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Investigation on Usage of Treated 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 some part of construction debris and reutilizing 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.

Key Words – Construction Debris, Grey water, Grey Water Treatment

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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 are required for 1 m^3 of concrete. On average 150 litres of water is required for 1m^3 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.

LITERATURE REVIEW

R.T. Peche, Dr. S.S. Jamkar, Dr. P.S. Sadgir in their research paper **"Greywater- A Potential Source of Water for Construction" IOSR-JMCE, PP 12-17** investigated the possibility of reuse of grey water in construction. Samples of grey water was collected from different domestic sources and their chemical analysis was done. Quality of grey water was compared with requirements of water for construction suggested by various codes. Concrete cubes of grades M20, M25, M30, M35, M40 were casted using potable and grey water and tested for compressive strength. The grey water used in this study met the standard specifications mentioned in various codes. The results of compressive strength of concrete with grey water are found to be almost same or little less than concrete with potable water.

Abdul Razak B.H., Dr. D.L. Venkatesh Babu in their research paper **"Experimental Investigation on usage of greywater in Concrete production" IRJET (20145)** studied the workability and strength behavior of concrete made using grey water and conventional concrete both in fresh and hardened state. Workability was checked by slump and compaction factor method. Strength behavior was studied with reference to compression strength, split tensile strength, and flexural strength of the concrete specimens by destructive methods. The result confirms that the use of secondary treated water will not alter fresh and hardened properties of the concrete significantly when compared with potable water. The study also concludes that there may be possibilities of corrosion of reinforcement due to organic and inorganic impurities present in grey water. Hence concrete made using grey water is suitable for plain concrete.

K.A. Olonade in their research paper **"A Review of the effects of waste water on reinforced concrete structures in Nigeria" NIJOTECH, pp. 234-241 (2016)** 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. Since many factors are involved, mechanism in degradation of concrete structures is a complex phenomenon. 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 the 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.

Ayoup M. Ghrair, Othman A. Al-Mashaqbeh, et.al. in their research paper **"Influence of grey water on physical and mechanical properties of mortar and concrete mixes" Ain Shams Engineering Journal 9 (2018) 1549-1525** stated that both TGW and RGW are potential alternatives for fresh water in the concrete manufacturing industry. Two types of greywater were collected (i.e. TGW and RGW) and transferred to labs and analyzed. Sample preparation and curing for concrete was done, effects on properties of mortar and effects on properties of concrete were observed.

Akash Jaiswal, Dr. J N Vyas in their research paper **"Study of the Effect of Curing with Fresh Water and Sewage Water on Structural Strength of Concrete- A Review" IJSRD 2019** stated the information of characteristics of sewerage, advantages and disadvantages of concrete, curing of concrete and its categories, physical and chemical characteristics of sewage, etc. This paper states the evaluation of compressive strength, tensile strength and flexural strength of concrete by curing with sewage water.

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" IJLERA, PP- 124-132** 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 for both treated and potable water and cured for 7,14 and 28 days. And 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. This paper concludes that treated waste water can be use in the preparation of concrete for both casting and curing purposes without affecting the target main strength of the concrete at the ages of 28 days curing for M20 grade concrete.

Prof. A. B. More, Prof. R.B. Ghodake, Himanshu. N. Nimbalkar, Pritam P. Chandake, Sagar P. Maniyar, Yogita D. Narute in their research paper **"Reuse of Treated Domestic Waste Water in Concrete - A Sustainable Approach" Indian Journal of Applied Research, ISSN- 2249-555X** used cement, fly ash, fine aggregates, coarse aggregates, PTWW (Primary treated waste water), STWW (Secondary treated waste water), GW (Grey water), TW (Tap water) under the guidelines of IS standards. From the experimental investigation it was concluded that STWW contains less impurities and fits as per IS provisions. The consistency, initial and final setting time of cement paste by mixing STWW is within the IS limits. There is no significant difference in tensile strength. Flexural strength is improved by using STWW.

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. Compression strength test was done on the concrete using treated grey water. This study states the use of part of construction debris along with coarse aggregates to treat GW and reuse it in concrete production.

FUTURE SCOPE

- Future study will focus on microscopic study of concrete properties using electronic microscope.
- Research on usage of treated grey water for the production of reinforced cement concrete can be carried out by studying the corrosion of reinforcement.
- Usage of construction debris in high amount for treating grey water and preparing concrete of different grades. Concrete preparation using different admixtures.

