REUSE OF PLASTIC WASTE AS A REPLACEMENT OF SAND IN CONCRETE

*L.Ashwini[1], D.Jayaseelan[2],
[1], *PG Student, Department of Structural Engineering, Global Institute of Engineering and Technology, Vellore, India*
[2],*Assistant Professor, Department of Structural Engineering, Global Institute of Engineering and Technology, Vellore, India*

Abstract: In the present scenario the construction cost as scarcity of sand is increasing day by day in order to counteract this problem, sand is partially replace by plastic waste material. Plastic waste is recycled for the production of new material which can be used as alternative component in concrete and is on of the best solution for disposing of plastic waste. Also this technique proves to be highly cost effective than conventional method. This project deals with the possibility of using the waste PET, PP bottles as the partial replacement of aggregate in cement. In this research paper a little try is to use the waste plastic crushed bottles of appropriate size in concrete with partial replacement of fine aggregates and it has the potential of disposing off large quantities of the catastrophic waste in a beneficial way. The environmental effects can be substantially reduced by proper encapsulation of these waste plastic bottles. The concrete specimens were tested for 3, 7 and 28days. The study also gives the comparison of compressive strength of normal conventional concrete with the concrete made from the partial substitution of aggregates with Plastic waste material.

Keywords: Plastic Waste bottles, Polypropylene, etc..,

I.Introduction

Concrete, one of the most common construction materials, requires a large amount of natural resources and energy. Natural resources used in concrete mixtures include lime stone, clay, sand, natural gravel, crushed stone, and water. With the rapid development in urban areas around the world in the recent years, our natural resources are depleting in an ever-increasing rate. Therefore, it is necessary to develop a new material that consumes less natural resources and energy in order to make our construction methods more sustainable.

The use of waste products in concrete helps in its disposal and it also make economical. Reuse of these wastes in bulk quantity is considered as the best environmental alternative for solving the problem of disposal. Among different waste fractions, plastic waste deserves special attention on account non-biodegradable property which is creating a lot of problems in the environment. In India approximately 40 million tons of solid waste is produced annually. This is increasing at a rate of 1.5 to 2% every year. Plastics constitute 12.3% of total waste produced most of which is from discarded water bottles. We have used plastic waste (polyethylene tere phthalate), such as bottles, bags etc…

Disposal of plastics waste in an environment is considered to be a big problem due to its very low biodegradability and presence in large quantities. In recent time use of such, Industrial wastes from polypropylene (PP) and polyethylene terephthalate (PET) were studied as alternative replacements of a part of the conventional aggregates of concrete. If plastic wastes can be mixed with the concrete mass in some quantity or in some form , without affecting the fundamental and other properties or slight negotiation in strength of concrete. Due to which we can consume large quantities of plastic waste by mixing it in the concrete masses additive.

II.REVIEW OF LITERATURE

Bakri et al., in 2007, worked on the effects of HDPE plastic waste aggregate on the properties of concrete, and carried out tests on Compressive Strength, Flexural Strength, Water absorption, Analysis DSC and Slump test and found that the compressive strength was measured after 28 days of curing and it was found that the PC is suitable for nonstructural usage. As for cost analysis, the results showed that the Polymer Concrete was more cost effective than conventional concrete.

Raghatate atul m. has done research on "Use of Plastic in a Concrete to Improve Its Properties". Plastic bags which are commonly used for packing, carrying vegetables, meat etc. creates a serious environmental problem. Plastic bag last in environment up to 1000 years because of plastic bag last so long the number of plastic bag accumulated increases each year. Disposal of large quantity of plastic bag may cause pollution of land, water bodies and air. The proposed concrete which is made up by adding plastic in concrete may help to reuse the plastic bag as one of the constituent's material of concrete, to improve the certain properties of concrete. The properties of concrete containing varying percentages of plastic were tested for compressive.Strength and Split tensile strength and shows that an appreciable improvement in tensile strength of concrete can be achieved by introducing cut pieces of plastic bags.

