Experimental Study of Concrete When Aggregate is replaced by Recycled Aggregate Made up Crushed Concrete Structures

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Abstract— Recycled aggregates are comprised of crushed, graded inorganic particles processed from the fabrics that have been applied in the constructions and demolition debris. The objective of this task is to find the force characteristics of recycled aggregates for application in high strength structural concrete, which will yield a fuller apprehension of the attributes of concrete with recycled aggregates, as an alternative material to coarse aggregate (NA) in structural concrete. The scope of this project is to find and compare the effectiveness of concrete by using different percentage of recycled aggregates. Recycled aggregate is also the case of artificial aggregate which is obtained from Construction and demolition (C&D) wastes. Constructions and demolitions are the procedures that work hand in hand. The demolished building rubble in India generally goes to waste in landfills. Recycling of these concrete waste materials from building demolition can provide a resolution to this problem. The probe was carried out using the sieve analysis test, Specific gravity test, Water absorption test, Impact test, Crushing value test, Workability test and compressive strength test. There were a total of six masses of concrete mixtures, consisting of every 20% growth of recycled aggregate replacement, from 0% to 100%.

Key words: Recycle Aggregate, Natural Aggregate, Concrete, Compressive Strength

I. INTRODUCTION

Construction and demolitions are the procedures that work hand in hand. The demolished building rubble in India generally goes to waste in landfills. After few years building and demolition waste will be more than half of the National total waste in most nations of the world so recycling of these concrete waste materials from building demolition can provide a resolution to this problem. Landfills are getting more and more hard to find, are too remote from the demolition site, or are overly costly to defend. At the same time sources of supply of suitable aggregate for making concrete are continuously being used up. The recycling of building demolition waste materials into new buildings can provide a solution to these problems. Grinding reinforced concrete buildings can reduce the volume of land filled debris by roughly 80%. While volume reduction itself is beneficial, recycling the waste creates a product that can be sold or used for fill, bank stabilization, pavement for trails and other purposes, thereby reducing further environmental burdens by substituting recycled aggregates for natural virgin aggregates. Reusing is the human action of processing the used material for usage in creating new merchandise. The use of natural aggregate is growing more and more intense with the advanced development in the base area. In parliamentary law to cut down the use of natural aggregate, recycled concrete aggregate can be applied as the replacement materials. Recycled concrete aggregate is comprised of broken down, graded inorganic particles processed from the fabrics that have been applied in the constructions and demolition debris.

II. MATERIAL USED

A. Cement:

According to IS 15658: 2006 Ordinary Portland Cement of Grade 53 is used, which conforming IS 12269. 53 grade cement is a prime brand cement with a remarkably high cs3 (tricalcium providing long-lasting) durability of concrete constructions. Produces highly durable and sound concrete due to really low percentage of alkalis chlorides, magnesia Cement used in the experimental work is Ordinary Portland cement of grade 53 conforming to IS 12269The physical properties of the cement obtained in conducting appropriate tests as per IS: 269/4831

B. Water:

Water used in the concrete is conforming the specification of IS 456 : 2000. Water used for mixing is free from injurious amount of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete.

C. Recycle Aggregate:

Recycle aggregate is a waste material collected from demolished concrete structure, for this project recycle aggregate is collected from a demolished concrete structure situated near hoshangabad road Bhopal. These totals are used after strictly passing from 20mm IS sieve.

D. Natural Aggregates:

Natural aggregates used in the fabrication of concrete paving blocks should fit the requirements for aggregates for concrete given in IS 383 Aggregates from natural sources Aggregates for concrete. Slag aggregates may also be employed if they can be demonstrated to be physically and chemically sound. Waste materials, or materials not in demand, are often sought after as these are generally relatively inexpensive. But the usage of such materials could be at the expense of quality or result in increased costs due to the need to use higher cement contents to preserve character. These materials might also create compaction difficulties which could adversely affect productivity and strength. The carrying out of aggregates at the modelling stage and in the hardened block depends on the united effects of particle size, grading, particle shape, and stiffness. Each of these attributes is discussed infra.

