The Study of Compression Strength of M20 Grade Concrete with the 20% Replacement of Coarse Aggregate with Plastic Aggregate Under the Temperature Variation

Ms. Vedika Patil[1], Mr. Prathamesh Dhavale[2], Mr. Prasad Mane[3,] Mr. Shrikant Ingale[4]
[1,2,3,4]*Member, Rajarambapu Institute of Technology, Rajaramnagar*

Abstract **- The rapid industrialization and urbanization in the country leads lot of infrastructure. This process leads to several problems like shortage of construction materials, increased productivity of wastes and other products. This project deals with the reuse of waste plastics as 20% replacement of coarse aggregate in M20 grade concrete. Usually M20 grade concrete is used for most constructional works. In our project we are going to replace about 20 % of natural coarse aggregate to recycled plastic aggregate. Tests were conducted to determine the properties of concrete with 20% replacement of coarse aggregate with the plastic aggregate under the temperature variation. We apply the temperature on coarse aggregate cubes, 20% replaced Plastic aggregate and Heat resisting paint applied cubes and place in furnace under certain interval (2000C, 3000C, 5000C) temperature. Then after 24 hours remove the cubes from furnace and take the compressive strength test on cubes.**

Index Terms **- Coarse aggregate, Plastic aggregate, Concrete, 20% replacement, M20 grade, compressive strength.**

I.INTRODUCTION

From the last two decades the utilization of a plastic in different things are increased in a whole world. This creates the large amount of plastic wastes every year so the whole world facing the problems regarding the disposal of plastic waste. The plastic is material which takes long time to dispose as well as its pollutes the environment. So recycling and reuse of plastic is only way to manage plastic waste. So considering the above sentence the recycled plastic aggregate where used to prepare the mixture of cement, sand, aggregate & water with the 20% replacement of natural coarse aggregate. In this project we studied effects of different interval of temperature in concrete strength by 20% replacement of coarse aggregate.

The precautions also taken that the mechanical properties of concrete should not be change under any condition hence we can use this concrete in RCC structure. Hence it will be beneficial construction industry if plastic is used to prepare aggregate rather than recycling it continuously. For solving this problem, we replaced 20% of plastic coarse aggregate with natural coarse aggregate in concrete. During exposure to high temperatures such as during fire, the mechanical properties of the concrete such as strength, elastic modulus and volumetric stability are significantly reduced.

In this project we apply the temperature on coarse aggregate cubes, 20% replaced Plastic aggregate cubes and Heat resisting paint applied cubes and place in furnace under certain interval (2000C, 3000C, 5000C) temperature for 1 hours and 2hours soaking in furnace. Then after 24 hours remove the cubes from furnace and take the compressive strength test on cubes.

II. METHODOLOGY

The following steps are followed to complete the work (study) were as follows:

a. Literature survey
b. Problem identification
c. Objectives finalization
d. Methodology:

1. Find out the quantity of materials
2. Collection of material
3. Testing of material such as cement, fine aggregate, coarse aggregate, plastic aggregate to determine its physical properties.
4. Mix design of M20 grade concrete
5. Casting of specimens
6. Curing of specimen
7. Testing on specimen

8. Result analysis
9. Report writing

A. Objectives

1. To prepare the M20 grade concrete with the recycled plastic coarse aggregate.
2. To study the compressive strength at the temperature variation.
3. Comparative study of behavior of conventional concrete cubes, concrete with recycled plastic aggregate cubes and recycled plastic aggregate with heat resistance paint applied cubes under the temperature variations.
4. To suggest the remedial measures for failure of concrete due to temperature variation.

B. Testing of Material

1)Cement: -

Cement is one of the binding materials in the construction work. In this project we used 53 grade Ordinary Portland Cement (OPC) From the IS: 8112 – 1989

Table No. 3.1 Properties of Cement

Sr. No.	Description of test	Test results	Specifications as per
1	Initial setting time	160 min	Min. 30 minutes
2	Final setting time	510min.	Max.600 minutes
3	Standard Consistency test	7mm (from bottom)	5 -7 mm
4	Specific gravity	3.10	3.15

2) Natural Coarse Aggregate. :-

It is most important construction material in the concrete which interconnect to each other. The aggregate which retains on the 4.75 mm sieve is known as Natural Course Aggregate.

Table No.3.2 Properties of Coarse Aggregate

Sr. No.	Description of item	Test result obtained	Specifications as per IS:383-1970
1	Specific gravity	2.76	2.5 – 3
2	Water absorption	1.20%	2%
3	Impact Value test	19.88%	45%
4	Fineness modulus	7.54	5.5 – 8
5	Density of Coarse aggregate	1680 Kg/m3	1680m

3) Fine aggregate: -

The aggregate which is passes through the 4.75 mm sieve it is called as fine aggregate.

Table No. 3.3 Properties of Fine aggregate

Sr. No	Description of item	Test result obtained	Specifications as per IS:383-1970
1	Specific gravity	2.29	2.5 – 3
2	Water absorption	2.3%	0.3 – 2.5 %
3	Fineness modulus	3.54	2-4

4)Plastic Coarse Aggregate: -

After study of various research papers, high density polyethylene (HDPE) was selected as a replacement of natural coarse aggregate. The melting point of HDPE plastic aggregate is 20 mm.

