* UNIT-2 *

* Non-Destructive Testing *

Non destructive Testing Methods

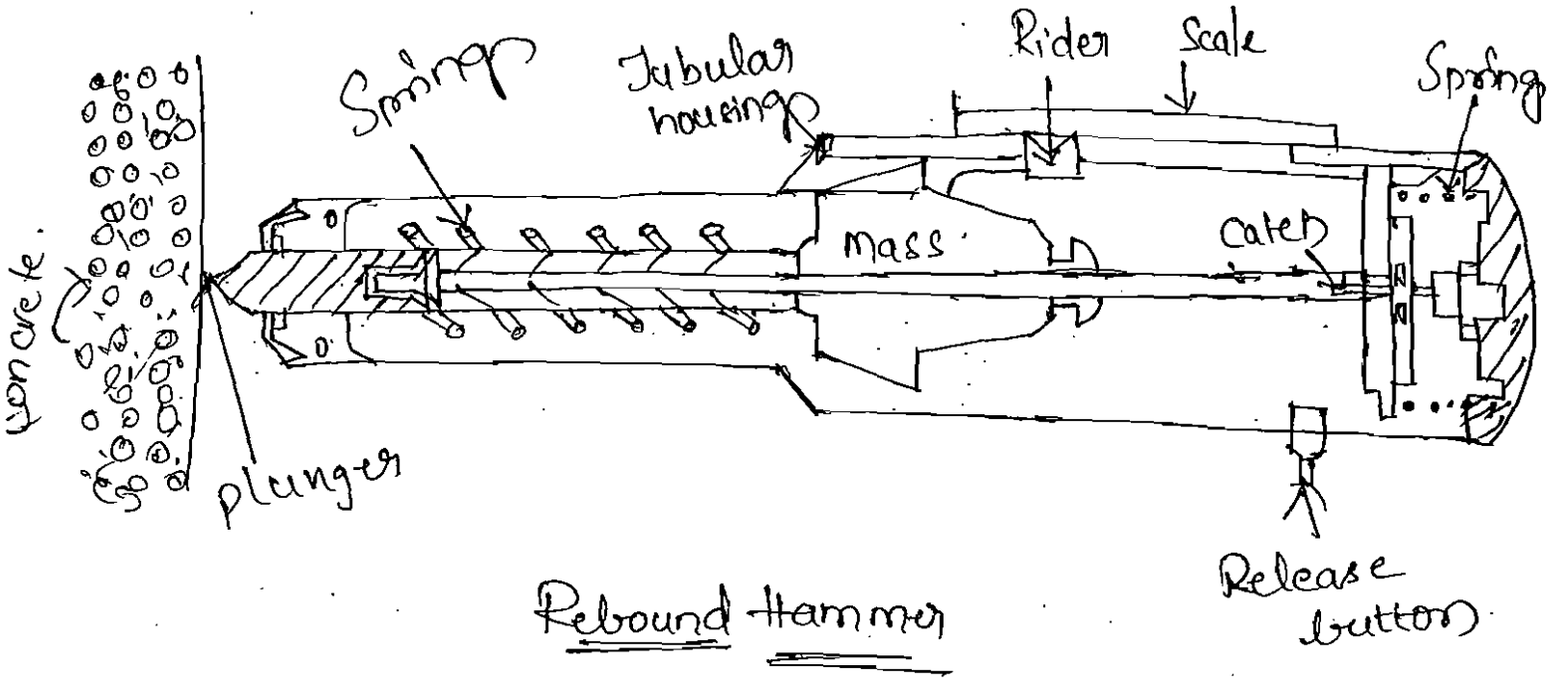
Non-destructive methods have been use for about 4 decades. In this period, the development has taken place to such an extent that it is now considered as a powerful method for evaluating existing concrete structures with regard to their strength and durability apart from assessment and control of quality of hardened concrete.

In certain cases, the investigation of crack depth, microcracks and progressive deterioration are also studied by this method. These methods, therefore attempt to measure some other properties of concrete from which an estimate of its strength, durability and elastic parameters are obtained. Based upon the above, Various non, destructive methods of testing concrete have been developed. They are

1. Surface hardness tests
2. Rebound test
3. Penetration & Pull out techniques
4. Dynamic or Vibration tests.
5. Combined method.
6. Radio Active & Nuclear methods.
7. Magnetic and Electrical methods
8. Acoustic emission techniques.
9. Surfaces hardness Methods.

