International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 02 Issue: 01 | Apr-2015 www.irjet.net p-ISSN: 2395-0072

Replacement of Natural Sand in Concrete by Polyethylene Bottles

[1]Sahil Verma, [2]Sahil Arora

[1] Assistant Professor, Civil Engineering, KCET, Punjab, India
[2] Assistant Professor, Civil Engineering, CU, Punjab, India

……***……

Abstract- *Presently a lot of attention has been taken on waste plastic materials which are generated in huge amount in all over the world. The main problem is disposal of waste plastic material. 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 study also gives the comparison of compressive strength of normal conventional concrete with the concrete made from the partial substitution of aggregates with Polyethylene Terephthalate bottles.*

Key words: *PET, Load, Strength, Concrete, Coarse Aggregates, Fine Aggregates*

1. INTRODUCTION

Plastic is one of the materials showing immense potential in our daily lives as it posses low density, high strength, user friendly designs, fabrication capabilities, long life, light weight and low cost characteristics are the factors behind such extraordinary growth. Although, plastics have been used in very large and useful applications, it bestows to an ever increasing amount in the solid waste stream. In the plastics waste, polyethylene forms the largest fraction, which is followed by Polyethylene terephthalate (PET) that represents one of the most common plastics in solid urban waste. In field of concrete technology India as well as other nation now is seeking for alternative for conventional aggregate that may be recognized as use plastic waste, for it might be realized as PET phase capacities. As per the estimates, India produces 500,000 tons of pet waste every year and due to increasing use of pet bottles in daily Consumption, the amount of waste is going to grow by leaps and bounds. At present, the total recycling capacity in India is around 145,000 TPA, out of which Reliance Industries Ltd. has a capacity of 42,000 TPA and Kanpur-based Ganesh Polytex Ltd (GPL) has a capacity of around 39,600 TPA and rest is with other small local players As such quantity of waste need to have large area of landfill to dump it, its use in concrete mix will prove a better option for land fill that, being non-degradable, remain for long years and cause problem before us. Concrete is the most widely used construction material in the world due to its high compressive strength, long service life, and low cost. Nowadays, unfortunately, the recycling rate of PET bottles is much less than the sales of virgin PET production for common uses. This gap is dramatically increasing, pushing towards finding a solution of this problem and a higher recycle of PET. Particular interest is stirring, at present, the use of fibers obtained from waste PET bottles. A possible application is to utilize waste PET fibers as replacement of fine aggregates in concrete. In this research experiment has been performed by taking the specified mix ratio 1:1.5:3 (M25), as per IS code 456.

2. OBJECTIVES-

2.1. To study the properties of PET.
2.2 To study the effect of PET over the compressive strength of concrete
2.3 To compare the strength of PET mix concrete with conventional mix concrete.

3. LITRETURE REVIEW

According to Chan et.al. (1999), the major degradation of the mechanical strength of concrete occurs at the stage between 950 and 1200° C, concrete becomes a consolidated

material and so experimented for three types of plastic waste aggregates, including coarse and fine particles, and studied two replacement ratios (7.5% and 15%), reach out with results that fire behavior of concrete is strongly influenced by its water content and its evaporation results in an increase of its volume which, due to being confined to concrete pores, causes internal pressures that can lead to cracking and to spelling of the surface layer of concrete.

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.

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.

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%. In the same year,

Vytlacilova worked for same and found similar result that reinforced concrete with the use of plastic waste give reliable result.

Pelisser.et.al. (2012) experimented on use of PET fiber in concrete and had got that, at 28 days, the concrete flexural toughness and impact resistance increased with the presence of PET fibers, except for the 0.05 % volume sample and no significant effect of the fiber addition on the compressive strength and modulus of elasticity were observed.And also show that an increase in porosity has occurred at 365 days for the fiber reinforced concrete, as determined by MIP (mercury intrusion porositimetry).

K.Ramadevi and Ms. R. Manju (2012), also worked on fibre concrete and result got revealed an increase in compression and tensile strength.

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.

Lopez1 et 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.

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.

Jose and Balasubramanian (2014), investigated the effect of waste polyethene as concrete mix design component and compared the compressive strength with conventional concrete mix cube.

4. Materials and Methodology

4.1 Cement:

The cement used for this experiment is OPC (43Grade) Conforming to IS 8112-1982 and has the following properties which have been experimentally determined at the time of use:

Type and grade	Ordinary Portland cement G-43
Specific gravity	3.15
Bulk density	1450 kg/m^3
Initial Setting time	30 min
Final Setting time	600 min
Soundness	Expansion 5mm

Table 1: Properties of cement used.

