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INTERNAL ASSESSMENT OF CONCRETE USING NON DESTRUCTIVE TECHNIQUES

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ABSTRACT: This paper investigates the efficiency of Ultrasonic Pulse Velocity (UPV) method for the internal assessment of concrete. The ultrasonic equipment used in this study for the evaluation of the concrete properties was the portable ultrasonic non-destructive digital indicating tester (PUNDIT).The relationship between velocities of ultrasonic stress waves transmitted along direct and semi direct paths was investigated. Tests were conducted on plain concrete beam. The results showed that the direct wave velocities were more than semi direct wave velocities. Concrete is a heterogeneous material, the interpretation of the relation between the strength and the Ultrasonic Pulse Velocity becomes complex. So to understand how some parameters influence the UPV, this work studied concrete manufactured with 30% replacement of sawdust as fine aggregate. The results show that it is possible to understand how the test condition variations affect the UPV outputs. Also the variation in ultrasonic wave velocity through concrete on application of external load was studied.
Keywords: NDT-Non Destructive Test, UPV-Ultra Sonic Pulse Velocity, RH-Rebound Hammer

I. INTRODUCTION

The testing of hardened concrete plays an important role in controlling and confirming the quality of concrete structures at site. This was made possible by NDT methods. The method allows doing the tests at the same place, making possible a continuous monitoring in the structures and determination of possible variations during a period of time. A comparison between direct and semi-direct UPV readings was studied. An attempt has been made to study an influence of sawdust on concrete.

SPECIMEN PREPARATION AND TEST PROCEDURES

Portland Pozzolona Cement (PPC) was used throughout. Crushed stone gravel with a 20-mm maximum size served as a coarse aggregate, while manufactured sand with a 4.75-mm maximum size served as a fine aggregate. The properties of fine and coarse aggregates were determined according to IS code test methods. Beams (15cm x 15cm x 70cm) for conventional concrete and sawdust concrete were casted. In Direct method Transmitting and Receiving Transducers are kept on its opposite faces. Since the maximum pulse energy is transmitted at right angles to the face of the transmitter, the direct method is the most reliable from the point of view of transit time measurement. Also, the path is clearly defined and can be measured accurately, and this approach should be used wherever possible for assessing concrete quality. The readings were taken along length (0.7m) and width (0.15m) of the beams. Along the length, readings were taken at 7 points and along the width 6 points were chosen at three layers say top, middle and bottom as shown in Figure1. The same procedure was carried out for all the beams.

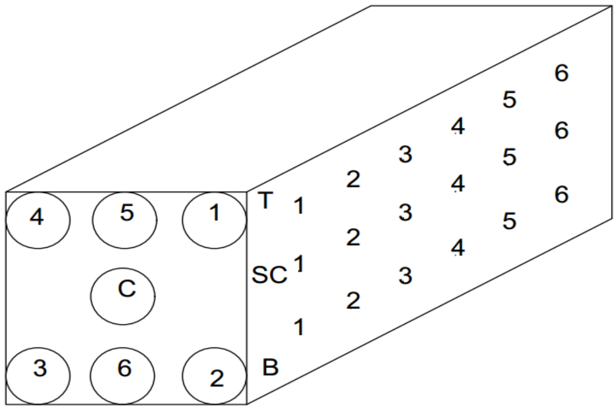

Figure 1: Positions of Probe on Beam

In Semi direct method, Transmitting and Receiving Transducers are kept on adjacent faces. The readings were taken in such a manner that the transducer was kept at top surface of the beam and receiver at the middle layer on the side face. Likewise, six readings were taken along the same direction.

Variation in Concrete Due To Application of External Loads

An early casted cube (15cm x 15cm x 15cm) was selected and an external load of various percentage of compressive strength, i.e. 40 N/mm2 was applied with the help of compression testing machine. Then, after releasing the external load, direct readings were taken using UPV testing machine.

