Study The Strength of Recycle Aggregate Concrete

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Abstract

Sustainable resource management and development have been at the forefront of important issues concerning the construction industry for the past several years. Specifically, the use of sustainable building materials and the reuse and recycling of previously used building materials is gaining acceptance and becoming common place in many areas. As one of the most commonly used building materials in the world, concrete, composed of aggregate, sand, cement and water, can be recycled and reused in a variety of applications. Using crushed concrete as fill and sub-grade material under roads, sidewalks and foundations has been the most common of these applications. However, research has been ongoing over the past 50 years in many countries including Germany, India, Canada, Japan, the United States, China, and Australia investigating the use of crushed concrete from demolished old concrete structures to fully or partially replace the virgin aggregate used to produce new concrete for use in building and pavement applications. Producing concrete using recycled concrete aggregates (RCA) has several advantages, namely, the burden placed on non-renewable aggregate resources may be significantly decreased, the service life and capacity of landfill and waste management facilities can be extended, and the carbon dioxide emissions and traffic congestion associated with the transport of virgin aggregates from remote sites can be reduced. Three recycled coarse aggregate (RCA replacement percentages (i.e., 0%, 50% and 100%) with mix (1:1.1:2.46), water-cement ratio 0.43 and mix (1:1.25:2.48), water-cement ratio 0.44, are considered in this paper. In this we perform the test on compressive, Split and Flexural Test. Based on the test results, the influences of both recycled coarse aggregate replacement percentages and water- cement ratio on the compressive strength, split strength, flexural strength test and water absorption test were investigate..

Keywords

Aggregates, Pavements, landfills, Sustainability.

I. Introduction

Concrete has been the leading building material since it was first used and is bound to maintain its significance 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 obtain 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 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 steel bar diameter are the factors that affect the bond strength of concrete. In pull-out tests on plain bar, 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 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. The load shall be applied to the reinforcing bar at a rate not greater than 2250 kg/mm^2, or at no-load speed of the testing machine head of not greater than 1.25 mm/min, depending on the type of testing machine used and the means provided foe ascertaining or controlling speeds. The maximum load for each type of failure shall be recorded. 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 used 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 material.

II. Experimental Program

Is:10262-1982 and is:456-2000, gives the guidelines for concrete mix designs. In this study, six batches of mixes were determined. Two mixes were taken with first mix (1:1.1:2.46, w/c =0.43) called control mix and second mix (1:1.25:2.48, w/c=0.44). The natural coarse aggregate was replaced by recycled coarse aggregate in the ratio of 50% and 100%. The properties such as compressive strength, bond strength, indirect tensile strength and were studied. Ordinary Portland cement of 43 grade (Source : Shree Ultra Cement) conforming to IS: 8112-1989 was used. The cement was tested as per IS 4031-1968. The test results of the cement are given in the table.

Table 1 : Physical Properties of cement 43-grade

PROPERTIES	OBSERVED VALUES	VALUES SPECIFIED BY IS:8112-1989
Fineness % (90 µm I.S. Sieve)	7	Not more than 10
Soundness (mm) (Le Charter Method)	1.0	Not more than 10
Normal consistency (%)	29	------------------------
Initial Setting Time (minutes)	220	>=30
Final Setting Time (minutes)	300	<=60
Compressive strength 3-day(Mpa)	24	22 (min.)

Compressive strength 7-day(Mpa)	36	33 (min.)
Compressive strength 28-day(Mpa)	45	43 (min.)

Table 2 : Sieve analysis of Recycled aggregate.

S.NO	IS Sieve Size (mm)	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative %age of Weight Retained	Percentage Passing
1	25	0	0	0	100
2	20	30	30	1.5	98.5
3	16	289	319	15.95	84.05
4	12.5	491	810	40.5	59.5
5	10	904	1714	85.7	14.3
6	4.75	261	1975	98.75	1.25
7	2.36	7	1982	99.1	0.9
8	Pan	-	-	-	-

Table 3 : Properties of Recycled Aggregates.

S.No.	Property	Observed Values
1.	Bulk Density (loose), kg/m3	1128
2.	Bulk Density (Compacted), kg/m3	1298
3.	Specific Gravity	2.46
4.	Free Moisture %	2.03
5.	Water Absorption %	5.4

Table 4 : Mix Proportions.

