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Experimental Study of Fiber Reinforced Concrete Casted with Treated Sewage Effluent

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Abstract

This study deals with the Performance of Fiber Reinforced Concrete Casted with Treated Sewage Effluent with respect to potable water. The study investigates the water quality of tests like ph, dissolve oxygen, chlorine content, alkanity test, COD, BOD with respect to normal water and treated sewage effluent. The sample of treated sewage effluent is collected from the sewage treatment plant which constructed in our premises. Concrete is an artificial material in which the arrangements both fine and coarse aggregate are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent characteristics and advantages either when green or hardened. The use of reinforcement in concrete brought a revolution in application of concrete. Concrete has unlimited opportunities for innovative application, design and construction techniques. It has been found that different type of fibers added in specific percentage to concrete Improves the strength properties of the structure. It is now established that one of the important properties of Fiber Reinforced Concrete. As per the available literature some author says that the using treated sewage effluent in concrete results gain in strength with compare to potable water, but no experiment done with fiber reinforced concrete casted by treated sewage effluent that is why we are preceding this study.

Keywords: - Treated Sewage Effluent, Fiber Reinforced Concrete, Potable water, Strength and Mechanical Properties, Polypropylene Plastic.

1. INTRODUCTION

Concrete is the most widely used construction material in the world. Some examples of successful water reuse projects are the use of reclaimed water in place of potable water for use in irrigation, and industrial uses. In present, experiments were conducted in two phases, each phase on a different type of wastewater. The main objective of this research is to determine the suitability of using treated wastewater for mixing concrete. Very nearly 80% of the water utilized for residential reason disseminates as civil emanating water. Treated waste water is acquired from treatment plant in the wake of treating metropolitan profluent water. It is fundamentally utilized for cultivating and in some circumstance for agrarian reason. Treated waste water is hard water, it chiefly contains sulfate and chloride content. So as to diminish the utilization of customary water being developed and to utilize the assistant treated sewage water in a ground-breaking way. It hopes to save million liters of waste water which may be deliberately orchestrate in the stream.

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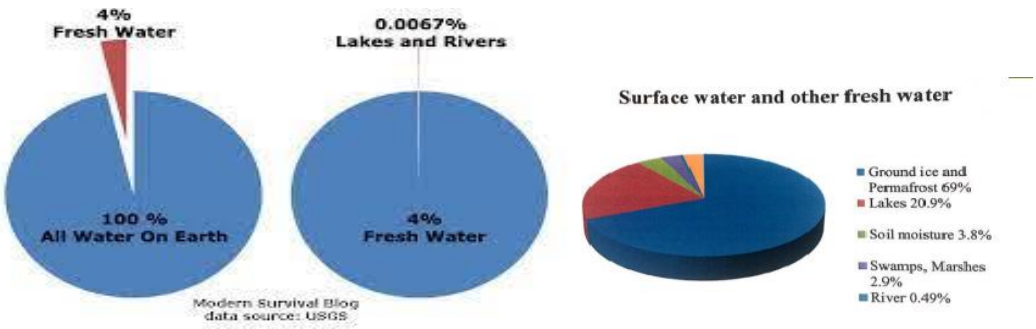

Figure 1: Fresh water and sources available on earth

As per literature reviews of different authors Concrete cube specimens were cast using tap water, preliminary treated wastewater, secondary treated wastewater, and tertiary treated wastewater obtained from the local wastewater treatment plant. It was found that the type of water used for mixing did not affect concrete slump and density. However, setting times were found to increase with deteriorating water quality. In addition, Concrete made with water from the primary and secondary treatment showed lower strengths for ages up to the age of one year and the possibility of steel corrosion increased too. Overall, tertiary treated wastewater was found to be suitable for mixing concrete without adverse effects.

In this Research treated sewage effluent is used for casting fiber reinforced concrete specimen .Subsequently all mechanical properties of the concrete casted by sewage effluent were accessed and compared with the traditional concrete specimen casted by potable water.

