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EFFECT OF TREATED SEWAGE EFFLUENT ON RCC ELEMENTS

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ABSTRACT

Infrastructural development is increases day by day throughout the world. Water is playing vital role in construction industry which is an important element required to develop infrastructural growth. As far as water availability is concern, fresh water on earth is only 2 %, perhaps the most critical environmental problem in several countries. The concrete industry alone uses over one trillion gallons of water each year worldwide. In addition, the use of water for industrial purpose increases. Therefore, it is essential to conduct research, to find out substitution of potable water by reclaimed water or treated sewage effluent to produce good quality of concrete. This research work deals with the effect of treated sewage effluent on the properties of RCC elements with respect to potable water. Prime objective of this research is to find out the feasibility of utilizing treated wastewater and untreated sewage wastewater for preparing the RCC elements of M25 grade with locally available material, which helps in environmental conservation using treated effluents as alternative to the potable water for mixing concrete which would in turn save large amount of fresh water. Detailed study with the effect on the casted concrete elements was done. Also, from this study it has been observed that there are not much significant differences in strength properties of RCC elements casted with treated sewage effluent as compared to elements casted with potable or tap water.

Keywords: Treated sewage effluent, compressive strength, flexural strength, corrosion.

1.0 Introduction

Population increases day by day in India. With the increasing population the water consumption is also increasing, which results is increased wastewater generation. Managing wastewater is one of the challenges nowadays. Water is required for industrial as well as construction purpose along with domestic needs. In construction industry there is no substitute for concrete and construction industry required ample amount of potable water for concreting and curing process. It seems to be very important part of structure. As far as use of water in construction is concern, we need to find out a solution/alternate way to reduce a water consumption or we must start a reuse of water.

Effluent is sewage that has been treated in a septic tank or sewage treatment plant. It is referred as “Trade effluent” or wastewater. Sewage effluent contains industrial waste, municipal waste, animal remains and slaughterhouse wastes, water and wastes from domestic baths, utensils and washing machines, kitchen wastes, fecal matter, and many others. It can be produced or discharge by any industrial or commercial premises. Sewage effluent means sewage after it has undergone at least one form of physical or biological treatment, flowing or pumped out of the sewage treatment plant.

The sewage effluent samples were collected from the sewage treatment plant. The sewage effluents are tested in the laboratory to find the chemical properties of water such as pH, Total Suspended Solids, BOD, COD, Alkalinity, Determination of chloride content. Sewage treatment is a type of wastewater treatment

which aims to remove contaminants from sewage to produce an effluent that is suitable for discharge to the surrounding environment or intended reuse application, thereby preventing water pollution from raw sewage discharge. Sewage treatment may often involve two main stages called primary and secondary treatment, while advanced treatment also incorporates a tertiary treatment stage with polishing process and nutrient removal. Secondary treatment can reduce organic matter (measured as biological oxygen demand) from sewage, using aerobic and anaerobic biological process. The main criteria for selection are desired effluent quality, expected construction and operating costs, availability of land, energy requirements and sustainability aspects.

In the present research, treated sewage effluent is used for casting RCC elements. Subsequently, all properties of the concrete elements are accessed and compared with the control specimen, which will be produced with fresh water. This approach in turn will lead to sustainable kind of approach where the replacement of potable water will find its place and will help us protect environment ultimately. The main objective of this research is to investigate the possibility of utilization of sewage wastewater in concrete mix. Therefore, considering the demand for the large amount of potable water all over the world, replacing it with sewage wastewater can provide economic and environmental benefits on global scale.

Figure 1: Treatment of wastewater

(a) **(b)**

Figure 2 (a) Treated wastewater (b) Untreated wastewater or Sewage water

2.0 Literature Review

As our population continues to grow, demands on precious water resources increase. There are many opportunities to use household water more efficiently without reducing services. Keeping in view of saving major environment resource many studies are available which suggests using treated sewage effluent an alternative source of water in construction industries and present results of its strength properties. Some of the case studies are given below:

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Table No. 1: Literature Review Details

