

Investigation on Usage of Grey Water in Production of Concrete

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ABSTRACT:Water is one of the important ingredients of concrete and most used material in construction practices. As the discharge of grey water within the urban areas is huge, the possibility of its reuse in construction industry is investigated. This paper states the study of grey water treatment using part of construction debris and reutilising the treated grey water in production of concrete. Concrete mix of M20 grade was used. Compressive strength test, flexural strength, split tensile strength tests were done in order to study the properties of concrete made by using treated grey water. Comparison was done between results of concrete made using treated grey water to that of concrete made using tap water.

KEYWORDS:Construction debris, Concrete strength, Treated grey water.

I. INTRODUCTION

The need of water is the most undefined subject. It was listed in 2019 by the world economic forum as one of the largest global risks in terms of potential impact over next decade. Two-thirds of the global population (4 billion) live under the conditions of severe water scarcity at least 1 month in a year. Even at the current stage of today's life, many people in many areas of India spend their entire day searching for water. By 2025, it is estimated that India will be facing some water crisis as per IWMI (International water management institute). The concrete industry alone uses over one trillion gallons of water each year worldwide, not including wash water and curing water. As per IS 10262-2009, 186 litres of water is required for 1 m³ of concrete. On average 150 litres of water is required for 1m³ of concrete. Construction industry demands huge quantity of potable water which is becoming scarce day by day.

Considering the increase in population and construction in India, treated grey water may become continuous and potential source of water. Grey water is the relatively clean water from baths, sinks, washing machines, and other kitchen appliances. Grey water may contain traces of dirt, food, grease, hair, and certain household cleaning products. Grey water contains fewer pathogens than domestic waste water hence it is generally safer to handle and easier to treat and reuse.

Paper is organized as follows. Section II describes literature review, problem statement, scope of study, and future scope. Methodology is discussed in Section III. Section IV presents experimental work, test and results. Finally, Section V presents conclusion.

II. LITERATURE REVIEW

Hawra Alradhawi, Dr. S.S. Angalekar, IJSR in their research paper "Study the Feasibility of Use of Grey Water in Concrete" stated the use of treated grey water and underground grey water in making concrete of M25 grade. Various tests such as compressive strength, flexural strength, split tensile strength were performed. Besides these, the durability tests of concrete were also conducted which consisted of rapid chloride penetration test and permeability test.

K.A. Olonade in their research paper "A Review of the effects of waste water on reinforced concrete structure in Nigeria" stated about the waste water generations and compositions in Nigeria, reinforced concrete structures used in handling waste water in Nigeria, sources of waste water generation and contaminating effects. Chemical combination of carbon, phosphorous and nitrogen form organic matter in waste water. This organic matter causes the growth of zooplankton as well as microbenthic invertebrates which further stimulates growth of bacteria and fungi. Bacteria and fungi break the toxic components of waste water. This microbiological activity in waste water produces acidic chemicals that are corrosive to concrete and steel. Different techniques were adopted for the preservation of concrete

structures from damaging effects of waste water namely use of admixtures, self healing concrete technology, and microbiological prevention.

Mr. Manjunatha. M, Mr. Dhanraj M R in their research paper “**An Experimental study on reuse of treated waste water in concrete- A Sustainable Approach**” stated the reuse of treated waste water and potable water in concrete for both mixing and curing. Concrete is prepared with M20 grade and SNF plasticizer and cured for 7, 14, 28 days. The compressive strength, durability properties and microscopic study for treated waste water and potable water was done. Scanning electron microscope was used in order to assert quality assurance, properties of concrete, long term performance, durability of concrete and other materials, evaluation of deterioration, development and improvement of new materials.

PROBLEM STATEMENT

The scarcity of potable water is increasing day by day with its increasing demand in construction industry, there is a need to investigate and examine the use of grey water for construction purpose. Thus, efforts are made to use grey water in concrete without affecting its properties. On the other hand, generation of construction and demolition (C&D) waste has caused various problems recently and therefore there is a need to its proper handling, disposal and reutilization.

SCOPE OF STUDY

The broad objective for treated grey water to be used in concrete preparation is that the concrete must be defined on the basis of its properties. To define compressive strength, flexural strength, split tensile strength of concrete. This study also states the use of part of construction debris along with coarse aggregates to treat grey water and reuse it in concrete production.

FURTHER SCOPE

Future scope will focus on microscopic study of concrete properties, Research on usage of Treated Grey water for production of reinforced cement concrete by studying the reinforcement of concrete, Using construction debris in high amount for treating grey water and preparing concrete of different grades, Concrete preparation using different admixtures.

III. METHODOLOGY

Collection of grey water was done from household kitchen appliances in 20 litres capacity buckets. The collected grey water samples were sent to laboratory for testing and studying the initial characteristics of grey water. After studying the initial characteristics, the raw grey water was treated using a filtration treatment unit of 3-barrel system as shown in figure below. The first barrel consists of two screen mesh, screening and floating of suspended materials is carried out in first barrel. After that water was allowed to pass through second barrel which consist of coarse aggregates of size 20 to 10mm. At last water was passed through third barrel consisting of half part of coarse aggregates of size 10 to 4.75 mm and half part of crushed, sieved, washed and dried concrete waste which acts as an alternative to river sand. The sludge valve is also provided for periodic backwashing. The water passed from all three barrels was treated and collected in a storage bucket and further tested before using in making concrete. After treating grey water was tested for its final parameters which were within permissible limits.



