Comparative Analysis of Concrete Strength Using Recycled Coarse Aggregate And Treated Domestic Waste Water

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Abstract- *Scarcity of water is the major issue that has been erupted worldwide in the recent times. Any effort which helps in tackling this emergency by preventing the depletion of the depletion of the ground water and conserving this limited resource is worthwhile. Waste generation from a construction site, mainly demolished concrete is one of the issues related to environment. Therefore reusing the aggregate extracted from the demolished concrete waste would favor in the conserving of the resources. Present investigation compares the strength of normal concrete with different combinations. In this experiment normal coarse aggregates are completely replaced with the recycled coarse aggregates and 'Tap water is replaced with Reed Bed and Sewage treatment plant water for mixing and curing respectively. The specimens were casted and tested for 7, 28, 56 days of curing.*

Keywords- Normal aggregates, Recycled aggregates, Tap water, Reed Bed Treated water, Sewage Treatment Plant water, compressive strength, flexure strength.

I. INTRODUCTION

The most extensively used construction material in the world is concrete and the instant most consumed material by humans after water is cement. Due to the growing agriculture, urban and industrial needs, water table in every continent are falling, by this the drinking water are becoming scare. It is suggested that with water, practical large scale solution is to use the resources which are not currently efficient. Concrete industry is consuming annually billion tons of mixing water in the world. Moreover large quantity of fresh water is used for curing of concrete. In the construction field, the water which is used for mixing and curing of concrete is normal portable water, which is used as per the provisions. In the design codes, it is acclaimed that the compressive strength of cubes made of Portable water should not to be less than 90% of cubes made with tap water. Water from different sources are collected and tested formerly before using it to the concrete. Nowadays ground water is depleting in a fast manner and lot of money are required and spent for search of water in the vicinity of water source. So the Used water can be recycled and used for industrial activities like construction purposes, if the water is found to be suitable. The partially treated water consists of lot of total dissolved solids which affect water so much. The waste water even if it is stored unused also it is a major pollution problem to the environment. The concrete industry has therefore serious impact on the environment with regard to consumption of water. Thus there is a need to study alternative to fresh water for mixing and curing of the concrete

The amount of construction waste has been dramatically increased in the last decade, and social and environmental concerns on the recycling of the waste have consequently been increased. Waste concrete is particularly crucial among the construction wastes. The recent technology has also improved the recycling process. In this rapid industrialized world, recycling construction material plays an important role to preserve the natural resources. This study aims to evaluate physical properties of concrete using recycled coarse aggregate

II. OBJECTIVE

- To prove that use of treated domestic water does not have any adverse effect on strength and durability of the concrete and can be used for mixing and curing.
- To reduce the usage of fresh potable water in construction and conserving or using it for domestic/industrial purpose.
- To find an alternative for basic material in concrete by utilizing the waste, generated from construction sectors.

III. EXPERIMENTAL WORK

The experiment mainly deals with the study of physical properties of concrete such as compressive strength as well as bending or flexural strength by complete replacement of normal coarse aggregate with recycled coarse aggregate which is extracted from the demolished concrete of a construction site and also usage of treated domestic waste

water from sewage treatment plant and Reed Bed treated water for mixing as well as curing of concrete.

Tests are carried out on different water samples to check the limits of Power of Hydrogen (PH), alkalinity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Chloride & TSS. Initial tests on aggregates and cement such as Sieve analysis, Specific gravity, Water absorption, Normal consistency, Initial setting time and Final setting time are carried out respectively which helps in calculation of mix design.

In order to compare the results with the concrete mixed with Normal aggregate and tap water, total of 6 different combinations of concrete mix is carried out as follows.

- Normal aggregate-Tap water
- Normal aggregate-STP water
- Normal aggregate- Reed Bed
- Recycled aggregate-Tap water
- Recycled aggregate-STP water
- Recycled aggregate- Reed Bed water

Compression tests on concrete cubes of size 150mm×150mm×150mm and flexural strength test on plain concrete beams of size 500mm×100mm×100mm is conducted for different curing days.