Schmidt's Rebound Hammer :—

Schmidt's rebound hammer developed in 1948 is one of the commonly adopted equipments for measuring the surface hardness. The sectional view of the hammer is shown in fig.



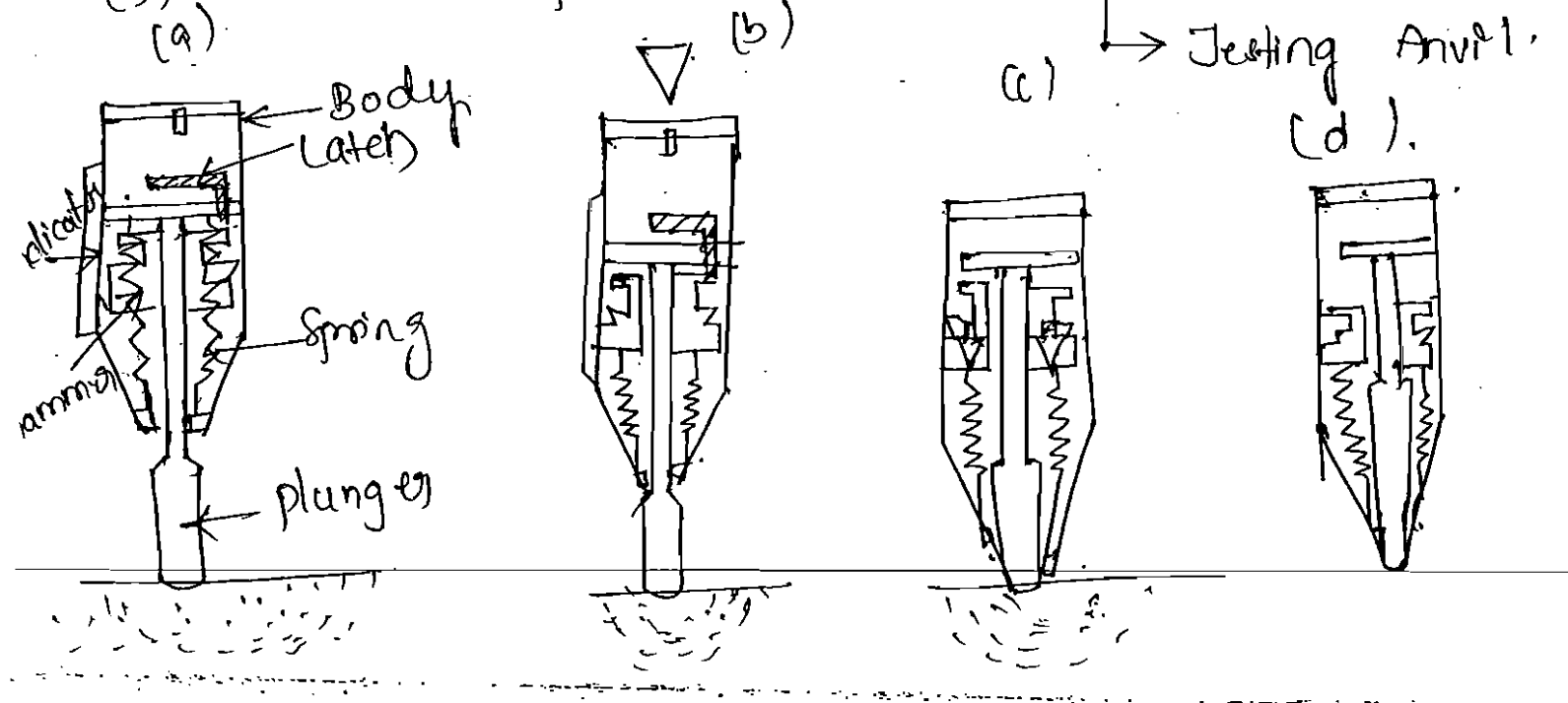
Rebound Hammer

It consists of a spring control hammer that slides on a plunger with in a tubular housing. When the plunger is pressed against the surface of the concrete, the mass rebound from the plunger. It retracts against the the force of the spring. The hammer impacts against the concrete and the spring control mass rebounds, taking the rider with it along the guide scale. By pushing a button, the reder can be held in position to allow the reading to be taken. The distance travelled by the mass, is called the rebound number. It is indicated by the rider moving along a graduated scale.

Each hammer varies considerably in performance & needs calibration for use on concrete made with the aggregates from specific source. The test can be conducted horizantally, Vertically-Upwards or Onwards or at any intermediate angle. At each angle the rebound number with hammer horizantal and Vertical on a dry or wet surface of concrete.

