The significance of Strength of Recycle Concrete Aggregate

Aditya Singh Dhillon, Dr. Arvind Dewangan, Dr.D.P.Gupta

***Abstract*— Efficient use of the demolished concrete would reduce the costs and definitely lead to conservation of the invaluable non-renewable sources of energy and hence must be given due importance. The demolished concrete could be used as aggregate for concrete resulting in large consumption of the material. Recycling is the act of processing the used material for use in creating new product. The usage of natural aggregate is getting more and more intense with the development in infrastructure area. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement materials. Recycled aggregate comprise of crushed, graded inorganic particles obtained 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. This study involves the experimental investigation of effect of fly ash and rice husk ash on the properties of burnt clay bricks. Determine the properties of the bricks casted with varying proportions of admixtures is taken into consideration whether the admixtures can be used for the production of clay bricks. On seeing the present day demand for bricks, an attempt is made to study the behavior of bricks manufactured using, different waste materials like rice husk ash and fly ash. The main aim of this work was to compare the compressive strength of the bricks. The bricks were made, sun dried and burnt in a kiln, and then with the help of Compression Testing Machine (C.T.M.) finely their compressive strength was calculated. From this test in this research work it was concluded that the bricks with fly ash as the waste material admixture, gave the highest compressive strength.**

***Index Terms*— Clay , Compressive strength, Fly Ash, Rice Husk Ash and bricks.**

I. INTRODUCTION

Concrete has been the leading building material since it was first used and is bound to maintain its significant role in the upcoming future due to its durability, maintenance free service life, adaptability to any shape and size, wide range of structural properties plus cost effectiveness. The concrete is the most important construction material which is manufactured at the site. It is the composite product obtained by mixing cement, water and an inert matrix of sand and gravel or crushed stone. It undergoes a number of operations such as transportation, placing, compaction and curing. The distinguishing property of concrete is the ability to harden under water. The ingredients can be classified into two groups namely active and inactive. The active group consists of cement and water, whereas the inactive group consists of fine and coarse aggregates. The inactive group is sometimes also called inert matrix. Concrete has high compressive strength but its tensile strength is very low. In situations where tensile stresses are developed the concrete is strengthened by using steel bars or short randomly distributed fibers forming a composite material called reinforced cement concrete (RCC) or fiber reinforced concrete.

The resistance of concrete to the slipping of reinforcing bars embedded in concrete is called bond strength. The bond strength is provided by adhesion of hardened cement paste and by the friction between concrete and reinforcement. It is also affected by the shrinkage of concrete relative to steel. On an average bond strength is taken approximately as 10% of the compressive strength. The roughness of the steel surface, water, the chemical composition of cement and steel bar diameter are the factors that affect the bond strength of concrete. In Pull-out tests on plain bars, the maximum load generally represents the bond strength that can be developed between the concrete and steel. With plain bars the maximum load is not very different from the load at the first visible slip, but in the case of the deformed bar, the maximum load may correspond to a large slip which may not in fact be obtained in practice before other types of failure occur.

II. METHODOLOGY

The selection of mix materials and their required proportion is done through a process called mix design. There are number of methods for determining concrete mix design. The methods used in India are in compliance with the BIS (Bureau of Indian Standards). The objective of concrete mix design is to find the proportion in which concrete ingredients-cement, water, fine aggregate and coarse aggregate should be combined in order to provide the specified strength, workability and durability and possibly meet other requirements as listed in standards such as IS: 456-2000. The specification of a concrete mix must therefore define the materials and strength, workability and durability to be attained. IS: 10262-1982 gives the guidelines for concrete mix designs. In this study, six batches of mixes were determined. Two mixes were taken with first mix (1:1:2.46, w/c=0.45) called control mix and second mix (1:1.25:2.48, w/c=0.48). The natural coarse aggregate was replaced by recycled coarse aggregate in the ratio of 25%, 50%, 75% and

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100%. The properties such as compressive strength was studied.

Physical properties of cement 43-grade

S. No.	Properties	Observed values	Values specified by IS:8112-1989
1.	Fineness % (90 µm I.S. Sieve)	4	Not more than 10
2.	Soundness (mm) (Le Chatelier Method)	1.0	Not more than 10
3.	Normal Consistency (%)	29	……………………
4.	Initial Setting Time (minutes)	220	>=30
5.	Final Setting Time (minutes)	300	<=600
6.	Compressive Strength (MPa) 3 days 7 days	 26.07 31.40	 >23 >33
7.	Specific gravity (Le-Chatelier's Method)	3.87	…………..

