggregate type and size, the humidity and the cement type. These variables affect directly the compressive strength and make difficult the identification of the concrete properties. Focusing on it, the ultrasonic tests allow to estimate a correlation between the variables and the compressive strength. This study indicates that UPV gives an important result of decision make about the conditions of concrete structures. It can be concluded that, by means of UPV, it is possible to contribute with the deterioration control and concrete structures quality. The second method is rebound hammer, It is one of the most popular nondestructive testing methods used to investigate concrete. Its popularity is due to its relatively low cost and simple operating procedures.

Keywords- Visual Inspection, Rebound Hammer, Ultrasonic pulse velocity, Compressive strength analysis.

Corresponding Author: MR. KASHINATH N. ZAMARE

Co Author: PROF. A. R. GUPTA

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INTRODUCTION

The standard life of R.C.C. frame structure is considered to be in the range of 50-60 years approximately depending upon the use and the importance of the structure. But it has been observed that many of the buildings completing just 50% of their life in coastal areas found to be in distressed condition and this needs the evaluation of the strength of the building so that appropriate remedial action can be taken to improve performance of the building depending upon the extent of deterioration of the structure.

Structure may also get damaged due to fire, earthquake, explosion, etc. there could be loss of strength and reduction in area of cross section due to fire depending on intensity of fire, temperature, duration of fire and size of the structural member. Stability of such member becomes critical. It is imperative to measure residual strength and assess stability by NDT means.

Earthquake effects could prevail on all members calling resistance to deformation and distortions by way of ductility and toughness available with them. The resulting distress is more pronounced at beam column junction, shear and flexural zones due to excessive deflection and deformations exhibited by way of surface and deeper penetrated cracks. In such cases there is a loss of integrity and stability of the structure. NDT is the only means to assess the extend of cracks and to decide whether any structural damage has occurred. This decision will help to undertake appropriate restoration or improvement strategy i.e. whether to go for simple grouting or strengthening of the member. Due to explosion, structure is suddenly loaded by way of impact forces. The structure may get heated up under high temperature generated by explosion and burn partially and deform when it is under loads. Visible damage may immediately help to decide for replacement of the member. But an invisible damage, which has distressed the structure, needs assessment for integrity, loss of strength and stability. Assessment through NDT can guide for reuse of the structure.

The Non Destructive Testing is being fast, easy to use at site and relatively less expensive can be used to test actual structure instead of representative cube samples.

- To test any number of points and at any location.
- Quality control and quality assurance management tool
- To assess the structure for various distressed conditions
- Damage assessment due to fire, chemical attack, impact, age etc.

- To detect cracks, voids, fractures, honeycombs and week locations
- To monitor progressive changes in properties of concrete & reinforcement.
- To assess overall stability of the structure
- Monitoring repairs and rehabilitation systems
- Scanning for reinforcement location, stress locations.

In the recent years significant advances have been made in Non-destructive Testing techniques, equipments and methods.

There are occasions when the various performance characteristics of concrete in a structure are required to be assessed. In most of the cases, an estimate strength of concrete in the structure is needed although parameters like overall quality, uniformity etc., also become important. The various methods that can be adopted for in-situ assessment of strength properties of concrete depend upon the particular aspect of the strength in question.

II. DISCONTINUITIES AND DEFECTS IN CONCRETE STRUCTURES

- Cracking of concrete:-

Cracking affects the appearance of concrete. In some cases it affects its structural adequacy and durability. In reinforced concrete cracking allows easier access to air and moisture which can cause steel to rust and eventually weaken the concrete. Cracks can occur at two stages.

- Spalling:-

This occurs when concrete edges or other surfaces chip or break. Spalling can be repaired by breaking out to sound and dense concrete then wetting and refilling the area with a cement material that is then compacted, finished and cured. Since this is a visual defect, non-destructive testing is not an applicable repair technique.

- Honeycombing:-

This is when too much coarse aggregate appears on the surface with some cavities underneath. It occurs as a result of poor compaction or if a bony mix is used with not enough sand. If it only occurs on the surface it can be reprofiled with a render (thin layer of sand/cement mortar) or a proprietary cement product. If cavities exist below the surface, it is more appropriate to break out to sound and dense concrete and repair as per spalling above.

