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Reuse of Treated Domestic Waste Water in Concrete - A Sustainable Approach

KEYWORDS: Primary Treated Waste Water (PTWW), Secondary Treated Waste Water (STWW), Gray Water (GW), Tap Water (TW), Compressive strength, Tensile strength.

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ABSTRACT *With current water crises in India there is need to look for alternative sources of water. India discharges Treated Waste Water (TWW) in natural water bodies, which can be used in construction industry. Water samples used were Primary Treated Waste Water (PTWW), Secondary Treated Waste Water (STWW), Grey Water (GW) and Tap Water (TW). Parameters of water were tested which was found well as per IS 456-2000 limits. Using TWW tests were conducted on cement, fresh and harden concrete. Initial and final setting time for STWW was same as TW but not for PTWW and GW. For compressive strength, concrete cubes for 3, 7, 28 and 60 days and Cement mortar cubes for 7 and 28 days were casted. For tensile strength cylinders and for flexural strength beams were casted for 28 days.*

Hence results for PTWW, STWW, GW and TW suggested STWW is appropriate for using in construction industry.

INTRODUCTION

In construction industry concrete being most widely construction material used, uses most of water. About 5 billion cubic yards of concrete are used each year; annual production is about two tons per person on the plane. As per provision of IS10262-2009 186 liters water is required for $1m^3$ of concrete. On an average 150 liters water is required for $1m^3$ of concrete. The construction of 100,000 sq. ft. multi-storey structure can require about 10 million liters water for production, curing and site development activity. A double lane flyover can consume 70 million liters water on the same scale. Also in construction industry water is used for mixing, aggregate washing, curing of concrete and for washing concrete related mechanical machines. . The mixing of water which is fit for drinking purpose is fit for concreting.

But about 97 percent of water is held in the oceans, while only 3 percent is fresh water. Of the freshwater, only 1 percent is easily accessible as ground or surface water, the remains are stored in glaciers and icecaps. Moreover, freshwater is not evenly distributed across land surfaces, and there are a number of heavily populated countries located in arid lands where fresh water is scarce.

Hence, the ultimate and last option will be treating the waste water and using it. But the humans have not accepted or will never accept the treated waste water for drinking purpose. So we can use this treated waste water in the construction industry where the large amount of share of water is used and save the freshwater. This paper explains how treated waste water can be used in construction industry and reduces the load on nature.

The impurities present in the waste water can affect the properties of the concrete when used for mixing in concrete. Also the impurities may not affect all properties of concrete but some. The water samples PTWW and STWW were collected from Mundhwa treatment plant, Pune, India. And GW was collected from Simply City, Hadapsar, Pune, India. The waste water was tested in the laboratory of JSPM's Imperial college of Engineering and Research, Pune, India which was found to be as per the IS standards.

So if we can use the treated waste water for above purposes in construction industry, we can save a lot of freshwater and try to spread awareness and importance of water.

MATERIALS AND METHODOLOGY

An experimental investigation was carried out to evaluate the feasibility of treated waste water in concrete. We had performed various experiments on cement, fresh concrete and harden concrete.

Cement, fly ash, fine aggregate, coarse aggregate, PTWW, STWW, GW and TW were used under guideline of IS standards.

Treatment and characteristics of waste water

Primary treated water is the sewage water from which removal of constituents like as racks, sticks, floatable grit and grease. Secondary treated waste water is the primary treated waste water from which removal of suspended solid, organic matter and biodegradable organic waste. Grey water is refers to the wastewater generated from bathrooms, kitchens, washing place and wash basins, etc. Composition of this waste does not involve higher concentration of organic matter and it is less polluted water as compared to sewage.

Table 1:-Characteristics of PTWW, STWW, GW, NW

Sr. No.	Parameters	Units	IS Guidelines	PTWW	STWW	GW
1.	pH		Not less than 6	6.28	6.41	6.18
2.	TSS	ppm	2000	350	<10	280
3.	Hardness	ppm	-	52	35	12
4.	BOD	ppm	-	50	<10	35
5.	COD	ppm	-	150	<100	133
6.	Oil & Grease	ppm	-	13	<5	8

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Experimental work:

Consistency of cement, initial and final setting time of cement

Consistency of cement paste was found out by vi-cat apparatus. The procedure used to perform this experiment is followed by IS 4031 (part 4)1988. After finding the consistency of cement paste, initial and final setting time of cement paste was found.

Compressive strength of cement

Compressive strength of cement was obtained by preparing the mortar cube for the curing of 7 and 28 days. The proportion of material for mortar mixture was one part of ordinary Portland cement to the three parts of standard sand. The water cement ratio was 0.4. The dimensions of mortar cubes were 70.7*70.7*70.7mm. The water used for casting was PTWW, STWW, GW and TW. The mortar was mixed according to IS 4031-1988.

Compressive strength of concrete

The M30 grade of concrete has been designed for preparing the concrete cubes as per IS 10262:2009. The mix proportion of concrete cube was 1:2.35:3.75:0.42 (cement: fine aggregate: coarse aggregate: fly ash) and the water cement ratio was 0.45. The cubes were casted by each type of water. The dimensions of cubes were 150*150*150mm. The concrete cubes were tested after 3 days, 7 days, 28 days and 60 days of curing. The test was performed according to IS 516 -1959 under compressive testing machine.

