Efficient Use of UPV Meter: A Non Destructive Test of Concrete by Fragmentation Analysis

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Abstract

For almost all the structures, concrete has been used as a basic and important construction material. It is made up of the mixture of cement, coarse aggregate, fine aggregate and water. Its properties depend upon W/C ratio, humidity, size of aggregate, type of components used, admixture used, amount of component used. While making a concrete structure, it is very essential to prepare it to eliminate its major drawbacks such as poor workability, surplus admixtures, honey combing of members, improper mixing. It should be kept in mind that these factors will affect the entire structure and leads to the destruction. To access the condition of the structure, UPV tests are very popular Non Destructive Test of concrete. This study deals with the UPV test procedure approach in Dry and Wet condition of concrete specimen with the use of probe location on various fragments. The results of both pre and post curing of the RCC block have been discussed in this paper with the recommendation of use of probe location. This study is entirely concentrated on pre and post curing to know the hydration behavior of concrete after placing.

Keywords – *Concrete Quality, Dry UPV test, Fragmentation analysis, Non Destructive Test, Pulse Velocity, UPV, Wet UPV test.*

Introduction to Ultrasonic Pulse Velocity Test

Condition of concrete can now be determined by the use of Non Destructive Test, since as per name, without breaking it we can determine its strength and its performance nearly close to the Destructive test of concrete. It is an advanced tool to find out the quality of concrete by monitoring anytime and anyplace. This new tool enables us to monitor the structure over a period of time so that it is economical to determine its treatment and recovery. Due to ultrasonic pulses are used in this approach, the tool can be used to determine its properties, quality along with homogeneity. From this, the strength is correlated with the NDT results to determine the strength of the structure.

The continuous monitoring should be done to prevent the concrete from weakening and make it healthy to serve the structural member stronger. Hence it is necessary to use the controlling methods to determine the existing condition of concrete. Ultrasonic pulse velocity method can play a vital role to overcome this necessity and allow us to monitor the member quality with ample amount of necessary information to know its existing behavior. However, it is necessary to know the influencing factors to determine the type of test result. This study is entirely concentrated on pre and post curing to know the hydration behavior of concrete after placing.

Ultrasonic Pulse Velocity Test

Ultrasonic Pulse Velocity Test is performed as per IS 13311 Part 1, since it is used as a non-destructive test to know the inside behavior of concrete structural members. In this, an ultrasonic pulse velocity meter is used with two probes to transmit and receive the signals as shown in Figure 2. Then some inputs will be provided in UPV meter to set the entire test model as per UPV configurations. The pulses are generated from one end of the probe, it is placed over one part, pulses travels throughout the specimen and received by receiving probe. The pulses get counted by the meter and as per configurations provided before the test it gives the result. Comparing the results as per Indian Standards, we get the quality of concrete. This test gives the best example of homogeneity inside the member, gives the information about the cracks, lumps, holes and cavity without the destruction of the member by destructive tests. It provides speedy results and calculations of the same. It uses both high and low frequency.

Objectives of UPV part experimental study

The study of something is proved only if the results analysis would have firstly were fixed by some main objectives. These objectives should be fulfilled by analyzing the correct figurative results. The results are then compared with each other and ultimately conclusions have drawn. As per the theme of the current study, the main objectives are decided and have finally demonstrated below are as follows:-

1. Use of direct transmission method of UPV test analysis.
2. To show the efficient location of the member by observing readings of various location by parting it into various fragments.
3. To obtain the most favorable part location case of direct NDT test for 7, 14 and 28 days.
4. To show he utmost part location case of direct NDT test for 7, 14 and 28 days.
5. To explore the possibilities of wet results obtained for quality of concrete by UPV meter for 7, 14 and 28 days.
6. To show the utmost results for quality of concrete by UP meter for 7, 14 and 28 days.
7. To discuss and draw the conclusive outcomes of the current theme with recommendations of the study.

Methodology and Experimental Approach

The time required for the generation of pulse to travel through the member and received by the transducer probe has indicated by the instrument itself. Since three methods of UPV test shown above indicates its own way of usage.

The assembly consists of UPV meter, the transducer and receiver probe, its wire connections and one crystal for calibration.

As per IS 13311 (Part I) 1992, quality of the concrete has shown by the following values:-

Table 1. Quality of Concrete for Direct NDT Method

S. No.	U.P.V. (km/sec.)	Quality of Concrete for Direct Method
1.	Above 4.5	Excellent
2.	3.5 to4.5	Good
3.	3.0 to 3.5	Medium
4.	Below 3km/sec	Doubtful
Note: - Readings of direct method generally by 1km/sec		

Efficiency of Ultrasonic pulse velocity test in life of concrete structure

The efficiency of the UPV test depends on the time taken by the pulse which is followed by the quickest route from the transmitter to the receiver probe ends. Since these waves travels in the form of pulses inside the member. These cannot passes by air voids, cracks and could be deflected by its path by the presence of moisture present in the member itself. As per I. S. recommendations, the three test method should be used while working with Ultrasonic pulse velocity meter. They are as follows:-

1. Direct method
2. Indirect Method
3. Semi Direct Method

As per methods mentioned above, the most accurate one is direct method UPV test, since this method can be used for exact evaluation of results. The opposite face of the member can be easily be used in this since both probe has sufficient length to expand its range as per thickness of the member.

