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Estimating the Concrete Compressive Strength of OHSR of Amritsar city by using NDT technique

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Abstract - Developing a non-destructive method which delivers fast, accurate and non-invasive results regarding the concrete compressive strength, is an important issue, currently investigated by many researchers all over the world . This paper provides the recent advances and researches about non-destructive testing (NDT) methods for defect characterization in engineering materials and composites. The paper covers the review on the capabilities of NDT applications. So to satisfy the open water need, water tanks should be developed, these tanks are structured according to Seems to be: 3370 for example Code of training for solid structures for capacity of fluids. BIS executed the reconsidered variant of IS 3370 (section 1& 2) after quite a while from its 1965 form in year 2009. Directly huge number of overhead water tanks is utilized to disperse the water for open utility. Effective methods for monitoring the condition and evaluating the deterioration level are required. This leads to the development of several destructive and non-destructive test methods. Rebound hammer and Ultrasonic pulse velocity test over any concrete structure reflects its conditions. Several physical and chemical properties of Overhead structures significantly influence the condition and hence enforce to evaluate the condition ratings by ultrasonic pulse velocity (UPV) and rebound hammer on the structure. Evaluating the present condition of overhead water retaining concrete structures by measuring UPV and compressive strength is significant for planning maintenances, durability and replacement of structures. In the present research study different water tanks are identified and selected according to their ages which are located in the city of Bhopal. The Research is aimed to evaluate the concrete durability of overhead tanks. Field test are carried out on selected twenty structures. The data obtained are analysed and presented the outcomes and findings of the research study. This research study and findings are useful for Engineers and authorities for proper planning and maintaining these structures in years to come. Accuracy of determining the compressive strength by CAPO- TEST related to core compressive strength is also determined in this paper

KEYWORDS: Durability, compressive strength, Overhead structures, Non Destructive test.

1. INTRODUCTION

Concrete is one of the most used construction material, particularly in the overall infrastructure, road and civil as well, all around the world. Whether there are involved new buildings or old buildings, knowing the concrete properties (mechanical or physical) is a fundamental issue, in order to assure the structural safety. One of the most important characteristics of concrete is the compressive strength. Non-destructive testing are methods to evaluate material integrity for surface or internal flaws or metallurgical condition without interfering in any way with the destruction of the material or its suitability for service. There are varieties of methods to evaluate materials and components as per their state of application. Water tanks are utilized to store water. Cost, shape, size and building materials utilized for developing water tanks are affected by the limit of water tank. State of the water tank is a significant structure parameter since nature and force of stresses depend on the state of the water tank. When all is said in done, for a given limit, roundabout shape is favoured in light of the fact that burdens are uniform and lower contrasted with different shapes. Lesser anxieties infer, lower amounts of material required for development which cuts down the development cost of water tanks. Water tank is one such water tank which has roundabout shape with a circular top and tapered chunk with round arch at the base. Considering the several and the obvious advantages of the non-destructive testing (NDT) for concrete structure evaluation, like the non-invasive character of the testing, not affecting the structure, less resource consumption in terms of money and time, etc., worldwide researchers were deeply interested in improving the existing NDT methodology and developing new ones, in order to

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increase the results accuracy and decrease their dependency to the destructive testing. So far studies demonstrated that there is no universal law to estimate the concrete compressive strength through NDT testing [1]

2. Objectives of research

The key objective for this research is based on the research intended to investigate the reasons of the concerns about the strength estimation of concrete with the rebound method when NDT is done on Water tank and provide a comprehensive analysis of the rebound method for a better understanding of the hardness of concrete and its relation to compressive strength. Objectives are as follows.

