Conserve Natural Resources Of Aggregate By Using Recycled Coarse Aggregate: A Review

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***Abstract*— Aggregates are the main material in concrete. The function of aggregate in concrete is to serve as filler. Aggregate give bulk to the concrete, strength, durability to concrete, decrease shrinkage and achieve economy. The main fact is that the aggregate covers 70%-75% of the total amount of each concrete mix. The strength characteristics of the concrete mix developed is dependent on the properties of aggregates used in the mix. The strength of concrete mix design is also depends on the bond strength between the aggregate and cement paste. As the construction works rapidly increasing day by day, the demand of aggregates is also increasing. This is hard to produce so much quantity at single time. Hence there is a demand for an alternative coarse aggregate arises. Demolished concrete is used to fill lands but if recycling is adopted then it may be an alternative to coarse aggregate.**

The objective of this paper was to conserve natural source of aggregate by using recycling coarse aggregate. Experimental studies and analysis has been done on the strength characteristics and durability by replacing coarse aggregate by recycled coarse aggregates in high strength concrete. The tests are performed for strength and durability such as test for saturated water absorption, compressive strength test of cubes, acid resistance test and porosity. We replaced the coarse aggregates in M40 concrete mix by percentage of recycled coarse aggregate i.e. 0%, 10%, 20%, 30%, 40% and 50%. A sample of reduced water/cement ratio was also tested with 50% of recycled aggregate. From tests and analysis it was observed that RCA can be used in HCS by adjusting the water-cement ratio and contents of admixture in the concrete mix.

The experimental tests focused on physical properties of concrete, workability, density and mechanical properties and compressive strength of concrete with RCA. The compressive strength of RCA concrete with 60 % recycled aggregate, is about 76 % of natural aggregate concrete. As per study the amount of recycled coarse aggregate is inversely proportional to the compressive strength of concrete i.e. compressive strength decreases with increase in RCA

***Keywords*— RCA, w/c ratio, workability, compressive strength, durability.**

I. Introduction

At construction site we need several materials such as cement, concrete, aggregate, steel, brick, sand, stone, clay, glass, admixture, clay, wood, mud, and so on. However, the main construction material used at construction site is cement concrete. For its flexibility and suitability with respect to the changing environment conditions, the concrete mix must be such that it can conserve natural resources, save the environment, and create proper usage of energy. To accomplish this, crucial attention must be laid on the use of wastes products and by products in cement and concrete mix used for new constructions. As we know concrete comprises of 75% of aggregate, so use of recycled aggregate will play a major role in conserving natural aggregate. There is a lot of application of recycled aggregate in the construction industries.

Due to urbanisation, the construction work increase with rapid rate which leads to shortage of natural aggregate. So it's important to research on the usage of waste construction materials. With increase in construction and demolition practices, material waste is increasing which leads to pollution. The reasons behind the exploration and analysis is that recycled aggregate are simple to obtain and the cost of recycled aggregate is cheaper than natural aggregate. With increase in construction need of aggregate is also increasing. Since there is limited source of natural aggregate, it is important to find out an alternative for natural aggregate. As demolished concrete is only used for land filling, it is better to recycled it for aggregates to reduced the need of natural aggregates,

II. Mechanical Properties

Compression Test Result and Analysis:-

From the compression strength test it is noted that there is increase in compressive strength in the early age of the concrete specimens. However, it is also noted that the compressive strength of natural aggregate specimens is more than the recycled aggregate specimens. The graphical representation of variation of compressive strength of mix is showed in Figure 1.

The target strength to be achieved in this project is 40MPa. From the result obtained, it is noted that the only batch fulfil the criteria of target strength, which is the batch with 0% recycled aggregate. The compressive strength for remaining batches is less than 40MPa. However the compressive strength of the batch of 50% recycled aggregate with 0.35 w/c ratio is 37MPa, which is approximately equal to the target strength. So according to this, in case of recycled aggregate up to 30 to 40 % replacement may achieve target strength or high strength by reducing the w/c ratio.

Table No:-1 - 7th Day Compressive Test Result

Percentage Of Recycled Aggregate (%)	7 Day Compressive Strength (MPa)
0%	28
10%	27
20%	25
30%	24
40%	22
50%(0.40 w/c ratio)	19
50%(0.35 w/c ratio)	27

The initial compression strength of the mix having 50% of recycled aggregate with 0.35 w/c ratio is maximum, but after day 7, the rate of increment of compressive strength is decreasing when compared to other batches. It is also observed that with the increase in percentage of recycled aggregate, compressive strength of concrete specimen decreases. Figure 1 shows the initial compressive strength is maximum for specimen having 50% recycled aggregate with 0.35 w/c ratio.