Cement: In this experimental study, Ordinary Portland cement (53 grade) is used.

Table 1 Test on cement

Property	Value
Specific gravity	3.14
Normal consistency	32%
Initial setting time	60 mins
Final setting time	320 mins

Aggregates: Locally available fine aggregate of size of 4.75mm down size is used. Normal coarse aggregate from the local quarry and Recycled coarse aggregate extracted from demolished concrete of 20mm size.

Table 2 Test on Aggregates

Material	Specific gravity	Water absorption
Recycled coarse aggregate	2.53	4.3%
Normal coarse aggregate	2.69	1%
Fine aggregate	2.65	3%

Table 3 Test on Water samples

Tests	STP	Reed Bed	Tap
PH	7.46	6.87	7.3
BOD	-----	-----	----
COD	215mg/l	221mg/l	243mg/l
Alkalinity	200mg/l	116mg/l	104mg/l
TSS	200mg/l	40mg/l	21mg/l
Chloride	10 mg/l	9mg/l	8 mg/l

Table 4 Mix Design

Cement (kg/m3)	Water (kg/m3)	Coarse Aggregate (kg/m³)	Fine Aggregate (kg/ m³)	Super plasticizer (kg/ m³)
350	242	683	1070	3.5

IV. METHODOLOGY

Casting of M20 concrete mix with different water samples

For M20 concrete different combination of concrete mixing will be carried out using recycled aggregates as given below:

- 6 cubes and 3 beams casted using normal aggregates and Tap Water(TP)
- 6 cubes and 3 beams casted using normal aggregates and Reed Bed treated water
- 6 cubes and 3 beams casted using normal aggregates and sewage treated water
- 6 cubes and 3 beams casted using recycled aggregates and Tap Water
- 6 cubes and 3 beams casted using recycled aggregates and Reed Bed treated water
- 6 cubes and 3 beams casted using recycled aggregates and Sewage treated water

Fig 1. Prepared specimens

Curing will be done by immersing the specimen in tap water, Reed Bed Treated water and STP water respectively. Two concrete blocks of each batch are tested for compressive strength in 7, 28 & 56 days respectively.

Fig 2. Curing with STP treated and reed bed treated water

V. TESTS AND RESULTS

Compressive strength test

This is the method used to check if the concrete is fit for its purpose gives and measures the compressible cube strength and relates directly to the required design strength specified by the design

Table 5. Compression test results

Mix	Compressive strength for 7days	(%) Diff	Compressive strength for 28days	(%) Diff	Compressive strength for 56days	(%) Diff
Normal aggregate-Tap water	22 N/mm²		32 N/mm²		36 N/mm²	
Normal aggregate-STP water	20 N/mm²	-9.0*	29 N/mm²	-9.3	34 N/mm²	-5.5
Normal aggregate-Reed Bed water	21 N/mm²	-4.5	27 N/mm²	-15.6	33 N/mm²	-8.3
Recycled aggregate-tap water	23 N/mm²	4.5	34 N/mm²	6.2	38 N/mm²	5.5
Recycled aggregate-STP water	20 N/mm²	-9.0	31 N/mm²	-3.1	33 N/mm²	-8.3
Recycled aggregate-Reed Bed water	19N/mm²	-13.6	29 N/mm²	-9.3	34 N/mm²	-5.5

*Negative value indicates decrease in the Flexure strength of Beams

Fig 3. Compression Test

Fig 4. Failure of 7 days cube

Table 6. Flexure strength test results

Mix	Flexure strength for 28days	variation in strength (%)	Flexure strength for 56 days	variation in strength (%)
Normal aggregate-Tap water	6.08 N/mm²		8.24 N/mm²	
Normal aggregate-STP water	5.71 N/mm²	-6.0	7.67 N/mm²	-6.9
Normal aggregate-Reed Bed water	5.22 N/mm²	-14.1	6.82 N/mm²	-17.2
Recycled aggregate-tap water	5.98 N/mm²	-1.6	8.06 N/mm²	-2.1
Recycled aggregate-STP water	5.67 N/mm²	-6.7	7.20 N/mm²	-12.6
Recycled aggregate-Reed Bed water	5.10 N/mm²	-16.1	6.68 N/mm²	-18.9

