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INVESTIGATION ON STRENGTH OF CONCRETE MADE USING TREATED WASTEWATER

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ABSTRACT

This paper reviews application of treated wastewater in concrete preparation including its strength. The presence of water is an essential requirement for the development of high strength concrete. If water shortage occurs in future there is a need to look for alternate sources of water in alternate source of water in production of concrete. M25 grade of concrete was prepared and the specimens were casted accordingly to the mix design. Concrete casted by using tap water as mixing and curing for mix 1, similarly by using tap water as mixing and treated wastewater as curing for mix 2, and then casted by using treated wastewater as mixing and curing for mix 3 and mixing with treated wastewater and curing with tap water for mix 4. Compressive strength of concrete was checked for 7, 14 and 28 days. The use of treated wastewater for concrete mixing and curing was found favourable for strength development when compared with the mix 3 conventional method.

Keywords: Compressive Strength, Concrete, Treated Wastewater

INTRODUCTION

Concrete is a construction material composed of cement, fine aggregates (sand), and coarse aggregates mixed with water which hardens with time. Water is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water causes hardening of concrete through a process called hydration. The role of water is important because water to cement ratio is the most critical factor in the production of concrete. If water shortage occurs in future, there is a need to look alternative sources of water, as water is essential component in the production of concrete. One option is application of treated wastewater in the concrete production. The water used in production of concrete was checked for chemical properties because the water used in concrete should be free from impurities. Since, the presence of acidic and basic salts can affect the strength of concrete. So, before use of treated wastewater it has to be checked for presence of impurities. Hence, the aim is to study the strength of concrete prepared by using treated wastewater and tap water comparatively.

MATERIALS & METHODS

EXPERIMENITAL:

1.1 Materials

CEMENT: OPC53grade Ultratech cement used has specific gravity of 3.12 and normal consistency 33% confirming to the requirements of IS 12269:1987 specifications.

FINE AGGREGATE: River sand was used as fine aggregate and required laboratory tests are carried out. Fine aggregate passing through IS 4.75 mm sieve was used. The sand used had fineness modulus 3.237 and Water absorption of 1.93%.

COARSE AGGREGATE: The aggregate size used was 20mm to get maximum increase in the compressive strength. A sieve analysis test was carried out for coarse aggregate for 20mm and other laboratory test was also done as per IS: 2386-1963.

WATER: The treated sewage water was collected from Sathyabama Treatment Plant situated in the Sathyabama Institute of Science and Technology, Chennai. Tap water was also used in the project. Laboratory tests were carried out as per IS: 3025 to find out the chemical properties of water.

1.2 Methodology

The outlay for preparing concrete mix is given below (Fig.1).