2. METHODOLOGY

Wastewater is used in concrete mix to get the required strength so that the natural resources are limited and used more efficiently and the environment is protected. Considerable research has been carried out on the use of treated sewage effluent in concrete. The main concern of using sewage effluent is not only cost effective but also to get the substitute for the potable water, which can indirectly protect the natural resource. To effectively study the improvement in the mechanical properties of the concrete, procedures and method must be wisely chosen. The criteria to access the mechanical properties are based on the activities to plan and preparation, which carried out before the testing of concrete.

These activities are:

1) Aggregate and cement testing
2) Sieve analysis
3) Mix Design
4) Water testing
5) Concrete Mixing and curing.

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The objective of the reseach is to compare the compressive strength of fiber reinforced concrete for M35 grade and M35 grade by using the different qualities of water such a tap water and Wastewater (Treated) which are available on different construction sites and are directly being used for making concrete, also identification of civil works where these water can be used without compromising structural strength parameters.

3. MIX DESIGN 3

Mix design for M35

1) Grade of designation = M35
2) Type of cement = Pozzolona Portland Cement PPC
3) Max nominal size of aggregate = 20 mm
4) Minimum cement content = 340 kg/m3 (IS 456)
5) Water-cement Ratio = 0.45
6) Standard deviation = 5 N/mm2 (IS 10262)
7) Workability of slump = 100mm
8) Exposure Condition = Very Severe
9) Target mean strength = 43.25 N/mm2

Summary

Cement = 394kg/m3
Water = 158kg/m3
Coarse aggregate = 1143kg
Fine aggregate = 870.65 kg
Admixture = 3.86 liters
W/C ratio = 0.4

Cement	F.A	C.A	Water
394	870.65	1143	158
1	2.20	2.9	0.4

Therefore specification for M35 PPC = 1: 2.2: 2.9

4. TESTS FOR PROPERTIES ON CONCRETE SPECIMEN

- **Compressive Strength Test**

Figure 2: Test performed on concrete cube break after compression

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Split Tensile Strength Test

Figure 3 Cylinder Cracked during split tensile strength test

Flexural Strength Test

Figure 4: Flexural strength Test Apparatus

All the test and procedure will be conduct in a Laboratory of premises. All the test will follow steps which mention above to obtained the results. The test performs for cement and mix design are as per IS code 456:2000. The fiber which are we use is polypropylene fiber which having a length of 6mm with specific gravity of 0.9-0.91gm/cm cube. It has resistant to abrasion, deterioration from chemicals, mildew, perspiration, rot, stain, soil and weather conditions In general, PPF fiber has excellent chemical resistance to acids and alkalis, high abrasion resistance. This fibre helps reduce water bleeding in concrete and reduces the concrete's permeability significantly. It has some advantages such as light weight, high strength, high toughness, and corrosion resistance. When PPF is added in concrete, the three-dimensional random distribution network structure can be formed in concrete, which effectively inhibit the microcrack generation and development [8–11]. As a result, the PPF can prevent water and other harmful ions entering into concrete.

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5. RESULTS AND DISCUSSION

This research focuses on the experimental results obtain from compressive test, split tensile test, flexural test and the analysis of the test results. The experimental tests were carried out to obtain the mechanical properties of untreated wastewater fiber reinforced concrete, treated wastewater fiber reinforced concrete and the potable fiber reinforced concrete. The comparisons of mechanical properties like compressive strength, split tensile strength and the flexural strength between fiber reinforced concrete PPF and steel fiber reinforced concrete is carried out. Observation for 3-, 14- and 28-days curing period ware recorded and presented in the form of tables and graphs.

- **For Conventional Concrete mix M35 casted with Potable water.**

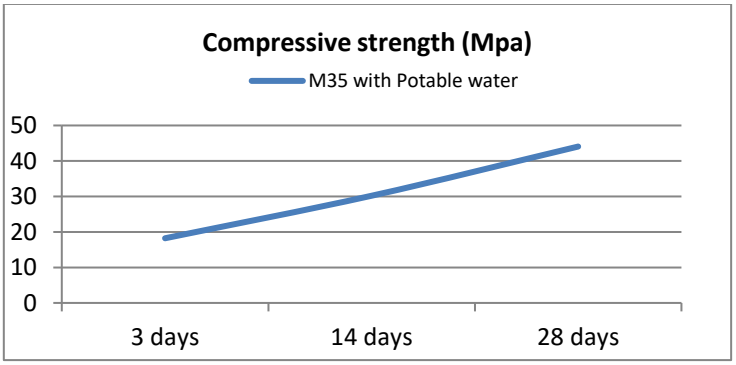

Figure 5: Compressive strength for conventional mix M35 casted with potable water.