III. MIX DESIGN

The concrete mix design is a procedure of choosing the desirable ingredients of concrete and determining their most

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optimum proportions which would grow, as economically as possible, concrete that satisfies the task demands, i.e. The concrete having a certain minimum compressive strength, the desired workability and strength. In improver to these demands, the cement content in the mix should be as low as possible to achieve maximum economy. The proportioning of the constituents of concrete is an important function of concrete technology as it guarantees the character and economy. Mix design of M40 has been done as per IS 10262 : 2009.

IV. EXPERIMENTAL PROGRAM

To determine the property of the material along with their behavior some test is performed on the cloths, which is dying to use in the manufacturing in concrete and their results help in the mix design of the concrete and to assess their different attributes. Some test which is done on the concrete is presented under:

1) Specific Gravity Test
2) Sieve Analysis of Aggregate
3) Fineness Modulus of Cement
4) Bulking of Sand
5) Water absorption Test
6) Aggregate Crushing Value
7) Aggregate Impact Test

A. Aggregate Crushing Value Test:

The principal mechanical properties required in stones are resistant to breaking down under the roller during construction and adequate resistance to surface abrasion under loading. Aggregate used in concrete should be hard enough to resist breaking up under different loading conditions. If the aggregate is weak the stability of the pavement construction is likely to be adversely affected. The effectiveness of the coarse aggregate is assessed by aggregate crushing test. The aggregate crushing value provides a comparative amount of resistance to breaking down under a gradually applied compressive strength load. To attain a high quality of pavement, the aggregate possessing crushing value should be chosen.

B. Aggregate Impact Test:

When a aggregate has been manufactured to a specified grading it is stockpiled, loaded into trucks, transported, tipped, spread and compacted. If the aggregate is weak, some degradation may take place and result in a change in grading and/or the production of excessive and unwanted genes. Therefore, an aggregate complying with a specification at the quarry may fail. Granular base layers and surfacing are subjected to repeated loadings and the emphasis at the touch points of aggregate particles can be rather high. These crushing tests can reveal aggregate properties subject to mechanical degradation of this kind.

C. Workability Test:

To go over the workability of the concrete Slump cone test is done to determine the workability of new concrete. The test is simple and effective. It is suited to use in the lab and also on site. Although the examination is simple, but the testing has to be managed cautiously. A huge slump may be obtained if there is any disruption in the procedure. Logic Sphere mentioned that the slump test will yield a fair reading of how easily a mix can be places, although it acts not directly evaluate the study required to compact the concrete. It also noted that a slump less than 25mm will indicate a very stiff concrete and a slump more than 125mm will indicate a very runny concrete.

D. Compressive Strength Test:

According to Cement Association of India (2003), compressive strength of concrete can be determined as the measured maximum resistance of a concrete to axial loading. Compression test is the most common exam used to test the hardened concrete specimens because the testing is easy to prepare. The force of the concrete specimens with different part of recycled aggregate replacement can be suggested through the compression test. The specimens used in the compression test were cubes of 150X150X150mm size. Nine specimens were used in the compression testing for every pot of mixture. Conflicts in the strength among the different portion of recycled aggregate used at the age of 7, 14 and 28 days was also indicated through the compression test. The compression testing procedures was, according to the Indian Standard Code.

