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USE OF RECYCLED CONCRETE AGGREGATES

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ABSTRACT

Use of recycled aggregate in concrete can be useful for environmental protection. Recycled aggregates are the materials for the future. The application of recycled aggregate has been started in a large number of construction projects of many European, American, Russian and Asian countries. Many countries are giving infrastructural laws relaxation for increasing the use of recycled aggregate. The amount of construction waste has been dramatically increased in the last decade, and social and environmental concerns on the recycling of the waste have consequently been increased Waste concrete is particularly crucial among the construction wastes. Recent technology has also improved the recycling process. In this rapid industrialized world, recycling construction material plays an important role to preserve the natural resources. This paper aims to evaluate physical properties of concrete using recycled coarse aggregate. Concrete properties like compressive strength, flexural strength, workability etc. are explained here for different combinations of recycled aggregate with natural aggregate.

***Keywords*: Aggregate Properties, Crushed Concrete, Portland Cement , Recycled concrete Aggregate**

I. INTRODUCTION

Concrete is the most widely used construction material across the world. It is used in all types of civil engineering works like infrastructure, low and high-rise buildings, defense structure, and environment protection structure. Concrete is a man-made product, essentially consisting of cement, coarse & fine aggregates, water and admixture.

Recycled concrete aggregate is a concrete obtained by using old demolished or broken concrete. Recycling is the Act of processing the used material for use in creating new product. To reduce the use of Natural aggregate, recycled aggregate can be used as the replacement materials. Recycled aggregate are comprised of crushed graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. These materials are generally from buildings, roads, bridges, and sometimes even from catastrophes, such as wars and earthquakes. The use of replacement material offers cost reduction, energy savings, arguably superior products, and fewer hazards in the environment.

The recycling of construction waste, including concrete, and the landfill-bound constituents of the municipal solid waste stream, including glass which occurs largely as mixed-color waste glass with limited market value, are considered important steps towards sustainable construction practices. Concrete rubble usually constitutes

the largest proportion of construction and demolition waste (C&D). Crushed concrete rubble, after separation from other concrete and demolition waste and sieved, can be used as a substitute for natural coarse aggregates in concrete or as a sub-base or a base layer in pavements.

When structures made of concrete are demolished or renovated, concrete recycling is an increasingly common method of utilizing the rubble. Concrete was once routinely trucked to landfills for disposal, but recycling has a number of benefits that have made it a more attractive option in this age of greater environmental awareness, more environmental laws, and the desire to keep construction costs down.

II. EXPERIMENTAL INVESTIGATION

2.1 MATERIALS

2.1.1 CEMENT

Ordinary Portland cement of 53 grade was used for the investigation. It was tested for the physical properties in accor dance with Indian standard specifications.

2.1.2 ADMIXTURE

Water-reducing and air-entraining super plasticizerwas also used in all mixtures. Surfactant based air entraining agent (with brand name of ALGISUPERPLAST N, manufactured by ALGI TECH) was used at a rate of 4 ml/kg of the cementitious material in all mixes.

2.1.3 AGGREGATES

The natural fine aggregate used for producing concrete is river sand of zone II type. The natural coarse aggregate used is microtonalite. The maximum size of this gravel is 25 mm. The cement used is OPC 43 grade Coromandal. Recycled aggregate used in this research is crushed concrete ,i.e. RCA obtained by crushing the concrete waste.

2.2 PROPERTIES OF NATURAL AND RECYCLED COARSE AGGREGATES

Sr. No.	Physical Property	NA	RCA
1	Water absorption (%)	1.56	6.4
2	Specific gravity	2.63	2.3
3	Bulk Density (kg/ m3)	1469.8	1325.93
4	Crushing Value(%)	19.5	20.5

5	Impact Value(%)	8.3	8.9

2.3 TREATMENT PROCESS FOR RECYCLED COARSE AGGREGATES

To improve the quality of RCA some treatment process in terms of washing and heating is required which is given in detail.

