EASTERN MEDITERRANEAN UNIVERSITY

DEPARTMENT OF CIVIL ENGINEERING

MATERIALS OF CONSTRUCTION LABORATORY

CIVL 484 REPAIR & MAINTENANCE OF CONCRETE

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Experiment No : #3

Name of the Experiment :PUNDIT

ASTM CODE: C597-16

Experiment 1
PUNDIT (Portable Ultrasonic Non-destructive digital Indicating Tester)

I. Objective and Scope

Goal of this experiment is determining the **homogeneity**, **compressive stress** and **strength of concrete** using PUNDIT which can be operated using internal or external battery or A.C lines.

PUNDIT can be used in the laboratory or on site to detect uniformity, cavities, cracks, freeze thaw damage, delaminating, deterioration and strength of the sample. It is accepted to be the Standard test method for ultrasonic pulse velocity testing in terms of accuracy and reliability. Concrete, ceramics, timber and many other materials can be tested with this method without any damage as it is a nondestructive test.

The underlying principle of this test is method consist of measuring the time of travel of ultrasonic pulse passing through concrete. Comparatively higher velocity of ultrasonic pulses demonstrates the better quality in terms of density, uniformity and homogeneity of concrete.

II. Apparatus

PUNDIT, concrete specimen, grease oil

III. Test Procedure

1. Before switching on the V meter the transducer should be connected to the socket marked TRAN (transmitter)and REC (receiver)
2. Turn on the device by put the switch on MAINS sign if you are going to use AC line otherwise by putting the switch on BATT to use internal battery of the device and CH sign demonstrates charging on the device.
3. Select the necessary range: for max accuracy it is recommended that the 0.1 microsecond range be selected for path length up to 400mm.you can select the range from 0.1, 1 and 10 depend on the length of specimen.
4. A reference bar is provided to check the calibration of instrument. The pulse time for the bar is engraved on its body (26.3).apply a smear of grease to the transducers faces before placing it on the opposite ends of the bar to prevent existing air on the bar. Adjust the SET REF control until the reference bar transit time is obtained (26.3) on the instrument read out. This procedure (calibration) should be applied every time we switch off the device.
5. Find the center of each surface of the specimen that you are supposed to pass the pulse through.
6. Measure the length of specimen.
7. Put receiver and transmitter perpendicular to the end surfaces of the concrete sample.
8. Having determined the most suitable test point on the material to be tested , make careful measurement of the path length L . Read the time from the screen of the PUNDIT and do not move the transducers until a reading is being taken as it can generate noise, signal and errors in measurement. Once the consistent reading appears on the screen you can move the transducers.
9. Record the time. It is the time in microsecond for the ultrasonic pulse to travel the distance of L. So the mean value of display reading should be taken when the units digit hunts between two values. NOTE: in separation of transducers leads be aware of taking leads into close contact to each other when the transit time measurement is being taken because the receiver lead can pick up unwanted signal from transmitter lead which causes an error in displaying the transit time.
10. By using velocity time equation find the velocity and from graph find the strength of the concrete.

IV. Calculations

$$X = V.t$$

Where

X : Length of the concrete specimen is based on either CM or MM so they have to be converted to KM by multiplying them in either 10^-5 or 10^-7

t : Time read from PUNDIT screen is in MS so they also have to be converted to S by multiplying them into 10^-6

V: Pulse velocity should be calculated in KM/S

$$V = \frac{X}{t}$$

once we calculated pulse velocity we refer to the graph to find the strength of specimen. On the graph two axis are provided which shows the pulse velocity on X axis and the strength on Y axis. We already founds the V so we draw the vertical line from the point on X axis once we reach the diagonal line from that point onward we draw a horizontal line to find corresponding strength for that specific pulse velocity.

