ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Feasible Concrete of Recycled Coarse aggregate with Partial Replacement of copper Slag

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ABSTRACT : In this rapid industrialized world, recycling construction material plays an important role to preserve the natural resources. In this research, recycled concrete aggregates (RCA) from demolished building were used. This research deals with recycled concrete aggregates (RCA) of 5years and 10 years as age group to replace natural coarse aggregates (NCA) in different proportions like 20%, 30%, and 40% for this, M20 grade of concrete is adopted. Curing of specimens were done for 7days and 28 days to attain the maximum strengths of 5years and 10years RCA. Partial replacement of fine aggregate with Copper slag at 5%, 10%, 15% &20% were done to reduce the waste percentage as well to gain more strength. After casting the specimens of RCA with Copper slag replacement, curing was done and the specimens were tested for compressive and tensile strengths.

Obtained results of compressive and tensile strengths of RCA concrete mix were compared with conventional concrete. In this direction, an experimental investigation of compressive and tensile strength were undertaken to use RCA as a partial replacement in concrete. It was observed that the concrete with recycled aggregates of 5years and 10years age group achieved maximum compressive strength of 26.82 N/mm2, 27.27 N/mm2 and tensile strength of 7.26 N/mm2, 8.95 N/mm2 were obtained at 30% and 20% replacement of RCA respectively. It is found that the compressive strength and Split tensile strength of RAC with copper slag was increased 8.20% and 2.90% when compared with the RAC.

I.INTRODUCTION

Nominal concrete is made by mixing cement, fine aggregate, coarse aggregate and water. The worldwide consumption of natural coarse aggregate in mortar/concrete production is very high and several developing countries have faced some problems in the supply of natural coarse aggregate. In order to reach increasing needs of infrastructural development in present days, the utility of recycled coarse aggregates is taken as partial replacement of coarse aggregate as 20%, 30%, 40% replacement and copper slag is taken as partial replacement for fine aggregate in order to decrease consumption of river sand and to use industrial waste in order to reduce the formation of waste in dumpy yards.

Several research projects are being conducted by incorporation of these waste materials to reduce their environmental impact, especially after being air dried. As an industrial concept and for the sustainable development of natural resources, copper slag might be used as by-product in some other industries. Copper slag is tested for its different compositions and concentrations have been tried with limited success in terms of quality.

The major difference between the natural coarse aggregate and recycled coarse aggregates (RCA) is the adhered mortar at the surface of the RCA. It is a porous material, exhibits lower bulk density and saturated surface dry density, 1290-1470 kg/m3 and 2310-1260 kg/m3 respectively. The bulk density of RAC is comparable to that of the light weight aggregates. The higher porosity of the RAC is due to higher content of adhered mortar responsible for its low resistance towards mechanical and chemical actions. Due to the presence of micro-cracks and residual cement paste bonded to the outer layer of recycled concrete debris, the increased porosity of aggregates generally results in considerably highest water absorption for the chemical reactions and, consequently, the actual water-cement ratio.

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III. LITERATURE SURVEY

P. Sravani (P. G. Student) and A. ChandanaJyothi (Assistant Professor Department of Civil Engineering, Chebrolu Engineering College, Guntur, A.P, India.) were carried out a study on mechanical properties of recycled coarse aggregates (RCA) and the influence of super plasticizers on RCA. They tested the relative influence of RCA on compressive strength, split tensile strength and abrasion test of various incorporation rates of coarse aggregates (i.e.20% 30%, 40%) and concluded that up to 30% replacement of NA is suitable to gain same compression and tensile strengths. They concluded that higher water absorption capacity of recycled aggregates has great influence on the water added to the mix, which can affect concretes workability. It is possible to gain the same compression and split tensile strengths as conventional concrete up to 30% replacement of natural aggregate with recycled ones. But from the overall study, both the compression and split tensile strength values are decreasing with the increase in replacement levels of recycled aggregates. The increase of recycled aggregates content beyond 30% has negative effect on compressive strength of recycled aggregates concrete.

HaraldS.Muller, Raphael Breiner, Jack S. Moffatt (Institute of Concrete Structures and Building Materials (IMB), Germany) and Michael Haist (Karlsruhe Institute of Technology (KIT), Germany) were researched on a topic of sustainable structural engineering. It follows the basic principle that the energy and resource consumption due to the construction and operation of a structure must be minimized. The evaluation of the sustainability potential of building materials as well as of entire buildings or structures is highly complex, as it involves the quantification of three interacting and interdependent parameters, i.e. the environmental impact, the technical performance and the lifetime. From this it is highly obvious, that a sole reduction of the environmental impact.
A final evaluation of the sustainability potential of green concretes was limited until now to pure comparisons between performance and environmental impact parameters, as reliable information on the durability parameters of such concretes with regard to standard expositions was missing so far. Therefore, the developed green concretes were examined in view of their frost behavior, carbonation tendency, chloride migration and water absorption behavior.

