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EFFECT OF TREATED WASTE WATER ON THE PROPERTIES OF HARDENED CONCRETE

P. RAMA MOHAN RAO[*], S. M. K. MOINUDDIN[a] and P. JAGADEESH[a]

[*]C. D. M. M., VIT University, VELLORE – 632014 (T.N.) INDIA
[a]S. M. B. S., VIT University, VELLORE (T.N.) INDIA

ABSTRACT

This paper focus on the usage of treated waste water in the production of concrete so that the shortage and cost using potable water can be greatly reduced. In this paper, it t is chosen treated waste water, which give us the exact idea of corrosion and for the construction as well as strength and durability properties of the concrete. To determine the mechanical properties of concrete cast cube specimens using M 20 grade concrete with potable and treated waste water. Water absorption test in order to determine the difference in absorption capacity. The other tests, which are conducted include Rapid Chloride Penetration Test (RCPT), sulphate and chloride test are conducted on potable as well as treated waste water at 7, 14 and 28 days. Concrete cast with treated waste water attained more compressive strength when compared with concrete cast with potable water and the chloride permeability is high for treated waste water concrete compared to potable water concrete.

Key words: Treated waste water, Potable water, Compressive strength, Water absorption, Chloride penetration

INTRODUCTION

In the era of new developments and an age in increasing human population coupled with the need to curb expenditure in various sectors of the government budget, attention must be brought to the re-use of resources whenever possible. Practice of reuse involves processing used materials into as an reuse able products in order to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from land filling) by reducing the need for conventional waste disposal. Reuse is one of key component of modern waste management and is an effective method to be in cooperated towards waste water use. Keeping in mind about the amount water required for the purpose of

[*]Author for correspondence; E-mail: rao_pannem@vit.ac.in

constructional work, if potable water could be replaced by any form of water that is recycled that it would render not only decrease the expenditure but it would also prevent a wastage of huge amount of potable water since in this era of modern development there is a lot of scarcity of potable water would not benefit us economically but would benefit us environmentally as well.

A popular criterion as to the suitability of water for mixing concrete is the expression that if water is fit to drink it is suitable for making concrete. Some waters, which do not meet these criteria have been found to produce concretes of satisfactory quality so in order to determine the type of water, which can be used we have used the treated waste water which is available in VIT University and we have carried out tests to determine the amount of chlorides and sulphates in the treated waste water and the result in the strength property as well as durability due to the presence of chlorides and sulphates.

Currently, there are no special tests developed to determine the suitability of mixing water except comparative tests. Generally, comparative tests require that, if the quality of water is not known, the strength of the concrete made with water in question should be compared with the strength of concrete made with water of known suitability. Concrete mixes made with potable as well as treated waste water and performed compressive strength test, pH determination test, water absorption test, acid attack test, Rapid Chloride Penetration Test (RCPT), mortar test, durability test, hardness test, and determination of chlorides and sulphates test.

EXPERIMENTAL

Review of literature

Ghusain and Mohammad J. Terro[1] studied the suitability of using treated water. Their test was based on using preliminary treated waste water, secondary treated waste water as well as tertiary treated waste water obtained from the local waste water plant. The water used by them did not affect slump and density however setting time was found to be increased with deteriorating water quality. They reported that, concrete cube specimens were cast using tap water, primary treated waste water, secondary treated waste water and tertiary treated waste water obtained from a local waste water treatment plant. Saleh[2] studied the concrete durability is the function of its internal pore structure, porosity and the permeation properties. Chloride induced corrosion and Sulphate ions permeate through the concrete mass in solution to react with the hydration product of cement. He studied and focused on decreasing the permeability properties of concrete. He reported that, the chloride and sulphate attack are very important and should be taken in consideration for constructional purposes using treated waste water.

Bucea et al.[3], studied two aspects of concrete serviceability, and their subject was based on the sulphate attack and chloride ion penetration. Their study was based on the basic chemistry involved in each of these processes and their study outlined differentiated effects on concrete and reinforcing steel described due to the chlorides and sulphates. Their study reports the recent introduction of performance tests intended to provide a means of assessing the contribution to resistance to these chemical actions of various cementations binder options now available for inclusion in concrete. Thavamalar[4] studied the possibility of usage of treated waste water in concrete production, so that the shortage and cost using potable water can be greatly reduced and the waste water can be suitably disposed for safe guarding the environment. He used Grade 30 and Grade 35 concrete mix design using Ordinary Portland Cement using potable water and treated waste water produce from paper recycling factory (which is treated in a facultative pond) were tested to determine the mechanical properties of concrete.