2.3.1 Los Angeles Abrasion:

When concrete waste in crushed, some amount of cement particles are stuck to the aggregate. So, Abrasion test is taken to remove the cement attached to the aggregates by use of Los Angeles machine. This is done to obtain a better finished recycle aggregate. As number of revolutions increases more and more fine recycled aggregates can be obtained. Hencethe aggregates were rotated for 200 and 500 revolutions.

Reference: IS:2386 (Part IV) – 1963, IS: 383- 1970

Fig 1: Abrasion Testing Machine

Fig 2: Recycled aggregates for NO revolution

Fig 3: Recycled aggregates for 200 revolutions

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Fig 4: Recycled aggregates for 500 revolutions

2.3.2 WASHING:

The aggregates collected by sieve analysis are washed by using bucket. This is done so as to remove the mortar adhered to the aggregates. In the bucket some quantity of aggregates were taken and was washed by inserting it water tank and taking it out. This process was done for 2mins for each bucket. Washing process cleans the aggregates to a considerable extent.

Fig 5: Washing of Aggregates

2.3.3 DRYING:

The RCA were then kept for sun drying for about 30 mins. In sun drying the wet aggregates dries completely. The figure below shows the drying process for coarse aggregate on pavements.

Fig 6: Drying of Aggregates

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2.4 CASTING AND CURING OF CUBE AND BEAM

The mould is arranged properly and placed over a smooth surface. The sides of the mould exposed to concrete were oiled well to prevent the side walls of the mould from absorbing water from concrete and to facilitate easy removal of the specimen. The reinforcement cages were placed in the moulds and cover between cage and form provided was 20 mm. Cement mortar block pieces were used as cover blocks. The concrete contents such as cement, sand, aggregate and water were weighed accurately and mixed. The mixing was done till uniform mix was obtained. The concrete was placed into the mould immediately after mixing and well compacted. The test specimens were remolded at the end of 24 hours of casting. They were marked identifications. They are cured in water for 28 days. After 28 days of curing the specimen was dried in air and white washed.

Fig 7: Casted Cubes and Beams

Table No 3. Number of specimens prepared

Sample	Size of mould	Specimens prepared
7 days cube	150X150X150	30
14 days cube	150X150X150	30
28 days cube	150X150X150	30
14 days beam	700X150X150	30

28 days beam	700X150X150	30

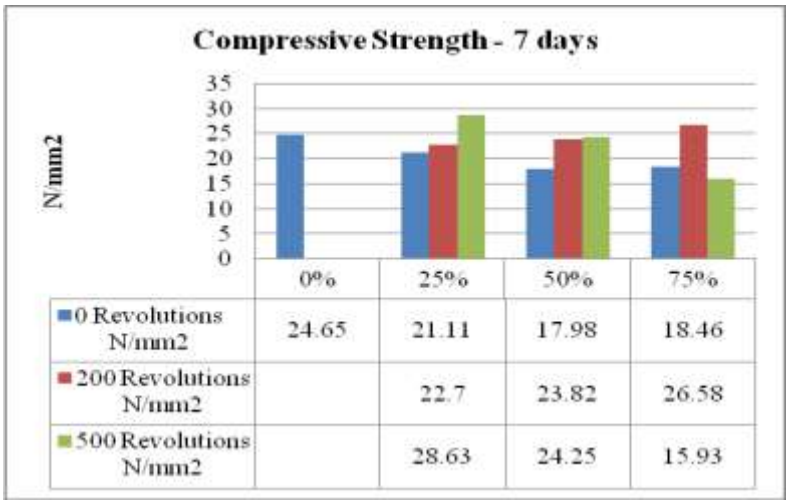
2.5 TESTING OF CUBE AND BEAMS

Tests shall be made at recognized ages of the specimens, the most usual being 7, 14 & 28 days. The ages shall be calculated from the time of the addition of water to the dry ingredients. For each different mixture at least 3 specimens of cubes are to be taken for testing at each 7, 14 and 28 days respectively. And at least 3 specimens of beams were tested at 14 and 28 days. Cubes and beams were tested for compression and flexural strengths. Compression test was taken on Compression Testing Machine and flexural test was taken on Universal Testing Machine. Figure below shows tests taken on cubes and beams.