Shivam Nema, Ibrahim Asi has done research on "Reuse of selected waste materials in concrete mixes". A modern lifestyle, alongside the advancement of technology has led to an increase in the amount and type of waste being generated, leading to a waste disposal crisis. This study tackles the problem of the waste that is generated from construction fields, such as demolished concrete, glass, and plastic. In order to dispose of or at least reduce the accumulation of certain kinds of waste, it has been suggested to reuse some of these waste materials to substitute a percentage of the primary materials used in the ordinary Portland cement concrete (OPC). The waste materials considered to be recycled in this study consist of glass, plastics, and demolished concrete. Such recycling not only helps conserve natural resources, but also helps solve a growing waste disposal crisis. The waste materials considered to be recycled in this study consist of glass, plastics, and demolished concrete. Such recycling not only helps conserve natural resources, but also helps solve a growing waste disposal crisis. Ground plastics and glass were used to replace up to 20% of fine aggregates in concrete mixes, while crushed concrete was used to replace up to 20% of coarse aggregates. To evaluate these replacements on the properties of the OPC mixes, a number of laboratory tests were carried out. The researchers concluded that the tests carried out in this study were primarily designed to provide an indication of relative advantages and disadvantages of the use of a number of construction wastes, such as crushed concrete waste, plastics, and glass. This would provide an overview of the reuse of construction waste materials in the construction industry.

Chowdhury.et.al (2013), have observed PET fiber reinforced concrete offers less compression strength and flexural rigidity than conventional concrete but it offers high ductility thereby increasing deforming capability of the concrete.Lopez.et.al.(2013), found, on use of Recycled PET fibers, a good performance of the PET fibers, especially in the case of continuous fibers, which were able to greatly increase the concrete properties.

Naik et al., (1996) researched on use of post-consumer waste plastics in cement-based composites, and carried out chemical treatments, Compressive Strength tests, Splitting Tensile Strength tests and came with the result that, on application of plastic High Density Polyethene.

F.J.Baldenebro-Lopez,al.(2014),

researched on "Influence of continuous plastic fibers reinforcement arrangement in concrete strengthened" and found a better performance of the continuous PET fiber reinforcement than that of the short, discontinuous one; the continuous PET samples presented a great increase in the concrete properties in 150% of the maximum load in bending.

Pai and Chandra (2013), carried out tests on Compressive Strength and Ultrasonic Pulse Velocity (UPV Test) and observed that with the use of fiber fire resistance property of concrete can increased significantly.Nibudey.et.al. (2013), performed several design concrete mixes with different percentages (0 % to 3 %) of waste plastic fibers and observed the improvement in mechanical properties of concrete (HDPE) in Concrete mix, it enhanced the compressive strength and tensile strength too.Oliveira. Et al., in 2011, carried out research on Physical and mechanical behavior of recycled PET fiber reinforced mortar following the experiments found that, by adding fraction of PET bottle in dry mix mortar about 0.5%, 1.0% and 1.5%, it significantly improved the flexural strength of mortars with a major improvement in mortar toughness. The maximum volume of PET fiber for a desired workability was 1.5%. **Irwan.et.al.** (2014), worked on "A comparative study on compressive and tensile strength of recycled ring waste pet bottle (RPET) fiber" and found ultimate tensile strength of RPET concretes were greater as compared to normal concrete. This has increased the fast vanishing of natural resources. It could be worth experimenting to use non-recyclable plastic bags in concrete to overcome the dual issue of shortage of raw material and safe disposal of leftover plastic to environment. This paper presents a comparative study of compressive strength of concrete made by mixing of plastic bags as concrete constituent.

III. METHODOLOGY

Finding out the by products from industries

↓

Finding the material having properties similar to cement properties

↓

Comparison and proportioning of materials

Testing of mixture such as consistency, initial and final setting time etc,..

↓

Casting of cubes, beams and cylinder for compression ,tension and flexural

Testing of samples for 7, 14 and 28 days along with conventional samples

↓

Comparison of results with conventional concrete

VI. PRELIMINARY TEST ON MATERIALS

1. cement: Ordinary Portland cement of 53grade [IS: 12269 – 1987] specifications for 53 grade OPC is used. Table 1

Physical Properties	Test Results
Specific Gravity(G)	2.60
Consistency	30%
Initial Setting time	112min
Final Setting time	125min

2.plastic waste: Waste plastic bottles like polypropylene. Table 2:

Physical Properties	Test results
Thickness	53microns
Density	1.4gm/cc
Type	Polyethylene terephthalate, poly propylene

Fig.4.1 plastic waste

3.Fine aggregate: River sand belongs to zone II. Table 3:

Properties	
Specific Gravity(G)	2.75
Water absorption%	1.20%
Fineness modulus	1.66