Mr.Tushar R Sonawane (research Graduate Maeer'sMit Pune) and Prof.Dr. Sunil S. Pimplikar (H. O. D. Civil Engineering Department, Maeer'sMit Pune) were investigated on Use of recycled aggregate, up to 30% does not affect the functional requirements of the structure as per the finding the test results. Various tests conducted on recycled aggregates and results compared with natural aggregates are satisfactory as per IS 2386.
Due to use of recycled aggregate in construction, energy & cost of transportation of natural resources & excavation is significantly saved. This in turn directly reduces the impact of waste material on environment. This paper reports the basic properties of recycled fine aggregate and recycled coarse aggregate & also compares these properties with natural aggregates.

Mr. Pradeep Chavan (Assistant professor) and Mr. G. V. Nandi (Department of Civil Engineering, SIET Vijayapur, Karnataka, india.) carried out work to compare the mechanical properties of copper slag concrete with conventional concrete. At 20%, 30%, 40% copper slag replacement concrete shows good durability compared to conventional concrete.
They concluded that, Resistance to acid attack is more for copper slag concrete then that of conventional concrete when percentage replacement of copper slag increased, decrease in loss of weight is observed. Water absorption &porosity capacity of copper slag is less as composed to conventional concrete except 10% replacement level less porosity & less water absorption capacity indicates more suitable concrete for water construction.

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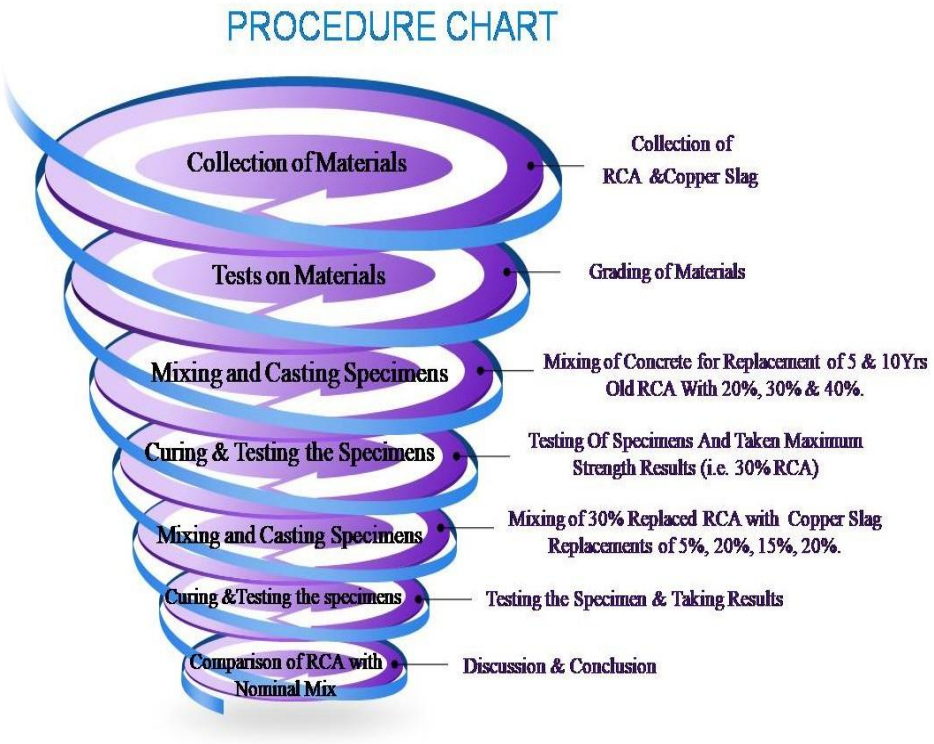
IV. METHODOLOGY



V. EXPERIMENTAL RESULTS

Physical Properties of Copper Slag:

S.No	Property	Value
1	Grading of copper slag	Zone II as per IS 383
2	Fineness modulus	3.4%
3	Specific gravity	6.33
4	Bulk Density	2.2
5	Water absorption	6%

Comparison between NCA and RCA (For 5 Yrs):

S.No	Property	NCA	RCA (for 5 Yrs)
1.	Impact	24.7%	20.95%
2.	Crushing Strength	10.34%	11.21%
3.	Abrasion	2.5%	5%
4.	Specific Gravity	2.739	2.4
5.	Sieve Analysis	3.4	2.5
6.	Bulk Density	8.4%	8.87%

