Performance assessment of concrete produced using different types of surface water

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Abstract - This research looks into the possibility of using surface water as a concrete mixing water. Three types of surface water were employed as mixing water in concrete, including Futala lake water, Ambazari lake water, and Sonegaon lake water, and the results were compared to concrete created with potable water in terms of mechanical and durability aspects. The purpose of this experiment is to determine how impurities in surface water collected from various locations affect the properties of concrete, as well as whether surface water may be utilized as a concrete mixing water. Compressive strength and split tensile strength tests were performed for mechanical properties, while rapid chloride penetration and water penetration tests were performed for durability properties. The results of the tests revealed that all surface water can be used as a concrete mixing water.

Key words – Concrete, Mixing water, Wastewater, strength, durability

I. INTRODUCTION

Streams, rivers, lakes, and wetlands all contain water. Surface water includes snow, ocean water, and any other water found on the earth's surface. Because it may be replenished by precipitation and transferred to the atmosphere by evaporation, surface water is an important part of the planet's hydrologic cycle. Surface water was taken from Futala Lake, Ambazari Lake, and Sonegaon Lake for this study.

All three lake are situated in vicinity of Nagpur city of Maharashtra. The lake's initial purpose of irrigating nearby agricultural land was one of its most important functions. The water is currently used for commercial fishing because it is unfit for human consumption. It is incapable of cleansing itself. As a result of the continual input of nutrients from many contaminated source. However, sewage from adjacent communities, as well as industrial waste from MIDC, have polluted the lake. Because of contamination, drinking lake water is no longer an option. The water in Sonegaon Lake has been polluted by anthropogenic activities, religious festivals such as Gauri-Ganesh and Durga idol immersion, surface runoff, and municipal sewage water input. Due to water scarcity throughout the summer, it is extremely difficult to use drinking water for construction activities, which could provide a significant challenge to the construction site.As a result, the purpose of this study is to explore if lake water may be used as a concrete mixing water, which will preserve drinking water and aid in long-term sustainability.

II. EXPERIMENTAL INVESTIGATION

Material

IS 12269 specifies that ordinary Portland cement (OPC) be used as a binder in concrete. The fine aggregates and coarse aggregate used in concrete meet all of the IS 383 requirements. In this investigation, three surface water samples were taken from different locations and used for concrete mixing: Futala lake water, Ambazari lake water, and Sonegaon lake water. All surface water samples were examined at Nagpur's Hydrology Project Division's Water Quality Lab, and the results of all wastewater samples are reported in table 1.

Table 1 Characteristics of all types of surface water studied in this research

Sr.No.	Characteristic (Parameter)	Unit	Analysis Result		
			Futala Lake Water	Ambazari Lake Water	Sonegaon Lake Water
1	pH		8.2	8.1	8.2
2	Total Dissolved Solids	mg/L	315	227	272
3	Total Suspended Solids	mg/L	10	9	7
4	Total Alkalinity (as CaCo3)	mg/L	286	174	194
5	Total Hardness (as CaCo3)	mg/L	258	160	185
6	Chloride (as CL)	mg/L	26	24	30

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7	Sulphate (as SO4)	mg/L	15	12	13
8	Nitrate (as NO3)	mg/L	6.20	2.66	5.32
9	Bi Carbonate (as CaCO3)	mg/L	234	152	166
10	BOD	mg/L	3.8	3.4	3.6
11	COD	mg/L	16	14	14

2.2 Casting and Testing of Specimen

Different types of surface water were used to make concrete mixes. For all sorts of concrete mixtures, the water cement ratio was the most important consideration. Concrete cube specimens of 150 x 150 x 150 mm, as well as cylindrical specimens measuring 150 diameter and 300 mm in length, were cast. Each type of surface water sample was used to create cube and cylinder specimens. Specimens are examined for average compressive strength, splitting tensile strength, water penetration, and rapid chloride penetration at various ages. Concrete was mixed with the help of a mechanical mixer. All mixes were slump tested, and slump was determined to be between 85 and 110 mm. At 7, 28, and 90 days, compression tests were performed according to IS 516, and split tensile tests were performed according to IS 5816-1999. At 28 and 90 days, water penetration and rapid chloride penetration tests were performed to determine the durability of each surface water sample.

III. RESULT AND DISCUSSION

3.1 Compressive Strength

The compressive strength of hardened concrete is a critical mechanical attribute of the material. According to IS -516, the compressive strength of all specimens was measured after seven, twenty-eight, and ninety days. Figure 1 shows the compressive strength of all specimens developed with various types of surface water.

