IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 13-18

Experimental Study on Use of Waste Plastic Aggregate as Partial Replacement of Conventional Course Aggregate

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Abstract: *Plastic waste is silent threat to the environment and their disposal is a serious issue for waste management. Various attempts were made through experimentation to check the feasibility of plastic waste to be use partially in concrete. In this research test were conducted to find out the properties of plastic aggregate such as crushing value, impact value, flakiness and elongation index, specific gravity, bulk density and voids. These properties of plastic aggregate were compared with the properties of natural aggregate. The compressive strength test, split tensile strength test and flexural strength test were performed. Effect of replacement of natural coarse aggregate with various percentages (0% to 40%) of plastic aggregate was studied. Behavior of concrete of M20 grade was experimentally investigated and the optimum percentage replacement of natural coarse aggregate was found out. It is found that the use of plastic aggregate results in the formation of light weight concrete. The compressive, tensile and flexural strength of concrete reduces with the increase of percentage of replacement of plastic aggregate.*

Keywords: *Plastic Aggregate, concrete, strength*

I. Introduction

Plastic waste is silent threat to the environment and their disposal is a serious issue for waste management. Now a day's society does not have any alternative to plastic products like plastic bags, plastic bottles, and plastic sheets etc. Instead of all efforts made to limit plastic use but unfortunately its utility is increasing day by day. To minimize this issue many efforts were made in the past to reuse the plastic waste but no significant results were achieved. If we can mixed plastic wastes with the concrete mass in some quantity or in some form, without affecting the fundamental and other properties or slight negotiation in strength the strength of concrete then we can consume large quantities of plastic waste by mixing it in the concrete mass as additive. However, concrete being the widely used construction material is facing problem due to unavailability of construction material (Cement, sand and coarse aggregate).This research work were based on to check the feasibility of plastic waste to be use partially in concrete with respect to various properties of strength, workability, and durability of concrete. The properties of plastic aggregate were compared with the properties of natural aggregate. Effect of replacement of conventional coarse aggregate with various percentages of plastic aggregate was study. We were try to find optimum percentage replacement of conventional coarse aggregate through this work.

II. Objectives

The main objective of this study is to evaluate the possibility of using plastic aggregate as coarse aggregate in concrete. Specific objectives of this work include

- To determine the properties of plastic aggregate.
- To conduct a comparative study of plastic aggregate and natural aggregate.
- To study the effect of replacing natural aggregate with plastic aggregate on workability, compressive strength, splitting tensile strength and flexural strength of concrete.
- To study the effect of replacing natural aggregate with plastic aggregate on weight of concrete.
- To find the optimum replacement of natural aggregate using plastic aggregate.

III. Methodology

In this work various tests carried out on both natural aggregate and plastic aggregate to determine the flakiness index, elongation index, crushing value, impact value, specific gravity, and bulk density. Also various test were performed on different ingredients of concrete as explain below.

2. 1. Material Properties

2.1.1. Cement

Cement used as a binding material in concrete. Development of design compressive strength within the specified period is the function of cement. In this work 53 grade of ordinary Portland pozolona cement properties are used confirming to code IS:12269-1987. The specific gravity of cement found in the laboratory is 3.14.

2.1.2. Aggregate

In this work fine aggregate passing through 4.75 mm IS sieve conforming to grading zone II of IS 383:1970 and .its specific gravity found to be as 2.6. Also crushed aggregate available from local sources with maximum size of 20 mm and conforming to IS2386:1963 (part I, II and III) was used as coarse aggregate. Specific gravity of coarse aggregate is found out as 2.65.

2.1.3. Water

For mixing and curing purpose Potable water was used in this experimental work.

2.1.4. Waste Plastic Aggregate

Waste plastic represents the discarded waste .The plastic aggregates were prepared from recycled HDPE sheets. Aggregate were prepared by crushing a recycled waste plastic sheets.