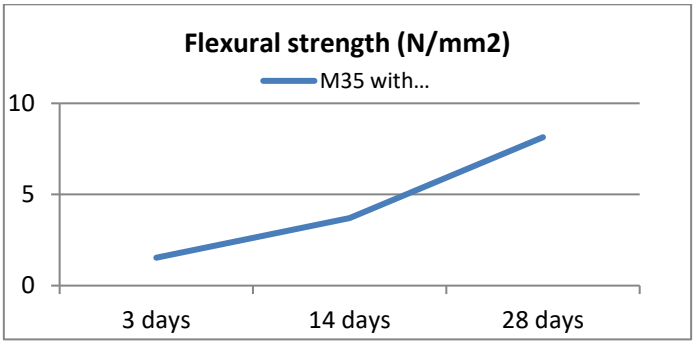

Figure 6: Flexural strength for conventional mix M35 casted with potable water.

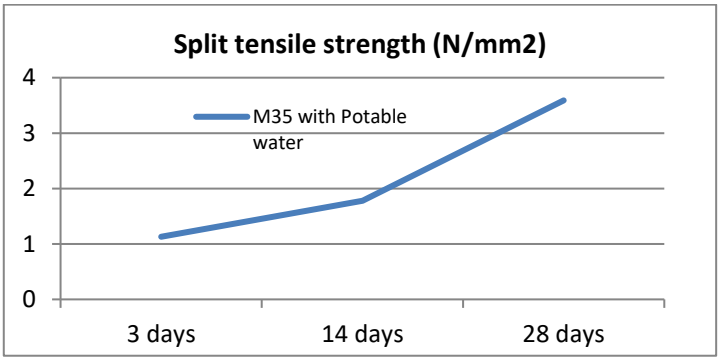

Figure 7: Split tensile strength for conventional mix M35 casted with Potable water.

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- **For Conventional Concrete mix M35 casted with Treated waste water.**

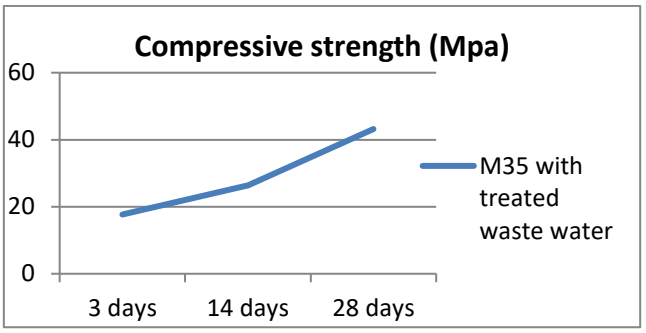

Figure 8: Compressive strength for conventional mix M35 casted with treated water

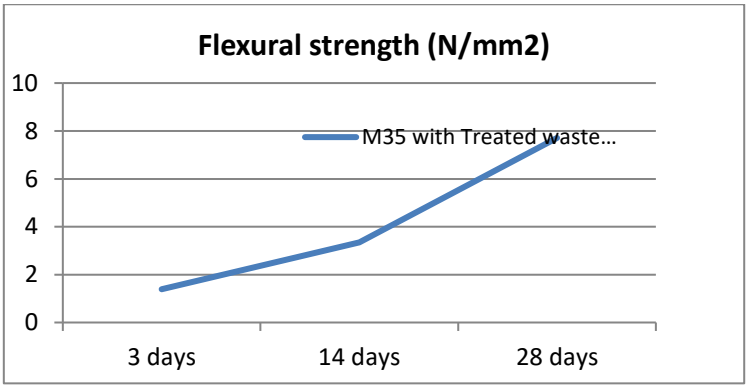

Figure 9: Flexural strength for conventional mix M35 casted with treated waste water.

