EXPERIMENTAL STUDY ON PLASTIC WASTE AS A COARSE AGGREGATE FOR STRUCTURAL CONCRETE

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Abstract : The use of plastic is increasing day by day, although steps were taken to reduce its consumption. This creates substantial garbage every day which is much unhealthy. A healthy and sustainable reuse of plastics offers a host of advantages. The suitability of recycled plastics as coarse aggregate in concrete and its advantages are discussed here. The initial questions arising of the bond strength and the heat of hydration regarding plastic aggregate were solved. Tests were conducted to determine the properties of plastic aggregate such as density, specific gravity and aggregate crushing value. As 100% replacement of natural coarse aggregate (NCA) with plastic coarse aggregate (PCA) is not feasible, partial replacement at various percentage were examined. The percentage substitution that gave higher compressive strength was used for determining the other properties such as modulus of elasticity, split tensile strength and flexural strength. Higher compressive strength was found with 20% NCA replaced concrete

Key words - Experimental Study, Plastic Waste, Coarse Aggregate, Concrete.

I. INTRODUCTION

Concrete is the most widely used man made construction material in the world and its second only to water as the most utilized substance in the planet. Seeking aggregates for concrete and to dispose of the waste from various commodities is the present concern. Today sustainability has got top priority in construction industry. In the present study the recycled plastics were used to prepare the coarse aggregates thereby providing a sustainable option to deal with the plastic waste. There are many recycling plants across the world, but as plastics are recycled they lose their strength with the number of recycling. So these plastics will end up as earth fill. In this circumstance instead of recycling it repeatedly, if it is utilized to prepare aggregates for concrete, it will be a boon to the construction industry. Most of the failures in concrete structures occur due to the failure of concrete by crushing of aggregates. PCAs which have low crushing values will not be crushed as easily as the stone aggregates. These aggregates are also lighter in weight compared to stone aggregates. Since a complete substitution for NCA was not found feasible, a partial substitution with various percentage of PCA was done. Both volumetric and grade substitution was employed in this investigation Generation of plastic waste is one of the fastest growing areas.Every year more than 500 billion plastic bags are used (nearly one million bag per minute). Hundreds of thousands of sea turtles, whales and other marine mammals die every year from eating discarded plastic bag for mistaken food. On land many animals suffer from similar fate to marine life. Collection, hauling ad disposal of plastic bag waste creates an additional environmental impact. In a landfill or in environment, Plastic bags take up to 1000 year to degrade. Many researches were conducted to use industry by products such as fly ash, silica of concrete. Flume, glass cullet, coir fibers, e-plastic waste in concrete to improve the properties. (17%) is higher than for the plastic industry elsewhere in the world. India has a population of over 1 billion and a plastic consumption of 4 million tonnes. One third of the population is destitute and may not have the disposable income to consume much in the way of plastics or other goods. The virgin industry does not target this population to expand its markets. The rising needs of the middle class, and abilities of plastics to satisfy them at a cheaper price as compared to other materials like glass and metal, has contributed to an increase in the consumption of plastics in the last few years.

II. OBJECTIVE

- To compare the compressive strength and Density of Recycled Plastics used as Coarse Aggregate for Constructional Concrete with the Conventional concrete
- To know its applications in construction industry.
- To reduce the pressure on naturally availability materials by replacing it with Recycled plastic aggregate
- To compare the physical characteristics of natural aggregate with Plastic recycled aggregate.
- To study the behaviour of fresh and hardened concrete with polymer waste coarse aggregate and compare its properties to those of conventional concrete
- To produce lightweight polymer concrete for multi-purpose use It represents an environmental friendly and
- economical viable solution, for utilization of waste plastic