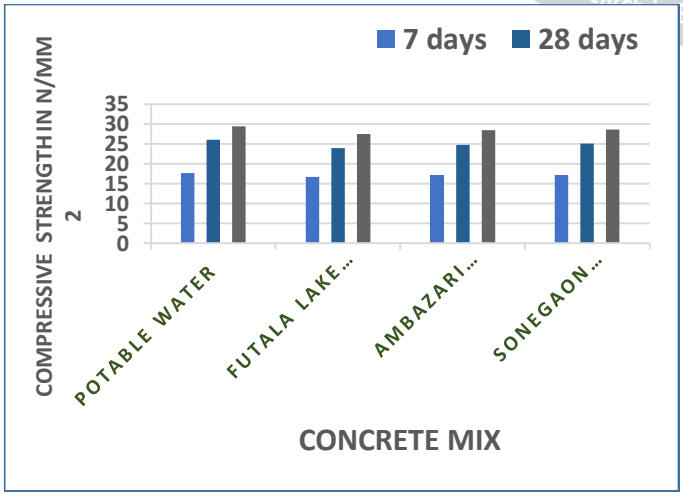

Fig.1 Compressive strength of all concrete mixes at testing age 7, 28 and 90 days

Compressive strength of concrete mix Futala lake water was lower than concrete mixes Ambazari lake water and Sonegaon lake water.Compressive strength of concrete mix Futala lake water gives 5.26 %,7.78% and 6.14 % lower strength than potable water at the 7 ,28 and 90 days curing period .Compressive strength of concrete mix Ambazari lake water reduces 2.65 % 4.58 % and 2.87 % than potable water at curing age 7,28 and 90 days Compressive strength of concrete mix Sonegaon lake water also decreased by 2.94 % ,3.43 % and 2.45 % than potable water at the curing 7,14 and 28 days The compressive strength of all surface water is less than that of potable water for both mix proportions, but not less than 90%.

3.1.2 Split Tensile Strength

The split tensile test was performed on a concrete specimen with a diameter of 150 mm and a length of 300 mm that was made using all types of surface water. According to IS 5816-1999, the tests were performed at the ages of 28 and 90 days. For each age of tests, three specimens were tested. The split tensile test was performed by applying compressive force down the length of the concrete cylinder at a rate of 1.2 to 2.4 Mpa/min. Figure 2 shows the split tensile strength of all specimens prepared with various types of surface water.

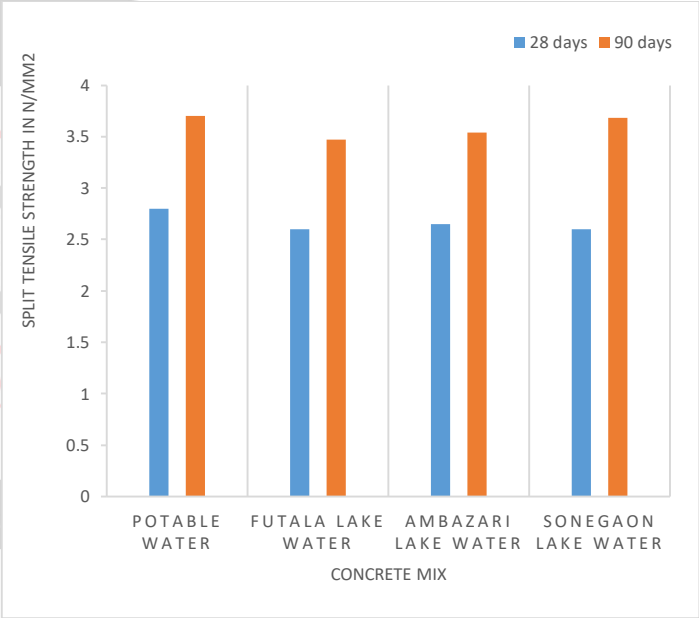

Fig.2 Split tensile strength of all concrete mixes at testing age 28 and 90 days

At 28 and 90 days of curing, the split tensile strength of concrete mix (Futala lake water) was found to be 4.12 percent and 3.32 percent lower than potable water. At 28 and 90 days of curing, the split tensile strength of concrete mix (Ambazari lake water) was lowered by 3.25 and 3.15 percent, respectively, compared to potable water. At 28 and 90 days of curing, the split tensile strength of concrete mix (Sonegaon lake water) was lowered by 2.90 percent and 0.50 percent, respectively, compared to potable water. The results of a split tensile test of all surface water revealed that all lake water can be used as concrete mixing water because the results are lower than potable water but not less than 90%, which is acceptable according to IS recommendations.

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.3.2 Durability Properties

3. 2.1 Rapid Chloride Penetration Test

The Rapid Chloride Penetration Test (RCPT) is a permeability indicator that determines how resistant concrete is to chloride ion penetration. Chloride penetration refers to the depth to which chloride ions from the surrounding environment or mixing water permeate the concrete. As a result, chloride permeability study is an important issue that influences the durability of concrete. Rapid chloride penetration tests were performed in this investigation according to C 1202 – 97.

