ANALYSIS FOR USE OF DEMOLISHED CONCRETE IN PAVEMENT CONSTRUCTION

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ABSTRACT

Recycled aggregates consist of crushed, graded inorganic particles processed from the material that have been used in the constructions and demolition debris. The target of the present thesis work is to determine the strength characteristic of recycled aggregates for the application in concrete pavement construction. The scope of the thesis is to determine and compare the compressive strength, flexural strength and sulphate resistance of concrete by using different percentages of recycled aggregates. The investigation was carried out by using workability test, compressive strength test, flexural strength test and sulphate resistance test. A total of five mixes with replacement of coarse aggregates with 0%, 10%, 20%, 30% and 40% recycled coarse aggregates were studied. The water cement ratio was kept constant at 0.38. It was observed that workability of concrete was decreased with the increase in recycled aggregates in concrete. For the strength characteristics, the results showed that the strengths of recycled aggregate concrete was comparable to the strengths of natural aggregates concrete.

Key Words: Recycled Aggregate, Sulphate Resistance, Concrete, RCC

Sub Area : Construction Technology & Mgmt

Broad Area: Civil Engineering

INTRODUCTION

In the era of construction, concrete has been the leading building material since it was discovered and found viable for future due to its durability, easy maintenance, wide range of properties and adaptability to any shape and size. Concrete is the composite mix of cement, aggregates, sand and water. Concrete gets hardened like stone on mixing water with cement and aggregates. Concrete have two type ingredients namely active and inactive. The active group consists of water and cement. The inactive part consists of sand and coarse aggregates. Concrete have high compressive strength and low tensile strength. To overcome this shortcoming, steel reinforcements are used along with the concrete. This type of concrete is called reinforced cement concrete (RCC).

Mix design is done to select the mix material and their required proportions. There are a lot of methods to determine the mix design. The methods used in India are in compliance with Bureau of Indian Standards (BIS). The motive of mix design is to determine the proportion in which concrete ingredients like cement, water, fine aggregates and coarse aggregates should be mixed to provide specified strength, workability, durability and other specified requirements as listed in standards such as IS: 456-2000. The designed concrete mix must define the material and strength, workability and durability to be attained. Concrete mix design guidelines are given in IS: 10262-1982. In the study, 5 batches of mixes were prepared. These batches were designated as m0, m1, m2, m3 and m4. Batch m0 was taken as control mix. The natural coarse aggregate was replaced by recycled aggregate in proportion of 0%, 10%, 20 %, 30% and 40% in m0, m1, m2, m3, and m4 respectively as given in table 1. Content of sand, cement and water were kept constant in every batch. In the study properties of concrete such as compressive strength, flexural strength and sulphate resistance of concrete were determined.

Table 1: Proportions of Natural and Recycled Aggregates in Batches

Type of Mix Used	Recycled Aggregate (%)	Natural Aggregate (%)
m0	0	100
m1	10	90
m2	20	80
m3	30	70
m4	40	60

Physical Properties of Cement of Grade 43

S.No.	Properties	Apparatus used	Observed Values	Values Specified by IS:8112-1989
1.	Fineness Percentage	90µm I.S Sieve	4	Not more than 10
2.	Soundness(mm)	Le Chatelier Method	1.0	Not more than 10
3.	Normal consistency	Vicat apparatus	30	……..
4.	Specific gravity	Le Chaterlier"s flask	3.76	…….

Sieve Analysis of Fine Aggregates

Weight of sample =1000gm

IS Sieve Size(mm)	Weight Retained(gm)	Cumulative Weight Retained(gm)	Cumulative %Age of Weight Retained(gm)	Percentage Passing
4.75	156	156	15.6	84.4
2.36	57	213	21.3	78.7
1.18	113	326	32.6	67.4
0.6	111	437	43.7	56.3
0.3	376	813	81.3	18.7
0.15	145	958	95.8	4.2
0.075	30	988	98.8	1.2

∑F=389.3

Fineness Modulus(F.M)=3.89

Sand conforming grading zone II of I.S 383-1970.

Physical Properties of Coarse Aggregates (20mm)

S.No.	Property	Observed Values
1.	Bulk Density (Loose),kg/m^3	1480
2.	Bulk Density, kg/m^3	1560
3.	Specific gravity	2.8
4.	Free moisture (%)	0
5.	Water absorption (%)	0.48

Mixing and Compaction

The ingredient materials were weighted on weighing machine as per design mix. In the present study, machine mixing was used for mixing of concrete. Power driven mixer was used for mixing the materials. All the mixing water was added to mixing drum before introducing the solid materials. Half of the coarse aggregate was added to drum, and then fine aggregate was added following the addition of cement and at the last remaining coarse aggregate was added to drum. Mixing was done after adding

the materials to drum and mixing was continued till uniform concrete was appeared. Cast iron moulds were used for cube casting and cast iron beams were used to cast beams. The samples were cast according to IS:516-1959. The compaction was done by using table vibrator for 1-2 minutes. Excess material was removed by using a iron rod. Top surface was smoothened by using suitable floats and trowel.