S.No.	% REC AGG	Cement (kg/m3)	FA (kg/ m3)	NCA (kg/ m3)	RCA (kg/ m3)	Water (kg/ m3)	Remark (% of recycled agg)
1.	0	490	539	1206	0	210	% =0
2.	50	490	539	603	603	210	%=50
3.	100	490	539	0	1206	210	% 100
4.	0	475	594	1178	0	209	%=0
5.	50	475	594	589	589	209	%=50
6.	100	475	594	0	1178	209	%=100

The two mix types chosen were 1:1.1:2.46, w/c = 0.43 and 1:1.25:2.48, w/c = 0.44 respectively. Two concrete mixes were prepared using 10mm & 20mm coarse aggregate obtain from demolished concrete from a building in Barwala town. Mix with equal amount of natural coarse aggregate i.e. equal weight of both ((NCA=50%) + (RCA=50%)) and then ((NCA=0%) + (RCA=100%)) were prepared and used to cast specimens.

In all the above mixes workability was measured by slump test, compacting factor test and flow table test. The test specimen is 150mm×150mm cube is used to study the compressive strength of various mixes. The cubes are filled with fresh concrete using vibrating table. Immediately after casting cubes, the specimens are covered with gunny bags to prevent water evaporation. As same 100mm×200mm cylinders for split tensile and carbonation and 150mm×300mm cylinders for bond strength. The specimens were cast according to IS: 516-1959. The specimens were tested at the age of 3, 7 and 28 days. The aggregates used were in saturated, surface-dry condition. The test procedures were followed as per relevant Indian standard specifications. The batching was done by weight.

III. Results and Discussion

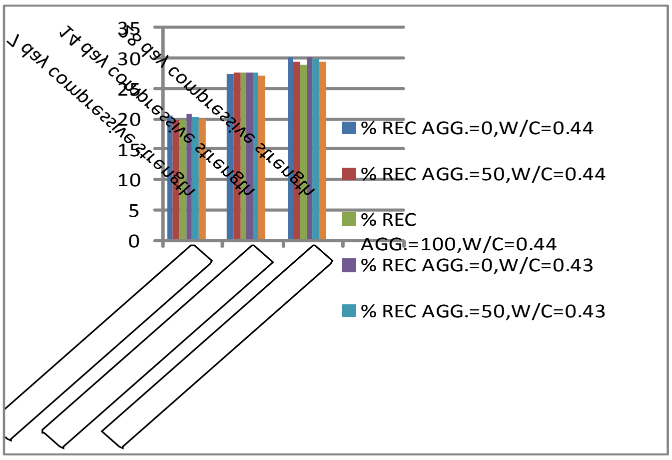

Fig.1 : Comparison of Different Mixes of Compressive Strength after 7 & 28 Days

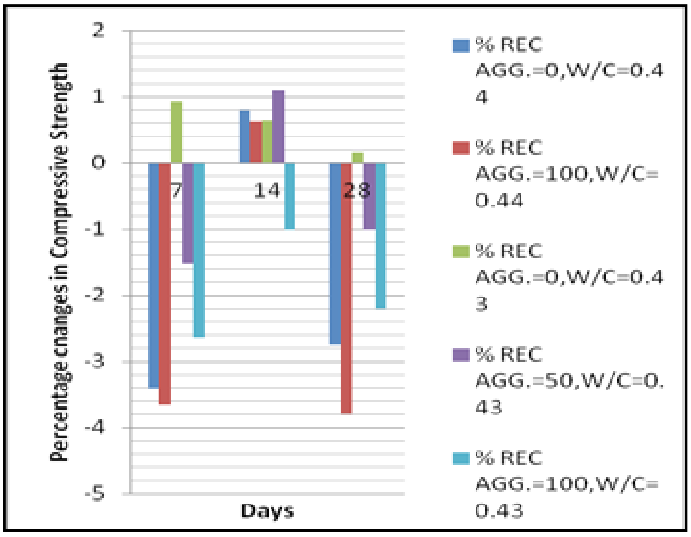

Fig. 2: Percentage (%) changes in Compressive Strength

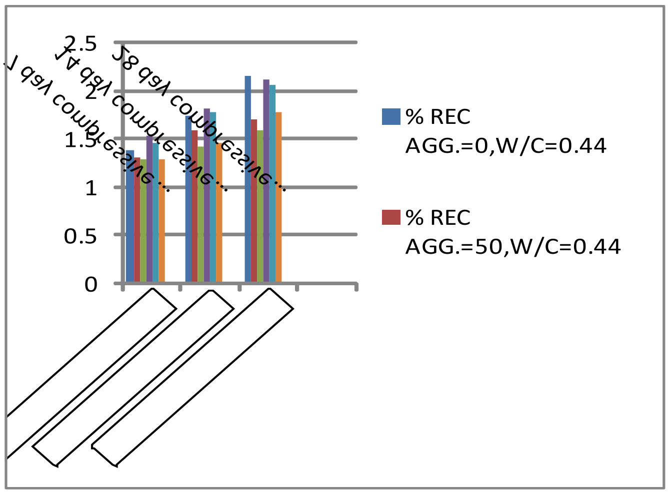

Fig. 3: Comparison of Different Mixes of Split Tensile Strength after 7 & 28 Days.