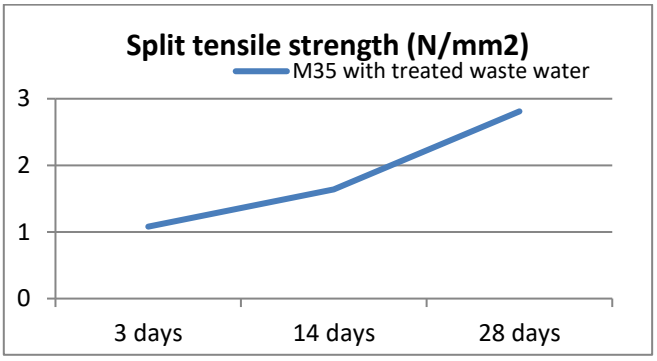

Figure 10: Split tensile strength for conventional mix M35 casted with treated waste water.

Compression Test For Fiber reinforced Concrete mix M35 casted with Potable water and Treated sewage water.

Test results obtain for compressive strength, flexural strength and split tensile strength for M35 mix added with 0.1%,0.15%,0.2% and 0.25% of Polypropylene Fiber (PPF) casted with Potable water and treated sewage water.

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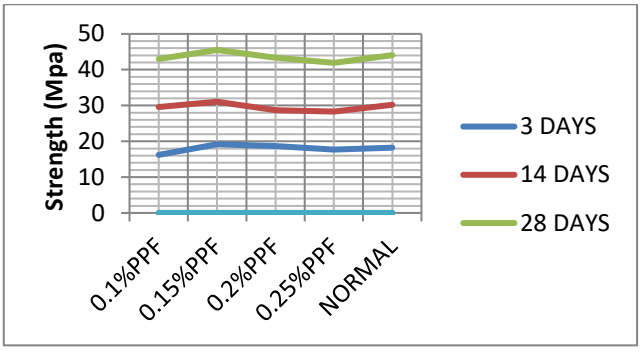

Figure 11: Compressive strength Fiber reinforced Concrete mix M35 casted with Potable water.

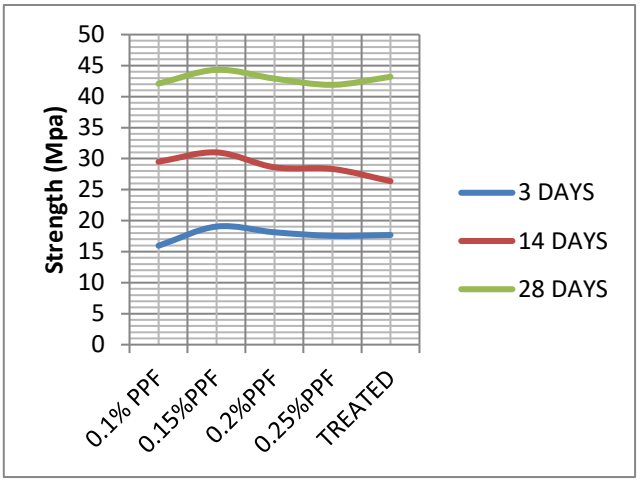

Figure 12: Compressive strength Fiber reinforced Concrete mix M35 casted with Treated sewage water.

- **Flexural Strength Test For Fiber reinforced Concrete mix M35 casted with Potable water and Treated sewage water.**