1. To perform NDT mainly rebound hammer test, core extraction test, cut and pullout test on various OHSR's Amritsar
2. To access the in-situ conditions of OHSR based on Rebound hammer test, core extraction test, cut and pullout test on various OHSR's Amritsar.
3. To co- relate the assessment made from rebound hammer test and with core extraction test and cut and pullout test

3. Methodology: Experimental approach

The proposed NDT methodology mainly consists in two complementary, non-invasive procedures: a) the ultrasonic testing of the concrete elements, performed on site; b) the mathematical interpretation of the data, taking in consideration the moduli of elasticity (static and dynamic) Rebound Hammer test is a Non-destructive testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. The rebound hammer is also called as Schmidt hammer that consist of a spring-controlled mass that slides on a plunger within a tubular housing. The operation of rebound hammer is shown in the Figure 1. When the plunger of rebound hammer is pressed against the surface of concrete, a spring-controlled mass with a constant energy is made to hit concrete surface to rebound back. The extent of rebound, which is a measure of surface hardness, is measured on a graduated scale. This measured value is designated as Rebound Number (rebound index). A concrete with low strength and low stiffness will absorb more energy to yield in a lower rebound value.

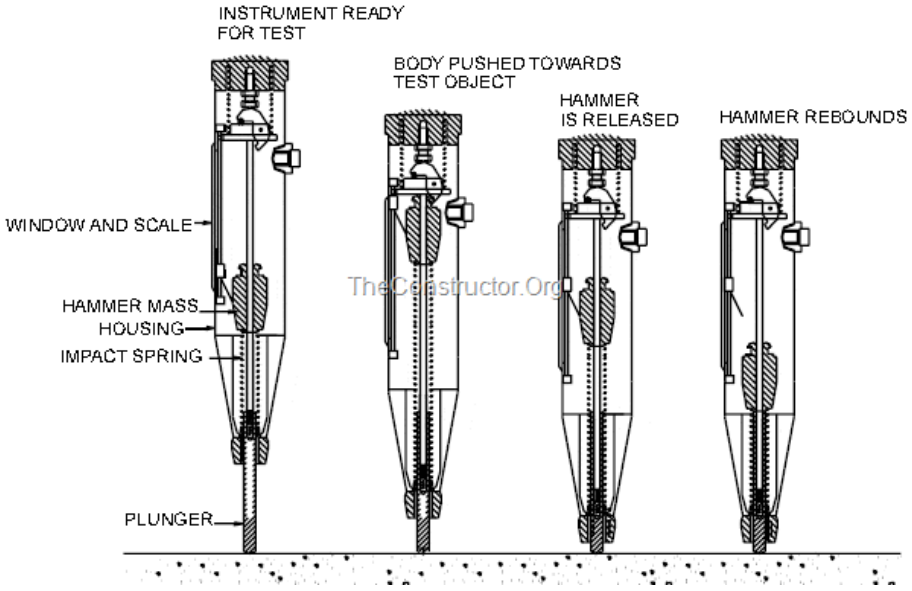

Figure 1: Operation of rebound hammer test.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 05, May-2023

Table-1: Impact Energy for Rebound Hammers for Different Applications As per IS: 13311(2)-1992

S. No	Applications	Approximate Impact Energy for Rebound Hammer in Nm
1	For Normal Weight Concrete	2.25
2	For light weight concrete / For small and impact resistive concrete parts	0.75
3	For mass concrete testing Eg: In roads, hydraulic structures and pavements	30.00