Sr. No	Author	Title	Remark
1	*Ayoup M. Ghrair*	"Influence of grey water on physical and mechanical properties of mortar and concrete mixes"	Evaluate the potential of reused grey water in concrete and mortar in order to preserve fresh water for drinking purposes
2	K. Nirmalkumar	"A Study on The Durability Impact of Concrete By Using Recycled Wastewater"	The basic properties of the treated and untreated water from the tannery industry were tested and the results were found to be satisfactory such that it can be used for construction purposes with some minimal treatment.
3	Ehsan Nasseralshariati	"Use of Industrial Waste water"	Using recycled materials and gray water can considerably contribute to the sustainability aspect of concrete production.
4	Micheal M. Farouk Mohamed and Michael M. Farouk	Use of secondary treated wastewater in production of concrete and curing	To examine the influence of using treated wastewater in the procedure of mixing and curing concrete cubes. Some of the concrete cubes will be mixed using potable water, while others will be mixed using secondary treated wastewater.
5	Ayoup M. Ghrair	Reuse of Grey Water in concrete	To evaluate the potential of reused grey water in concrete and mortar to preserve fresh water for drinking purposes. Using both Treated Grey Water and Raw Grey Water (TGW and RGW, respectively) led to a significant increase in the initial setting time and a decrease in the concrete slump value
6	H.El-Ghorab	Effect of Using Treated Wastewater in Mixing and Curing of Concrete on its Compressive Strength	To identify the effect of using treated wastewater in mixing ang curing of concrete on its compressive strength to identify the suitability of its usage.
7	Mayuresh S. Bajbalkar	Reuse of Effluent	The wastewater collected is mainly from domestic. After secondary or tertiary treatment, the water is released. So, it is possible to reuse the effluent water for construction (mainly for Concrete casting & curing.
8	Chikoti Sateesh	Design of concrete mix by using treated magnetised wastewater	investigates and presents the effect of "magnetisation" on the compressive strength of concrete mixed with different treated wastewater. In this technology, by passing water through a magnetic field, some of its physical properties change.

From the literature review it has been observed that a incredible work has been done to study the effect of Wastewater on properties of concrete. Various studies show satisfactory results on the properties of concrete when casted with treated sewage effluents and has not much adverse effect on concrete but no one mainly focuses on strength parameters of RCC elements casted with treated sewage effluents and its effect of corrosion on steel in concrete. so, in this research we focus on same.

3.0 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:

Aggregate and cement testing

Sieve analysis

Mix Design

Water testing

Concrete Mixing and curing.

Basically, this research is designed to investigate the behavior of treated sewage effluent when used in RCC mix. For this purpose, mainly beams and columns were casted and tested under flexure and compressive loadings respectively. M25 grade concrete is used for casting RCC beams and columns. Conventional RCC beams and columns of same grade are casted to compare results in both cases.

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 water.
2) Determining the laboratory properties of ingredients used in concrete.
3) Casting of conventional (using potable or tap water) 9 RCC beams and columns each of size 150 x 150 x 700mm.
4) Casting of 9 RCC beams and columns each using treated water of size 150 x 150 x 700mm.
5) For curing purpose all the specimens were kept under curing taking for 7, 14, and 28 days.
6) After 3, 7 & 14 days of curing RCC beam specimens were tested for flexure and RCC columns were tested under compression loadings.
7) Results of flexural strengths of RCC beams and compressive strengths of RCC columns casted using treated sewage effluent were taken and compared with the conventional one's.
8) After 28 days of curing and final compressive strength testing on RCC columns casted of both waters i.e. treated and tap water, the specimens were broken and the bars from the it was taken out and tested under UTM machine to test for ultimate load of bar so as to access if there was any effect on the corrosion on bars if treated sewage effluent is used.

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B. Tests Performed on RCC Specimen

1. **Columns tested for Compression**

Figure 3: RCC Column Placed Under & UTM Crack in RCC column at the ultimate load

2. **Flexural Strength Test**

Figure 4: Flexural strength for center point loading

3. **Ultimate tensile strength test**

Figure 5: Tensile splitting of 10mm bar

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4.0 Results and Discussion

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 RCC ELEMENTS

RCC columns and beams were tested under compression and flexure respectively for M25 grade concrete and results were recorded.

