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FEASIBLE CONCRETE OF RECYCLED COARSE AGGREGATE WITH PARTIAL REPLACEMENT OF COPPER SLAG

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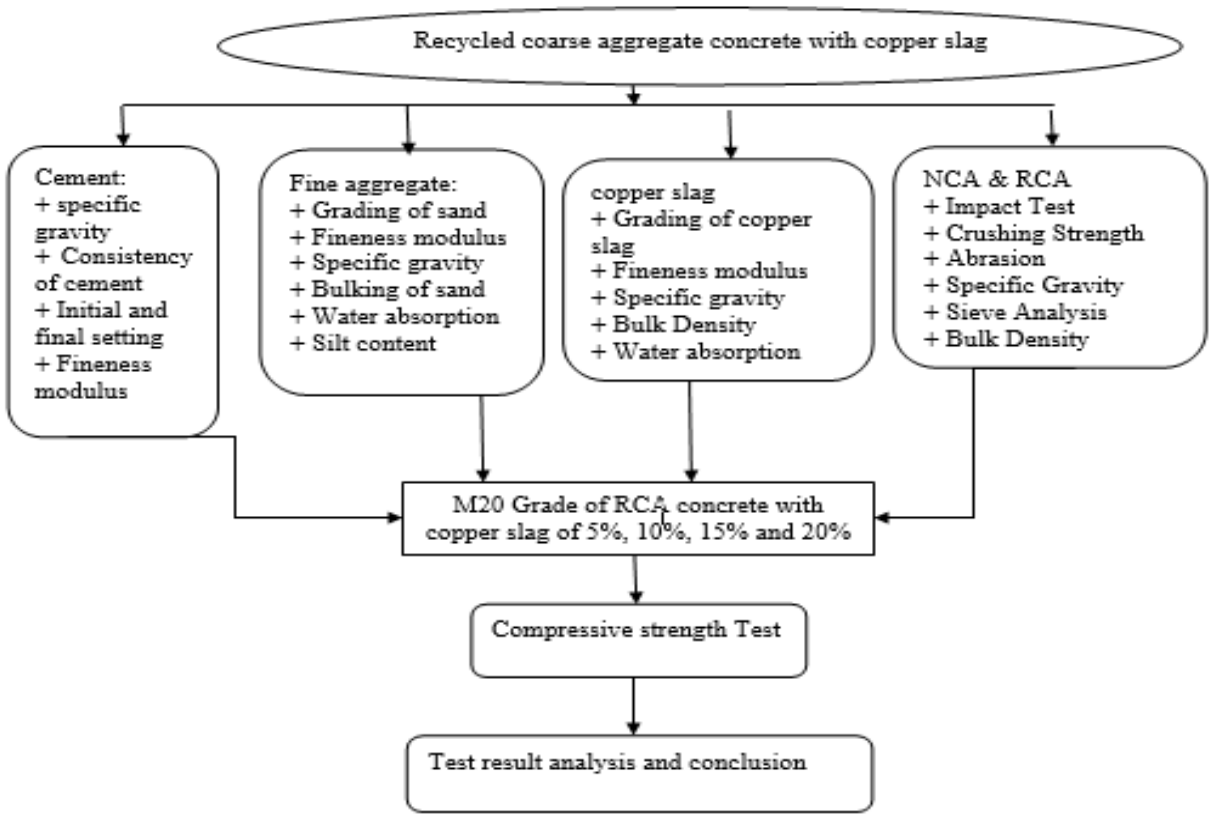
Abstract—Day to day the natural coarse aggregate was vaporized and usage of recycled coarse aggregate was mandatory to enhance the economy of construction as well as to decrease the environmental impact from construction industry. In this research deals with the M20 grade of concrete made up of recycled coarse aggregate (RCA) from demolished building of ages of 5 years and 10 years were used and compared with conventional concrete. Fine aggregate partially replaced with the copper slag of 5%, 10%, 15% and 20%. These concrete specimens were cast and curing was done for 7 days and 28 days and observed the compressive strength for each specimen. From the experimental study it was observed that the compressive strength was decreased by increase in percentage of recycled coarse aggregate and there was increment in compressive strength while adding copper slag when comparing with the conventional concrete for 7 days and 28 days curing period.

