ASSESSMENT OF LONG TERM DURABILITY CONSIDERATION OF CONCRETE ON COLUMNS AND BEAMS OF HEXAGONAL SHAPED CONCRETE STRUCTURE AT DELHI EARTH STATION (ISRO), DELHI, INDIA BY USING NON DESTRUCTIVE TEST METHODS

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ABSTRACT:- *Interaction of concrete with persistent prevailing environmental condition will alter its material properties and cause deteriorations. There are various causes of deterioration in concrete structure such as improper construction practices, post construction expansion due to alkali aggregate reaction, corrosion of reinforcement, non homogeneity of concrete, Development of cracks due to shrinkage/thermal stresses, aging etc.*

Aging of concrete structures and their interactions with persistent prevailing environmental conditions will alter its material properties and cause deteriorations. Inspite of maintaining the best quality control concrete may not behave as a homogeneous medium. Conducting any test in the modest way is the key factor for true assessment of the status of substratum. Diagnosis of the residual strength of concrete in in-situ condition using non-destructive tests provides useful information for adopting suitable preventive measures. Deteriorations in the concrete can be broadly imaged using ultrasonic pulse velocity technique. However, the results of ultrasonic pulse velocity depend on various factors.

Key Word: Concrete, Aging, Diagnostic tool, Ultrasonic, Non-Destructive.

1.0 INTRODUCTION

The hexagonal concrete structure is approximately 40 years old and supporting a 10.7 m diameter parabolic antenna weighing approximately 28000 kg. The concrete structure was 4.5 m above ground level. The structure was made of six concrete columns and six concrete beams connecting all the columns with a roof slab on top. No visible distresses were observed in columns. In order to assess the quality of in-situ concrete, non-destructive testing of concrete of various columns and beams of concrete structure by ultrasonic pulse velocity method using Portable Ultrasonic Non- destructive Digital Indicating Tester (PUNDIT) was taken up.

Fig: 1 View of Concrete Structure (ISRO, Delhi)

2.0 PROGRAMME OF INVESTIGATION

Columns:

All six columns are in square section having cross section of 70cm x70cm.The non-destructive tests on the concrete columns were carried out using PUNDIT equipment. The UPV tests were conducted by direct method of pulse transmission as this is more reliable method. The test points were marked at 42 cm from ground level and thereafter 28 cm intervals vertically avoiding direct contact of stirrups on each column. Locations of stirrups were ascertained by using Micro Cover meter. UPV tests were conducted on 6 columns by the same method.

Beams:

All six beams are having cross section of 50cm x 50cm with roof slab. The non-destructive tests on the concrete beams were carried out using PUNDIT equipment. The test points were marked at 50 cm from each column and then at 30 cm intervals horizontally along the length avoiding the stirrups on each beam. Locations of stirrups were ascertained by using Micro Cover meter. UPV tests were conducted for all the 6 beams from outer and inner faces directly opposite to it in two rows by direct method.

3.0 ULTRASONIC PULSE VELOCITY TEST

3.1 Basic Principal

Pulses of longitudinal 'P' waves are produced by an electro-acoustical transducer which is held in contact with one surface of the concrete under test. After traversing a known path length L in the concrete, the pulse of vibrations is converted into an electrical signal by a second transducer and electronic circuits enable to determine the transit time T of the pulse to be measured.

The pulse velocity V is given by

$V = L / T$ for direct transmission of pulse velocity Where L is the path length and T is the time

3.2 Acceptance Criteria

Velocity Criterion for Concrete Quality Grading as per IS:

13311 (Part I), 1992

Pulse Velocity by cross probing, km/sec	Concrete quality grading
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful

4.0 DISCUSSION OF TEST RESULTS

4.1 Concrete Column No. 1 Scanned from Bottom to Top

The Ultrasonic pulse velocity tests were conducted by direct method on column of size 70 cm x 70 cm at 38 test points with 70 cm path length. It was observed that out of 38 locations that were tested, 23 (60.53%) test locations indicate that concrete quality fell under good category, 7 (18.42%) test locations fell under medium category and the remaining 8 (21.05%) test locations fell under doubtful category. Overall quality of concrete was good.

Fig: 2 UPV Test by Direct Method on Column

4.2 Concrete Column No. 2 Scanned from Bottom to Top

It was observed that out of 40 locations that were tested, 28 (70%) test locations indicate that concrete quality fell under good category, 9 (22.5%) test locations fell under medium category and the remaining 3 (7.5%) test locations fell under doubtful category. Overall quality of concrete was good.

