Study on Strength and Related Properties of Recycled Aggregate as Coarse Aggregate in Concrete

Ranjith S[1], Velrajkumar G[2]

[1]*Assistant Professor, EBET Group of Institution, Erode, India-638108*

[2] *Assistant Professor, SVS College of Engineering, Coimbatore, India-642109*

Abstract: Use of recycled Coarse aggregate(RCA) in concrete plays an important role to preserve the natural resources. Nowadays many construction projects were started using the application RCA as the alternative material to the concrete. In this respect the study on basic properties of RCA in concrete has been carried out. This paper discusses the basic properties of RCA Concrete such as Compression Strength, Split tensile and workability and its values are compared with Concrete with natural aggregate. In this study various size of RCA are mixed as a replacement of 20%,30%and 40% to that of natural aggregate. The results indicated that 40% replacement of RCA shows greater compressive strength and this RCA concrete posses low tensile Strength when compared to normal concrete.

Keywords: recycled aggregate (RA), recycled aggregate concrete (RAC),recycled concrete aggregate (RCA).

1. INTRODUCTION

Concrete is the most widely used construction material across the world. The production of concrete requires a vast amount of natural resources, especially for obtaining aggregate, which is the largest component (by volume, and usually by weight as well) of the final concrete mixture. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement materials. Recycled aggregate can be generated from demolished construction structure which comprises of broken members or components likes the slab, beam, brick wall and others. The broken structures like many old buildings, concrete pavements, bridges, structures have overcome their age and limit of use due to structural deterioration beyond repairs and need to be demolished, the structures, even adequate to use are under demolition because they are not serving the needs in present scenario, new construction for better economic growth, structures are turned into debris resulting from natural disasters like earthquake, cyclone and floods etc. The density of the recycled coarse aggregate is lower than natural aggregate. When compared with natural aggregate, recycled coarse aggregates have lower density because of the porous and less dense residual mortar lumps that is adhering to the surfaces.

The Cost of recycled aggregate is cheaper than virgin aggregate. It depends on the aggregate size limitation and local availability. This is just around one and half of the cost for natural aggregate that used in the construction works.. The enormous quantities of demolished concrete are available at various construction sites, which are now posing a serious problem of disposal in urban areas. In recent years certain countries have considered the reutilization of construction and demolition waste as a new construction material as being one of the main objectives with respect to sustainable construction activities. This project focuses on recycling of concrete waste as an aggregate in concrete.

1.1 NEED FOR STUDY

- For reusing the waste resource in concrete
- For reducing the environment pollution
- For minimizing the cost of construction

2. EXPERIMENTAL INVESTIGATION

Properties of materials used in this investigation were determined by testing of cement, fine aggregate and coarse aggregate. The details of the test results are given below. In this project, cement by replacement of fly ash(10%) and fine aggregate by replacement of manufactured sand(70%).

Cement:

Type : OPC 53 grade

Specific gravity : 3.15

Fineness of cement =1

Standard Consistency = 30 %

Fly ash: class F

Manufactured sand

Specific gravity : 2.38

Fineness modulus: 2.12

Grading zone : III

Fine aggregate:

Specific gravity : 2.44

Fineness modulus: 2.58

Grading zone : II

Coarse aggregate:

Specific gravity : 3.18

Fineness modulus: 1.82

Recycle coarse aggregate:

Size : 10mmand 20mm

Super plasticizer: Glenium ACE 30

2.1 MANUFACTURING PROCESS OF RCA

Recycling of concrete is a relatively simple process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality.

Initially, wasted Hollow core slabs are brokened into small pieces by using Mechanical breaking devices. Reinforcing steel and other embedded items, if any, must be removed, and care must be taken to prevent contamination by other materials that can be troublesome, such as asphalt, soil and clay balls, chlorides, glass, gypsum board, sealants, paper, plaster, wood, and roofing materials.

These materials are collected from the company damping yard and transported to the quarry. In the quarry, the concrete pieces are allowed to pass through the crushing machine and the aggregates are collected from the conveyor belt.

The collected aggregates are sieved by manually. The aggregates passing through 20mm and 12.5mm and retained in 16mm and 10mm are used in this project as Recycled coarse aggregates. These aggregates are possessed as like as natural aggregates.

Recycled aggregate contains crushed and uncrushed parent aggregate coated with mortar and small pieces of hardened mortar. These aggregates are in angular shape.