- Dusting:-

Appears as fine powder on the concrete surface and comes off when brushed. It is caused by finishing the concrete before bleed water has dried out, as well as by inadequate curing. It is repaired by applying a chemical floor hardener or bonded topping.

- Crazing:-

This type of cracking resembles a map pattern. The cracks only extend through the surface layer. It is caused by minor surface shrinkage as a result of the drying conditions. It is avoided by finishing and curing as soon as possible. These cracks do not cause any subsequent deterioration of the concrete. If appearance is a problem a surface coating of paint can be applied to cover the cracks.

- Rain damage:-

Surface pitted or eroded concrete can occur as a result of heavy rain. It is avoided by covering newly placed concrete with plastic sheeting when it rains. If there is rain damage and the concrete has not hardened it can be reworked and refinished.

- Corrosion of reinforcing bars:-

Corrosion occurs when the concrete surface cracks allowing water entry, or if water enters the concrete by diffusion during carbonation. The increase in diameter of the reinforcing bars caused by the formation of iron oxide (rust) can cause the concrete above the affected bars to spall off.

SITUATIONS WHERE NDT IS AN OPTION TO CONSIDER FOR INVESTIGATION OF IN SITU CONCRETE

- To investigate the homogeneity of concrete mixing
- Lack of grout in post tensioning ducts
- To determine the density and strength of concrete in a structure
- To determine the location of reinforcing bars and the cover over the bars
- To determine the number and size/diameter of reinforcing bars
- To determine the extent of defects such as corrosion

- To determine the location of in-built wiring, piping, ducting, etc.
- To determine whether internal defects such as voids, cracks, delaminations, honeycombing, lack of bonding with reinforcing bars, etc. exist in concrete.

III. BASIC METHODS FOR NDT OF CONCRETE STRUCTURE

A) VISUAL INSPECTION:-

- Introduction:-

Visual testing is probably the most important of all non-destructive tests. It can often provide valuable information to the well trained eye. Visual features may be related to workmanship, structural serviceability, and material deterioration and it is particularly important that the engineer is able to differentiate between the various signs of distress which may be encountered. These include for instance, cracks, pop-outs, spalling, disintegration, colour change, weathering, staining, surface blemishes and lack of uniformity. Extensive information can be gathered from visual inspection to give a preliminary indication of the condition of the structure and allow formulation of a subsequent testing programme. The visual inspection however should not be confined only to the structure being investigated. It should also include neighboring structures, the surrounding environment and the climatic condition. This is probably the most difficult aspect of the whole structural investigation or any diagnostic works since what appears obvious to one may not be so to another. The importance and benefits of a visual survey should not be underrated. Often the omission of what appears to be insignificant evidence can lead to a wrong conclusion being made. The advantage of a trained eye is best described by Sherlock Holmes when he wrote: “I see no more than you but I have trained myself to notice what I see.”

- Tools And Equipment For Visual Inspection:

An engineer carrying out a visual survey should be well equipped with tools to facilitate the inspection. These involve a host of common accessories such as measuring tapes or rulers, markers, thermometers, anemometers and others. Binoculars, telescopes, borescopes and endoscopes or the more expensive fibre scopes may be useful where access is difficult. A crack width microscope or a crack width gauge is useful, while a magnifying glass or portable microscope is handy for close up examination. A good camera with the necessary zoom and micro lenses and other accessories, such as polarized filters, facilitates pictorial documentation of defects, and a portable colour chart is helpful in identifying variation in the colour of the concrete. A complete set of relevant drawings showing plan views, elevations and typical structural details allows recording of observations to be made.

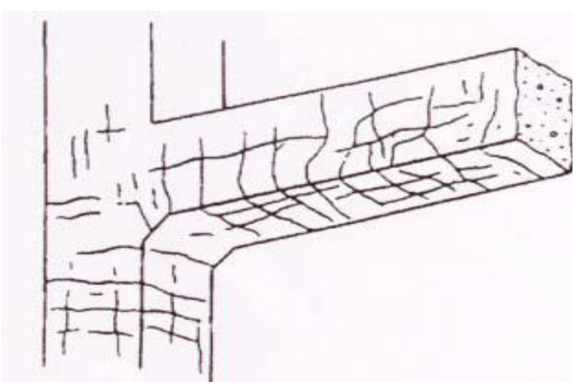
- General Procedure Of Visual Inspection:

Before any visual test can be made, the engineer must peruse all relevant structural drawings, plans and elevations to become familiar with the structure. Available documents must also be examined and these include technical specification, past reports of tests or inspection made, construction records, details of materials used, methods and dates of construction, etc.