4.Coarse aggregate: Table 4

Properties	
Specific Gravity(G)	3.10
Impact Value(%)	30.73
Moisture content	0.1

VI. Mix Design and Batching:

Designed a mix for M25 grade concrete for the following data,

a) Grade designation : M25
b) Type of cement : OPC 53 grade
c) Cement content : 300kg/m^3
d) Water cement ratio : 0.40
e) Method of Placing : Manual
f) Degree of supervision : good
g) Type of aggregate : fine

vii. Fresh concrete Tests:

I. Slump cone test:

These tests measures the consistency of fresh concrete and also check the workability of the fresh concrete. Slump value for cement mixed concrete is 84mm and mixture mixed concrete is 79mm. Hence it is good workable condition for beams and columns.

ii.Compaction factor test:

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959.Compaction factor value is 0.98.The degree of workability of fresh concrete is medium.

viii. Tests on Harden concrete:

I. Compression Test:

The strength compressive strength of concrete cubes were tested of size 150mmx150mmx150mm for different proportion of replacement. And at the end of tests the results were compared with conventional concrete to check the strength obtained. Table 5

Plastic %	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
0%	18.34	25.54	30.08
5%	18.20	25.32	30.00
10%	18.20	25.15	29.75
15%	17.07	24.73	29.14

ii. split-tensile test:

The split tensile test is conducted to find the strength of concrete in tension. For the testing of concrete, samples of different proportions are casted of 10cm in diameter and 20cm in length of a cylinder. Table 6

Plastic %	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
0%	1.62	2.16	3.33
5%	1.53	2.08	3.21
10	1.15	1.80	3.18
45%	1.08	1.64	3.07

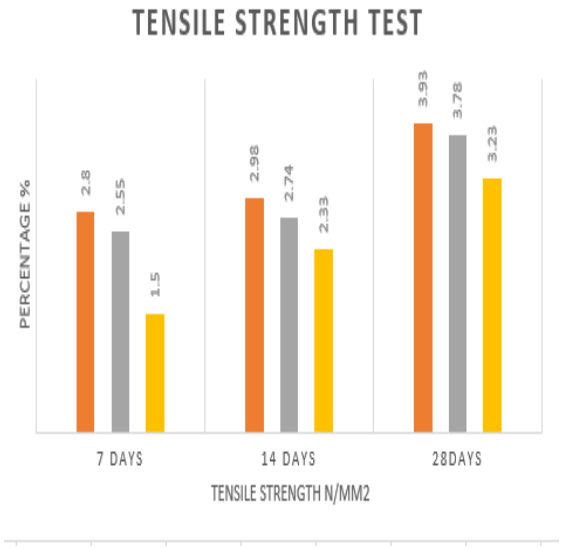

fig 5.2: tensile test

iii. Flexural strength test: Table 7

Plastic %	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
0%	0.145	0.234	0.278
5%	0.139	0.228	0.270
10%	0.130	0.224	0.265
15%	0.128	0.220	0.260

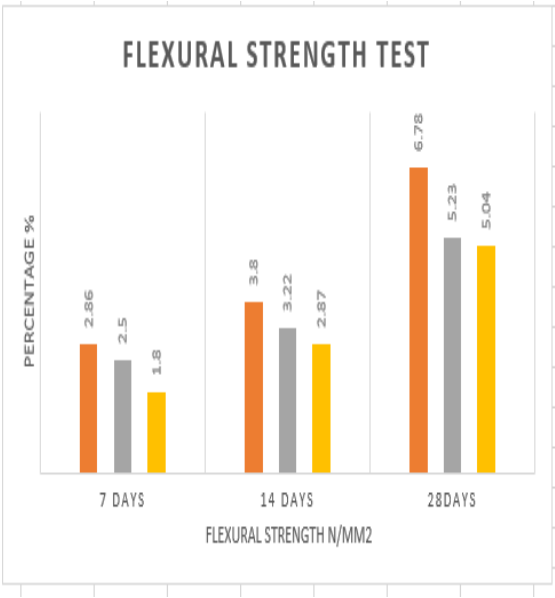

fig 5.2:flexural strength test

VI. Durability test:

1. Acid Attack (H_2SO_4)
2. Chloride Attack (NaCl)
3. Sulphate Attack ($MgSO_4$)

Weight reduction after acid attack.
Table 8:

Samples	Initial weight (kg)	Weight after acid attack (kg)	Weight reduction (%)
1	6.85	6.50	4.65
2	6.80	6.38	5.10
3	6.90	6.36	5.15
4	6.84	6.18	7.31

Weight reduction after chloride attack
Table 9:

Samples	Initial weight (kg)	Weight after chloride attack (kg)	Weight reduction (%)
1	6.78	6.75	0.14
2	6.76	6.75	0.16
3	6.78	6.75	0.26
4	6.87	6.86	0.97

Weight reduction after sulphate attack
Table 10:

Samples	Initial weight (kg)	Weight after sulphate attack (kg)	Weight reduction (%)
1	6.78	6.76	0.11
2	6.55	6.44	0.12
3	6.82	6.80	0.18
4	6.75	6.72	1.0

IX. Conclusion

The experimental investigations were carried out. From the study the conclusions are drawn.

From the observation of mix proportions, M25 grade it have been concluded that partially replacement of plastic waste have more strength. Uniformity of all specimens with plastic waste good category like sand specimens as per IS1331/1.The workability of concrete was found to increase with the increase in percentage of plastic in concrete.We can attain the strength by replacing sand and adding of plastic waste as 0%, to 20%. The use of waste plastic in concrete is relatively new development in the world of concrete technology and this research must prove that the replacement of plastic waste in concrete is possible as natural river sand. Reuse of plastic waste as replacement of sand in concrete" can be conveniently used as an alternative research to the convectional concrete in the construction industry.

X. References

[1] Baboo Rai, S. TabinRushad, Bhavesh Kr, and S.K.Duggal Of study of waste plastic mix concrete with plasticizer, National Institute of Technology Patna, Patna 800005,India, International Scholarly Research Network ISRN Civil Engineering Volume 2012,article ID 469272,5 pages.

[2] G Sarangapani, H S Suresh Chandra and B G Nareshkumar of Waste Plastic Concrete blocks N.I.E., Mysore, India, Journal of civil Engineering Technology and Research, Volume 2, Number (2014), pp. 249-257.

[3 IbrrahimShehataa, ShaharamVarzavand, Ahmed Elsawy, and Mohammed Fahmy Of The use of solid waste materials as fine aggregate substitute in cementations concrete compositions , University of Northen Iowa, Cedar falls , Iowa 50614-0178 21St August 2014.

[4] J.N.S. Suryanarayana Raju , M.Senthil Pandian Of Mechanical study on concrete with waste plastic , VIT University , Chennai , India, International Journal of Research in civil engineering , Architecture and Design Volume 1, Issue 1 , July September,2013,pp62-67, ISSN Print 2347-8284.

[5] J.M. Irwan, S.K.faisal , N.Othman , Wan Ibrahim M.H, R.M. Ashraf and M.M.K. Anna's, of Performance of concrete using Light Waste PET Fiber , University Ton Hussein On Malaysia, Advanced Materials Research Voi.. 795(2013) pp. 352-355.

6] Khileshsarwe, of Study of strength property of concrete using waste plastics and steel fiber, Jabalpur Engineering College, Jabalpur, India. International Journal of Engineering and Science (IJES) Volume 3, Issue 5, PP 09-11, 2014, ISSN: 2319-1813.

[7] M.Elzafraney, P.Soroushian and M.Deru of Development of Energy – Efficient Concrete Buildings Using Recycled Plastic aggregates, Journal of Architectural Engineering ASCE/DECEMBER 2005.

[8] Madan mohanreddy .K , Ajitha .B. and bhavani .R , of Melt densified Post-consumer Recycled Plastic Bags Used As Light Weight Aggregate In Concrete, Srikalahasteeswara Institute of Technology , Srikalahasti , AP , India – 517640 , Volume 2 , Issue , July –August 2012, pp. 1097-1101.

[9] MalekBatayin s nech, Iqbal Marie, Ibrahim Asi, of Use selected waste materials concrete mixes , The Hashemite university , Zarka 13115, Jordan, Science direct , waste management 27(2007) 1870-1876..

[10] Md.MostafizurRahman, Md. Akhtarul Islam, mainuddin Ahmed and Md. AbdusSalam, of Recycled Polymer materials as aggregates for concrete and blocks, Shahajalal University of Science and technology (SUST) , Sylhet-3114, Bangladesh, Journal of chemical Engineering IEB Volume, Che.27, No.1, June, 2012.