EFFECT OF TREATED WASTEWATER ON PROPERTIES OF CONCRETE

Aastha Gupta[1], Ayush Dhruw[2], Gaurav Kumar Sinha[3], Nilesh Kumar Sahu[4], Praveen Sahu[5] , Tushar Saxena[6]

1,2,3,4,5 – Student, 6 –Assistant Professor - Department of Civil Engineering, Bhilai Institute Of Technology - Durg, India

[5]praveenabc43@gmail.com, [3]sinhagaurav577@gmail.com, [6]tushar.saxena@bitdurg.ac.in

Abstract - *By introducing innovative strategies and methodologies, the modern world is focusing on asset conditioning, sustainability, and recycling. In order to assess the strength of concrete constructed with treated waste water, an experimental investigation was done. Before filling the mould, tests are performed on the cement paste. The curing time for the test cubes was 3, 7, and 28 days. The compressive and tensile strength of hardened cement cubes were measured after curing. The compressive and tensile strengths of cement cubes made using treated waste water were higher than those of cubes made with regular water . Following the cement tests, the concrete paste was applied to the moulds, which were subsequently tested after 7 days, 14 days, and 28 days of curing. The compressive strength test was calculated for the concrete cubes. The results revealed that the concrete constructed using treated sewage water had higher strength than regular water. So as per the results it can be concluded that the treated sewage water can be used for preparation of cement mortar and cement concrete.*

Keywords - Normal water, Treated Waste Water, Cement Cubes, Concrete Cubes, Coagulants.

1. INTRODUCTION

The construction industry appears to be responsible for the consumption of a huge amount of fresh water and we know that Freshwater is the highest consumed natural entity on the planet earth. India is facing a water shortage problem for a long time. Concrete, on the other hand, owing to its extensive use in construction, has emerged as the most widely consumed manmade entity of the present era. With its worldwide usage standing next to the water, the requirements of rendering concrete production sustainable have been well appreciated. The concrete industry uses water not only for production but also for curing and cleaning aggregates. In fact, with a minimum of 250 kg of cement per 1 m3 of concrete and a 0.5 w/c ratio, approx. 825 billion liters of water were consumed in the production of concrete during the year 2010 (Tony and Jenn, 2008). Also, the wastewater released from different types of industries is in general release, directly to surface water after treatment, as it can't be used for domestic works and have storage issues. Thus, releasing treated wastewater into water bodies reduces the quality of surface water and ends up polluting the groundwater too. The concrete industry has a serious impact on the environment with regard to the consumption of water. Therefore, need to find an alternative source of fresh water in concrete production. The ultimate option will be treating the wastewater and this treated wastewater will be used in the construction industry to save the freshwater. So, if we can use the treated wastewater for the above purposes in the construction industry, we can save a lot of fresh water and try to spread awareness of and importance of water.

OBJECTIVE

The main objective of this study is to obtain results using treated wastewater of the Treatment plant directly mix into the concrete**.** The primary aim of this work is to study the effect of wastewater during concrete mix for M25 grade concrete. All this is done to find a sustainable or economical solution for the construction industry by replacing potable water with treated wastewater.

LITERATURE REVIEW

K. Nirmalkumar and V. Sivkumar (2008)

Investigated the durability effect of concrete with the aid of using the use of treated wastewater. They used the treated wastewater from the tannery enterprise for creation purposes, in order that the lack in water may be reduced. Then the specimens have been additionally casted with the aid of using including the relevant admixture with dosages of 0.5%, 1.0%, 1.5%, 2.0% and 2.5%. The specimens have been examined for durability properties for 28 days, ninety days, and 365 days. These cubes have been forged and examined for durability.

M. Silva and T. R. Naik (2010)

They investigated that, stainable use of resources, which include using reclaimed water, especially sewage treated water in concrete. A preliminary laboratory research was performed samples had been gathered from the Milwaukee Metropolitan Sewerage District (MMS D) and analyzed the Characteristics of treated wastewater. According to their research, the compressive strength with sewage treated water has proven development in strength all through 3 to 28 days and elevated through the period of 91 days.