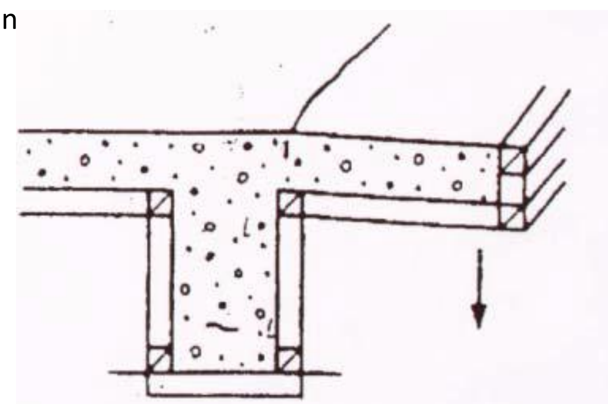
Visual inspection is not confined to the surface but may also include examination of bearings, expansion joints, drainage channels and similar features of a structure. Any misuse of the structure can be identified when compared to the original designed purpose of the structure

An assessment may also need to be made of the particular environmental conditions to which each part of the structure has been exposed. In particular the wetting and drying frequency and temperature variation that an element is subjected to should be recorded because these factors influence various mechanisms of deterioration in concrete. For example, in marine structures it is important to identify the splash zone. Settlement of surrounding soil or geotechnical failures need to be recorded. Account must also be taken of climatic and other external environmental factors at the location, since factors such as freeze thaw conditions may be of considerable importance when assessing the causes of deterioration.

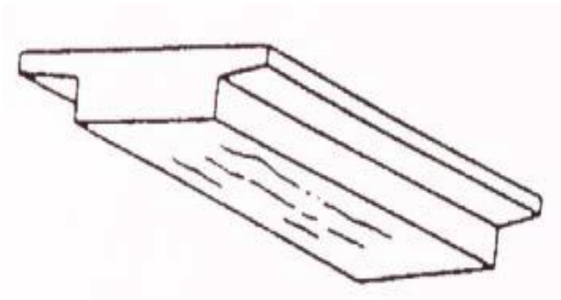
- Sketches of typical defects found by visual inspection



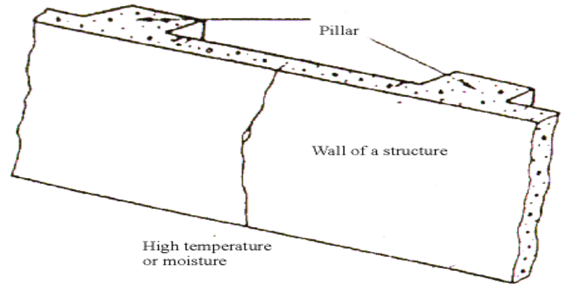
Sketch of effect of fire on concrete



Sketch of cracking due to sinking of timbering.



Cracks due to insufficient reinforcing bars.



Effect of atmospheric conditions.

B) REBOUND HAMMER TEST:

- Fundamental principle:-

The Schmidt rebound hammer is principally a surface hardness tester. It works on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges. There is little apparent theoretical relationship between the strength of concrete and the rebound number of the hammer. However, within limits, empirical correlations have been established between strength properties and the rebound number. Further, Kolek has attempted to establish a correlation between the hammer rebound number and the hardness as measured by the Brinell method.

- Equipment for rebound hammer test:-

The Schmidt rebound hammer is shown in Fig. The hammer weighs about 1.8 kg and is suitable for use both in a laboratory and in the field. The main components include the outer body, the plunger, the hammer mass, and the main spring. Other features include a latching mechanism that locks the hammer mass to the plunger rod and a sliding rider to measure the rebound of the hammer mass. The rebound distance is measured on an arbitrary scale marked from 10 to 100. The rebound distance is recorded as a "rebound number" corresponding to the position of the rider on the scale.