2.2. Experimental Testing

After performing all tests, a mix design was produced in accordance with the properties obtained from test results for M20 grade concrete. After mix design total fifteen cubes, beams and cylinders for M20 grade of concrete with five different volume percentages of plastic (0%,10%, 20%, 30%,40%) were cast as recommended by IS: 10262- 1982.Tests conducted on these concretes include the slump of fresh concrete. For the hardened concrete, compressive strength, split tensile strength, flexural strength was calculated for 28 days and the results of each testing age are recorded on an average. The engineering properties of the plastic aggregate were compared to the natural aggregate.

Table 1: Quantity of ingredient of concrete as per Mix Design

Proportion as per design 1:1.65:3.27					
Material	0%	10%	20%	30%	40%
Cement	8.38	8.38	8.38	8.38	8.38
Sand	11.42	11.42	11.42	11.42	11.42
Natural aggregate	19.08	17.16	15.26	13.35	11.44
Plastic aggregate	-	0.58	1.15	1.73	2.30
Total Aggregate	19.08	17.74	16.41	15.05	13.70

IV. Result and Discussion

3.1Result of test on natural and plastic aggregate

Table 2: Properties of Natural and Plastic Aggregate

Test	Natural Aggregate	Plastic Aggregate
Flakiness index	29.69 %	20.6 %
Elongation index	54.77 %	29.84 %
Specific gravity	2.65	0.92
Bulk density	2.2 kg/lit	0.664 kg/lit
Voids	16.98 %	25.39 %
Impact value	10.79 %	2.08 %
Crushing value	5.88 %	0.96 %

As per IS 383-1970 permissible limit of crushing value being up to 30%. Crushing value of natural aggregate is 5.88% and of plastic aggregate is 0.96%, which is within permissible limit. This shows that plastic aggregate have more compressive strength than natural aggregate. As per IS 2386 Part IV-1963 aggregate impact value shall not exceed 45%. Impact value of natural aggregate is 10.79% and of plastic aggregate is 2.08% which is within permissible limit. This shows that the plastic aggregate is more tough than the natural aggregate. Since plastic aggregate have crushing value and impact value within the permissible limit.. Flakiness and elongation index of plastic aggregate is within permissible limit. Therefore, natural aggregate can be replaced with plastic aggregate without change in its properties.

3.2. Result on Workability

In this work the workability was determined by the slump cone method and for every fresh mix the slump cone test was carried out. With the replacement of natural aggregate with plastic aggregate workability of concrete decreases. But with the more replacement of natural aggregate with plastic aggregate workability decreases noticeable as shown in graph.

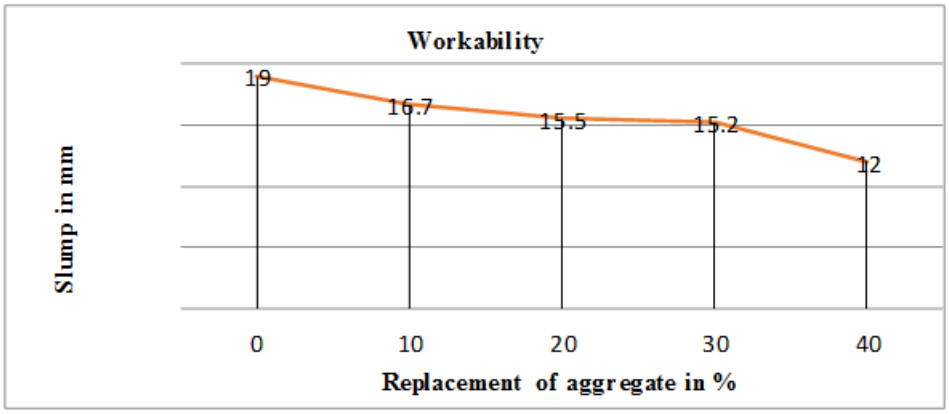

Figure 1: Comparison of Workability of Concrete

3.3. Result on Compressive strength of concrete

After the curing of concrete, specimen was removed from curing tank and the cubes were tested on compression testing machine to find compressive strength of concrete. In this work the average of three specimen compressive strength was estimated for all the mixes. From the result it is found that Compressive strength of concrete decreases with increase percentage of plastic aggregate. The maximum compressive strength is 19.93 MPa at 10 % replacement of natural aggregate with plastic aggregate.