Sieve Analysis of Natural Fine Aggregate (Yamuna River Sand)

Weight of Sample Taken=1000gm

IS Sieve Size (mm)	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative percentage of Weight Retained	Percentage Passing
4.75	152	152	15.2	84.8
2.36	51	203	20.3	79.7
1.18	116	319	31.9	68.1
.6	114	433	43.3	56.7
.3	379	812	81.2	18.8
.15	144	956	95.6	4.4
0.75	25	981	98.1	1.9
Pan	-	-	-	-

$\sum F=385.6$

Fineness Modulus (F.M.)=3.86

Sand conform to grading zone II of I.S. 383-1970

Physical Properties of Natural Fine Aggregate

S. No.	Property	Observed Values
1.	Bulk Density (Loose), kg/m^3	1682
2.	Bulk Density (Compacted), kg/m^3	1886
3.	Specific Gravity	2.54
4.	Free Moisture %	1.48
5.	Water Absorption %	14.3

Sieve Analysis of Coarse Aggregate (10mm)

Weight of Sample Taken = 2000gm

IS Sieve Size (mm)	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative percentage of Weight Retained	Percentage Passing
25	0	0	0	100
20	0	0	0	100
12.5	8	8	.4	99.6
10	541	549	27.45	72.55
4.75	1414	1963	98.15	1.85
2.36	32	1995	99.75	.25
Pan	-	-	-	-

$\sum C=125.6$

Fineness Modulus (F.M.)=6.2

Physical Properties of Coarse Aggregate (10 mm)

S. No.	Property	Observed Values
1.	Bulk Density (Loose), kg/m^3	1307
2.	Bulk Density (Compacted), kg/m^3	1469
3.	Specific Gravity	2.61
4.	Free Moisture %	0
5.	Water Absorption %	.5

Sieve Analysis of Coarse Aggregate (20mm)

Weight of Sample Taken = 2000gm

IS Sieve Size (mm)	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative percentage of Weight Retained	Percentage Passing
25	0	0	0	100
20	72	72	3.6	96.4
16	740	812	40.6	59.4
12.5	577	1389	69.45	30.55
10	546	1935	96.75	3.25
4.75	54	1989	99.45	0.55
Pan	-	-	-	-

∑C=199.8

Fineness Modulus (F.M.)=6.99

Physical Properties of Coarse Aggregate (20 mm)

S. No.	Property	Observed Values
1.	Bulk Density (Loose), kg/m^3	1477
2.	Bulk Density (Compacted), kg/m^3	1554
3.	Specific Gravity	2.66
4.	Free Moisture %	0
5.	Water Absorption %	.3

Mix proportion

S. No.	R%	Cement (kg/m^3)	FA (kg/m^3)	NCA (kg/m^3)	RCA (kg/m^3)	Water (kg/m^3)	Remark
1.	0	480	535	1210	0	216	%R=0
2.	25	480	535	907.5	302.5	216	%R=25
3.	50	480	535	605	605	216	%R=50
4.	75	480	535	302.5	907.5	216	%R=75
5.	100	480	535	0	1210	216	%R=100
6.	0	470	580	1180	0	225.6	%R=0
7.	25	470	580	885	295	225.6	%=25
8.	50	470	580	590	590	225.6	%R=50
9.	75	470	580	295	885	225.6	%R=75
10.	100	470	580	0	1180	225.6	%R=100

Compressive Strength

The specimens were tested at the age of 3, 7, 28, 56 and 90 days. The cubes were tested on universal testing machine after drying at room temperature according to IS 516-1959. The load was applied continuously without impacts and uniformly @140N/cm$^{2/}$minute. Load was continued until the specimen failed and maximum load carried by the specimen was recorded. The cube compressive strength was obtained by considering the average of three specimens at each age.

The results of compressive strength and the workability of concrete mixes are given in Tables 4.1 to 4.3 and in Figures 4.1 to 4.13. These results are discussed in the following sections as under.