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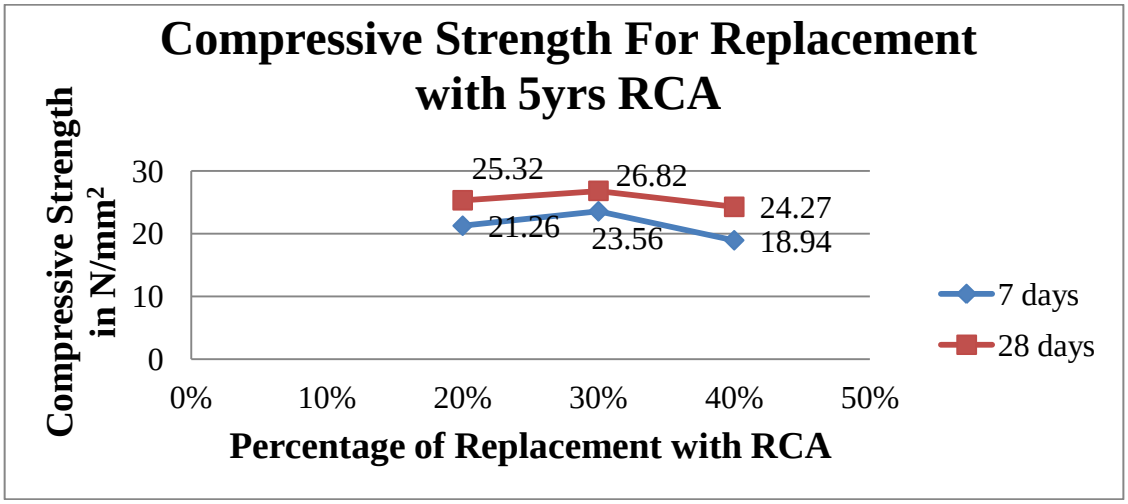
Comparison between NCA and RCA (For 10 Yrs):

S.No	Property	NCA	RCA(for 10 yrs)
1.	Impact	24.7%	30.05%
2.	Crushing Strength	10.34%	18.6%
3.	Abrasion	2.5%	8.2%
4.	Specific Gravity	2.739	2.42
5.	Sieve Analysis	3.4	2.2
6.	Bulk Density	8.4%	10.49%

COMPRESSIVE STRENGTH OF SPECIMEN:

Test Results for 5 Years RCA



S. No	%RCA	7 Days (N/mm2)			Avg.	28 Days (N/mm2)			Avg.
1.	20%	20.32	21.83	21.63	21.26	24.72	25.78	25.46	25.32
2.	30%	22.93	24.25	23.5	23.56	25.93	27.66	26.87	26.82
3.	40%	19.23	19.44	18.15	18.94	23.67	24.81	24.33	24.27

Table-Compressive Strength for 5years RCA Replacement

Result: From different percentage replacements with 5 year old RCA, we obtained maximum compressive strength at 30%, so we taken 30% of RCA as reference to replacement of copper slag.

Tests Results for 5years RCA (Replacement of Copper Slag)

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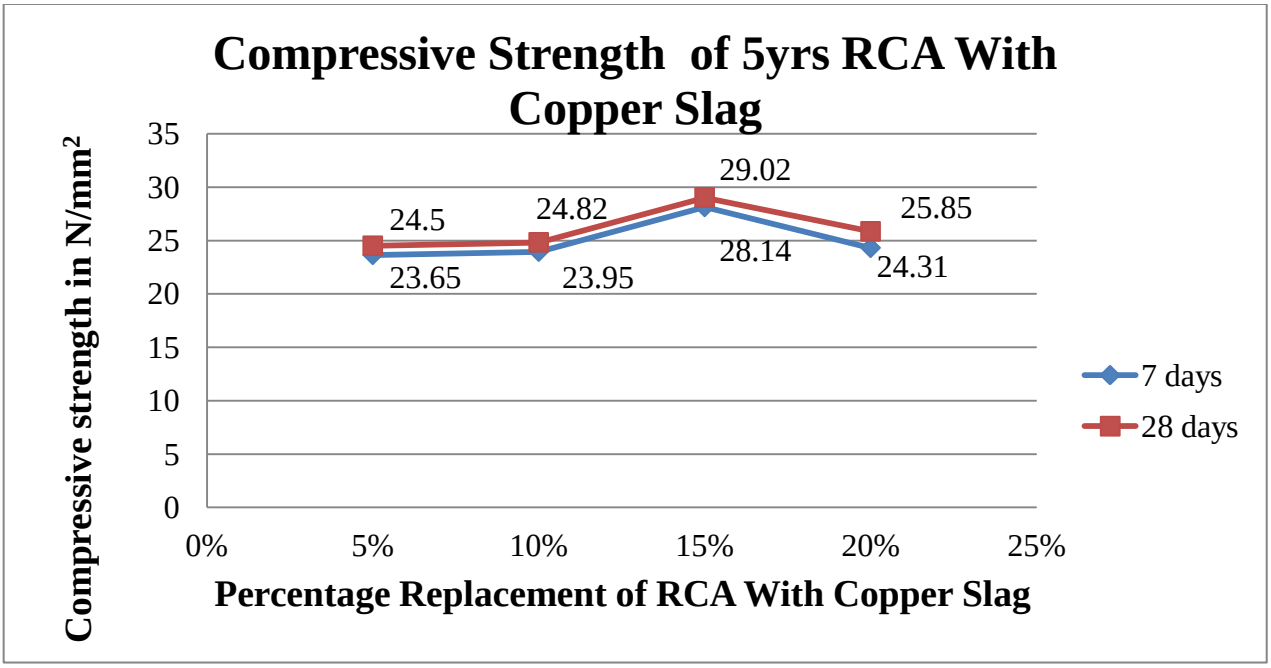