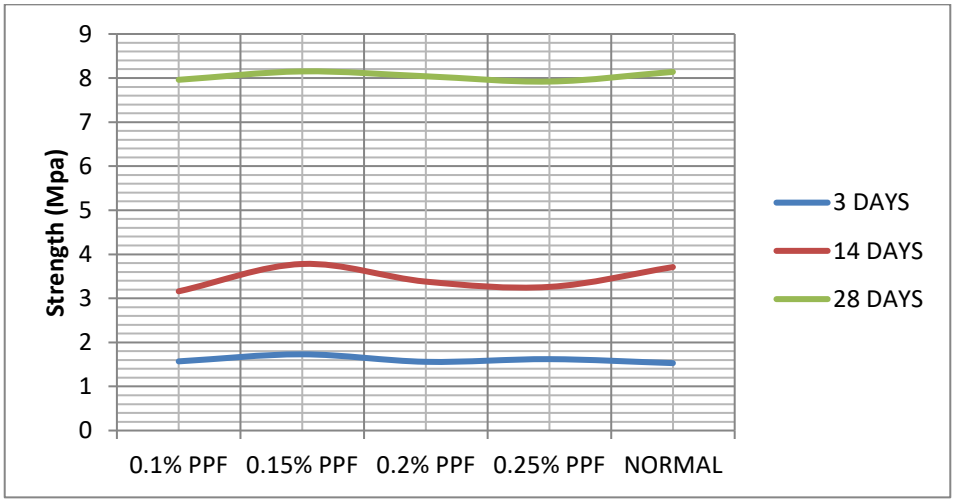

Figure 13 Flexural strength Fiber reinforced Concrete mix M35 casted with Potable wate

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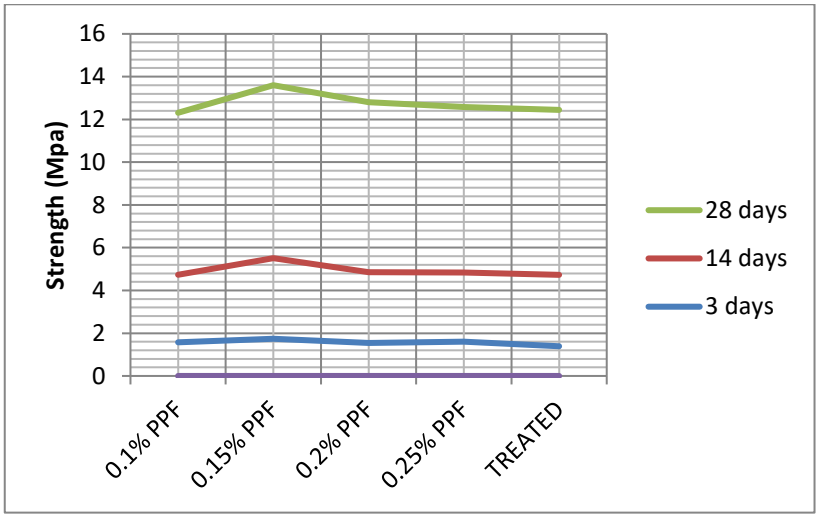

Figure 14: Flexural strength Fiber reinforced Concrete mix M35 casted with Treated sewage water.

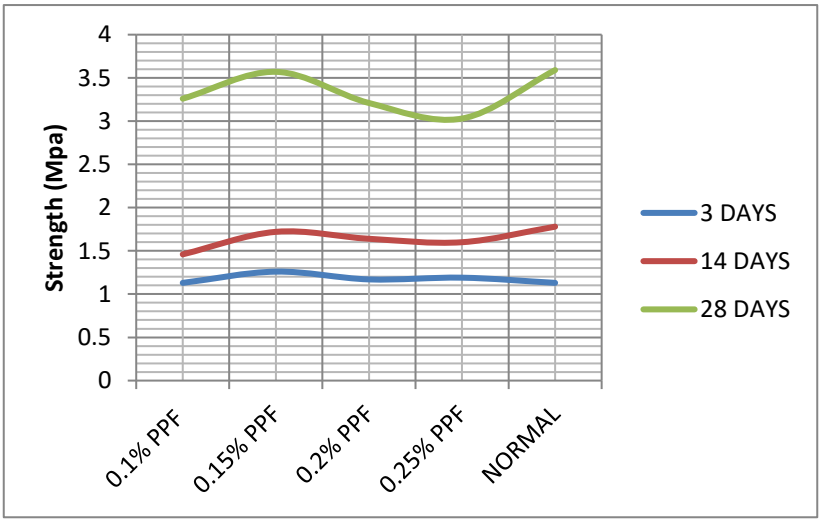

Figure 15: Split Tensile strength Fiber reinforced Concrete mix M35 casted with Potable water.