4. Classifications of Water Tanks

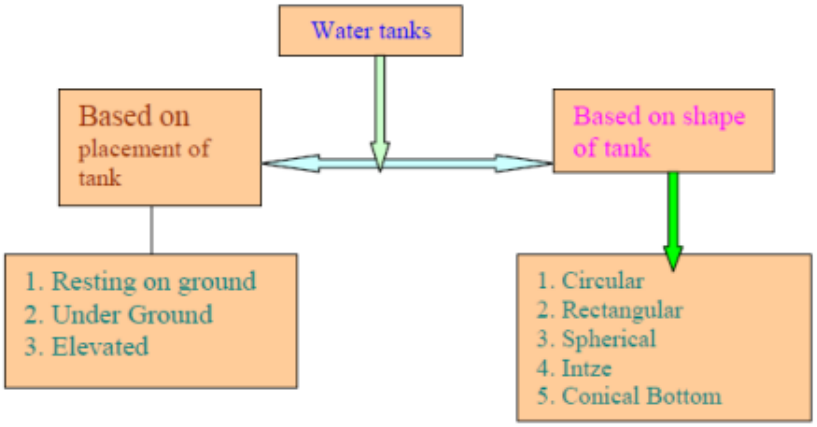

Table 2 : NDT test on Different OHSR in Amritsar city

S. No.	Address	Type of tank	Latitude	Longitude
1.	Ajit Nagar zone no-1 , ward no- 26 Golden Cloth Market, Sultanwind Gate, Amritsar smart city project, Amritsar.Punjab	Over Head Reservoir	31°37'09.7"N	74°53'08.6"E
2.	Kesari Bagh, Katra Ahluwalia, Amritsar Cantt., Punjab 143006.	Over Head Reservoir	31°37'23.8"N	74°52'48.9"E
3.	Zone No-1A, Ward No-129, Azad nagar, Amritsar	Over Head Reservoir	31°36'44.19"N	74°53'41.80"E
4.	Daburji ,Kanwar Avenue, Baba Phoola Singh, Amritsar, Punjab 143006	Over Head Reservoir	31°35'57.3"N	74°55'45.7"E
5.	Zone No-1A, Ward No 33, Kot Mit singh (JNNURM)	Over Head Reservoir	31°35'24.9"N	74°53'19.8"E

International Journal of Engineering Research & Technology (IJERT)
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Vol. 12 Issue 05, May-2023

6.	Pink Plaza Market, Amritsar, Punjab 143001	Over Head Reservoir	31°37'52.0"N	74°52'22.1"E
7.	lahori gate zonal office, Amritsar, Punjab 143001	Overhead Water Tank,	31°37'12.3"N	74°51'51.1"E
8.	Zone No-3A, Ward No-37, Gilwali Gate Amritsar	Overhead Water Tank,	31°36'37.7"N	74°52'24.1"E
9.	Shaktribagh tank no. 13 Overhead Water Tank, Guru Ram Das Nagar, Himatpura, Amritsar Cantt., Punjab 143006	Overhead Water Tank.	31°36'41.05"N	74°52'42.94"E
10.	Zone No-3A, Ward No-39, Kot Mahna singh.	Overhead Water Tank.	31°36'25.90"N	74°52'58.08"E
11.	Borian Wala Bazar, Shakti Nagar, Amritsar, Punjab 143006 Amritsar, Punjab	Overhead Water Tank.	31.616834,	74.867650
12.	Karta Moti Ram	Overhead Water Tank.	31°37'37.6"N	74°52'14.6"E

a) Water tank -1.

b) Water tank- 2.

c) Water tank -6

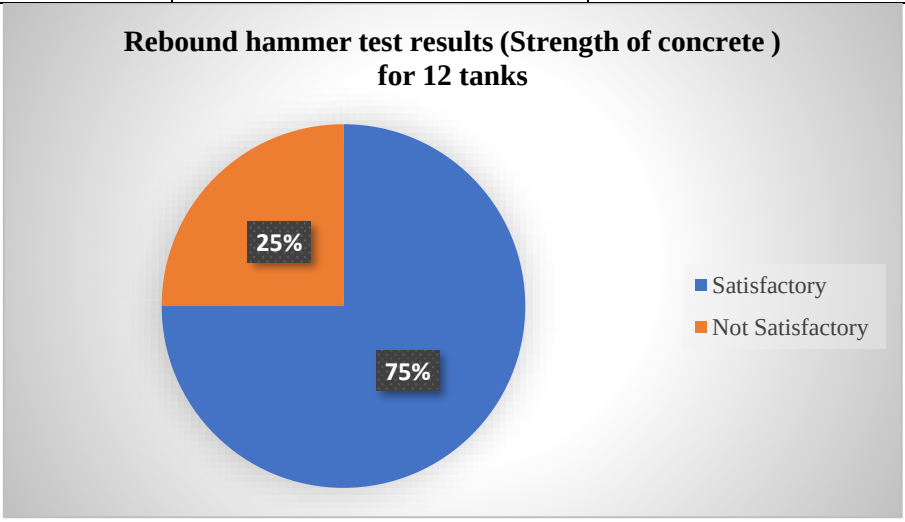
Figure 2. Water tank images

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 05, May-2023

5. Experimental result

Table 3: concluded results for rebound hammer test for all the Water Tanks .

