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Performance of concrete casted with treated wastewater: A sustainable solution in construction industry

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Abstract

The main aim of this research is to know an effectiveness of sustainable construction techniques, needed to be implemented in construction industry. Particularly, those techniques that can be applied in medium/ major size construction projects. Due to the achievement of the sustainable system in many segments, the construction industry has adapted sustainable techniques to eliminate waste and increase long term profit. If we successfully adopt the sustainable practice in construction technology then it is very eco-friendly solution for construction industry. In this research paper the effectiveness of the sustainable construction techniques is evaluated through the implementation of sustainable and simple approaches by studying performance of treated effluent on concrete. Experimental and analytical study were carried out to ascertain the effectiveness of sustainable practice, consequentially after conducting research treated effluent on concrete it observed that use of treated effluent on concrete are cost effective and sustainable solutions.

Keywords: Treated effluent, sustainable solution, corrosion

1. Introduction

The enduring problems of construction are well-known to everyone as low productivity, poor safety, inferior working conditions, and insufficient quality. A number of solutions or visions have been offered to relieve these problems in construction. Industrial development (i.e., prefabrication and modularization) has for a long time been viewed as one direction of progress. At present, reuse of water in construction is seen as a vital way to reduce fragmentation in construction, which is a major cause of present problems. The vision use of treated effluent on concrete construction, closely related with combined construction, is another solution promoted by researchers.

Sustainable construction is a philosophy based on the concepts of sustainable methods or material optimization methods. It is about dealing and improving the construction process to cost-effectively deliver what the customer needs. In construction projects, significant uncertainty exists throughout the project. Meteorological conditions, soil conditions, owner changes, and the interaction between multiple operations can produce unique circumstances, which could be as critical as the planned activities and have a significant impact on project cost.

2. Summary of Literature Review

After carried out a literature from various researcher it is found that sustainable technology has a huge scope in construction industry and hence proper technology is need to developed/study. Water is a main material in concrete and as far as potable water is concern. Sources of potable water is lower nowadays and hence research in terms of reuse of water is initiated in this research paper. Research papers mentioned in the reference list are reviewed and referred in this paper.

3. Methodology

The objective of the present work is to compare the compressive strength of concrete for M20 grade and M25 grade by using the different qualities of water such a tap water and Wastewater (Treated and Untreated) which are available on diverse construction sites and are directly being used for making concrete, also identification of civil works where these water can be used without flexible structural strength parameters.

A. Procedure Adopted

The whole process of this study is to collect water samples, carried out laboratory test over the water sample and cement, Sand and aggregate, analyze the test result and finally come to conclusion.

1) Determining the laboratory properties of all water samples i.e. Potable, Treated and Untreated
2) Determining the laboratory properties of ingredients used in concrete.
3) Casting of conventional concrete 3 cube, 2 cylinder and 2 beams as per design mix .
4) Casting of concrete using treated water and untreated water from WTP with 9 cube , 9 cylinder and respectively .
5) Let the cube cylinder and beam for curing
6) After 3, 7 & 14 days comportment compressive strength test, flexural strength test and split tensile test on cubes, beams and cylinder respectively.
7) Determining the compressive strength, flexural strength, tensile strength results of concrete and compare conventional, treated and untreated

B. Tests For Properties on Concrete Specimen

- **Compressive Strength Test**

From the result it is observed that the addition of untreated waste water has a little effect on the compressive strength. It is observed that the use of treated wastewater increases the compressive strength of concrete when the untreated waste water is used then reduction in compressive strength is observed. The decrease in compressive strength is observed when the untreated wastewater or direct sewage water get used. The use of untreated wastewater undergoes absorption in concrete, when the untreated water is use during mix the concrete absorb more percent of water as compare to treated waste water. Due to absorption of more water the concrete form by using untreated wastewater is of poor quality and does not give good strength.