Keywords— recycled coarse aggregate, compressive strength, copper slag

I. INTRODUCTION

Concrete is a composite material composed of water, coarse granular material (the fine and coarse aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. Copper slag is used in the concrete as one of the alternative materials. The results obtained for cement mortars revealed that all mixtures with different copper slag proportions yielded comparable or higher compressive strength than that of the control mixture. The results obtained for natural coarse aggregate concrete revealed that recycled coarse aggregate concrete with different copper slag proportions yielded comparable or higher compressive strength than that of the control mixture. The properties of fresh as well as hardened concrete made of partial/full replacement of recycled coarse aggregate are found out and the results are compared with that of concrete using virgin coarse aggregate.

II. Methodology



III. Materials Used

Materials used in concrete preparation are as follows:

A. Cement

Cement is the most widely used material in existence and is only behind water as the planet's most-consumed resource. Portland cement of 53 grade was used to establish bonding between concrete constituents. The physical and chemical properties of cement were observed as follows.

Table 1. Test results on Cement

S.No	Test particulates	Results	Remarks
1	Specific gravity of cement	2.89	2-3 is suitable as per IS CODE
2	Normal Consistency of Cement	34%	25%-38%
3	Initial setting time	41 mints	Should be more than 30 mints
4	Final setting time	572 mints	Should not be more 600 mints
5	Fineness of cement	2%	

B. Aggregate

i) Fine aggregate: Most important constituent in the concrete to provide stability and workability. Fine aggregate of following physical properties were imported and tested in labouratory.

Table.2 Sieve analysis of fine aggregate

S.No	IS Sieve	Weight Retained in Gms	%Weight Retained	Cumulative % Wt Retained	% Passing
1	4.75mm	0	0	0	100
2	2 mm	147.925	9.87	9.86	90.14
3	1 mm	157.235	10.48	20.34	79.66
4	600mic	350	23.33	43.67	56.33
5	300mic	440	29.33	73	27
6	150mic	360	24	97	3
7	75mic	34.48	2.29	99.29	0.71

Table.3 Test results on fine aggregate

S.No	Property	Value
1	Grading of sand	Zone II as per IS 383
2	Fineness modulus	4.43
3	Specific gravity	2.7
4	Bulking of sand	0.16
5	Water absorption	8%
6	Silt content	2%

Table.4 Sieve analysis of fine aggregate (copper slag)

S.No	Is Sieve	Weight Retained (G)	% Weight Retained	Cumulative % Weight Retained	%Passing
1	4.75mm	0	0	0	100
2	2.0mm	0.011	1.1	1.1	98.9
3	1.0mm	0.081	8.1	9.2	90.8
4	600mic	0.138	13.8	23	97.7
5	300mic	0.056	5.6	28.6	71.4
6	150mic	0.018	1.8	30.4	69.6
7	75mic	0.88	8.8	40	60

A. Copper Slag

Copper slag is mainly used for surface blast-cleaning. Copper slag is the main suitable replacement constituent in concrete having abrasive blasting properties used as cementitious materials in recent researches. Days by day the rate of consumption has been increased in conventional concrete to decease the natural wastage. The blasting media manufactured from copper slag brings less harm to people and environment than sand. Copper slag is just one of many different materials that may be used as abrasive grit. Rate of grit consumption, amount of dust generated, and surface finish quality are some of the variables affected by the choice of grit material.

Fig.1 copper slag

Table.5 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%

ii) *Coarse aggregate:* Natural coarse aggregate was used from nearby quarries and recycled coarse aggregate of 5 years age group and 10 years age group was imported and chipped as coarse aggregate. These were tested in in laboratory, the test results were as follows.