Limitations: Although, rebound hammer provides a quick inexpensive means of checking uniformity of concrete, it has serious limitation & these must be recognized. The results are affected by.

(a) Smoothness of Surface under test.
(b) Size, shape & rigidity of the specimen.
(c) Age of specimen.
(d) Surface and internal moisture condition of the concrete
(e) Type of coarse Aggregate
(f) Type of cement
(g) Type of mould. → Type of moulds → concrete test hammer normal.
(h) Carbonation of concrete → concrete test hammer digital
→ Testing Anvil.



Ultrasonic Pulse Velocity

which involves measurement of the time of travel of electricity generated mechanical pulses through the concrete. It gained considerable popularity all over the world. when mechanical impulses are applied to a solid mass, three different kinds of waves are generated. These are generally known as longitudinal waves, shear waves and surface waves are generated. These 3 waves travel @ different speeds. The longitudinal or compressional waves travel about 2 times as fast as the other 2 types. Shear or transverse waves are not so fast, the surface waves are the slowest.

The pulses can be generated either by hammer blows or by the use of electroacoustic transducer. Electroacoustic transducers are preferred as they provide better control on the type and frequency of puke generated. It is called "Sonlscope"

Ultrasonic pulse Velocity method consists of measuring the time of travel of an ultrasonic pulse, passing through the concrete to be tested. The pulse generator circuit consists of electronic circuit for generating pulses and transducer for transforming these electronic pulses into mechanical energy having vibration frequencies in the range of 15 to 50 kHz. The time of travel b/w transducer divided ~~by~~ b/w initial onset and reception of the puke is measured electronically. The path length b/w transducer divided by the time of travel gives the avg. velocity of wave propagation.

Recently, battery fully portable digitised units have become available in UK. One such unit is called "PUNDIT" (protable Ultrasonic Non-Destructive Digital - Indicating Tester). It only weights 3 kg.

Techniques of Measuring Pulse Velocity through concrete

There are 3 ways of measuring pulse velocity through concrete they are.

(a) Direct transmission

(b) Indirect transmission.

(c) Surface transmission.

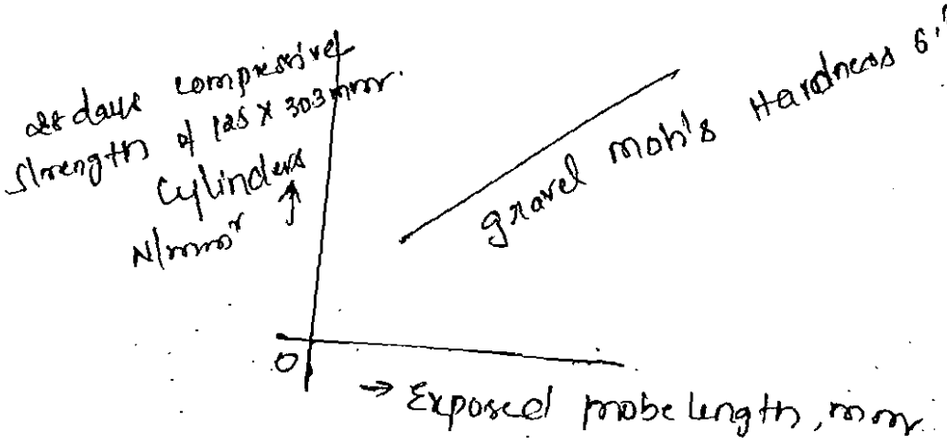
Factor affecting the measurement of pulse Velocity :-

The measurement of pulse velocity is affected by a number of factor regardless of the properties of concrete