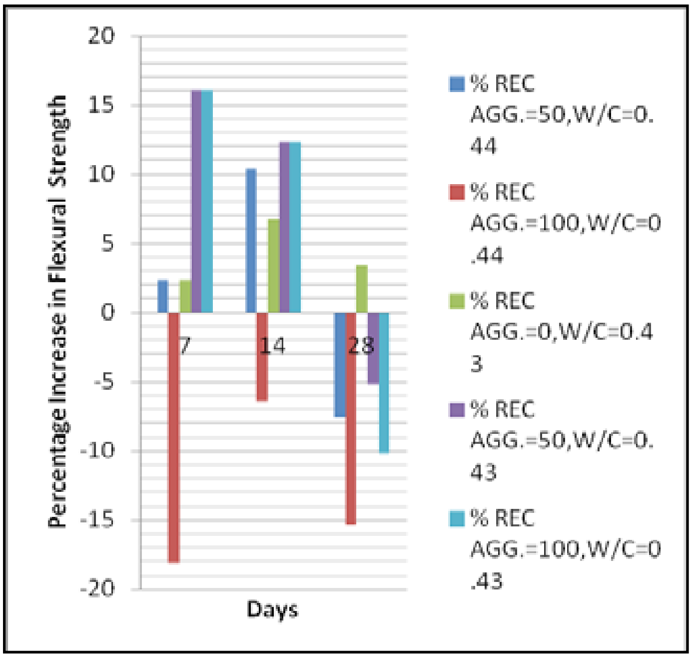

Fig 4: % change in flexural strength.

The main objective of the present work is to investigate the effect of using recycled aggregates in lieu of natural aggregate on compressive strength and bond strength of concrete. The major observations from this experimental work are as under:

1. In ratio 0.44 the compressive strength of NCA is 30.17 N/mm² and after the replacement of RCA of 50 % and 100% the compressive strength respectively decreases 2.75% and 3.8% in 28 days, But in the ratio 0.43 the compressive strength of NAC is 30.22 N/mm² and after the replacement of RCA of 50 % and 100% the compressive strength respectively 1.02% and 2.2% in 28 days. The compressive strength of NAC mixes is relatively higher than RAC mixes.
2. In ratio 0.44 the split strength of NCA is 2.15 N/mm² and after the replacement of RCA of 50 % and 100% the split strength respectively decreases 21.11% and 25.98% in 28 days, But in the ratio 0.43 the split strength is 2.12 N/mm² and after the replacement of RCA of 50 % and 100% the split strength respectively decreases 4.87% and 17.87% in 28 days. The split strength of NAC mixes is relatively higher than RAC mixes.
3. In ratio 0.44 the flexural strength is 5.2 N/mm² and after the replacement of RCA of 50 % and 100% the flexural strength respectively decreases 7.6% and 15.38% in 28 days, But in the ratio 0.43 the flexural strength is 5.38 N/mm² and after the replacement of RCA of 50 % and 100% the flexural strength respectively decreases 5.19% and 20.19% in 28 days. The flexural strength of NAC mixes is relatively higher than RAC mixes.
4. RCA posses relatively lower bulk density, specific gravity and high water absorption as compared to NCA. This is mainly due to the porous mortar adhering to recycled concrete aggregate.
5. It is advisable to carry out trial castings with recycled concrete aggregate proposed to be used in order to arrive at the water content and its proportion to suit the workability levels and strength requirements respectively.
6. Economical and environmental pressures justify consideration of this alternative material source i.e. aggregate from demolished concrete, in places where there is non availability of virgin aggregate or available sources of new rocks are inaccessible either because of high land values or zoning constraints. It can be said it is a creative and environment friendly solution to use demolished concrete as aggregate.
7. In this research we find out that there is a little change in the compressive, Split and Flexure strength when we use the recycled aggregate in concrete with the replacement of 50% and 100% in the mix 1:1.1:2.46 (W/C=0.43) and 1:1.25:2.48 (W/C=0.44) at 28 days.

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Vol. 3, Issue 1 Jan. - Mar. 2016
ISSN : 2348 - 9065 (Online)
ISSN : 2349 - 3143 (Print)

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