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Measurement of Properties of Recycled Aggregate Concrete with Natural Aggregate

*Manish Kumar[1],Neeraj Syal[2],Lekhraj Saini[3]
Research Scholar Indus International University
Assistant Professor (Guide) Civil Engg Department Indus International University
Dean School of Engineering & Technology, Indus International University
*Corresponding Author: *Manish Kumar*

ABSTRACT:-The application of recycled aggregate has been started in a large number of construction projects of many European, American, Russian and Asian countries. Many countries are giving infrastructural laws relaxation for increasing the use of recycled aggregate. So, this paper reports the basic properties of recycled fine aggregate and recycled coarse aggregate & also compares these properties with natural aggregates. Basic changes in all aggregate properties are determined and their effects on concreting work are discussed at length. Similarly the properties of recycled aggregate concrete are also determined.

Keywords- Recycled aggregate, construction waste, concrete properties, recycling.

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I. INTRODUCTION

Making use of demolished concrete has been the subject of investigation for a long time and it has been established that the use of recycled aggregate is an appropriate solution to the problem of dumping hundreds of thousands tons of debris and hauling natural aggregate from long distances [1] [2] [3]. Recycled aggregate is proven to be a valuable building material in technical, environmental and economical respect. Traditionally, recycled aggregate has been used as landfill. But now a day, the use of recycled aggregate in construction areas has increased [4] [5].

The concrete obtained from the demolition sites can be used for the production of aggregate of acceptable quality which in turn reduces the consumption of the natural aggregate and hence reduces the ever rising costs of construction. Also it saves energy used in the manufacturing process [6] [7] [8] [9] [10]. Hence the present work involves systematic study of fresh and hardened state properties of concrete using aggregates obtained from fresh demolition operations. The properties (Compressive Strength) of the concrete made from demolished concrete are compared with properties of the concrete made from natural aggregate. In the present work the use of recycled aggregate in varying proportions of 0%, 25% 50%, 75% & 100% as a replacement of natural coarse aggregates has been done. It includes the study of various properties like Compressive Strength.

II. STRUCTURE OF CONCRETE MIX DESIGN

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 100%.
The mechanical and physical properties of cement, sand, natural coarse aggregate and coarse aggregate from demolished concrete as per IS: 2386-1963 were determined.

a) Cement
b) Natural Fine Aggregate Natural Coarse aggregate
c) Coarse Aggregate from demolished concrete Water
d) Mix Proportion
e) Casting of Specimen

f) Preparation of concrete from demolished concrete Aggregate
g) Source of Demolished concrete aggregate
h) Preparation of aggregate from Demolished concrete
i) Processing of Demolished concrete Aggregate
j) Mixing and Compaction
k) Properties of Fresh Concrete(Workability)
l) Testing Procedure
m) Compressive Strength

III. RESULTS AND DISCUSSION

The results of compressive strength and the workability of concrete mixes are given in Figures 1 to 10. These results are discussed in the following sections as under.

Variation of Compressive Strength with Age has been shown below:

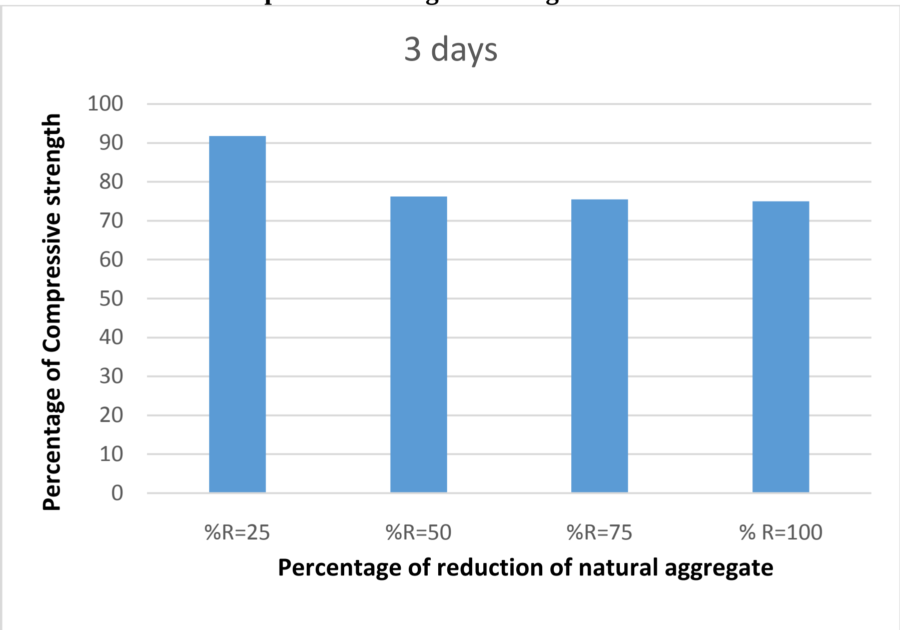

Fig.1: Percentage of compressive strength vs. percentage of reduction of natural aggregate after 3 days

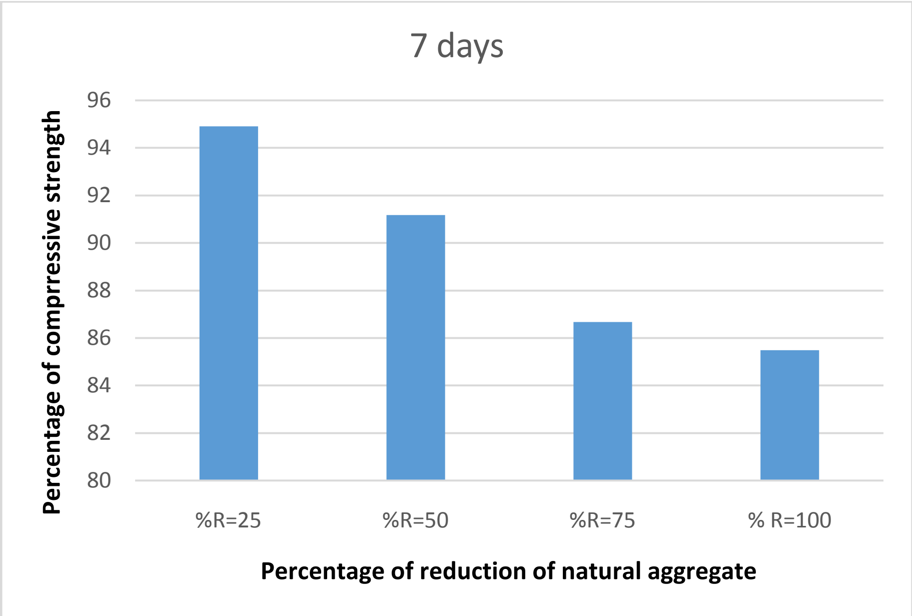

Fig.2 : Percentage of compressive strength vs. percentage of reduction of natural aggregate after 7 days