RESULTS AND OBSERVATIONS

1. DIRECT VS SEMI DIRECT METHODS OF UPV

Conventional Concrete

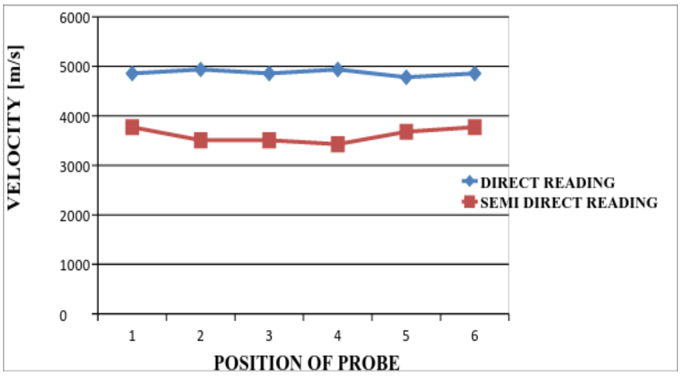

Figure 2: Comparison between Direct and Semi Direct Readings of Conventional Base Beam

A graph (Figure 2) was plotted between velocity of wave transmitted and position of probe to study the comparison between direct reading and semi direct reading for conventional concrete. The average velocity for direct reading and semi direct reading is obtained as 4868m/s and 3608m/s respectively. It has been observed that the velocity is 35% more for direct reading compared to semi direct reading.

Sawdust Concrete

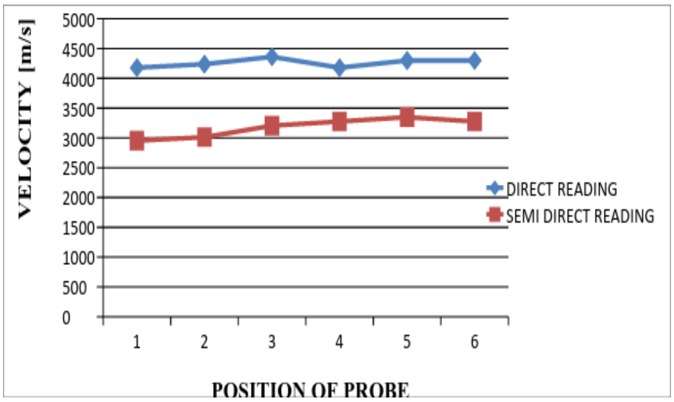

Figure 3: Comparison between Direct and Semi Direct Readings of Sawdust Base Beam

A graph (Figure 3) was plotted between velocity of wave transmitted and position of probe to study the comparison between direct reading and semi direct reading for sawdust concrete. The average velocity for direct reading and semi direct reading is obtained as 4258m/s and 3178m/s respectively. It has been observed that the velocity is 34% more for direct reading compared to semi direct reading.

II. VARIATION IN VELOCITY THROUGH CONCRETE DUE TO APPLICATION OF LOAD

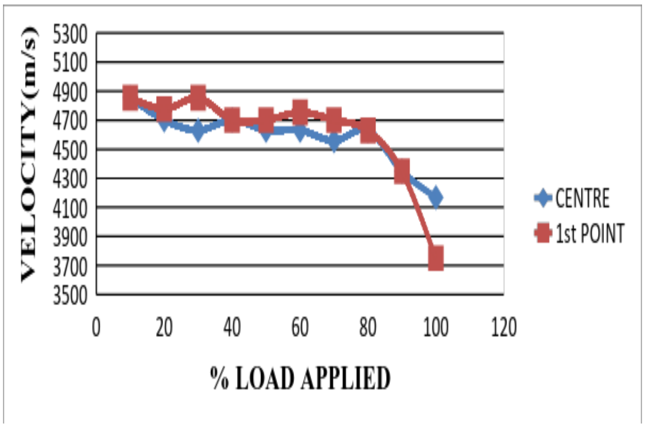

Figure 4: Variation in Velocity of Wave with Increase in External Load

A graph (Figure 4) was plotted between velocity of transmitted wave and percentage of load applied to study the variations in velocity through the concrete. It has been observed that the velocity almost remains constant up to 80%, then decreases till the concrete fails. Up to 80%, the transition zone breaks at several locations and finally leads to ultimate failure of the concrete.

