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NON-DESTRUCTIVE TESTING FOR BUILDING MATERIALS

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Abstract—*Concrete is the combination of cement mortar and binders and is of wide use in many places. Its applications range from small covering slabs to huge buildings. The necessity to know the strength, its ability to withstand load and durability is a factor of grave concern. The existence of the building is entirely relied on the concrete structure it is made of. Based on the mixing proportions, composition and wetting the properties of concrete can vary. Hence it is necessary to test concrete strength wherever possible. In this paper concrete slabs of different dimensions and characteristics are taken and subjected to destructive test by compressive strength testing and non- destructive testing by rebound hammer method. Further on the result is compared and analyzed.*

Keywords*: Rebound hammer, compressive strength, curing, concrete*

1. INTRODUCTION

The standard technique of deciding strength of hardened concrete consists of testing concrete cubes in compression. The standard of entire concrete of a structure can\'t be totally assessed by testing many concrete cubes. The results obtained in testing cubes don\'t continually mirror the particular strength of concrete in construction. In a whole day, concreting work cubes area unit forged in an exceedingly few batches, the variations (unintentional and intentional) within the composition aren\'t uncommon, their compaction and their hardening conditions continually dissent a lot of or less from those of the structure. Additionally, the quantity of take a look at cubes is usually thus little that they will solely be thought-about as random tests. Sometimes, just in case of failure of cubes, uncertain concrete, cracks, deterioration of concrete, etc. it becomes necessary to assess the standard and strength of concrete of the structure. As way back as early thirties, the need was felt to develop instruments by that unaltered strength of concrete is also obtained. varied non-destructive strategies of testing concrete are developed, that embrace, Firing technique, Skramtayev's technique, Polakov's technique, Magnitostroy technique, Fizdel ball hammer, Einbeck setup hammer, Ball indentation hammer, Rebound hammer, Pull out techniques, Windsor probe, inaudible pulse speed strategies, hot and nuclear strategies, Magnetic and electrical strategies. Altogether these strategies of tests, as a result of simplicity, rebound hammer take a look at supported surface hardness becomes most well liked within the world for nondestructive testing of unaltered concrete.

The Swiss engineer Helmut Heinrich Waldemar Schmidt reported experiments with a concrete take a look at hammer that measures the surface hardness of concrete (Schmidt, 1950, 1951).The device, called the Helmut Heinrich Waldemar Schmidt Rebound Hammer, measures the rebound of a elastic device mass impacting the free finish of a plunger (steel rod) that\'s control against the concrete surface. The extent of the rebound of this mass is expressed because the rebound variety R. Helmut Heinrich Waldemar Schmidt states in his paper that "the rebound variety R are often thought-about as a brand new quality parameter of the concrete; it characterizes the hardness of the mortar (concrete minus coarse aggregates) at one single location near the surface. The rebound hammer permits the determination of the concrete quality by victimization planned correlation charts between the rebound variety and compressive strength.

The rebound of Associate in nursing elastic mass depends on the hardness of the surface against that its mass strikes. Once the plunger of the rebound hammer is ironed against the surface of the concrete, the pring-controlled mass rebounds and also the extent of such a rebound depends upon the surface hardness of the concrete. The surface hardness and thus the rebound is taken to be associated with the compressive strength of the concrete. The rebound price is scan from a graduated scale and is selected because the rebound variety or rebound index. The compressive strength are often scan directly from the graph provided on the body of the hammer. Once the plunger of rebound hammer is ironed against the surface of the concrete, the spring-controlled mass rebounds and {therefore the|and also the} extent of such rebound depends upon the surface hardness and therefore the rebound is taken to be connected tothe compressive strength of the concrete. The rebound is scan off on a graduated scale and is selected because the rebound variety or rebound index

2. EXPERIMENTAL PROCEDURE

2.1 Procedure of Obtaining Correlation between Compressive Strength of Concrete and Rebound Number

The most satisfactory means of building a correlation between compressive strength of concrete and its rebound range is to live each the properties at the same time on concrete cubes. The concrete cube specimens square measure command in an exceedingly compression testing machine beneath a hard and fast load, measurements of rebound range taken and then the compressive strength determined as per IS 516 : 1959. The mounted load needed is of the order of 7 N/mm^2 once the impact energy of the hammer is concerning a pair of.2 Nm. The load ought to be exaggerated for calibrating rebound hammers of larger impact energy and slashed for calibrating rebound hammers of lesser impact energy. The check specimens ought to be as massive a mass as doable so as to minimise the dimensions impact on the check results of a full scale structure. a hundred and fifty millimeter cube specimens square measure referred for calibrating rebound hammers of lower impact energy (a pair of.2 Nm), whereas for rebound hammers of upper impact energy, for instance thirty Nm, the check cubes mustn't be smaller than three hundred millimeter.

