

Experimental Investigation on Concrete by Replacing Natural Coarse Aggregate Partially with Recycled Coarse Aggregate (RCA) & Addition of Natural Coir Fibres

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Abstract - This thesis aims to find the possibility of the structural usage of recycled aggregate concrete in lieu or mixed with natural aggregates along with addition of natural coir fibres, based on better understanding of behavior of recycled aggregate with coir fibre in concrete structures. To identify the effects on workability and mechanical strength properties due to the addition of these recycled coarse aggregate and coir fibres, workability tests such as slump test, and the mechanical strength tests on standard specimens such as compressive strength and split tensile strength were conducted on the different ratios. The standard cubes and cylinders for conventional concrete were prepared and tested under compressive and tensile loads. Based on the experimental results of workability and mechanical strength studies, a constant length of 50 mm of coir fibre and diameter 0.34, 1% by weight of cement were used along with varying percentages of recycled coarse aggregate as 0%, 10%, 20%, 30%, 40%. It is found that by replacing 20 % natural aggregate by recycled aggregate, the compressive strength and tensile strength yielded best results. It has been noticed that a increase of 24% and 8% of compressive strength and tensile strength has been noticed respectively.

Key Words: RCA, Coir Fibres, Compressive Strength, Split Tensile Strength...

1. INTRODUCTION

One of the major challenges of the present society is the protection of environment. Some of the important elements in this respect are the reduction in the consumption of energy, natural materials and extensive use of waste materials. Nowadays these are getting considerable attention under sustainable development. In addition to the environmental benefits in reducing the demand of land for disposing the waste, the recycling of demolition wastes can also help to conserve the natural resources.

1.1 RCA (Recycled Concrete Aggregate)

In India, a huge quantity of construction and demolition wastes is produced every year. India is presently generating construction and demolition waste

of 23.75 million tons annually and these figures are likely to double in the next 7 years. . And the continuous use of natural resources for making conventional concrete leads to the reduction in their availability and results in the increase of the cost of the coarse aggregate and fine aggregate. The possible use of recycling demolition waste as coarse aggregate in the construction industry is thus increasing importance. When recycled coarse aggregate is used in structural concrete, the assessment of physical, mechanical and durable characteristics of recycled coarse aggregate is very important. The physical and mechanical properties of concrete with the recycled coarse aggregate (RCA) are to be evaluated to assess its application as structural concrete. Properties of the recycled concrete aggregates depend on the source, quality of the waste material, percentage ratio of components and also on the sieve-fraction of aggregate.

1.2 Coir Fibres

Coconut fibre is a natural fibre extracted from the husk of coconut. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Brown coir harvested from fully ripened coconuts is thick, strong and has high abrasion resistance. Total world coir fibre production is 250,000 tones. India, mainly in Pollachi and the coastal region of Kerala State, produces 60% of the total world supply of coir fibre. Over 50% of the coir fibre produced annually throughout the world is consumed in the countries of origin, mainly India. Together, India and Sri Lanka produce 90% of the coir produced every year.

This research is aimed at putting into effective use of recycled coarse aggregate and coir fibre in a good proportion to reduce the high cost of structural concrete. Coir fibre is an agricultural waste product, and how to dispose of it is a problem to waste managers. The most expensive concrete material is its aggregates and if such all-important expensive material is partially replaced with more natural, local and affordable material like RCA and coir fibre will not only take care of waste management but will also reduce the problem of high

cost of concrete and housing. There is an increasing importance to preserve the environment in the present day world.

2. Objectives

The main objective of this experimental investigation is to study the performance of RCA & Coir Fibre in concrete under variable amplitude loading by varying the percentages of RCA & Coir Fibre by the weight of coarse aggregates and cement respectively.

Experimental investigation include the basic tests carried out to check the physical properties of material used and properties of concrete in fresh state like Compaction factor test, Slump test, Vee-Bee test.

