Use of Treated Waste Water for Concrete Mixing

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Abstract— This work deals with the effect of different type of treated waste water on properties of strength of concrete such as compressive strength, tensile strength & flexural strength with respect to potable water. The waste water sample was collected from waste water treatment plant near Pimpri Chinchwad, Pune. Water samples were used as Primary Treated Waste water (PTWW), Secondary Treated Waste Water (STWW), Domestic Waste Water, Portable Waste Water (PWW) was analyzed for chemical properties in laboratory. In that the used of concrete mix as M30 and the potable water is fully replaced with the PTWW, STWW, Domestic Waste Water and Portable Water tests were carried out initial and final setting time, compressive strength, tensile and flexural strength compared with mix of M30 of potable water. The results indicate that the initial and final setting time was same as that of potable water and STWW but not for PTWW was be decreases and for the compressive strength will be increased in STWW and domestic water at long duration, for tensile and flexural strength will be same, there is no any improvement in Tensile and flexural strength by using STWW.

Key words: Domestic Water, Potable Water, PTWW, STWW

I. 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-stores 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.

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 I was use this treated waste water in the construction industry where the large amount of share of water was used and save the freshwater. In this topic explains how treated waste water can be used in construction industry and reduces the load on nature.

Water is the basic need of all living beings rather than air, food and shelter. Without water man cannot survive. In early days, water was primarily used for domestic needs like drinking, washing, bathing and cooking etc. But due to modernization, water is also required for industrial, construction purpose and ornamental and sewerage purposes along with domestic needs. It is also required for parks, gardens, swimming pools etc. Water is also required for fire protection. Now a day, well designed and organized public water supply schemes are absolutely necessary to cater for various water requirements. Enormous quantity of water required for future industries and construction purpose is required to be taken into account for use of treated waste water.

The main source of water is rainfall. When the rain falls from clouds, it dissolves various impurities like gases and minute suspended particles present in the atmosphere. Rain water collects dust and other impurities present on the surface of the earth. Some part of rainfall evaporates and some part percolates in the earth, dissolving various soluble matters in it and ultimately joins the underground water raising its level. The balance amount of rainfall left after evaporation and percolation, floes over the surface of earth and joins nallas, streams and rivers. This flowing water is called as runoff or surface flow. It is improve as it collects lot of matter laying on surface of earth during its flow. Also surface water contains wastes discharged by various industries. Sometimes untreated sewages are also discharged in such flowing water, causing its pollution.

Hence, water, either from surface or from underground source, is not suitable for drinking due to various impurities present in it. Also water may contain pathogenic bacteria leading to water borne diseases like cholera, dysentery and typhoid etc. therefore, it is necessary to treat such water and make it fit for various purpose. Water is treated in treatment units (all called as water works) which require proper design and maintenance. These treatment units reduce impurities up to acceptable standards.

II. LITERATURE REVIEW

Water is life blood of the environment, without water no living being survive. Water plays unique role in development of all sectors in any economy of every country. Water is used for agricultural, domestic, industrial, power generation and other various purposes. There are various sources of non-fresh water including sea and alkali waters, mine and mineral waters, waters containing sewage and industrial wastes, wastewater produced from ready-mixed concrete plants, and solutions of common salt were previously tested for use in concrete mixtures. It is difficult to draw a common conclusion regarding the use of these waters in concrete mixtures since impurities that exist in each water type are different. However, the general consensus is that there is a reduction in the ultimate strength of concrete when impure water is used. But with proper mix design (such as use of more cement and use of cementitious materials and admixtures) and by using some acceptable tolerance limits, it is possible to use impure water in concrete mixing and curing.

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III. METHODOLOGY

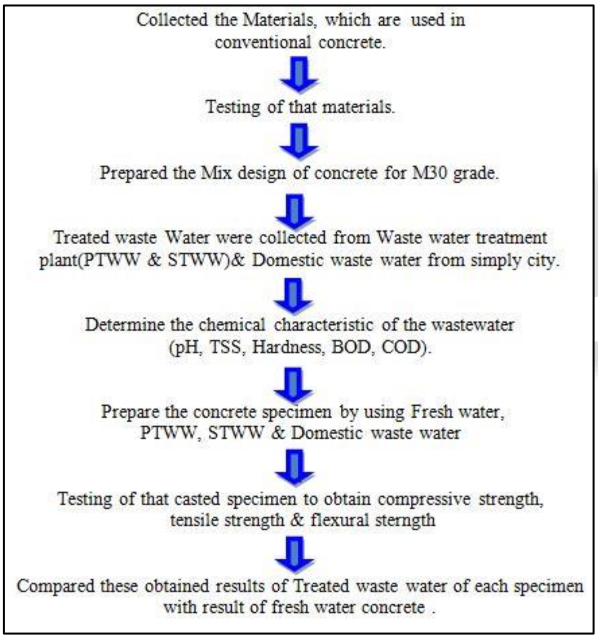


Fig. 1: Flow chart

Methodology of the work gives us a brief idea about the consideration and terminology made in this work and how exactly work will be carried out. [05]

