ASSESSMENT OF LONG TERM DURABILITY CONSIDERATION OF CONCRETE ON COLUMNS AND BEAMS OF CONCRETE STRUCTURE (BUILDING) BY USING NON DESTRUCTIVE TEST METHOD

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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 Words: Concrete, Aging, Diagnostic tool, Ultrasonic, Non-Destructive.

1.0 INTRODUCTION

The concrete structure (building) having two blocks (Block A & Block B) was constructed 40 years ago. It was decided as a part of maintenance of building, the structural health assessment of building was required for checking the quality of concrete which was essential for developing methodology for repair and strengthen of building. In this regard, Non-destructive tests were conducted on columns & beams of building by Ultrasonic Pulse Velocity method for assessment of in-situ quality of concrete.

Non-destructive testing can be applied to both old and new structures. For new structures, the principal applications are likely to be for quality control or the resolution of doubts about the quality of materials or construction. Cases of distress to structure under construction and in service have posed problem to engineers for investigation of such structures. Hence, need is felt to test the concrete in a structure in-situ by Non-destructive testing so as to evaluate its condition for taking appropriate remedial measures for rehabilitation/restoration. The various application of Non-destructive testing are assessment of overall quality/strength of concrete, diagnosis, categorization of distressed structures, ascertaining existing condition of concrete, checking of efficiency of repairs and for other time dependent studies. This paper mainly covers Non-destructive testing of concrete on columns and beams of building (Block A & Block B) by Ultrasonic Pulse Velocity method. In order to assess the quality of in-situ concrete, non-destructive testing of concrete of various columns and beams of concrete structure (building) by ultrasonic pulse velocity method using Portable Ultrasonic Non- destructive Digital Indicating Tester (PUNDIT) was taken up.

Fig: 1 View of Concrete Structure (Building)

2.0 PROGRAMME OF INVESTIGATION

Columns:

All columns (24 Nos. for block A & block B, 12 Nos. for each block) were in square section having cross section of 50cm x50cm.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 20 cm from ground level and thereafter 30 cm intervals vertically avoiding direct contact of stirrups on each column. Locations of stirrups were ascertained by using Micro Cover meter. Columns were selected for UPV tests on visual inspection and UPV tests were conducted on 16 columns (8 columns for Block A & 8 columns for Block B) by the same method.

Beams:

All beams (12 Nos. for block A & block B, 6 Nos. for each block) were in cross section of 40cm x 40cm with roof slab. The non-destructive tests on the concrete beams were carried out using PUNDIT equipment. The test points were marked at 20 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. Beams were selected for UPV tests on visual inspection and UPV tests were conducted on 8 beams (4 beams for Block A & 4 beams for Block B) 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

Fig: 2 Ultrasonic Pulse Velocity Test Equipment (Proceq Model- PL 200)

4.0 DISCUSSION OF TEST RESULTS

4.1 Concrete Column No. 1 (Block A) Scanned from Bottom to Top

The Ultrasonic pulse velocity tests were conducted by direct method on column of size 50 cm x 50 cm at 30 test points with 50 cm path length. It was observed that out of 30 locations that were tested, 25 (83.33%) test locations indicate that concrete quality fell under good category, 4 (13.33%) test locations fell under medium category and the remaining 1 (3.33%) test location fell under doubtful category. Overall quality of concrete was good.

Fig: 3 UPV Test by Direct Method on Column

4.2 Concrete Column No. 2 (Block A) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 27 (90%) test locations indicate that concrete quality fell under good category, 2 (7.40%) test locations fell under medium category and the remaining 1 (3.33%) test location fell under doubtful category. Overall quality of concrete was good.

4.3 Concrete Column No. 3 (Block A) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 23 (76.66%) test locations indicate that concrete quality fell under good category, 5 (16.66%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.4 Concrete Column No. 4 (Block A) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 25 (83.33%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.5 Concrete Column No. 5 (Block A) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 26 (86.66%) test locations indicate that concrete quality fell under good category, 2 (6.66%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.6 Concrete Column No. 6 (Block A) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 24 (80%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 3 (10%) test locations fell under doubtful category. Overall quality of concrete was good.

4.7 Concrete Column No. 7 (Block A) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 23 (76.66%) test locations indicate that concrete quality fell under good category, 4 (13.33%) test locations fell under medium category and the remaining 3 (10%) test locations fell under doubtful category. Overall quality of concrete was good.

4.8 Concrete Column No. 8 (Block A) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 26 (86.66%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 1 (3.33%) test locations fell under doubtful category. Overall quality of concrete was good.

