International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 06 | Jun 2022 www.irjet.net p-ISSN: 2395-0072

USE OF PLASTIC AGGREGATE WITH GFRP BARS

Mahesh Bhagwanrao shinde[1], Prof. Rahul Patil[2]

[1] PG Student, Master of Structural Engineering –Deogiri Institute of Engineering and Management Studies, Aurangabad, Maharashtra
[2] Prof. Civil Engineering Department- Deogiri Institute osf Engineering and Management Studies, Aurangabad, Maharashtra

---

Abstract - *The use of plastic in our life is at his peak but due to the non-degradable properties of plastic waste as well as unsustainable use and disposal methods such as plastic waste managed with three common methods which is recycling, landfilling, incineration. these methods not giving impact in reducing the plastic waste due to all this things pollution is increasing and it has become very serious problem in front of world. In this project research we have studied the properties and behavior of the concrete which made by using plastic coarse aggregate and GFRP bar. Plastic Aggregate is made from HDPE type of Plastic and we have replaced it partially in percentage of 0%, 5%, 7.5% and 10%. Then we have analyzed and observe the behavior of compressive strength and Flexural strength of concrete. In This experiment we have checked and evaluate that how much percentage of plastic coarse aggregate can replace to get more compressive strength. And GFRP bars is use to instead of normal steel to evaluate behavior of flexural strength.*

***Key Words*: - GFRP Bar, Plastic Coarse Aggregate (PCA)**

1. INTRODUCTION

HDPE plastic helps in reducing concrete cost, land fill cost, energy saving and protection of environment from pollution. The low cost, light weight and high plasticity qualities of plastic materials make them widely used in various fields of the world, and provide great convenience for people's lives. However, due to the stable physical and chemical structure, plastic waste may not be decomposed in the natural environment for tens to hundreds of years and it is often treated by landfill and incineration, which has caused serious damage to the ecological environment. Therefore, the method of recycling waste plastic not only acts eco-friendly, but also costs less on raw materials and improves economic efficiency. In the field of civil engineering, structures constructed by tradition concrete materials with quasi brittle characteristics often show a brittle failure when external load cannot be born. As a result of the good ductility of waste plastic, the replacement of a part of aggregates with waste plastic granules for concrete preparation can not only reduce the pressure on environmental pollution, but also improve the ductility of concrete and reduce the cost of concrete-casting. Therefore, there is a good prospect to combine tradition concrete with plastic granules in engineering construction The GFRP bars indicated good bond behavior to concrete, mainly due to high ribs on the bar surface. Corrosion of steel reinforcement leads to cracking of concrete and thus reduces its durability life. GFRP bars displayed a viable solution to the corrosion problem. These bars are suitable for corrosive environment in several structures' applications. To get effective and non-corroding reinforcement GFRP bars are most important. For lightweight concrete structural elements, the relatively more flexible, than steel, GFRP bars provide realistic reinforcement and allow constructing load-bearing elements In this analysis the main moto is to know that how much increase in the flexural strength using GFRP bars and normal steel with partial replacement of fine aggregate by HDPE granules.

1.1 Plastic Aggregate

The use of plastic waste as a replacement os coarse aggregate is become popular topics in the construction technic. The use of plastic waste in construction helps to reduce the use of natural aggregate, which has become one of the important concerns. Many researchers has taken efforts to examine the benefits and power of using different types of plastic waste such as PET, HDPE, LDPE, PP and PVC in concrete. A so much of studies have been conducted on different uses of plastic aggregate for example for bricks production in the pavement and for making of coarse aggregate.

In this study we have use Plastic aggregates are made from locally available plastic which heated and melt it down and then we have made cube of it then we crush, them in aggregates size 12mm to 20mm. HDPE plastic gives, Good chemical resistance, light weight, high density, High tensile strength, Excellent rigidity, due to these properties. plastic is good replacement for the aggregate.

