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RESEARCH ARTICLE OPEN ACCESS

A Study on the Behaviour of Recycled Aggregate Concrete with Plastic Waste and Fly Ash

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ABSTRACT
Concrete plays a vital role with in the development of infrastructure globally. Certain amount of cement can be replaced with fly ash which aids the usage of less cement content in the concrete mix. Natural aggregates can be replaced with RAC to make it more vulnerable and eco-friendly. From past studies it is known that use of recycled concrete aggregates might reduce the strength. To compensate this strength reduction PET were employed. PET fibers can be obtained from as bottles and containers. In the present experimental investigation, concrete having compressive strength 40 MPa used. Fly ash proportion in concrete kept constant as 25%. The coarse aggregate replaced with RCA are 0, 25, 50, 75, 100 percentages with natural aggregates. PET is added 1% of the total weight of the cement. Various tests are carried out by casting different mix proportions of cubes, cylinders and beam prisms to perform compressive strength, split tensile strength and flexural strength for 7 and 28 days. This project aims to know the usage of fly ash, recycled aggregates and PET fibers will give similar strength.

Keywords - fly ash, PET (Poly Ethylene Terephthalate), RAC (Recycled Aggregate Concrete)

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I. INTRODUCTION

The word concrete comes from Latin word "concretus". Concrete is a strong and versatile moldable construction material. It consists of cement, sand, aggregate and water. The cement and water is to form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the entire mix together. The initial hardening reaction usually occurs within a couple of hours. It takes four weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many yearsConcrete has excellent resistance to compression, but is very poor in tension. To give it good load bearing capability when under tension, it has to be reinforced with steel bars, polymer strands or fibers .It is the most commonly used building materialwhich is recyclable. It is strong, durable, available and versatile. It is capableto resist the compressive load to a limit, but if the load applied on the concrete is quite than their limit of resisting load, it causes the strength reduction ofconcrete produces the cracks in concrete. Based on ingredients present concrete can be classified intotwo types:

- Normal Concrete
- Special Concrete

Normal Concrete has the ingredients namely cement, sand, aggregates (coarse) and water mixed in some proportion to realize concrete of desired strength and property.

Special concrete also called as modern concrete, other than these ingredients namely admixtures and fibers. Admixtures are added to concrete to achieve special properties like ultra high strength or resistance whereas fibers are added to achieve tensile forces.

II.METHODOLOGY

Experiments were guided on concrete prepared by partial replacement of natural aggregate with 0%, 25%, 50%, 75%, 100% recycled aggregate and cement with 25% of fly ash, 1% of PET to the total weight of concrete and the mix design was prepared.

III.MATERIALS USED:

Cement:

Ordinary Portland cement of grade53 conforming to Indian Standards IS 12269-1987 was used throughout the experimental program. In general similar types of cements have quite different rheological and strength characteristics,

mainly when used in combination with admixtures and cementing material. Specific gravity of cement is 3.15

Table1:Chemicalcompositionofcement:

S.NO	Chemical composition	OPC
1	Sio_2	20.8
2	Na_2o	0.31
3	CaO	65.40
4	MgO	1.3
5	Al_2O_3	4.60
6	K_2O	0.44
7	SO_3	2.2
8	Fe_2O_3	2.8

FLYASH:

Most fly ash is a pozzolanic material, which means it is a siliceous or siliceous and aluminous material that reacts with calcium hydroxide to form cement. When Portland cement reacts with water, it produces a calcium silicate hydrate and lime. This reaction of fly ash is lime in concrete improves strength. Typically, fly ash is added to the structural concrete 15-35 percent to weight of the cement.