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.

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.

Image 1 : Image of Filtration Treatment Unit

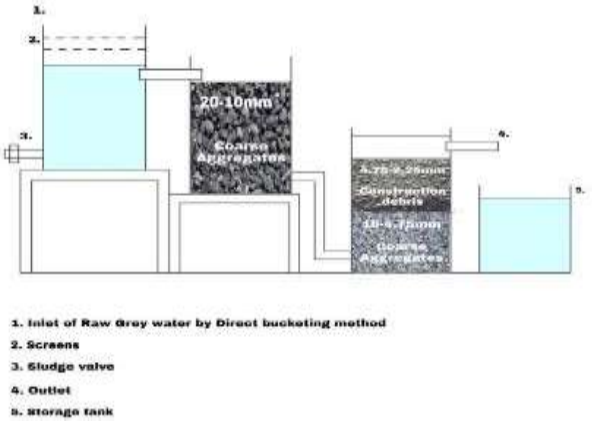

Fig 1 : Schematic diagram of Filtration Treatment Unit

Image 2 : Filtration Treatment Unit

TEST AND RESULTS

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.

1) Grey water Characteristics

Table 1: Characteristics of Grey Water

Parameter	Unit	Initial	Final
Turbidity	NTU	24	13
BOD	Mg/l	50	22
COD	Mg/l	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 minute	
Oil and grease	Mg/l	Not more than few visible traces	

Table 2: Max. permissible limits as per IS Code

Parameter	Unit	Final	Maximum permissible limits
Turbidity	NTU	13	-
BOD	Mg/l	22	-
COD	Mg/l	29	-
TSS	Mg/l	32	≤2000 - EN1008
Chloride	Mg/l	21.3	≤500 - IS456
pH	-	7.5	>6 – IS456
Sulphate	Mg/l	2.2	<400 – IS456

2) Compression strength test

Table 3: Compression test results

Type of concrete	7 days curing (N/mm²)	14 days curing (N/mm²)	28 days curing (N/mm²)
Using Tap Water	21.29	23.84	24.61
Using Treated Grey Water	19.95	22.43	23.12

Image 3 : Placing of concrete in still position for 24 hours

Image 4 : Testing of concrete cubes

3) Flexural strength test

Table 4: Flexural test results

Type of concrete	7 days curing (N/mm²)	28 days curing (N/mm²)
Using Tap Water	6.37	7.13
Using Treated Grey Water	6.13	6.88

Image 5: Concrete beams

Image 6 : Testing of beams

4) Split tensile strength test

Table 5: Split tensile strength test results

Type of concrete	7 days curing (N/mm²)	28 days curing (N/mm²)
Using Tap Water	2.37	3.32
Using Treated Grey Water	2.15	3.02

Image 7: Testing of Cylinder

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.

REFERENCES

[1] R.T. Peche, Dr. S.S. Jamkar, Dr. P.S. Sadgir: "Grey water- A Potential Source of Water for Construction" IOSR-JMCE, pp. 12-17

[2] Abdul Razak B.H., Dr. D.L. Venkatesh Babu, "Experimental Investigation on usage of grey water in Concrete production" IRJET (20145)

[3] K.A. Olonade (2016). "A Review of the effects of waste water on reinforced concrete structures in Nigeria" NIJOTECH, pp. 234-241.

[4] Ayoup M. Ghrair, et. al. (2018). "Influence of grey water on physical and mechanical properties of mortar and concrete mixes" Ain Shams Engineering Journal 9, pp. 1549-1525

[5] Akash Jaiswal, Dr. J N Vyas (2019). "Study of the Effect of Curing with Fresh Water and Sewage Water on Structural Strength of Concrete- A Review" IJSRD.

[6] Mr. Manjunatha. M, Mr. Dhanraj M R: "An Experimental Study on Reuse of Treated Waste Water in Concrete – A Sustainable Approach" IJLERA, pp. 124-132

[7] Prof. A. B. More, Prof. R.B. Ghodake, Himanshu. N. Nimbalkar, Pritam P. Chandake, Sagar P. Maniyar, Yogita D. Narute: "Reuse of Treated Domestic Waste Water in Concrete - A Sustainable Approach" Indian Journal of Applied Research, ISSN- 2249-555X

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