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Figure 1: Compressive test carried out on concrete cube

- **Split Tensile Strength Test**

Figure 2: Cylinder Cracked during split tensile strength test

It is noted that with the use of untreated wastewater the split tensile strength decreases. The result shows that the split tensile strength increases with the use of treated waste water and gives similar results to that of potable water. The test was performed on CTM. The fig shows the setup for the split tensile strength test on CTM. The task of this test was performed to find the increase and differences of strength of concrete according to the use of different water.

- **Flexural Strength Test**

Figure 4: Flexural strength Test Apparatus

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4. 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. This research is also deals with the experimental results obtain from Ph test, Alkalinity test, acidity test and chloride content of different types of water. The experimental tests were carried out to obtain the mechanical properties of untreated wastewater concrete, treated wastewater concrete and the potable concrete. The comparisons of mechanical properties like compressive, strength split tensile strength and the flexural strength is carried out. Effect of corrosion due to wastewater is also studied. Observation for 3, 7 and 14 days curing period ware recorded and presented in the form of tables and graphs

A. Test Performed on Concrete

Compressive strength, Flexural strength and split tensile strength test results for M25 concrete.

For Conventional Concrete mix M25

Test results obtain for compressive strength, flexural strength and split tensile strength

- **Compressive strength for conventional mix M25**

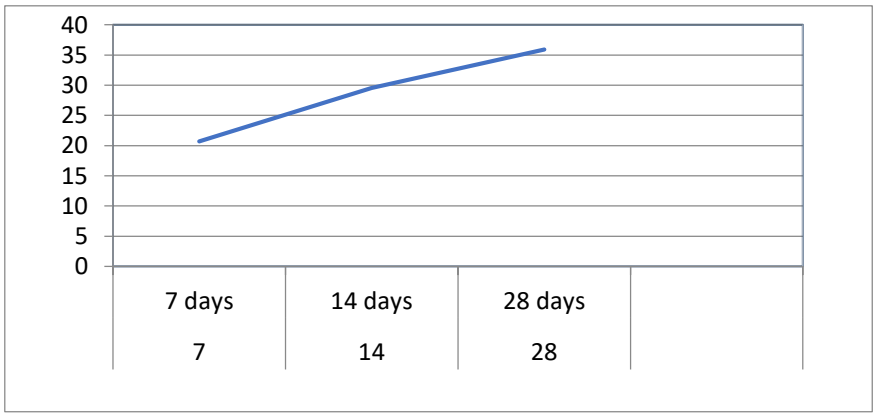

Figure 5: Compressive strength for conventional mix M25

From the above figure it can be seen that the conventional concrete has achieved satisfying results according to days of curing i.e. at 7 days period of curing the concrete has achieved about 60% results, at 14 days curing about 80% and at 28 days achieved 100%

Flexural strength for conventional mix M25

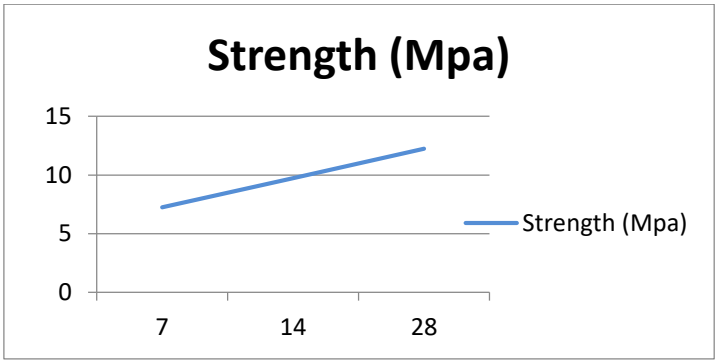

Figure 6: Flexural strength for conventional mix M25

From the figure, it can be seen that the flexural strength for the M25 mix of 7,14 & 28 days curing shows good gain in strength.