If the specimens square measure wet cured, they ought to be far from wet storage and unbroken within the laboratory atmosphere for concerning twenty four hours before testing. To get a correlation between rebound numbers and strength of wet cured and correlation between the strength of wet tested cubes and therefore the strength of dry tested cubes on that rebound readings square measure taken. An instantaneous correlation between rebound numbers on wet cubes' and therefore the strength of wet cubes isn't counseled. Solely the vertical faces of the cube as forged ought to be tested. a minimum of 9 readings ought to be taken on every of the 2 vertical faces accessible within the compression testing machine once victimization the rebound hammers. The points of impact on the specimen should not be nearer a grip than twenty millimeter and will be not but twenty millimeter from one another. Identical points should not be wedged quite once.

Fig. 2.1: Rebound hammer apparatus

2.2 Procedure for application of rebound hammers on concrete wall

1. For testing, smooth, clean and dry surface is to be elite. If loosely adhering scale is gift, this could be rubbed of with a emery wheel or stone. Rough surfaces ensuing from incomplete compaction, loss of grout, spalled or tooled surfaces don't offer reliable results and will be avoided.
2. The purpose of impact ought to be a minimum of twenty millimeter aloof from any edge or form separation.
3. Mainly, 2 experiments square measure conducted one to seek out the applied math relation between three slabs processed seperately and second to seek out the coorelation between compressive Strength of Concrete and Rebound range
4. For taking a mensuration, the rebound hammer ought to be command at right angles to the surface of the concrete member. The check will -thus be conducted horizontally on vertical surfaces or vertically upwards or downwardly on horizontal surfaces. If the case demands, the rebound hammer are often command at intermediate angles additionally, however in every case, the rebound range are completely different for identical concrete.
5. Rebound hammer check is conducted around all the points of observation on all accessible faces of the structural component. Concrete surfaces square measure completely cleansed before taking any mensuration. Around every purpose of observation, 9 readings of rebound indices square measure taken and average of those readings once deleting outliers as per IS 8900: 1978 becomes the rebound index for the purpose of observation.

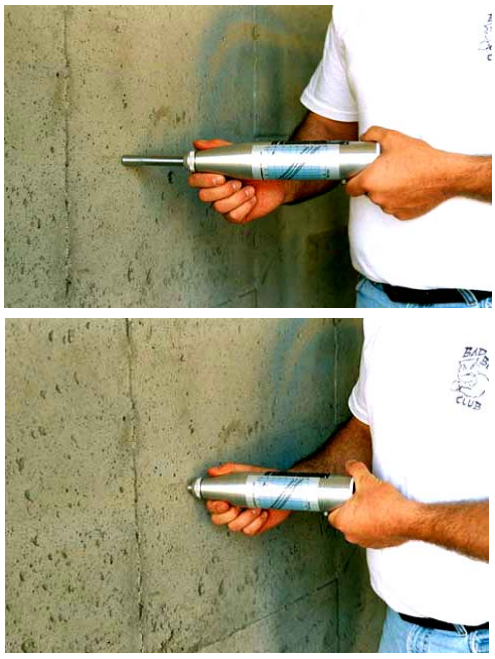

Fig. 2.2: Horizontal orientation of hammer during measurement

3. RESULT AND DISCUSSIONS

3.1 Statistical analyses of concrete slabs by rebound hammer

3 cubic slabs of required dimensions were made in 3 different methods

3.1.1 Slab 1 created by Membrane solidification

The method of curing described above come under the category of moist curing. Another methodology of solidification is to hide the wetted concrete surface by a layer of water proof material, that is unbroken up-to-date with the concrete surface of seven days. This methodology of solidification is termed as membrane solidification. A membrane can stop the evaporation of water from the concrete. The membrane will be either in solid or liquid kind. They're conjointly called waterproofing compounds. Bituminised water proof papers, wax emulsions, hydrocarbon emulsions and plastic films area unit the common kinds of membrane used.Whenever hydrocarbon is applied over the surface for solidification, it ought to be done solely when twenty four hours solidification with sacking luggage. The surface is allowed to dry out in order that loose water isn't visible so the liquid asphalt sprayed throughout. The wet within the concrete is so preserved. It's quite enough for solidification.