III. PREPARATION AND TESTING

The Plastic Waste concrete is manufactured by as similar to the classical concrete.Initially the dry materials Cement, Aggregates & Sand are mixed. The liquid component of the mixture was then added to the dry materials and the mixing continued for further about 4 minutes to manufacture the fresh concrete. The fresh concrete was cast into the moulds immediately after mixing, in three layers for cube specimens.For compaction of the specimens, each layer was given 60 to 80 manual strokes using a rodding bar, and then vibrated for 12 to 15 seconds on a vibrating table. Before the fresh concrete was cast into the moulds, the slump value of the fresh concrete was measured.The Plastic Waste concrete specimens should be wrapped during curing at elevated temperature in a dry environment to prevent excessive evaporation.Extensive trails revealed wrapping of concrete specimens by using vacuum bagging film is effective for temperature up to 100c for several days of curing. To tighten the film to the concrete moulds, a quick lock seal or a twist tie wire was utilized. The later was used in all further experimental work due to its simplicity and economics. Preliminary test also revealed that Plastic Waste -based concrete did not harden immediately at room temperature. When the room temperature was less than 30^{O}C, the harding did not occur (rather than setting time used in the case of OPC concrete) for Plastic Waste -based Concrete.

3.1 Testing the sample

Within the experimental research program concerning the development of mechanical properties of a Plastic waste concrete of grade M30 was considered with the following composition, accordingly. The w/c-ratio is 0.46. Coarse aggregates were chosen, having a particle size mainly varying between 12 mm and 20 mm. In order to mitigate this and to prevent early-age cracking, additional internal curing water will be provided by means of SAP.

An intensive experimental program is performed to study the effect of internal curing on different types of concrete properties:

- fresh properties (slump and density)
- mechanical properties (compressive strength, flexural strength, splitting tensile strength).

3.2 Compressive Strength Test

ForAt the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block will be noted. From the noted values, the compressive strength may calculated by using below formula

Compressive Strength = Load / Area

Size of the test specimen = 150mm x 150mm x 150mm

3.3 Split Tensile Test

The size of cylinders 300 mm length and 150 mm diameter are placed in the machine such that load is applied on the opposite side of the cubes are casted. Align carefully and load is applied, till the specimen breaks. The formula used for calculation.

$$\text{Split tensile strength} = 2P/\pi dl$$

3.3 Flexural Strength Test

During the testing, the beam specimens of size 700mmx150mmx150mm were used. Specimens were dried in open air after 7 days of curing and subjected to flexural strength test under flexural testing assembly. Apply the load at a rate that constantly increases the maximum stress until rupture occurs. The fracture indicates in the tension surface within the middle third of span length.

3.4 Photos of Plastic cube and Testing

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IV. RESULTS AND DISCUSSION

COMPRESSION STRENGTH TEST

M20 GRADE 7 DAYS CURING FOR CONVENTIONAL CONCRETE

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	326250	14.5
2	150x150x150	335250	14.9
3	150x150x150	344250	15.3

AVERAGE =14.9 N/mm^2

M20 GRADE 14 DAYS CURING FOR CONVENTIONAL CONCRETE

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	407250	18.1
2	150x150x150	418500	18.6
3	150x150x150	427500	19.0

AVERAGE =18.5 N/mm^2

M20 GRADE 28 DAYS CURING FOR CONVENTIONAL CONCRETE

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	479250	21.3
2	150x150x150	492750	21.9
3	150x150x150	504000	22.4

AVERAGE =21.8 N/mm^2

Plastic waste 5%:

M20 GRADE 7 DAYS CURING

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	360000	16
2	150x150x150	364500	16.2
3	150x150x150	35500	15.8

AVERAGE =16 N/mm^2

M20 GRADE 14 DAYS CURING

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	438750	19.5
2	150x150x150	445500	19.8
3	150x150x150	450000	20

AVERAGE =19.77 N/mm^2

M20 GRADE 28 DAYS CURING

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	517500	23
2	150x150x150	526500	23.4
3	150x150x150	522000	23.2

AVERAGE =23.2 N/mm^2

Plastic waste 10%:

M20 GRADE 7 DAYS

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	387000	17.2
2	150x150x150	391500	17.4
3	150x150x150	384750	17.1

AVERAGE =17.23 N/mm^2

M20 GRADE 14 DAYS

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	474750	21.1
2	150x150x150	481500	21.4
3	150x150x150	472500	21