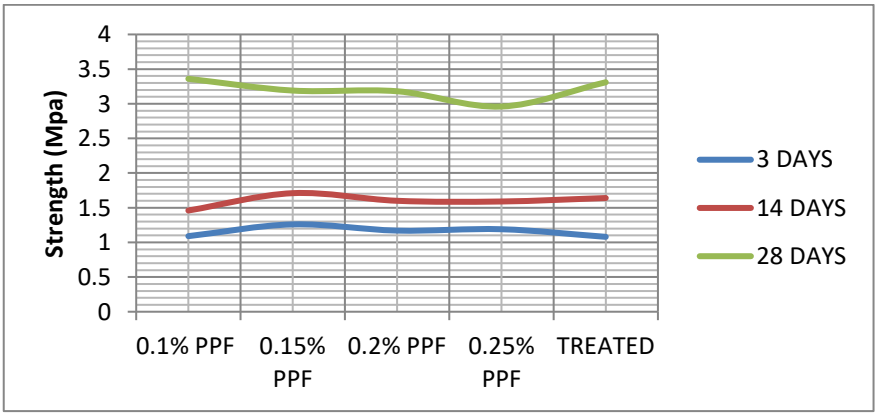

Figure 16: Split Tensile strength Fiber reinforced Concrete mix M35 casted with Treated sewage waste water

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5.1 Comparison between Polypropylene fiber PPF and Steel fiber reinforced concrete.

Generally, Fiber reinforced concrete is a Portland pozzolana cement concrete which is reinforced with more or less randomly distributed fibers and has been developed in recent years. Steel fiber remains the most used fiber of all i.e. almost 50% of total tonnage used followed by polypropylene (20%), glass (5%) and other fibers. But using steel fibers in M35 mix casted by Treated sewage water can develops corrosion effects on steel due to is metal properties. Alkali, chlorine and other salinity which are already presents in treated sewage water can cause the steel fiber. To overcomes this problem Polypropylene Fiber is best fiber reinforced for this condition. Due to having non metallic properties there is no adverse effect of chemical which present in treated sewage water on Polypropylene fibers. Also the performance of polypropylene fibers have achieved the targeted strength in M35 mix grade of concrete casted with Treated sewage water as well as Potable water. So there is no compromise has done with respect to mechanical properties of Concrete.

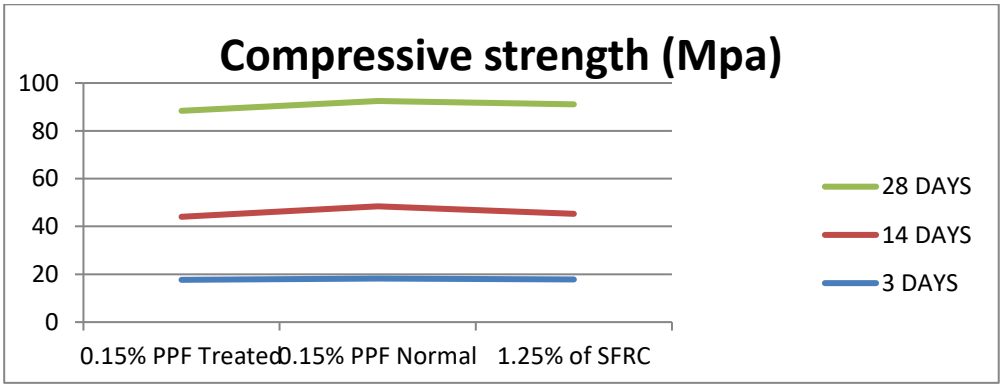

Figure 17: Compressive strength Comparisons between Steel Fiber reinforced concrete M35 mix casted with Potable water and Polypropylene Fiber concrete M35 mix casted with Treated sewage water and Potable water.