Sr.no	Test Carried out	Results & Stipulation	Remarks
TANK -1	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 9.76 to 59.79 N/mm^2.	Strength of concrete is satisfactory based on rebound hammer test conducted.
TANK - 2	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 17.8 to 29.9 N/mm^2.	**Strength of concrete is not satisfactory based on rebound hammer test conducted.**
TANK -3	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 20.79 to 33.07 N/mm^2.	Strength of concrete is satisfactory based on rebound hammer test conducted.
TANK - 4	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 26.22 N/mm^2 to 55.58 N/mm^2	Strength of concrete is satisfactory based on rebound hammer test conducted.
TANK- 5	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 7.11 to 24.89 N/mm^2.	Strength of concrete is satisfactory rebound hammer test conducted.
TANK- 6	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 4.69 to 34.42 N/mm^2.	Strength of concrete is satisfactory based on rebound hammer test conducted.
TANK -7	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 20.22 to 35.40N/mm^2	Strength of concrete is satisfactory based on rebound hammer test conducted.
TANK -8	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 34.7 to 56.08 N/mm^2.	Strength of concrete is satisfactory based on rebound hammer test conducted.
TANK-9	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 21.3 to 32.8 N/mm^2.	Strength of concrete is satisfactory based on rebound hammer test conducted.
TANK-10	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 12.32 to 48.92 N/mm^2.	**Strength of concrete is not satisfactory based on rebound hammer test conducted.**
TANK-11	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 7.29 to 31.7 N/mm^2.	**Strength of concrete is not satisfactory based on rebound hammer test conducted.**
TANK-12	Rebound hammer Tes	In-situ strength of concrete in structure is ranges from 15.97 to 21.99 N/mm^2.	Strength of concrete is satisfactory based on rebound hammer test conducted.



International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 05, May-2023

Figure 3: Average rebound hammer test results for all 12 tanks.

Table 4: Concluded results for Pull off (CAPO) test for all the Water Tanks .

Sr.no	Test Carried out	Results & Stipulation	Remarks
TANK -1	Pull off (CAPO) Test	Average In situ strength of concrete in tested structure is 16.628 N/mm^2.	**Strength of concrete is not satisfactory.**
TANK - 2	Pull off (CAPO) Test	Average In situ strength of concrete in tested structure is 18.8 N/ mm^2.	**Strength of concrete is not satisfactory.**
TANK -3	Pull off (CAPO) Test	In-situ strength of concrete in tested structure varies from 19.4 to 23.4 N/mm^2	**Strength of concrete is not satisfactory.**
TANK - 4	Pull off (CAPO) Test	Average In-situ strength of concrete in tested structure varies from 32.42.	Strength of concrete is satisfactory.
TANK- 5	Pull off (CAPO) Test	Average In-situ strength of concrete in tested structure 24.16 N/mm^2	Strength of concrete is satisfactory.
TANK- 6	Pull off (CAPO) Test	The Average In-situ strength of concrete in tested structure varies 17.9 to 27.3 N/mm^2	**Strength of concrete is not satisfactory.**
TANK -7	Pull off (CAPO) Test	Average In-situ strength of concrete in tested structure 18.64.	**Strength of concrete is not satisfactory.**
TANK -8	Pull off (CAPO) Test	Average In-situ strength of concrete in tested structure 49.2 N/mm^2	Strength of concrete is satisfactory.
TANK-9	Pull off (CAPO) Test	In-situ strength of concrete in tested structure varies from 15.3 to 25.9 N/mm^2	**Strength of concrete is not satisfactory.**
TANK-10	Pull off (CAPO) Test	Average In-situ strength of concrete in tested structure 20.24 N/mm^2.	**Strength of concrete is not satisfactory.**
TANK-11	Pull off (CAPO) Test	Average In-situ strength of concrete in tested structure 21.42.	**Strength of concrete is not satisfactory.**
TANK-12	Pull off (CAPO) Test	Lowest In-situ strength of concrete in tested structure 19.4.	**Strength of concrete is not satisfactory.**