AVERAGE =21.17 N/mm^2

M20 GRADE 28 DAYS

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	540000	24
2	150x150x150	544500	24.2
3	150x150x150	537750	23.9

AVERAGE =24 N/mm^2

Plastic waste 15%:

M20 GRADE 7 DAYS

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	339750	15.1
2	150x150x150	342000	15.2
3	150x150x150	333000	14.8
		AVERAGE	=15 N/mm^2

M20 GRADE14 DAYS

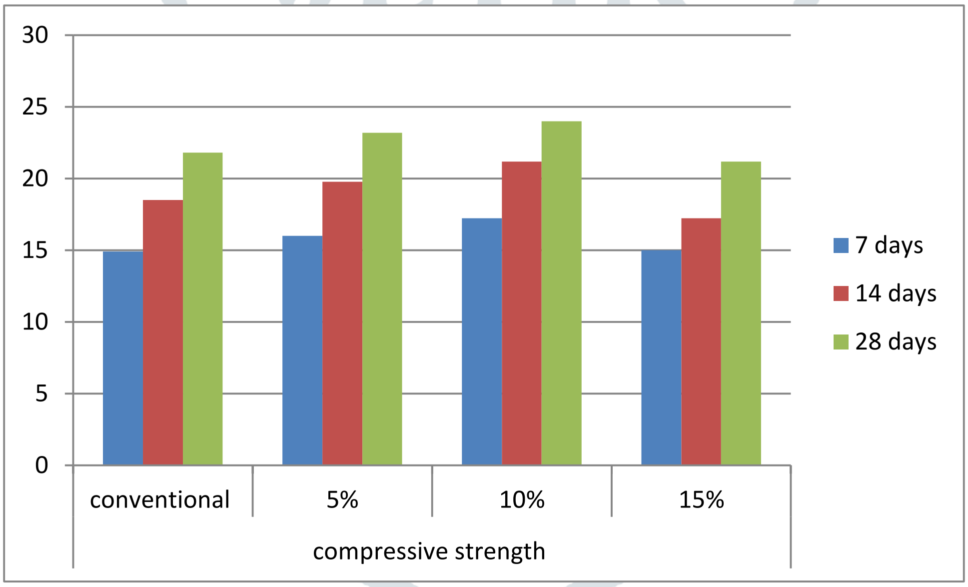
S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	387000	17.2
2	150x150x150	391500	17.4
3	150x150x150	384750	17.1
		AVERAGE	=17.23 N/mm^2

M20 GRADE 28 DAYS

S.NO	CUBE SIZE (mm)	LOAD (N)	COMPRESSION STRENGTH (N/mm^2)
1	150x150x150	474750	21.1
2	150x150x150	481500	21.4
3	150x150x150	472500	21
		AVERAGE	=21.17 N/mm^2

COMPARATIVE CHART

Compressive strength test results



IV. CONCLUSION

This paper present an overview of mechanical properties of reinforced concrete, It advantage it application during the last decade incredible development have been made in concrete technology .one of the major progress his reinforced concrete it can be designed as a composition material consisting of conventional concrete reinforced by the random dispersal of short discontinuous and discrete fine of specific geometry. The performance steel reinforced concrete has shown a significant improvement in flexural strength and over all toughness compared against convention reinforced concrete.

This study intended to find the effective ways to reutilize the hard plastic waste particles as concrete aggregate. Analysis of the strength characteristics of concrete containing recycled waste plastic have the following results. It is identified that plastic waste can be disposed by using them as construction materials Since the plastic waste is not suitable to replace fine aggregate it is used to replace the coarse aggregate The compressive strength and split tensile strength of concrete containing plastic aggregate is retained more orless in comparison with controlled concrete specimens. However strength noticeably decreased when the plastic content was more than 5%. Has been concluded 15% of plastic waste aggregate can be incorporated as coarse aggregate replacement in, concrete without any long term detrimental effects and with acceptable strength development properties.

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