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INVESTIGATIONS ON RECYCLED CONCRETE AGGREGATE AND MSAND AS AGGREGATE REPLACEMENT IN CONCRETE

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ABSTRACT

Gigantic numbers of building and destruction trashes are produced in emerging countries like India. The clearance of these trashes is serious problem because it requires huge space. The present work is to study the properties of concrete with replacement of 50% of nature sand by manufactured sand and coarse aggregates by different proportions with recycled concrete aggregates (RCA). A mix proportion for M20 grade concrete is derived with standards confirming to IS codes. RCA was partially replaced for coarse aggregate in the proportions of 10%,20%,30% and 40%and fine aggregate by M-sand for 50% as constant. Results showed that recycled aggregates decreases the workability of concrete. But that can be easily avoided with plasticizers. The fresh and hardened properties of new concrete are studied and compared with concrete made using conventional materials. The compressive strength of recycled coarse aggregate (RCA) is found to be higher than that of normal concrete when used up to a 50 %. With respect to the flexural strength, recycled aggregate concrete was slightly lower with increase in % of RCA after 28days. At the end it can be said that the RCA up to 50 % can be used for obtaining good quality concrete.

KEYWORDS: Recycled Concrete Aggregate, M-Sand, Recycled Concrete, Demolition Waste

INTRODUCTION

Concrete is the premier construction material used widely across the world in all types of engineering works, it plays an important role in shaping our environment and sustainability of construction industry. Efforts to improve the properties of concrete are continuously being made by researchers. In the last decade, construction industry has been conducted research on the utilization of waste products in concrete. Unwanted concrete and brickwork can be reprocessed by arranging, crushing and separating into recycled aggregate. Aggregates normally make up around 55% to 70% of the capacity of a concrete mixture. The management of C&D waste is a alarm due to growing considerable amount of demolition's rubble, lack of dumping spots, rise in shipping and clearance cost. But most of the industries and construction companies are still not aware of this environmental dangerous wastages and its recycling. As a standby to river sand, Manufactured sand (M-sand) has been produced by crushing stone. Several experimental results shows that the quality of M-sand is better than the river sand in several phases. Investigational outcomes recommend that the sharp ends of the particles in non-natural sand offer healthier connection with the cement. The main objective of the present work is to systematically study the properties of concrete with constant replacement of 50% of nature sand by manufactured sand and coarse aggregates with recycled aggregates at the rate of 0%, 10%, 20%, 30%, 40% and 50%.

M-sand

Manufactured sand is an alternate fine aggregate that may be used in the making of the concrete. Here that term "manufactured" denotes purposely taking coarse aggregate, primarily granite, and crushing it to create a new product sand. these particles have sharp edges and rough surface textures. When they are used in concrete, it involves the usage of admixtures to rise the flexibility of the wet concrete. In order to avoid these deficiencies the surface textures of the sand particles should be smooth and edges should be rounded. There are machines to manufacture sand having good surface texture and edges of the granules of the sand are rounded.

Need for RCA

- It is resource efficient that is minimizing depletion of our natural resources.
- The price and carrying distances of traditional coarse aggregates continue to upswing as resources turn out to be scarce.

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- Unprocessed RCA is suitable to be applied as filling, bank protection, sub-basement, road construction, noise barriers and embankments.
- Processed RCA are widly used in fresh concrete for pavements, shoulders, median barriers, sidewalks, curbs and gutters, and bridge foundations.

EXPERIMENTAL INVESTIGATION

The strength [flexural, split tensile and compressive] and workability [slump and compacting factor] were studied on concrete with partial replacement of natural sand by manufactured sand and coarse aggregate with recycled.. Table 7 presents the M20 grade concrete mix design for concrete and six trial mix series based on partial replacement of natural aggregates. All of the experiments were performed in normal room temperature. The concrete ingredients namely cement, coarse aggregate, fine aggregate, M-sand and RCA were first mixed in dry state, then calculated amount of water was added and mix it thoroughly to get a homogeneous concrete mix. Workability of fresh concrete was determined by the slump and compacting factor test according to Indian standers. The typical size of cube 150mm×150mm×150mm was used to determine the Compressive strength. Split tensile strength was carried out on the cylinder with 150mm diameter and 300mm height. To calculate the flexural strength, beams of length 1000mm are casted. These were cured in water and it tested at 7, 14 and 28 day's on compression testing machine. For each trial mix three cube, three beam and three cylinders were casted. In this experimental work, a total of 54 numbers of concrete specimens were casted. The engineering properties of the RCA were compared to those of the reference concrete.

MATERIALS

Cement

Ordinary Portland Cement (OPC) is factory-made in the formula of different grades. Grade-53, Grade-43 and Grade-33 are extensively consuming grades in India. The grade 43 is licensed with IS 8112:198. Grade 43 is in great requirement in India. Today OPC 43 is most widely available in all the regions of India through an extensive distribute on network. In this paper, OPC43 grade cement was used.

Fine aggregate

Fine aggregate is obtained from locally available river sand, which is passed through 4.75 mm sieve. According to IS 383:1970 [7] the FA is being classified into four different zones, that is Zone-I, Zone-II, Zone-III, Zone-IV. The fine aggregate used in this study is under zone II.

M-sand

M-sand was used as fine aggregate. It is manufactured in a central plant by crushing stone making use of the Vertical Shaft Impact (VSI) crusher. Due to the use of this technology the sand particles can be shaped very similar to that of the naturally available fine aggregate. During the process of engineering, filtering is done by means of water jet and the satisfactory parting by screw classifiers. Using this method sand falling in any Zone can be manufactured according to our requirement. M Sand used for the present study was manufactured as fine aggregate falling under Zone II.

