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An Experimental Study on Effect of Pharmaceutical Industrial Waste Water on Compressive Strength of Concrete

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ABSTRACT: The scarcity of water is a critical environmental issue worldwide due to various natural and/or artificial causes. The construction industry has serious impact on environment with regard to consumption of water. Hence, there is need to search alternative to fresh water for mixing and curing of concrete. The aim of this paper is to check suitability of reusing waste water effluent from pharmaceutical industry in plain concrete production. The experimental work is carried out to evaluate the effect of partial replacement of mixing water by pharmaceutical industrial waste water on compressive strength of concrete for M40 grade of concrete. The percentage of waste water in total mixing water varies from 0 to 100% with an increment of 25%. The concrete cubes of standard size were cast and tested for 7, 28 and 90 days normal water curing period. Based on test results obtained, it seems that 25% pharmaceutical industry waste water blended with potable water could be used as mixing water in concrete without any adverse effects on compressive strength of concrete. Reuse of such mixed waste water results in reduction of fresh water consumption, disposal cost, environmental pollution and hazard without affecting strength requirements of concrete.

KEYWORDS: Compressive Strength, Dry Density, Pharmaceutical Waste Water.

I. INTRODUCTION

Increase in population, growing agriculture, urban industrial needs resulting into lowering of water table in every continent. Also due to global environmental changes, climate changes sources of fresh water are depleting. It is estimated that concrete industries in the world are consuming nearly about more than 1 billion tons of water for mixing in concrete annually. The concrete industry has therefore serious impact on environment with regard to consumption of water therefore, there is an urgent need to find alternative options of fresh water for mixing and curing of concrete.

In last few decades, there has been a tremendous increase in domestic and industrial waste water generation due to rapid growth of population and accelerated pace of industrialization. Almost 80% of water used for domestic purpose results into waste water. Particularly, treatment of industrial waste water is an important task as it may contain toxic impurities, soluble salts and other chemicals which can harm environment and human life directly or indirectly. The waste water generated from pharmaceutical industry can be mixed with fresh water and reused in various civil engineering activities related to concrete production and curing.

According to IS 456-2000[11] related to properties of mixing water used in concrete, waste water cannot be directly used as it is not suitable for hydration reaction. It has to be mixed with fresh mixing water in some proportion and checked its properties as per limitations specified and used as mixing water for concrete if found suitable. The effect of using waste water from pharmaceutical industry as a partial replacement of fresh mixing water on compressive strength of concrete is discussed with experimental results.

Various literatures have been referred to understand the present scenario of the use of waste water in concrete that helps in finding out scope for research in this area. The objectives of these experimentation can be formulated based on the remarks on literature reviewed. Ibrahim and Mohammad [6] reported the use of treated sewage in concrete. The pathogenic activity of the micro-organisms was reduced substantially after pH exceeded 12, due to the rapid saturation with the calcium hydroxide formed by cement hydration. Effect of quality of water on initial as well as final setting times was observed for different types of concretes made with various types of treated wastewater. The treated paper industry effluent was beneficially used for mixing in concrete [3]. Abdol and William [1] found no effect on concrete slump by using Ready Mixed Concrete (RMC) waste water. The retarding of setting time of cement and lowering of strength development in concrete was observed.

The setting time of cement and compressive strength of concrete were tested by mixing of waste water from sugar factory [5]. The setting time was found increased with an increase in percentage replacement of water by waste water. Also, the strength increased with an increase in curing period. Waste water from three car washing stations were used for testing the effect on the properties of high strength concrete [2]. It was observed that there was no significant difference in the compressive strength of concrete among the different mixes after 28 days of curing. The treated domestic waste water was used for mixing and curing of concrete [17]. A minimal change in compressive strength was observed after 7 days, 14 days and 28 days.