IV. RESULTS & ANALYSIS

A. Treated waste water:

The result for water analysis provided, an experimental Investigation shows that there was significant difference in analyzed parameters i.e. pH, Alkalinity, Hardness, TSS etc

Sr No	Parameters	Units	BIS	WHO	GOI	PTWW	STWW	Domestic waste water
1.	pH		6.5-8.5	7-8.5	7-8.5	6.28	6.41	6.18
2.	TSS	mg/L	100			350	<10	280
3.	Hardness	mg/L	300	100	200	52	35	12
4.	BOD	mg/L	20	-	-	50	<10	35
5.	COD	mg/L	250	-	-	150	<100	133

Table 1: Laboratory tests on waste water

1) *Discussion of results:*
   1) The pH of PTWW, STWW, Domestic water and Portable water is above 6.
   2) The TSS of PTWW, Domestic water was more but for STWW was less than 100mg/l which is within given limits as per BIS.
   3) BOD and COD of PTWW, STWW, and Domestic water are within the desirable limit.

B. Consistency of Cement Paste:

As the quality of mixing water deteriorates it affects consistency of cement.

1) The consistency of cement paste using STWW increases by 1.69% as compared to potable water.
2) The consistency of cement paste using PTWW and Domestic water is more than STWW.
3) As per IS guidelines consistency of cement is 24–30 % of cement. So the results obtained are within permissible limits.

C. 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.

Sr No	Parameters	Units	BIS	Tap Water	PTWW	STWW	Domestic waste water
1.	Initial	Mm	< 30	45	53.88	47.64	50.23
2.	Final	Mm	>600	242	287	298	266

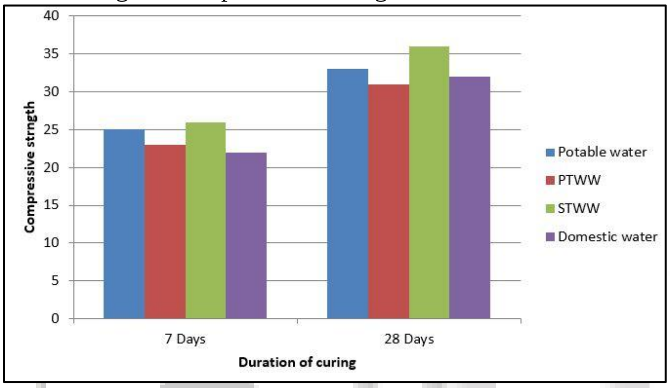
Table 2: Initial and final setting time

1) *Discussion of results:*
1) The initial setting time of cement paste is increased by 5.88% for STWW as compared to potable water.
2) The initial setting time of cement paste for PTWW and Domestic water is more than STWW.
3) 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.
4) The initial and final setting time of cement paste is as per guidelines recommended by IS456:2000 Quantity of cement sample taken for test (W1) gm.-400 gm.

D. Compressive strength of mortar cubes:

The compression test of the concrete cube was taken on compression testing machine.

Fig. 2: Compression testing of cement cube



Graph 1: Compression strength of cement

1) Discussion on results:

Compressive strength of mortar cube by mixing STWW for 7 days is near about same as Potable water.

Compressive strength of mortar cube prepared with STWW shows improvement in the strength by 7.7% as compared to Potable water for 28 days.

The mortar cubes prepared with PTWW and Domestic water shows decreasing results as compared with potable water.

The result suggested that the organic content present in STWW may be acting as a dispersing agent, improving the dispersion of particles.

E. Workability of Concrete:

For PTWW, STWW, Potable water and Domestic water the slump value varied between 90 – 100 mm. Slump of concrete is not affected by adding PTWW, STWW, Domestic water compared to Potable water.