Fig. 1 plastic coarse aggregate

1.2 GFRP Bar

Reinforced concrete is very commonly use material in the construction such as, road, airport construction, bridges, buildings etc. Due to increasing in demand of reinforced concrete. Corrosion in reinforcement is mostly causes in buildings. Therefore, the application of any other materials which replace the steel can considered as important alternative. Now, Glass fiber reinforced polymer bars is promising and very effective replacement for steel which increase life of reinforced-concrete structures exposed to severely environment. Glass Fiber Reinforced Plastic rebar is provided good results in corrosion resistance. GFRP bars are composed of glass fibers with a thermosetting resin and procced using a pultrusion process. Its advantages include high stiffness to weight ratio, high longitudinal strength, tensile strength, corrosion resistance and light weight, resist chemical attack and electromagnetic neutrality for this reason we are using GFRP bar in this excrement.

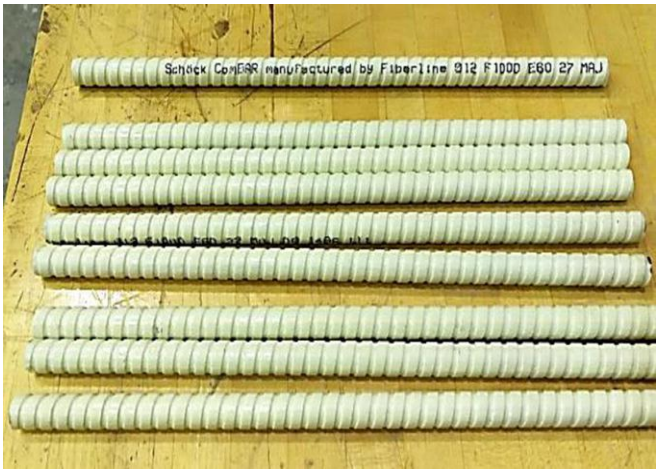

Fig. 2 GFRP Bar.

2. METHODOLOGY

In experiment We have used M30 grade of concrete and we are done weight batching of coarse aggregate the quantity of material as cement, sand, coarse aggregate, plastic aggregate required as per there proportion for the replacement of coarse aggregate by the plastic coarse aggregate of in the percentage of 0%, 5%, 7.5%, 10%.

we have six casted cubes for the compression test with weight batching of plastic aggregate. Containing the plastic aggregate if 0%, 5%, 7.5%, 10% And six beam of each proportion of plastic aggregate of 5%, 7.5%, 10% of using two number of 8mm GFRP bar at top and two bar at bottom of the beam named it Mix 2, Mix3, Mix4 respectively which shown in following table 2 with addition to this we have casted six beams which reinforced with 8 mm diameter TMT bars of two number as main reinforcement and two number as hanger bars with concrete containing 0% plastic aggregate and named it as mix 1 which mention in the table 2 As per standard we have use stirrups of 8mm TMT bar with spacing of 100mm in all the beams. The clear cover of 25mm is taken.

Tests conducted on these concretes include compressive strength and flexural tensile Tests were conducted test at the age of 7 and 28 days on 3 specimen of each proportion and the results at each testing age are reported as an average. The molds were coated with oil to ensure that no water escaped during filling and to prevent adhesion of concrete. Concrete casting was accomplished in three layers Each layer was compacted using a vibrating table for 1–15 min until no air bubbles emerged from the surface of the concrete mold.

3. MIX DESIGN

The mix was designed of concrete is made as per IS 10262:2009 for M30 grade concrete with 0.4 water cement ratio. Concrete mixes are prepared by partial replacement of natural Aggregates by plastic aggregates with different percentages (0%, 05%, 7.5%, 10%) respectively for every mix. The materials of each mix are given in table 1 for the casting of cube and in table 2 for the casting of beam.