V. RESULT AND DISCUSSION

A. Crushing Value Test:

Form the result of crushing value we come to know that the recycle aggregate is having more resistance to the wear and tear than the natural aggregate. Result of Crushing value test is given below in table 1

Aggregate	Crushing Value
Natural Coarse Aggregate	15.22%
Recycle Aggregate	22.46%

Table 1: Aggregate Crushing Value

B. Impact Test:

Impact test is the good indicator of strength and durability from the test result we can say that natural and recycled aggregate are having wide difference of impact and crushing value, which again shows that rock of recycled aggregate is stronger than that of natural aggregate. Result of impact test is given below in table 2

Aggregate	Impact Value
Natural Coarse Aggregate	7.65%
Recycle Aggregate	11.35%

Table 2: Aggregate Impact Value

C. Specific Gravity Test:

Specific gravity is the ratio of the density of a substance to the density (mass of the same unit volume) of a reference substance. Result given in table 3

Aggregate	Specific Gravity
Natural Coarse Aggregate	2.70
Natural Fine Aggregate	2.62
Recycle Aggregate	2.84
Cement	3.14

Table 3: Result Specific Gravity Test

D. Sieve Analysis of Aggregate:

Sieve analysis test is performed on the aggregate i.e Natural coarse aggregate, Natural fine aggregate and recycle aggregate and their result given in table 4.

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Aggregate	Sieve Analysis
Natural Coarse Aggregate	2.65
Natural Fine Aggregate	1.92
Recycle Aggregate	2.6

Table 4: Result of sieve Analysis Test Result

E. Fineness Modulus:

Fineness modulus test is performed on cement and result of test is 4, i.e. Fineness modulus of cement is 4.

F. Water Absorption:

Water absorption of is performed on the aggregate and it has find that all aggregate have water absorption below 5% and their result given in table 5.

Aggregate	Water Absorption %
Natural Coarse Aggregate	1.83
Natural Fine Aggregate	0.206
Recycle Aggregate	4.45

Table 5: Result of Water Absorption Test

G. Bulking of Sand:

Sand is used as a fine aggregate and to use sand in concrete we have to check its bulking and Bulking of sand is 33.3 and it comes in zone II

H. Combined Test Result:

All material test result is combined in a table given below table 6

S.No.	Test	Natural Coarse aggregate	Recycled Aggregate	Fine Aggregate	Cement
1	Water Absorption	1.83%	4.45%	0.206%	-
2	Specific gravity	2.70	2.84	2.62	3.14
3	Crushing value	15.20 %	22.46 %	-	-
4	Impact value	7.64%	11.33%	-	-
5	Sieve Analysis	2.65	2.6	1.92	-
6	Fineness Modulus	-	-	-	4
7	Bulking of Sand	-	-	33.3	-

Table 6: Combined Test Result

I. Slump Cone Test:

The slump test indicates a decreasing trend of workability when the percentage of recycled aggregate increased. Table 7 below shows the average slump recorded during the test. Graph 1 and 2 below shows a graphical representation of slump height.

Mix	Slump (mm)
CC	61
RA20	52
RA40	40
RA60	26
RA80	22
RA100	19

Table 7: The Slump Result for Each Batch of Mix Concrete

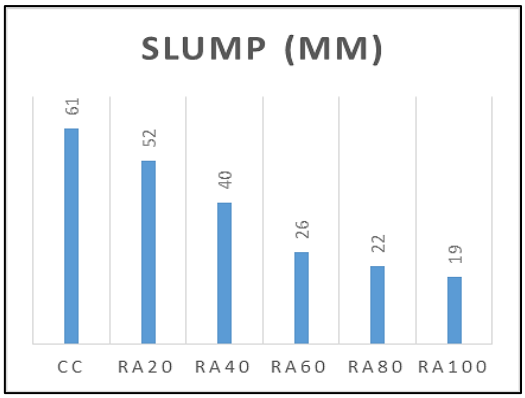

Fig. 1: Graph 1: Variation of Slump Value

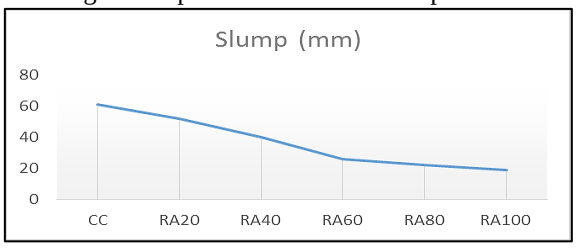

Fig. 2: Graph 2: Variation in Slump

According to the result, the highest slump obtained was 61mm and the lowest slump was 26mm. From the result it indicates that the workability was tending to harshness with increase in replacement with recycled aggregate.

