

Analysis of Effects of Recycled Aggregates on Properties of Concrete

Er.Sunil Kumar¹, Er.Vikram Dhillon², Er. Jatin Goyal³

M.Tech Scholar, Department of Civil Engineering, JCDMCOE, Sirsa, India

Assistant Professor, Department of Civil Engineering, JCDMCOE, Sirsa, India

M.Tech Environmental Science Engineering, Co-Guide, Sirsa, India

ABSTRACT: Rapid growth in urban infrastructure demands large quantity of aggregates for construction. Infrastructural waste in the form of demolished concrete aggregate is one of the major components of solid waste. The solid waste or concrete obtained from demolished building in India generally consumed in filling up of street holes, empty plots or for landfills. This solid may be utilized as a replacement of natural aggregates. This will help us to improve scarcity of natural aggregates. For this M20 mix was taken under study. Various experiments on fresh and hardened concrete with different replacement ratios of natural aggregate with recycled aggregate were performed and there are comparable. Recycled aggregates are composed of crushed and inorganic particles which were prepared by crushing the waste concrete obtained from the laboratory test cubes and demolished building. 5 different types of concrete mixtures were tested by taking 90 specimens. The water cement ratios used were 0.45, 0.50 and 0.55. The investigation was carried out by using workability test and compressive strength test. The workability of concrete is considerably reduced when we increase amount of recycled aggregate. This is analyzed through standard slump test. The other properties of fresh and recycled aggregates such as specific gravity of aggregates, bulk density of aggregates, Impact value of aggregates, water absorption of aggregates are find out and their results are comparable. The overall analysis shows that as the W/C ratio increases the strength of concrete using virgin aggregate is decreases and that of recycled aggregate concrete is increases. The mix-A and mix-E gave comparable compressive strength after 7 days and 28 days respectively at W/C = 0.55 which indicates that recycled aggregates can be used with natural aggregates or as a replacement of natural aggregates .The values of Specific gravity, bulk density, Impact value and water absorption of recycled aggregates are also comparable to that of natural aggregates.

KEYWORDS: Recycled aggregate concrete (RAC), Natural aggregate (NA), Natural fine aggregate (NFA), Natural coarse aggregate (NCA), Recycled fine aggregate (RFA), Recycled coarse aggregate (RCA).

I. INTRODUCTION

Use of recycled aggregate with natural aggregate in concrete may be useful for environmental protection. Recycled aggregates are the materials for the future. The use of recycled aggregate has been started in a large number of construction projects of many European, American, Russian and Asian countries. Some of the countries are giving infrastructural laws relaxation for increasing the use of recycled aggregate. Most of properties of recycled fine aggregate and recycled coarse aggregates are similar to the properties of natural fine aggregate and coarse aggregates. Recycled aggregate (RA) is derived from demolition of buildings, bridges, roads, and other civil engineering infrastructures. The concrete manufactured using such aggregates is termed as recycled aggregate concrete (RAC).the recycled aggregate is accepted as a sustainable construction material. Generally speaking, unprocessed recycled aggregates are used for bulk fill, bank protection, for drainage structures as base or fill, construction of roads, and embankments. The unprocessed crushed concrete aggregate can be used for pavement sub-bases. After contaminants are removed by selective demolition, screening, air separation and size reduction in a crusher to aggregate sizes, the

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crushed concrete aggregates can be used for making new concrete. This RAC is commonly utilized in various applications such as pavements, curbs and gutters, bridge foundations

II. LITERATURE REVIEW

According to Parekh D. N. Use of recycled aggregate in concrete can be beneficial for environmental protection and economical terms. Recycled aggregates are the materials for the future. He work on the basic properties of recycled fine aggregate and recycled coarse aggregate. He also compares these properties with natural aggregates. He explained the concrete properties like compressive strength, flexural strength, and workability for different combinations of recycled aggregate with natural aggregate. His work shows that there is significant potential for growth of recycled and secondary aggregates as an appropriate and “green” solution to the anticipated increased world – wide construction activity and with it the demand for RSA. **According to Mr. Tushar R** determines the basic properties of recycled fine aggregate and recycled coarse aggregate & also compares these properties with natural aggregates. He explained the changes in all aggregate properties and their effects on concreting work. He also find the properties of recycled aggregate concrete. Basic concrete properties like compressive strength, flexural strength, workability etc. are explained by him for different combinations of recycled aggregate with natural aggregate. His results show that use of recycled aggregate up to 30% does not affect the functional requirements of the structure. He performed various tests on recycled aggregates and compared these results with natural aggregates which are satisfactory as per IS 2386. **Shodolapo Oluyemi Franklin** makes a study on the global concern of sustainability in building and construction engineering. He also gives views about RCA and how to use these aggregate and up to what extent. He makes a detailed study of compressive strength, split tensile strength, flexural strength, and the modulus of elasticity of the concrete.