S.o	%RCA	7 days (in N/mm2)			Avg.	28 days (in N/mm2)			Avg.
1.	5%	22.96	24.94	23.05	23.65	24.14	24.75	24.61	24.50
2.	10%	23.7	24.06	24.09	23.95	24.37	24.85	25.24	24.82
3.	15%	28.45	27.93	28.04	28.14	29.46	29.03	28.57	29.02
4.	20%	24.26	24.02	24.65	24.31	26.01	25.45	26.09	25.85

Table- Compressive Strength of 5yrs RCA with Copper Slag

Result: From different percentage replacements with 30%RCA, we obtained maximum compressive strength at 15% replacement with copper slag.

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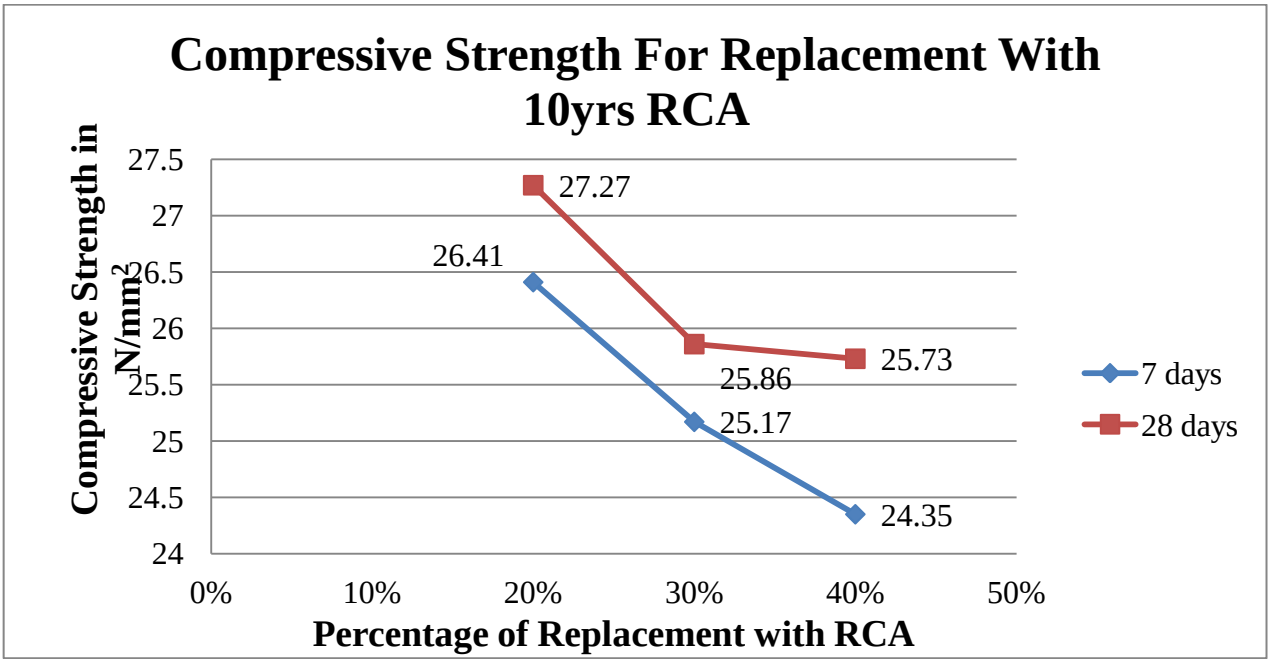
Test Results for 10years RCA
Table-Compressive Strength for Replacement with 10yrs RCA



