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Local Construction And Demolition Waste Used As Coarse Aggregates In Concrete

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ABSTRACT

In the present study the use of crushed construction and demolition waste as a Recycled Concrete Aggregate (RCA) in the production of new concrete was investigated. The performance of compressive strength produced by Recycled Aggregate Concrete (RAC) and results are compared with the Natural Coarse Aggregate Concrete (NAC). The RCA are collected from local demolished structure. The studies were conducted with an M20 mix with the selected w/c ratio: 0.5 and the development of compressive strength of the RAC and NAC at the age of 7 & 28 days were studied. The result shows the compressive strength of RAC is on average 87% of the NAC and the Slump of RAC is low and that can be improved by using Saturated Surface Dry of RCA (SSD RCA) [1]. This study, however, shows that the RAC specimen makes good quality concrete.

Keywords - Recycled Concrete Aggregate (RCA), Recycled Aggregate Concrete (RAC), Natural Coarse Aggregate Concrete (NAC), Compressive Strength, Slump

I. INTRODUCTION

When concrete pavements, structures, sidewalks, curbs, and gutters are removed, they become waste or can be processed for reuse. The resulting concrete must either be disposed of in landfills, or crushed for subsequent use as aggregate base material or as aggregate in new concrete. Crushing the material and using it as coarse aggregate in new concrete makes sense because it reduces waste and reduces the need for natural aggregate [2].

The use of aggregates from construction and demolition waste in pavement beds is the most usual way of reusing this material. Even though considered as a valid reuse technique, it is not the best economic valorization of this resource and it is considered by many researchers to be a down-cycling process that depreciates the capacities of the material. But the production of structural concrete with recycled aggregates, however, offers great potential and recycles the materials viably and effectively [3].

Etxeberria et al. [4] found concrete made with RCA is less workable than conventional concrete. This is a result of the absorption capacity of recycled aggregate. This study found concrete made with recycled coarse aggregates and natural fine aggregates typically needs 5% more water than conventional concrete to obtain the same workability.

Additional cement is needed for concrete made with 100% RCA to achieve similar workability and compressive strength as NAC.

The main aim of this research project is to utilise RCA as Natural Coarse Aggregate (CA) for the production of concrete. It is essential to know whether the replacement of RCA in concrete is inappropriate or acceptable.

II. MATERIALS

2.1 Cement

Ordinary Portland Cement (OPC) of 53 grade UltraTech conforming to IS:12269-1987 [5] was used. The physical properties of cement used were given in Table 1.

2.2 Water

Potable water conforming to IS: 3025-1964 [6]is used for mixing.

2.3 Aggregates

Fine Aggregate (FA) is material passing through an IS sieve that is less than 4.75mm gauge beyond which they are known as CA. According to IS 383:1970 [7] the FA is being classified into four different zones, that is Zone-I, Zone-II, Zone-III, Zone-IV. Also in the case of CA maximum 20 mm coarse aggregate is suitable for concrete work.

RCA was collected from local Construction and Demolition site in Srikalahasti town and collected RCA were manually crushed up to the natural coarse aggregate size (i.e. 20 mm). The Srikalahasti is a town on the banks of River Swarnamukhi, which is one of the holy centers in Chittoor district of Andhra Pradesh and its geographical coordinates are 13° 45' 24.21504" North, 79° 42' 14.73804" East. The township is close to Tirupati and is a part of the Tirupati Urban Development Authority (TUDA), AP, India.

III. RESULTS AND DISCUSSION

Tests on physical properties are carried out on aggregates to determine the Specific Gravity, Water Absorption, Bulk Density, Moisture Content and Aggregate Crushing Value. The physical properties of FA, CA and RCA were presented in Table 2.

From the above test result, the bulk density of gravel is 1475 kg/m3 and the RCA is 5.2% lower in bulk density than the gravel. The specific gravity of RCA is lower than those of CA because of the lower density and higher water absorption. The absorption and moisture content of RCA are higher than those of CA because of the cement paste which adhered to the recycled aggregate is high in porosity.

After testing, a mix design (M20) is designed with the Indian Standard Code guidelines IS: 10262:2009 [8]. The tests are carried out with the water-cement ratio of 0.5. A reference specimen with CA and mix specimen with RCA were casted and cured for testing. Table 3 shows the mix proportions of reference specimen and mix specimen.

Tests conducted on RAC and NAC concretes include the slump of fresh concrete. For the hardened concrete, dry density and compressive strength were determined. Compressive strength testing was performed in general accordance with ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens [9]. For the compressive strength, tests were conducted at the ages of 7 and 28 days and the results at each testing age are reported as an average. The engineering properties of the mix specimen were compared to those of the reference specimen.

The slump of concrete with 100% of CA, 100% replacement of RCA and 100% replacement of the RCA were studied. The results show that slump of reference specimen is higher while the concrete Mix specimen (100% replacement of RCA) has no slump. The slump of RAC is low and that can be improved by using Saturated Surface Dry of RCA (SSD RCA) to improve the workability of fresh concrete. From the results obtained, concrete made with 100% SSD RCA has competitive slump compared to the concrete made with CA as shown in Table 4.

Dry density of concrete with RCA is low because of it contains saturated surface and it absorbs moisture. The development of compressive strength of the RAC and NAC at the age of 7 days were 18.20Mpa and 16.80MPa & 28 days were 25.5Mpa and 22.18Mpa respectively. The result shows the compressive strength of RAC is on average 87% of the NAC at an age of 28 days.

IV. TABLES

Table 1. Physical Properties of Cement

Type of cement	Specific Gravity	Normal Consistency (%)	Setting Time in minutes		Compressive Strength in MPa		
			Initial	Final	3 days	7 days	28 days
UltraTech OPC 53	3.09	33	48	240	25.5	36	53.5

Table 2. Physical Properties of FA, CA and RCA

S.No.	Aggregate properties	FA	CA	RCA
1	Specific Gravity	2.65	2.72	2.45
2	Water Absorption (%)	1.0	0.5	4.3
3	Bulk Density (kg/m^3)	1460	1475	1398
4	Moisture Content (%)	1.5	1.8	3.5
5	Aggregate Impact Value (%)	-	16.25	25.3
6	Fineness Modulus (%)	3.53	4.50	4.50

Table 3. The mix design (M20) proportions of reference specimen and mix specimen.

Specimen Type	W/c ratio	Cement	FA	CA/ RCA
Reference specimen (100 % CA)	0.5	1.0	1.77	3.38
Mix specimen (100 % RCA)	0.5	1.0	1.72	3.23

Table 4. The various test results of NAC and RAC

Specimen Type	**Slump (mm)**	**Dry density (Kg/m^3)**	**Compressive strength (MPa)**	
			7 days	**28 days**
Reference specimen (100 % CA)	45	2385.8	18.20	25.50
Mix specimen (100 % RCA)	0	-	-	-
Mix specimen (100 % RCA SSD)	43	2263.6	16.80	22.18

V. CONCLUSION

The present study reveals that concrete can be successfully produced using RCA that have been produced from demolition and construction waste. Concrete produced by RCA does not perform as well as concretes produced by CA in terms of strength. However, the concrete still has a strength that would make it suitable for some applications.

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