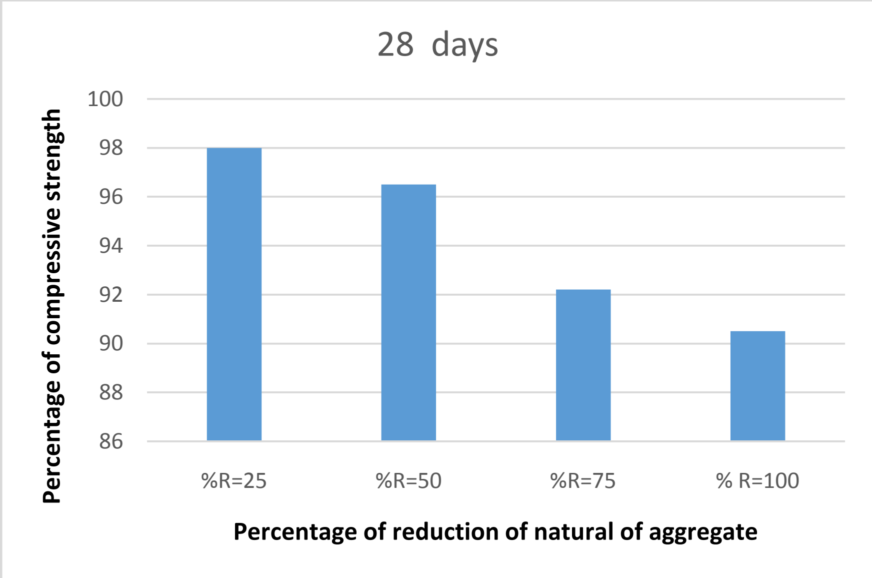

Fig.3: Percentage of compressive strength v/s percentage of natural aggregate after 28 days

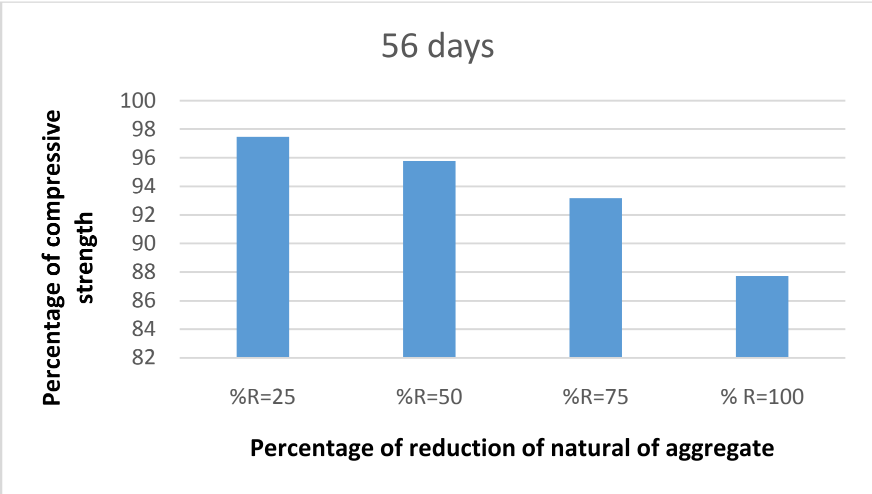

Fig.4: Percentage of compressive strength vs. percentage of reduction of natural aggregate after 56 days

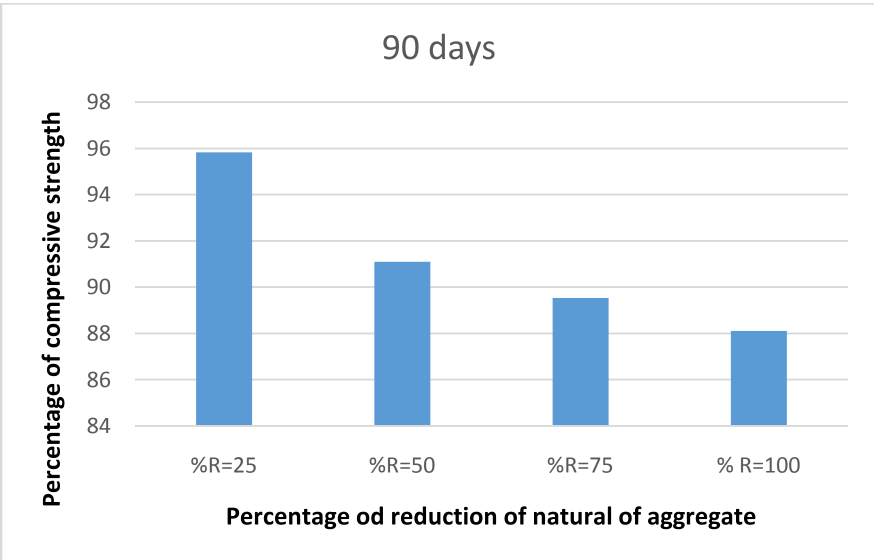

Fig.5: Percentage of compressive strength vs. percentage of reduction of natural aggregate after 90 days.