Fig. 1. Filtration treatment unit

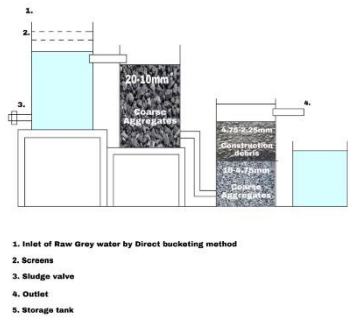


Fig. 2. Schematic diagram of Filtration treatment unit

The treated grey water was then used in producing concrete mix of M20 grade. Various tests were conducted on concrete to determine and compare mechanical properties of concrete. Compressive strength test of concrete cubes 150 x 150 x 150 mm was done after curing for 7, 14 and 28 days. Flexural strength was conducted of concrete beams 150 x 700 x 700 mm after curing in water for 7 and 28 days. Split tensile strength of concrete cylinders of 150 mm diameter x 300 mm length after curing in water for 7 and 28 days was done. Comparison of test results were made to understand the effect of treated water in concrete.

IV. EXPERIMENTAL RESULTS

EXPERIMENTAL PROCEDURE FOR DETERMINING THE CHARACTERISTICS OF GREY WATER

As stated in methodology, the grey water was first collected from kitchen appliances and was sent to laboratory for determining the initial characteristics of raw grey water. The grey water was treated in the unit as discussed previously and again sent in laboratory for final characteristics after treatment.

The following table shows the initial and final characteristics of grey water-

| Parameter | Unit | Initial | Final |
|------------------|------|----------------------------------|-------|
| Turbidity | NTU | 24 | 13 |
| BOD ₅ | mg/l | 50 | 22 |
| COD | | 68 | 29 |
| TSS | mg/l | 130 | 32 |
| Chloride | mg/l | 26 | 21.3 |
| pH | - | 8.1 | 7.5 |
| Sulphate | mg/l | 21.4 | 2.2 |
| Colour | - | Light milky | |
| Detergent | - | Foam disappeared within 1 min | |
| Oil and grease | mg/l | Not more than few visible traces | |

Table 1. Characteristics of Grey water

TESTS AND RESULTS ON CONCRETE

1) Compression strength test



Image 1. Filling of moulds



Image 2. Placing of concrete in still position for 24 hours



Image 3. Curing of concrete



Image 4. Testing of Concrete cubes

Concrete cubes of standard size 150 mm x 150 mm x 150 mm were made using M20 grade concrete. The compression test was done as per IS 516 after curing in water for 7, 14 and 28 days. Test was conducted for both concrete cubes made with tap water and concrete cubes made with treated grey water. The compressive strength values were recorded and compared. The value of concrete cube made with TGW for 7 days of curing was decreased from 21.29 N/mm² to 19.95 N/mm². There is no significant difference in the values of concrete made using TGW and Tap water after 14 and 28 days of curing.

| Type of concrete | 7 days curing | 14 days curing | 28 days curing |
|-------------------------------|-------------------------|-------------------------|-------------------------|
| Concrete made using tap water | 21.29 N/mm ² | 23.84 N/mm ² | 24.61 N/mm ² |
| Concrete made using TGW | 19.95 N/mm ² | 22.43 N/mm ² | 23.12 N/mm ² |

Table 2. Compressive test results

2) Flexural strength

Concrete beams of dimension 150 mm x 150 mm x 700 mm were made using M20 grade concrete. The flexural strength test was done after curing in water for 7 and 28 days. Test was conducted for both concrete beams made with tap water and concrete beams made with treated grey water. The flexural strength values were recorded and compared. The values of concrete beam made with TGW for both 7 and 28 days of curing were decreased but still the difference was within limits.



Image 5. Dried concrete beams

| Type of concrete | 7 days curing | 28 days curing |
|-------------------------------|------------------------|------------------------|
| Concrete made using tap water | 6.37 N/mm ² | 7.13 N/mm ² |
| Concrete made using TGW | 6.13 N/mm ² | 6.88 N/mm ² |

Table 3. Flexural strength test results



Image 6. Testing of beam

3) Split tensile strength

Concrete cylinders of dimension 150mm diameter x 300mm length were made using M20 grade concrete. The Split tensile strength test was done after curing in water for 7 and 28 days. Test was conducted for both concrete cylinders made with tap water and with treated grey water. The strength values were recorded and compared. Not much difference was noted between the values after comparison, thus concluding that TGW can be used as an alternative to normal water in concrete.



Image 7. Testing of Cylinder

| Type of concrete | 7 days curing | 28 days curing |
|-------------------------------|------------------------|------------------------|
| Concrete made using tap water | 2.37 N/mm ² | 3.32 N/mm ² |
| Concrete made using TGW | 2.15 N/mm ² | 3.02 N/mm ² |

Table 4. Split Tensile Strength test results

V. CONCLUSION

This study concludes that there is not much difference between strength values of concrete made with TGW and tap water. Although, the values of concrete made with TGW are lesser than those made using tap water, the differences are still not higher. Concrete made using TGW can overcome scarcity of water at some aspects. Also, the construction waste if used in treating water can be proved beneficial than its unsafe disposal techniques. Concrete made using TGW is more suitable for plain concrete.

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