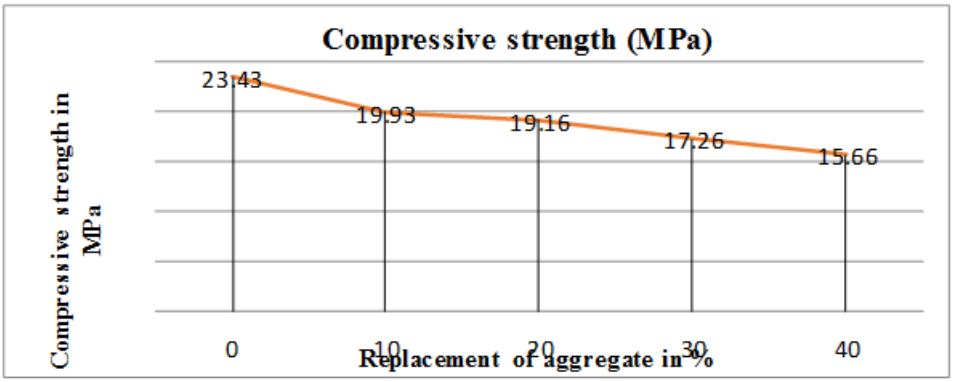

Figure 2: Comparison of compressive strength of concrete

3.4. Result on Density of concrete

In this work density of concrete is also work out .based on experimental result it is found that Maximum density of concrete is at 10 % replacement of plastic aggregate made from waste plastic. There is a gradual reduction in density of concrete by increasing percentage of replacement of plastic aggregate. Thus by introducing the plastic aggregate in concrete make it light weight.

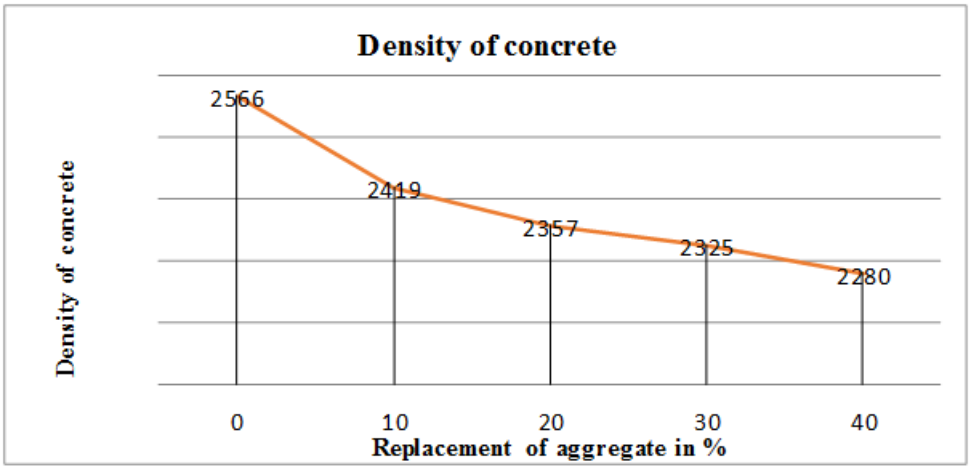

Figure 3: Comparison of Density of concrete

3.5. Result on Split Tensile Strength of Concrete

As we know that concrete is strong in compression and weak in tension hence it is necessary to find tensile strength of concrete. As there is no direct method to find tensile strength of concrete , split tension test is used . so in this work a cylinder of 100mm diameter and 300mm deep were casted and cured and then tested under UTM. From the graph as shown below it is found that the maximum split tensile strength is 9.04 MPa at 10 % replacement of natural aggregate with plastic aggregate. Also it is observed that Split tensile strength of concrete decreases with increase percentage of plastic aggregate.