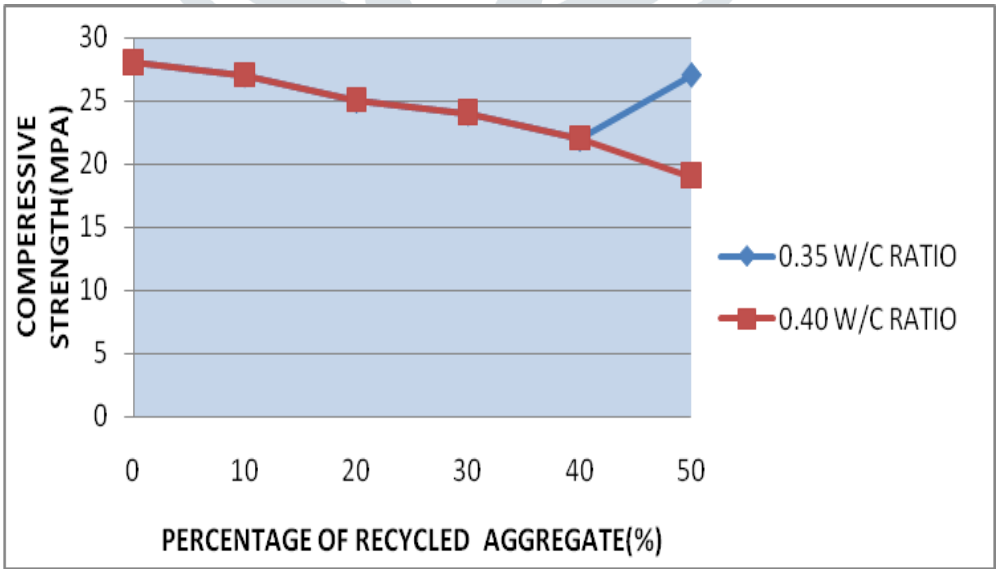

Figure 1: Variation of compressive strength after 7 days

Table No 2 - 28th Day Compressive Test Result

Percentage Of Recycled Aggregate (%)	28 Day Compressive Strength (MPa)
0%	41
10%	38
20%	35
30%	33
40%	30
50%(0.40 w/c ratio)	26
50%(0.35 w/c ratio)	38

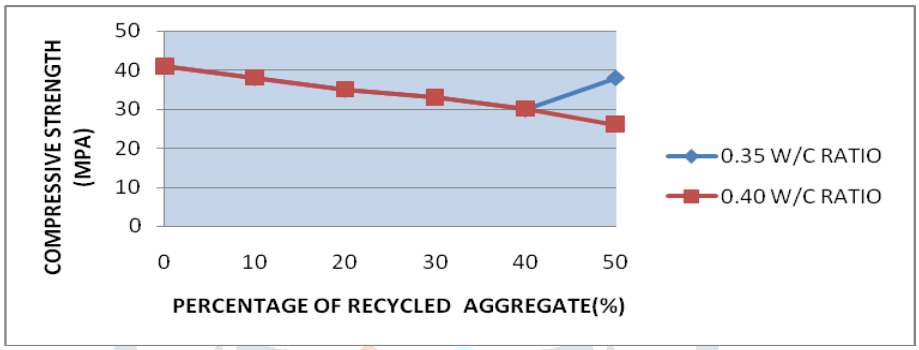

Figure 2 Variation of compressive strength after 28 days

Acid Resistance Test:-

Table no.3 shows the results of acid resistance test (durability test). If the percentage of recycled coarse aggregate is increase, the loss of weight of concrete cubes also increase after 45 days of immersion in sulphuric acid (3%). It is reported that the concrete with recycled aggregate with less w/c ratio is minimum affected by sulphuric acid.

Table:-3 Reductions in Compressive Strength Based On Acid Resistance Test

Percentage Replaced	28 day Compressive Strength (MPa)	Percentage Reduction in weight	Compressive Strength (MPa)	Percentage Reduction in compressive strength compared to 28 day strength
0	41	0.43	39	4.48
10	38	0.48	34.8	88.42
20	36	0.52	32	11.11
30	33	0.57	28.4	13.94
40	31	0.58	25.8	16.75
50	26	0.64	20.3	21.92
50 % with reduced w/c ratio	37	0.53	32.2	12.98