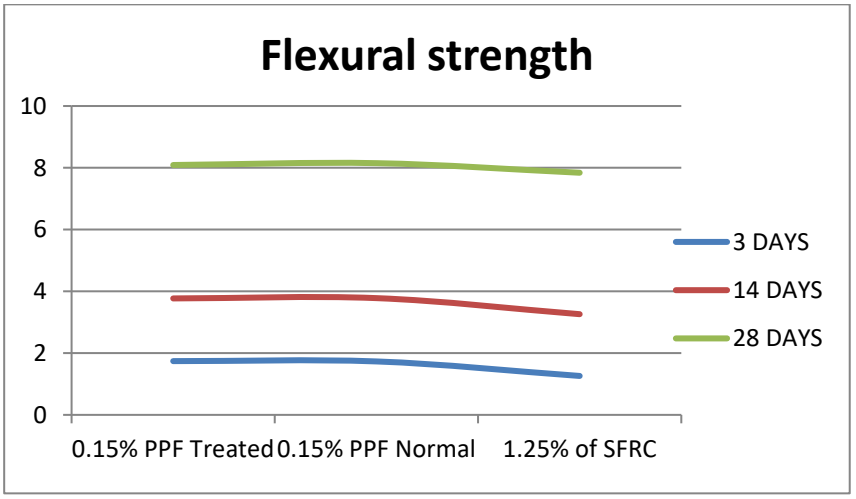

Figure 18: Flexural strength Comparisons between Steel Fiber reinforced concrete M35 mix casted with Potable water and Polypropylene Fiber concrete M35 mix casted with Treated sewage water

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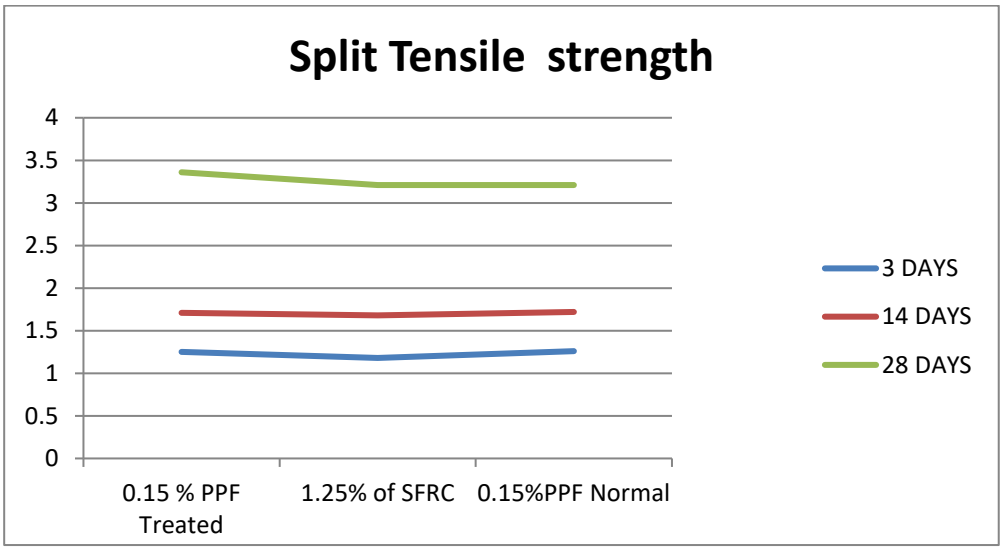

Figure 19: Split Tensile strength Comparisons between Steel Fiber reinforced concrete M35 mix casted with Potable water and Polypropylene Fiber concrete M35 mix casted with Treated sewage water.

The Results show the Mechanical properties of M35 mix casted with treated water and potable water has adequate values. It satisfy the values at 0.15% of PPF with Mix design calculation values. We also compare the M35 mix Polypropylene fiber reinforced concrete casted with treated and potable water with M35 mix Steel reinforcement concrete casted with Potable water and the results show that PPF at 0.15% added have better performance in Flexural test and Split tensile test at 28 days of curing.