III. COMPARISON BETWEEN DIRECT READING OF CONVENTIONAL CONCRETE AND SAWDUST CONCRETE ALONG LENGTH

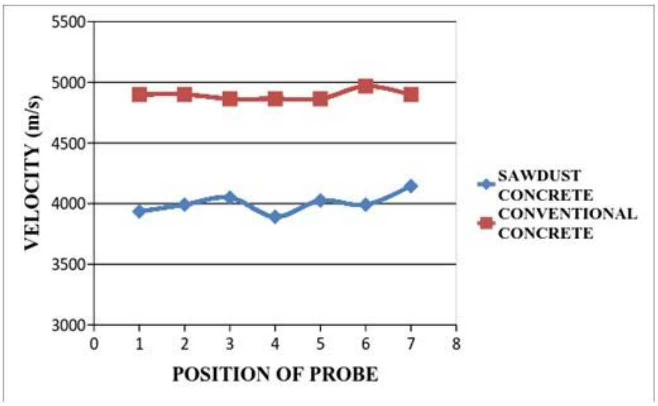

Figure 5: Comparison between Conventional Concrete and Sawdust Concrete

A graph (Figure 5) was potted between velocity of transmission wave and position of probe to study the variation in velocity of wave in conventional concrete and sawdust concrete. The direct readings were taken along length of the beam. The average velocity for conventional concrete and sawdust concrete is obtained as 4894m/s and 4004m/s respectively. It has observed that the velocity is 23% more for conventional concrete compared to sawdust concrete. In conventional concrete, the inter-molecular bond strength of particles is more compared to the sawdust concrete. Thus, the wave transmission through conventional concrete is more than through sawdust concrete. Therefore, the density of conventional concrete is more than sawdust concrete.

IV. CONCRETE QUALITY GRADING

Table 1: Velocity Criterion for Concrete Quality Grading (IS 13311–PART1:1992)

Sl.no.	Pulse velocity by cross probing (km/sec)	Concrete quality grading
1	Above 4.5	Excellent
2	3.5 to 4.5	Good
3	3.0 to 3.5	Medium
4	Below 3.0	doubtful
Position of Probe	Velocity of Wave(m/s)	
	Sawdust Concrete	Conventional Concrete
1	3935	4899
2	3991	4899
3	4049	4864
4	3891	4864
5	4025	4864
6	3991	4968
7	4144	4899

Table 2: Velocity of Wave in Conventional and Sawdust Base Beam

A comparison is made between conventional concrete and sawdust concrete with velocity of wave transmitted. The average velocity of transmitted wave in conventional concrete along length is 4894m/s and in sawdust concrete 4004m/s (from Table 2). Referring to IS 13311-PART 1:1992 (Table 1), the conventional concrete is of excellent quality. Sawdust concrete is of good quality. Since, the wave penetration through sawdust is low, the velocity of wave through sawdust concrete is less.

V. CONCLUSIONS

Based on the experiments conducted in this study, the following conclusions were drawn:

- The direct reading is more compared to semi direct reading. In conventional concrete, direct reading has 28%-36% more than semi direct reading. In sawdust concrete, direct reading is 25%-42% more than semi direct reading.
- The relative velocity through the concrete decreases depending on the external load applied. Up to 80%, the transition zone breaks at several locations and finally leads to ultimate failure of the concrete.
- The velocity of wave transmission through sawdust concrete is less compared to that of conventional concrete. This shows that conventional concrete is denser than sawdust concrete.
- Referring to IS 13311-PART 1:1992 the conventional concrete is of excellent quality. Sawdust concrete is of good quality. Since, the wave penetration through sawdust is low; the velocity of wave through sawdust concrete is less.

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