POSSIBLE OUTCOMES OF REPLACING POTABLE WATER WITH SECONDARY TREATED WASTE WATER IN CONCRETE

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***Abstract* —** Water. The word itself sends chills down the spine. Such is the situation today. Almost all over the globe all kind of living beings are facing water scarcity. But clause 5.4 of IS 456 – 2000 states that "potable water is satisfactory for mixing and curing of concrete". This work tries to deviate from this norm and secondary treated waste water (STWW) was used instead of potable water in production of M20 grade concrete both for mixing and curing to study the effects. All the necessary preliminary tests on STWW were conducted and found that all properties were well within the BIS limits. Further compressive strength tests and splitting tensile strength tests were conducted and results were on par with the results of control concrete. Cost analysis was also done and STWW was found to be cheaper than potable water. It was inferred that STWW can be used instead of potable water in production of concrete.

Keywords* — *Secondary Treated Waste Water (STWW), Potable Water, BIS limits.

I. INTRODUCTION

Underground aquifers that took millions of years to fill are now running dry. Over populating the planet without thinking about the resources available should be considered a crime and each and every human being living on this Earth should take credit for this. It is indeed shocking to know that India is the largest consumer of groundwater in the world; it uses around 230 km^3 of groundwater per year – which sums up to over a quarter of global total [11].

The construction industry is responsible for the consumption of huge amount of fresh water. Production of 1 m^3 of concrete necessitates approximately 150 liters of water and this is without counting other uses of water in the construction industry. Mr. S Bardhan [7], in his study, states a research done by United Nations Environment Program (UNEP) which reveals that construction industry in India alone consumes 30% of global average of fresh water; upon that the same industry produces 30% of world's effluents.

The clause 5.4 of IS 456 – 2000 states that the potable water is satisfactory for mixing and curing of concrete. But potable water is also fit for drinking and other daily needs of all animals and human beings. The stark truth is, around 97 % of whole water on this Earth is salted in the oceans; just 3 % is fresh water. In that, only 1 % is simply available as ground water or surface water, the rest is locked in the Polar Regions as ice. Water treatment is an age-old technology to purify the used and discarded water.

Today we are losing millions of liters of treated waste water. Not only that we are losing it but also contaminating the fresh water by releasing the treated water to the lakes, rivers and oceans. This very thought compelled us to replace potable water with the Secondary Treated Waste Water (STWW) sourced from Sewage Treatment Plant (STP) at GMIT, Davanagere campus for production of M20 grade concrete.

The purpose of this work is to show the possibilities in use of treated water in mixing and curing of concrete and effectively use treated waste water in construction industry and lessen the load on environment.

II. LITERATURE REVIEW

A. Miss. Kirtimala Laxman Narkhede & Mr. F. I. Chavan in their work ***Effect of treated waste water on the strength of concrete****, June – 2017*

Have investigated about the possibilities of effective use of treated waste water in construction industry. In construction industries, concrete is most extensively used construction material. About 5 billion cubic yards of concrete is used each year; and production of 1 m^3 of concrete necessitates approximately 150 liters of water and this excludes other uses of water in construction industry. They have concluded that STWW is fit as per IS 456-2000 provision. The compressive strength increases by mixing STWW. The compressive strength of concrete with STWW gives same strength as of concrete with potable water at 28 days and split tensile strength remained almost same and there is an improvement in flexural strength in concrete with STWW.

B. Ramkar AP, Ansari U.S in their work ***Effect of Treated Waste Water on strength of concrete****, Dec – 2016*

Conducted a study on the effects of different types of treated waste water samples on engineering properties of concrete with respect to the concrete with potable water. The waste water samples were marked as primary treated waste water (PTWW), secondary treated waste water (STWW) which were analyzed for their chemical properties in laboratory. Preliminary tests on cement were also conducted. Compressive strength, tensile strength and flexural strength results of concrete specimens with PTWW and STWW were compared with the concrete with potable water of grade M30. The initial and final setting time of cement paste with potable water were same as that of cement paste with STWW but decreased with PTWW. The compressive strength was increased in STWW, domestic waste water for longer duration, for tensile and flexural strength test was same results so, there was no any improvement in tensile and flexural strength by using STWW. The compressive strength is increased by using STWW. The compressive strength is further increased in STWW concrete for a curing period of 60 day.