Experimental Representation

The experiment has carried out with a cube specimen of M40 grade concrete and able to understand whether the moisture in it has affected its result. Ultracon 170 series UPV meter used in this experiment. IS 13311 (1992 part-1) standard specification has been used in this work. Since the actual concrete member behavior values can be determined by the small experimental approach in this test. To overcome the deficiencies of the member like air voids, cracks, space, non-uniformity etc. can be detected by UPV test along by the approach of parting, the test results are optimum. Direct test method approach has used in this approach, since it is very accurate one as per standards with accuracy of the results.

Figure 1 shown below describes the location of test on the 15cm x 15cm x 15 cm cube on which experimental approach has carried out. The marking on the cube describes the location position of the reading that has to be analyzed. Each marking has the same value opposite to it on which both the transmitter and receiver probe touched.

3	2	1
4	5	6
9	8	7

Figure 1: Markings used for Partition of Cube

The results obtained from this kind of location test approach will suggest the better and efficient way in order to understand the behavior of concrete under UPV test.

Figure 2: Ultrasonic Pulse Velocity Meter Apparatus Used

Figure 3: Test Performed on Part 3 of Cube

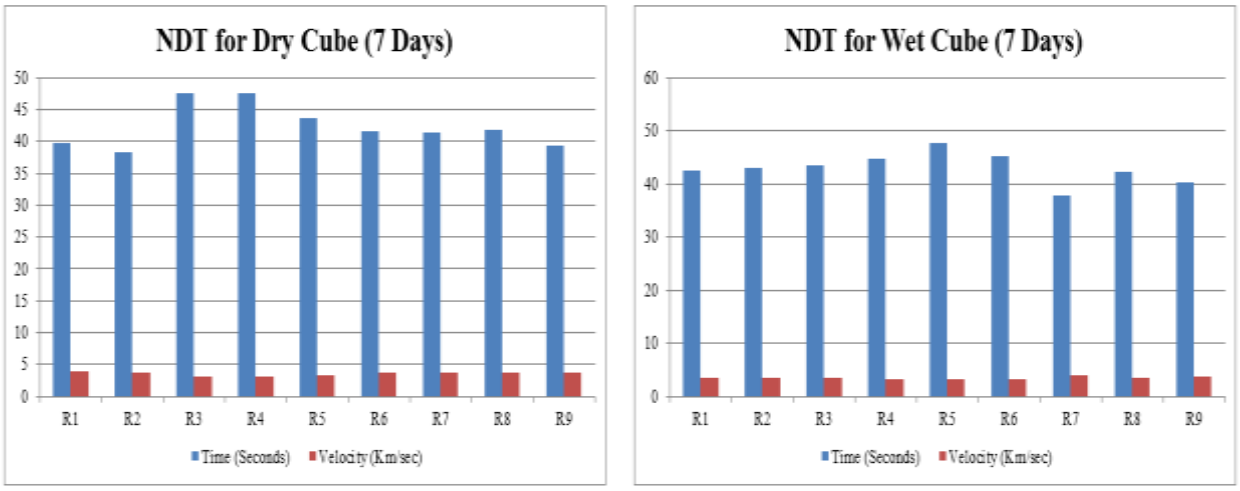
Figure 4: Oven Used for Test

Result Analysis

Since after doing the partition of M40 cube, has been cured for 7 days, 14 days and 28 days, following results has been drawn shown in table below along with its graphical representation:-