4.3 Concrete Column No. 3 Scanned from Bottom to Top

It was observed that out of 36 locations that were tested, 25 (69.44%) test locations indicate that concrete quality fell under good category, 1 (2.77%) test location fell under medium category and the remaining 10 (27.77%) test locations fell under doubtful category. Overall quality of concrete was good.

4.4 Concrete Column No. 4 Scanned from Bottom to Top

It was observed that out of 33 locations that were tested, 25 (75.75%) test locations indicate that concrete quality fell under good category, 5 (15.15%) test locations fell under medium category and the remaining 3 (9.09%) test locations fell under doubtful category. Overall quality of concrete was good.

4.5 Concrete Column No. 5 Scanned from Bottom to Top

It was observed that out of 39 locations that were tested, 28 (71.79%) test locations indicate that concrete quality fell under good category, 7 (17.94%) test locations fell under medium category and the remaining 4 (10.25%) test locations fell under doubtful category. Overall quality of concrete was good.

4.6 Concrete Column No. 6 Scanned from Bottom to Top

It was observed that out of 32 locations that were tested, 26 (81.25%) test locations indicate that concrete quality fell under good category, 3 (9.37%) test locations fell under medium category and the remaining 3 (9.37%) test locations fell under doubtful category. Overall quality of concrete was good.

4.7 Concrete Beam No. 1 Scanned from Column No.6 to Column No. 1

It was observed that out of 19 locations that were tested, 18 (94.74%) test locations indicate that concrete quality fell under good category and 1 (5.26%) test location fell under medium category. Overall quality of concrete was good.

4.8 Concrete Beam No. 2 Scanned from Column No.1 to Column No. 2

It was observed that out of 21 locations that were tested, 20 (95.23%) test locations indicate that concrete quality fell under good category and 1 (4.76%) test location fell under medium category. Overall quality of concrete was good.

4.9 Concrete Beam No. 3 Scanned from Column No. 2 to Column No. 3

It was observed that out of 22 locations that were tested, 19 (86.36%) test locations indicate that concrete quality fell under good category and 3 (13.64%) test locations fell under medium category. Overall quality of concrete was good.

4.10 Concrete Beam No. 4 Scanned from Column No. 3 to Column No. 4

The Ultrasonic pulse velocity tests were conducted by direct method on beam of size 50 cm x 50 cm at 22 test points with 50 cm path length. It was observed that out of 22 locations that were tested, 22 (100%) test locations fell under good category.

4.11 Concrete Beam No. 5 Scanned from Column No. 4 to Column No. 5

It was observed that out of 24 locations that were tested, 23 (95.83%) test locations indicate that concrete quality fell under good category and 1 (4.16%) test location fell under medium category. Overall quality of concrete was good.

Fig: 3 UPV Test by Direct Method on RCC Beam

4.12 Concrete Beam No. 6 Scanned from Column No. 5 to Column No. 6

It was observed that out of 19 locations that were tested, 18 (94.74%) test locations indicate that concrete quality fell under good category and 1 (5.26%) test location fell under medium category. Overall quality of concrete was good.

5.0 CONCLUSION AND RECOMMENDATIONS Columns:

6 columns were investigated using UPV Direct method which was most reliable had been adopted in taking the pulse readings. In all 218 points were scanned for the entire 6 columns. Based on the results, 155 (71.10%) points had indicated that in-situ quality of concrete for the entire 6 columns had been found to be good category. The quality of remaining points 63 (28.89%) varied between medium and doubtful category. Since the UPV tests indicate exclusively the quality of in-situ concrete, it was suggested to extract cores from columns having quality good, medium and doubtful to assess the In-situ compressive strength and also the depth of carbonation.

Beams:

6 beams were investigated using UPV by Direct method which was most reliable one. In all 127 points were scanned for the entire 6 beams. Based on the test results, 120 (94.48%) points had indicated that in-situ quality of concrete for the entire 6 beams had been found to be good category. The quality of remaining points 7 (5.51%) had been found to be medium category. Since the UPV tests indicate exclusively the quality of in-situ concrete, it was suggested to extract cores from beams having quality good and medium to assess the In-situ compressive strength and also the depth of carbonation.

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