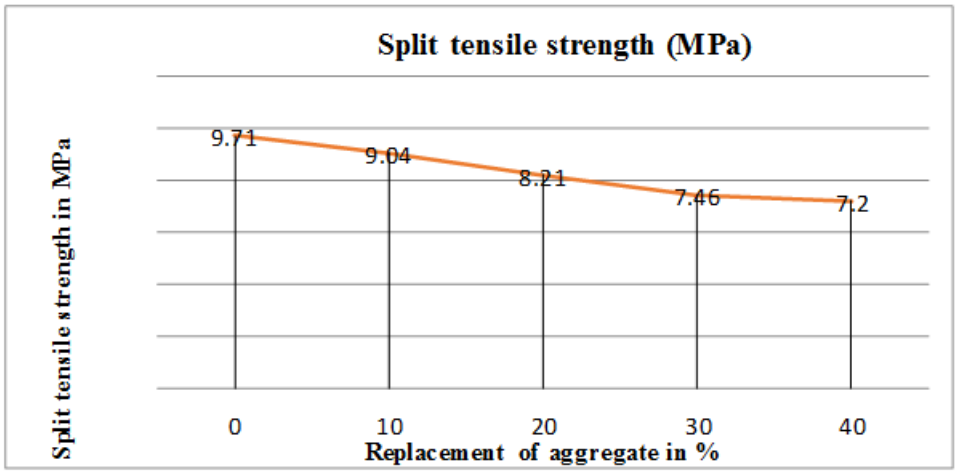

Figure 4: Comparison of split tensile strength of concrete

3.6. Result on Flexural Strength of Concrete

A beam specimen of size 100mmx100mmx500mm was casted and cured to find flexural strength of concrete. A specimen was tested on universal testing machine by applying two point load. From the result obtain a graph was plotted as shown in figure. From the result it is found that the maximum flexural strength is MPa at 10 % replacement of natural aggregate with plastic aggregate. Also Flexural strength of concrete decreases with increase percentage of plastic aggregate.

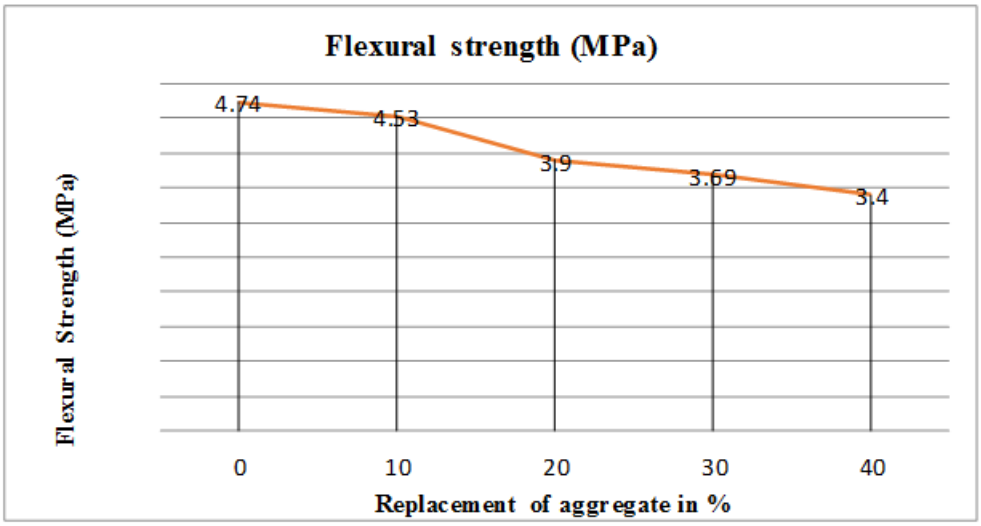

Figure 5: Comparison of split Flexural strength of concrete

V. Conclusion

A study was conducted to investigate the possibility of making plastic aggregate and using the aggregate made from plastic as a substitute for natural coarse aggregate in concrete. The present work is aimed at studying the strength and workability of concrete with partial replacement of natural aggregate by plastic aggregate. The study can be concluded as follows:

- This study show that partial replacement of natural coarse aggregate is possible. Since strength of concrete with plastic aggregate is approximately same as of concrete with natural coarse aggregate.
- Using plastic aggregate make the concrete light weight.
- Density of concrete decreases when plastic content is increased.
- The workability of concrete decreases by 35% for a mix containing 40% plastic aggregate.
- It was observed that compressive, split tensile and flexural strength further decreases with increase in percentage of replacement of plastic aggregate. This happened due to poor bonding between plastic and ingredient of concrete.
- The optimum percentage replacement of natural coarse aggregate using plastic aggregate was obtained as 10 % which give maximum compressive strength.

References

[1] Ankit Mathur, Akhil Choudhari, Parnika Singh Yadav and Mr. Krishna Murari. 'Experimental Study of Concrete using Combination of E-waste and Plastic Waste as Coarse Aggregate', *SSRG International Journal of Civil Engineering* – Volume 4 Issue 5 – May 2017

[2] Patil Hiteshkumar S, Baviskar Shrikant R, Dr Ahirrao Sarjerao P and Dr Amol B Saner. 'Polymer Concrete by Using Waste Plastic Granules', *International Journal of Innovative Research in Science, Engineering and Technology* Vol. 6, Issue 3, March 2017

[3] Mr. Govind,V. Dhanani, Mr. Priyank and D. Bhimani. 'Effect of Use Plastic Aggregates as Partial Replacement of Natural Aggregates in Concrete with Plastic Fibers', *International Journal of Recent Research Aspects* Vol. 2, Issue 3 2013, pp. 25-89

[4] Gaurav Verma1, Mohd. Afaque Khan and Mr Abhishek Kumar. 'Effect of Waste Plastic as Partial Replacement of Aggregate in Concrete Mixture', *Int. Journal of Engineering Research and Applications* Vol. 6, Issue 7, (Part - 1) 2016, pp.103-101

[5] M Mahesh, B Venkat Narsimha Rao and CH. Satya Sri. 'Re-Use of Polyethylene Plastic Waste in Concrete', *International Journal of Recent Research Aspects* Vol. 5, Issue 3, 2016, pp. 24-28

[6] Anju Ramesan et al. 'Performance of Light Weight Concrete with Plastic Aggregate', *International Journal of Engineering Research and Applications*, Volume 5, Issue 8, (Part - 5) August 2015, pp.105-110

[7] Kasib R.Malik. 'Use of Waste Plastic in Concrete Mixture as an Aggregate Replacement', *International Journal of Engineering, Education and Technology www.ardigitech.in*, Volume 3, Issue 2, April 2015

[8] S. Vanitha, V. Natrajan and M. Praba. 'Utilization of waste plastic as a partial replacement of a coarse aggregate in concrete block', *Indian Journal of Science and Technology*, Vol 8(12), June 2015

[9] Ahmed Abu Ishaiba, 'Mechanical Study on Concrete with Waste Plastic', *The Islamic University-Gaza Research and Postgraduate Affairs Faculty of Engineering Civil Engineering Department Design and Rehabilitation of Structures* 2015

[10] T.Subramani and V.K.Pugal et al. 'Experimental Study On Plastic Waste As A Coarse Aggregate For Structural Concrete', *International Journal of Engineering Research and Applications* Vol. 4, Issue 7, (Part - 3) 2015, pp.103-103