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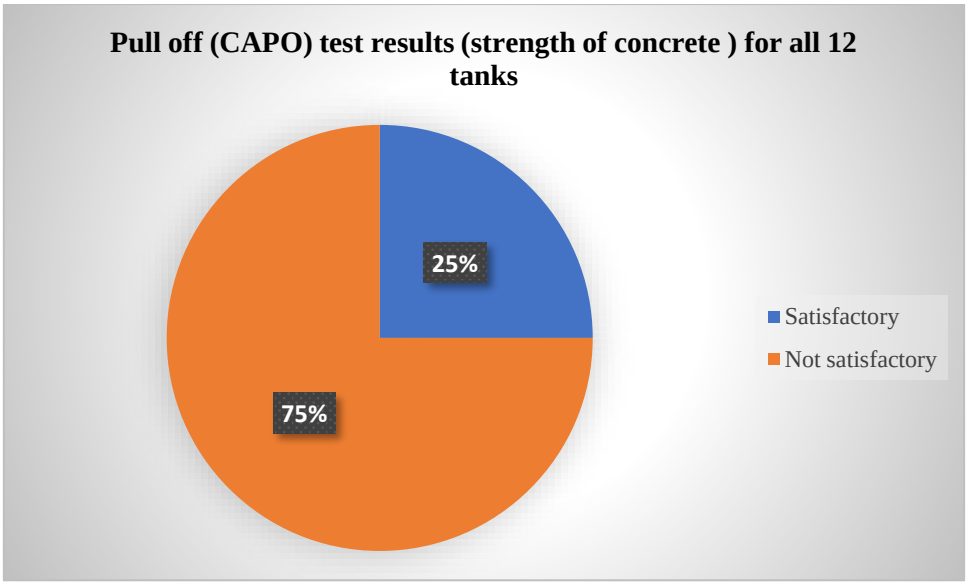

Figure 4 : Average Pull off test results for all 12 tanks.

Table 5: Concluded results for Compressive Strength on Core samples for all the Water Tanks.

Sr.no	Test Carried out	Results & Stipulation	Remarks
TANK -1	Compressive Strength on Core samples	The average relative strength of concrete core samples is 17.487 N/mm^2.	**Strength of concrete is not satisfactory.**
TANK - 2	Compressive Strength on Core samples	The average relative strength of concrete core samples varies from 18.94 to 26.75 N/mm^2.	Strength of concrete is satisfactory.
TANK -3	Compressive Strength on Core samples	Strength of concrete core samples varies from 21.77 to 24.78 N/mm^2	**Strength of concrete is not satisfactory.**
TANK - 4	Compressive Strength on Core samples	The average relative strength of concrete core samples varies from 40.74 to 54.28 N/mm^2.	Strength of concrete is satisfactory.
TANK- 5	Compressive Strength on Core samples	The average relative strength of concrete core samples varies 27.3 N/mm^2	Strength of concrete is satisfactory.
TANK- 6	Compressive Strength on Core samples	The In situ strength of concrete core sample varies from 18.5 to 34.17 N/mm^2.	Strength of concrete is satisfactory.
TANK -7	Compressive Strength on Core samples	The average relative strength of concrete core samples varies from 11.39 to 27.86N/mm^2.	**Strength of concrete is not satisfactory.**
TANK -8	Compressive Strength on Core samples	The average relative strength of Concrete core samples is 51.467 N/mm^2.	Strength of concrete is satisfactory.
TANK-9	Compressive Strength on Core	Strength of concrete core samples varies from 17.8 to 25.9 N/mm^2	**Strength of concrete is not satisfactory.**