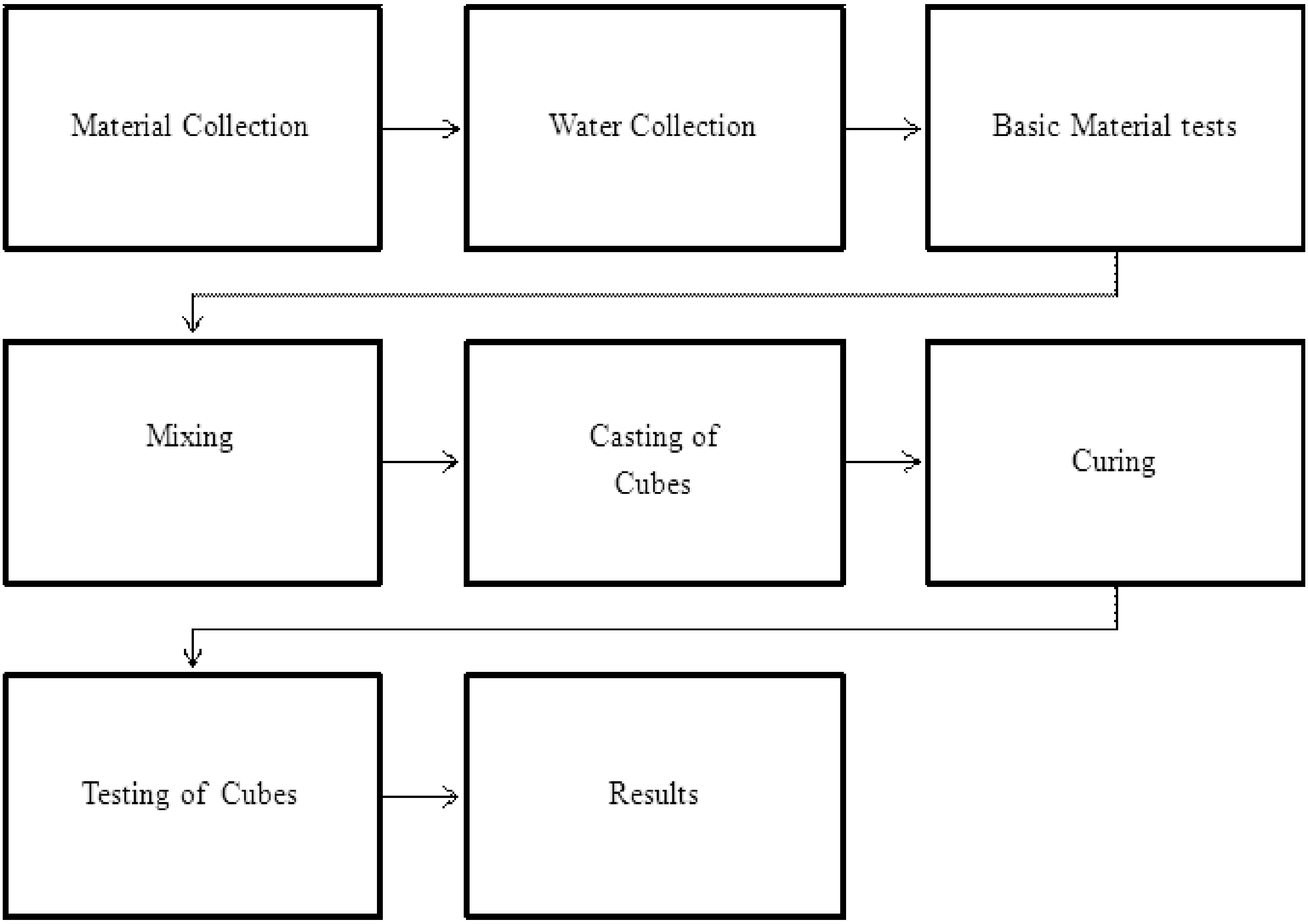

Table 1a. Tap Water Analysis

Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1.Quantity of 0.02N NaOH required to neutralize 100mL of water sample using phenolpthalein as an indicator	0.8mL	Shall not be more than 5mL
2.Quantity of 0.02N H2S04 required to neutralize 100mL of water sample using mixed indicator	16.7mL	Shall not be more than 25mL
3.Chlorides as Cl	715mg/L	500 mg/L max for RCC 2000 mg/L max for PCC
4.Sulphates	208 mg/L	400 mg/L max
5.Inorganic solids	1390 mg/L	3000 mg/L max
6.Suspended matter	1 mg/L	2000 mg/L max
7.Organic solids	120 mg/L	200 mg/L max
8. pH	8.05	Shall not be less than pH 6

Table 1b. Treated Wastewater Analysis

Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1.Quantity of 0.02N NaOH required to neutralize 100mL of water sample using phenolpthalein as an indicator	2.1mL	Shall not be more than 5mL
2.Quantity of 0.02N H2S04 required to neutralize 100mL of water sample using mixed indicator	20.4mL	Shall not be more than 25mL
3.Chlorides as Cl	1390 mg/L	500 mg/L max for RCC 2000 mg/L max for PCC
4.Sulphates	167 mg/L	400 mg/L max
5.Inorganic solids	2140 mg/L	3000 mg/L max
6.Suspended matter	2 mg/L	2000 mg/L max
7.Organic solids	150 mg/L	200 mg/L max
8.pH	7.88	Shall not be less than 6

1.3 Mix design: Mix design was carried out as per IS: 10262-2009 for M25 grade concrete.

1.4 Casting: Concrete were casted according to the mix proportion.

1.5 Curing: Curing was done by immersing the pecimens in curing ponds of laboratory tap water and treated domestic wastewater under regular supervision. For each of these above three mixes, three curing ages were selected i.e. 7days, 14days, & 28days and characteristics of two types of curing waters used are given in Table 1a and 1b.

RESULTS AND DISCUSSION

The chemical composition of wastewater is generally higher than the tap water but within the specified limits (Table 1a,b).

Table 2. Slump test

MIX	Trial -1 (in mm)	Trial -2 (in mm)	Average (in mm)
MIX 1	30	31	31
MIX 2	35	35	35

Table 3. Compressive Strength for 7 days curing

MIX	Trial -1 (N/MM^2)	Trial-2 (N/MM^2)	Trial-3 (N/MM^2)	Average (N/MM^2)
MIX 1	11.3	11.37	11.55	**11.40**
MIX2	9.7	10.4	10.2	**10.1**
MIX 3	11.7	13.11	12.4	**12.4**
MIX 4	11.5	10.6	11.2	**11.1**

MIX 1- Tap Water (Mixing + Curing)
MIX 2- Tap Water (Mixing) + Treated Sewage Water (Curing)
MIX 3-Treated Wastewater (Mixing + Curing)
MIX 4- Treated Sewage Water (Curing) + Tap Water (Mixing)

The higher concentration of chloride may affect the reinforced concrete structures but for plain cement concrete chloride content was within the limit. So, the treated wastewater can be used only for plain cement concrete structure. There was no significant difference in compressive strength of concrete after 28 days of curing (Table 2-5, Fig. 2). But, there was increased compressive strength in mix 2 (tap water mix + treated wastewater curing) when compared to mix 1 (conventional mix). Similarly, high split tensile strength in mix 2 compare to mix 1 (Table 6-8, Fig. 3). It may be concluded that the study should be extended to investigate the effects of wastewater on the durability of concrete.