III. COMPARISON OF NATURAL & RECYCLED AGGREGATE

Construction demolition wastes which consist of plain cement concrete and reinforced cement concrete are collected from various sites. The laboratory concrete waste also collected for making the recycled aggregates. Now this material is crushed by hammer. The aggregates of various sizes are separated by using sieve analysis. Various properties of recycled aggregates and fresh aggregates are compared as shown in Table 1

Table-1

Sr.No.	Characteristics	NFA	NCA	RFA	RCA
1	Specific gravity of aggregate	2.69	2.91	2.46	2.52
2	Bulk density of aggregate	1446 Kg/m ³	1620Kg/m ³	1354Kg/m ³	1426 Kg/m ³
3	Water absorption of aggregate	0.80%	0.60%	2.6%	2%
4	Aggregate Impact value of coarse aggregate	17.32 %		25.34%	

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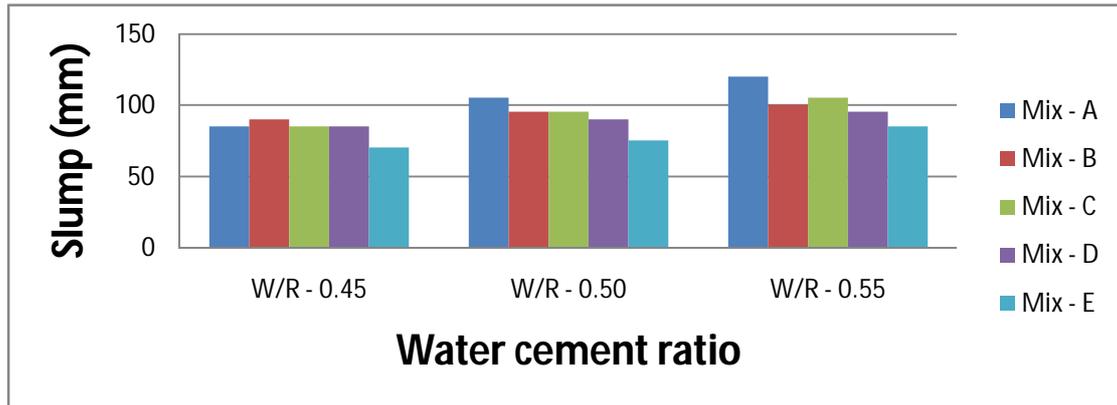


Figure 1

As per Table 1

Specific Gravity in saturated surface dry condition of recycled concrete aggregate was found 2.46 of fine aggregates and 2.52 of coarse aggregates which are comparable to the specific gravity of natural aggregates. If specific gravity is less than 2.4, it may cause segregation; honeycombing & also yield of concrete may get reduced.

Bulk Density of recycled aggregate is lower than that of natural aggregate. This mean recycled aggregate is lighter than natural aggregate.

Water Absorption capacity of recycled aggregate is more than natural aggregate. The average water absorption rate of recycled aggregate is around 2.3%, but water absorption rate of natural coarse aggregate is only 0.60% and fine aggregate is 0.80%. This result shows that more water needed to be added when using recycled aggregate in the concrete mixing to get an acceptable workability.

The recycled aggregate is weaker than the natural aggregate against different mechanical actions. As per IS Specifications, the **Impact values** of aggregate lies between 10- 35% gives satisfactory performance. The impact value of recycled aggregates is 25.34% which is less than the specified values. Hence recycled aggregates can be conveniently use.

All mixes contain NA and RCA in various ratios as coarse aggregate and fine aggregate with water cement ratio varies from 0.45 to 0.55. The maximum slump value was 120mm for Mix- A-3 in which 100% natural aggregate were used with W/C ratio 0.55 and minimum slump is 70mm for Mix- E-1 in which 100% RCA were used with W/C ratio 0.45.

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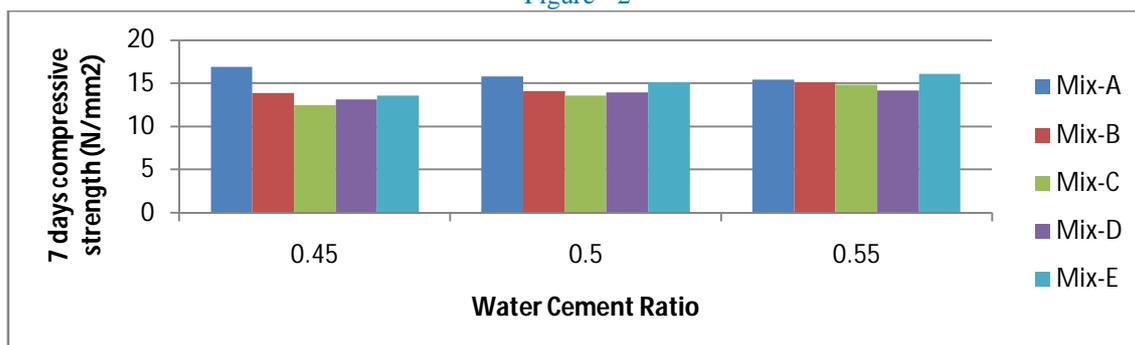
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IV. DATA SAMPLING