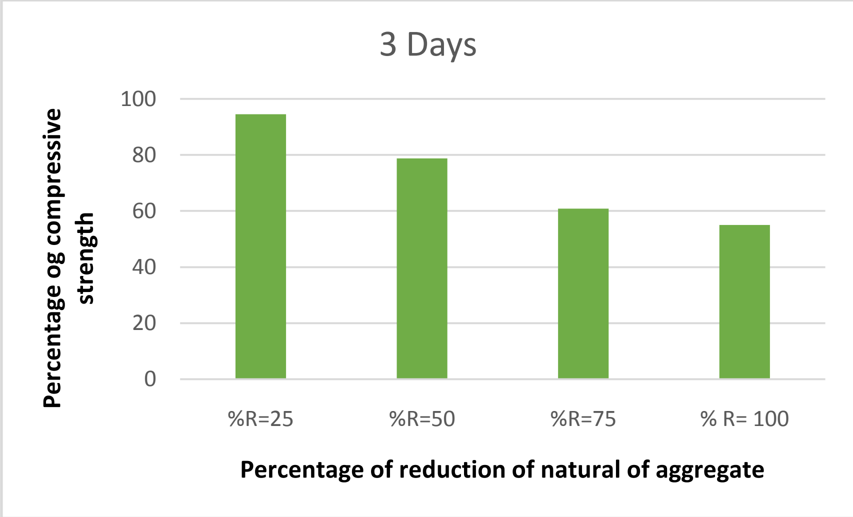

Fig.6: Percentage of compressive strength vs. percentage of reduction of natural of aggregate after 3 days

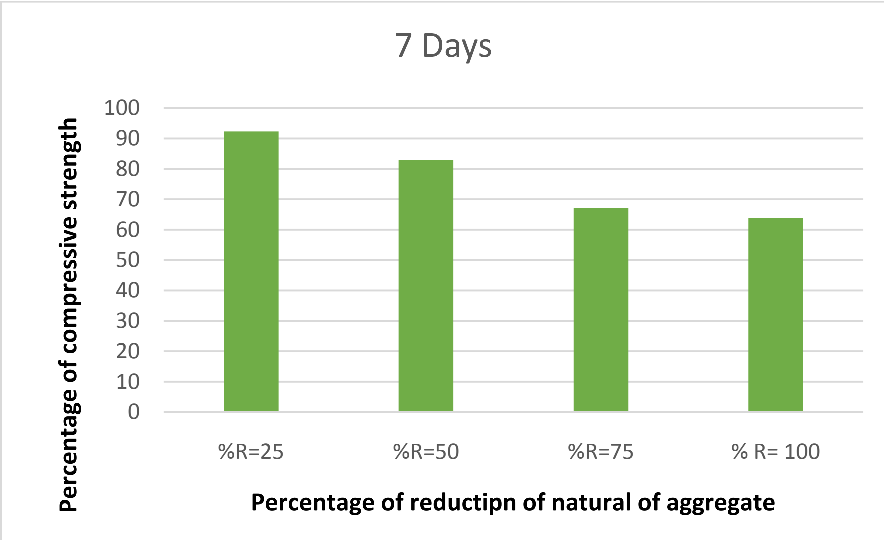

Fig.7: Percentage of compressive strength vs. percentage of reduction of natural of aggregate after 7 days

