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NON-DESTRUCTIVE TESTING OF RCC STRUCTURE

(ULTRASONIC PULSE VELOCITY TEST)

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Abstract:

In this paper, you have been told that what is ultrasonic pulse velocity testing, how many methods are there, how it is done, how crack depth will be calculated and how the test condition is affected with methodology.

Key Words: Non-destructive testing , Ultrasonic testing of RCC Structure , Ultrasonic pulse velocity test , Crack depth

1.Introduction

Sonic testing is been used for testing materials or rather individual specimens such as forgings castings where gross internal defects can be detected by the change in the ringing note when the specimen struck with a hammer. Testing by sound is non-destructive testing methods to check for internal defects or any other flaws. Modern electronics and the development of piezoelectric materials have made it possible to have a more dependable and repeatable testing method. The size and position of a flaw can be determined by measuring the time taken by the pulse of ultrasonic vibrations to travel from a transducer and back again after being reflected as an echo from the flaw or placing the two transducers across the specimen and to measure time taken by Ultrasonic vibration to arrive at the other transducer.

2.Remember

The same technique can not be applied to concrete for three reasons:

1. Echo are generated from the many aggregate boundaries, which the pulse meets when passing through the concrete.

2. The velocity of an Ultrasonic pulse is not constant in concrete as it is in a particular type of metal, but varies with a quality composition of concrete.

3. It is not possible to direct a concentrated beam of Ultrasonic pulses through the concrete as it is though most metals. This is partly because the very high frequency pulses necessary to produce a narrow beam become highly attenuated when passing through concrete and also because the multiple reflections at the aggregate boundaries cause the beam of vibrations to scattered.

3.Test Method

For Assessing the quality of concrete from Ultrasonic pulse velocity measurement, it is necessary for the measurement to be of high order of accuracy. This is done by using an apparatus which generates suitable pulses and accurately measures the time of their transmission (i.e The transit time) through the concrete. The distance which the pulses travels in the material (i.e The path length) must also be measured to enable the user to determine the velocity as follows:

Pulse velocity = (Path length) / (Transit time)

Path length & transit times each should be measured to an accuracy of about (+-1%)

Time taken for the earliest part of the pulse to reach the receiving transducer measured from the time it leaves the transmitting transducer.

Fig 1 shows how the transducer may be arranged on the surface of the specimen tested, the transmission being either Direct, In direct, Semi-direct.