Rebound Hammer

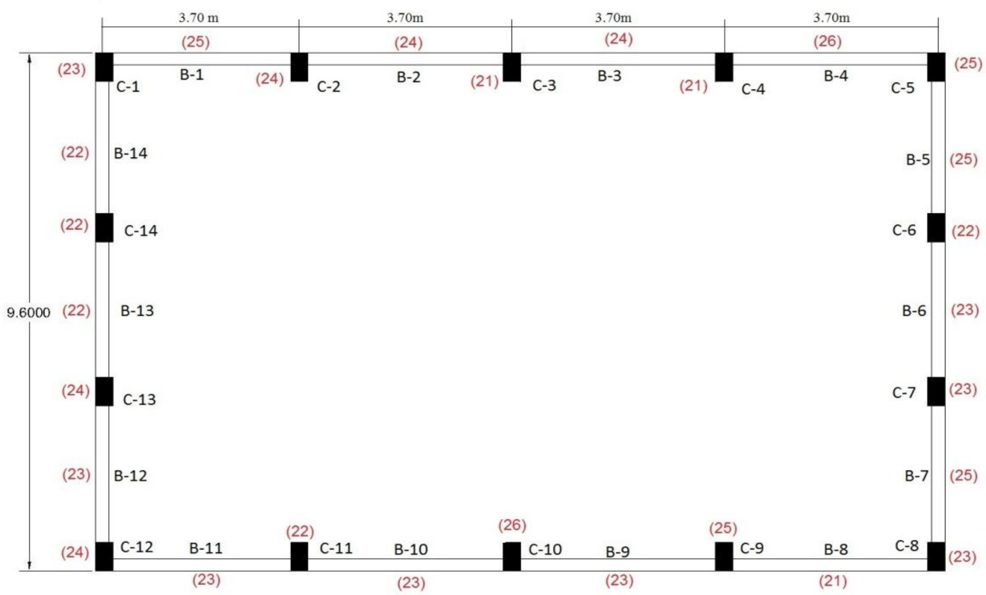
- General procedure for schmidt rebound hammer test:-

The method of using the hammer is explained using following Fig. With the hammer pushed hard against the concrete, the body is allowed to move away from the concrete until the latch connects the hammer mass to the plunger, Fig. a. The plunger is then held perpendicular to the concrete surface and the body pushed towards the concrete, Fig. b. This movement extends the spring holding the mass to the body. When the maximum extension of the spring is reached, the latch releases and the mass is pulled towards the surface by the spring, Fig .c. The mass hits the shoulder of the plunger rod and rebounds because the rod is pushed hard against the concrete, Fig.d. During rebound the slide indicator travels with the hammer mass and stops at the maximum distance the mass reaches after rebounding. A button on the side of the body is pushed to lock the plunger into the retracted position and the rebound number is read from a scale on the body.

IV CASE STUDY

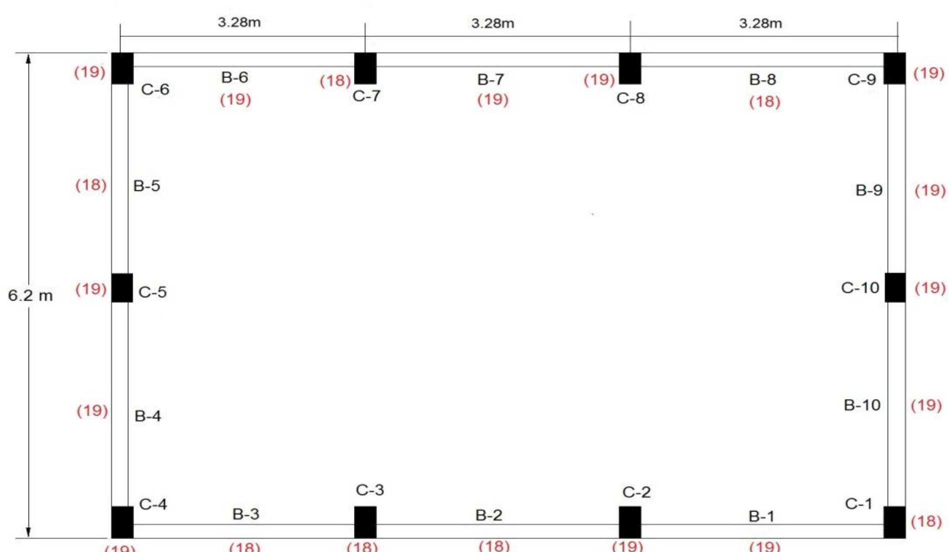
The experimental work was carried out on different age buildings. The rebound hammer test was performed on the following buildings,

- Architecture Building (Age:-6 Months)
- Civil Department Building (Age:-16 Year).



