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Use of Sewage Treated Water in Concrete

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***Abstract*: Effective utilization of the available resources is imperative approach to achieve the apex of productivity. The modern world is focusing on the conditioning, sustainability and recycling of the assets by imparting Innovative techniques and methodologies. Keeping this in view, an experimental study was conducted to evaluate the strength of concrete made with treated waste water for structural use. In this study mixes with coarse aggregates in combination with FW (Fresh Water), TSW (Treated sewage water). The workability of Fresh concrete was checked before pouring of cylinders. The test cylinders were left for 7, 14, 21 and 28 Days for curing. After curing, the compressive strength was measured on hardened concrete cylinders accordingly. Test results showed that workability of all the four mixes were between 25-50mm but ultimate compressive strength of concrete with WW was decreased and with TWW, TS at the age of 28 days do not change significantly. This research will open a new wicket in the horizon of recycling of construction materials. The conditioning and cyclic utilization will reduce the cost of the construction and building materials as well as minimize the use of natural resources. This novelty and calculating approach will save our natural assets and resources.**

***Keywords*: Recycled Aggregate, Fresh Water, Wastewater, Treated Wastewater, Treated Sewage, Concrete, Compressive Strength.**

1. Introduction

Due to growing agriculture, urban and industrial needs, water tables in every continent are falling, by this the drinking water resources are becoming scare. It is suggested that with water, practical large scale solution is to use the resources which are not currently efficient. The most widely used construction material is concrete, commonly made by mixing Portland cement with sand, crushed rock (aggregates) and water. Normal concrete contains about 70 % aggregate, 20% cement and 10% mixing water by mass approximately. Concrete industry is consuming annually 1 billion tons of mixing water in the world. Moreover, large quantity of fresh water id used for curing of concrete. The concrete industry has therefore serious impact on the environment with regard to consumption of water. Therefore, there is a need to study alternative to fresh water for mixing and curing of the concrete. Water is used for domestic and industrial purpose from surface water body and underground water sources all over the world. In last few decades, there has been a tremendous increase in both domestic wastewater and industrial wastewater generation due to rapid growth of population and accelerated pace of industrialization. Almost 80% of the water used for domestic purpose comes out as wastewater. Impurities in water used for mixing concrete, when excessive, may affect not only the concrete strength but also setting time. Therefore, certain optional limits may be set on chlorides, sulphates, alkalis and solids in mixing water or appropriate tests can be performed to determine the effects the impurity can have on various properties.

2. Literature review

Paper 1: secondary treated waste water construction by Vidhya lakshmi and Arul gideon

Human life, as with all animal and plant life on the planet, is dependent upon water. Not only do we need water to grow our food, generate our power and run our industries, but need it as a basic part of construction purpose. Now at a present stage of water is in great demand of construction field.so as to fulfill the demand of this project the water used in concrete is replaced by secondary treated waste water from sewage water treatment plant. Sewage treatment is process of removing contaminants from waste water and household sewage, both runoffs, domestic, commercial, and institutional. It includes physical, chemical, and biological processes to remove contaminants. The aim of the present research work is to investigate the possibility of using the secondary treated waste water for the purpose of construction works on continuous basis. By evaluating and comparing the compressive and tensile strength of the convectional concrete cubes and secondary treated water concrete cubes it is found that the strength obtained is greater in secondary treated waste water concrete cubes. Hence, on the continuous basis secondary treated waste water can be used for the construction purpose. Tests performed in this study suggest the secondary treated wastewater is an interesting candidate for use in concretes for applications in the mixture. There is significant increases in the load carrying capacity, the compressive strength of the secondary treated wastewater concrete when compared with the convectional concrete. The compressive strength is 9.62% more in case of concrete cubes confined with secondary treated wastewater. Concrete prepared by using secondary treated wastewater gives aesthetically pleasant appearance. It is found that the compressive strength and tensile strength in secondary treated wastewater concrete increases when compared with the convectional concrete. Sewage is generated by residential, institutional, commercial and industrial establishment. It includes household waste liquid toilets, kitchen, bath, sinks and so forth that is dispose of via sewers. In many areas, sewage also includes liquid waste from industry and commerce. The separation and draining of household waste into grey water and black water is becoming more common in the developed world, with grey water being permitted to be used for watering plant or recycled for flushing toilets. Sewage may include storm water runoff. As rainfall travels over roofs and the ground. It may pick up various contaminants including soil particles and other sediments, heavy metals, organic compounds, animal waste, oil and grease. From the experimental results following conclusion are made:

- Test performed in this study suggest that secondary treated wastewater is an interesting candidate for use in concrete for application in the mixtures.
- There are significant increases in the load carrying capacity, the compressive strength of the secondary treated water concrete when compared with convectional concrete.
- The compressive strength is 9.62% more in case of concrete cubes confined with secondary treated waste water.
- Concrete prepared by using secondary treated wastewater gives aesthetically pleasant appearance.
- It is found that the compressive strength and tensile strength in secondary treated water concrete increases when compared with the convectional concrete.