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- **Split tensile strength for conventional mix M25**

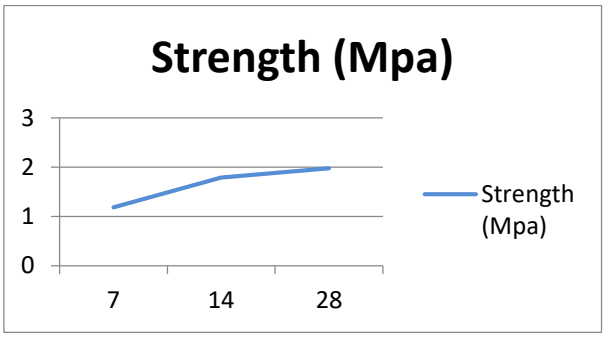

Figure 7: Split tensile strength for conventional mix M25

From the above figure it can be seen that the split tensile strength for 7, 14 & 28 days shows satisfying results.

B. Treated wastewater added concrete mix M25

Treated sewage wastewater is used in concrete with replace to potable water in concrete and from the tests results obtained for compressive strength, flexural strength and split tensile strength.

Compressive strength for treated wastewater added concrete.

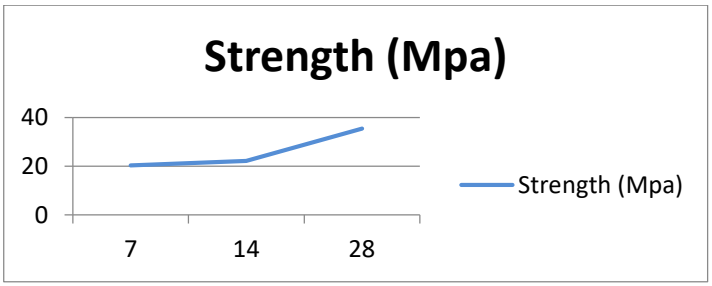

Figure 8: Compressive strength for treated wastewater mix M25

From the fig above plotted graph for the variation of compressive strength of concrete using treated wastewater shows similar results to that of conventional mix .

Flexural strength for treated wastewater added concrete

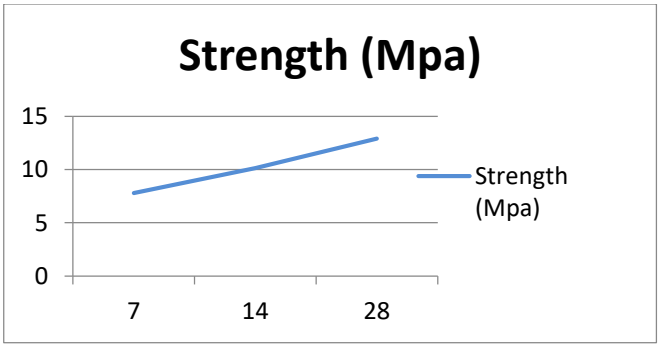

Figure 9: Flexural strength for treated wastewater mix M25

From the fig above plotted graph for the variation for the flexural strength of concrete for mix proportion of M25 using treated wastewater. The strength of conventional concrete is similar to the treated wastewater concrete but if we increase the curing days or time of curing then we

get the more strength than the conventional concrete. So we conclude that use of treated wastewater is preferable over the potable water.

Split tensile strength for the treated wastewater added concrete

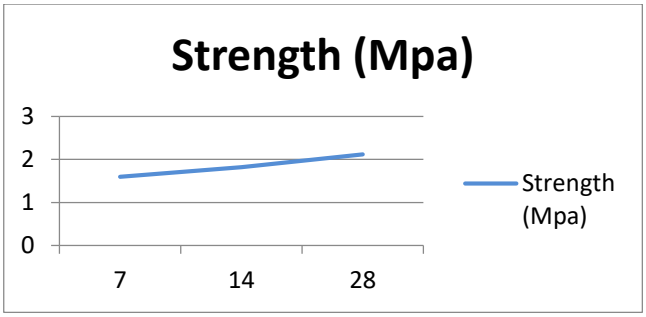

Figure 10: Split tensile strength for treated wastewater mix M25

From the fig above plotted graph for the variation of split tensile strength test of treated wastewater added concrete mix M25. The strength of conventional concrete and treated wastewater added concrete is similar and gives good strength. So we conclude that the use of treated wastewater concrete in place of potable is preferred.