S. No	% RCA	7 days (in N/mm2)			Avg.	28 days (in N/mm2)			Avg.
1.	20%	24.89	26.21	28.14	26.41	28.37	28.35	28.09	27.27
2.	30%	24.73	22.76	27.86	25.17	25.18	26.49	25.91	25.86
3.	40%	23.21	22.18	27.64	24.35	25.64	25.72	25.83	25.73

Result: From different percentage replacements with 10 year old RCA, we obtained maximum compressive strength at 20%, so we taken 20% of RCA as reference to replacement of copper slag.

S. No	% RCA	7 Days (In N/mm2)			Avg.	28 Days (In N/mm2)			Avg.
1.	5%	22.61	24.68	21.37	22.88	24.58	24.94	24.37	24.63
2.	10%	24.11	25.31	23.16	24.15	25.67	26.03	26.21	25.97
3.	15%	26.27	24.83	27.44	26.18	27.09	27.89	27.07	27.35
4.	20%	26.14	28.48	27.73	27.45	28.23	28.75	29.39	28.79

Result: From different percentage replacements with 20%RCA, we obtained maximum compressive strength at 20% replacement with copper slag.

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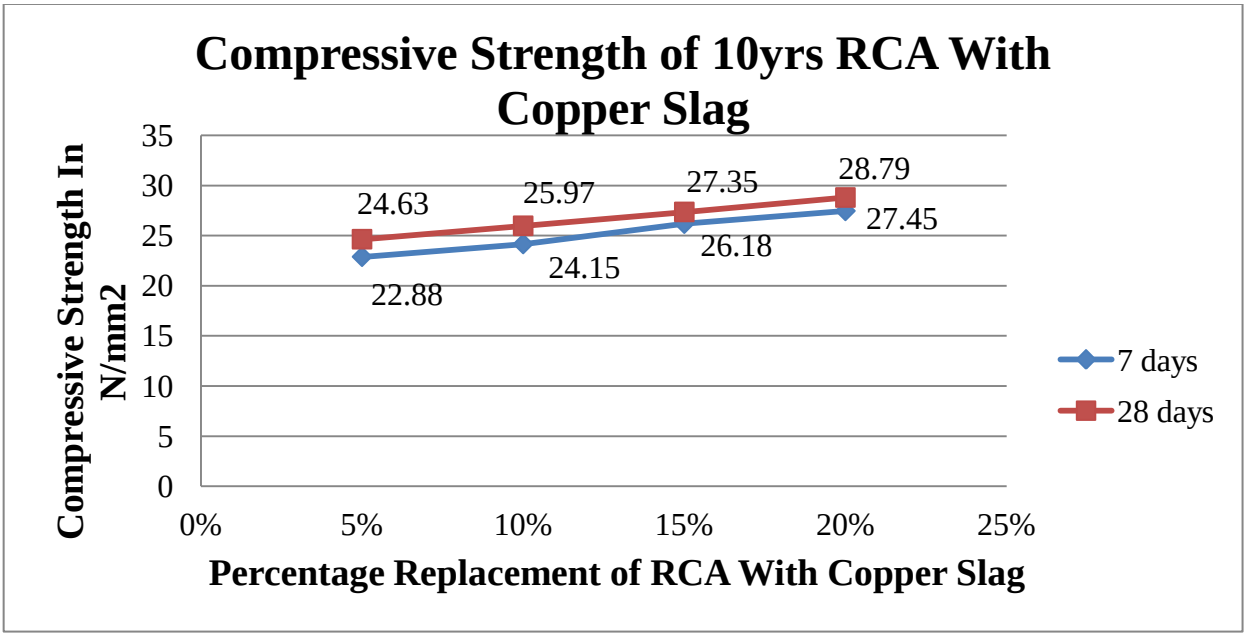
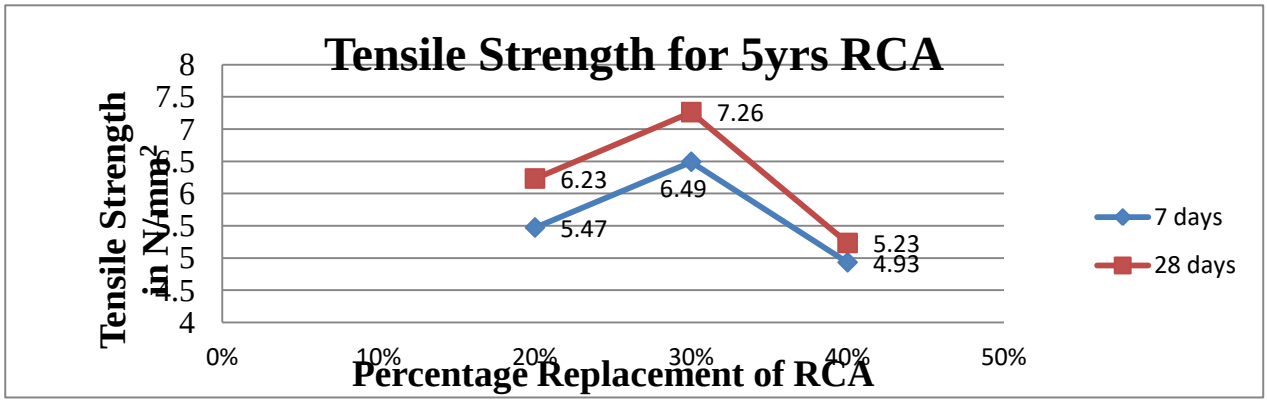