Table.6 Physical Properties of 5 years and 10 years Recycled coarse aggregate

S.No	Property	Value
1	Impact value of 5yr old RCA	20.95%
2	Impact value of 10yr old RCA	30.05%
3	Crushing value of 5yr old RCA	11.21%
4	Crushing value of 10yr old RCA	18.6%
5	Abrasion value of 5yr old RCA	5%
6	Abrasion value of 10yr old RCA	8.2%

Table. 7 Comparison between NCA and RCA (For 5 Years)

S.No	Property	NCA	RCA (for 5 Years)
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%

Table. 8 Comparison between NCA and RCA (For 10 Years):

S.No	Property	NCA	RCA(for 10 Years)
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%

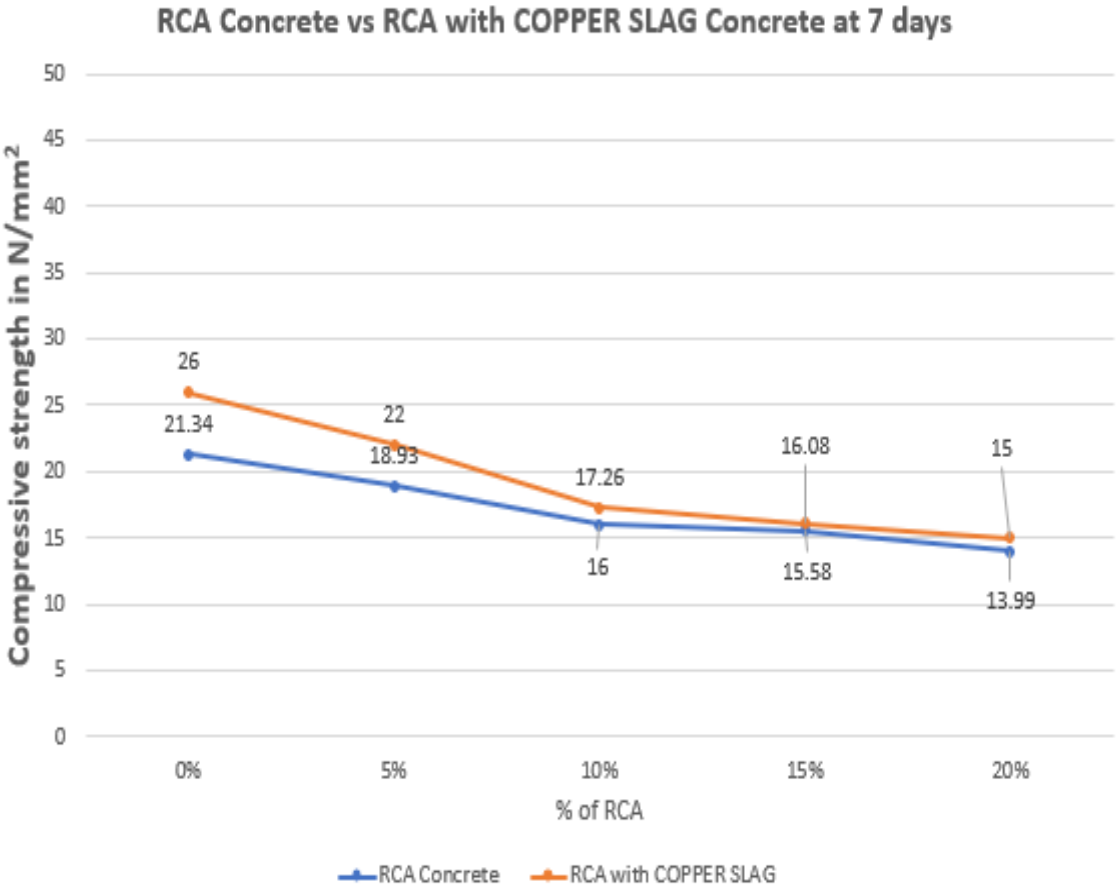
B. Water

Water is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water causes the hardening of concrete through a process called hydration. Hydration is a chemical reaction in which the major

compounds in cement form chemical bonds with water molecules and become hydrates or hydration products. Details of the hydration process are explored in the next section.