C. Untreated wastewater added concrete mix M25

Treated sewage wastewater is used in concrete with replace to potable water in concrete and from the tests results obtained for compressive strength, flexural strength and split tensile strength.

Compressive strength for untreated wastewater added concrete.

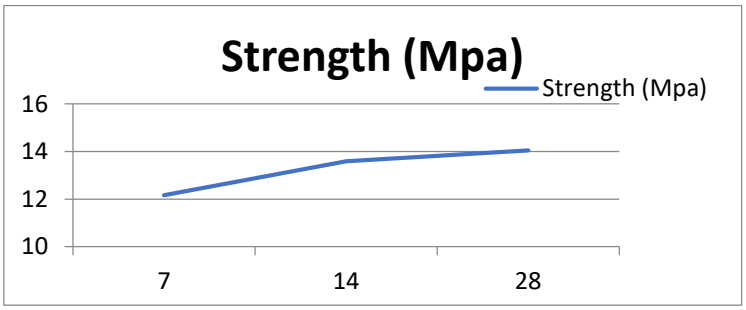

Figure 11: Compressive strength for untreated wastewater mix M25

From the fig above plotted graph for the variation of compressive strength of concrete using treated wastewater shows that the results are drop as compared to treated wastewater and conventional.

Flexural strength for untreated wastewater added concrete

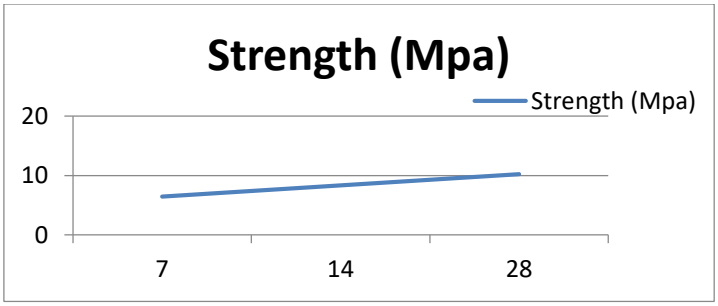

Figure 12: Flexural strength for untreated wastewater mix M25

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From the fig above plotted graph for the variation for the flexural strength of concrete for mix proportion of M25 using treated wastewater. The strength of conventional concrete is not similar to the Untreated wastewater concrete. The results of strength for untreated wastewater concrete decreases as compared to treated wastewater concrete. So we conclude that the untreated wastewater should not be used in concrete.

Split tensile strength for the untreated wastewater added concrete

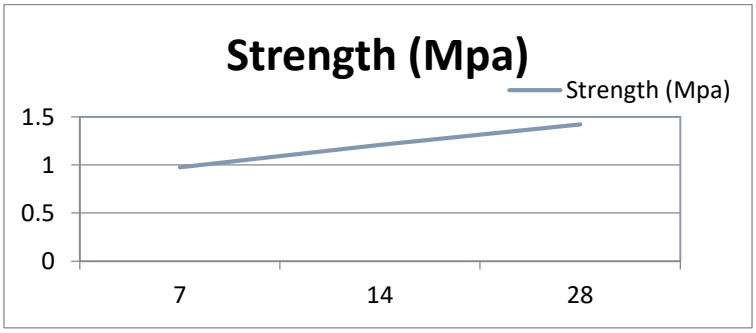

Figure 13: Split tensile strength for untreated wastewater mix M25

From the fig above plotted graph for the variation of split tensile strength test of treated wastewater added concrete mix M25. The strength of conventional concrete and treated wastewater added concrete is similar and gives good strength. So, we conclude that the use of treated wastewater concrete in place of potable is preferred.