TENSILE STRENGTH OF SPECIMEN:
Test Results of Tensile Strength for 5yrs RCA



S.No	%RCA	7 Days (N/mm2)			Avg.	28 Days (N/mm2)			Avg.
1	20%	5.24	5.64	5.53	5.47	6.18	6.32	6.19	6.23
2	30%	6.35	6.57	6.55	6.49	7.17	7.3	7.31	7.26
3	40%	4.89	4.97	4.93	4.93	5.18	5.24	5.27	5.23

Table Tensile Strength for 5yrs RCA

Result: From different percentage replacements with 5 year old RCA, we obtained maximum tensile strength at 30%, so we taken 30% of RCA as reference to replacement of copper slag.

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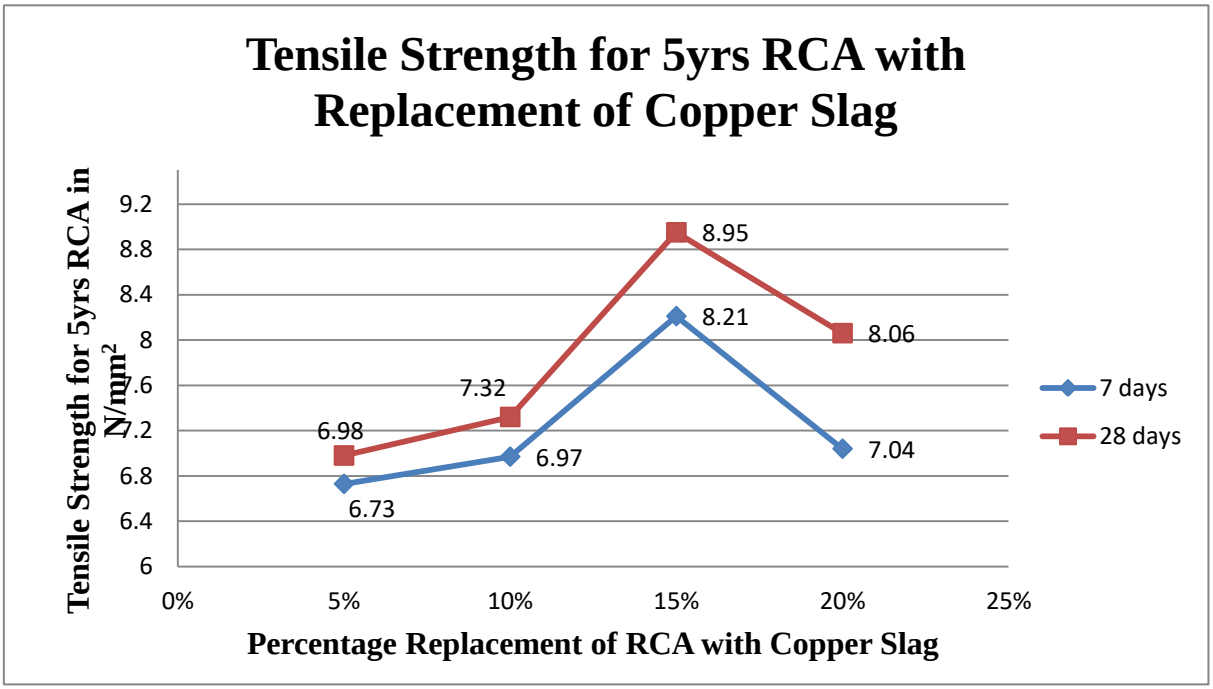
Test Results of Tensile Strength for 5yrs RCA with Replacement of Copper Slag



