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Case 4.8 NDT & strength evaluation of overhead water tanks, Punjab, India

The water tanks that supply potable water to a part of city were built in late 1970s/ early 1980s. During this period, concrete was generally produced in small batches using portable mixers on the project location itself. The concrete was transported from the mixer and placed on site using manual labor.

This resulted in high variability and less than desired quality and durability of concrete in the RCC structures built during that period.

Avantech Engineering of India, was assigned the task of investigating the health of concrete and reinforcement in four water tanks constructed, using Non Destructive and partially destructive test methods.

The objective of the investigations was to assess the in-situ concrete compressive strength, concrete homogeneity, surface hardness, corrosion risk, concrete cover and depth of carbonation using Non-Destructive and minimally destructive techniques to diagnose the type and cause of distress in the5structures.

This information would then be utilized by the owner for validation of structure design and carrying out repair/ rehabilitation.

Concrete Strength

Compressive strength **(MPa)**	**Dome** CAPO Test ¤)	**Columns** CAPO Test ¤)	**Beams** Core Test ¤¤)	**Beams** CAPO Test (only 2 tests for core validation)
Range	24 to 50	22 to 49	16 to 39	23-33
Mean Value	38.5	39	23	26

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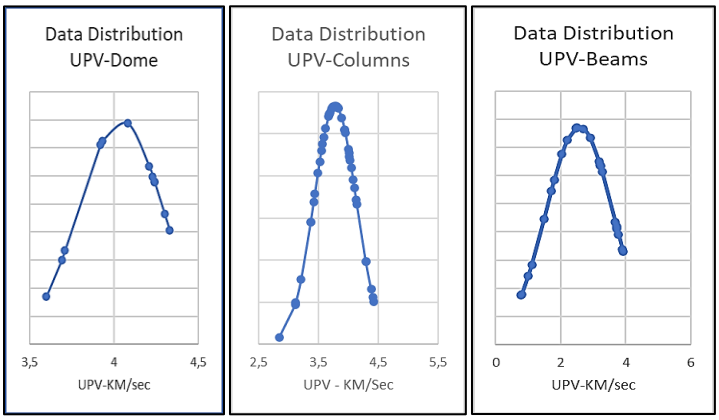
Median	**39**	**41**	**21**	-
Standard Dev	8.5	9	6	-

¤) Nos of CAPO-TEST: 20

¤¤) Nos of cores: 12 (dia 68 mm, water soaked 48 hours)

Concrete Homogeneity

UPV (Ultrasound Pulse Velocity) tests were carried out to assess the general quality and homogeneity of concrete.



Aver:	**4.0**	**3.8**	**2.4**
km/s	Dome	Columns	Beams

Evaluated by UPV the quality of domes and columns was generally good and uniform with all UPV values above 3.5 km/sec. The beams exhibited the worst quality with about 74% readings below 3.5 km/s and average UPV only 2.4 km/s .

Rebound Hammer

Rebound hammer data collected was not in conformity with the visual inspection, UPV, CAPO and Core Test results and therefore not used for estimation of in-situ strength in this case.

Corrosion

Half Cell Potential tests were conducted using the Half Cell Method and based on average -mV readings. The average risk of corrosion was observed to be 50% for most structures tested. Beams exhibited maximum average negative potentials in all tanks.

Cover

The lowest cover was on the beams (22 -27 mm), on the domes (45-67 mm) and on the columns (43-57 mm)

Carbonation

Depth of carbonation: Beams (40-52 mm), do and the beams (36-52 mm)

In almost all cases the depth of carbonation was larger than the depth of the reinforcement, causing loss of protection from the concrete´s alkalinity, and making the rebars corrode.

CONCLUSIONS & RECOMMENDATIONS

1.The in-situ strength of concrete in beams was observed to be considerably lower than concrete strength in domes and columns. This may be corroborated with original design data and suitable structural design checks. .

2. Concrete homogeneity in domes and columns was adequate, however, the concrete quality and homogeneity in beams was found to be poor.

3. There is a significant risk of active corrosion in rebars in all tanks. The carbonation depths are quite significant, exceeding the cover depth in most cases and therefore appear to be the main cause of active corrosion. Poor homogeneity of concrete and lower cover depths as observed in beams increase the porosity and therefore the risk of higher active corrosion.

4. The customer was advised to take adequate remedial measures to arrest the active corrosion and draw a plan for repair/ rehabilitation of the water tanks.

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Testing organized / reported by **NDTitan Parampreet Singh**