D. Variation in the optimum percentage of potable concrete, treated wastewater concrete and untreated wastewater concrete.

Treated wastewater concrete and Conventional Concrete

- **Compressive strength at optimum percentage**

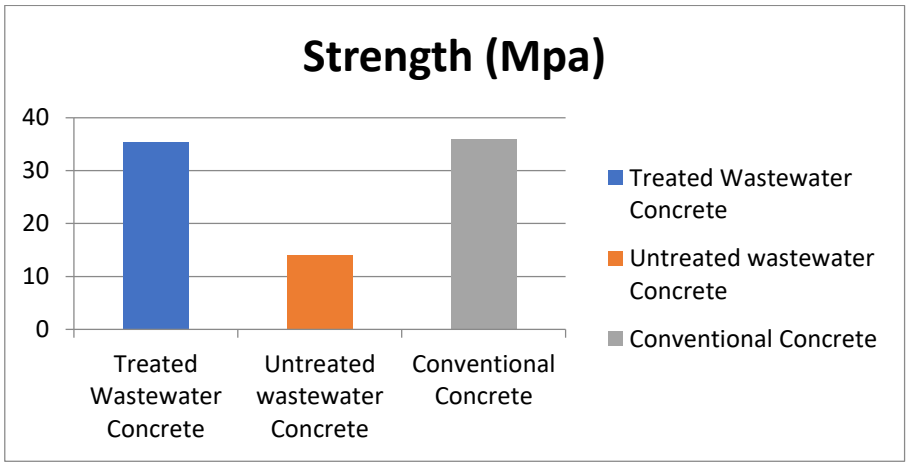

Figure 14: Compressive strength at optimum percentage

Bar graph from the figure above shows the variation in compressive strength for the type of water used in concrete mix. Here treated waste water and conventional mix gives comparatively same results but the untreated wastewater mix gives less strength. Treated waste water concrete mix satisfied the target strength but the untreated wastewater concrete mix cannot satisfy the target strength.

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- **Flexural strength at optimum percentage**

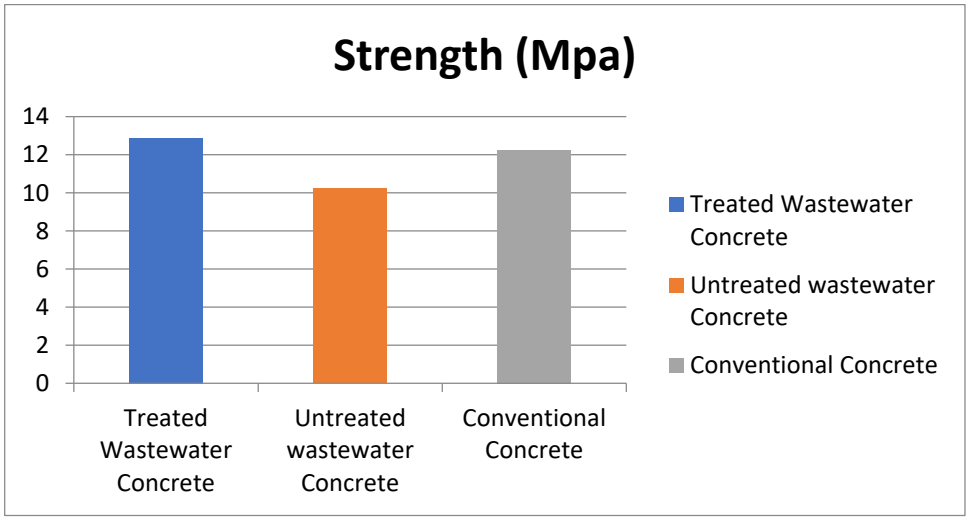

Figure 15: Flexural strength at optimum percentage

Bar graph from the figure above shows variation in flexural strength for the different types of water used in concrete mix. Here treated wastewater shows comparatively good strength than that of conventional concrete and untreated wastewater. The strength for treated wastewater concrete and conventional concrete satisfying the target strength.