Architecture Department Building

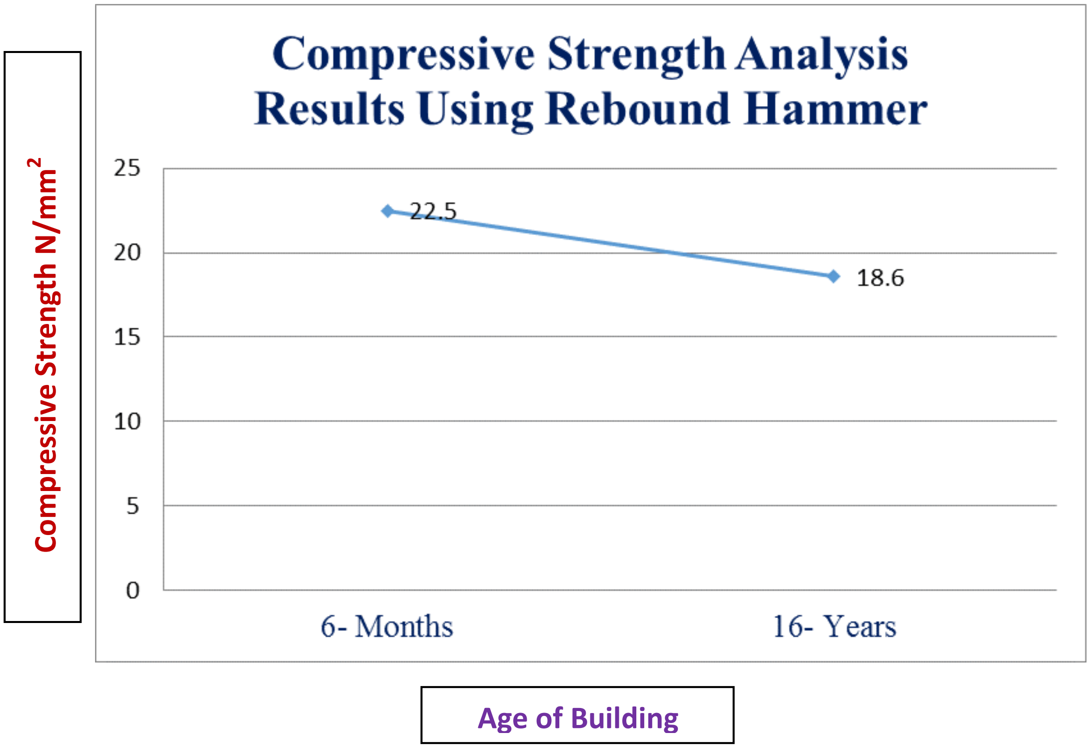
Rebound Hammer Test Result on 6 month old building



Civil Department class Room

Rebound Hammer Test Result on 16 year old building

(Note:- The values shows the compressive strength for that particular member)



V. CONCLUSION

The structural health monitoring by NDT methods such as UPV and Rebound hammer becomes very useful for predicting the service life of the structures and deterioration of the structures provided the periodical monitoring of the same member of the structures is being carried out. Since the concrete is heterogeneous and tests are affected by various factors such as age of the concrete, carbonation depth, reinforcement, cracks and voids inside the concrete, a combined test helps for assessment the strength and durability.

According to my experimental work using the Rebound Hammer the results shows that the compressive strength of RCC structure is decreases with respect to Age.

REFERENCES

1. IS 10262-1982, "Indian Standard Recommended Guidelines for concrete mix design", BIS, New Delhi.

2. IS 13311(Part 1):1992 Non-destructive testing of concrete-Methods of test Part 1 (Ultrasonic Pulse velocity.)

3. IS 13311(Part 2):1992 Non-destructive testing of concrete-Methods of test Part 2 (Rebound Hammer.)

4. Guidebook on Non-Destructive Testing Of Concrete Structures Iaea, Vienna, 2002 Iaea–Tcs–17 Issn 1018–5518.

5. "Indian Standard Code of Practice for Plane Reinforced Concrete Structures". IS: 456 (2000), Bureau of Indian Standards, New Delhi.