Testing on hardened concrete like compressive strength for cubes and split tensile for cylinders is carried out.

3. Physical Properties of Coir Fibre

Length of coconut fibre:

Generally, the natural lengths of coconut fibers are from 40-200mm. the length of fibres were measured using steel ruler and 10 pieces were randomly chosen to find out the length of coconut fibre. However, in this study chopped coconut fibres used with size of 50mm.

Diameter of coconut fibre:

To determine the diameter of coconut fibre, micrometer was used with precision of 0.01mm. It has been observed that diameter of coconut fibre is from 0.34 mm.

Natural humidity of coconut fibre:

To determine the natural humidity, fibres were at first open air-dried for 5 days and then the same fibres were dried in an oven at 80 Celsius for 5hours. The weights of fibres were measured using electronic bench scale with a precision of 0.01g. the natural humidity "H" was calculated using the eq (1) and found the natural humidity of coconut fibre is 12.2%. It can be seen that humidity percentages are nearly similar for different types of coconut fibre samples

$$H = \frac{W_d - W_o}{W_o} \times 100\%$$

Where Wd & Wo are the weights of air-dried and oven-dried fibres, respectively.

Water Absorption:

During mixing and drying of matrix, the fibres absorb water and expand. The swelling of the fibres

pushes away the concrete at least at the micro-level. Then at the end of drying process, the fibres lose the moisture and shrink back almost to their original dimensions leaving very fine voids around themselves. The water absorption capacity "W" was calculated using equation

$$W = \frac{W_{sw} - W_{ad}}{W_{ad}} \times 100$$

Where Wsw and Wad are the weight of soaked fibres in drinking water and weight of air dried fibres, respectively. The measurements were carried out at 24 hours interval for 7 days. Experimental data shown that the maximum water absorption of the coir fibre occurs during the first 24h and until increase up to 120h. after 120h the fibre get into fully saturated condition.

4. Properties Recycled Coarse Aggregate:

S.NO.	TEST	VALUES OBTAINED (%)
1.	Specific gravity	2.4
2.	Water absorption	0.75
3.	Impact value	23

5. Results and Discussions

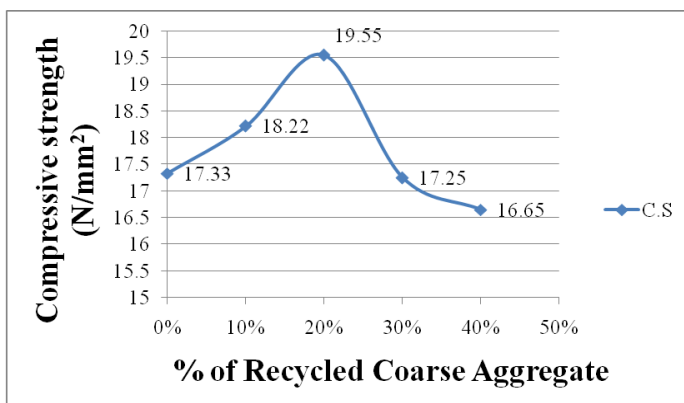
This chapter consists of two types of hardened concrete testing. They are compression test and tensile test. All the procedure used was according to the Indian Standard Code. Experiments were conducted on normal concrete and modified concrete by replacing natural coarse aggregate with recycled coarse aggregate with varying percentages of 0%, 10%, 20%, 30%, 40% and addition of natural coir fibre of 1% by weight of cement.

5.1 Compressive Strength

compressive strength of concrete can be defined as the measured maximum resistance of a concrete to axial loading. Compression test is the most common test used to test the hardened concrete specimens because the testing is easy to make. The strength of the concrete specimens with different percentage of recycled aggregate replacement can be indicating through the compression test.