Fig 1.Concrete blocks before crushing

Fig 2. Recycled Coarse aggregates after Crushing and sieving

Table 1: Mix proportion for M40 grade concrete

Materials for M40 Mix	**Weight of materials for 1m^3 of concrete (kg)**
Ordinary Portland Cement (53 grade)	430
Fly ash	50
20 mm coarse aggregate	625
10 mm coarse aggregate	515
River sand	201
Manufactured sand	469
Water	163.2
Water cement ratio	0.34

3.RESULTS

3.1 SLUMP VALUES FOR MIXES WITH THE REPLACEMENT OF RCA

Table 2: Slump values for various mixes

Replaced size of aggregares	Replacement percentage	Slump value in mm
20 mm	20%	180
	30%	140
	40%	150
10 mm	20%	140
	30%	185
	40%	130
20 mm &10mm (combination)	20%	150
	30%	170
	40%	150
Conventional concrete	-	160

3.2 COMPRESSIVE STRENGTH OF VARIOUS CONCRETE MIXES

Table 3**:** Comparison of conventional mix Vs RCA mix (20 mm aggregates)

Replaced size of aggregares	Replacement (%)	Compressive strength(MPA)		
		3days	7days	28days
20 mm	20%	43.4	48.1	53.96
	30%	42.85	42.8	47.5
	40%	41.26	45.86	63.43
Conventional concrete	-	33.7	45.2	50.31

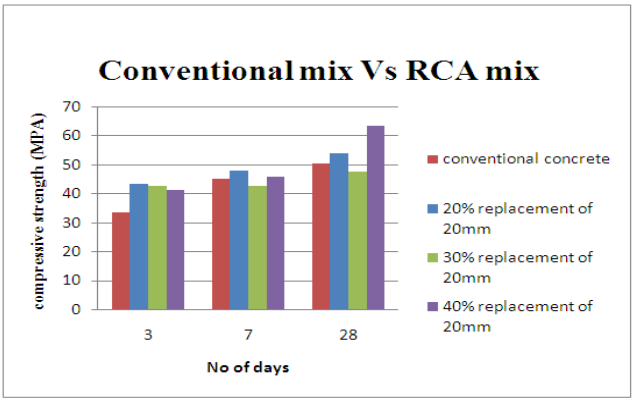

Fig 3. Compressive Strength of RCA Mix (20mm aggregates)

Table 4**:** Comparison of conventional mix Vs RCA mix (10 mm aggregates)

Replaced size of aggregares	Replacement (%)	Compressive strength(MPA)		
		3days	7days	28days
10 mm	20%	37.7	48.1	55.3
	30%	41.7	46.5	45.7
	40%	41.7	37.3	56.4
Conventional concrete	-	33.7	45.2	50.31

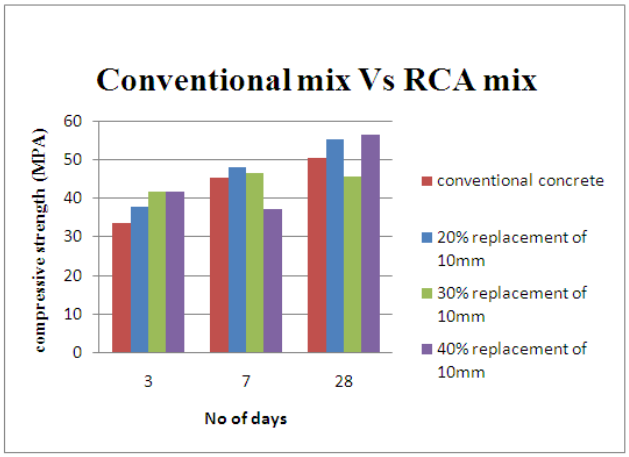

Fig 4 Compressive Strength of RCA Mix (10mm aggregates)

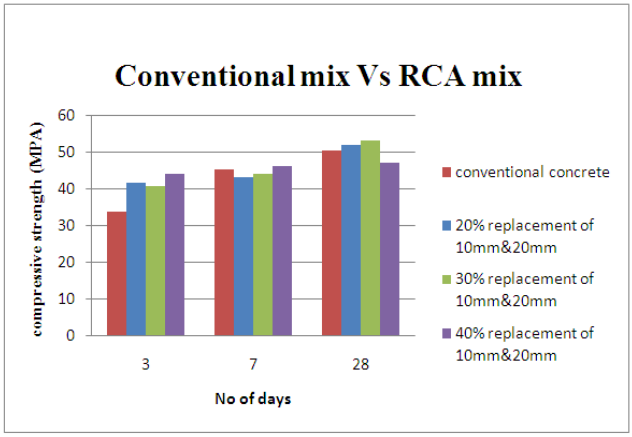

Fig 5 Compressive Strength of RCA Mix (10mm & 20mm aggregates)

Table 5**:** Comparison of conventional mix Vs RCA mix (10 mm & 20mm aggregates)

Replaced size of aggregates	Replacement (%)	compressive strength		
		3days	7days	28days
20 mm &10mm	20%	41.7	43.2	51.8
	30%	40.8	43.9	53.1