The effect of chemical impurities in mixing water on different properties of concrete using potable, groundwater and sewage water was studied [13]. An increase of 33.34% in compressive strength of potable water concrete was observed when compared with concrete made using sewage water. With increase in pH value of water, the strength of concrete reduced substantially. The reuse of treated wastewater effluent in place of potable water in plain concrete production was studied [16]. The compressive strength result obtained from treated effluent showed an increase in 8.26 % for 28 days compared to fresh water. For garage water an increase in 5.14% was observed compared to fresh water.

The influence of ash produced from incinerated hospital wastes used as partial substitute for Portland cement on mechanical properties and durability of high-performance concrete (HPC) was critically studied [15]. The results at 10% replacement were found positive and the ash could be suitable for formulation of HPC.

The use of waste water sludge in concrete mix resulted in no significant strength loss but the density of sludge concrete was found decreased when used treated water instead of tap water [14]. It was observed that the sources of water used in mixing concrete have a significant impact on the compressive strength of the resulting concrete and regardless of the mixing water sources; the compressive strength of concrete increases with increase in curing age [4].

II. EXPERIMENTAL WORK

The effect of using mixing water with partial replacement of pharmaceutical waste water is studied by keeping all other parameters constant with only varying percentage of waste water in mixing water on compressive strength of concrete.

MATERIALS

The ingredients of concrete i.e., cement, fine aggregate, coarse aggregate were tested for their physical properties. Testing of cement in accordance with IS 12269:1987[8] and coarse and fine aggregate in accordance with IS 2386:1963[9] was done. The properties of cement, coarse aggregate, and fine aggregate were found satisfactory in accordance with limits specified in IS 383:1970[10], hence found suitable for use in experimental work.

PHARMACEUTICAL WASTE WATER

The waste water used for mixing in concrete was obtained from Emcure Pharmaceuticals Company's treated waste water located at Kurkumbh, Tal. Daund, Dist. Pune (Maharashtra, India). The various tests such as colour, pH, suspended solids, oil and grease, T.D.S., B.O.D. and C.O.D on waste water had been performed to check the properties and to compare the results with the standard specifications (Table 1).

Table 1. Properties of Pharmaceutical Waste Water

Sr. No.	Test	Result	Specification
1	Colour	Clear colourless liquid	Clear colourless liquid
2	pH	7.8	Between 5.5 to 9.0
3	Suspended Solids	10 mg/lit	Below 100 mg/lit
4	Oil and Grease	0.5 mg/lit	Below 10 mg/lit
5	TDS	610mg/lit	Below 2000 mg/lit
6	BOD	21 mg/lit	Below 100 mg/lit
7	COD	78 mg/lit	Below 250 mg/lit

This treated waste water was then mixed with potable water to form new mixing water with range from 0 to 100% with an increment of 25 % to study its effect on compressive strength of concrete. The properties of this water are tabulated in Table 2.

Table 2. Chemical Properties of Pharmaceutical Wastewater and Potable Water

Parameters	Potable Water	Varying percentages of waste water			
		25%	50%	75%	100%
pH	7.11	7.23	7.35	7.53	7.61
TDS (mg/lit)	1652	1785.00	1799.00	1839.00	1853.00
Chlorides(mg/lit)	99	101.00	125.00	130.00	139.00
Sulphate(mg/lit)	103	111.00	126.00	130.00	132.00

The IS 10262:2009 (Method of mix proportioning) was used for mix proportioning of concrete. The standard concrete of M40 grade was prepared for comparing the results. The quantities of ingredients and mix proportions as per mix design were obtained as follows:
Water: Cement: F.A.: C.A. = 0.4: 1: 1.65: 2.965

The mixing of waste water in potable water for concrete preparation was done using various proportions. The cube specimens of 150 × 150 × 150 mm size were used to determine the compressive strength. After curing, these cubes were tested on compressive testing machine as per I.S. 516-1959[12], after 7 days, 28 days and 90 days. The failure load was noted and recorded for each percentage of cube specimens. The compressive strength was calculated for each cube specimen.