4.2 Variation of Compressive Strength with Age

Compressive Strength at different ages (W/C=0.45)

S. No.	Mix	W/C	Age (Days)	Compressive Strength (MPa)				
				%R=0	%R=25	%R=50	%R=75	%R=100
1.	1:1:2.46	0.45	3	28.52	26.18	21.74	21.52	21.40
2.	1:1:2.46	0.45	7	28.66	27.20	26.13	24.84	24.50
3.	1:1:2.46	0.45	28	33.48	29.88	32.31	29.13	30.30
4.	1:1:2.46	0.45	56	35.79	34.88	34.27	33.34	31.40

5.	1:1:2.46	0.45	90	37.84	36.26	34.47	32.24	33.34

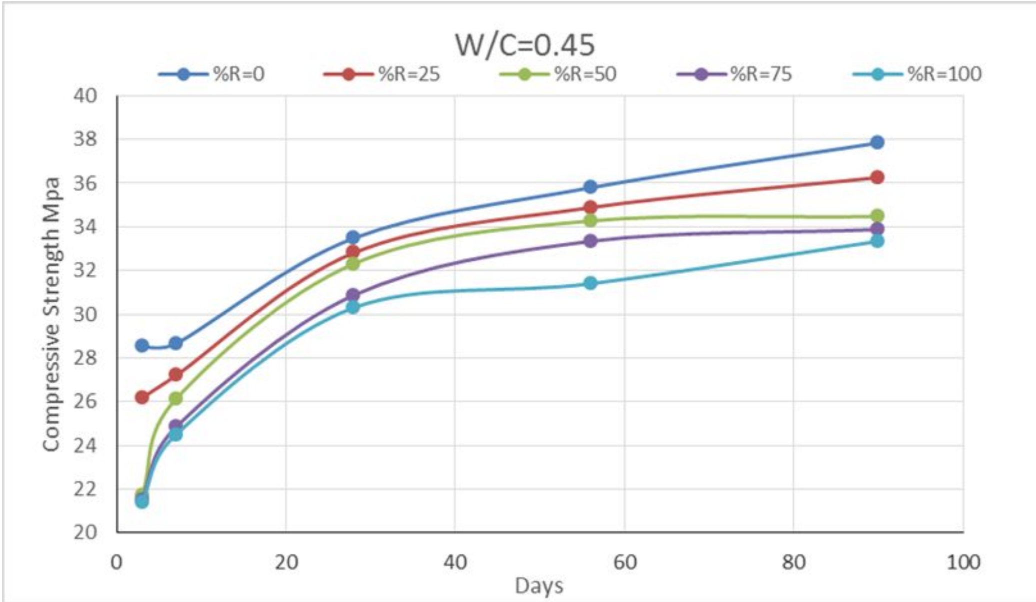

Figure 4.1Compressive strength vs. days graph at W/C=0.45

Table 4.2 Compressive Strength at different ages (W/C=0.48)

S. No.	Mix	W/C	Age (Days)	Compressive Strength (MPa)				
				%R=0	%R=25	%R=50	%R=75	%R=100
1.	1:1.25:2.48	0.48	3	26.80	25.34	21.10	14.20	14.75
2.	1:1.25:2.48	0.48	7	28.66	26.45	23.78	17.34	18.30
3.	1:1.25:2.48	0.48	28	30.64	28.55	25.72	22.13	24.10
4.	1:1.25:2.48	0.48	56	35.35	32.45	30.12	27.39	29.40
5.	1:1.25:2.48	0.48	90	36.10	34.82	33.34	28.88	29.96