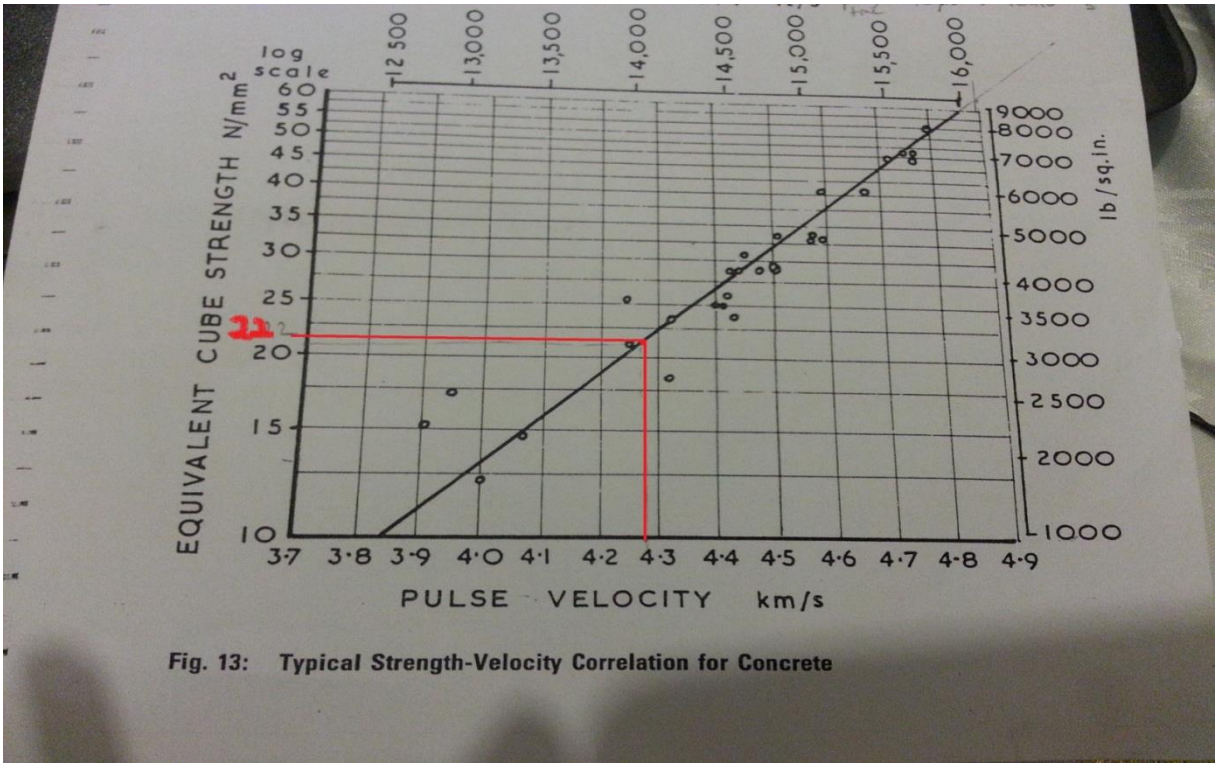


Fig. 13: Typical Strength-Velocity Correlation for Concrete

Typical strength –Velocity Correlation for concrete

Experiment 2
Measurement of the crack depth using PUNDIT

I. Object and Scope

Goal of this experiment is determining thedebt of crack in concrete using PUNDIT which can be operated using internal or external battery or A.C lines. This test method covers the determination of the depth of the crack.

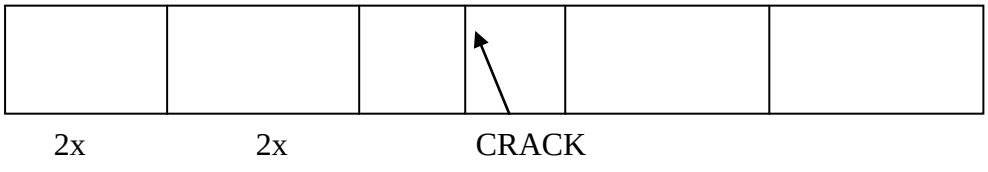
Pulse velocity is the measurement of the transit time of an ultrasonic pulse between a transmitter and a receiver. This method is widely used because it is non-destructive evaluation. The readings are influenced by the presence of reinforcing steel. It reduces the transit time.

II. Apparatus

PUNDIT, specimen with crack and grease oil

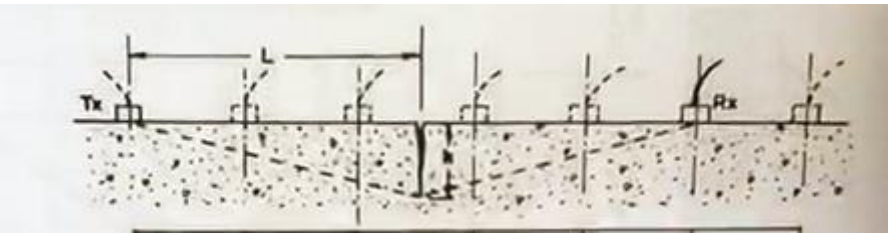
III. Test Procedure

1. Before switching on the V meter the transducer should be connected to the socket marked TRAN (transmitter)and REC (receiver)
2. Turn on the device by put the switch on MAINS sign if you are going to use AC line otherwise by putting the switch on BATT to use internal battery of the device and CH sign demonstrates charging on the device.
3. Select the necessary range: for max accuracy it is recommended that the 0.1 microsecond range be selected for path length up to 400mm.you can select the range from 0.1, 1 and 10 depend on the length of specimen.
4. A reference bar is provided to check the calibration of instrument. The pulse time for the bar is engraved on its body (26.3).apply a smear of grease to the transducers faces before placing it on the opposite ends of the bar to prevent existing air on the bar. Adjust the SET REF control until the reference bar transit time is obtained (26.3) on the instrument read out. This procedure (calibration) should be applied every time we switch off the device.
5. Measure the length of specimen. then according to its length divide it into equal part using marker draw a line to separate each division. Note that the division measurement should be in the way that the crack fall in exact middle of the middle division it means if each division length is 2X , the division in which the crack fell into has to be X and X XX



6. dividing the surface into equal part applied when the crack is perpendicular on the surface.