V. Kulkarni (2014)

He investigated that, compressive strength of concrete by using treated waste water for mixing and curing of concrete. By using treated waste water utilized in concrete preparation where there was a scarcity of fresh water. They discussed physical properties of Materials and chemical properties of treated waste water of mix proportion for M20 and M40 grade concrete The number of specimens to be casted for different curing regimes and average compressive strength results of M20 grade concrete cast by using Tap water as mixing and curing water for Mix M1 & treated waste water as mixing and curing water for Mix M2. Similarly average compressive strength results of M40 grade concrete casted by using Tap water as mixing and curing water for Mix M3 & treated waste water as mixing and curing water for Mix M4.

Abdul Razak. & D. L. Venkatesh Babu (2015)

There is a lower withinside the workability of concrete the use of treated wastewater. There is no considerable distinction withinside the compressive strength of concrete made the use of treated wastewater and potable water. The tensile strength of concrete made the use of treated wastewater became observed to be lesser in comparison to that of potable water. Construction expenses may be decreased via way of means of utilising the treated water for simple cement concrete.

Ayoup M. Ghrair and Othman Mashaqbeh's (2016)

This study has evaluated the use of treated wastewater for concrete and mortar production. The water quality analysis showed that treated wastewater is suitable for concrete and mortar production. This study has shown that treated wastewater is a good alternative to freshwater for making concrete. Therefore, the current guidelines for wastewater recuse should be revised by the governmental authorities to encourage the use of treated wastewater as a substitute for fresh water in concrete making.

Material used

1 Cement – Cement is a binding material that is used in building construction. It is the main constituent of concrete. Principal constituents of cement are compounds of lime. The cement used for this study is PPC of grade 53. The Standard Consistency, Initial & Final Setting Time, Compressive Strength, and Tensile Strength of cement are determined from laboratory tests.

2 Fine Aggregate - Aggregate is the granular material used to produce concrete or mortar and when the particles of the granular material are so fine that they pass through a 4.75mm sieve, it is called fine aggregate. Natural sand is used as fine aggregate. The grading must be uniform. The moisture content or absorption characteristics must be closely monitored.

3 Coarse Aggregate - When the particles of the granular material remain through a 4.75mm sieve, it is called coarse aggregate. The maximum size of coarse aggregate is generally limited to 20mm. The aggregate of size 12 to 10 mm is desirable for structures having congested reinforcement.

4 Wastewater - Waste Water is generated after the use of fresh water in a variety of applications. About 80% of demand water is converted into wastewater. It contains a wide range of contaminants. Here we have collected the treated wastewater from the sewage treatment plant located in Bhilai.

5 Concrete – *Concrete* is defined as the composite material that is created by mixing binding material (cement) along with the aggregate (sand, gravel, stone, brick chips, etc.) with water, and admixtures in specific proportions. The strength and quality are dependent on the mixing proportions. In this study, we have made a concrete mix for M25 Grade of concrete.

6 Mix Design - Concrete mix design involves a process of preparation in which a mix of ingredients creates the required strength and durability for the concrete structure. For this study we have made a mix design for M25 Grade of concrete for this mix design the mix proportion comes as –

MIX PROPORTION RATIO

CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER/CEMENT RATIO
1	2.14	2.89	0.51

METHODOLOGY

5.1 Collection of treated sewage water

Treated sewage water was collected from the NSPCL township, Talpuri, Bhilai. The township has its own water treatment plant which treats the used water and then the treated sewage water is used for gardening purpose in the township's gardens and parks, one other good application of this treated sewage water can also be at the construction sites for mixing and curing. In the areas of Gurugram and Delhi NCR the ground water level got depleted. By this method we will be able to prevent the depletion of ground water table.

5.2 Chemical analysis of sewage water

The treated sewage water was chemically tested and analysed to know about its parameters such as pH, turbidity, conductivity etc after being used as raw water and after being treated. The analysis will also help us to compare the parameters of treated sewage water with that of raw water.

