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Utilization of Recycled Concrete Aggregate for New Construction

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Abstract - *Crushing the demolished concrete to produce coarse aggregate for the production of new concrete is one common means for achieving a more eco-friendly/sustainable concrete in addition to the reduction in valuable landfill space and use of natural resources. The use of recycled concrete aggregate (RCA) in concrete as partial and full replacements of natural coarse aggregate is growing interest in the construction industry, as it reduces the demand for virgin aggregate. In this project we use recycled concrete aggregate as coarse aggregate (about 90% crushed stone aggregates, 8% brick aggregates and 2% tile aggregates) and natural aggregate of approximate size 20mm for Physical and Mechanical properties test. The Results were compared and discussed in this project. The compressive strength tests are performed on concrete cube by partial replacement of natural coarse aggregate with recycled coarse aggregate .Cubes were casted by replacing natural coarse aggregate with 25%,50% and 100% recycled coarse aggregates. The concrete cubes are designed for M20 as per Indian Standard codes.*

Key Words: Recycled Coarse aggregates, Natural Coarse aggregates, recycled brick aggregates, compressive strength, comparison

1. INTRODUCTION

As urbanization is increasing over time, the demand for new building and infrastructure has sharply risen. The existing old buildings are demolished to make way for new modern ones based on the need. Due to modernization, demolished materials are dumped on land & not used for any purpose .Such situations affect the fertility of land. As per report of Central Pollution Control Board (CPCB) Delhi, in India, 48 million tons solid waste is produced out of which 14.5 million ton waste is produced from the construction waste sector, out of which only 3% waste is used for embankment. It is anticipated that there will be an increase in the amount of concrete waste, a shortage of disposal sites, and depletion in natural resources especially. These lead to the use of recycled aggregate in new concrete production, which is deemed to be a more effective utilization of concrete waste. As we know that concrete is the main construction material across the world and the mostly used in all types of civil engineering works. As aggregate represents about 70-80% of concrete components so it will be beneficial to recycle the aggregate for construction works and also to solve the environmental problems. To minimize the problem of excess of waste material it is a good step to utilize the recycled aggregates provide that the desired final product will meet the standards. The Cost of Recycled Concrete Aggregate may be less than 20 to 30 % less than natural aggregate in some regions. By using the recycled aggregate the consumption of natural aggregate can be reduced. The raw materials used in the production of recycled aggregates come from demolition of pavements and buildings. This material is broken into large pieces and transported to the processing plant. It must be clean, free of contaminants like steel reinforcing bars, wood and soil. Then it passes through three main phases crushing, sizing and blending. The processes of recycling of construction and demolition wastes are similar to those producing natural aggregate both have the same equipments, crushers, screens, removal impurities and transportation facilities.

1.1 BENEFITS OF USING RECYCLED COARSE AGGREGATES

There are many economic, environmental and social benefits to using recycled aggregates.

Cost Saving

- Making use of recycled aggregates over virgin materials can save money as they are less expensive to produce.
- If recycled materials are available locally then this can reduce the cost of transporting the aggregates.
- Producing recycled aggregate for resale is more cost-effective than sending un-wanted materials to landfill and incurring landfill tax.

Eco-Friendly

- Recycled Aggregate is regarded to be a 'green' construction material.
- Using recycled aggregate reduces the amount of virgin aggregates which are created and therefore means less use of natural resources.

Versatile

Recycled aggregates can be used for various different functions, suitable for use with construction projects, landscaping and in home improvement applications

1.2 OBJECTIVES

I. To reduce the environmental pollution as well as providing an economic value for the waste material by the use of recycled concrete aggregate in construction.

II. To compare the physical and mechanical properties of Recycled coarse aggregates and Natural coarse aggregates.

III. To determine the compressive strength of concrete by partial replacement of Natural coarse aggregates with Recycled coarse aggregates.

2. MATERIAL USED

2.1 Cement

Ordinary Portland Cement (OPC) 43-grade confirming to IS: 8112-1989 is available in the market and it was used in the present studies.

Table 1: Properties of cement

PROPERTY	VALUE
Specific Gravity	3.14
Fineness	328 (m^2/kg)
Consistency	34
Initial Setting time(Minutes)	52
Final setting time (Minutes)	258

2.2 Fine Aggregate

Locally available river sand is used in this project with specific gravity 2.48.

2.3 Natural Coarse Aggregates

For this project, natural coarse aggregates are obtained from local supplier. The size of coarse aggregate is approax 20 mm.

Table 2: Properties of Natural Coarse aggregates

PROPERTY	VALUE
Max.Aggregate Size	12.5mm
Water Absorption	1.31%
Fineness Modulus	7.14
Specific Gravity	2.6
Impact value	17.53%

2.4 Recycled Coarse Aggregates

For this project, recycled coarse aggregates are obtained from IL&FS Burari Plant New Delhi. These recycled coarse aggregates are obtained from crushed concrete and it consists of about 90% stone aggregates and 10 % brick aggregates. The size of recycled coarse aggregates is approax 20 mm.