1. RCC elements casted using tap water of M25 grade

Test results obtained for compression and flexural strength are as follows:

- Axial load carrying capacity of RCC columns casted using tap water for M25 grade

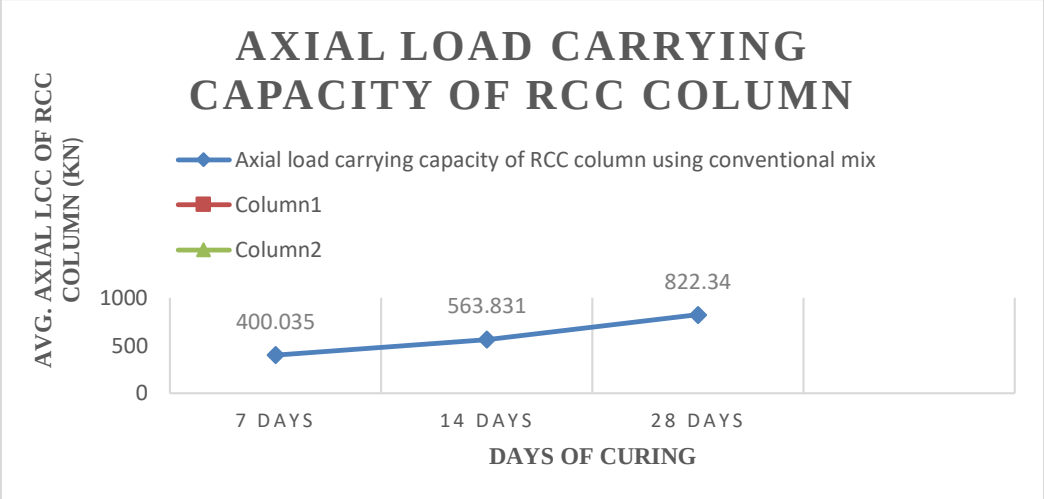

Figure 6: Axial load carrying capacity of RCC columns casted using tap water of M25 grade

From the above figure it can be seen that the RCC columns casted using tap water have 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 of RCC beams casted using tap water for M25 grade

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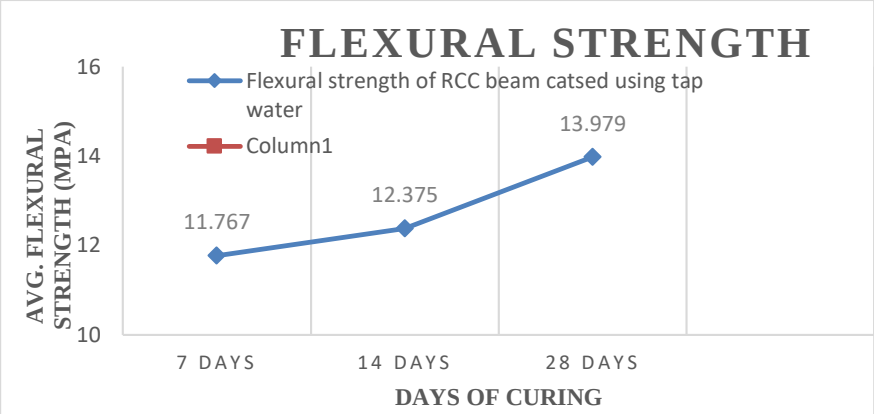

Figure 7: Flexural strength of RCC beams casted using tap water for M25 grade

From the figure, it can be seen that the flexural strength of RCC beams casted using tap water for M25 grade for of 7,14- & 28-days curing shows good gain in strength. With the increase in days of curing the strength has been consistently increasing.

2. RCC elements casted using treated sewage effluent for M25 grade

Treated sewage effluent is used in concrete with replacement of tap water in concrete mix and the tests results are obtained for compressive strength and flexural strength which are as follows:

- Axial load carrying capacity of RCC columns casted using treated sewage effluent.

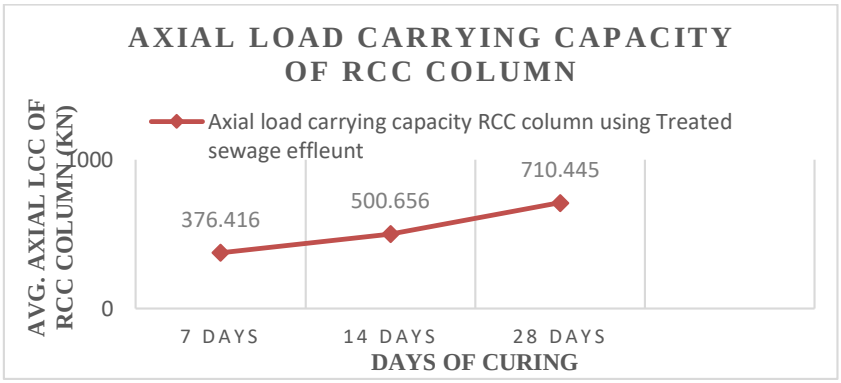

Figure 8: Axial load carrying capacity of RCC columns casted using treated sewage effluent

From the fig above plotted graph for the variation of compressive strength of RCC columns using treated wastewater shows approximately similar results to that of RCC columns casted using tap water. There is not much distinct effect on compressive strength on RCC columns from both the cases.

