Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 04, April -2018

INVESTIGATION AND COMPARISON OF MATERIAL PROPERTIES AND NORMAL CONCRETE WITH WASTE PLASTIC AGGREGATE AND REPLACED COARSE AGGREGATE CONCRETE

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Abstract: *For developing countries like Pakistan, waste disposal and management is one of the important issues which need to be addressed urgently. Today, in Pakistan a large quantity of waste accumulated in cities and towns. This is a big challenge for the government to safely dispose-off these waste so that to provide a good and healthy environment. Plastics are stable material and are not biodegradable material. Their open disposal creates problems in surrounding environment. In this scenario research studies are going on all over the world for the effective use of plastic waste as an addition and partial replacement of coarse aggregates in plain concrete and reinforced concrete as well for many reasons [1, 2]. This research study will help in contributing the effective utilization of plastic waste in RC concrete structural members in order to minimise the environmental pollution. Three types of concrete are made with 0%, 5% & 10% replacement of coarse aggregate with palletized coarse aggregate. The properties of materials were individually found out in laboratory & compared with plastic aggregates. The mix proportion is prepared on the basis of the properties of materials for concrete of 3000 psi compressive strength. The resulting reference concrete with all natural aggregates is then compared coarse aggregate replaced concretes for compressive strength & tensile strength. It was found that the compressive strength & tensile strength are reduced but the concrete can be used at places of low strength. This research also gave the basic data for effective utilization of plastic aggregate in concrete with basic guidelines.*

Keywords- *Plastic Aggregate Replacements; Compressive Strength; Tensile Strength;*

I. INTRODUCTION

The structure of plastic materials is primarily consisted of an unlimited set of polymers. While, a polymer is an organic macromolecule (which is a large molecule and based on mainly carbon) comprise of a No. of hundreds or even thousands of identical units which are called mars and these are connected jointly to form a chain. Every plastic material is unique and there are thousands types of plastic materials [3]. Pakistan has a recent population growth of approx.; 3.5% per annum and waste is averagely produced at a rate of 0.8 kg/cap/day. In the past decade, like the year 1996, as per census Pakistan recorded population of about 160 million people and 55000 tons of unwanted waste was formed on daily basis [4]. With the continuous increasing population of about 190 million people recorded in year 2014, 71000 tons of unwanted waste was produced on daily routines. However, the present population has increased up to 200 million people, in which the urban area get larger which is one of the reason of high quantity of waste production. This increasing quantity of unwanted solid waste is one of the big issues for government to preserve the cities clean and environment friendly.

In addition to increasing urban population, the other sources of plastic waste are commercial and industrial. The processing of waste material used in this research consists of collection, cleaning, washing, drying, sorting, size reduction, cutting, shredding, agglomeration and palletizing. Concrete is widely used as construction material in the world. The coarse aggregate typically account for 50 to 60% of the concrete volume. Plastic waste will not only resolve the issue of waste disposal but also help in sustainability of virgin aggregate for concrete. Some work has been done for determining the properties of concrete with recycled plastic aggregate in different countries, both developed & under developed. The research into plastic aggregate as concrete aggregate has been taken as pilot project by Eco-innovation Endeavour of the European Union.

Many forms of waste plastic such as polyethylene terephthalate (PET) bottle [4,5,6,7,8,9,10], polyvinyl chloride (PVC) pipe [11], high density polyethylene (HDPE) [12], thermosetting plastics [13], shredded plastic waste [14,15], expanded polystyrene foam (EPS) [16], glass reinforced plastic (GRP) [17] are used as aggregate addition and as a replacement in the preparation of cement mortar and concrete. The objective of the study are to advance the knowledge of behaviour of reinforced concrete with plastic waste as coarse aggregate & get results for its use with certain parameters and to help in reducing the scepticism related to use of new products especially reused plastic aggregate & help in environment sustainability in the with localized perspective.

For the purpose to achieve, material property of aggregates has been evaluated for normal & plastic aggregates. Fineness modulus, gradation & moisture content have been the properties to be checked for individual materials. A property of fresh & hardened concrete has been evaluated for slump, compressive & flexural strength. Concrete has been made with a specific mix proportion 1:2.54:3.85 (cement: sand: coarse aggregate) by volume based on the properties of aggregates for a desired compressive strength of 3 ksi. Three types of concrete have been made with 0%, 5% & 10% replacement of coarse aggregate with plastic aggregate.

II. METHODOLOGY

The materials used for research include Fine aggregate (Sand), Coarse aggregate (mountain quarry stones crushed in maximum size of ¾" max), Ordinary Portland cement, potable water at room temperature & palletized plastic aggregate. As the testing was performed in University of Engineering & Technology, Peshawar, Pakistan so good materials from the vicinity of the city were brought for concreting. The sand was procured from Nizampur area near Attock city, the coarse aggregate from Besai quarry in Khyber agency, & cement manufactured at a factory near Kohat city by the brand name as Kohat Cement. The palletized plastic aggregate were procured from Karachi city.