Sr. No.	Mix	Cement (kg)	F.A. (kg)	N.C. A (kg)	P. A (kg)
01	Mix 1	10.11	15.4	30.00	00
02	Mix 2	10.11	15.4	28.50	1.50
03	Mix 3	10.11	15.4	27.75	2.25
04	Mix 4	10.11	15.4	27.00	3.00

Table 1. Mix Proportion for six cubes

Sr. No.	Mix	Cement (kg)	F.A. (kg)	N.C. A (kg)	P. A (kg)
01	Mix 1	13.96	18.48	37.00	00
02	Mix 2	13.96	18.48	35.10	1.90
03	Mix 3	13.96	18.48	34.30	2.80
04	Mix 4	13.96	18.48	33.30	3.70

Table 2. Mix Proportion for six cubes

4. TEST AND SPECIMAN

The sizes of mold as per is code and the placing of reinforcement in beam is mentioned below. Concrete is produced with all material as mention above and replacement of normal coarse aggregate by the 0%, 5%, 7.5% and 10% of HDPE plastic as coarse aggregate. Six cubes of each proportion are casted and tested at 7 days and 28 days. the size of one cube is 150 mm x 150 mm x 150 mm were cast in accordance to relevant standard for testing of compression test then the 6-beam of each proportion of size 100mm X 100mm X 500mm as per IS 516-1959 for the testing of flexural strength of Concrete.

5. MATERIALS AND PROPERTIES

5.1 Water

Portable tab water is used for preparation of specimens and curing of specimens.

5.2 Cement

we have used Ordinary Portland Cement grade 53 cement for preparation of the concrete. OPC – 53 grade cement is used to obtain higher strength with lesser quantity of cement content. cement of 53-grade was used as it satisfied the requirements

Initial setting time		25min.
Final setting time.		240min
Compressive strength	3days	32.3 N/mm^2
	7days	41.9 N/mm^2
	28days	59. 5 N/mm^2
Fineness (90umsieve)		1.7%
Standard consistency		31.5%

Table 3. Properties of cement

5.3 Fine aggregate (sand)

The aggregates passing through 4.75 mm is termed as fine aggregates. The Sand we used for experimental program was locally available river sand. The specific gravity of fine aggregate was found to be 2.638.

5.4 Coarse Aggregate

Coarse aggregates manly involving to the strength of the concrete. The coarse aggregate is Locally available and the size of aggregate is passing through 20 mm sieve as a same time retained in 12.5 mm sieve used in present work

Specific gravity	2.836
Water absorption	1.06%
Aggregate Impact value	12.4
Surface Moisture	Nil

Table 4. Properties of Coarse aggregate

5.5 TMT Bar (8mm)

8mm TMT steel bar of grade fe500 is use in the beam as main & distribution steel. And the stirrup used in beam is also made up of 8mm steel bar.

Density	7850 kg/m3
Ultimate Tensile Strength	545 N/mm2.
Yield Strength	500 N/mm2.
Young's Modulus of Elasticity	200 GPa
Percentage Elongation	>12

Table 5. Properties of 8mm TMT bar

5.6 GFRP Bar

An experimental Glass Fiber Reinforced Plastic (GFRP)has emerged as promising alternative to conventional steel with excellent results in terms of corrosion resistance.

Tensile strength (MPa)	>1000
Modulus of elasticity (GPa)	>60
Transverse Shear Strength (MPa)	220
Bond strength to concrete (MPa)	>20
Density (Kg/m3)	2100

Table 6. Properties of GFRP Bar

GFRP bars are usually composed of glass fibers reinforced with a thermosetting resin and manufactured using a pultrusion process. Its advantages include high longitudinal strength and tensile strength, high stiffness to weight ratio, resistance to corrosion and chemical attack, light weight, controllable thermal expansion and damping characteristics and electromagnetic neutrality.

5.7 Plastic Aggregate

we have use HDPE plastic as it gives high density, Light weight, Good chemical resistance, High tensile strength, Excellent rigidity, Low creep due to these properties' plastic is good replacement for the aggregate. It is used in a variety of applications. Plastic toys, liquid containers, milk and cream bottles, detergent and cleaner bottle and thousands of consumer goods are made out of HDPE.