S. No	%RCA	7 Days (N/mm2)			Avg.	28 Days (N/mm2)			Avg.
1	5%	6.65	6.78	6.76	6.73	6.86	6.93	7.15	6.98
2	10%	6.89	6.95	7.07	6.97	7.24	7.29	7.43	7.32
3	15%	8.13	8.24	8.26	8.21	8.78	8.98	9.09	8.95
4	20%	6.98	7.09	7.05	7.04	7.95	7.99	8.24	8.06

Table-Tensile Strength for 5yrs RCA with Replacement of Copper Slag

Result: From different percentage replacements with 30%RCA, we obtained maximum tensile strength at 15% replacement with copper slag.

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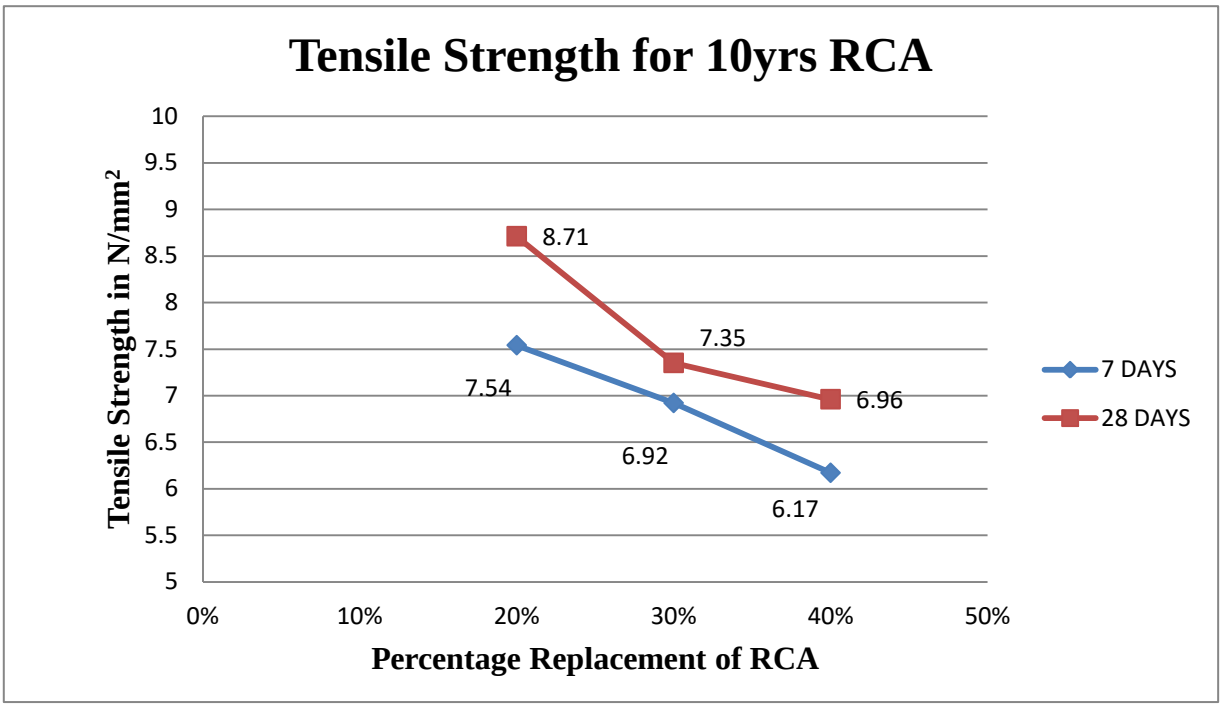
Test Results of Tensile Strength for 10yrs RCA
Graph Tensile Strength for 10yrs RCA



S. No	% RCA	7 Days (N/mm2)			Avg.	28 Days(N/mm2)			Avg.
1	20%	7.34	7.49	7.79	7.54	8.54	8.79	8.8	8.71
2	30%	6.8	6.96	7	6.92	7.29	7.36	7.4	7.35
3	40%	6.03	6.19	6.29	6.17	6.86	6.98	7.04	6.96

Table Tensile Strength for 10yrs RCA

Result: From different percentage replacements with 10 year old RCA, we obtained maximum tensile strength at 20%, so we taken 20% of RCA as reference to replacement of copper slag.