Material property of aggregates was evaluated for normal & plastic aggregates. Fineness modulus, specific gravity, gradation & moisture content were the properties to be checked for individual materials.

Property of fresh & hardened concrete was evaluated for slump, compressive & flexural strength. Concrete was made with a specific mix proportion 1:2.54:3.85 (cement: sand: coarse aggregate) by volume based on the properties of aggregates for a desired compressive strength of 3000 psi. The water cement ratio was calculated depending on the moisture content of materials. The slump of 1-4 in. was designed for achieving a stiff workable concrete. The same was regulated & maintained during concreting. For proper material mixing, machine mixing was used for concreting & for the current research half bag mixer machine (the mix batch materials was calculated on the basis of half bag cement with design mix proportion). The mixing was done by volume using a batching box of dimensions 1ft. x 1 ft. x 1.25 ft.

Three types of concrete were made with 0%, 5% & 10% replacement of coarse aggregate with plastic aggregate. The comparison between normal concrete & the others with plastic aggregate has been drawn.

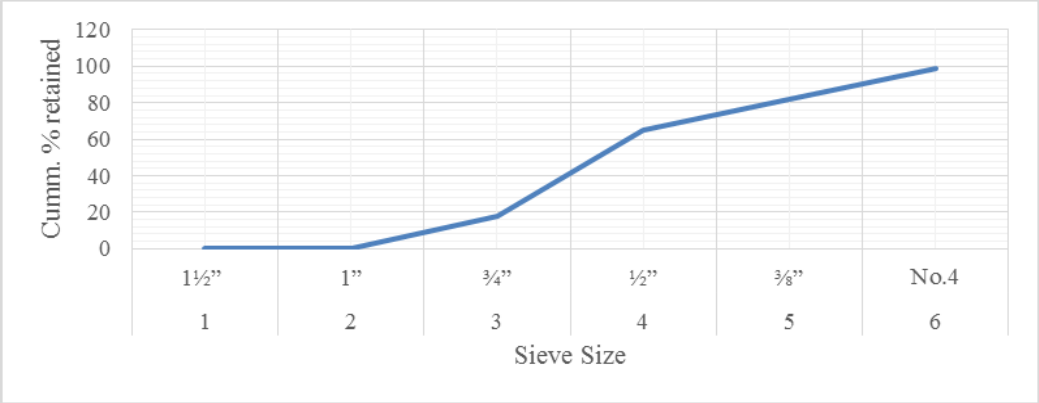
Slump test during concreting

Nine Concrete cylinders of size (12 in. length & 6 in. in diameter) for each type of concrete were casted, so twenty seven cylinders in total has been casted and tested. These cylinders were tested for each individual type of concrete as follows:

- 3 Concrete Cylinders: Split cylinder testing for tensile strength
- 3 Concrete Cylinders: Crushing test for compressive strength at 7 days
- 3 Concrete Cylinders: Crushing test for compressive strength at 28 days

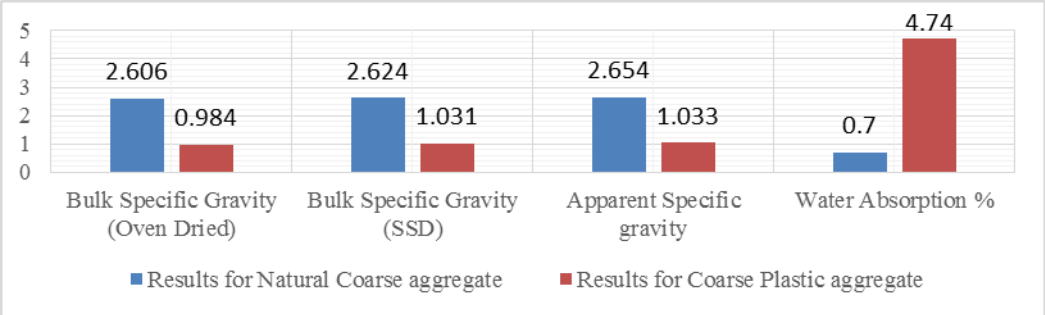
III. Results & Discussions

The Fineness modulus for sand came out be 2.44 as compared to the optimum value of 2.0 to 3.2. While the gradation curve of coarse aggregate is given below.