6. CONCLUSION

After carried out experimental study on the usage of different types of water such as Potable, Treated sewage wastewater and untreated sewage wastewater, following conclusion are drafted

1. The experimental results of research shows that, the mechanical properties of concrete after using a treated waste water and potable water were similar.
2. The flexural strength is found to have highest value for treated wastewater at a percentage of 0.15% of PPF. If we increase curing days then the strength increases than conventional flexural strength.
3. The Compressive strength and split tensile strength is found to satisfactory value for treated waste water at 0.15% of PPF as compare to Potable water. If we increase curing days then the strength increases than conventional Compressive strength and Split Tensile strength.
4. Using treated wastewater in concrete mix proved to be very useful to solve environmental problem. Therefore it is recommended to re-use the naturally treated sewage wastewater in concrete to move towards sustainable development in construction industry.

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5. No adverse effects of corrosion on reinforcement like polypropylene Fiber as compared to steel fiber reinforcement.
6. This results shows that using Treated waste water in Fiber reinforced concrete like Polypropylene fiber is always preferable than Steel fiber. Due its non metallic properties of polypropylene fiber is better option than steel fiber.
7. The difference in cost also varies polypropylene fiber is cheaper than steel fiber. 1 bag (1kg) of polypropylene fiber is 180Rs where as the cost of 1 bag (1kg) of steel fiber is 370Rs.
8. The results shows that the using 0.15% added concrete M35 mix casted with both treated waste water and Potable water has more strength in compressive, split tensile and flexural strength values than conventional M35 mix casted with potable and treated sewage water.
9. While testing the specimens, the Conventional cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of beam in two piece geometry. But due to addition of Polypropylene fibers in concrete cracks gets ceased which results into the ductile behavior of PPFRC.

PHOTOGRAPHS:

Pic 1: Casted Cube and Cylinders

Pic 2: Split beam and cross section of beam

REFERENCES

1. Guirguis, B. E. and Potter, R. J., "Polypropylene Fibres in Concrete," Technical Report TR/F90, Cement and Concrete Association of Australia, 1985
2. pooja Kirange , Monali Mhanavar , Ruchita Borhade , Shweta Tanksale, Yogesh Tamke ANALYZING THE EFFECT OF USING TREATED WASTE WATER ON STRUCTURAL CONCRETE, ISBN. No. 978-93-87901-03-2 February, 15th and 16th, 2019
3. V. Kulkarni (2014), "Study on compressive strength of concrete by using treated domestic waste water as mixing and curing of concrete", International Journal of Research in Engineering and Technology.
4. IBRAHIM AL-GHUSAIN AND MOHAMMAD J. TERRO,Use of treated waste water in concrete mixing in Kuwait 2003
5. Rakesh A. More and Prof. S.K. Dubey , Effect of Different Types of Water on Compressive Strength of Concrete IJET 5(2): 40-50(2014)
6. ACI committee 544, 3R-08, 2008. "Guide for specifying, proportioning, and production of fiber reinforced concrete." American concrete institute, Farmington hills, USA.
7. D. Pérez-Rocha, A. B. Morales-Cepeda, F. Navarro-Pardo, T. Lozano-Ramírez, and P. G. LaFleur, "Carbon fiber composites of pure polypropylene and maleated polypropylene blends obtained from injection and compression moulding," *International Journal of Polymer Science*, vol. 2015, Article ID 493206, 8 pages, 2015.
8. Y. Tapiero, B. L. Rivas, and J. Sánchez, "Activated polypropylene membranes with ion-exchange polymers to transport chromium ions in water," *Journal of the Chilean Chemical Society*, vol. 64, no. 4, pp. 4597–4606, 2019.
9. B. Ali, L. A. Qureshi, and R. Kurda, "Environmental and economic benefits of steel, glass, and polypropylene fiber reinforced cement composite application in jointed plain concrete pavement," *Composites Communications*, vol. 22, Article ID 100437, 2020.
10. A. A. Mahmoud and S. Elkatatny, "Improving class G cement carbonation resistance for applications of geologic carbon sequestration using synthetic polypropylene fiber," *Journal of Natural Gas Science and Engineering*, vol. 76, Article ID 103184, 2020.
11. Rui D. Neves and Joao C. O. Fernandes de Almeida, 2005. "Compressive behavior of steel fiber reinforced concrete", structural concrete. 2005-06.