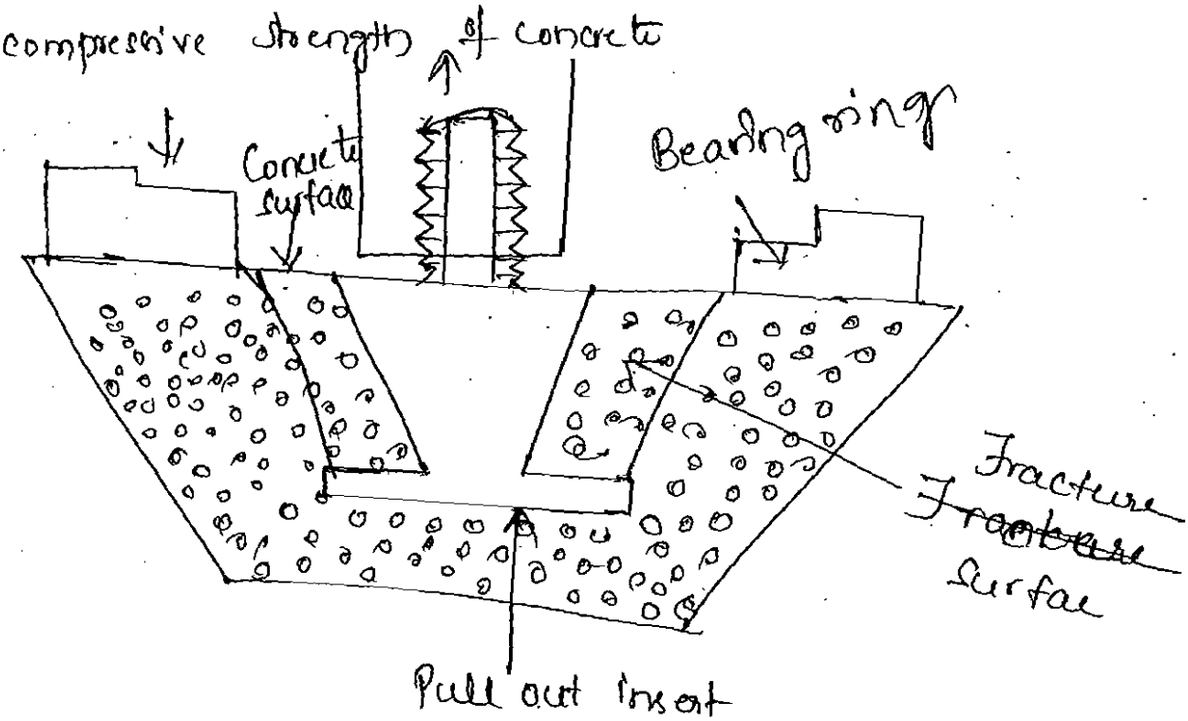
* Smoothness of contact surface under test.
* Influence of path length on pulse velocity.
* Temperature of concrete.
* Moisture condition of concrete.
* Presence of reinforcing steel.
* Accuracy of Measurement.

Penetration Technique

The measurement of hardness by probing technique was first reported during 1954. two techniques were used. On one case, a hammer known as, "Simbi". was used to perforate.



concrete and the depth of borehole was corelated to compressive strength of concrete cubes in the older technique the probing of concrete was acheived by blasting with split pins and the depth of penetration of the pins was correlated with compressive strength of concrete



Diagramatic representation of the pull out test

The Accuracy of this test was found to be ± 25 %. However, it is further seen that seen that, "Gimbi" and split pins were more effected by the arrangement of coarse Aggregate, than the tests using rebound hammer.

During 1964 and 1966 a technique known as the "windsor probe" was developed testing concrete in the laboratory and in situ. The windsor probe is a hardness tester of surface of the concrete.

It is an equipment consisting of a powder activated gun, hardned alloy probes, loaded cartidges, and depth gauge for measuring pentration of probe. It

The probe is driven into the concrete by calibrated firing of a precension powder charge cartridges. The exposed length is measured by calibrated depth gauge and this is corelated to the strength of concrete cylinder.

It can only be considerd non-destructive to the extent that concrete can be tested in situ and structural member. In case of big structures like pavements or retaining walls etc., the structure need not be discarded

Pullout Test:

A pullout test measures the force required to pull out from the concrete a specially shaped rod whose enlarged end has been cast into that concrete. The stronger the concrete the more is the force required to pullout. The ideal way to use pullout test in the feild would be the incorporate assemblies in the structure. These standard specimens could then pulled out at any point of time. The force required

denotes the strength of concrete. Another way to use pullout test in the field would be to cast one or two large blocks of concrete incorporating pullout assemblies. Pullout test could then performed to assess the strength of concrete.

Rebar Locators

* Rebar locator is one of the NDT, which are used to locate the steel bar embedded in concrete before drilling and before taking core test.
* It is the easiest and fastest ways for detecting reinforcing bar in concrete. It is widely used before coring & drilling holes to find "safe spots"
* It will indicate rebar location, direction & also will give an indication of the depth of concrete cover
* The rebar detection instrument (Profoscope) has a unique real time visualization mechanism allowing the contractor to actually see the location of rebar beneath the concrete surface. The profoscope features data storage for automatic collection of data to make rebar detection more efficient.