5.3 Design of concrete mix

A good concrete mix leads to strong foundation for structures. Physical properties of cement, coarse aggregate, fine aggregate(sand) and water were determined as their properties varies from place to place. The physical properties obtained after tests were used in the designing of concrete mix. This will ensure the structure will be sound and prevent mix from failure.

5.4 Casting of concrete cubes

Once the concrete mix is prepared, cubes of 15 cm and 7 cm were prepared to perform the compressive strength test of cement and concrete respectively.The cubes were then submerged in the tank for curing. Tensile strength test is also performed using the same mix.

5.5 Curing of concrete cubes

Concrete curing is the process of maintaining adequate moisture in concrete within a proper temperature range in order to aid cement hydration in early ages.

After casting the cubes, moulds were removed after one day and the cubes were put into tank for curing purpose to gain strength.

5.6 Compressive strength tests of concrete cubes

The cubes were tested on 7^{th}, 14^{th} and 28^{th} for concrete and 3^{rd} ,7^{th} and 28^{th} days for cement respectively with the help of compressive strength test machine also the tensile strength was determined on the same days with the help of tensile strength test machine with same concrete mix but in a different mould.

5.6 Validation

Validation of this project here means if the results of the tests of cubes prepared with raw water are better or same as that of cubes prepared with fresh water then the treated sewage water will be applicable for the use of mixing of concrete and curing. The use of treated sewage water in the construction purpose will help us achieve the idea of sustainable development.

TEST PERFORMED AND RESULTS

1 TEST FOR WATER

Water quality of normal water and treated wastewater has been analyzed for pH, Conductivity, Turbidity, Alkalinity, Acidity, Hardness and Chloride Content. And their results are shown below –

Parameters	Observation (Normal water)	Observation (Treated water)
pH	7.39	8.56
Conductivity	512 µS/cm	734 µS/cm
Turbidity	5NTU	24.4 NTU
Alkalinity	30 mg/l	70 mg/l
Hardness	18.5 ppm	20.5 ppm
Acidity	50 ppm	75 ppm
Chloride Content	114.9 ppm	230 ppm

2 TESTS FOR FINE AGGREGATE

Aggregate quality has been checked before making concrete. The main tests done on Fine Aggregate are Specific Gravity, Fineness, and Water Absorption. And the results for all the tests mentioned are given below –

Properties	Observation
Specific Gravity	2.64
Fineness Modulus	3.02
Water Absorption	2 %

3 TESTS FOR COARSE AGGREGATE

Same tests are done for coarse aggregate as well which are Specific Gravity, Fineness and Water Absorption. Their results are given below –

Properties	Observation
Specific Gravity	2.82
Fineness Modulus	7.05
Water Absorption	0.5 %

4 TESTS FOR CEMENT

As we know that cement is the most important material which is used in concrete making. So that's why a quality check for cement is done before making concrete. Quality check for cement has been done by testing it for Consistency, Initial & Final Setting Time, Compressive Strength, Tensile Strength, Soundness, and Specific Gravity. And the result for all the tests are given below

Properties	**Observation(Normal Water)**	**Observation (Treated Water)**
Consistency	31%	33%
Initial Setting Time Of Cement	95 Min	135 Min
Final Setting Time Of Cement	7 Hours	10 Hours
Cement Expansion (in mm)	2 mm	2 mm
Specific Gravity of cement	3.14	3.14
Compressive Strength (3 days)	21.33 N/mm2	22.66 N/mm2
Compressive Strength (7 days)	23.33 N/mm2	24 N/mm2
Compressive Strength (28 days)	33.33 N/mm2	35.33 N/mm2
Tensile Strength (3 days)	75 KG	61.6 KG
Tensile Strength (7 days)	80 KG	83.33 KG
Tensile Strength (28 days)	101.67 KG	103.33 KG