Table 2: NDT of Cube for 7 days

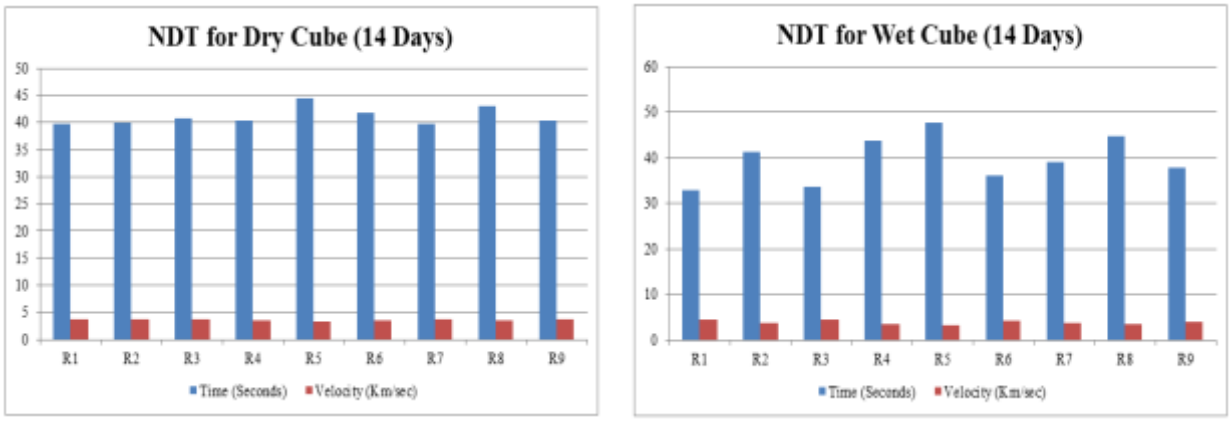
Reading No.	Type of Specimen	Type of Transmission	Path Length (mm)	Dry (8.7 KG)		Wet (8.75 KG)	
				Time	Velocity	Time	Velocity
R1	CUBE (150mm x 150 mm x 150 mm) Grade M 40	Direct	150	39.8	3.88	42.5	3.54
R2		Direct	150	38.3	3.82	43	3.45
R3		Direct	150	47.6	3.15	43.4	3.46
R4		Direct	150	47.5	3.18	44.6	3.31
R5		Direct	150	43.7	3.4	47.7	3.12
R6		Direct	150	41.6	3.68	45.3	3.28
R7		Direct	150	41.3	3.63	37.8	3.94
R8		Direct	150	41.9	3.7	42.2	3.47
R9		Direct	150	39.4	3.72	40.3	3.71
Average Velocity					3.96		3.47



Graph 1: NDT of Dry and Wet Cube (7 days)

Table 3: NDT of Cube for 14 days

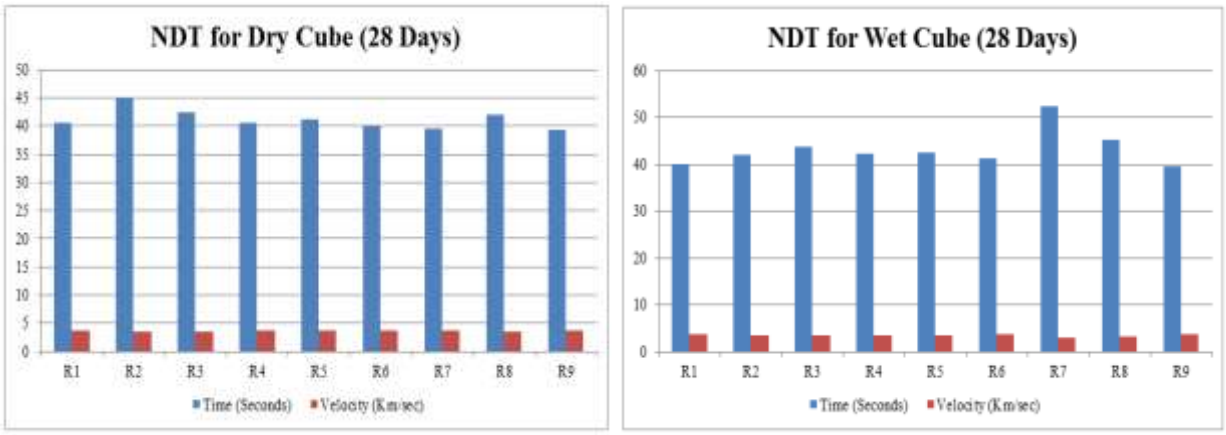
Reading No.	Type of Specimen	Type of Transmission	Path Length (mm)	Dry (8.76 KG)		Wet (8.80 KG)	
				Time	Velocity	Time	Velocity
R1	CUBE (150mm x 150 mm x 150 mm) Grade M 40	Direct	150	39.8	3.77	32.8	4.57
R2		Direct	150	39.9	3.77	41.3	3.65
R3		Direct	150	40.7	3.67	33.6	4.47
R4		Direct	150	40.3	3.45	43.7	3.47
R5		Direct	150	44.4	3.38	47.7	3.16
R6		Direct	150	41.8	3.57	36.1	4.15
R7		Direct	150	39.8	3.77	39.1	3.80
R8		Direct	150	43	3.52	44.7	3.39
R9		Direct	150	40.3	3.73	37.8	3.94
Average Velocity					3.62		3.84



Graph 2: NDT of Dry and Wet Cube (14 days)