Type of water	Tap Water	PTWW	STWW	Domestic waste water
Value in mm	130	90	100	97

Table 3: Workability of concrete

F. Compressive strength of concrete:

The effect of mixing waste water in concrete on compressive strength of concrete for 3 days, 7 days, 28 days and 60 days. Procedure for making the concrete cube as per the IS guideline:

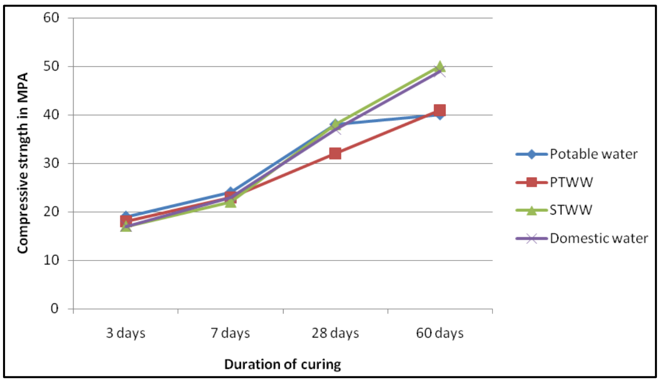
1) Calculate the materials required for preparing the concrete of given proportions.
2) Mix them thoroughly in mechanical mixer until uniform color of concrete is obtained.
3) Four concrete in the oiled with medium viscosity oil. Fill concrete in cube moulds in two layers each of approximately 75 mm and ramming each layer with 35 blows evenly distributed over the surface of layer.
4) Fill the moulds in 2 layers each of approximately 75 mm deep and ramming each layer.
5) Struck off concrete flush with the top of the moulds.
6) Immediately after being made, they should be covered with wet mats.
7) Specimens are removed from the moulds after 24 Hrs and cured in water 28 days.
8) After 24 hrs of casting, cylinder specimens are capped by neat cement paste 35 percent water content on capping apparatus. After another 24 hours the specimens are immersed into water for final curing.
9) Compression tests of cube and cylinder specimens are made as soon as practicable after removal from curing pit. Test – specimens during the period of their removal from the curing pit and till testing are kept moist by a wet blanket covering and tested in a moist condition.
10) Place the specimen centrally on the location marks of the compression testing machine and loads applied continuously, uniformly and without shock.
11) Also note the type of failure and appearance of cracks.

1) Calculation:

Compressive strength= Max. Load Applied to the Specimen / (N/mm^2) Cross-Sectional Area of Specimen.

Fig. 3: Compressive strength test of concrete

Fig. 4: Compressive strength test of concrete



Graph 2: Compression strength of concrete

2) Discussion on results:

1) The compressive strength of concrete is increased by 2 % for STWW at end of 60 days as compared to Potable water.
2) The strength gained is slower but at the end of 60days it is more than potable water.
3) PTWW contains more algae content and thus reduce the strength of concrete.

G. Splitting tensile strength:

Splitting tensile strength tests were performed on cylindrical specimen. Three samples per batch were tested with the average strength values reported in table.

1) Cylindrical specimen tested immediately on removal from the water while they are still in weight.
2) Surface water and grit then with wiped off the specimen and any projecting fine remove from the surface which are to be in contact with the packing strips.
3) Central line drowns on the two opposite face of the cylinder to ensure that they are in the same axial plane.
4) The test specimen placed in the machine so that the specimen is located centrally.
5) It is ensure that the upper platen is parallel with the lower platen.
6) The load applied without shock and increase continuously until failure.
7) The maximum load applied on the cylinder specimen then recorded.
8) The appearance on broken surface of a concrete observed if any unusual features in the type of failure then noted.

The measured splitting tensile strength fc, of the specimen shall be calculated to the nearest 0.05 N/mm2 using the following formula:

$$f_{ct}=2P/\pi ld$$

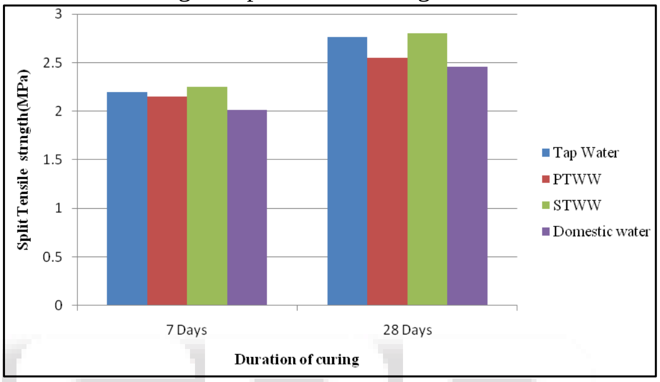
Where,

P = maximum load in Newton's applied to the specimen,

I = length of the specimen and

d = cross sectional dimension of the specimen


Fig. 5: Spilt tensile strength test



Graph 3: Spilt Tensile strength

1) Discussion on results:

1) The spilt tensile strength of concrete by mixing PTWW, STWW and Domestic water was not affected.
2) The strength of STWW was slightly increased compared to Portable water.
3) The strength of PTWW and Domestic waste water is also normally increased.