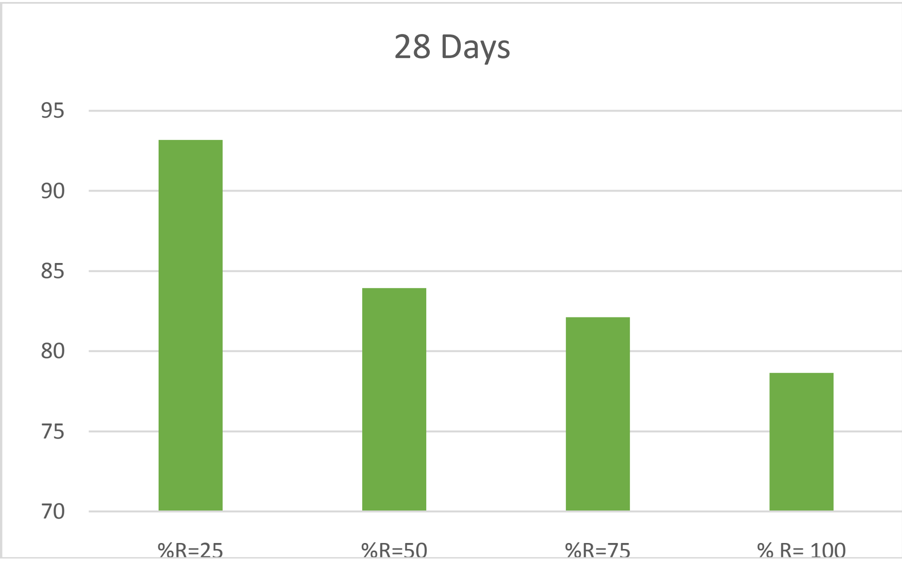

Fig.8: Percentage of compressive strength vs. percentage of reduction of natural of aggregate after 28 days

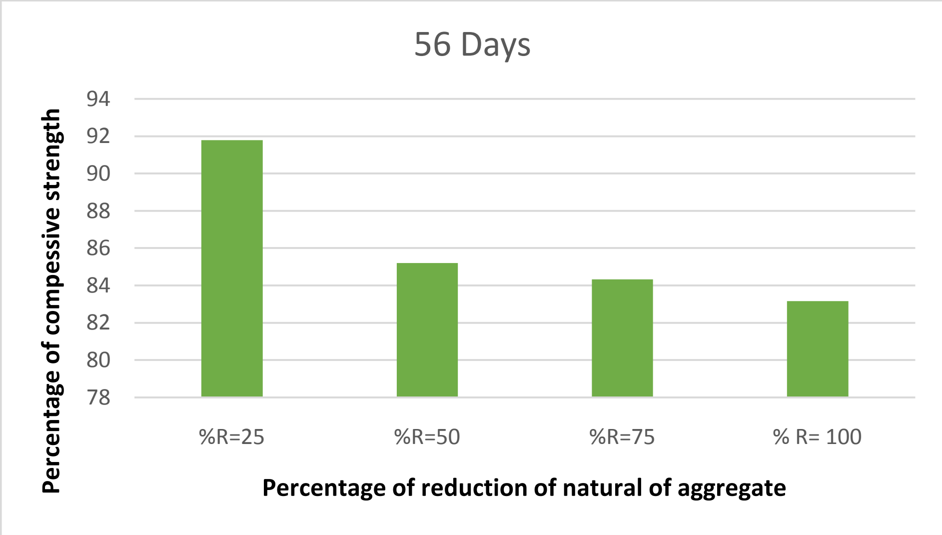

Fig.9: Percentage of compressive strength vs. percentage of reduction of natural of aggregate after 56 days.