- Flexural strength of RCC beams casted using tap water for M25 grade

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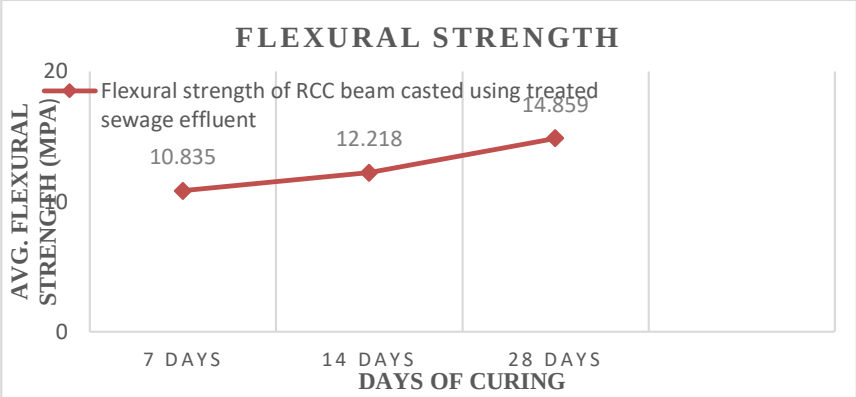

Figure 9: Flexural strength for RCC beams casted using treated sewage effluent

From the fig above plotted graph for the variation for the flexural strength of RCC beams for mix proportion of M25 using treated wastewater shows gain in strength over the period of curing. The strength of conventional concrete is approximately similar to the treated wastewater. Hence can be preferably used in construction practices over the potable water.

3. Variation in Strengths of RCC Elements

- Axial load carrying capacity of RCC columns

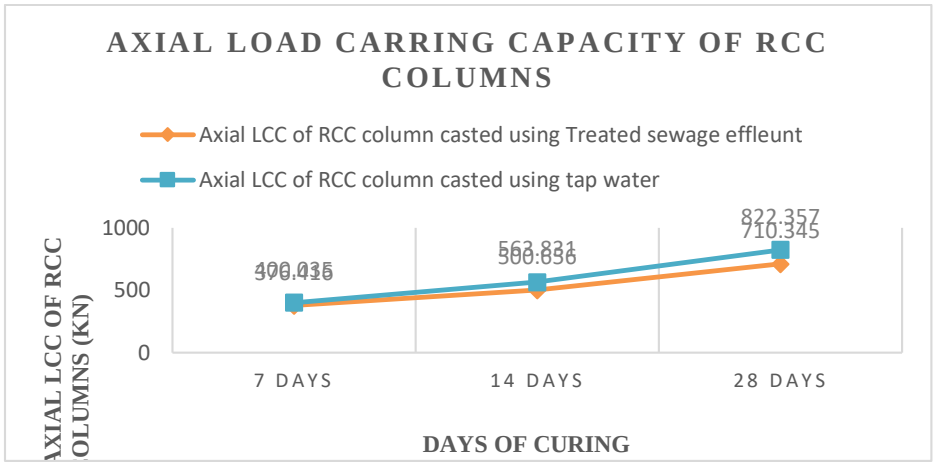

Figure 10: Variation in Axial LCC of RCC Columns

Graph from the above figure shows the variation in load carrying capacity for the type of water used in concrete mix. Here treated wastewater and potable water mix gives comparatively same results. Treated sewage effluent used in concrete mix has achieved satisfied the target strength when compared to the tap water concrete mix in RCC columns. Variation in the results of both the cases do not show much differences in LCC gained over the period of curing.