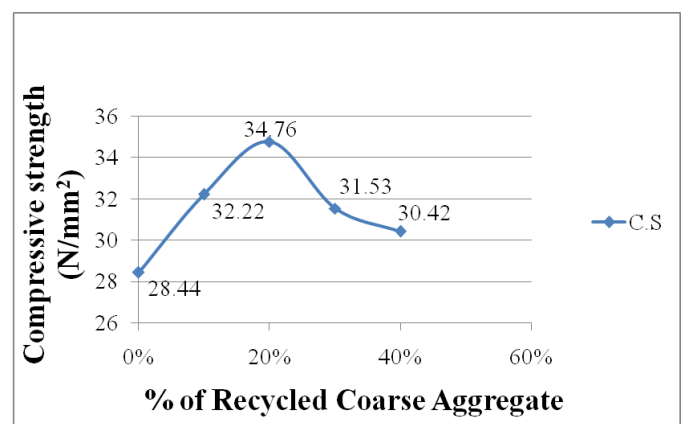
Specimen	w/c ratio	% of coir fibre added	% of RCA	Compressive strength
				7 days
1.	0.5	1%	0%	17.33 N/mm ²
2.			10%	18.22 N/mm ²
3.			20%	19.55 N/mm ²
4.			30%	17.25 N/mm ²
5.			40%	16.65 N/mm ²

Specimen	w/c ratio	% of coir fibre added	% of RCA	Compressive strength
				28 days
1.	0.5	1%	0%	28.44 N/mm ²
2.			10%	32.22 N/mm ²
3.			20%	34.76 N/mm ²
4.			30%	31.53 N/mm ²
5.			40%	30.42 N/mm ²



Compressive Strength at 7 Days

The value obtained for 20% addition of recycled coarse aggregate and water cement ratio 0.5 yielded highest results for compressive strength. However, the compressive strength decreased on the increase in RCA addition. Therefore there is an optimum value of RCA to cement ratio, beyond which the compressive strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum RCA content was taken as 20% along with coir fibre of 1%.



Compressive Strength at 28 Days

From the graph it is seen that when fibre content is increased there is an increase in tensile strength with a maximum at 20% of RCA. However when the RCA content is increased beyond this value a downward slope of the graph is observed.

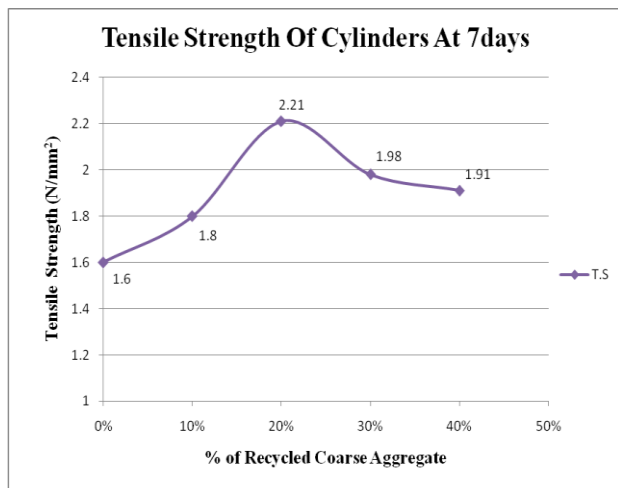
5.1 Split Tensile Strength

Split tensile strength tests were conducted on standard cylinders of dimension 15cm diameter and 30cm depth, specimens each for plain concrete, RCA and coconut fibre reinforced concrete were cast at varying percentages of RCA (0%, 10%, 20%, 30%, and 40%). For each case 7 &