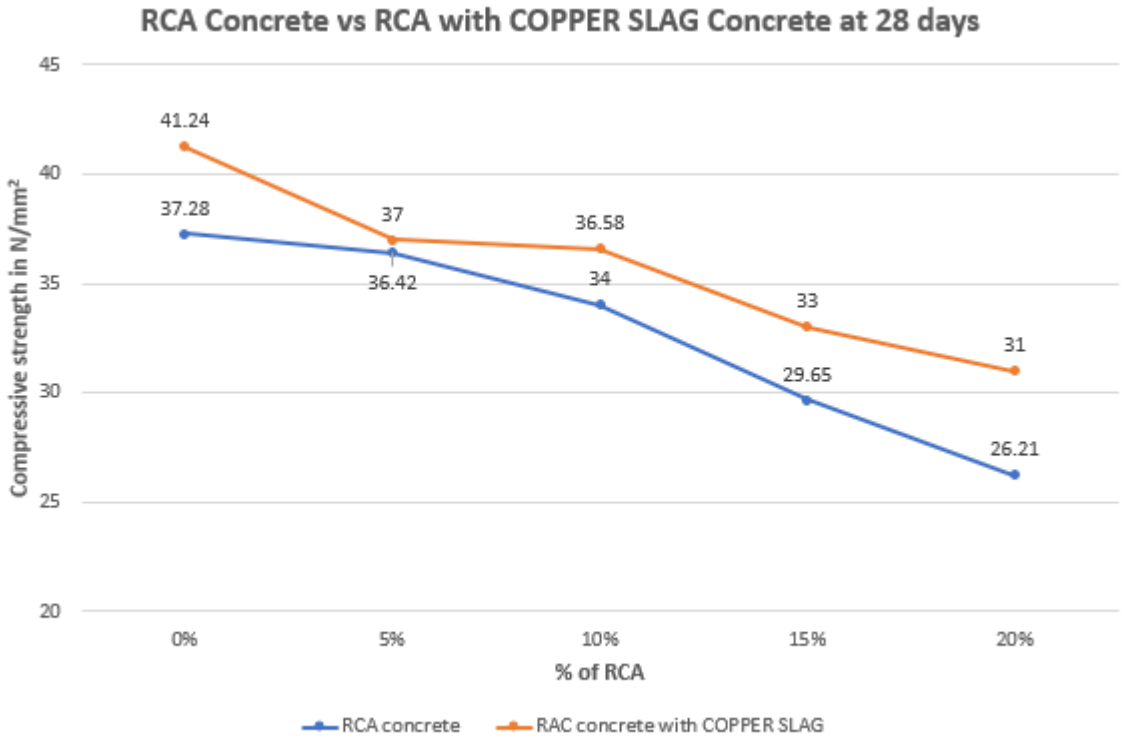
than sand.

IV. Test Results on Concrete



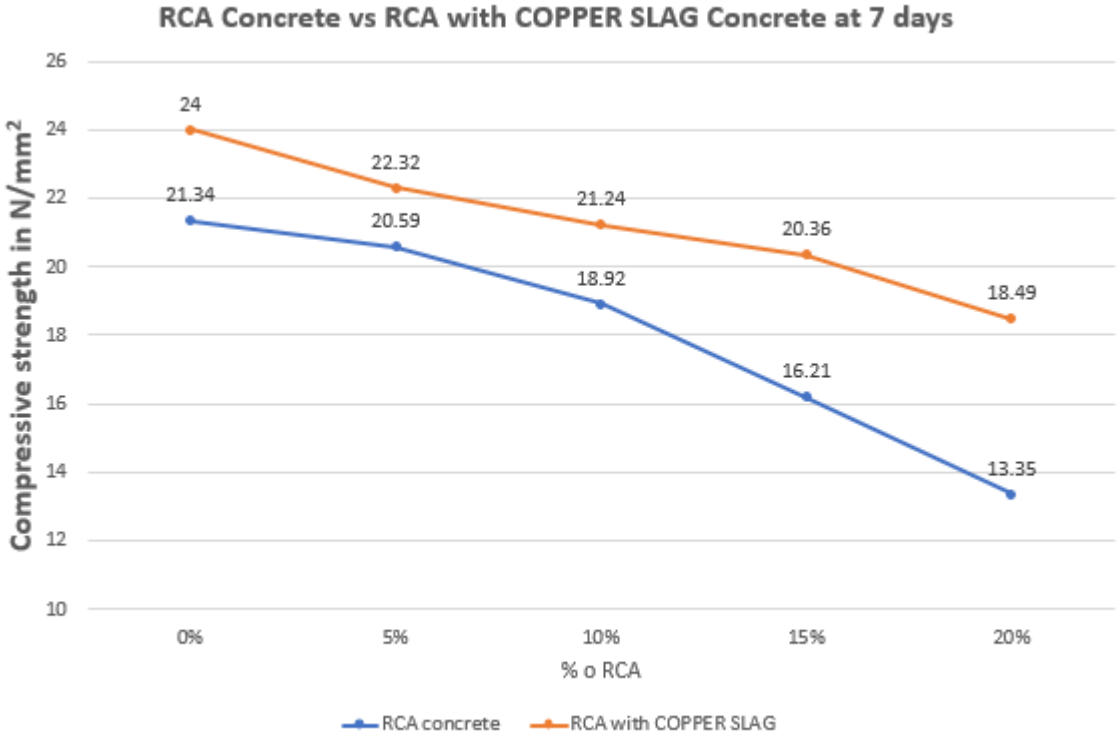
Graph.1 Compressive Strength for 5years RCA Replacement at 7 Days