*Negative value indicates decrease in the Flexure strength of Beams

Flexural strength:

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading (500 x100 x100-mm) concrete beams. The flexural strength is expressed as Modulus of Rupture (MR) in psi (MPa) and is determined by standard test methods

Fig5.Flexure test

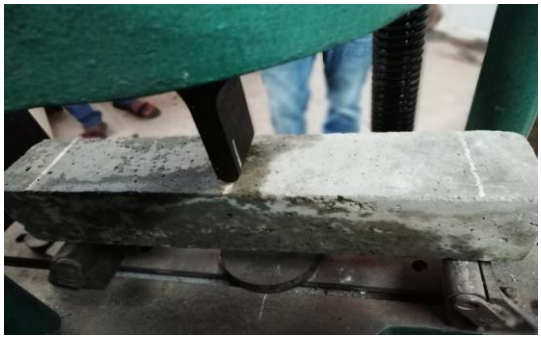

Fig 6. Centre point loading

VI. DISCUSSION

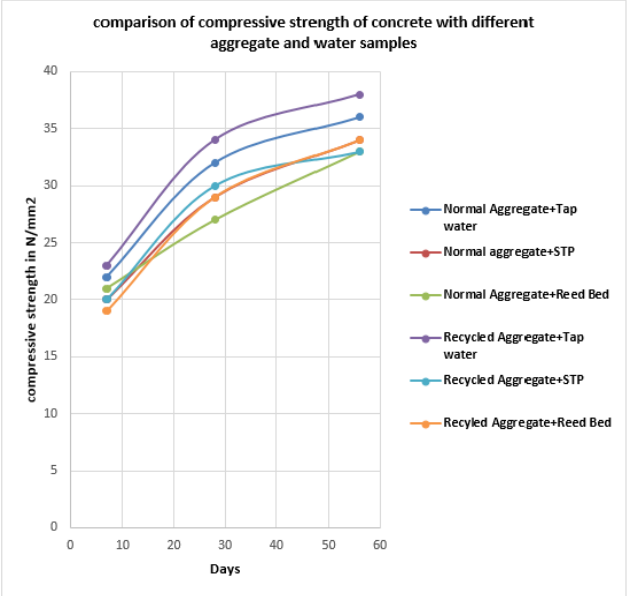

Fig 7. Comparison of strength of concrete with different aggregate and water samples

On comparison of Compression and Flexure test results of six combinations of concrete, Recycled aggregate and Tap water yielded the highest strength**.**

VII. CONCLUSION

1) The results of the laboratory analysis of three types of water samples obtained from three different sources shows that the treated effluents from both 'Reed Bed' and 'Conventional Sewage Treatment Plant' could be used as mixing and curing water in concrete.
2) From the results of compression tests conducted for concrete cubes made with different water types and aggregate mix, it is observed that , the concrete cubes prepared with 'Recycled aggregate and Tap water' shows increase in compressive strength of 4.5% , 6.2%, 5.5% than that of conventional concrete for 7, 28, 56 days of curing respectively.
3) There is 1.6% & 2.7% of decrease in flexural strength for the concrete beams prepared from recycled aggregate and tap water, when compared with the flexural strength of concrete beams prepared from normal aggregates and tap water for 28 & 56 days of curing respectively.
4) Since the concrete casted by replacing normal aggregates with recycled aggregates and normal water with 'STP and Reed Bed' treated water achieves minimum target strength both in compression and Flexure, Hence can be considered as the ideal replacement for normal aggregates and tap water.

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