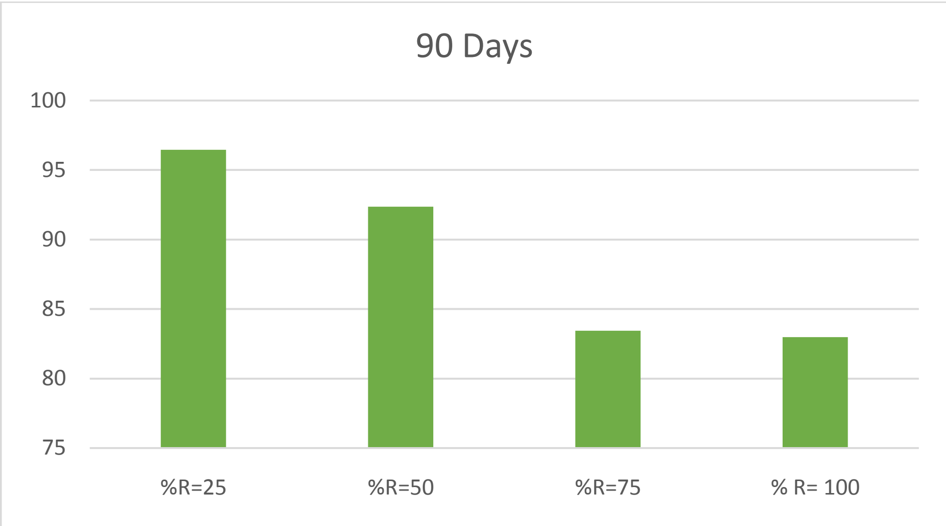

Fig.10: Percentage of compressive strength vs. percentage of reduction of natural of aggregate after 90 days

Compressive Strength at 28 days with W/C=.45 was observed as 34.48 MPa with NCA=100% + RCA = 0%, 32.81 MPa with NCA=75% + RCA = 25%, 32.31 MPa with NCA=50% + RCA = 50%, 30.87 MPa with NCA = 25% + RCA = 75% and 30.3 MPa with NCA = 0% + RCA = 100% respectively. Experimental results at the ages of 3, 7, 28, 56 and 90 days are given in Table 1.

Table .1 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	28.39	26.11	21.54	21.55	21.43
2.	1:1:2.46	0.45	7	28.56	27.08	26.03	24.79	24.56
3.	1:1:2.46	0.45	28	33.47	29.74	32.27	29.09	30.35
4.	1:1:2.46	0.45	56	35.69	34.67	34.31	33.25	31.29
5.	1:1:2.46	0.45	90	37.71	36.16	34.39	32.18	33.46

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 .2.

Table .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	26.78	25.21	21.04	14.18	14.67
2.	1:1.25:2.48	0.48	7	28.53	26.37	23.61	17.18	18.19
3.	1:1.25:2.48	0.48	28	30.69	28.48	25.79	22.11	24.06
4.	1:1.25:2.48	0.48	56	35.23	32.37	30.03	27.26	29.26
5.	1:1.25:2.48	0.48	90	36.16	34.72	33.16	28.78	29.88

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.

IV. CONCLUSION AND FUTURE SCOPE

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. Recycled aggregate is chapter in comparison to natural aggregate. So, the builders can carry out the construction task with lesser material costs. It was observed in this work that reduction in W/C ratio in recycled aggregates mixes, improved tensile strength and compressive strength. Recycled aggregate can be applied in structures, but lesser water content would cause lower workability. Whenever recycled aggregate is applied, water content in the concrete mix has to be monitored carefully as the water absorption capacity of recycled aggregate varies.

Following conclusions have been drawn based on the observations and discussion of test results:

1. The compressive strength of NAC mixes is relatively higher than RAC mixes. The compressive strength decreases by 4.2%, 9%, 10.1% and 12% for RAC replacement percentage of 25%, 50%, 75% and 100%, at mix 1:1:2.46 and W/C=0.45 at 90 days. In the same way the compressive strength decreases by 3.5%, 7.5%, 16% and 17.5% for RAC replacement percentage of 25%, 50%, 75% and 100%, at mix 1:1.25:2.48 and W/C=0.48 at 90 days.
2. RCA possess 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.
3. 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.
4. 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 constrains. It can be said that it is a creative and environment friendly solution to use demolished concrete as aggregate.

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