7. To test the concrete, apply grease oil on each division line to again prevent air penetration between transmitter and receiver and surface .
8. With keeping the position of the transmitter constant, receiver is moved each time further from transmitter by one division.

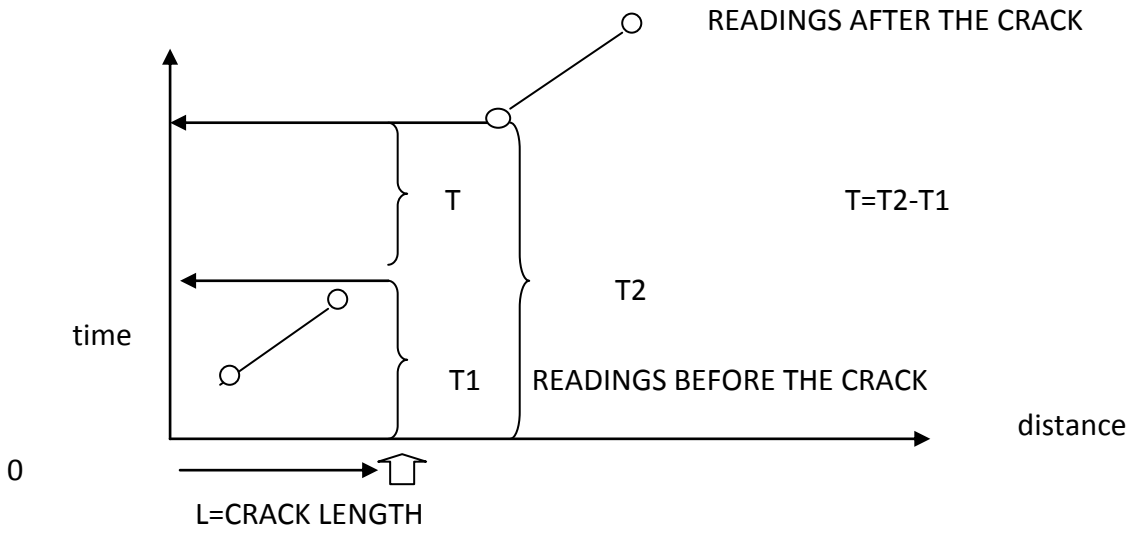


9. by keeping the receiver constant Readings has to be taken from the device for each division.
10. Once reading is finished the table is formed based on distance for each division and the recorded time from the device.

IV. Calculations

Distance(cm)	Time (μs)

after forming our table using spreadsheet we draw a graph accordingly the X axis on the graph indicates the distance on each division where the Y axis indicates the recorded time by device.



following formula enabling us to calculate crack depth:

$$D = \frac{L}{2}\left(\frac{T2}{T1} - \frac{T1}{T2}\right)$$

D: Depth of crack

Experiment 3
SCHMIDT HAMMER (mechanical concrete test hammer)

ASTM CODE : ASTM D5873 - 14

Objective and scope:

The concrete test hammer is an instrument which is easy to use for quick and approximate measurement of the resistance to pressure of manufactured concrete products. The principle on which Schmidt hammer works are based on the rebound impact of a hammer on a piston which rest against the surface of the concrete specimen. The greater the resistance of the concrete the greater the rebound impactthe test hammer maybe used for non-destructive control on cement during the normal of factories and bridges.

The test makes it possible to learn the strength of impact, which depends on the resistance of cumulus in the absence of large inner lump or clusters of sand and gravel. From the force of impact the resistance of cumulus surface can be deduced and eventually the resistance of concrete.

