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Comparison between Different Methods of Ultrasonic Pulse Velocity Tests on Concrete

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ABSTRACT
The relationship between velocities of Ultrasonic waves propagating along direct, semi-direct and indirect method is investigated. Simple cement concrete beams of M 25 grade and fabricated anomalies namely rubber pieces and re-bars are casted for experimentation. The comparisons of UPV results between direct, indirect and semi-direct methods describe.
Keywords **–** Direct, Indirect, Semi-direct, Ultrasonic waves, Velocity.

I. INTRODUCTION

Ultrasonic Pulse Velocity test is used to evaluate the material properties, to detect defects on the concrete structures. In addition to physical deterioration of the concrete structure is also access by UPV test.

Concrete material consist of two separate constitutes i.e. matrix and aggregates which have different dynamic modulus of elasticity and strength properties. Transmitting transducer is used to create Ultrasonic waves and receiving transducer is used to receive this stress waves. And travel time of this stress wave from one point to another point is measured. Distance measured between this points which plays a vital role in case of indirect method of Transmission. Ultrasonic waves are totally independent to geometry of the specimen. It is depends on material property, frequency of the stress wave, dynamic modulus of elasticity and density of the material. In this study, the test on concrete specimens has been carried out with different three methods namely direct, indirect and semi-direct methods.

II. AIM AND OBJECTIVES

Basically, Ultrasonic waves are stress waves which may be shear, compressive or surface waves. The stress wave propagation depends on material properties and frequency of the wave. Effect of different method of UPV on velocity and behavior of the stress wave in concrete specimen are found out.

III. EXPERIMENTAL PROCEDURE AND APPARATUS

Experimental procedure consists of 12 nos. cement concrete beams. M25 grade concrete with Ordinary Portland Cement is used. Locally available 10 and 20 mm aggregates and river sand is used. And the concrete proportions are as follows:

Table 1: Concrete Proportion

Material	**Per m^3 Concrete Quantity**
Cement	340kg
Sand	689kg
CA 20mm	789kg
CA 10mm	526kg
Water	181 liters

3.1 CASTING AND CURING PROCEDURE

Casting of concrete and mortar specimens was done in drum mixture. The purpose of casting of specimens with different anomalies is to know wave behavior in different media having different acoustic medium. From Fig 1 and Fig 2, Total 6 nos. of Concrete beams are casted. And 3 nos. of Concrete mixed with small rubber pieces & rebar mixed with concrete are casted. Size of the Beam element is 150X150X700 mm. All specimens of concrete are

subjected to same condition. Specimens are compacted and cured at ambient temperature until the date of testing.

Fig 1: Rubber anomalies mixed with concrete

Fig 2: 2-8 mm Ø Bar placed at center from all direction of beam

3.2 TESTING APPARATUS AND PROCEDURE

Ultrasonic stress (compression or shear) waves are produced by electro acoustic transducers made up of piezoelectric material. Transducers convert electric energy to the mechanical energy in form of stress wave which may be surface, compressive or shear waves.

PUNDIT 7 is shown in Fig 3 is used for UPV testing of specimens. From Fig 4 Piezoelectric Transducers having 54 kHz frequency are employed. As a coupling agent petroleum gel is used. Gel facilitates an airtight bond between concrete or mortar specimen and Transducers.

The Testing Procedure is consisting of UPV test by Direct, Indirect and Semi-direct method at ages of 7, 28 and days interval.

Fig 3: PUNDIT 7 Equipment

Fig 4: Transducers with 54 kHz frequency

In Direct method, Transmitting and Receiving Transducers are kept on its opposite faces. While in Semi direct method, Transmitting and Receiving Transducers are kept on adjacent faces. And in Indirect method, Transducers are kept on the same face. All three methods are shown in Fig 5. The readings are taken by putting transmitter and receiving transducer on opposite faces in case of direct method. While In semi direct method, the readings are taken by putting transmitter on top and bottom faces sequentially and by varying receiver transducers on adjacent faces. In Indirect method, the receiving and transmitting Transducers are kept on same face with different interval. And it has been varied by 150 mm distance on same face.

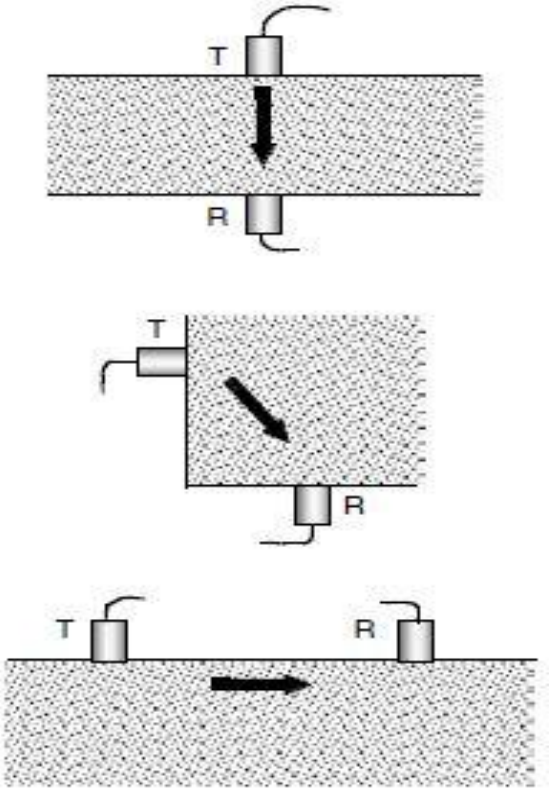

Fig 5: Direct, Semi-direct and Indirect Method.