Fig. 1: Recycled coarse aggregates

Table 3: Properties of Recycled coarse aggregates

PROPERTY	VALUE
Max.Aggregate size	12.5mm
Water Absorption	5.64%
Fineness Modulus	7.84
Specific Gravity	1.88
Impact Value	21.83%

2.5 Water

Fresh and clean water is used for casting and curing of specimen. The water is relatively free from organic matters, silt, oil, sugar, chloride and acidic material as per requirements of Indian standard. Combining water with a cementitious material forms a cement paste by the process of hydration.

3. METHODOLGY

A mix M20 grade of concrete is used as per IS 456:2000.Mix proportion adopted is cement, fine aggregate and coarse aggregate (Recycled and natural) in ratio 1:1.5:3.Water-cement ratio was taken 0.50.The cubes are made in the percentage of 25%, 50% and 100% of replacement of natural aggregates. That means that in the first case we have taken 25% recycled aggregates and 75% natural aggregates. In second case we have taken 50% natural and 50% recycled aggregates. In third case we have taken 100% of recycled

aggregates. In Fourth case we have taken 100% of Natural aggregates. And thus we have performed the compressive strength tests on these 4 sets of concrete cube at the age of 7 days and 28 days curing. The replacement is done as per volume. That means the volume of recycled coarse aggregates is matched with the volume of Natural coarse aggregates.

4. TESTING

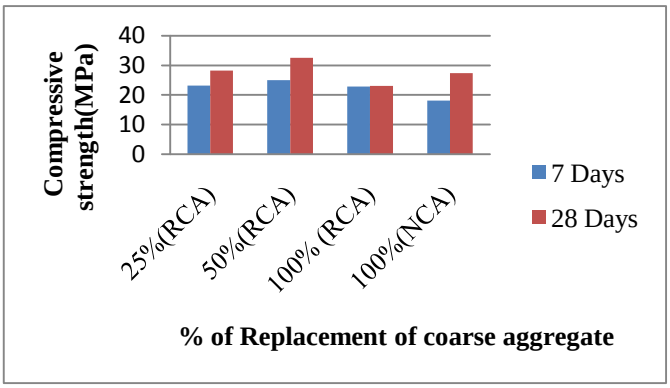
4.1. Compressive Strength

Compression test is the most common test to be conducted on hardened concrete, because most of the properties of concrete are qualitatively related to its compressive strength. The compression test was carried out as per IS 516:1959 using compression testing machine.

A total of 24 concrete cubes of size 150 mm * 150mm * 150mm were tested for compressive strength at curing periods 7 and 28 days. The average value of three specimens was taken as the compressive strength of the concrete. The loading rate on the cube is 140 N/mm2 per min. The comparative studies were made on their characteristics for concrete mix ratio of 1:1.5:3 with partial replacement of natural aggregate with recycled aggregates as 25%, 50% and 100%.

Table 4: Partial and Full Replacement of Natural & Recycled coarse aggregates

Sample No.	Replacement of coarse aggregate	Compressive Strength Test(N/mm2)	
1	25% (RCA)	23.18	28.29
2	50% (RCA)	25.03	32.58
3	100% (RCA)	22.81	23.11
4	100% (NCA)	18.07	27.40



GRAPH 1: Comparison on compressive strength of cube by partial and full replacement of Natural and recycled coarse aggregates

The results show that cube compressive strength of recycled aggregate concrete has more compressive strength than natural aggregate concrete. This is due to stiff bond between cement and recycled brick and stone aggregate, since brick aggregate has rough texture ensuring better bond than stone aggregate with binding material. This can be attributed to the cement mortar coat of recycled coarse aggregate participate in hydration process and contribute additional strength. It is observed that the recycled coarse aggregate concrete at 50% of RCA attained more strength.

5. CONCLUSION

Recycling and reuse of demolished building wastes have been found to be an appropriate solution to the problems of dumping hundred of thousands tons of debris accompanied with shortage of natural aggregates. The use of recycled aggregates in concrete proves to be valuable building materials in technical, environment and economical respect. The value of specific gravity of natural coarse aggregate meet the requirement however the Recycled coarse aggregate doesn't meet the requirement and is lower than the natural coarse aggregate. Then the value of absorption of natural coarse aggregate is lower and recycled coarse aggregate is higher. The value of recycled coarse aggregates with 50% replacement in concrete has the highest compressive strength .Then when 100% replacement of natural aggregate has lower compressive strength. Thus, from this result it concluded that the percentage of recycled coarse aggregate that can be used in concrete is maximum 50% replacement of natural coarse aggregate.

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