Apparatus:

Schmidt hammer , concrete specimen , graph, compression machine

TEST PROCEDURE:

1. The test must be carried out on smooth and uniform surface so take care to remove any materials such as paint or plaster covering the concrete.
2. Fix the concrete specimen using pressing device.
3. Gently push the piston inward by pressing it against the any surface the piston will release itself from its catch and emerge from the body of the device which will then be ready for testing.
4. Press the piston against the surface of the concrete specimen to be tested, holding the device perpendicularly to the surface. Gradually apply increasing pressure until the mass impact in released.
5. Keep the device firmly pressed against the specimen surface and look at the rebound reading on the scale.
6. Never use the Schmidt hammer on the top or the bottom of specimen where aggregation of material is suspected.
7. Low rebound number on testing specimen indicates the empty space (air) in material and very high rebound number indicates a cumulus of material.
8. Read the H value (hammer rebound) value and considering the desirable number of reading for each specimen is between 10 to 15 collect your data.
9. **Note: do not touch the side button whilst pressing on the piston. On removing the device from the surface the piston once more emerges completely from the device which is immediately ready for the second test.**
10. **Note: if it is difficult to see the reading under abnormal circumstances, press the side button only after the impact and remove the device in order to read the scale.by pressing the button it will keep piston inside and unable us to read the hammer rebound value easier. But in order to perform further test we need to perform procedures which mentioned in paragraph 2.**
11. **Note: the spots you are testing on the specimen should be more than 1 cm away from each other to avoid the effect of hitting on each spot on other spots.**

Calculation:

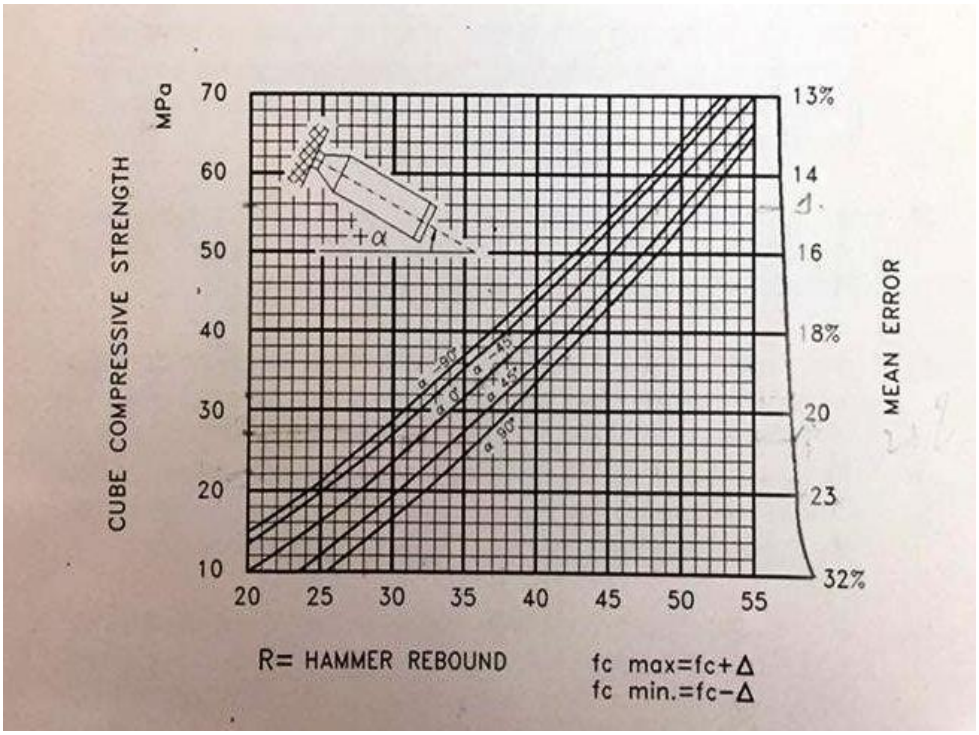
1. The first step is validate our readings which can be done by calculating the average of our rebound value and check with following table

H value	15	30	45
Discard reading +/-	2.5	3	3.5

Once we found the average value our reading which falls out of the +/- discard reading area should not be considered and subsequently another sampling should be done.

2. Once we obtained the 10 best readings. We can refer to the graph to obtain the compressive strength of the specimen .the graph is normally provided on the Schmidt hammer as depicted in follow:

The graph shown in the detailed form in following picture:



There are 5 curves shown in the graph which indicates the position of hammer and the surface which has been tested. if the hammer tested against the vertical wall (a=0),If it was in downward position against the floor (a=-90) against the ceiling (a=90) and consequently +45 and -45 degree.

3. Once the curve is chosen find the H value on X axis of the graph and by drawing the line from our point to chosen curve respectively find the cube compression strength on Y axis.
4. You will be able to calculate $f_{c\,max}$ and $f_{c\,min}$ by adding and subtracting the amount of mean error (Δ) which could be derivate from the above graph using the amount of compressive strength.

$F_{c\,max} = f_c + \Delta$ $F_{c\,min} = f_c - \Delta$

5. Note: These curves are valid for compact cements made with Portland cement, with sand and gravel resistant materials .the cement must be 14 to 56 days old. The specimen include