(combination)	40%	44.1	46.1	47.1
Conventional concrete	-	33.7	45.2	50.31

3.3 TENSILE STRENGTH OF VARIOUS CONCRETE MIXES

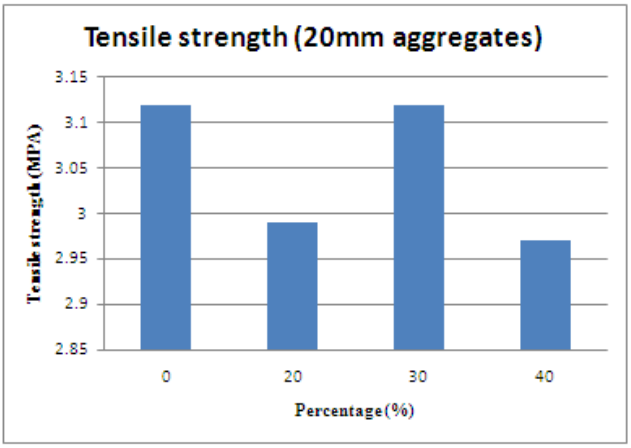

Fig 6 Tensile Strength of RCA Mix (20mm aggregates)

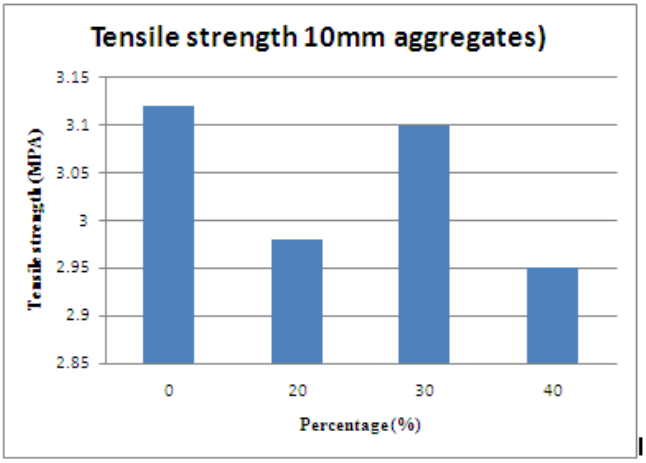

Fig 7 Tensile Strength of RCA Mix (10mm aggregates)

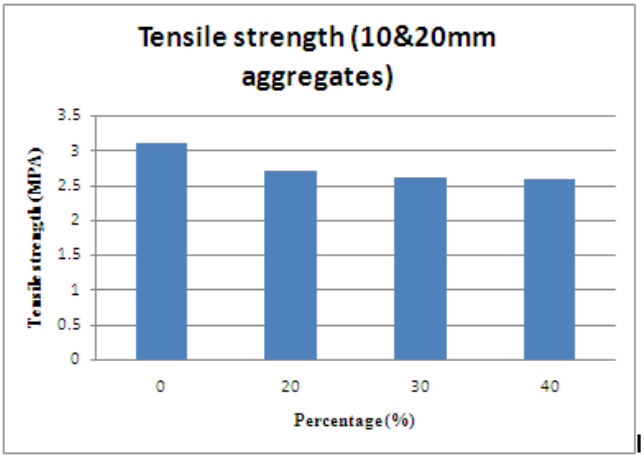

Fig 8 Tensile Strength of RCA Mix (10mm & 20mm aggregates)

4. CONCLUSION

For the given mix proportion, cubes are casted by Replacing Recycled coarse aggregates in different percentages. From the Compressive strength test results, it is observed that 40% Replacement of 10 mm aggregates and also 40% Replacement of 20 mm aggregates in RCA mix are gain more strength as compared to conventional mix at 28 days. It is also found that, Compressive strength of 20% Replacement of 10 mm, 20 mm and combination of 10 mm and 20 mm in RCA mix cubes are comes closer to the compressive strength results of conventional concrete at 12 hours, 3 days, 7 days, 28 days. Compressive strength is decreased while replacing recycled coarse aggregates of 30% in mix at 28 days. But the earlier strength is same as like conventional concrete mix. From tensile strength result, conventional concrete is high. Finally, overall results are equal to the conventional concrete results at all ages. It is also noted that, further investigation should be carried out for using this concrete in structural purposes .from the tensile

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AUTHOR'S PROFILE

S. Ranjith has received his Bachelor of Engineering degree in Civil Engineering from Bannari amman Institute of Technology, Sathyamangalam,Tamil nadu in the year 2011 and M.E. with the specialization of Structural Engineering from Bannari amman Institute of Technology, Sathyamangalam,Tamil nadu in the year 2013. At present he is working as an Assistant Professor at EBET Group of

Institution, Erode, India-638108. His areas of interests are Concrete Technology, Concrete Structures.

G. Velrajkumar has received his Bachelor of Engineering degree in Civil Engineering from Dr. Sivanthi Aditanar College of Engineering, Tamil nadu in the year 2009 and M.E. with the specialization of Structural Engineering from Bannari Amman Institute of Technology, Sathyamangalam, Tamilnadu in the year 2013. At present he is working as an Assistant Professor at SVS college of engineering, Coimbatore, India-642109. His areas of interests are Concrete Structures, Steel Structures.