The (profometer + 5) combines rebar detection & measurement of concrete cover and bar diameter in one instrument

Types :—

Profoscope : The fully integrated profoscope for quick & easy rebar detection

Profoscope 4+ :- The profoscope+ has the same features as the profoscope, but additionally offers the innovative memory function for data acquisition.

profosope 5+ :-

It is an advanced device for NDT of rebar and for the measurement of concrete cover and bar diameter.

profometer PM-600 / 630 :-

They are advanced cover meter which come with the new generation profometer Touch Screen unit.

Procedure

* The instrument is laid at the surface of the column of slab
* An instrument is moving from the left from the left to right and then from the bottom to up to get the position of reinforcement
* Once the location of rebars are found, a masonary drill is used to locate the total cover to the rebars.

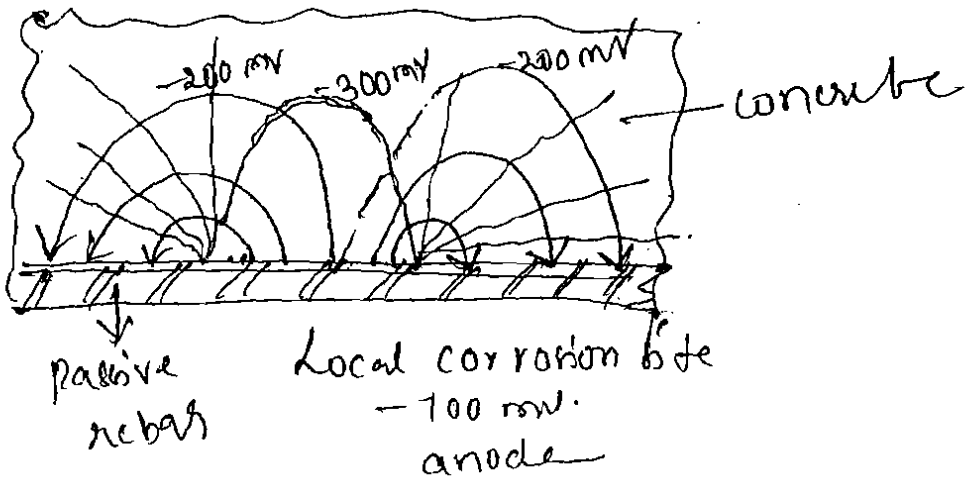
Methods of Corrosion measurement and Assement :-

Corrosion of reinforcement has been established as the predominant factor causing widespread premature deterioration of concrete construction world wide, especially of the structures located in the coastal marine environment. The most important causes of corrosion initiation of reinforcing steel are the ingress of chloride ions & CO_2 to the steel surface.

Half-cell potentials :-

The corrosion potential E_{corr} (half cell rebar/concrete) is measured as potential difference (or voltage) against a reference electrode (half-cell). As a corrosion detection technique this was first used by stratful. The numerical value of the measured potential diff b/w steel in concrete & the reference electrode will depend on the type of reference electrode used and on the corrosion condition of the steel in concrete.

In addition half-cell potentials of steels in concrete cannot be measured directly at the interface concrete / rebar due to the presence of concrete cover. The potentials are thus influenced by IR drop in the cover, by macrocell current and possibly by junction potentials.



Procedure

Potential measurements can be performed with a single electrode (point measurement) or with one of several wheel electrodes (potential mapping)

Potential Measurement :-

Measurements with a single electrode will usually be performed with a large grid size (0.5 m up to 2m) in phase of restoration or condition assessment (in order to get a rapid and cost effective overview on the corrosion state of structure) or on comparatively small objects. These measurements can be made on vertical, on top of bottom horizontal surface from the bottom, care has to be taken that the reference electrode is filled with sufficiently electrolyte solution.

potential mapping

potential mapping is usually performed with a multiple wheel arrangement and a small grid size of ca. 0.15 m on large surfaces (bridge, decks, walls, parking decks etc) with single or multiple electrode instruments & computer assisted data acquisition. several $100 m^2$ per hr can be measured. Abt. 30-50 single measurements are taken per square meter of concrete surface for this reason the precision of the individual surfaces.

Sources of errors in measurements :-

The requirements for stability of a single half-cell potential reading are higher for point measurements with a large grid size than for potential mapping because every point is representative of a large area.

* Drift of half-cell potential readings
* Randomly fluctuating reading.

Data Presentation :-

The way of representing half-cell potential measure may vary according to the number of readings taken. If a large grid size was used or only a few readings were taken, the half-cell potential values may be given as be written directly into plan view. A large no. of data can be presented as potential map & / or for statistical

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