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 05, May-2023

	samples		
TANK-10	Compressive Strength on Core samples	The average relative strength of concrete core samples is 21.8 N/mm^2.	**Strength of concrete is not satisfactory.**
TANK-11	Compressive Strength on Core samples	The average relative strength of concrete core samples varies from 21.74 to 25.82 N/mm^2.	**Strength of concrete is not satisfactory.**
TANK-12	Compressive Strength on Core samples	The Lowest strength of concrete core samples is 20.67 N/mm^2.	**Strength of concrete is not satisfactory.**

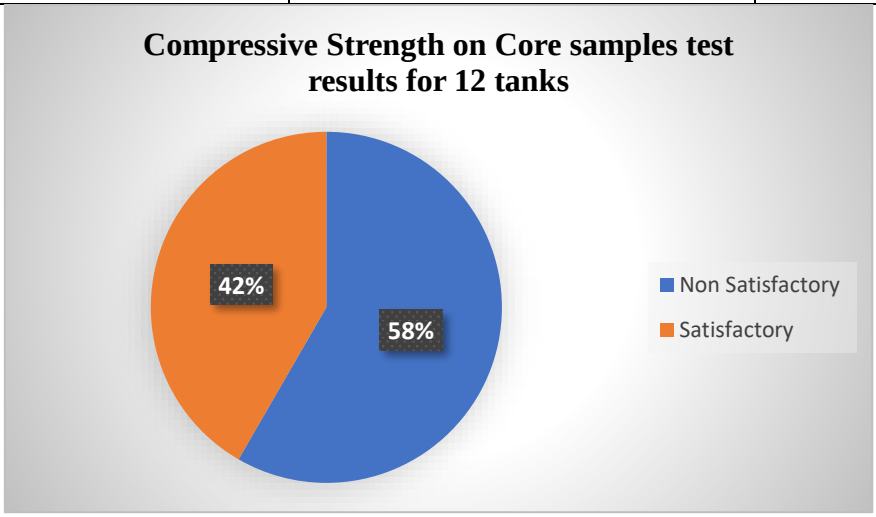

Figure 5: Average of Compressive Strength on Core samples test results for all 12 tanks.

Accuracy of determining the compressive strength by CAPO- TEST related to core compressive strength α(L): 100%($f_{cm,\,cub}(L)$- $f_{cm,\,cub}(c_r)$)/ $f_{cm,\,cub}(c_r)$.
Where
$f_{cm,\,cub}(c_r)$- Mean cube compressive strength determined by testing of core (MPa)

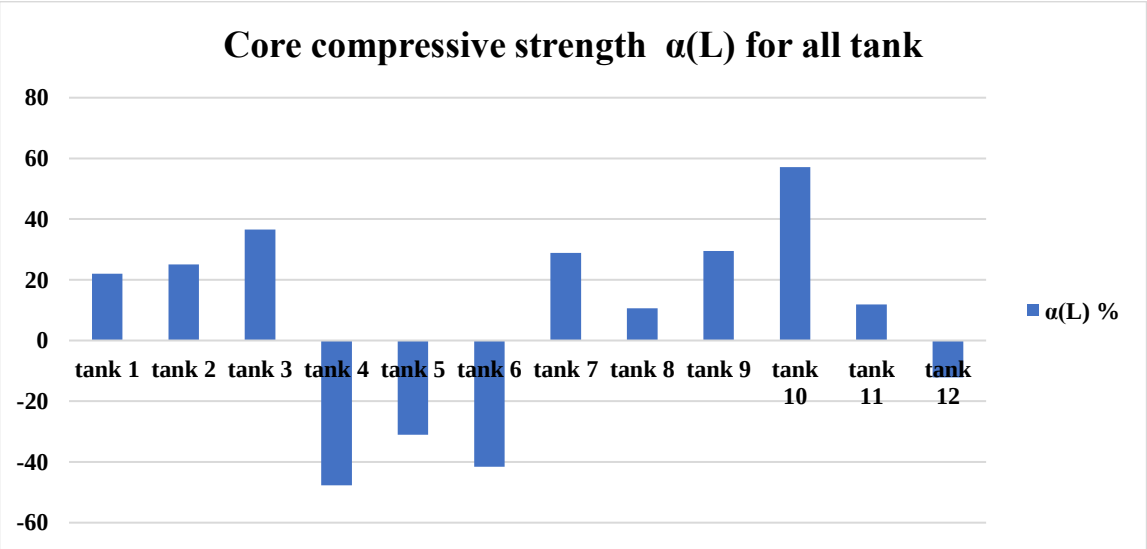

Figure 6: Core compressive strength α(L) for all tanks

International Journal of Engineering Research & Technology (IJERT)
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Vol. 12 Issue 05, May-2023

5 CONCLUSION

These are the various conclusion made from rebound hammer test, pull off test and core extraction test are are explained below.