4.9 Concrete Column No. 9 (Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 24 (80%) test locations indicate that concrete quality fell under good category, 4 (13.33%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.10 Concrete Column No. 10 (Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 23 (76.66%) test locations indicate that concrete quality fell under good category, 5 (16.66%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.11 Concrete Column No. 11(Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 22 (73.33%) test locations indicate that concrete quality fell under good category, 5 (16.66%) test locations fell under medium category and the remaining 3 (10%) test locations fell under doubtful category. Overall quality of concrete was good.

4.12 Concrete Column No. 12 (Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 26 (86.66%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 1 (3.33%) test locations fell under doubtful category. Overall quality of concrete was good.

Fig: 4 UPV Test by Direct Method on Column

4.13 Concrete Column No. 13 (Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 23 (76.66%) test locations indicate that concrete quality fell under good category, 5 (16.66%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.14 Concrete Column No. 14 (Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 24 (80%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 3 (10%) test locations fell under doubtful category. Overall quality of concrete was good.

4.15 Concrete Column No. 15 (Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 25 (83.33%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.16 Concrete Column No. 16 (Block B) Scanned from Bottom to Top

It was observed that out of 30 locations that were tested, 23 (76.66%) test locations indicate that concrete quality fell under good category, 5 (16.66%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.17 Concrete Beam No. 1(Block A) Scanned from Column No.1

It was observed that out of 30 locations that were tested, 25 (83.33%) test locations indicate that concrete quality fell under good category and 5 (16.67%) test locations fell under medium category. Overall quality of concrete was good.

Fig: 5 UPV Test by Direct Method on RCC Beam

4.18 Concrete Beam No. 2 (Block A) Scanned from Column No. 3

It was observed that out of 30 locations that were tested, 27 (90%) test locations indicate that concrete quality fell under good category and 3 (10%) test location fell under medium category. Overall quality of concrete was good.

4.19 Concrete Beam No. 3 (Block A) Scanned from Column No. 5

It was observed that out of 30 locations that were tested, 26 (86.67%) test locations indicate that concrete quality fell under good category and 4 (13.33%) test locations fell under medium category. Overall quality of concrete was good.

4.20 Concrete Beam No. 4 (Block A) Scanned from Column No. 7

It was observed that out of 30 locations that were tested, 25 (83.33%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.21 Concrete Beam No. 5 (Block B) Scanned from Column No. 9

It was observed that out of 30 locations that were tested, 23 (76.66%) test locations indicate that concrete quality fell under good category, 5 (16.66%) test locations fell under medium category and the remaining 2 (6.66%) test locations fell under doubtful category. Overall quality of concrete was good.

4.22 Concrete Beam No. 6 (Block B) Scanned from Column No. 11

It was observed that out of 30 locations that were tested, 24 (80%) test locations indicate that concrete quality fell under good category, 3 (10%) test locations fell under medium category and the remaining 3 (10%) test locations fell under doubtful category. Overall quality of concrete was good.

4.23 Concrete Beam No. 7 (Block B) Scanned from Column No. 13

It was observed that out of 30 locations that were tested, 22 (73.33%) test locations indicate that concrete quality fell under good category, 5 (16.66%) test locations fell under medium category and the remaining 3 (10%) test locations fell under doubtful category. Overall quality of concrete was good.

Fig: 6 UPV Test by Direct Method on RCC Beam

4.24 Concrete Beam No. 8 (Block B) Scanned from Column No. 15

It was observed that out of 30 locations that were tested, 27 (90%) test locations indicate that concrete quality fell under good category, 2 (7.40%) test locations fell under medium category and the remaining 1 (3.33%) test location fell under doubtful category. Overall quality of concrete was good.

5.0 CONCLUSION AND RECOMMENDATIONS

Columns:

16 columns (Block A & Block B of building) were investigated using UPV Direct method which was most reliable had been adopted in taking the pulse readings. In all 480 points were scanned for the entire 16 columns. Based on the results, 389 (81.04%) points had indicated that in-situ quality of concrete for the entire 16 columns had been found to be good category. The quality of remaining points 91 (18.95%) 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:

8 beams (Block A & Block B of building) were investigated using UPV by Direct method which was most reliable one. In all 240 points were scanned for the entire 8 beams. Based on the test results, 199 (82.91%) points had indicated that in-situ quality of concrete for the entire 8 beams had been found to be good category. The quality of remaining points 41 (17.08%) 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 beams having quality good, medium and doubtful to assess the in-situ compressive strength and also the depth of carbonation.

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