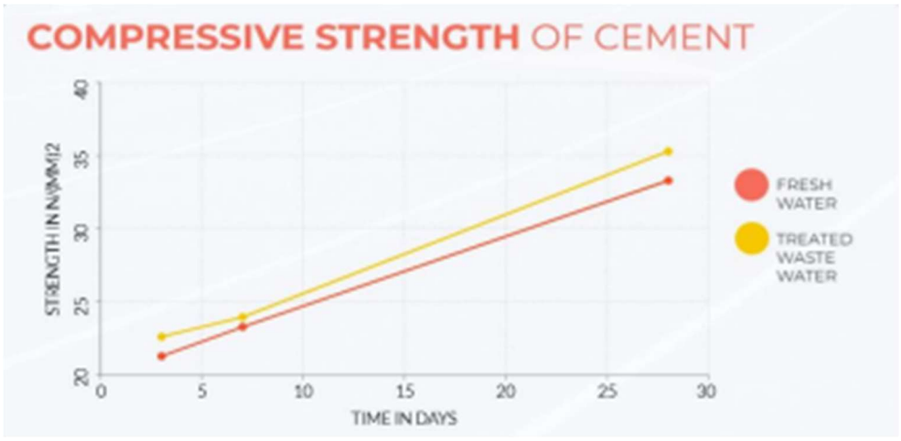
5 TEST FOR CONCRETE

The main aim of this study is this only – to check the compressive strength of concrete made with a concrete mix of M25 Grade of Concrete. These concrete cubes were tested after 7 days, 14 days, and 28 days of curing. And the result for that test is given below –

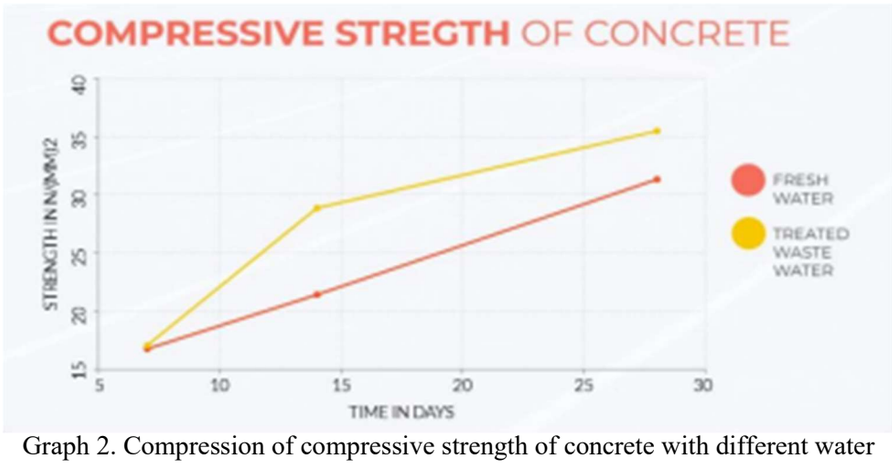
	Specimen 1	**Specimen 2**	**Specimen 3**	**Average**
7 Days (Normal)	17.1 N/mm2	16.74 N/mm2	16.52 N/mm2	16.78 N/mm2
14 Days (Normal)	22.05 N/mm2	20.45 N/mm2	21.85 N/mm2	21.45 N/mm2
28 Days (Normal)	30.47 N/mm2	31.83 N/mm2	31.75 N/mm2	31.35 N/mm2
7 Days (Treated)	17.1 N/mm2	16.82 N/mm2	17.32 N/mm2	17.08 N/mm2
14 Day (Treated)	28.49 N/mm2	29.03 N/mm2	29.15 N/mm2	28.89 N/mm2
28 Days (Treated)	35.26 N/mm2	35.41 N/mm2	35.87 N/mm2	35.51 N/mm2

DISCUSSION

From the studies and tests performed earlier, it is clear that the treated sewage water can be used to prepare cement mortar as the impurities are under permissible limits according to the tests. It was observed that under normal conditions this water gives comparatively the same compressive and tensile strength hence it is economical to use the treated sewage water for curing and preparing cement mortar. On the other hand, while testing the performance of the same water for the preparation of cement concrete. The result obtained was more than normal water. Thus, the treated sewage water can also be used for the preparation of cement concrete. So, it is clear that the treated wastewater can be used for construction works and thus, the commercial use of treated sewage water will encourage many more industries to install more sewage treatment plants resulting in the reuse of water. The idea of sustainable development can be achieved by the use of treated sewage water.