IV. RESULTS AND DISCUSSION

UPV results by different three methods at different age. The results are taken at 7 and 28 days of different beam specimens with different anomalies.

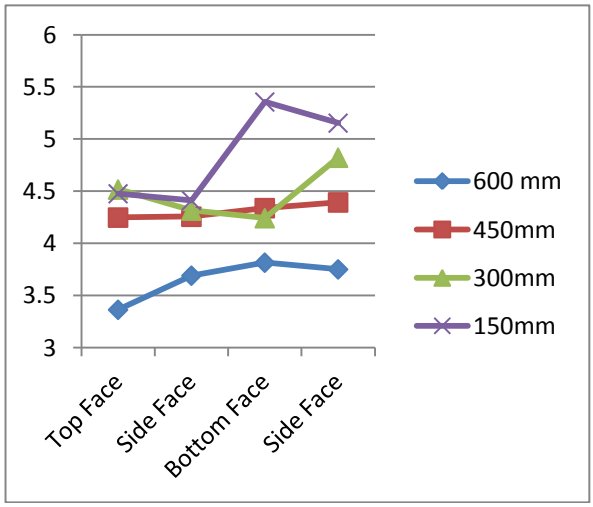

Fig 6: UPV of Indirect method on Beam at different interval vs different faces of the concrete beam.

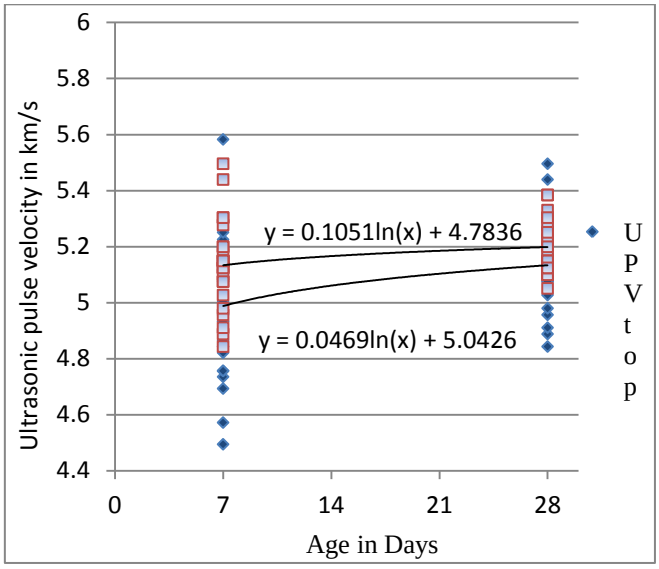

Fig 7: UP velocity of top and bottom surface versus Age of Concrete

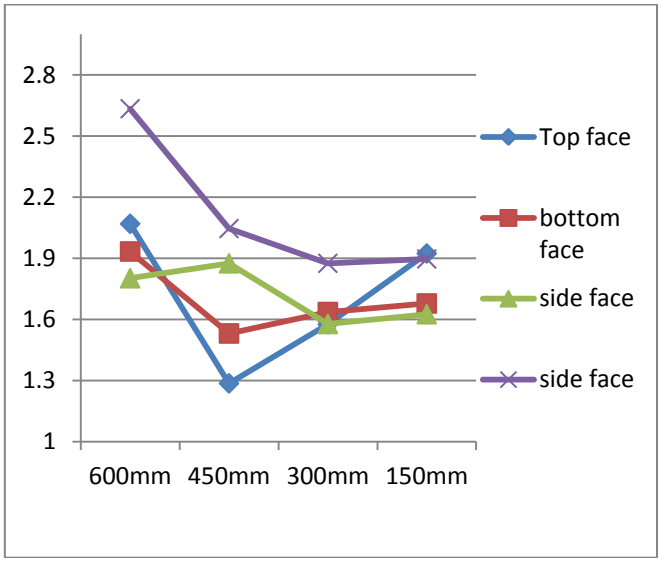

Fig 8: UP velocity of rubber anamolies mixed with concrete versus diff distance

V. CONCLUSION

Ultrasonic Pulse Velocity is observed in Fig 6 that In indirect method velocity increase with decreasing path length. And from Fig 7, the UP Velocity continuously increasing much slower rate which is observed between 7 and 28 days of casting in semi-direct method. In Indirect method when path length is less than its depth than surface wave reaches first on receiver while in direct method compressive wave reaches first on receiver.

Thus, in small path length wave can't go throughout depth so result may be faulty. From Fig 7 different material having different acoustic impedance so rubber having low acoustic impedance

compare to concrete, shows from Fig 6 and Fig 8.while steel having much acoustic impedance compare to concrete so waves can pass much faster rate compare to concrete.

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