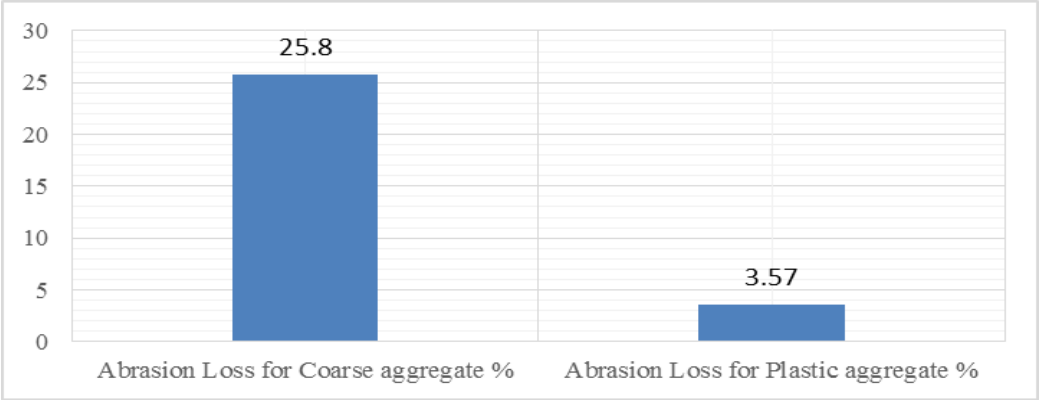
Gradation Curve of coarse aggregate

Other properties of aggregates compared with plastic aggregate are given below.



Comparison of properties of aggregates

Los Angeles abrasion values for the aggregates are given below.



Comparison of L.A abrasion loss

The Compressive & tensile test results for the control concrete were recorded as:

S. No.	Property/Test Description	Test Result (tons)	Test Result (psi)	Average (psi)
1	Cylindrical Compressive Strength for 7 Days	31.08	2422.80	2301.19
2		29.39	2291.21	
3		28.10	2190.58	
4	Cylindrical Compressive Strength for 28 Days	54.16	4222.17	4181.54
5		58.99	4598.95	
6		47.76	3723.49	
4	Split Cylinder Tensile Strength for 28 Days	20.15	392.66	403.78
5		21.95	427.70	
6		20.06	390.97	

Compressive and tensile test results of control concrete cylinders

The Compressive & tensile test results for the concrete with 5% coarse aggregate with waste plastic aggregate were recorded as:

S. No.	Property/Test Description	Test Result (tons)	Test Result (psi)	Average (psi)
1	Cylindrical Compressive Strength for 7 Days	24.16	1883.96	1794.5
2		23.02	1794.50	
3		21.87	1705.04	
4	Cylindrical Compressive Strength for 28 Days	37.3	2908.00	2941.78
5		37.8	2946.98	
6		38.1	2970.37	
7	Split Cylinder Tensile Strength for 28 Days	15.6	304.013	296.22
8		14.8	288.422	
9		15.2	296.218	

Compressive and tensile test results of 5% palletized aggregates used

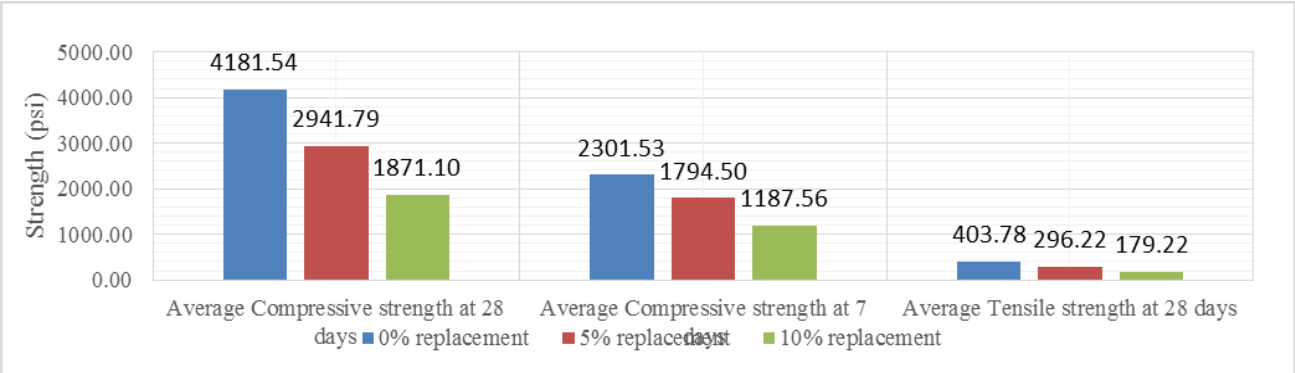
The Compressive & tensile test results for the concrete with 10% coarse aggregate with waste plastic aggregate were recorded as:

S. No.	Property/Test Description	Test Result (tons)	Test Result (psi)	Average (psi)
1	Cylindrical Compressive Strength for 7 Days	14.58	1136.69	1187.56
2		16.67	1299.83	
3		14.44	1126.17	
4	Cylindrical Compressive Strength for 28 Days	25.4	1980.25	1871.12
5		23.5	1832.19	
6		23.1	1800.93	
4	Split Cylinder Tensile Strength for 28 Days	10.7	208.52	179.22
5		7.1	138.36	
6		9.79	190.78	

Compressive and tensile test results of 10% palletized aggregates used

The comparison of averages of different strength of different type's concrete is given as:

Comparison of averages of different strengths of three types of concretes



IV. Conclusions

In the research work, coarse aggregates were replaced by palletized plastics in 5% and 10% maximum and the properties of resulting concrete were investigated and compared with the control concrete having zero palletized aggregates.

The average cylindrical compressive strength for 28 days with 5% replacement of palletized aggregate is decreased by 30% while that of 10% replacement is decreased by 55% as compared to average cylindrical compressive strength of Concrete with zero replacement. While the average split cylindrical tensile strength of 5% replacement of natural aggregate is 27% less and that of 10% replacement for coarse aggregate is 56% less than the average split cylindrical tensile strength of control concrete with 0% replacement.

No additional advantage is found with replacement of plastic aggregate with palletized plastic aggregate. It is concluded that if the plastic aggregate is used for utilization of waste plastic for sustainability of environment in structural element like beams the sections & reinforcement may be selected so as to counter the decreased capacity. The concrete may be used at places of low demand.

REFERENCES

1. Sivaraja, M., Kandasamy, S., & Thirumurugan, A. (2010). Mechanical strength of fibrous concrete with waste rural materials.
2. Sivaraja, M., & Kandasamy, S. (2007). Reinforced concrete beams with rural composites under cyclic loading. *Journal of Engineering and Applied Sciences*, *2*(11), 1620-1626.
3. Muccio, E. A. (1994). *Plastics processing technology*. ASM international.
4. Crawford, R. J. (1998). *Plastics engineering*. Butterworth-Heinemann.
5. "www.wikipedia.org," July 2017. [Online].
6. "Japan International Cooperation Agency (JICA), Pakistan Environmental Protection Agency (Pak-EPA) Guidelines for solid waste management," 2005.
7. Masood, M., Barlow, C. Y., & Wilson, D. C. (2014). An assessment of the current municipal solid waste management system in Lahore, Pakistan. *Waste Management & Research*, *32*(9), 834-847.
8. Siddique, R., Khatib, J., & Kaur, I. (2008). Use of recycled plastic in concrete: a review. *Waste management*, *28*(10), 1835-1852.
9. Akçaözoğlu, S., Atiş, C. D., & Akçaözoğlu, K. (2010). An investigation on the use of shredded waste PET bottles as aggregate in lightweight concrete. *Waste management*, *30*(2), 285-290.
10. Albano, C., Camacho, N., Hernandez, M., Matheus, A., & Gutierrez, A. (2009). Influence of content and particle size of waste pet bottles on concrete behavior at different w/c ratios. *Waste Management*, *29*(10), 2707-2716.
11. Choi, Y. W., Moon, D. J., Chung, J. S., & Cho, S. K. (2005). Effects of waste PET bottles aggregate on the properties of concrete. *Cement and concrete research*, *35*(4), 776-781.
12. Choi, Y. W., Moon, D. J., Kim, Y. J., & Lachemi, M. (2009). Characteristics of mortar and concrete containing fine aggregate manufactured from recycled waste polyethylene terephthalate bottles. *Construction and Building Materials*, *23*(8), 2829-2835.
13. Kim, S. B., Yi, N. H., Kim, H. Y., Kim, J. H. J., & Song, Y. C. (2010). Material and structural performance evaluation of recycled PET fiber reinforced concrete. *Cement and concrete composites*, *32*(3), 232-240.
14. Marzouk, O. Y., Dheilly, R. M., & Queneudec, M. (2007). Valorization of post-consumer waste plastic in cementitious concrete composites. *Waste management*, *27*(2), 310-318.
15. Yesilata, B., Isıker, Y., & Turgut, P. (2009). Thermal insulation enhancement in concretes by adding waste PET and rubber pieces. *Construction and Building Materials*, *23*(5), 1878-1882.
16. Kou, S. C., Lee, G., Poon, C. S., & Lai, W. L. (2009). Properties of lightweight aggregate concrete prepared with PVC granules derived from scraped PVC pipes. *Waste Management*, *29*(2), 621-628.
17. Naik, T. R., Singh, S. S., Huber, C. O., & Brodersen, B. S. (1996). Use of post-consumer waste plastics in cement-based composites. *Cement and concrete research*, *26*(10), 1489-1492.