Al-Amoudi[5] studied to evaluate the corrosion performance of reinforced prepared with plain cements and blended cements were being exposed to sulphate chloride environments. Their tests determined the use of treated waste water in the preparation of concrete. Hewayde et al.[6] studied the degradation of concrete sewer pipes by sulphuric acid attack, resulting in substantial economic losses each year. An attempt was made to determine whether there is a relationship between the effect of the various admixtures on mechanical strength and porosity and the resistance of concrete to H_2SO_4 attack. Its contribution to the resistance of concrete to chemical sulphuric acid was minor relationship could be established between the mechanical and physical properties of concrete (compressive strength and porosity) and its resistance to sulphuric acid attack.

Methodology

Determination of pH

Mostly acidic nature of the water is harmful for the concrete and may result in hindering the strength and durability properties of concrete whereas basic nature has got no such important role so in order to determine the nature of the water this test is specifically more important. pH determination test was conducted on both Potable Water (PW) and Treated Waste water (TWW). pH test was conducted on Treated Waste water (TWW) on the 7th, 14th and 28th also in order to see the change in the basic nature of the water during the given period of time. The values of potable water and treated waste water are 7.10, 7.29, 7.28 and 8.03, 8.02, 8.08, respectively at 7, 14 and 28 days,

Materials required

Cement: OPC 53[8] grade cement was used because it has high amount of tricalcium silicate (C_3S), which leads to high strength.

Aggregates: Coarse aggregates passing through 20 mm sieve and aggregates, which were retained in 12.5 mm sieve are being taken as the moulds, which are being used are of size 150 mm. Fine aggregates retained in 2.36 mm sieve are being used for the preparation of cubes.

Water: Potable water used for mixing and curing and treated waste water, which is available in VIT University.

Mixing, casting and curing

The M20 concrete mix was prepared and cast the cube specimens and the curing was done in potable water and treated waste water at 7, 14 and 28 days of curing, respectively.

Tests on hardened concrete

Compressive strength test

Compressive strength[7] is measured on a universal testing machine in order to determine the strength of the concrete and it plays a very important role to determine the strength difference in concrete cubes using potable water as well as treated waste water, which are calculated on 7th, 14th and 28th day, respectively. The results are shown in the Fig. 1

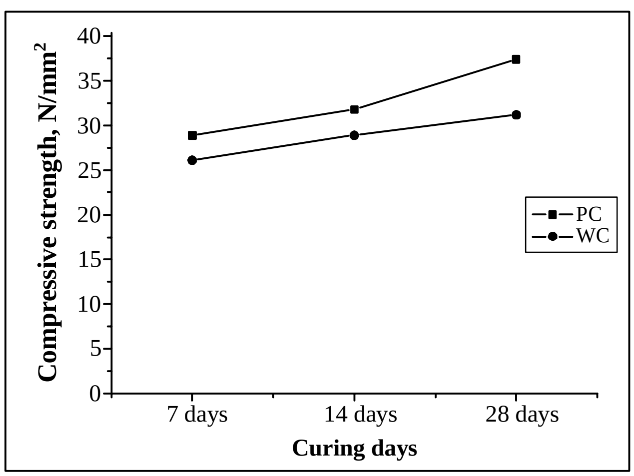

Fig. 1: Variation of Compressive strength with age

Water absorption test

As per IS : 2386 (part 3) water absorption test is done in order to determine the water absorbing capacity of the concrete. Our project deals with the concrete, which is made by using potable water as well as treated waste water and to find out the difference in the water absorbing capacity of the concrete. The water absorption values are shown in the Fig. 2

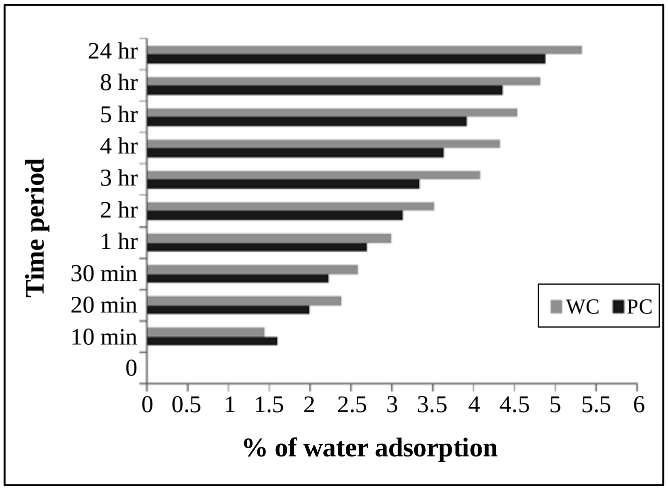

Fig. 2: Water absorption values of mixes with time period

From the above tests, it can be concluded that the water absorbing capacity for concrete cube containing potable water is 2.60 and for treated waste water is 2.596; hence there is no such difference in between two cubes and thus treated waste water is suitable for construction activities.