Coarse aggregate

Coarse aggregate was obtained from locally available crushed stone aggregate quarry. Maximum of 20mm size aggregate has been used trough out the experiment.

Water

Potable water conforming to IS: 3025-1964 [6] is used for mixing. Water is a chief constituent of concrete as it essentially play a part in the chemical response with cement. As it supports to form the strength providing gel, the measure and eminence of water are mandatory to be observed into very cautiously. Sulphate content, hardness and pH of water were 5.8 mg/lt, 3.9 mg/lt and 6.3 respectively.

RCA

RCA was collected from local Construction and Demolition site in Erode town and collected RCA were manually crushed up to the natural coarse aggregate size (i.e. 20 mm).

Mix design

The mix design for M20 grade concrete is done according to the IS design method to obtain the optimum mix. Once the optimum mix is determined, it is used to produce concrete with 0%, 10%, 20%, 30%, 40% and 50% replacement of RCA and a constant replacement of 50% of natural sand by M-sand.

Tables:

Table 1. Physical properties of cement

PROPERTY	VALUE
Specific Gravity	2.904
Standard consistency	36%
Initial setting time	30 minutes
Fineness	5%

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Table 2. Chemical composition of cement

COMPONENT	%
Sio_2	21.8
Al_2O_3	4.8
Fe_2O_3	3.8
CaO	63.3
SO_3	2.2
MgO_3	0.9
Loss of ignition	2
Insoluble residue	0.4

Table 3. Physical properties of Fine aggregate

PROPERTY	VALUE
Specific gravity	2.495
Fineness modulus	2.647

Table 4. Physical properties of M-sand

PROPERTY	VALUE
Specific gravity	2.62
Fineness modulus	2.71

Table 5. Physical properties of Coarse aggregate

PROPERTY	VALUE
Specific gravity	2.62
Fineness modulus	2.71

Table 6. Physical properties of Recycled Coarse Aggregate

PROPERTY	VALUE
Specific gravity	2.62
Fineness modulus	2.71

Table 7. Concrete mix design proportion (M20 grade)

MIX	CONCRETE MIX DESIGN PROPORTION					
	W/C	C	FA	CA	M-SAND	RCA
					FA	CA
B0	*0.52*	*1*	*1.75*	*3.06*	*0*	*0*
B1	*0.52*	*1*	*0.875*	*2.754*	*0.875*	*0.306*
B2	*0.52*	*1*	*0.875*	*2.448*	*0.875*	*0.612*
B3	*0.52*	*1*	*0.875*	*2.142*	*0.875*	*0.918*
B4	*0.52*	*1*	*0.875*	*1.836*	*0.875*	*1.224*
B5	*0.52*	*1*	*0.875*	*1.530*	*0.875*	*1.530*

RESULTS AND DISCUSSION

Workability

Increasing percentage replacement of both RCA and manufactured sand decreased the workability. This can be easily avoided by using super plasticizer. The results show that slump of reference specimen is higher while the concrete Mix specimen (50% replacement of RCA) has lesser slump. The slump of RAC is low and that can be improved by using Saturated Surface Dry of RCA (SSD RCA) to improve the workability of fresh concrete. From the results obtained, concrete made with 50% SSD RCA has competitive slump compared to the concrete made with CA Fresh Concrete

Compressive strength

Compressive strength testing was performed in general accordance with Indian Standard Test Method. For the compressive strength, tests were conducted at the ages of 7, 14 and 28 days

It has been observed that the compressive strength goes on increasing with replacement of 50% of natural sand by manufactured sand and coarse aggregate with RCA up to 50% replacement.

Tensile Splitting Test

The split tensile strength of a concrete is carried on cylindrical specimen of diameter 150mm and length 300mm. Two wooden-bearing strips are placed. The specimen was loaded until it fails. The test is done at the age of 7, 14 and 28 days. The machine used was the same UTM that used for compression test.

Flexural strength test

We observed that the flexural strength of beam increases as the partial replacement of RCA increases during early stages of concrete. But Flexural strength constantly decreases as the curing period goes on increasing. The control mix had a flexural strength of 3.2 N/mm^2 at 28 days. But with 50 % of replacement of river sand with M-sand and 50% of the coarse aggregate by RCA gives only 3.14 N/mm^2 which is lower value compared to normal mix.

Figures:

Fig.1 Comparison of Compressive strength of cubes for different % of RCA and M-sand

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Fig.2 Comparison of split tensile strength of cylinder for different % of RCA and M-sand

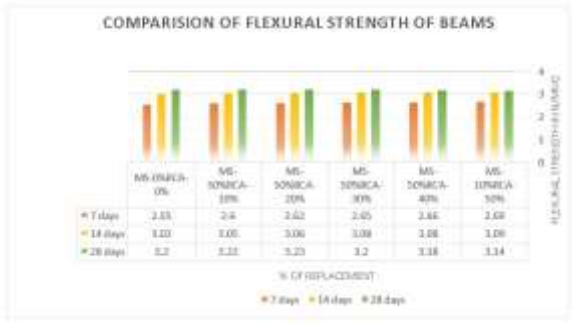

Fig.3 Comparison of flexural strength of beam for different % of RCA and M-sand

CONCLUSION

1. Recycled concrete aggregate may be an alternative to the natural coarse aggregate.
2. Water required producing the same workability increases with the increase in the percentage of both M-sand and RCA.
3. Up to 50% replacement of coarse aggregate with recycled aggregate and 50% replacement of river sand with M-sand, physical properties of Recycled Aggregate concrete was equivalent to conventional concrete.
4. Up to 50% of coarse aggregate replaced by RCA gave both compressive strength and split tensile strength closer to the strength of plain concrete but flexural strength decrease with increase in % of RCA at later stages of concrete.

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