H. Flexural strength:

Flexural strength tests were performed on flexural testing machine having 100KN capacity using beam specimen. Three samples per batch were tested with the average strength values reported in table.

1) The specimen stored in water tested immediately on removal from the water they are in wet condition.
2) The bearing surface of the supporting and loading rollers then wiped clean and any loose sand or other material removed from the surface of the specimen where they are to make contact with the roller.
3) The specimen placed in the machine in the manner that the load applied to the uppermost surface as cast in the mould, along two lines spaced 20 cm apart.
4) The axis of the specimen then carefully aligned with the axis of loading device.
5) The load applied without shock and increasing continuously.
6) The load to be increase until the specimen fails and the maximum load applied to the specimen during the test to be noted.

7) If any unusual features appearance of the fractured face observed in the type of the failure are recorded.

The flexural strength of the specimen shall be expressed as the modulus of rupture *f*b, which, if '*a*' equals the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen, in cm, shall be calculated to the nearest 0.5 kg/sq cm as follows:

$$Fb = pl/bd^2$$

when '*a*' is greater than 20.0 cm for 15.0 cm specimen, or greater than 13.3 cm for 10.0 cm specimen, or

$$fb = 3pa/bd^2$$

When '*a*' is less than 20.0 cm but greater than 17.0 cm for 15.0 cm specimen or less than 13.3 cm but greater than 11.0 cm for a 10.0 cm specimen

b = measured width in cm of the specimen,

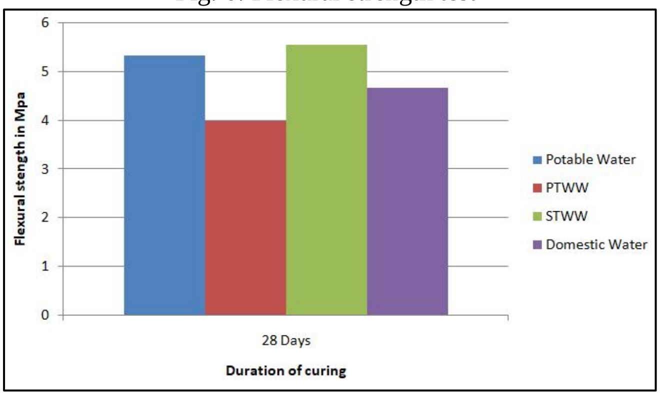
d = measured depth in cm of the specimen at the point of failure,

l = length in cm of the span on which the specimen was supported, and

p = maximum load in kg applied to the specimen.

If '*a*' is less than 17.0 cm for a 15.0 cm specimen, or less than 11.0 cm for a 10.0 cm specimen, the results of the test shall be discarded.

Fig. 6: Flexural strength test



Graph 4: Flexural strength of concrete

1) Discussion on results:

1) The PTWW was giving the less strength as compared with portable water as 4.0 N/mm^2.
2) The flexural strength of concrete is increased by 4.4 % by mixing STWW as compared to potable water given as 5.56 N/mm^2.
3) The Domestic waste water giving the better results as compared to PTWW.

I. Flexural strength test for reinforce concrete beam:

As per the IS guide line we used the reinforcement of 4 Nos of 8 mm dia and 6 mm bar of 150 mm c/c spacing in beam of size 150mm x 150 mm x 1000 mm and cured for 28 days.

Sr. No.	Water	Specimen Size (mm)	Strength at 28 Days N/mm^2
1	Portable water	150 x 150 x 1000	13.28
2	PTWW	150 x 150 x 1000	12.48
3	STWW	150 x 150 x 1000	13.23
4	Domestic waste water	150 x 150 x 1000	12.62

Table 4: Flexural strength test for Reinforced concrete

Fig. 7: Casting of reinforced beam

1) Discussion on results:

1) From the above results the STWW given less strength compare to the portable water.
2) The PTWW shown the slightly less strength compare to the Domestic waste water.
3) The as per the above results the reinforcement carrying a better result than the plane concrete but not suitable because need to study on corrosion of reinforcement.

V. CONCLUSION

From this work we conclude that 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 concrete is increased by mixing STWW at the end of 28 days. The compressive strength of concrete is increased with 2% 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.

There is no much more difference in the reinforced concrete beam but need to study the corrosion of reinforcement.

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