Specific gravity	0.96
Water absorption	0.57
Tensile strength	27.58 N/mm2
Flexural modulus of elasticity	1379.31 N/mm2
Density	940 Kg/M3

Table 7. Properties of Plastic Aggregate

6 RESULTS AND DISCUSSION

6.1. Compressive Strength

The results for the compressive strength are shown in Fig. 7 and Table 4. The test was taken out conforming to IS 516-1959 to achieve compressive strength of concrete at the age of 7 days and 28 days.

The cubes were loaded and observed the data using Compression Testing Machine (CTM). The testing machine standard is based on ASTM. The testing machine is the digital compression testing machine of sufficient capacity for the tests and capable of applying the load at the rate specify.

The permissible error for calibration of testing machine shall be not greater than ± 2% of the maximum load. The specimen shall be placed in the machine in such a way that the load can applied to opposite sides of the cubes, as a same time not to the top and bottom and is shown in Fig. 3. The axis of the specimen shall be carefully arranged with center of the seated late; no need packing between the faces of the test specimen and the steel plate of the testing machine. The load should apply without shock.

Fig 3. Compression Testing Machin

Mix	Compressive Strength N/mm2	
	7 Days	28 Days
Conational Concrete	18.90	27.11
5% PCA	15.00	18.67
7.5% PCA	3.50	16.40
10% PCA	10.11	12.74

Table 8. Result of Compression test

The compressive strength is calculated from the failure load divided by the cross-sectional area resisting the load. The compressive strength results are given in above table. we can see that strength of concrete goes on decreasing as we increase the plastic aggregate in concrete the magnitude of maximum compressive strength was observed at 5% replacement. The compressive strength for samples content 5% of HDPE plastic is lower than the control but still acceptable because it reaches the target strength of M30 grade concrete at the end period of curing. For the samples content 7.5% of HDPE, the development of their strength is same as 10% but it does not reach the target strength at age 28 days.

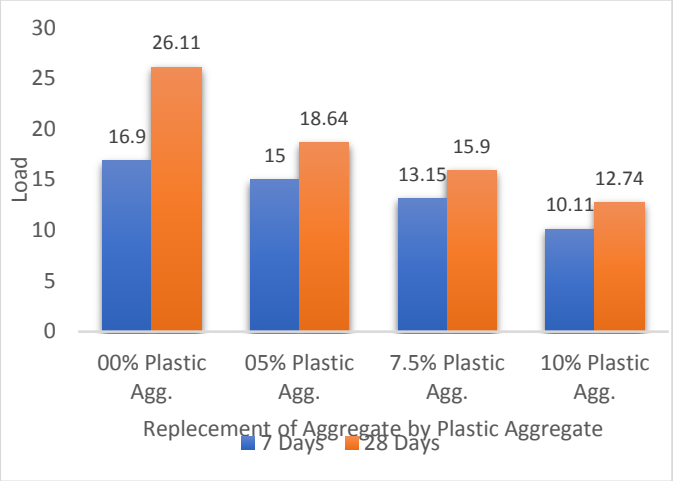

Fig 4. Graph of Compression test

From graph and table of result obtained by this experiment it is understood that this kind of concrete is not suitable for structural element. But this is suitable for Plain Cement Concrete (PCC) works like roadwork, pavement, floor slab etc. Hence, plastic aggregate can be used as an alternative in PCC works and hence, the plastic waste can be managed.

6.2. Flexural Strength

All the beams were cast and kept in a curing tank for 28 days. The beams of 500 mm length were simply supported with an effective span of 400 mm. one-point loads were applied at a center of the beams to create pure bending at the middle portion of the beams. A distribution beam was placed to the bottom end of the actuator for application of one-point loads on the concrete beam specimens. beams reinforced with TMT and GFRP bars with plastic aggregate under static loading.

The result obtains for this experiment the beams contain 8mm TMT bar and 0% PCA (Mix 1 in table) test results include crack initiation load and the corresponding deflection. the average crack imitation load is 18.80KN and corresponding deflection 5mm on 7 days testing. then after 28 Days the average crack imitation load for the beams is 27.50KN and average deflection is 5.50 mm.