Fig 8: Compression test on Cube

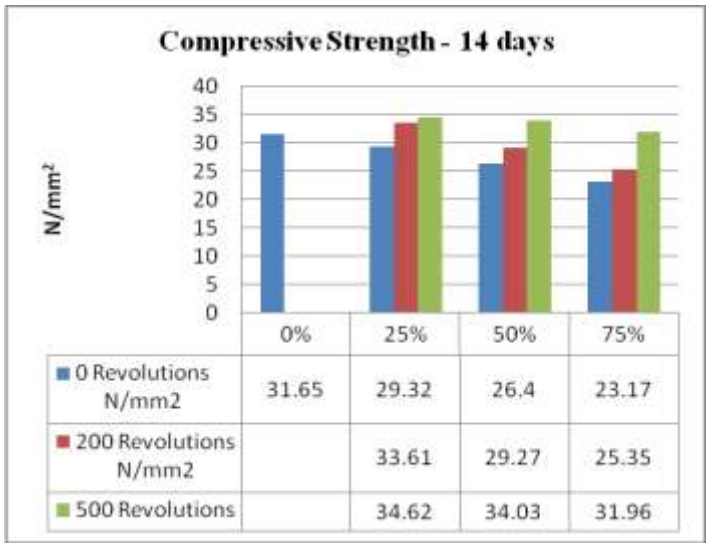
Fig 9: Flexural test on Beam

III. EXPERIMENTAL TEST RESULTS



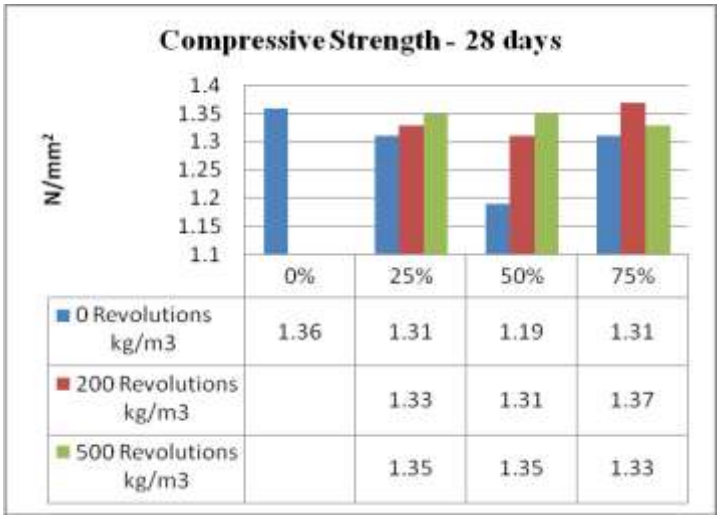
Graph 1. Compressive Strength after 7 days

Above graph shows comparison of compressive strengths for concrete blocksof various proportions which were tested after 7 days of curing. We all know that strength of natural concrete will be less as compared to different proportions. Here, the strength of natural concrete is 24.6 N/mm2, whereas for no revolution at 25% the strength is less and it goes on increasing for more fine aggregates. As the number of revolution increases the strength of concrete also goes on increasing. But, for 75% mixture the strength is comparatively very less &thus it cannot be used for construction.



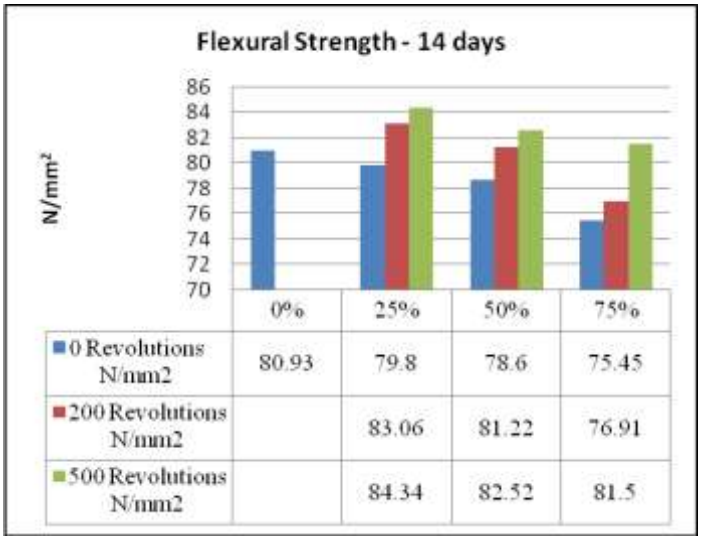
Graph 2. Compressive Strength after 14 days