[11] Fahad K. Alqahtani1, Gurmel Ghataora, M. Iqbal Khan, Samir Dirar, Azzedine Kioul and Mansour Al-Otaibi. 'Lightweight Concrete Containing Recycled Plastic Aggregates', *International Journal of Engineering, Education and Technology*, Volume 4, Issue 2, 2015

[12] Daniel Yaw Osei. 'Experimental Investigation on Recycled Plastic as Aggregate in Concrete', *International Journal of Structure & Civil Engineering* Volume 3, Issue 2, May 2014

[13] Vishal Yadav et al. 'Study on Properties of Concrete Containing Recycled Plastic Aggregate', *International Journal of Recent Research Aspects*, Volume 1, Issue 3, December 2014, pp. 24-27

[14] Tomas U. Ganiron. 'Effect of Thermoplastic as Fine Aggregate to Concrete Mixture' *International Journal of Advanced Science and Technology*, Volume 62, (2014), pp.31-42
[15] Raghatate Atul M. 'Use of plastic in a concrete to improve its properties', *International Journal of Research in Civil Engineering, Architecture & Design* Volume 4, Issue 4, July 2014
[16] S. Gavela, C. Karakosta, C. Nydriotis, V. Kaselouri-Rigopoulou, et al. 'A study of concrete containing thermoplastic waste as a aggregate', *National Technical University of Athens, School of Chemical Engineering*, Volume 8 (1997) 47-52
[17] Ghassan Subhi Jameel. 'Study the Effect of Addition of Waste Plastic on Compressive and Tensile Strength of Structural Lightweight Concrete Containing Broken Bricks as a Coarse Aggregate', *International Journal of Research in Civil Engineering*, (2013), Volume 4, Issue 2, March-April 2013, pp.415-432
[18] J.N.S. Suryanarayana Raju & M. Senthil Pandian. 'Mechanical Study on Concrete with Waste Plastic', *International Journal of Research in Civil Engineering, Architecture & Design*, Volume 1, Issue 1, July-September, 2013, pp.62-67
[19] Dewanshu Ahlawat. 'Coconut Shell as Partial Replacement of Coarse Aggregate in Concrete', *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)* e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 61-64
[20] Praveen Mathew, Shibi Varghese, Thomas Paul, Eldho Varghese. 'Recycled Plastics as Coarse Aggregate', Structural Concrete *International Journal of Recent Research Aspects* Volume 2, Issue 3 2013, pp. 25-29
[21] Md. Mostafizur Rahman, Md. Akhtarul Islam and Mainuddin Ahmed. 'Recycling of Waste Polymeric Materials as a Partial Replacement for Aggregate in Concrete', *International Conference on Chemical, Environmental and Biological Sciences (ICCEBS'2012) Penang, Malaysia*
[22] Baboo Rai, S. Tabin Rushad, Bhavesh Kr and S. K. Duggal. 'Study of Waste Plastic Mix Concrete with Plasticizer', *International Scholarly Research Network ISRN Civil Engineering* Volume 2012, Article ID 469272, 5 pages doi:10.5402/2012/469272
[23] Dr. Prahallada M.C and Dr. Prakash K.B. 'Strength and Workability Characteristics of Waste Plastic Fiber Reinforced Concrete Produced from Recycled Aggregates', *International Journal of Engineering Research and Applications* Vol. 1, Issue 4, pp.1791-1802
[24] Madan Mohan Reddy. K, Ajitha. B and Bhavani R. 'Melt-Densified Post-Consumer Recycled Plastic Bags Used as Light Weight Aggregate in Concrete', *International Journal of Engineering Research and Applications* Vol. 2, Issue4, July-August 2012, pp.1097-1101
[25] Sabina, Tabrez A.Khan, Sangita, DK Sharma and BM Sharma. 'Performance evaluation of waste plastic modified bituminous concrete mixes', *Journal of Scientific & Industrial Results* Vol.68 November 2009, pp.975-979
[26] M.S Shetty. *Concrete Technology,* (S.Chand & Company Ltd. Ram Nagar New Delhi - 110 055)