Rapid chloride permeability test

Rapid Chloride penetration test has been conducted as per ASTM C 1202[9] in determining the resistance of chlorine to chloride ions penetration. Since chloride ions can undergo pitting corrosion to the concrete surface and this pitting corrosion may also result in the corrosion of the steel reinforcements of the structure.

Calculation

The following formula, based on the trapezoidal rule can be used to calculate the average current flowing through one cell.

$$Q = 900\ (I_0 + 2I_{30} + 2I_{60} + 2I_{90} + 2I_{120} + \ldots + 2I_{300} + 2I_{330} + I_{360})$$

Where, Q = Current flowing through one cell (coulombs)

I_0 = Current reading in amperes immediately after voltage is applied, and

I_t = Current reading in amperes at t minutes after voltage is applied

Table 1: RCPT values (Charge passed in coulombs)

Mix	28 days	56 days
Potable mix	3406	3026
Waste water mix	4448	4120

Tests on water

Determination of sulphate ions

Determination of sulphate ions is done by taking 100 mL of the solution in Erlenmeyer flask and 20 mL of the buffer solution is added, which is being mixed in a stirring apparatus. While stirring a spoonful of $BaCl_2$crystals are being added, which is being stirred at a constant speed for 62 seconds. After stirring period is over the solution is poured into absorption cell of photometer having maximum transmittance near 420 nm and providing a light path of 2.5 to 10 cm and measure turbidity at 5 mins. For the preparation of the calibration curve estimated SO_4^{2-} concentration in sample is prepared by comparing turbidity reading with a calibration curve prepared by carrying SO_4^{2-} standards through entire procedure. Space standards at 5 mg/L increments in the 0 to 40 mg/L SO_4^{2-} range. Above 40 mg/L accuracy decreases and $BaSO_4$ suspension lose stability. For this reliability of calibration curve is to be checked for every 3 to 4 samples.

Table 2: Sulphate ions observation

Sample	Wave	% T	ABS	ppm
Treated waste water	420	3.47	1.460	1.460
	420	0.40	2.398	2.398
				Avg.: 1.929
Potable water	420	2.05	0.90	0.90
	420	0.32	1.43	1.43
				Avg.: 1.165

The concentration of sulphate ions in treated waste water is greater than the concentration of sulphate ions in potable water.

Determination of chlorides

Determination of chlorides is done by taking 20 mL of the treated waste water and diluting it to 100 mL. The burette is filled up with silver nitrate titrant. Add 2 to 3 drops of potassium chromate indicator to the sample. The blank solution is titrated with standard $AgNO_3$ (1.32 gms) until the end point comes from yellow to brick red. Two samples of treated waste water are to be calculated in order to get an exact idea of the chlorides in the sample solution. For the first trial 10 mL of treated waste water is being taken and for the second time 20 mL of the treated waste water is taken.

The amount of chlorides present in 10 mL and 20 mL treated waste water is more than the amount of chlorides present in 10 mL and 20 mL potable water and thus it can cause some sort of damage to the concrete in the long run

CONCLUSION

From compressive strength of concrete tests, it can be concluded that concrete containing treated waste water is having more compressive strength than concrete containing potable water and hence from this test it can be concluded that treated waste water is suitable for constructional activities without comprising strength of concrete.

From pH determination test, it can be concluded that treated waste water can be used for constructional purposes since it is slightly basic in nature and the water is in no way harmful for constructional activities.

The water absorption test for potable water as 2.60 and for treated waste water as 2.596 and hence there is a very small amount of difference in absorbing capacity in between potable water and treated waste water.

Rapid Chloride Penetration Test, it can be concluded that the charge passed in coulombs is less than 4000 so chloride permeability is moderate for potable water and in treated waste water charge passed in coulombs is more than 4000 so chloride permeability is high.

Sulphate ions concentration in treated waste water is greater than concentration of sulphate ions in potable water by a very small margin hence as far as sulphate ions are concerned treated waste water is suitable for the purpose.

The amount of chlorides present in 10 mL and 20 mL treated waste water is more than the amount of chlorides present in 10 mL and 20 mL potable water and thus it can cause some sort of damage to the concrete in the long run.

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