- **Split tensile strength at optimum percentage**

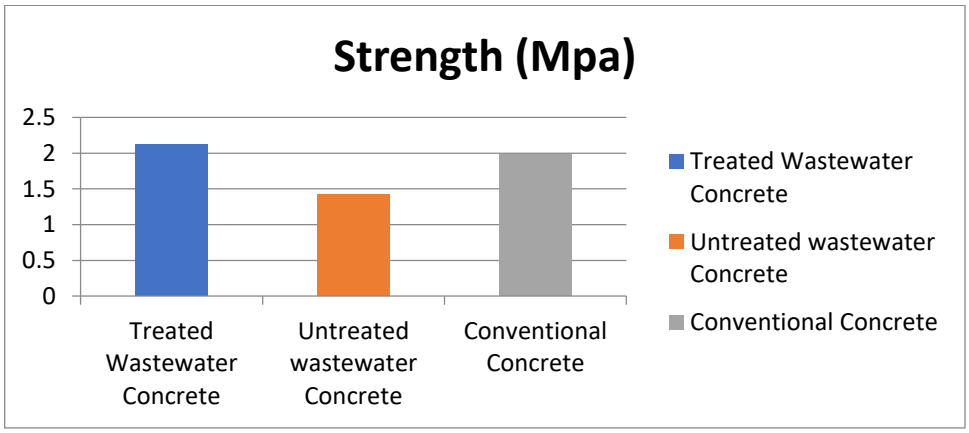

Figure 16: Split tensile strength at optimum percentage

From the fig above split tensile strength for treated wastewater shows highest results than untreated wastewater and Conventional concrete.

E. Effect of corrosion on reinforced bars

Corrosion of reinforced bars is the most important part of the concrete structure. The type of water used affects the corrosion property of reinforced bars. As the properties are concrete important during replacement of water in such a way the effect of corrosion is also important. In this research to understand that effect of corrosion we performed an small test in our laboratory by using different diameter of bars in different types of water.We use 10mm, 12mm and 16mm bar for the test and also the bar of diameter 16mm which is coated is also used.

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Procedure :

1) Collect the different diameter of bars which we were used in our regular construction work.
2) Take 3 samples of each bar
3) Dip that bar separately in different type of water i.e. Potable water, Treated wastewater and Untreated wastewater.
4) Wt the water properly before imbedded the bar in it and after removal of bar
5) From that wt calculate the results obtain.

We performed this test for the duration of 24 hour: From this test we observed that the corrosion of bar in untreated wastewater is more as compared to treated and treated wastewater is more than the potable. But if we use the coated bar in construction then the treated water affects less and the corrosion due to treated wastewater is similar to the potable one.nThere are some figures which shows the corrosion effect due to due of different types of water as follows:

Figure 17: Effect of corrosion on reinforced bars

The Above figures shows the effect of corrosion due to use of different types of water.

5. CONCLUSION

This research focus on implementing a sustainable practice in construction technology, such as performance of Treated Effluent on Concrete. Based on this sustainable practice used in this research following conclusion is presented.

1. From the experimental results, it can be concluded that use of treated wastewater shows the highest compressive strength like predictable strength. The flexural strength, split tensile strength is initiate to have highest value for treated wastewater. If we increase curing days then the strength increases than conventional flexural strength.
2. Treated wastewater in concrete mix proved to be very useful to solve environmental problem. Therefore, it is suggested to re-use the unsurprisingly treated sewage wastewater in concrete to move towards sustainable development in construction industry with proper care of the corrosion effect due to treated wastewater is more than the potable water.
3. Consequentially, sustainable practice in construction industry shows the potential for achieving economy with serviceability in long term effect.

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