Sr. No.	Mix Designation	Mix proportion	W/C ratio	Proportion of coarse aggregate (4.75-10 :10-20) (40:60)		Proportion of fine aggregate (35% of total aggregate) {FA=FA/(FA+CA)}		Workability (Slump in mm)	Average Compressive Strength (N/mm ²)	
				VA	RCA	VA	RCA		7 Day	28 Day
1	A1	1:1.5:3	0.45	100	0	100	0	85	16.89	25.28
2	A2	1:1.5:3	0.50	100	0	100	0	105	15.80	23.28
3	A3	1:1.5:3	0.55	100	0	100	0	120	15.40	24.10
4	B1	1:1.5:3	0.45	100	0	50	50	90	13.88	20.40
5	B2	1:1.5:3	0.50	100	0	50	50	95	14.10	20.60
6	B3	1:1.5:3	0.55	100	0	50	50	100	15.16	21.40
7	C1	1:1.5:3	0.45	50	50	50	50	85	12.44	19.30
8	C2	1:1.5:3	0.50	50	50	50	50	95	13.55	20.92
9	C3	1:1.5:3	0.55	50	50	50	50	105	14.87	21.55
10	D1	1:1.5:3	0.45	0	100	50	50	85	13.10	19.50
11	D2	1:1.5:3	0.50	0	100	50	50	90	13.95	20.73
12	D3	1:1.5:3	0.55	0	100	50	50	95	14.20	21.00
13	E1	1:1.5:3	0.45	0	100	0	100	70	13.55	20.01
14	E2	1:1.5:3	0.50	0	100	0	100	75	15.11	21.20
15	E3	1:1.5:3	0.55	0	100	0	100	85	16.10	22.20

Figure - 2



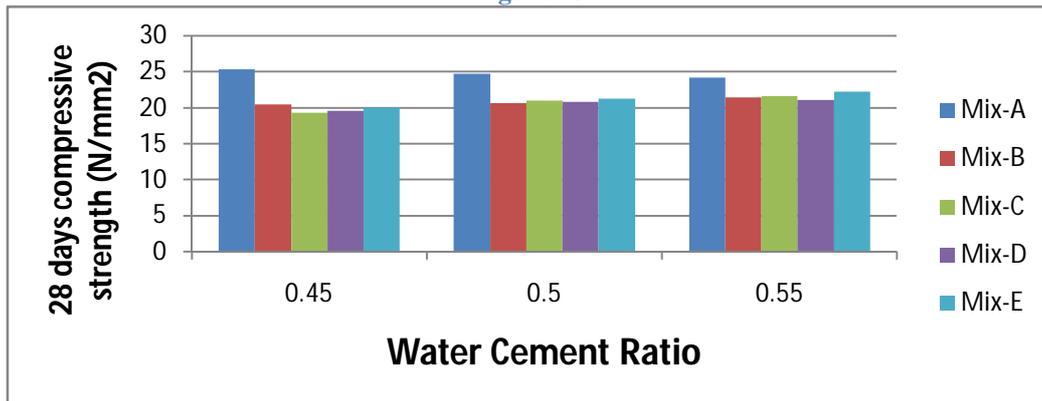
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Figure - 3



V. RESULTS AND DISCUSSION

In data sampling the table shows that the reason for difference in slump is the high absorption capacity of RCA. This indicates that unless aggregate is saturated before handling, RCA concrete may have a lower workability than natural aggregate which lead to difficulty in placing, compacting and finishing the concrete. The average compressive strength of cubes of all mixes was tested after 7 days and 28 days as shown in Table – 2. The compressive strength of various mixes using recycled aggregate 100% or in different proportion with natural aggregate was quite good. The strength of the recycled aggregate specimens is lower than that of natural aggregate but in some condition there is very little difference in compressive strength of specimens. Figure – 2 and figure - 3 compare the compressive strength after 7 days and 28 days of all mixes with three different W/C ratios 0.45, 0.50 and 0.55. The results show that as the W/C ratio increases the strength of concrete using natural aggregate is decreases and that of recycled aggregate concrete is increases. The mix-A and mix-E gave compressive strength of 15.40N/mm² and 16.10N/mm² after 7 days and 24.10N/mm² and 22.20 N/mm² after 28 days respectively at W/C = 0.55. The difference is very low and acceptable. If we compare the strengths of Mix-A and Mix-B at W/C = 0.55, the values of 7 days compressive strength are 15.40N/mm² and 15.16 N/mm² respectively. The values are near about same, it means the use of recycled fine aggregate does not affect the compressive strength of concrete.

VI. CONCLUSION

1. At lower W/C ratio the difference in compressive strength of NA concrete and RA concrete is considerable, while it is only marginal at higher water cement ratio.
2. When only fine recycled aggregate are used with natural aggregates with W/C = 0.55 the strength is not much affected.
3. The reason for the difference in slump of natural aggregate and recycled aggregate is the high absorption capacity of recycled aggregate
4. When only recycled coarse and fine aggregate are used with W/C = 0.55, satisfactory strength and workability are achieved.
5. Minimum strength and workability are achieved with W/C= 0.45



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