Table 4. Compressive Strength for14days curing

MIX	Trial -1 (N/MM^2)	Trial-2 (N/MM^2)	Trial-3 (N/MM^2)	Average (N/MM^2)
MIX 1	26.67	31.11	28.54	**28.64**
MIX2	22.2	23.11	21.43	**22.24**
MIX 3	33.33	32.3	33.10	**32.91**
MIX 4	28.8	27	28.88	**28.22**

Table 5. Compressive Strength for 28days curing

MIX	Trial -1 (N/MM^2)	Trial-2 (N/MM^2)	Trial-3 (N/MM^2)	Average (N/MM^2)
MIX 1	40.44	40.4	39.54	**40.12**
MIX2	39.56	38	39.55	**39.03**
MIX 3	37.78	36.6	37.76	**37.38**
MIX 4	35.56	36.1	35.65	**35.77**

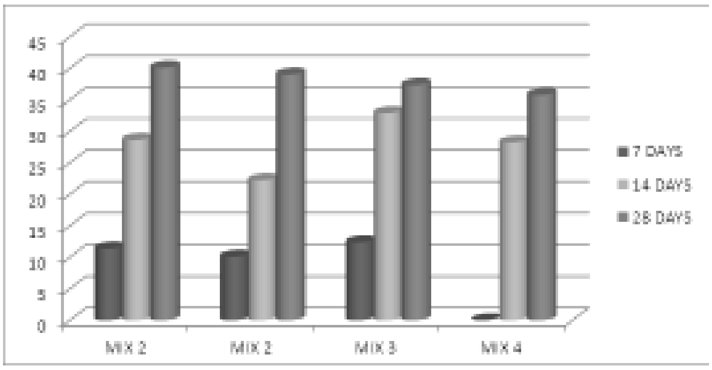

Fig.2. Graphical Representation of Compressive Strength

Table 6. Split tensile strength for 7 days

MIX	Trial -1 (N/MM^2)	Trial-2 (N/MM^2)	Trial-3 (N/MM^2)	Average (N/MM^2)
MIX1	3.14	2.98	3.06	**3.56**
MIX2	3.18	3.39	3.21	**3.26**
MIX3	3.11	3.04	3.16	**3.71**
MIX4	3.2	3.15	3.05	**3.13**

Table 7. Split tensile strength for 14days.

MIX	Trial -1 (N/MM^2)	Trial-2 (N/MM^2)	Trial-3 (N/MM^2)	Average (N/MM^2)
MIX1	4.24	4.17	4.05	4.15
MIX2	4.60	4.41	4.52	4.51
MIX3	4.26	4.3	4.12	4.22
MIX4	4.33	4.52	4.45	4.52

Table 8. Split tensile strength for 28 days

MIX	Trial -1 (N/MM^2)	Trial -2 (N/MM-)	Trial -3 (N/MM^2)	Average (N/MM^2)
MIX 1	3.9	3.4	3.4	**3.07**
MIX 2	2.8	2.4	2.78	**2.66**
MIX 3	3.5	3.45	3.2	**3.18**
MIX 4	2.8	2.9	2.8	**2.833**

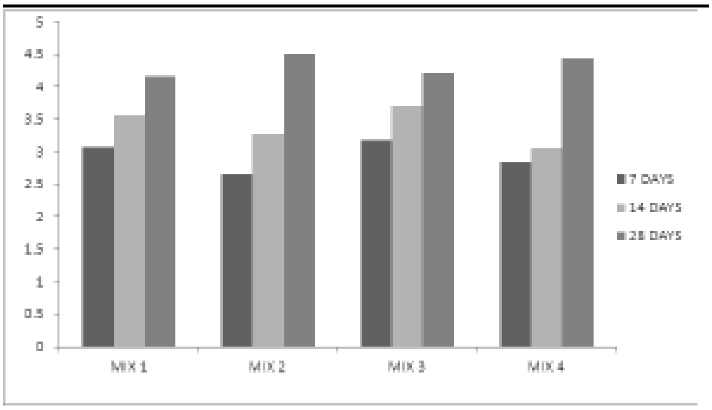

Fig. 3. Graphical representation of split tensile strength

Suggested Readings

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