Properties of Fresh concrete (Workability)

There are a lot of methods of for measuring workability of concrete. Each method measures only a specified aspect of it and there is really no method which measures the workability of concrete in its totality. So, it is assumed that none of the methods are wholly satisfactory. But by checking the uniformity of the workability it was easier to ensure a uniform quality of concrete and hence uniform strength for a particular job. In the present study, two tests were performed to find workability.

1. Slump Test
2. Compaction Factor Test

The slump values and the compaction factor test values are summarized in table 2.

Table 2: Properties of Fresh Concrete (Slump values and Compactor Factor value)

S.No.	Mix	W/C	Super Plasticizer	%RCA	Slump Value(mm)	Compaction Factor Value
1.	m0	0.38	0.6%of cement	0	42	0.842
2.	m1	0.38	0.6%of cement	10	43	0.865
3.	m2	0.38	0.6%of cement	20	40	0.843
4.	m3	0.38	0.6%of cement	30	38	0.828
5.	m4	0.38	0.6%of cement	40	40	0.826

Testing Procedure

After casting samples were kept in water for curing for specified period. In case of sulphate resistance testing, cubes were kept in sulphate solution after keeping them in water for 28 days. Sulphate solution curing was done for specified time period.

After specified time period of curing, samples were taken out of curing tank and wiped out their surface to clean. They were dried for 24 hours. Various tests were performed to determine the desired strengths. Following tests were performed.

1. Compressive strength of cubes at the age of 7, 28, 56 and 90 days.
2. Flexural strength of beams at the age of 7, 28 and 90 days.
3. Sulphate resistance of cubes at the age of 7, 28 and 56 days.

Calculation

The flexural strength of the specimen should be expressed as the modulus of rupture σ Calculated as below

$$\sigma = \frac{FL}{bd^2}$$

Where

4. *F* is the load (force) at the fracture point in MPa
5. *L* is the length of the support (outer) span in mm
6. b is width in mm
7. d is thickness in mm

RESULTS AND DISCUSSION

Testing of sample was done at 7, 28, 56 and 90 days for compressive strength. For flexural strength testing of samples was done at 7, 28 and 90 days. Testing for sulphate resistance was done at 7, 28 and 56 days. In this chapter, results of these tests are discussed along with the results of workability.

Workability

As discussed in chapter 4, workability varied with change in proportion of demolished aggregates. The slump values and compaction factor values did not show a uniform pattern as the percentage of demolished aggregates was uniformly varied. Super plasticizer was used to maintain the workability as water absorption increased due to presence of demolished concrete aggregates water cement ration (W/C) water kept constant (0.38). Figure 5.1 gives the variation of slump values versus type of mixes. Figure 5.2 gives the variation of compaction factor versus type of mixes.

CONCLUSIONS

The research on usage of RCA in construction of pavement is very important because material waste is gradually increasing with the increase in urban development and increase in population. Recycled aggregates are easily available while natural aggregates need mining and their cost is much higher than the cost of natural aggregates. Recycled aggregates are cheaper than the virgin aggregates, so builders can easily afford these for construction purpose if their strength is equal or comparable to natural aggregates.

The study examines the properties of RCA when used with natural coarse aggregates. A lot of studies have been carried out on use of RCA concrete in construction. But in case of highway construction some more investigation is required. The main objective of the study was to investigate whether RCA can be used as material aggregates for concrete pavement construction. Compressive strength, flexural strength and sulfate resistance of RCA concrete is examined, where it was observed that mixing of RCA cause increased water absorption. To avoid this, super plasticizer is used to reduce the cement consumption. Concrete mix of M40 was designed as per properties of aggregates. The results of this study showed that RCA concrete gave comparable strength to conventional concrete. This indicated that RCA concrete can be viable source for construction of pavements. From the results, it is also found that workability of concrete is decreased due to higher water absorption. Whenever recycled aggregate is applied, water content is monitored carefully in concrete mix as water absorption is increased due to presence of porous mortar. In this study, super plasticizer (0.6% of cement) is used to overcome this problem.

Following conclusions can be drawn from results and discussion of results from the study:

1. The compressive strength of all mixes exceeded at the age of 28 days. Compressive strength of control mix i.e. of m0 is 50.05 MPa which is greater than the target strength of 48.25 for M40 concrete. Compressive strength of m1 is slightly increased to 50.36. So the compressive strength increases by 0.5%. For m2, compressive strength is increased to 50.20 MPa, it also showed an increase in compressive strength by 0.3%. Compressive strength of m3 is decreased to 49.11 MPa that showed a decrease in compressive strength by 1.9%. But in case of m4, there is sudden increase in compressive strength that raises the compressive strength to 52.36 MPa. Compressive strength is increased by 4.5%. So the results of test show that compressive strength does not follow a regular trend from m0 to m4. But from the results it is also concluded that compressive strength never went below the target strength for 28 days. This indicates that RCA can be used as replacement aggregates for compressive strength.

ACKNOWLEDGMENT

Authors express sincere thanks to Director- HCTM Technical Campus Kaithal, and The Head, Civil Engineering Department, HCTM Technical Campus, Kaithal,Haryana, India for facilities and encouragement

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