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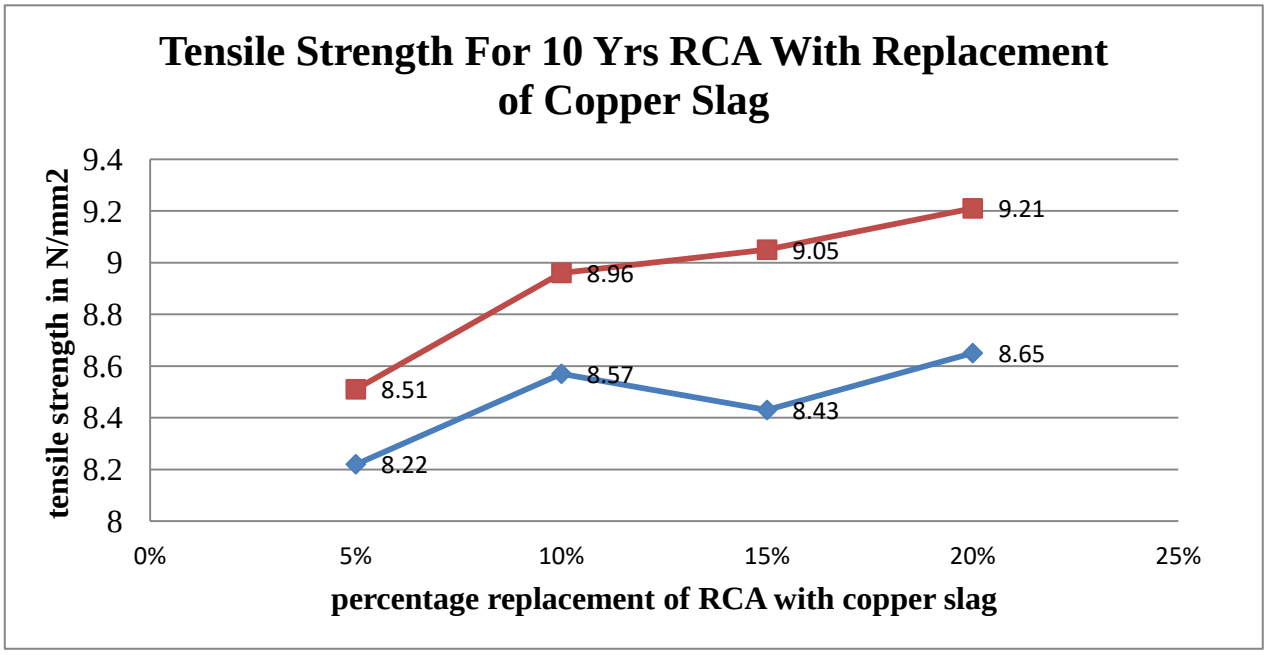
Test Results of Tensile Strength for 10 Yrs RCA with Replacement of Copper Slag
Graph. Tensile Strength for 10 Yrs RCA with Replacement of Copper Slag



S. No	%RCA	7 Days (N/mm2)			Avg.	28 Days (N/mm2)			Avg.
1	5%	8.09	8.19	8.43	8.22	8.39	8.47	8.67	8.51
2	10%	8.39	8.45	8.87	8.57	8.69	8.93	9.27	8.96
3	15%	8.32	8.44	8.53	8.43	9.03	8.96	9.16	9.05
4	20%	8.4	8.89	8.66	8.65	8.94	8.99	9.7	9.21

Result: From different percentage replacements with 20%RCA, we obtained maximum compressive strength at 20% replacement with copper slag.

Table- Tensile Strength for 10 Yrs RCA with Replacement of Copper Slag

VI.CONCLUSION

Recycling and reuse of building wastes have been found to be an appropriate solution to the problems of dumping thousand tons of debris accompanied with shortage of natural aggregates. Even though it makes more time, on other hand it is very economic and most importantly this save natural resources which are essential to environment. The use of recycled aggregates in concrete proved to be a valuable building material in technical, environment and economical aspect.

1. Recycled aggregates posses relatively lower bulk density, crushing and impact values and higher water absorption as compared to natural aggregate. The compressive strength of recycled aggregate concrete is relatively less than natural aggregate concrete.
2. By using 5years & 10years RCA at different replacements, 30 and 20% of replacements with RCA gives higher strength results with replacement of copper slag at 15 & 20% respectively.
3. It is proven that tensile strength of concrete are as very much low compared to compressive strength of RCA.

4. Here we concluded that, the strength of concrete is decreasing when the coarse aggregate is replaced with recycled aggregates and it is unsatisfactory as compared to normal strength, however it is satisfactory for feasibility of environmental.
5. As we observed that strength is increasing when the replacement of fine aggregate with copper slag and coarse aggregate by recycled aggregates is satisfactory, when compared to the normal concrete.

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