Tensile strength of concrete

Cylinders were casted for 28 days by M30 grade of concrete. The cylinders were 150 dia. * 300mm.The cylinders were casted by mixing each types of water and tested under compressive testing machine according to IS standard.

Flexural strength of concrete

The beams were casted for 28 days of curing to check the flexural strength of concrete. The dimensions of beams were 150*150*700mm. beams were casted by using PTWW, STWW, GW and TW. The beam were tested under universal testing machine as per guideline of IS: 516-1959; (Method of test for strength of concrete) and IS: 9399-1979(Specification for flexure testing of concrete).

RESULT AND DISSCUSION

The experimental investigation shows the following results

Treated waste water

The result for water analysis provided in table no1. An experimental investigation shows that there was significant difference in analyzed parameters i.e. pH, Alkalinity, Hardness, TSS etc. The pH of PTWW, STWW, GW and TW is above 6 and the TSS of PTWW, STWW, GW and TW is less than 2000 mg/l which is within given limits in IS 456: 2000. BOD and COD of PTWW, STWW, GW and TW are within the desirable limit.

Consistency of cement paste

As the quality of mixing water deteriorates it affects consistency of cement. The consistency of cement paste using STWW increases by 1.785% as compared to TW. The consistency of cement paste using PTWW and GW is more than STWW. As per IS guidelines consistency of cement is 24 – 30 % of cement. So the results obtained are within permissible limits.

Initial and Final setting time of cement

As the salt present in water it affects the time of setting and the dissolved organic matter retards the time of setting. The initial setting time of cement paste is increased by 5.88% for STWW as compared to TW. The initial setting time of cement paste for PTWW and GW is more than STWW. As per recommendation of IS standards the initial setting time should not be less than ±30 min and final setting time should be less than 600 min given in IS 456 : 2000. The initial and final setting time of cement paste is as per guidelines recommended by IS 456: 2000

Compressive strength of mortar cubes

The effect of mixing water in mortar is shown in the figure 2.

Compressive strength of mortar cube by mixing STWW for 7 days is near about same as TW. Compressive strength of mortar cube prepared with STWW shows improvement in the strength by 7.76% as compared to TW for 28 days. The mortar cubes prepared with PTWW and GW shows decreasing results as compared with TW. The result suggested that the organic content present in STWW may be acting as a dispersing agent, improving the dispersion of particles and reducing clumping.

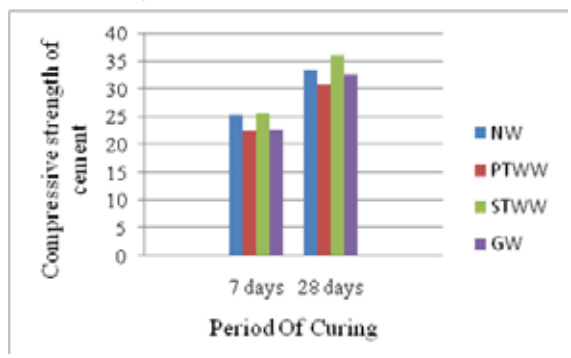

Figure No. 1

Workability of concrete

For PTWW, STWW, GW and TW the slump value varied between 90 – 100 mm.

Slump of concrete is not affected by adding PTWW, STWW, GW compared to TW.

Compressive strength of concrete

Figure2. shows the effect of mixing waste water in concrete on compressive strength of concrete for 3 days, 7 days, 28 days and 60 days. The compressive strength of concrete is increased by 2.37% for STWW at end of 60 days as compared to TW. The strength gained is slower but at the end of 60 days it is more than TW. PTWW contains more algae content and thus reduce the strength of concrete.

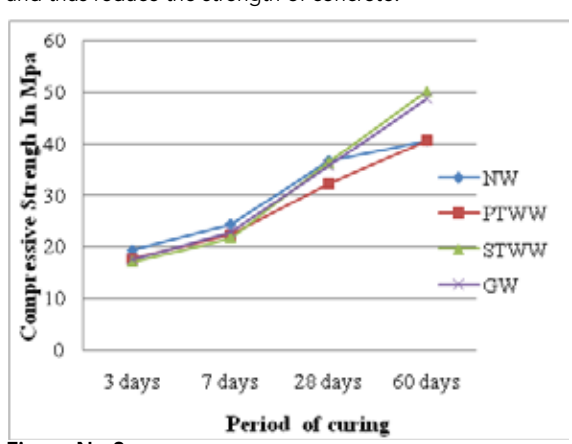

Figure No.2

Split tensile strength and flexural strength of concrete

The tensile strength of concrete by mixing PTWW, STWW and GW was not affected. The flexural strength of concrete is increased by 4.32% by mixing STWW as compared to TW.

CONCLUSION:-

From this experimental investigation we conclude that

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- STWW contains less impurities and is fit as per IS provision.
- The consistency, initial and final setting time of cement paste by mixing STWW is within the IS limit.
- The compressive strength of mortar is increased by mixing STWW at the end of 28 days.
- The compressive strength of concrete is increased by mixing STWW at the end of 60 days.
- There is no any significant difference in tensile strength and flexural strength is improved by using STWW.

Future scope

Future work to be performed will include the intensive laboratory experiments.

- The reinforcement should be provided with different cover of concrete.
- The preparation of concrete for different grades concrete like M40, M45, M50 etc. for more accurate results.
- The concrete preparation by adding different admixtures so that effect of admixtures on the properties of concrete can be determined.

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