FineAggregate:

Fine aggregate (sand) used for this entireinvestigationforconcretewasriversandconforming tozone-IIofIS:383-1970.Locallyavailableriversandpassedthrough4.75 mmISsieveisconsideredasfineaggregate.Specificgravityofriversandis2.61

CoarseAggregate:

In this project two types of aggregates were using, they are

- Natural aggregates
- Recycled aggregates

Natural aggregates:

Coarse Aggregate occupies upto35 to 70% of the volume of the concrete. Smallsized aggregates produce higher strengthconcrete. Theworkability offreshconcreteisaffectedbyparticleshapeandtexture .Coarseaggregate iscrushed granite of 20 mm size has been usedascoarse aggregate.Specificgravityofcoarseaggregateis2.75.

Recycled aggregates:

The aggregates should be sieved and taken according to the required sizes. In this case the recycled aggregates should be passed through 20mm sieve and should be retained on 16mm sieve. The aggregates collected by sieve analysis are washed for about 15 to 20 mins. Washing process cleanses the aggregates to a considerable extent. The RCA kept in sun for drying for about 30 mins. The RCA heated in an oven at temperature around 150 º C for about an hour. The RCA were kept in trays when heated.

PET fibers:

Poly Ethylene Terephthalate commonly abbreviated PET. It is thermoplastic polymer resin of the polyester family and issued in synthetic fibers,PET is one of the most important tend extensively used plastics. The PET bottles are collected from the households which are left over after its usage. These bottles are cut down into pieces which are then cut down as fibers manually with scissors. Fig 3.6 shows the PET fibers of dimension 40mm x 2mm. The aspect ratio of fibers is 20. The aspect ratio is kept constant throughout the project.

Super plasticizers:

Their addition to concrete reduces the water-cement ratio, not affecting the workability of the mixture, and enables the production of self-consolidating concrete and high performance concrete. Super plasticizer used is Conplast SP430

IV .MIXDESIGN

Mix design for M40 grade of concrete wasprepared by using the guidelines of IS 10262:2009.The mix proportion of mix design of material is1:2.11:2.69withwatercementratioas0.364.Thestudy is conducted to determine the compressive strength, split tensile strength and flexural strength of concrete when cement is replaced by50% of recycled aggregate ,1% of PET,25% of fly ash .Themouldsusedinthisexperimentarecubewithasizeof150mm×150mm×150mm,cylinderwithasize of150mm dia. and 300mm height, prism beamwithsizeof700mm×150mm×150mm.Thecement,coarseaggregate,fineaggregate, fly ash ,PET, recycled aggregates are mixed thoroughly until uniform mixture is attained and then is mixed with super plasticizer and water. Compression and split tensile strength are conducted on compressive strength machine and flexural strength is conducted on flexural testing machine .Three samples per batch were tested, the average strength values are reported.

V. RESULTS AND DISCUSSION:

Compressive Strength of Concrete:

The test was carried out conforming to IS 516-1965 to obtain compressive strength of concrete at the

age of 7 days and 28 days. The specimens (cubes) were tested using compression testing machine CTM: 2000KN

Mix-1: 0% recycled aggregate, 25% Fly Ash and 1% PET fibers Concrete Mix

Mix-2: 25% recycled aggregate,, 25% Fly Ash and 1% PET fibers Concrete Mix:

Mix-3:50% recycled aggregate,, 25% Fly Ash and 1% PET fibers Concrete Mix

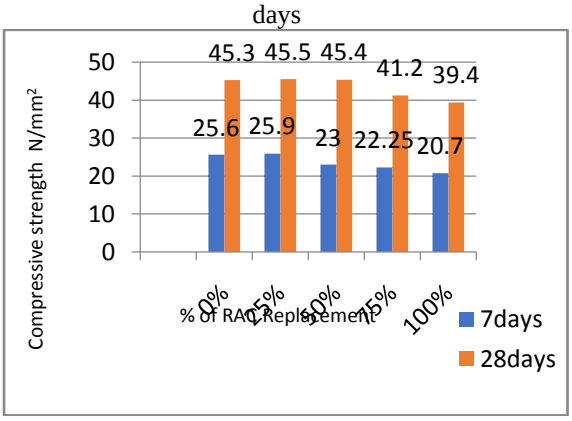
Mix-4For 75% recycled aggregate,, 25% Fly Ash and 1% PET fibers Concrete Mix