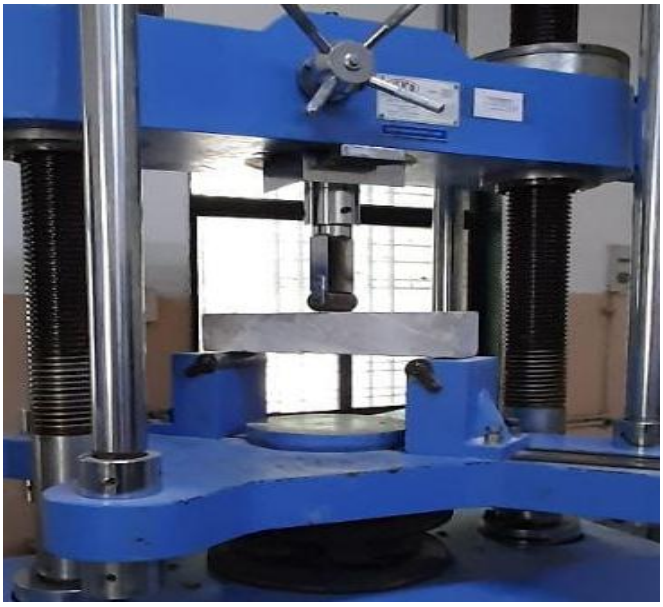

Fig 5. Graph of UTM Machine

The beams contain 8mm GFRP bar and 5% PCA (Mix 2 in table) test results show the average crack imitation load is 20KN and corresponding deflection 5mm on 7 days testing. then after 28 Days the average crack imitation load for the beams is 25.90KN and average deflection is 5.30 mm.

Specimen Name / Mix	Average crack initiation load 7 Days (KN)		Average crack initiation load 28 Days (KN)	
	Avg. Load (kg)	Deflection (mm)	Avg. Load (kg)	Deflection (mm)
Mix 1	18.80	5.0	27.70	5.5
Mix 2	20.00	5.0	25.90	5.3
Mix 3	14.70	4.0	18.20	4.0
Mix 4	13.80	4.0	17.80	4.0

Table 9. Result of Flexural strength test

The beams contain 8mm GFRP bar and 7.5% PCA (Mix 3 in table) test results show the average crack imitation load is 14.70KN and corresponding deflection 4mm on 7 days testing. then after 28 Days the average crack imitation load for the beams is 18.20KN and average deflection is 4.0 mm.

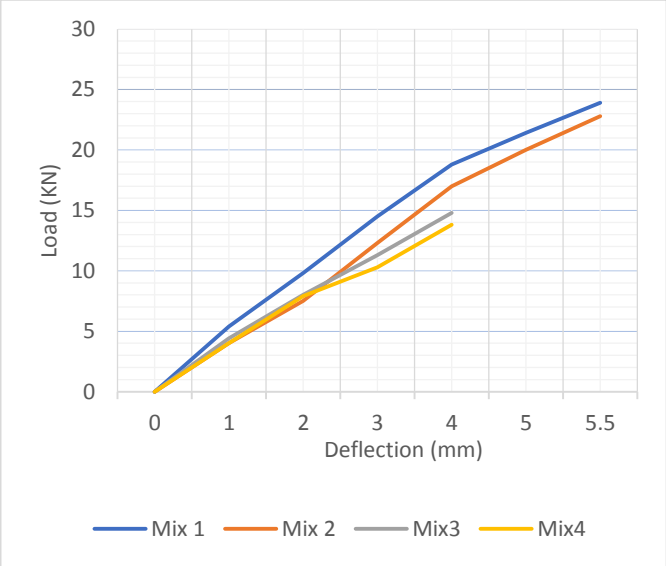

Fig 6. Graph of All Specimen

It was observed That the flexural strength of the concrete with the addition of recycled plastic aggregate is decreased linearly with the increasing plastic proportions and it was observed that the concrete made with 5% PCA have the flexural strengths ranging between 3.5 and 4.5 mpa.

7 CONCLUSIONS

1. The compressive strength of concrete is increased up to certain percentage (i.e., up to 5%) and then drastically decreases with an increase in the percentage of PCA.