- Flexural strength RCC beams

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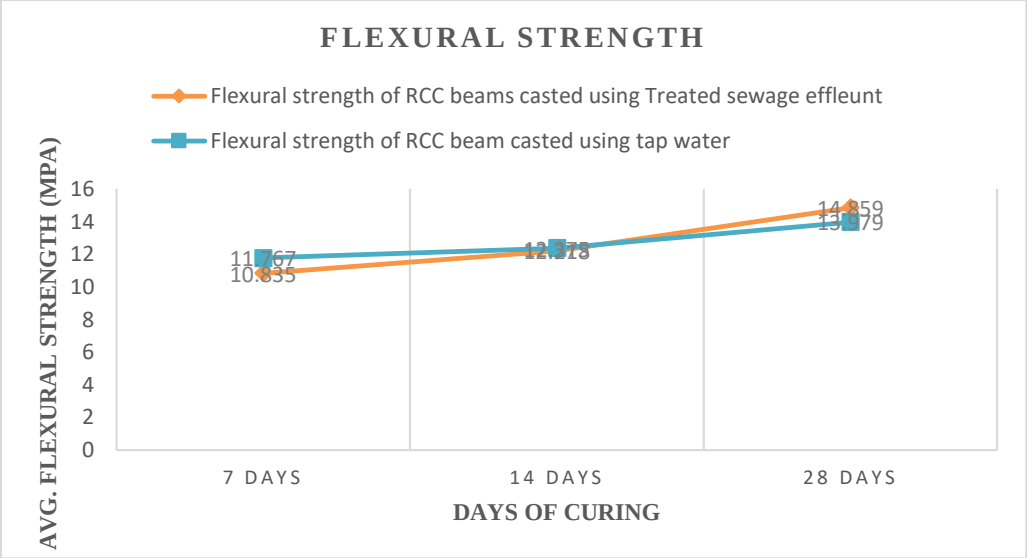

Figure 11: Variation of Flexural strength of RCC Beams

Bar graph from the above figure shows variation in flexural strength for the different types of water used in concrete mix. Here treated sewage effluent concrete mix has gained sufficient flexural strength with the increase in curing period. It can be seen that after 28 days of curing flexural strength is slightly the differences are not so drastic but gives us the clear idea that there not much noticeable effect on the strength when compared.

4.ULTIMATE TENSILE STRENGTH TEST OF STEEL

Test results after conducting the tensile strength of 10mm diameter bars from RCC columns of both treated sewage effluent specimen and of potable water casted specimen cured for 28 days are as follows:

- Variation of Ultimate tensile strength of 10 mm diameter bars

Table No. 2: Variation of Ultimate tensile strength of 10 mm diameter bars

Ultimate Tensile Strength (Mpa)	Bars from Tap water sample	Bars from Treated sewage effluent sample	Normal Bar
Sample 1	631.526	645.532	634
Sample 2	645.532	630.253	644
Average	638.529	637.892	640

The main purpose of conducting ultimate tensile strength of bars of column just to study the effect of treated sewage effluent on bars when compared to the potable water specimen if there is any corrosion on the bars due to which it may show variation in ultimate tensile strength of bar. But we have observed that the ultimate tensile strength of bars from both the cases shows nearly same strength and treated sewage effluent has no adverse effect of corrosion on bars and hence can be preferably used in RCC construction purposes.

Conclusion

Based on overall results, analysis and comparison in terms of properties such as compressive strength of

RCC columns, flexural strength of RCC Beams and tensile strength of bars and also the behavior of overall RCC elements casted using treated sewage effluent, the conclusion drawn are as follows:

1) From the experimental results of load carrying capacity, the RCC Columns casted using treated sewage effluent has about similar strength after 28 days of curing when compared with the elements casted using tap water. So, it is clear that there is no such drastic effect on overall average load carrying capacities in both cases and treated sewage can be effectively used.
2) The flexural strength of RCC Beams increased with the duration of curing and RCC beams casted using treated sewage effluent have shown significant increase in strength after 28 days when compared to the elements casted using tap water. Flexural strength for the 7 and 18 days of curing nearly same values in both the cases when compared.
3) Moreover, the tensile strength of bars of RCC specimen casted using treated sewage effluent and tap water shows approximately same strength i.e. there is no adverse effect of treated sewage effluent on bars of specimen cured for about 28 days. Though the corrosion factor is being related to the durability and cannot be assessed so quickly but the initial process thus start from the formation of corrosion film around the bars and that was also found to be negligible.
4) Form the observation of results we can say that there is no much effect on strength properties of RCC elements from both the cases and the naturally treated sewage effluent can be effectively used in construction practices replacing the tap water which in turn helps in saving of resource and guides a way towards sustainable approach as well in construction industry.

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