III.RESULTS AND DISCUSSION

COMPRESSIVE STRENGTH TEST

The results of compressive strength of concrete with respect to variation of percentage of waste water after 7 days, 28 days, and 90 days are presented in Table 3. Various IS codes have been used for design and testing of concrete specimen (7,8,9,10,11,12).

Table 3. Results of Compressive Strength Test of Concrete

Sr. No.	Waste water (%)	Average Compressive Strength (f_c) (N/mm ²)		
		7 days	28 days	90 days
1	0	25.78	39.16	41.82
2	25	26.40	39.31	41.16
3	50	25.12	38.06	40.34
4	75	24.67	38.04	40.68
5	100	24.71	37.89	40.11



The compressive strength increases with minor amount with increment in partial replacement of pharmaceutical waste water in normal mixing water after 28 days curing up to 25% and then decreases with small amount. In long term strength this variation with respect to normal concrete is not significant up to 25% replacement but slightly decreases after wards. This variation is presented in the form of graph (Fig. 1).

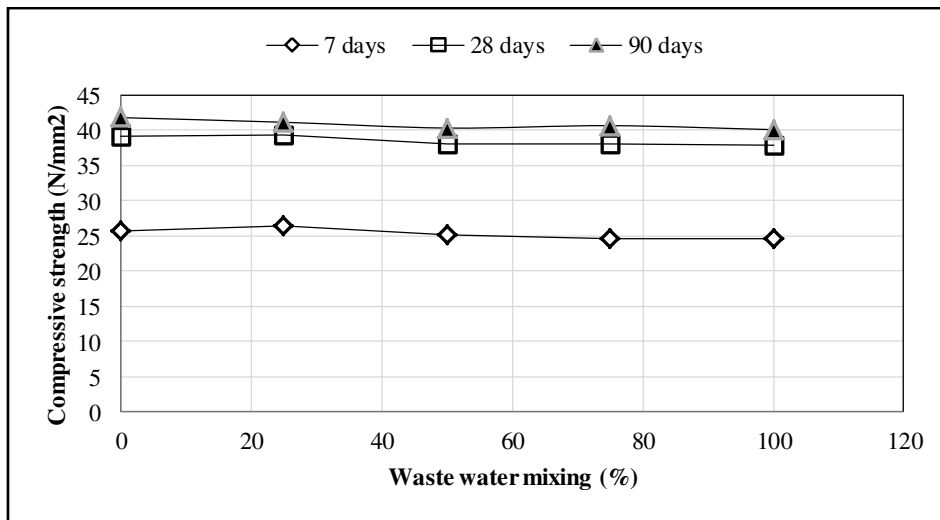


Fig. 1. Compressive strength variation for various mix proportions

DRY DENSITY OF CONCRETE

The density of concrete is a measure of solidity and microstructure of concrete. The density is obtained by measuring the mass and volume of cube respectively. The details of densities of concrete cube with varying percentage of waste water are shown in Table 4.

Table 4. Dry Densities of Concrete with Varying Waste Water Content

Sr. No.	Waste Water (%)	Dry Density (kg/m ³) After 28 Days	% Variation in Dry Density
1	0	2580	0
2	25	2586	0.232
3	50	2532	-1.860
4	75	2517	-2.442
5	100	2511	-2.674

IV. CONCLUSIONS

The following conclusions are drawn based on experimentation on partial replacement of potable water by treated pharmaceutical waste water in mixing of concrete:

1. Treated Pharmaceutical waste water is feasible solution for concrete production in both economic and environmental aspects.
2. Increase in compressive strength of concrete for 25% wastewater blended with potable water by 2.15% for 7 days and 0.20% for 28 days and for 90 days reduced by 1.98%.
3. The dry density of concrete continuously decreases with increasing the blending percentage of waste water with potable water except only for 25% proportion.
4. Due to use of waste water in concrete, potable water can be saved to a certain quantity. This can give an alternate solution for mixing water for concreting in arid zone and during summer season with proper reuse of treated pharmaceutical waste water.



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