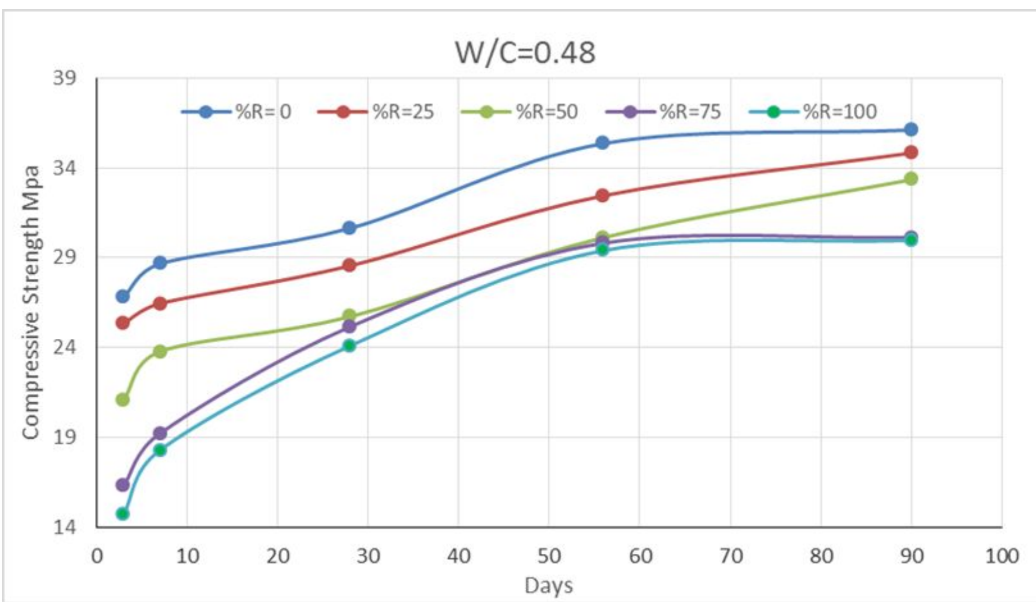

Figure 4.2 Compressive strength vs. days graph at W/C= 0.48

Table 4.3- % Variation of Compressive Strength at different ages

Sr. No.	Mix	W/C	Age (Days)	%Reduction in Compressive Strength			
				%R=25	%R=50	%R=75	%R=100
1.	1:1:2.46	0.45	3	91.79	76.22	75.45	75.03

2.	1:1:2.46	0.45	7	94.90	91.17	86.67	85.48
3.	1:1:2.46	0.45	28	97.99	96.50	92.20	90.50
4.	1:1:2.46	0.45	56	97.45	95.75	93.15	87.73
5.	1:1:2.46	0.45	90	95.82	91.09	89.53	88.10
6.	1:1.25:2.48	0.48	3	94.55	78.73	60.89	55.03
7.	1:1.25:2.48	0.48	7	92.28	82.97	67.09	63.85
8.	1:1.25:2.48	0.48	28	93.17	83.94	82.11	78.65
9.	1:1.25:2.48	0.48	56	91.79	85.20	84.32	83.16
10.	1:1.25:2.48	0.48	90	96.45	92.35	83.43	82.99

For W/C =0.45

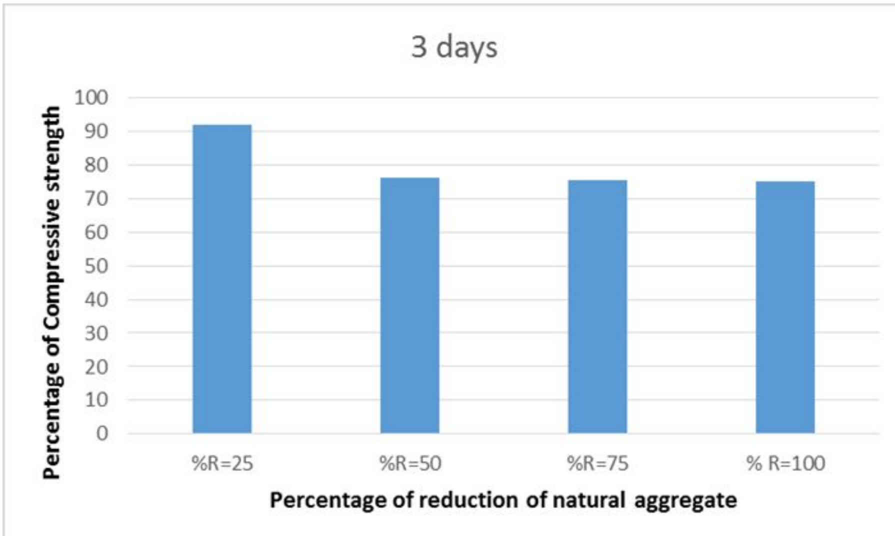

Figure 4.3 percentage of compressive strength vs. percentage of reduction of natural aggregate after 3 days