Table 4: NDT of Cube for 28 days

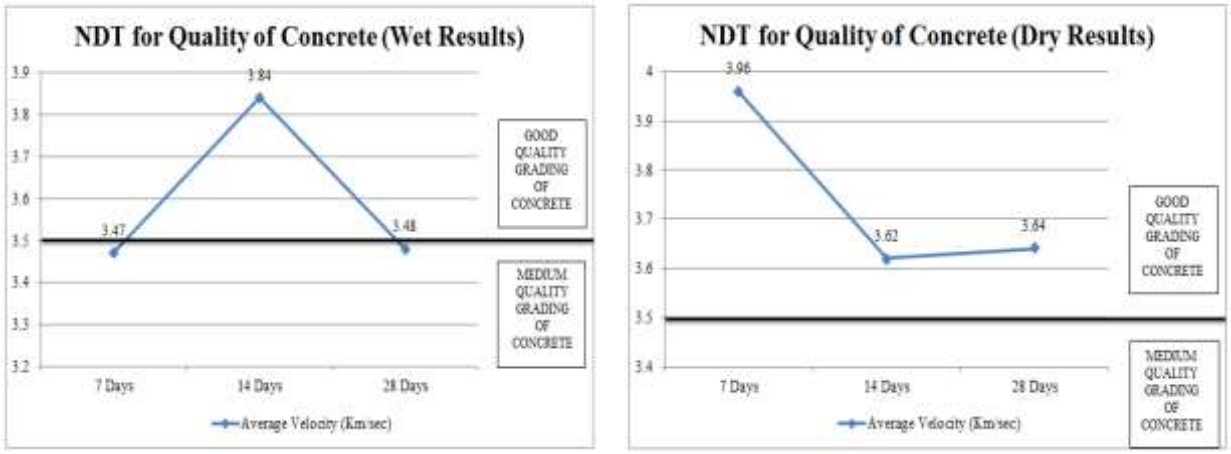
Reading No.	Type of Specimen	Type of Transmission	Path Length (mm)	Dry (8.76 KG)		Wet (8.80 KG)	
				Time	Velocity	Time	Velocity
R1	CUBE (150mm x 150 mm x 150 mm) Grade M 40	Direct	150	40.5	3.72	40	3.72
R2		Direct	150	44.8	3.42	42.1	3.58
R3		Direct	150	42.5	3.52	43.7	3.43
R4		Direct	150	40.5	3.69	42.3	3.55
R5		Direct	150	41.2	3.64	42.5	3.51
R6		Direct	150	39.9	3.75	41.3	3.63
R7		Direct	150	39.5	3.75	52.4	2.88
R8		Direct	150	42	3.52	45.2	3.32
R9		Direct	150	39.4	3.8	39.6	3.77
Average Velocity					4.06		3.48



Graph 3: NDT of Dry and Wet Cube (28 days)

Table 5: NDT Optimum Result for Quality of Concrete

Test Duration	Type of Transmission	Path Length (mm)	Wet Result	Dry Result
			Average Velocity	Average Velocity
7 days	Direct	150	3.47	3.96
14 days	Direct	150	3.84	3.62
28 days	Direct	150	3.48	3.64



Graph 4: NDT for Quality of Concrete (Wet Results) and (Dry Results)

Conclusion

The result has gone through both dry NDT test and wet NDT test, since the concrete has the tendency to absorb the water and for that it is essential to check how the specimen behaves when NDT test is going on. The result analysis conducted above has both dry test result as well as wet results. After going through these results, the following conclusions have been drawn:-

1. The variations comparison between dry cube and wet cube has observed.
2. Before testing, it is observed that there is increase in weight of concrete specimen when it has been cured under water for 7, 14 and 28 days.
3. A different test result value has seen when the specimen is parted to detect the exact position location of probe used.
4. The wet results have been drawn after removing the specimen from curing tank, wipe water out by a cloth and then NDT test has performed and after then, it has placed in oven to maintain and remove the moisture, than after dry test has performed.
5. Due to partition of specimen different result obtained with specimen has moisture in its Core and the fluctuation in result seen in part 5.
6. Weight of cube changes with absorption of water during curing.
7. Variation in result obtained when thickness of specimen changes along with distance of probe in our case, thickness is 15 cm.

Recommendations

1. Since density of concrete is more in part 1as compared to other parts, since all parts have corner.
2. Other concrete specimen can also be checked by dividing into numerous parts and optimum value can be used in this work our optimum location will be part.
3. For dry test of specimen a threshold is set for good and medium quality of concrete for that one should be use only 14 day results for wet condition.
4. For wet test of specimen again a threshold is set for good and medium quality of concrete for that one should use 7day, 14day, result for dry condition.
5. When the specimen is resting on ground, the ultrasonic pulses gets travelled into ground or get absorbed by human body, the best result obtain when the specimen is put above the ground surface (best on wooden plane) with use of sponge or cloth.

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