Graph 1. Compression of compressive strength of cement with different water



Graph 2. Compression of compressive strength of concrete with different water

CONCLUSION

We have studied and performed various tests on the sewage water and as a whole the study concluded that the treated sewage water can be used for the production of concrete as all of its chemical tests give positive results and the impurities are under permissible limits. Also when this water is used to prepare cement cubes under normal condition, then those cubes gives a satisfactory result of compressive strength and tensile strength The compressive strength of cement cube prepared with treated sewage water is 6% more than the cement prepared by freshwater while The tensile strength of cement prepared by treated sewage water is 1.63% more than the cement cube prepared by freshwater. As the pH of treated sewage water is more than that of normal water so the binding properties of cement work better at higher pH hence the strength increases. As a whole, it can be concluded that the treated sewage water can be used to prepare cement mortar. When treated waste water is used in making concrete cubes, the compressive strength result came was satisfactory , in fact, the cubes made with the treated sewage water shows more compressive strength. The compressive strength of concrete cubes prepared using treated waste water after 7, 14, 28 days are 1.78% , 34.68% and 13.26% respectively . Increased alkalinity of cement paste due to relatively higher alkalinity in treated wastewater is known to increase the initial rate of hydration thereby increasing early strength. pH of treated waste water is higher hence supports the high pH of fresh concrete which helps in increasing the binding properties.It can also be concluded that using treated sewage water will be a necessary step for the conservation environment as the fresh groundwater can be used for other important uses and also disposing of it off to the rivers can be avoided to save the aquatic life.

REFERENCES

1. K. Nirmalkumar and V. Sivkumar (2008), “Study on the durability impact of concrete by using recycled waste water”, Journal of Industrial Pollution Control, pp 1-8.
2. R. A. Taha (2010), “The feasibility of using Ground (brackish) water and Production (oily) water in construction compared with Tap water”, International Journal of Sustainable Water and Environmental system, Vol. 1, pp 39-43.
3. M. Silva and T. R. Naik (2010), “Sustainable use of resources”, Second internationa conference construction material.
4. K. S. al jabri (2011), “The effect of wastewater on properties of high strength concrete”, Twelfth East Asia-Pacific Conference on Structural Engg., 370-376.
5. V. Kulkarni (2014), “Study on compressive strength of concrete by using treated domestic wastewater as mixing and curing of concrete”, International Journal of Research in Engg. And Technology.
6. R.A. More and S.K. Dubey (2014), “Study on the effect of different types of water on compressive strength of concrete”, International Journal of Research in Engg. And Technology, pp 40-50
7. F. Adeyemiand (2014), “Experimental investigations on the effect of seawater on the compressive strength of concrete”, International Journal of Engg. Science Invention, pp 23-31.
8. N. Reddy (2015), “Use the Treated domestic wastewater as a mixing water in cement mortar”, International Journal of Engg. Science Invention, pp 23-31.
9. MS Shetty, Concrete Technology Theory and Practice. 5th ed. S. Chand and Co. Ltd., Ramnagar, New Delhi, India, 2004.
10. IS-456 - 2000-Plain and Reinforced Concrete Code of Practice.
11. IS – 383 – 1970 – Coarse and Fine Aggregates from Natural Sources for Concrete.
12. IS-10262- Guidelines for Concrete Mix Design proportioning
13. IS-269-1976-Specification for Portland Cement
14. IS 2386-1963 Method of Test for Aggregate for Concrete.
15. IS-516-1959 -Methods of tests for strength of concrete.