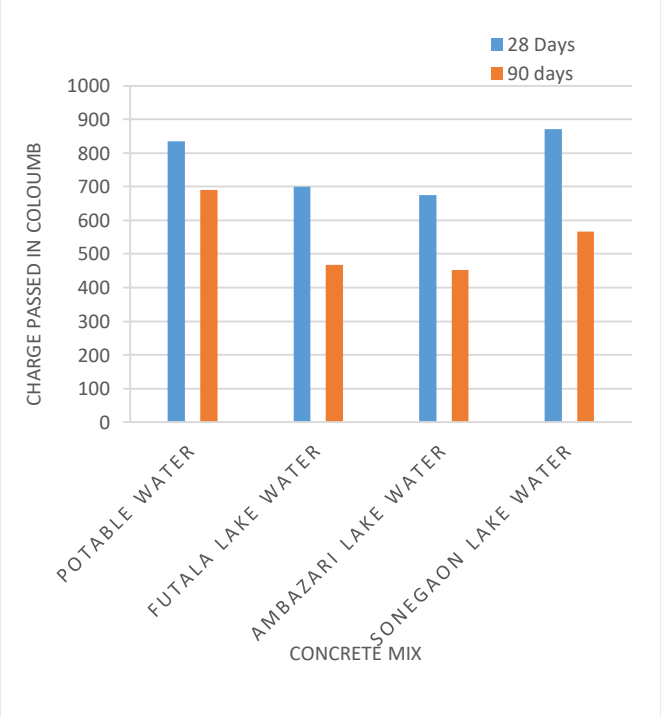

Fig.3 Rapid chloride penetration test of all concrete mixes at testing age 28 and 90 days

Chloride penetration were observed low for concrete mix made with all types of surface water at ninety days curing age .Low chloride penetration shows that concrete mix developed with all types of surface water not significantly affected .

3.2.2 Water Penetration Test

One of the durability parameters of concrete is its water permeability. Corrosion of reinforcement occurs as a result of water absorption, and impure water containing dangerous chemicals also penetrates the concrete, reacting with cement ingredients and having a significant impact on concrete qualities. Figure 4 depicts the water permeability of concrete specimens made with various types of surface water.

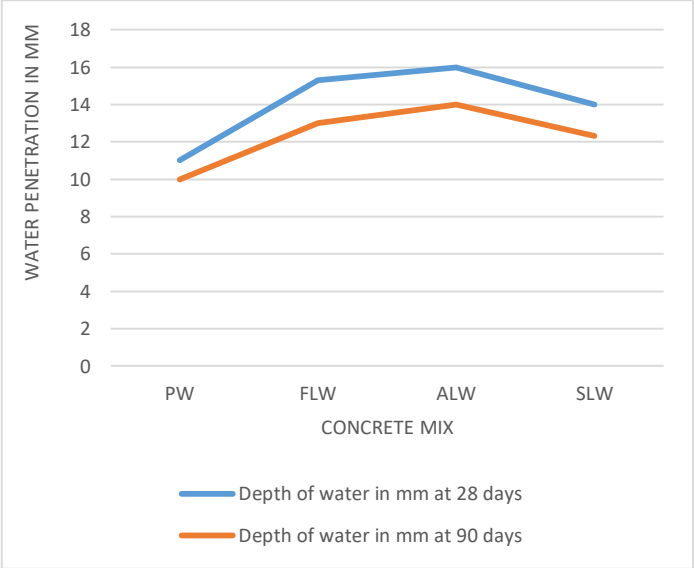

Fig.4 Water penetration of all concrete mixes at testing age 28 and 90 days

The results of the water permeability investigation show that various forms of surface water have no significant impact on the development of concrete. Water penetration in concrete samples prepared with potable water reduced over time. When compared to potable water concrete mix, Sonegaon lake water exhibits lesser water penetration at 28 and 90 days. Concrete mix made using Futala lake water and Ambazari lake water shows intermediate water penetration, which could be attributed to organic matter absorbing water during the mixing process.

IV. CONCLUSION

1. Futala Lake, Ambazari Lake, and Sonegaon Lake observed 93.86%, 97.13%, and 97.55% compressive strength of concrete, respectively, compared with that of concrete developed using potable water which is acceptable as per IS 456 recommendation.

2. The split tensile strength of all types of surface water was greater than 95 percent when compared to concrete made with potable water.

3. Rapid chloride penetration test demonstrated that all concrete mixes prepared with surface water have low chloride ion permeability.

4. Water penetration result for concrete mix prepared using Futala lake, Ambazari Lake and Sonegaon Lake are not significantly affect.

5. According to the findings of this study, surface waters studied in this research can be used as a mixing water in concrete which will help to save potable water.

6. The analysis showed that surface water, having more or less impurity can be successfully utilized in the construction industry where water scarcity is the problem for the formation of concrete structures, especially rigid pavement construction, which has no issue with the environment and

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odor related problems during the applicability of such water resources.

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