From above graphical representation, it was observed that the compressive strength of 5 years RCA concrete was decreasing by 11.29%, 25%, 26.99 and 34.44 at 5%, 10%, 15% and 20% when comparing with conventional concrete. And its was observed that the compressive strength of 5 years RCA concrete was increased by 17.92%, 16.21%, 7.8%, 3.2% and 7.21% when comparing with 5 years RCA with COPPER SLAG at same percentage of 5 years RCA at 7days curing period.



Graph.2 Compressive Strength for 5 years RCA Replacement at 28 Days

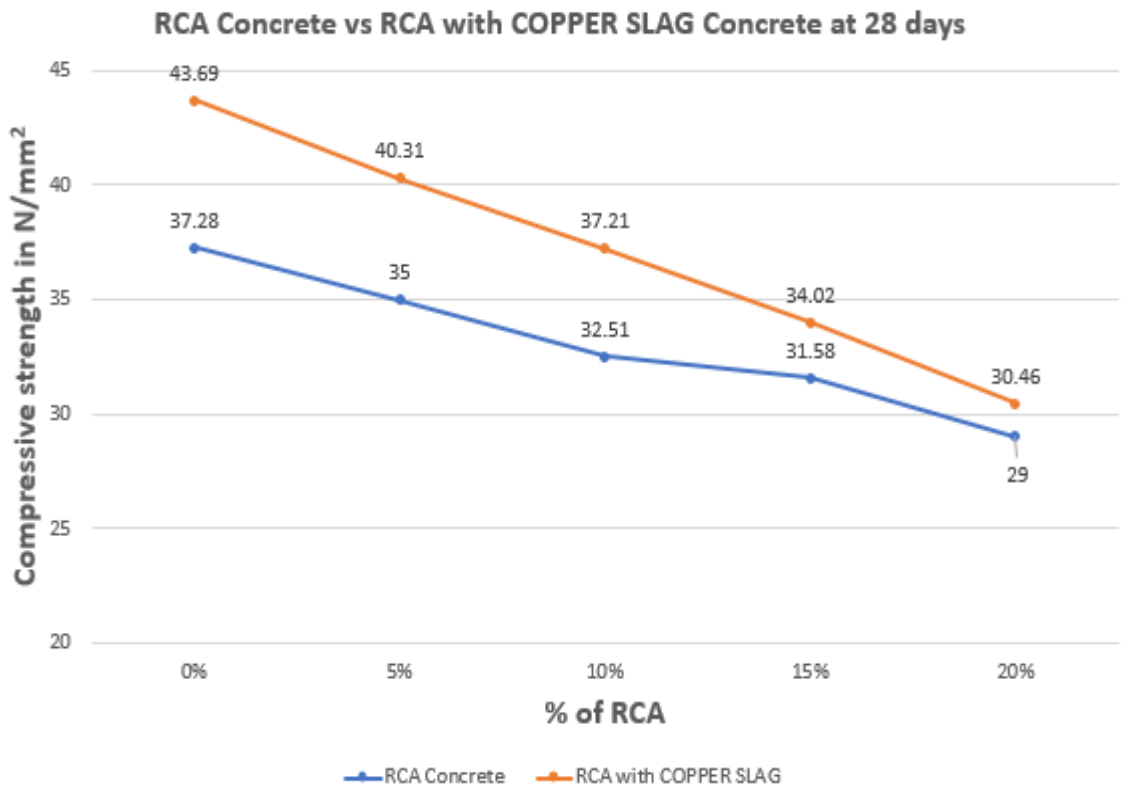
From above graphical representation, it was observed that the compressive strength of 5 years RCA concrete was decreasing by 2.3%, 8.79%, 20.46 and 29.69 at 5%, 10%, 15% and 20% when comparing with conventional concrete. And it was observed that the compressive strength of 5 years RCA concrete was increased by 10.62%, 1.59%, 7.58%, 11.29% and 18.27% when comparing with 5 years RCA with COPPER SLAG at same percentage of 5 years RCA at 28 days curing period.