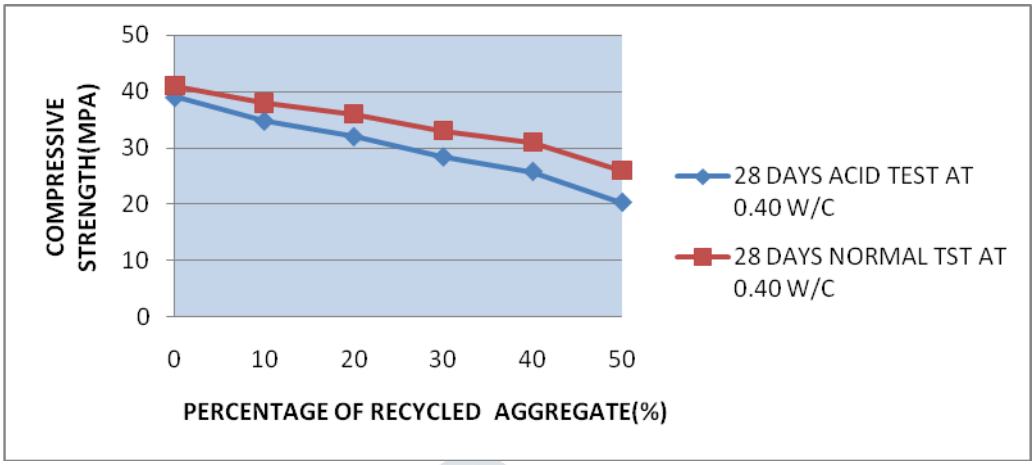

Figure 3 - 28th Day Comparison b/w Normal and Acid Compressive Test Result (0.40w/c ratio)

Figure 3 indicates that the decrement of the strength after 28th days is linear with the recycled aggregate percentage. This is for the 0.40 w/c ratio for normal test and acid test for the specimen. The figure 4 shows that the 0% to 50% recycled aggregate strength decrement for 0.40 water/cement ratio. But when the water/cement ratio reduces the strength of specimen is increase for 50% of recycled aggregate. The change of variation show in figure 3 & 4 for 50% recycled aggregate in different water/cement ratio. That is the reaction of acid in the 45 days in compressive strength result.

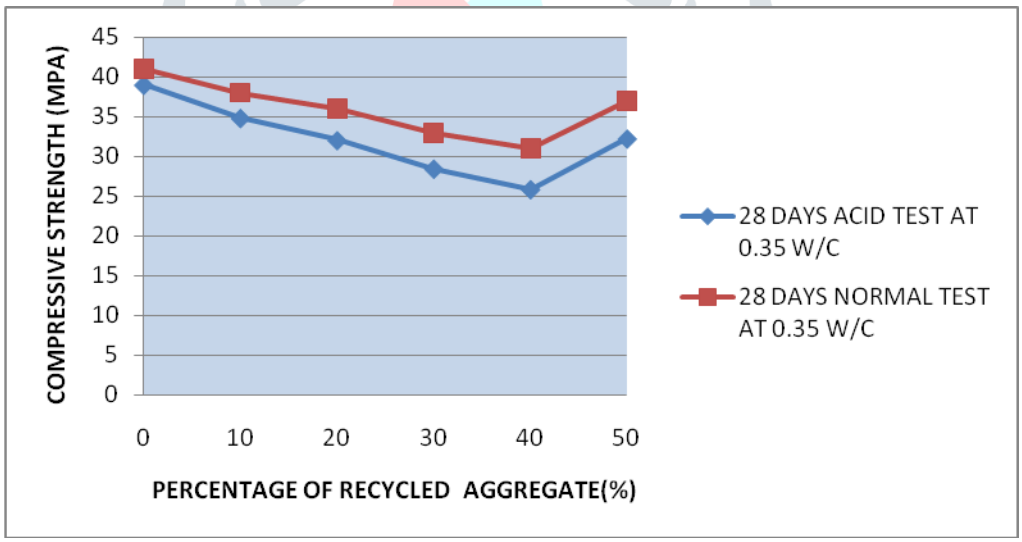

Figure 4- 28th Day Comparison b/w Normal and Acid Compressive Test Result (0.35w/c ratio)

III. Conclusion

Experimental studies and analysis had been done on the strength characteristics and durability by replacing coarse aggregates by recycled coarse aggregates in high strength concrete. The result of study are listed below:-

1) With the increase in the % of recycled aggregates, compressive strength will decrease. But with reduced water/cement, the compressive strength increases.

2) Decreasing the w/c ratio and mixing admixture in proper ratio will help to achieve the target compressive strength (40MPa) for 30 to 40 % of recycled coarse aggregate replacement. This is categorised as high strength performing concrete and can be used in infrastructures, which require compressive strength up to 40MPa.

3) After conducting the acid resistance test, the percentage loss in weight of concrete cubes is negligible for 30 to 40% recycled coarse aggregate replacements. It shows the cube mix are less attacked by acid.

4) In case of recycled coarse aggregate, the water absorption and porosity of cubes mix are higher than normal mix but within the permitted limits. By reducing water cement ratio and mixing admixtures, porosity and water absorption can be modified.

5) The research and analysis shows that recycled coarse aggregate can be used in high strength concrete mixes with suitable engineering properties such as compressive strength, flexural strength and modulus of elasticity.

6) There is workability issue in the recycled coarse aggregate, for high strength concrete we reduce w/c ratio which will reduces the workability, so we have to neglect this fact. Since recycled coarse aggregate absorb more water than natural aggregate, so proper monitoring can be done for water content.

7) There is lack of guidelines and supervision in the use of recycled aggregate so it is important to introduce new standards for recycled aggregates. So that these materials can be used successfully in practice, under arrange of environmental conditions.

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