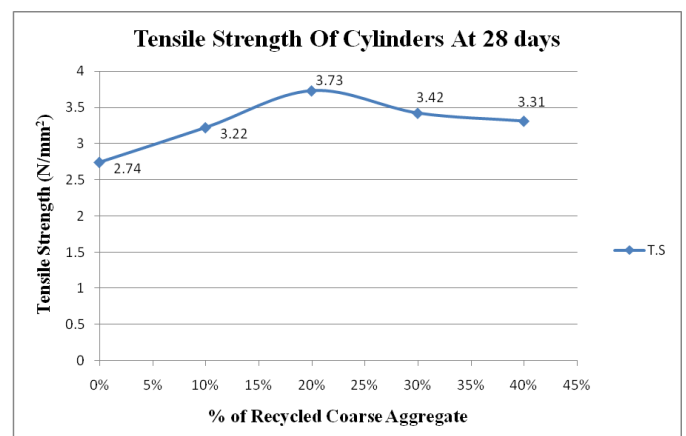
28days strength values were obtained by loading under a compression testing machine.

Specimen	w/c ratio	% of coir fibre added	% of RCA	Tensile strength
				7 days
1.	0.5	1%	0%	1.61 N/mm ²
2.			10%	1.8 N/mm ²
3.			20%	2.21 N/mm ²
4.			30%	1.98 N/mm ²
5.			40%	1.91 N/mm ²

Specimen	w/c ratio	% of coir fibre added	% of RCA	Tensile strength
				28 days
1.	0.5	1%	0%	2.74 N/mm ²
2.			10%	3.22 N/mm ²
3.			20%	3.73 N/mm ²
4.			30%	3.42 N/mm ²
5.			40%	3.31 N/mm ²



Split Tensile Strength graph at 7 Days



Split Tensile Strength graph at 28 Days

The value obtained for 20% addition of recycled coarse aggregate and water cement ratio 0.5 yielded highest results for tensile strength. However, the tensile strength decreased on the increase in RCA addition. Therefore there is an optimum value of RCA to cement ratio, beyond which the tensile strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum RCA content was taken as 20% along with coir fibre of 1%.

6. CONCLUSIONS

- The workability of recycled aggregate and fibre concrete mix is greater than natural aggregate, concrete mix with 20% recycled aggregate concrete and 1% coir fibre has satisfied workable concrete.
- The recycled aggregate concrete has a convenient compressive strength and tensile strength, which means a convenient concrete for structural elements in concrete structures.
- Although recycled aggregate can be applied in the high strength structure, but one issue must not be neglected as recycled aggregate with reduce water content would have low workability. Whenever recycled aggregate is applied, water content in the concrete mix has to be monitored carefully due to the water absorption capacity of recycled aggregate will vary. This type of concrete can only be used under the condition that does not involve a lot of handling works.
- At 1% addition of coconut fibre with a water cement ratio of 0.5, compressive strength tests yielded best results.
- There is an optimum value of RCA, beyond which the compressive strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum fibre content was taken as 1%.

REFERENCES

- [1] Nelson and Shing Chai NGO Research Project "High-Strength Structural Concrete with Recycled Aggregates", submitted November 2004, University of Southern Queensland Faculty of Engineering Surveying.
- [2] Majid Ali, Anthony Liu, HouSou, Nawawi Chouw, "Mechanical and Dynamic Properties of Coconut Fibre Reinforced Concrete." Construction and Building Materials. Reed Business Information, Inc. (US). 2012. High Beam Research. 5 Sep. 2013.
- [3] Noor Md. Sadiqul Hassan, Habibur Rahman Sobuz (2012), "Use of coconut fibre in production of structural light weight concrete", Journal of applied sciences 12(9) 831- 839, 2012.
- [4] Mahapara Abbass "Coconut Fiber as Fiber Reinforcement: A Review" PG Research Scholar, Department of Civil Engineering, Swami Devi Dyal Institute of Engineering & Technology, Haryana, India.
- [5] Syed Ahmad Zuhud, "Performance of Recycled Aggregate Concrete," the Islamic University of Gaza Faculty of Engineering, November 2008.
- [6] S. K. Singh, Scientist, Structural Engineering Division, Central Building Research Institute, Roorkee "RECYCLED AGGREGATES IN CONCRETE".

BIOGRAPHIES



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