Graph.3 Compressive Strength for 10 years RCA Replacement at 7 Days

From above graphical representation, it was observed that the compressive strength of 10 years RCA concrete was decreasing by 3.51%, 11.34%, 24% and 37.44% at 5%, 10%, 15% and 20% when comparing with conventional concrete. And it was observed that the compressive strength of 10 years RCA concrete was increased by 12.46%, 8.4%, 12.26%,

25.6% and 38.5% when comparing with 10 years RCA with COPPER SLAG at same percentage of 10 years RCA at 7 days curing period.



Graph.4 Compressive Strength for 10 years RCA Replacement at 28 Days

From above graphical representation, it was observed that the compressive strength of 10 years RCA concrete was decreasing by 6.11%, 12.79%, 15.28% and 22.21% at 5%, 10%, 15% and 20% when comparing with conventional concrete. And it was observed that the compressive strength of 10 years RCA concrete was increased by 17.19%, 14.88%, 17.53%, 7.72% and 5.03% when comparing with 10 years RCA with same percentage COPPER SLAG at 28 days curing period.

V. Conclusion

From the experimental investigation on coarse aggregate partially replaced with RCA and fine aggregate was partially replaced with copper slag to improve the mechanical properties as follows.

- From above graphical representation.1, it was observed that the compressive strength of 5 years RCA concrete was decreasing by 11.29%, 25%, 26.99 and 34.44 at 5%, 10%, 15% and 20% when comparing with conventional concrete. And it was observed that the compressive strength of 5 years RCA concrete was increased by 17.92%, 16.21%, 7.8%, 3.2% and 7.21% when comparing with 5 years RCA with COPPER SLAG at same percentage of 5 years RCA at 7days curing period.
- From above graphical representation.2, it was observed that the compressive strength of 5 years RCA concrete was decreasing by 2.3%, 8.79%, 20.46 and 29.69 at 5%, 10%, 15% and 20% when comparing with conventional concrete. And it was observed that the compressive strength of 5 years RCA concrete was increased by 10.62%, 1.59%, 7.58%, 11.29% and 18.27% when comparing with 5 years RCA with COPPER SLAG at same percentage of 5 years RCA at 28 days curing period.
- From above graphical representation.3, it was observed that the compressive strength of 10 years RCA concrete was decreasing by 3.51%, 11.34%, 24% and 37.44% at 5%, 10%, 15% and 20% when comparing with conventional concrete. And it was observed that the compressive strength of 10 years RCA concrete was increased by 12.46%, 8.4%, 12.26%, 25.6% and 38.5% when comparing with 10 years RCA with COPPER SLAG at same percentage of 10 years RCA at 7 days curing period.
- From above graphical representation.4, it was observed that the compressive strength of 10 years RCA concrete was decreasing by 6.11%, 12.79%, 15.28% and 22.21% at 5%, 10%, 15% and 20% when comparing with conventional concrete. And it was observed that the compressive strength of 10 years RCA concrete was increased by 17.19%, 14.88%, 17.53%, 7.72% and 5.03% when comparing with 10 years RCA with same percentage COPPER SLAG at 28 days curing period.

VI. Scope of The Project

1. Recycling of stone, aggregate, will be reduce the quarrying and mining for stones.
2. The earth surface can be saved and ecological disturbances will be reduced.
3. The ability of land for waste disposal will be increased
4. To conserve the conventional natural aggregate for other important works.

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