The above graph shows the comparison of compressive strengths of all proportions after 14 days of curing. In this, we see that there is increase of strength as we go from 200 to 500 revolutions for 25% & 50% mixture. But in case of 75% mixture the strength is very less as compared to others. Hence, it cannot be used for construction process. Thus from this we conclude that use of RCA up to 50% is beneficial as it is economical.



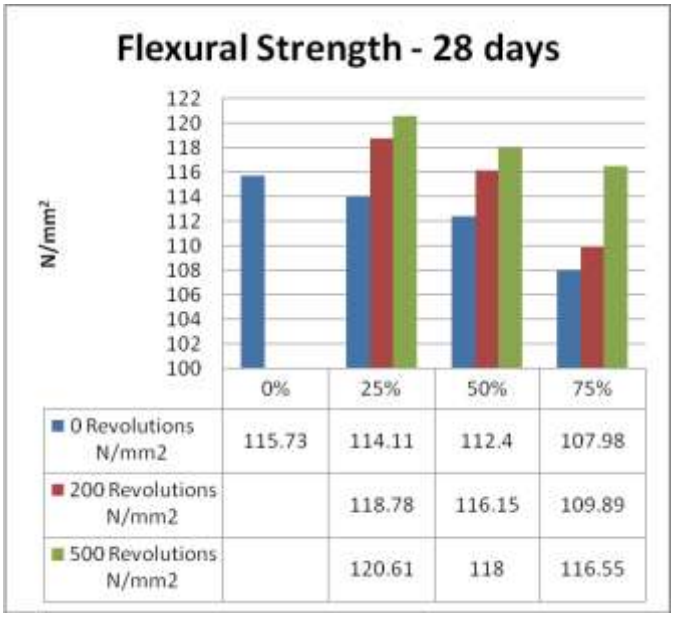
Graph 3. Compressive Strength after 28 days

The above graph shows the comparison of compressive strengths of all proportions after 28 days of curing. In this, we see that there is increase of strength as we go from 200 to 500 revolutions for 25% & 50% mixture. But in case of 75% mixture the strength is very less as compared to others. Hence, it cannot be used for construction process. Thus from this we conclude that use of RCA up to 50% is beneficial as it is economical.



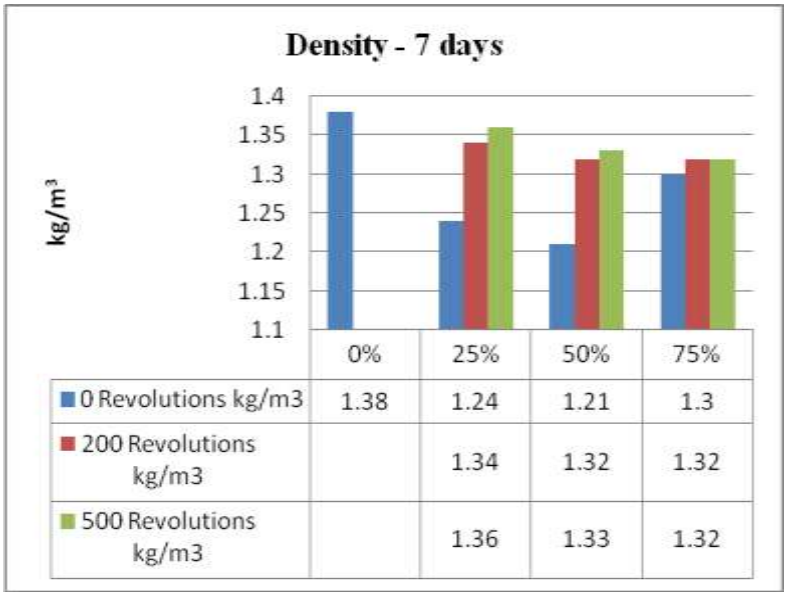
Graph 4. Flexural Strength after 14 days