III. MATERIALS AND METHODOLOGY

3.1 Materials

The following materials were used in this work

- Cement (OPC 43 Grade Ultra Tech Cement)
- Fine Aggregates (Manufactured Sand)
- Coarse Aggregates
- Water (Potable water)
- Secondary Treated Waste Water (sourced from Sewage Treatment Plant, GMIT campus)
- Super plasticizer (Fosroc Conplast SP 430)

3.2 Methodology

- All the necessary preliminary tests on the above listed materials were conducted.
- Mix design for M20 grade concrete was prepared.
- Trial mixes were conducted, and the final mix was arrived at.
  M20 – 1 : 2.04 : 3.32 : 0.55 with 0.2% SP
- Cubes of 150 X 150 X 150 mm were cast.
- Cylinders of 150 mm dia and 300 mm height were cast.
- Compressive strength tests were conducted after 7, 14 and 28 days of curing.
- Splitting Tensile strength tests were conducted after 7, 14 and 28 days of curing.
- Cost analysis for Secondary treatment of waste water was done.

IV. OBSERVATIONS

4.1 Cement

Table 4.1 properties of cement

Sl. No.	Tests Conducted		
	Specific Gravity	*IS limits*	*Remarks*
1	3.10	---	---
	Fineness		
2	9%	< 10%	---

4.2 Fine Aggregates (Manufactured Sand)

Table 4.2 properties of m – sand

Sl. No.	Tests Conducted		
	Specific Gravity	***IS limits***	***Remarks***
1	2.60	---	---
	Zoning of Sand		
2	Zone II	---	---

4.3 Coarse Aggregates

Table 4.3 properties of coarse aggregates

Sl. No.	Tests Conducted		
	Specific Gravity	***IS limits***	***Remarks***
1	2.71	---	---
	Impact Test		
2	8.49%	< 10%	---

4.4 Potable Water

Table 4.4 properties of potable water

Sl. No.	Tests Conducted	*Results*	*IS Limits*
1	***pH***	7.22	> 6
2	***Acidity***	32.6 mg/l	< 50 mg/l
3	***Alkalinity***	210 mg/l	< 250 mg/l
4	***Chlorides***	67.57 mg/l	< 250 mg/l
5	***Turbidity***	9.15 NTU	< 5 NTU
6	***Calcium hardness***	48 mg/l	< 200 mg/l
7	***Magnesium hardness***	7.2 mg/l	< 100 mg/l

4.5 Secondary Treated Waste Water (STWW)

Table 4.5 properties of STWW

Sl. No.	Tests Conducted	*Results*	*IS Limits*
1	***pH***	7.41	> 6
2	***Acidity***	30 mg/l	< 50 mg/l
3	***Alkalinity***	132 mg/l	< 250 mg/l
4	***Chlorides***	111.32 mg/l	< 250 mg/l
5	***Turbidity***	48.7 NTU	< 5 NTU
6	***Calcium hardness***	46 mg/l	< 200 mg/l
7	***Magnesium hardness***	86 mg/l	< 100 mg/l

V. RESULTS AND DISCUSSIONS

5.1 Fresh Concrete

Table 5.1 workability of concrete (slump test)

TRIAL NO	W / C RATIO	SLUMP VALUE (mm)
Potable Water Concrete		
1	0.55	95
2		80
3		110
STWW Concrete		
1	0.55	85
2		95
3		90

Slump test was conducted to measure the workability of concrete. Both cases rendered nearly 100 mm slump which is workable.