Fig. No.1 High Density Polyethylene Plastic Aggregate

Table No.3.4 Properties of Plastic Aggregate

Sr. No.	Description of item	Test result obtained	Specifications as per IS:383-1970
1	Specific gravity	0.95	2.5 – 3
2	Water absorption	0%	2%
3	Fineness Modulus	7.25	5.5 – 8
4	Crushing value	0.81%	45%

5)Water: -

water is used for mixing & curing was clean & free from injurious amounts of oil acid salt sugar & organic materials. Portable water is generally considered satisfactory for mixing concrete & curing. The pH value shall not be less than 6.

C. DESIGN OF M20 GRADE CONCRTE MIX PROPORTION (AS PER IS 10262: 2009)

Mix	% of Plastic Agg.	Cement (kg/m^3)	Fine Agg. (kg/m^3)	Coarse Agg. (kg/m^3)	Plastic Agg. (kg/m^3)
M1	0	394.32	657.612	1156.77	-
M2	20	394.32	657.612	925.416	231.354

D. Casting and Curing:

Concrete mixture was proportioned with suitable quantity of fine and coarse aggregates based on selected water cement ratio and cement content-based mixes. Concrete mixtures were proportioned for M20 grade concrete having mix proportion 1: 1.668: 2.934 at w/c ratio 0.50 (As per IS:2009) mix plastic aggregate in concrete by 20% replacement of coarse aggregate by volume. The water cement ratio was maintained constant for all mixes. The materials were mixed by manually and by using concrete mixer in a laboratory. After mixing the concrete was then smoothly pore into the moulds in three layers and compact each layer by using table vibrator and tamping rod and level the top surface of mould by using trowel. The moulds were covered with gunny bags for 24 hrs. and then after 24 hrs. specimens were de-moulded and placed in water for 28 days for a curing.

E. Tests Conducted:

Specimens of size 150 x 150 x 150 mm was determined 28 days. After the removing cubes from curing, take 9 cubes of 20% replacement of plastic aggregate cubes and then apply heat resistant paint on cubes (Heat resisting capacity 6000C) and then place the specimens for drying the paint (Min. 1 day). Specimens were placed in the furnace at temperature 2000C, 3000C, 5000C for 1 hours temperature and 2 hours soaking for achieve a uniform temperature distribution across them after specimens were allowed to cool in the oven for 21 hours a total of 24 hours of heating and cooling past the curing age. Then take a compressive strength test on specimens of 20% replacement of plastic aggregate cubes, Normal aggregate cubes and heat resistance paint applied cubes by using compression testing machine.

III. RESULT AND DISCUSSION

A. Workability Test

Slump test was conducted on fresh concrete with 20 % replacement of plastic aggregate cubes to determine the workability as per IS: 1199(1989). It was noticed that mixing of plastic aggregate as a coarse aggregate does not affect the workability of concrete. The slump value is observed in the test is 100mm i.e. True slump was observed.

B. Compressive Strength test:

Compressive strength of concrete cubes of 0% & 20% proportion determined at 7, 14 and 28 days was tabulated in Table No.1At 28 days percentage of 20% replacement of plastic aggregate cubes compressive strength was decreased when compared to conventional concrete. When we gave temperature on cubes at a temperature 2000C, 3000C, 5000Cwe conducted the tests and observed that as temperature increases the strength of cubes was decreases are tabulated in Fig No. 1,2,3 respectively.

Table No.1 Compressive strength of cubes of 0% & 20% Proportions

Mixing Proportion series	COMPRESSIVE STRENGTH IN N/MM^2		
	7 DAYS	14DAYS	28 DAYS
0%	1.95	27.82	32.84
Weight (Kg)	8.590	8.875	8.910
20%	15.48	21.36	23.36
Weight (Kg)	7.812	7.812	7.785

Comparison Between behavior of conventional concrete cubes, concrete with recycled plastic aggregate cubes and recycled plastic aggregate with heat resistance paint applied cubes

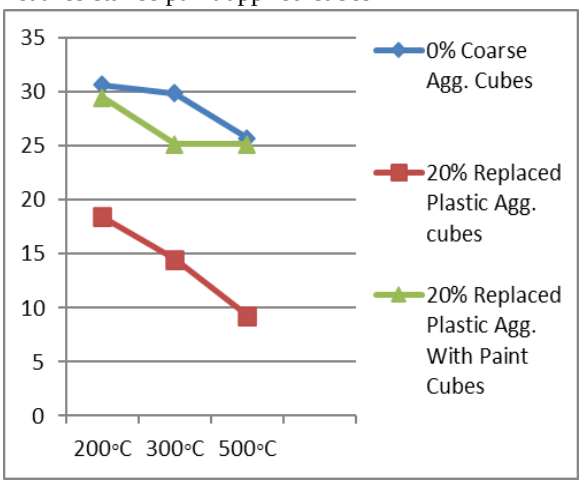


Fig. No. 1 Comparison of C. A. Cubes, P.A. Cubes, P.