The above graph shows the comparison of flexural strengths of all proportions after 14 days of curing. In this, we see that there is increase of strength as we go from 200 to 500 revolutions for 25% & 50% mixture. But in case of 75% mixture the strength is very less as compared to others. Hence, it cannot be used for construction process. Thus from this we conclude that use of RCA up to 50% is beneficial as it is economical.

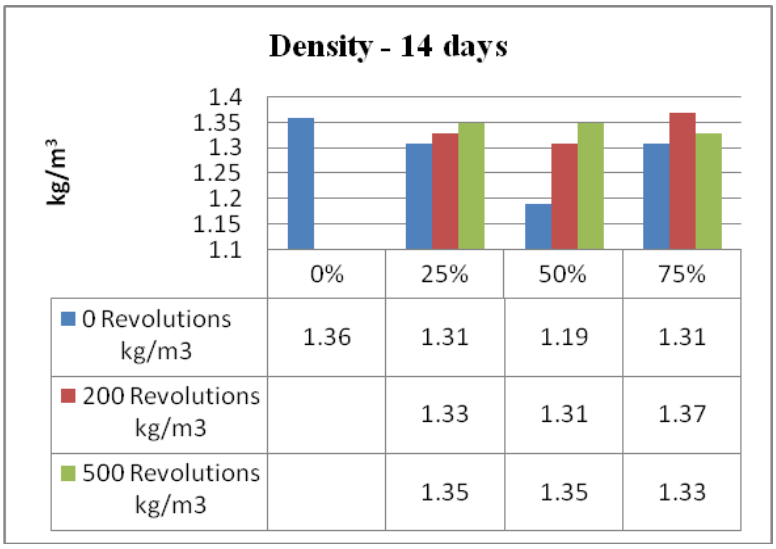


Graph 5. Flexural Strength after 28 days

The above graph shows the comparison of flexural strengths of all proportions after 28 days of curing. In this, we see that there is increase of strength as we go from 200 to 500 revolutions for 25% & 50% mixture. But in case of 75% mixture the strength is very less as compared to others. Hence, it cannot be used for construction process. Thus from this we conclude that use of RCA up to 50% is beneficial as it is economical.



Graph 6: Density of concrete – 7 days



Graph 7: Density of Concrete – 14 days

III.CONCLUSION

On the basis of our comparative analysis of test results of the basic properties of concrete withfour different percentages of coarse recycled aggregate content (0%, 25%,50% and 75%), the following conclusions are made.

1. Recycling of aggregates can reduce disposal costs and also the cost of new aggregate on infrastructure projects. The environmental benefit is obvious, reducing unlawful disposal problems and conserving limited landfill space.
2. workability of concrete with natural and recycled aggregate is almost the same if water saturated surface dry recycled aggregate is used. Also, if dried recycled aggregate is used and additional water quantity is added during mixing, the same workability can be achieved after a prescribed time. The workability was good and can be satisfactorily handled for 0% recycled aggregate to 60% recycled aggregate.
3. The experimental results show that the early compressive strength of concrete made of natural coarse aggregate is lesser than RCA. The slump test indicates a decreasing trend of workability when the percentage of recycled aggregate are increased. According to the result, the highest slump obtained was 29 cm and Lowest Slump obtained was 25 cm for M25 Grade Concrete.
4. Concrete compressive strength mainly depends on the quality of recycled aggregate. If good quality aggregate is used for the production of new concrete, the recycled aggregate has no influence on the compressive strength, regardless of the replacement ratio of natural coarse aggregate with recycled aggregate. The same conclusion is valid for concrete flexural strength. It shows that the strength of recycled aggregate specimens were gradually increase up to 50% replacement of recycled aggregate& then it decreases.

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