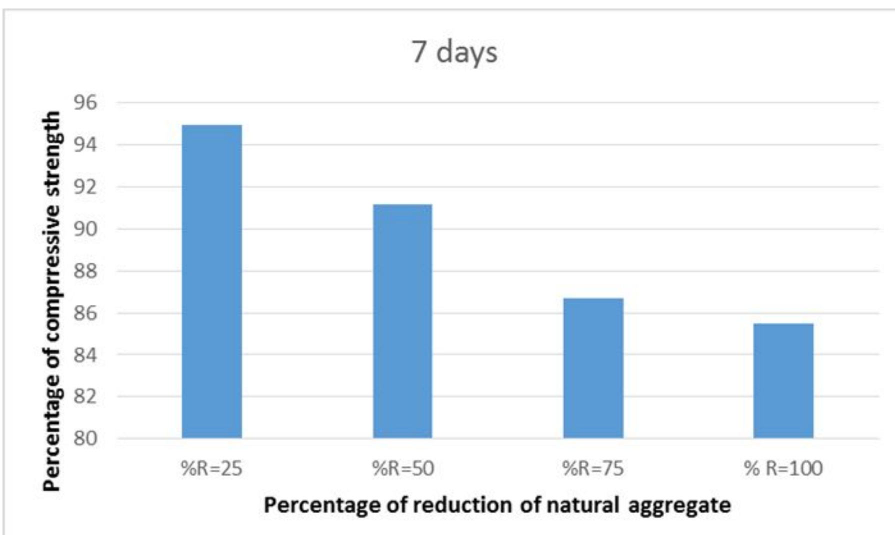

Figure 4.4 percentage of compressive strength vs. percentage of reduction of natural aggregate after 7 days

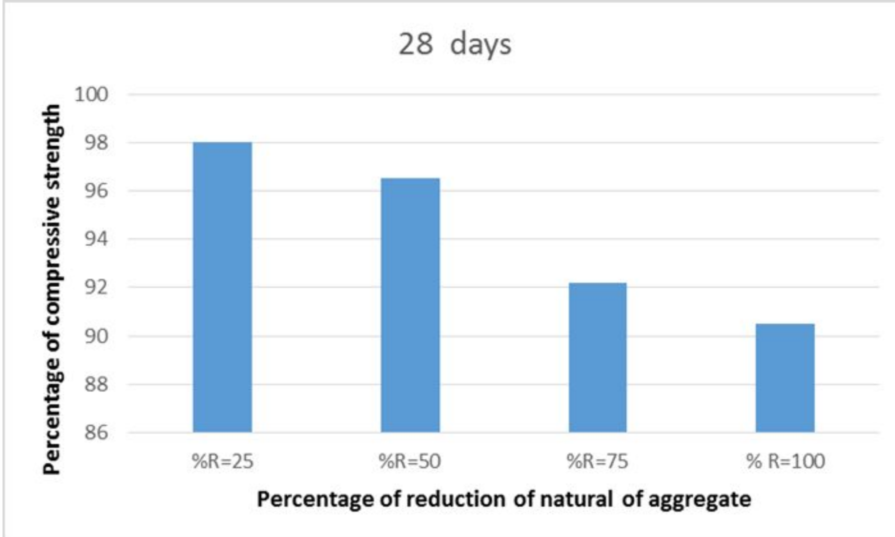

Figure 4.5 percentage of compressive strength vs percentage of natural aggregate after 28 days

Compressive Strength at 28 days with W/C=.48 was observed as 30.64 MPa with NCA=100% + RCA= 0%, 28.55 MPa with NCA=75% + RCA= 25%,25.72 MPa with NCA = 50% + RCA = 50% and 25.16 MPa withNCA=75% +RCA=25% and 24.01 MPa with NCA= 0% + RCA = 100% respectively. Experimental results at the ages of 3, 7, 28, 56 and 90 days are given in Table 4.2 and Fig. 4.2 and 4.8- 4.12.

The compressive strength of recycled aggregate is less than that of natural aggregate concrete at various ages because recycled aggregate absorbs more water and has low specific gravity than that of natural aggregate.

CONCLUSION

Research on the usage of waste construction materials is very important because material waste is gradually increasing with the increase in population and increase in urban development. Recycled aggregate is easy to obtain and costs chapter than virgin aggregate. Virgin aggregate needs to be mined but recycled aggregate can be easily obtained. The aim of present work is to determine the strength characteristics of recycled aggregate such as bond strength for potential application in the high concrete structural concrete. The study shows that when the water/cement ratio was decreased, the bond strength increased. This is classified as medium strength concrete and they can be applied in the infrastructures, which need compressive strength up to 30MPa.

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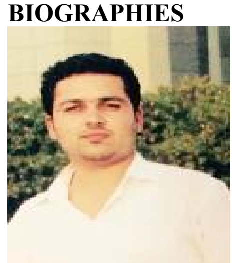
BIOGRAPHIES



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