Mix-5: For 100% recycled aggregate,, 25% Fly Ash and 1% PET fibers Concrete Mix

Table2:Compressivestrengthat7daysand28days

S.N0	Mix	7days (N/mm^2)	28days (N/mm^2)
1	Mix -1	25.6	45.3
2	Mix -2	25.9	45.5
3	Mix -3	23	45.4
4	Mix -4	22.25	41.2
5	Mix -5	20.7	39.4

Figure1: Compressive strength at 7 days and 28 days



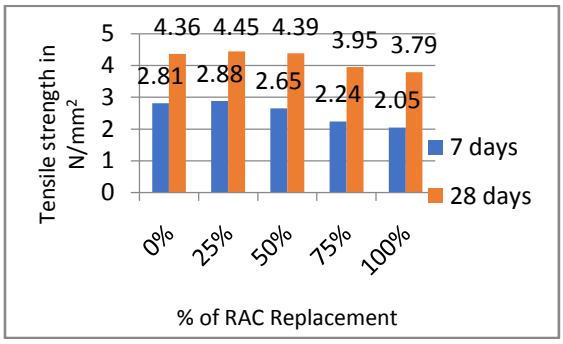
Split Tensile Strength:

The test was carried down conforming to IS 516-1959 to obtain split tensile strength of concrete at the age of 7 days and 28 days. The cylinders were tested by using compression testing machine (CTM) of capacity 2000KN

Table3: Splittensilestrengthat7daysand28days.

S.NO	MIX	7 days	28 days
1	Mix -1	2.81	4.36
2	Mix -2	2.88	4.45
3	Mix -3	2.65	4.39
4	Mix -4	2.24	3.95
5	Mix -5	2.05	3.79

Figure2: Splittensilestrengthat7daysand28day



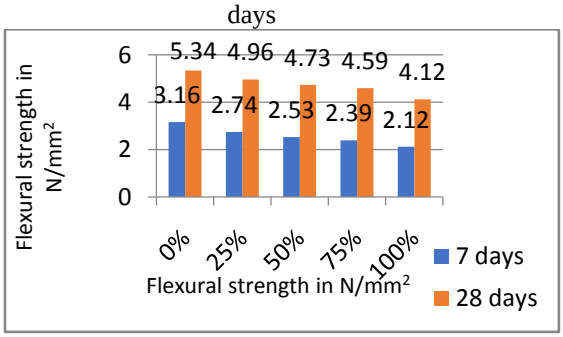
Flexural Tensile Strength:

The test was carried down conforming toIS 516-1959 to obtain Flexural strength of concreteat the age of 7 days and 28 days. The prisms weretested usingflexural testing machine

Table4: Flexuraltensilestrengthat7daysand28days

S.NO	MIX	7 days	28 days
1	Mix -1	3.16	5.34
2	Mix -2	2.74	4.96
3	Mix -3	2.53	4.73
4	Mix -4	2.39	4.59
5	Mix -5	2.12	4.12

Figure3: Flexuraltensilestrengthat7daysand28days



VI.CONCLUSIONS

The following conclusions are drawn from the results:

The workability of the concrete has increased by 15% when 50% RAC is used while compared to normal concrete.

While increasing the percentage of RAC the workability got decreased.

The average 28 days compressive strength of M40 grade concrete has increased by 14% when replacement of RAC was up to 50%, further on increasing the RAC the compressive strength decreases gradually.

Split tensile strength of recycled aggregate concrete has increased by 5% up to 50% of RCA, on further increase of replacement the tensile strength decreases slightly.

- The flexural strength of recycled aggregate concrete has decreased by 12%, the flexural strength decreases gradually while increasing in replacement of RAC.
- The experimental results shows that up to 50% of recycled aggregates can be used instead natural aggregates. More than 50% use of recycle aggregates leads to decrease in its strength.

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