2. For 5% plastic replacement in coarse aggregate, there is 27.5% reduction in compressive strength, for 7.5% replacement, there is compressive 36.4% reduction in strength and for 10% plastic replacement, there is 49.1% reduction in compressive strength.

3. Flexural strength of beam containing plastic aggregate is less than the strength of the normal concrete beam but that is up to the mark and can be acceptable.

4. We get maximum Flexural strength at beam contain 5% plastic aggregate but that strength is lesser then the beam which tested with normal concrete.

5. Flexural strength of beam goes on increasing up to the certain limit of replacement of PCA and after that adding of each percentage of plastic aggregate, we can clearly observe that there is drop down in the flexural strength of beam.

6. We can get the low-cost materials which would help to resolve some solid waste problems and reduce environment pollution by using this we can save the natural resources for some extend.

7. This type of partial replacement of plastic waste aggregate in coarse aggregate is suitable for PCC road works, pavement, floor slab and other non – structural members but should be avoided in load bearing structures.

8. From the above experimental results, it was analyzed that plastic can be used as an alternative material for coarse aggregate, thereby reducing coarse aggregate consumption and it is economical.

ACKNOWLEDGEMENT

This Seminar Project work has been carried out for the academic requirements of Dr. BATU University, Loner, for the completion of Masters in technology of Structural Engineering. I sincerely thanks to my guide Prof. R. S. PATIL (Prof. At Civil Dept.), Dr. G.R. GANDHE (HOD Civil Dept.), Dr. Ulhas Shiurkar (Principal and, Director of Deogiri Institute of Engineering and Management Studies, Aurangabad), for the guidance technical support and unending encouragement.

Last but not list I would like to thank my family member for their moral support, encouragement and for their love. I dedicate my work to each and every one of them.

REFERENCES

- Nur Hanis Zulkernain Utilization of plastic waste as aggregate in construction materials: A review
- Allan Manalo a,* , Ginghis Maranan a , Brahim Benmokrane b , Patrice Cousin b , Omar Alajarmeh a , Wahid Ferdous a , Ray Liang c , Gangarao Hota (2020):- Comparative durability of GFRP composite reinforcing bars in concrete and in simulated concrete environments
- Brahim Benmokrane a,⇑ , Salaheldin Mousa b,c , Khaled Mohamed d , Mahmoud Sayed-Ahmed (2020) :- Physical, mechanical, and durability characteristics of newly developed thermoplastic GFRP bars for reinforcing concrete structure
- S. Suriya a,⇑ , M. Madhan Kumar b (2020) : strength studies on FRC with partial replacement of plastic waste as coarse aggregate
- Ramachandra Murthy , ,Vishnuvardhan, Gandhi (2020) :- Performance of concrete beams reinforced with GFRP bars under monotonic loading

- Brahim Safi a,⇑ , Mohammed Saidi a , Djamila Aboutaleb a , Madani Maallem (2013) :- The use of plastic waste as fine aggregate in the self-compacting mortars: Effect on physical and mechanical properties
- T.S.J. Edmund et a, Sun Zhuowen and Pang – Waste plastic as partial replacement for aggregates
- E. Gudonis,1* R. Kacianauskas,2 V. Gribniak,1,2 A. Weber,3 R. Jakubovskis,:- mechanical properties of the bond between gfrp reinforcing bars and concrete
- Nur Liza Rahim1,a, Shamshinar Salehuddin1,b, Norlia Mohamad Ibrahim1,c Roshazita Che Amat1,d and Mohd Faizal Ab Jalil (2013):- use of Plastic Waste (High Density Polyethylene) In Concrete Mixture as Aggregate Replacement

BIOGRAPHIES.

Mr. Mahesh Bhagwanrao Shinde
M-TECH in Structural Engineering,
PG Student, Department of Civil Engineering.
Deogiri Institute of Engineering and Management Studies, Aurangabad.
Maharashtra, India
E-mail address:
Shindem11195@gmail.com