J. Compression Test Result and Analysis:

The compression test by CTM (Compressive Testing machine) indicates an increasing trend of compressive strength with age of the concrete specimens. However, it shows that the strength of recycled aggregate specimens is lower than natural aggregate specimens. Table 8 below shows the increase of compressive strength with age recorded during the test. Graphs 3 and 4 shows comparison of all batches of concrete

Mix	Compressive Strength (MPa)		
	7 Days	14 Days	28 Days
CC	36.5	43.20	49.89
RA20	34.55	40.11	45.66
RA40	33.11	38.62	44.12
RA60	25.31	34.29	43.26
RA80	22.62	30.61	38.6
RA100	20.1	27.61	35.11

Table 8: Variation of Compressive Strength of Recycle Concrete.

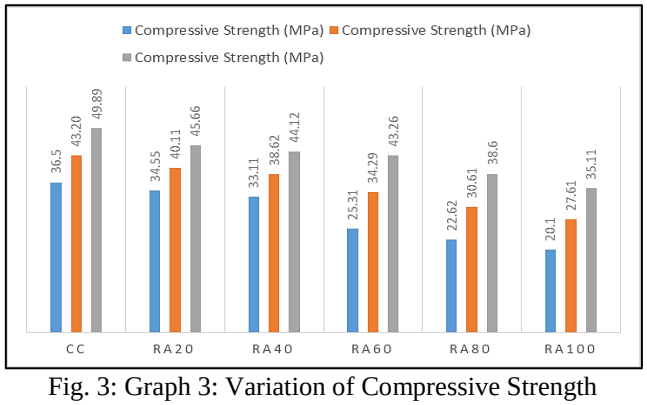

Fig. 3: Graph 3: Variation of Compressive Strength
Variation of Compressive Strength of Recycle Concrete.

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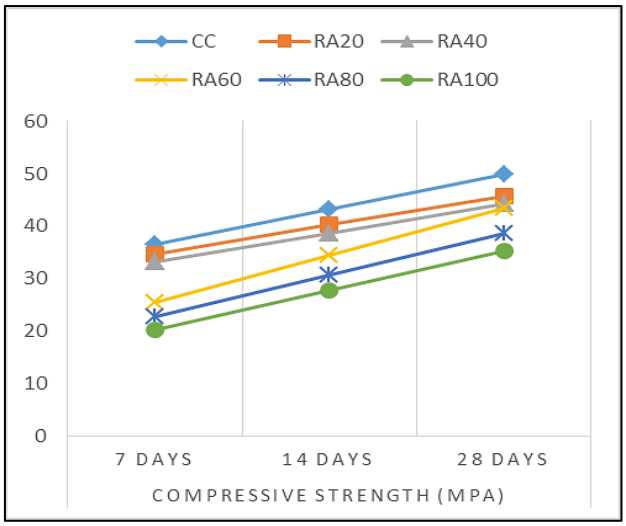

Fig. 4: Graph 4: Variation of Compressive Strength
Variation of Compressive Strength of Recycle Concrete with Age

VI. CONCLUSION

Test results suggest that as the percentage of Natural Aggregate decreases by replacing the recycled Aggregate, the corresponding strength goes on decreasing, yet up to 60% replacement it achieves target mean strength. Hence, for structural concrete, natural Aggregate can be substituted by the recycled aggregate up to 60% limit. The workability of concrete, considerably reduces as the quantity of recycled aggregate increases. This inquiry project is proposed to ascertain the durability characteristics of recycled aggregate concrete for potential application in the structural concrete. Whenever recycled aggregate is used, water content in the concrete mix has to be supervised carefully, owing to increased water absorption capacity of recycled aggregate.

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