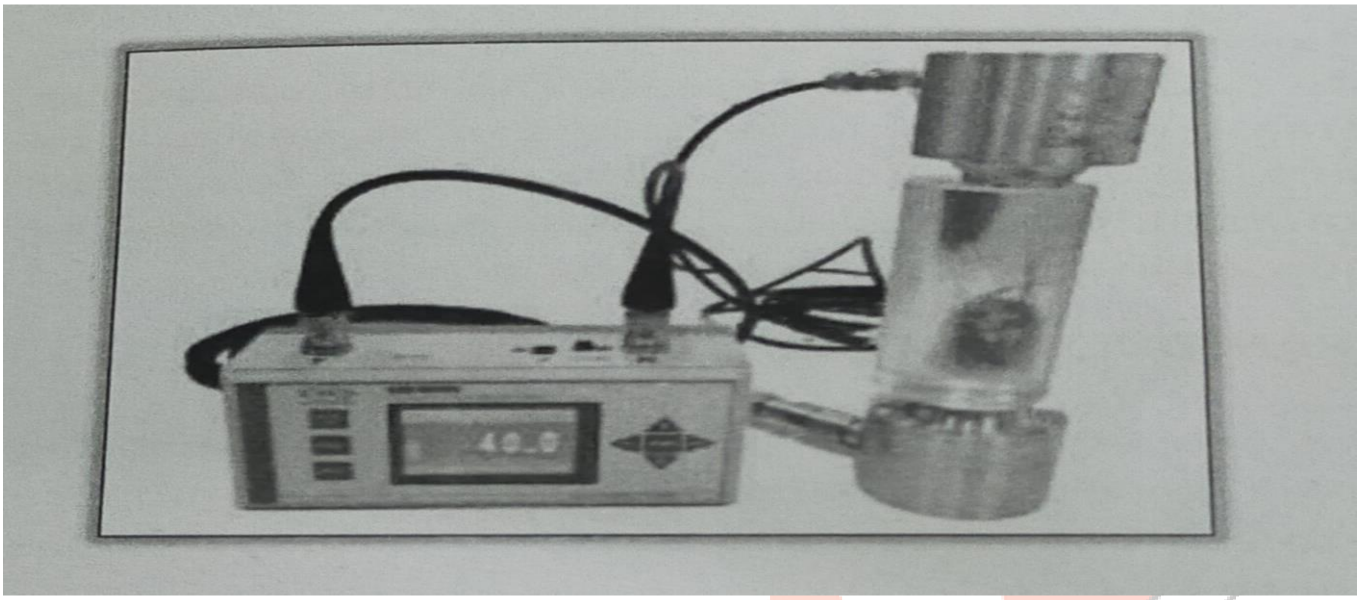

Fig.1

3.1Direct Method

The direct transmission arrangement is the most satisfactory one since the longitudinal pulse leaving the transmitter, are propagated most strongly in the direction normal to the transducer face.

Fig.2 Direct method

Formula - Velocity (Km/s) = distance (mm)/time (µs)

3.2Indirect Method

The indirect arrangement is possible because the beam of ultrasonic vibration is scattered within the material tested but, the strength of the pulse detected in this case is only about 1% or 2% of the detected of the same path length when the direct transmission arrangement is used.

Fig.3 Indirect Method

3.3Semi Direct Method

This method is not accurate like direct & indirect, in this method we place transducer & receiver at inclined surface as shown in figure.

$$\text{Velocity (Km/s)} = \text{distance (mm)}/\text{time } (\mu s)$$

$$d = \sqrt{x^2+y^2}$$

Fig.3 **S**emi Direct Method

$$d = \sqrt{x^2+y^2}$$

4.Crack Depth Calculation

In this method you will get directly crack depth in mm.

1. Time t1 – Place two transducer on 150mm equidistance on either side of crack and note time t_1
2. Time t2 – Place two transducer on either side of crack and note time t_2.
3. Apply the formula.
4. $d = 150 \sqrt{4t_1^2 - 4t_2^2 / t_2^2 - t_1^2}$

5.Influence of Test Condition

The pulse velocity in concrete may be influenced by:

1. Path length
2. Lateral dimensions of the specimen tested
3. Presence of reinforcing steel
4. Moisture content of the concrete
5. Temperature effect

The influence of path length will be negligible provided, it is not less than 100mm when 20mm size aggregate is used or not less than 150mm for 40mm size aggregate. Pulse velocity will not be influenced by the shape of the specimen provided its least lateral dimension (i.e its dimension measured at right angle to the pulse path) is not less than the wavelength of the pulse vibrations. For pulse of 50KHZ frequency, this corresponds to least lateral dimensions of about 80mm otherwise the pulse velocity may be reduced and the result of the pulse velocity measurements should be used with caution. The velocity of pulse in a velocity measurements made in the vicinity of reinforcing scheme may be high and not representative of the concrete since the time for the first pulse to reach the receiving transducer. The influence of the reinforcement is generally small if the bars run in the directions at right angles to the pulse path and the quantity of the steel is small in relation to the path length. And influence may be allowed for when the bar diameter lies directly along the pulse path. If the Ratio L_s / L is known the measured pulse velocity may be corrected by multiplying it by the correction factor. Corresponding to the ratio and the quality of the concrete it is however, preferable to avoid such a path arrangement and to choose a path, which is not in a direct line with a bar diameter.

When the steel bars lie in a direction parallel to the pulse path the influence of the steel may be more difficult to avoid and it is however not easy to make reliable correction for the influence of steel and the corresponding factor given and it is generally found that these values represent an upper limit of the steel influence. Again it is advisable to choose pulse path, which avoids the influence of steel as far as possible.

The moisture content of concrete can have a small but significant influence on the pulse velocity. In general the velocity is increased with increase in moisture content the influence being more marked for lower quantity concrete the pulse velocity of saturated concrete may be of 2% higher than that in dry concrete of the same composition and quality although this figure is likely to be lower for high strength concrete.

The temperature of the concrete has been found to have no significant effect on pulse velocity over the range of 5 degree to 30 degree centigrade so that except for abnormally extreme temperatures temperature influence may be disregarded.

6.Points Keep in Mind While Ultrasonic Pulse Velocity Measurement Are Made

When pulse velocity measurements are made on concrete as a quality check a contractor may be encouraged to keep the concrete wet for as long as possible in order to achieve and has value of pulse velocity. This is generally and advantage since it provides an incentive for good curing practice.

7.Methodology

The following non-destructive instruments were used to observe the various parameters. A brief of these instruments is discussed below

- Pulse generator & Transmitter
- Receiving transducer & amplifier
- Time measuring circuit
- Display unit