A. with Paint Applied cubes at Various Temp.

In fig. no. 2 shows the results on 3000C was achieved up to 27.032N/mm2, 26.596 N/mm2, 21.8N/mm2

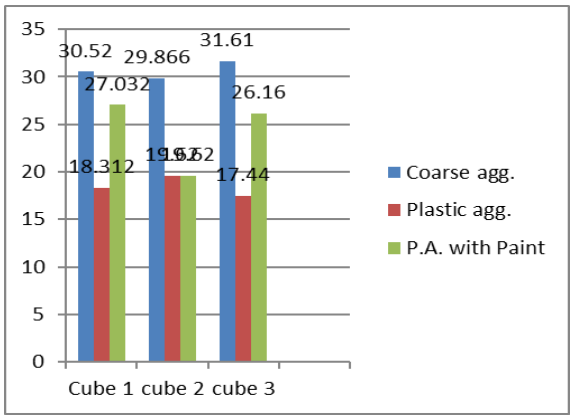
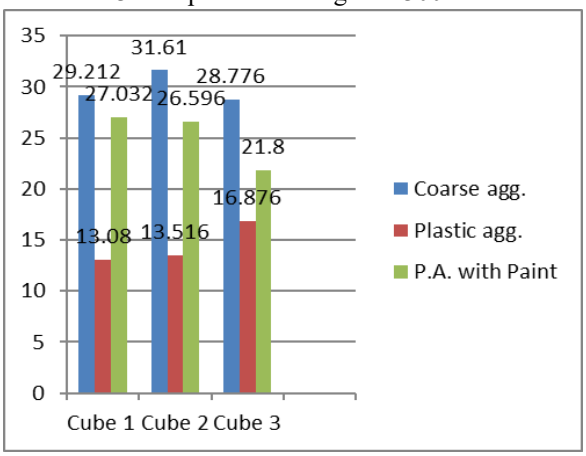


Fig. No. 2 Compressive strength of 200 ℃ Cubes

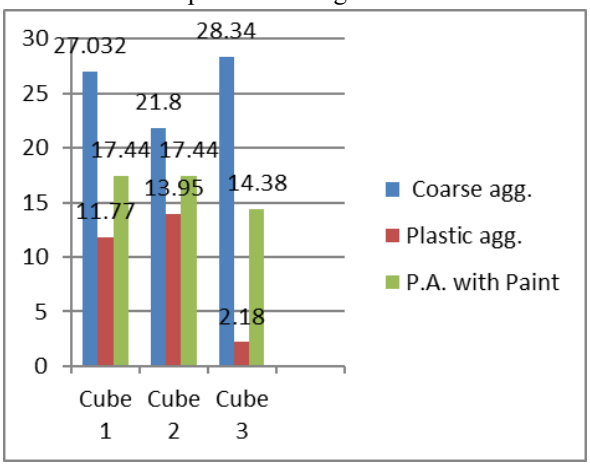
In fig. no. 3 shows the results on 3000Cwas achieved up to 27.032N/mm2, 26.596 N/mm2, 21.8N/mm2

Table No. 3 Compressive strength of 300℃ cubes



In fig. no. 4 shows the results on 5000Cwas achieved up to 17.44N/mm2, 17.44N/mm2, 14.38N/mm2

Table No. 4 Compressive strength of 500℃ cubes



IV.CONCLUSION

1. After 20% replacement of a natural coarse aggregate with the plastic aggregate we can prepare M20 grade concrete.
2. Due to the replacement of a plastic aggregate with natural aggregate is 20% the weight of concrete is reduced up to 12.63% for per meter cube.
3. For a M20 grade concrete which is prepared by natural coarse aggregate the compressive strength for a temperature 200°C, 300°C and 500°C is always more than 20 N/mm^2 but its compressive strength is reduced by 6.64 %, 9.08% and 21.68% increase in temperature 200°C, 300°C and 500°C respectively.
4. For a M20 grade concrete which is prepared by natural coarse aggregate with 20% replacement of plastic aggregate the compressive strength for a temperature 200°C, 300°C and 500°C is always more than 20 N/mm^2 but its compressive strength is reduced by 22.67%, 37.97% and 60.19% increase in temperature 200°C, 300°C and 500°C respectively.
5. After the application of heat resistant paint to the M20 grade concrete which is prepared by the 20% replacement of a natural aggregate to the plastic aggregate the compressive strength of the M20 grade concrete is increased by 14. 79%, 4.4% and 16. 82% for a temperature 200°C, 300°C and 500°C respectively.
6. We can use such type of aggregate in a structure where the chances of fire hazardous is less.
7. By using heat resistant (Capacity 600°C), we can improve the performance of M20 grade concrete which is prepared by natural aggregate with the 20% replacement of plastic aggregate by using this paint we can improve the compressive strength of concrete is up to 12.00 3%.
8. As the weight of the concrete is reduces hence the structure becomes light in weight so automatically Steel required is also uses so we can achieve the economy by using such type of aggregate.

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