1. Rebound hammer test shows that the compressive strength is not satisfactory for tank 2,10, and 11. In tank 1 The locations where the cracks, corrosion & spalling observed in these tanks in most of the part where as for rest of the tanks the rebound hammer test results is found to be satisfactory .
2. From Pullout test results it have been concluded that for Tank 1,2,3,6,7,9,10,11,12 Strength of concrete is not satisfactory. But for rest of the tank it is observed average and satisfactory
3. α(L) found to be 23.93 % which is average core compressive strength for all 12 tanks

Future recommendation

1. Advanced data analysis software should be developed with the capacity to analyze large data sets. This would allow more enhancements in the automation of the techniques for more convenient field inspections.
2. Referring to ample available literature, much like those reviewed in this report, standardized guides should be developed for the increased use of NDT techniques in the field evaluations.

REFERENCES

1. Chunguang Xu, Wentao Song, Qinxue Pan, Huanxin Li, Shuai Liu. Nondestructive Testing Residual Stress Using Ultrasonic Critical Refracted Longitudinal Wave. Physics Procedia. 2015 Dec 31;70:594-b
2. Eiichi Sato, Mitsuharu Shiwa, Yoshio Shinagawa, Takashi Ida, Satoshi Yamazoe and Akiyoushi Sato. Ultrasonic testing method for detection of planar flaws in graphite material. Materials transactions. 2007;48(6):1227-35.
3. Gabriel Dan Taşcă, Gheorghe Amza. Research regarding ultrasonic examination of complex parts.
4. Malcolm K. Lim , Honggang Cao. Combining multiple NDT methods to improve testing effectiveness. Construction and Building Materials, ISSN. 2003:0950-618.
5. MR Jolly, A. Prabhakar, B. Sturzu, K. Hollstein, R.Singh, Thomas, P. Foote & A. Shaw. Review of Non-destructive Testing (NDT) Techniques and their Applicability to Thick Walled Composites. Procedia CIRP. 2015 Dec 31;38:129-36.
6. M. Rojek, J. Stabik, S. Sokół. Fatigue and ultrasonic testing of epoxy-glass composites. Journal of Achievements in Materials and Manufacturing Engineering. 2007 Jan;20(1-2):183-6.
7. Pandey. Non-destructive Test methods for RCC OHWT, International Research Journal of Engineering and Technology, Volume: 08, Issue: 02 pp. No. 866- 874
8. S. Kumar, D. G. .Mahto. Recent trends in industrial and other engineering applications of non destructive testing: a review. International Journal of Scientific & Engineering Research. 2013 Sep;4(9).
9. S.Gholizadeh. A review of non-destructive testing methods of composite materials. Procedia Structural Integrity. 2016 Dec 31;1:50-7.
10. Tirupan Mandal , James M. Tinjum , Tuncer B. Edil. Non-destructive testing of cementitiously stabilized materials using ultrasonic pulse velocity test. Transportation Geotechnics. 2016 Mar 31;6:97-107.
11. Yang Zhan-Feng, Zhang Wei-Bin, Tian Yong, LI jing-ming, LI li. Nonlinear ultrasonic testing technique for micro-damage of TATB based Polymer Bonded Explosive, 2012 , 18th World Conference on Nondestructive Testing, 16-20 April 2012, Durban, South Africa.
12. ASTM Standards, C876-91, Standard Test Method for Half-cell potentials of uncoated reinforcement steel in concrete, Annual Book of ASTM Standards, Vol. 3.02, Philadelphia, PA, 1994.