3.1.2 Slab 2 a pair of Covering Concrete Surfaces With jackboot or sacking luggage

This is a wide used methodology of solidification, notably for structural concrete. Here exposed surface of concrete is prevented from drying out by covering it with jackboot, canvas or empty cement luggage. The covering over vertical and sloping surfaces ought to be secured properly. This area unit sporadically is wetted. The interval of wetting can depend on the speed of evaporation of water. It ought to be ensured that the surface of concrete isn't allowed to dry even for a brief time throughout the solidification amount. Special arrangements for keeping the surface wet should be created at nights and on holidays.

3.1.3 Slab 3 by sprinkling of Water

Sprinkling of water ceaselessly on the concrete surface provides associate degree economical solidification. It's principally used for solidification floor slabs. The concrete ought to be allowed to line sufficiently before sprinkling is started. The aerosol can be obtained from a perforated plastic box. On little jobs sprinkling of water is also done by hand. Vertical and sloping surfaces will be unbroken ceaselessly wet by sprinkling water on prime surfaces and permitting it to run down between the forms and also the concrete. For this methodology of solidification the water demand is higher

Table 3.1: Rebound hammer results on 3 slabs cured differently

	READING NO	SLAB 1 (Rebound No.)	SLAB 2 (Rebound No.)	SLAB 3 (Rebound No.)
	1	31	20	33
	2	25	23	35
	3	23	23	39
	4	26	27	19
	5	24	21	35
	6	24	23	35
	7	23	23	31
	8	21	25	25
	9	26	25	22
AVERAGE		24.88	23.00	29.00
STD DEV		2.48	2.83	5.95
VARIANCE		6.13	8.00	3.54

3.2 Comparison between Rebound hammer test and Compressive strength test

Specimen shape: CUBE

Specimen size: 150*150*150mm

Table 3.2: Comparison between rebound hammer testing and compressive strength testing

CONCRETE	Rebound hammer (MPa)	Compressive strength (MPa)
Low cement content	28	27.32
Intermediate cement content	35	34.83
High cement content	37	42.63

To analyse the similiarity and dissimilliarities in compressive test and rebound hammer test method 3 slabs were taken with varying composition of cement content. The difference in the values by tesing can also be found out. The slab1 containing 25 % of cement was mixed in the ratio 1:2:1 and tested. The slab 2 of 35 % of cement was mixed in the ratio 7:6:7 and the slab 3 of 55% cement composition were made of the mixing ratio 11:5:4. The values of compressive test obtained using rebound hammer test and compression test are almost similar.This suggests that a non destructive method using reound hammer can replace the destructive testing done by compression test. Slab1 shows the value of 28 MPa when tested by the rebound hammer apparatus.The same specimen when subjected to compression test resulted in 27.32 MPa that is much closer to the obtained rebound value. The Slab 2 when tested with rebound resulted in the value of 35 MPa that was almost close to the value of 34.83 obtained by compressive test.

The value of rebound hammer test on slab 3 is 37 MPa which when compared to its compressive test value 42.63 MPa has a deviation in its result. Though this value is similar to the rebound value the variation can suggest that there is a variation in the obtained result for high cement content concrete, which is much below the compressive test value.

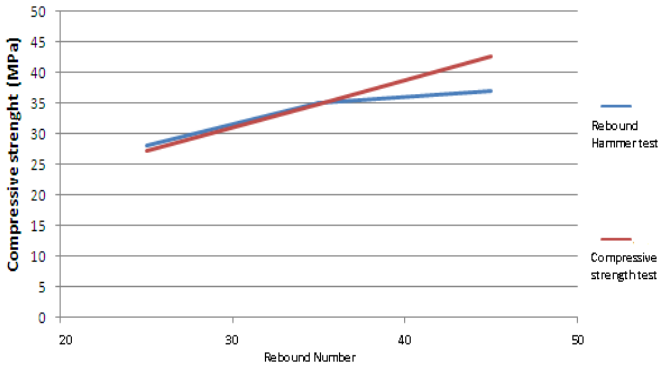

Fig. 3.1: Graph showing relation between rebound hammer testing and compressive strength testing

4. CONCLUSION

The rebound hammer technique provides a convenient and fast indication of the compressive strength of concrete by suggests that of building an acceptable correlation between the rebound index and therefore the compressive strength of concrete. In general, the rebound variety will increase because the strength will increase however it's conjointly plagued by variety of parameters like kind of cement, aggregate, surface condition and wet content of the cement. it's conjointly known that rebound indices ar indicative of compressive strength of concrete to a restricted depth from the surface. If the concrete in an exceedingly specific member has internal microcracking, flaws or heterogeneousness across the cross-sectional, rebound hammer indices won't indicate a similar.

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