Paper 2: the reuse of treated domestic waste water in concrete in concrete by pritam chandake, sagar maniyar and yogita narute

With current crises water in India there is need to look for alternative sources of water. India discharge Treated Waste Water in natural water bodies, which can be used in construction industry, water samples used were primary treated waste water, secondary treated waste water, grey water and tap water. Parameters of water were tested which was found well as per IS 456-2000 limits. Using TWW tests were conducted on cement, fresh and harden concrete. Initial and final setting time for STWW was same as TW but not for PTWW and GW. For compressive strength concrete cubes for 3, 7, 28 and 60 days and cement mortar cubes for 7 and 28 were casted. For tensile strength cylinders and for flexural strength beams were casted for 28 days. An experimental investigation was carried out to evaluate the feasibility of treated waste water in concrete. We had performed various experiments on cements, fresh concrete and harden concrete. Cement, fly ash, fine aggregate, coarse aggregate, PTWW, STWW, GW and TW were used under guideline of IS standards. As the quality of mixing water deteriorates it affects consistency of cement. The consistency of cement paste using STWW increases by 1.785% as compared to TW. The consistency of cement paste using PTWW and GW is more than STWW. As per IS guidelines consistency of cement is 24-30% of cement. So the results obtained are within permissible limits. As the salt present in water it affects the time of setting and the dissolved organic matter retards the time of setting. The initial setting time of cement paste for PTWW and GW is more than STWW. As per the recommendations 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. The initial and final set setting time of cement paste is as per guidelines recommended by IS 456: 2000.

- The consistency, initial and final setting time of cement paste by mixing STWW is within the IS limit.
- The compressive strength of mortar is increased by mixing STWW at the end of 28 days.
- The compressive strength of concrete is increased by mixing STWW at the end of 60 days.
- There is no significant difference in tensile strength and flexural strength is improved by using STWW.
- The reinforcement should be provided with different cover of concrete.
- The preparation of concrete for different grades concrete like M40, M45, M50 etc. For more accurate results.
- The concrete preparation by adding different admixtures so that effect of admixtures on the properties of concrete can be determined.

Paper 3: study on compressive strength of concrete by using treated domestic waste water as mixing and curign of cement by vinut kulkarni, suresh g patil and shivasharanappa

The authors deal with introduction to treated domestic waste water utilized in concrete preparation where there is a scarcity of fresh water. They discussed practical properties of materials and chemical properties of treated domestic waste water. Experimental program was presented in their research for mix proportion of M20, M40 Grade concrete. Number of specimens to be cast for different curing regimes were also presented in the paper. It also elaborated average compressive strength results M20 grade concrete cast by using tap water as mixing and curing water for mix M2. Discussion of result covers, M20 grade concrete at the age of 7 days the average compressive strength for all the 2 mixes is nearly same. At the 28 days curing age decrease in compressive strength was observed. This decrease is compressive strength may be due the use of treated domestic waste water for mixing and curing. Curing is done by immersing the specimens in curing ponds of laboratory tap water and treated domestic waste water under regular supervision. For each of these above three mixes, three curing ages were selected i. e. 7 days, 14 days. 21 days and the types of curing waster were used.

Three specimens cast and cured by using 100% tap water and three specimens and cast and cured by 100% lab tap water. From this study it was observed that decrease in compressive strength may be due to the presence of bicarbonates content (647mg/l) higher than the permissible limit compared to the allowable limits (400mg/l). It is observed that 7 days compressive strength for the 2 mixes is nearly same. At the age of 14days marginal increase in strength is observed. Increase in compressive strength is observed at the age of 28days for all the 2 mixes. All the 2mixes have resulted in compressive strength higher than the target strength. At 28 days curing age decrease in compressive strength M2. This decrease in compressive strength may be due the use of treated domestic waste water for mixing and curing. It is observed that 7 days compressive strength for all the 2 mixes is nearly marginal increase in compressive strength is observed for all the 2 mixes. Increase in compressive strength is observed at the age of 28days for mix M3 but in case of mix M4 compressive strength same. At the age of 14days decreases compared to 14days compressive strength results. The mix M3 resulted in compressive strength higher than the target resulted in compressive strength lower than the target due to the use of treated domestic waste water for mixing strength but the mix M4 strength, this decrease in strength may be curing. Lowest strength is exhibited by mix mean or M4 i.e. 43.45Mpa is less than the target mean strength of 48.25Mpa. From this study it is observed that decrease in compressive strength may be due to the presence of bicarbonates content (647mg/l) higher than the permissible limit compared to the allowable limits (400mg/l)

3. Methodology

A. Flowchart of the methodology

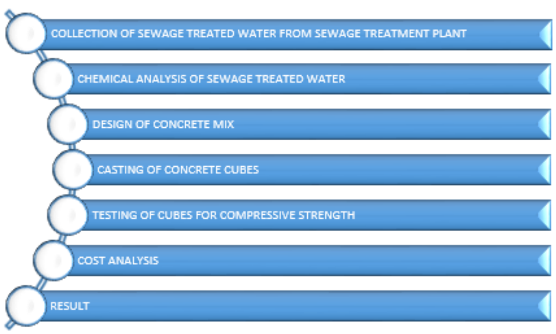

Fig. 1. Flowchart of the methodology

4. Results and discussion

Based on the chemical analysis of treated sewage water and the testing of cubes made with that water, following results were observed:

Table 1
Results of chemical Analysis of Treated Sewage Water

S. No.	Name of Test	Results	Permissible Limits, Max. (As Per Is 456:2000)
1.	Total Suspended Solids	1498 Mg/L	2000 Mg/L
2.	Sulphates	14 Mg/L	400 Mg/L
3.	Ph Value	6.9	Should Not Be Less Than 6
4.	Alkalinity	188 Mg/Lit As $Caco_3$	3000 Mg/L
5.	Chloride	124.08 Mg/L	2000 Mg/L
6.	Total Solids	1686 Mg/L	5000 Mg/L

A. Discussion

From the studies and tests performed earlier, it is clear that the treated sewage water is an interesting candidate for use in concreting for the application in construction works. The treated sewage water is found to be fit in the chemical analysis conducted on it, all the impurities or say suspended matter are under the permissible limit. This treated sewage water can also be used the curing water, as it is satisfy the chemical standards to be fit for the same. The treated sewage water when used in concreting or making concrete specimen cube, the compressive strength of cubes were satisfactory, in fact the cubes made with the treated sewage water attained more compressive strength. The compressive strength is 10.830% more in case of concrete cubes prepared by using treated sewage water. Also it was observed that the concrete cubes prepared by using treated sewage water give aesthetically pleasant appearance.

Table 2
Compressive Strength of Concrete Cubes

S. No	Grade of Concrete	Water Used	Age (in Days)	Compressive Strength(N/Mm)
1.	M20	Treated Sewage Water	7 14 28	30.96 39.40 49.2
2.	M20	Tap Water	7 14 28	23.9 34.66 38.37
3.	M40	Treated Sewage Water	7 14 28	29.92 41.03 51.25

5. Cost analysis

A. Cost Involved in the construction related to water

The cost of transportation and purchasing water for the concreting work is the major constituent in the total cost of any construction project. Water is used for many purpose on any construction site like, concreting, curing, flooring, plastering, and many more things. Sometimes the demand of water of construction site is fulfilled by natural resources of water like pond, river, and well or bore well etc. but when the natural resources is not available then procurement of water done commercially. And due to rapid exploitation of natural water resources and the unavailability of fresh water the rates of water for commercial use is increasing day by day. Hence the old idea of recycling the water can be of use to meet the demand of water in construction field. Suggested by our study, the use of treated water can be beneficially in cost cutting of the construction project.

B. Cost of normal (conventional/fresh) water in any construction work

Suppose a construction site functioning in Akurdi, requires 3 water tankers of 5000 liters capacity each to fulfill its demand at the rate of Rs. 800 per tanker, Then the cost of water for one day = 3*800=Rs. 2400 And if the site runs for average of 180 days then he cost spent only on water will be approximately 4 lacs.

C. Cost of treated sewage water in any construction work.

As mentioned in the previous section the cost of water is a big amount included in the budget of any project. Majorly the cost of water included the transportation cost of water and cost of water.

If the sewage treated water is used in the construction practices, then the cost of water will only include the transportation cost of water because the sewage treated water can be available freely at any government STP. The treated water is however discharged into the natural stream without being of much significance, rather than that it can be used to supply water to construction sites. So if the treated water can be available freely or at a very nominal charge then the transportation cost only remains as the cost of water. Suppose the maximum transportation cost be Rs. 20 per Km, and if the nearest STP is situated 20 km away from the construction site even then the cost of water would be, cost of water (includes only transportation cost) = 20*20=Rs. 400.

Hence it can be concluded that if the treated sewage water is used in construction practices then it can cut half of the cost of water required to fulfill the demand.

6. Conclusion

We have studies and performed various test on the sewage water and as a whole the studied concluded that, the treated sewage water can be used concreting as a chemical test give positive results and the impurities / suspended matter are under permissible limits. Also when this water is used to prepare concrete cubes under normal condition, then those cubes gives satisfactory result of compressive strength.it is observed that the compressive strength of the cubes made with the treated sewage water is more than the cubes made with normal tap water. This implies that the treated sewage water used in concreting works under normal condition. The use of treated sewage water is economical than the use of convectional water and help in conserving the portable fresh water for other life giving purpose rather than construction. Commercial use of treated sewage water also encourages the authorities to set up more sewage treatment plants to achieve the capacity of water recycling. The objective of sustainable development can be achieved through the use of sewage treated water. Regarding the durability of concrete made with the treated sewage water, it can be concluded that, if the treated sewage water satisfies the required limits and purify the standards as mentioned in the IS 456:2000, then it can definitely satisfy the durability demands. For getting a more clean and commercial view, we can work out on this project on real ground and use of treated sewage water in construction practices, and we think that the water recycled from STP deserves a chance to be used in concreting works so that the valuable portable water can be saved for other purposes.

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