5.2 Hardened Concrete

5.2.1 Compressive strength

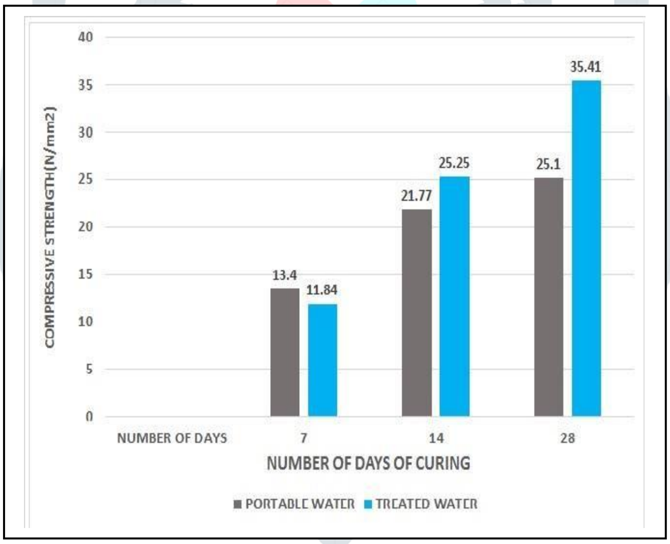

fig. 5.1: Compressive strengths of STWW concrete compared with Control Concrete

It is clear from the above chart that the compressive strength is almost same for both cases at 7 days curing, at 14 days curing the STWW concrete takes a lead and finally at 28 days curing, STWW concrete is taking way greater load and its compressive strength is as good as 35.41 N/mm^2 compared to control concrete's 25.1 N/mm^2. Hence, we can infer that compressive strength is not disturbed with the use of STWW in place of Potable water.

5.2.2 Splitting Tensile Strength

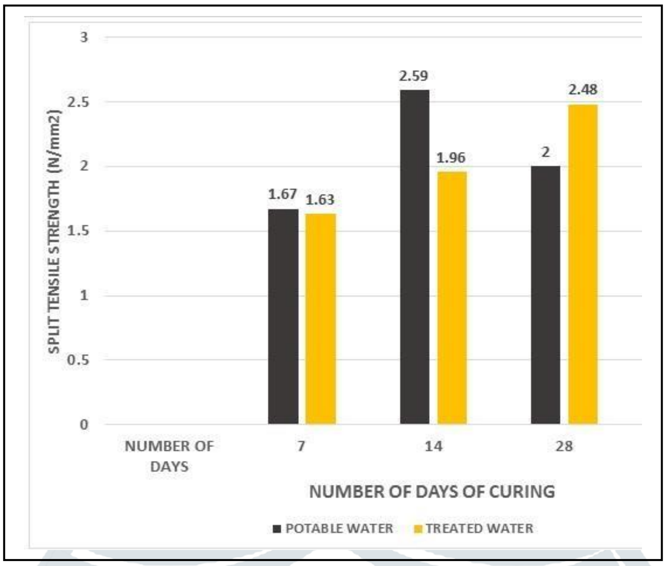

Fig. 5.2: Splitting tensile strengths of STWW concrete compared with Control Concrete

It is clear from the above chart that the splitting tensile strength is almost same for both the cases at 7 days curing, at 14 days curing the STWW concrete takes a dip and finally at 28 days curing, STWW concrete is taking way more greater load and its splitting tensile strength is as good as 2.48 N/mm^2 compared to control concrete's 2.00 N/mm^2. Hence, we can infer that splitting tensile strength is not disturbed with the use of STWW in place of potable water.

5.3 Cost Analysis

Table 5.2 Cost analysis

Sl. No.	Type of Water	Rate (paisa / l)
1	Potable Water	15 [a]
2	STWW	10 [b]

a – Sourced from local water suppliers
b – Sourced from STP office, GMIT campus, Davanagere

The above table shows the cost analysis of both potable water and STWW. STWW turns out to be cheaper at 10 paisa per liter put against potable water at 15 paisa per liter. We can infer that STWW not only reduces the cost of construction but also reduces the huge amount which we might have to pay for getting access to potable water in future days.

VI. CONCLUSIONS

Based on the above observations, results and discussions the following conclusions are drawn:

1. The preliminary tests on STWW reveal that the basic parameters, except turbidity, are well within the IS limits compared to potable water and hence STWW can be used in place of potable water both for mixing and curing of concrete.
2. The compressive strength tests show that the strength of STWW concrete is on par with the Potable water concrete.
3. The Splitting Tensile strength tests show that the strength of STWW concrete is on par with the Potable water concrete.
4. Therefore, the strength parameters are not altered with the use of STWW in place of Potable water.
5. The cost of STWW is cheaper than Potable water therefore using STWW reduces cost of construction.
6. Using STWW in concrete production not only paves way for effective usage of STWW but also solves disposal issues of STWW to some extent.

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