4.2 Aggregates:

The size of the aggregate, particle shape, color, surface texture, density (heavyweight or lightweight), impurities, all of which have an influence on the durability of concrete, should conform to IS: 383–1970. The size of coarse aggregates used are 20mm and that of fine aggregates are of ZONE-II as given

Aggregates	Fine aggregates	coarse aggregates
Type	River sand (Zone II)	Crushed granite
Maximum nominal size	—	20mm
Specific gravity	2.60	2.65
Bulk density (kg/m^3)	1700	1800
Fineness modulus	2.3	6.0
Free surface moisture (%)	2.0	1.0

4.3 PET Fiber:

The polyethylene (PET) bottle which can easily be obtained from the environment with almost no cost is chopped and added into ordinary concrete to examine the strength behavior of various specimens. Thermal insulation enhancement in concretes by adding waste PET and rubber pieces can also be studied. Also the plastic waste is found to have no water absorption (based on literature) and hence corrosion control analysis can be done. The products which are aimed in this project really have a commercial value since there is a need for alternate materials for construction owing to the rapid depletion of the natural resources. The properties of PET are as follows:

Sr.No.	Coefficient of friction	0.2 -0.4
1	Hardness – Rockwell	M94-101
2	Poisson's ratio	0.37-0.44
3	Tensile modulus	2-4 GPa
4	Tensile Strength	80
5	Density (g.cm3)	1.3-1.4 g.cm^3
6	Water absorption equilibrium	<0.7 %
7	Water absorption over 24 hours	0.1 %

Table 2: Properties of PET

4.4 Methodology "

Mixing of concrete: Mixing of the actual quantities of the ingredients of concrete is done in a concrete mixer for 3 minutes Preparation of cubes: Cubes were prepared conforming to IS 456-2000. For most of the work cubical size of 15cmX15cmX15cm is used.

Curing: cubes were stored in moisture for 24 hours and period were marked the removed from the moulds and kept submerged in fresh water until test is performed.

Testing: Test cubes were taken under compressive testing machine and load applied gradually at rate of 1.4 to 2.1 MPa/min till specimen fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

5. Experimental Results:

Going through the experiments with actual M25 (conventional concrete), Concrete with various proportions of PET in place of aggregate, the following result are obtained that enlisted below in tables:

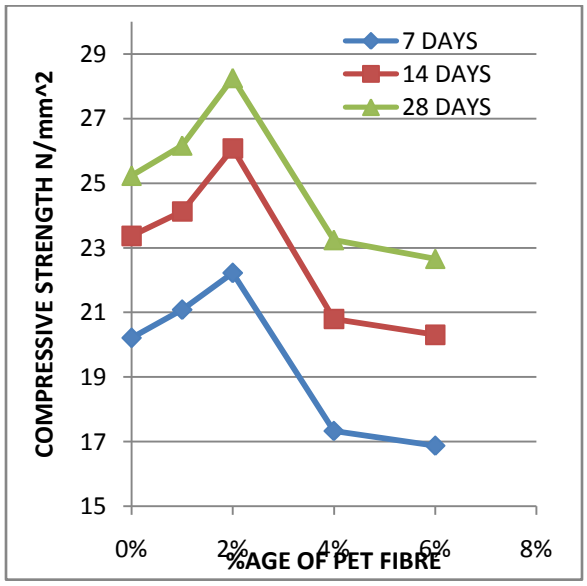

Figure1. Average compressive strength with various %age of PET fiber at different curing periods

From **Figure-3** the comparison of compressive strength of conventional concrete and concrete with PET fiber, it is very clear that PET fiber concrete gives better results than conventional concrete. It is also visible that with the replacement of fine aggregates with waste PET fiber, there is increase in compressive strength upto 2% replacement, at which there is 12% increase in compressive strength. For percentage replacement more than 2% there is decrease in compressive strength.

6. Discussion

From the above experimental results, it is clear that the compressive strength of cube increases with increase in PET fiber and it gives peak value at 2% of PET. Thereafter, it start decreasing and minimum is at 6%.

6.1 CONCLUSION

According to the discussion of results the following conclusions are derived by this study:

- Upto 2% replacement of fine aggregates with waste PET fiber, there is increase in compressive strength of concrete.
- Concrete mixed with waste PET fiber is eco-friendly, non-hazardous as it easily get dispersed in concrete mix
- Hence concrete with waste PET fiber can be used as an effective plastic waste management practice in future.

References

1. A. Mohd Mustafa Al Bakri, G. Che Mohd Ruzaidi, M.N. Norazian, H. Kamarudin and S. Mohammad Tarmizi (2007) “Effects of hdpe plastic waste aggregate on the properties of concrete”.

2. Chan, Y., N., Peng, G., F., Anson, M., 1999. Residual strength and pore structure of high-strength concrete and normal strength concrete after exposure to high temperatures. Cement and Concrete Composites 21 (1), 23-27

3. Fernando Pelisser, Oscar Rubem Klegues Montedo, Philippe Jean Paul Gleize and Humberto Ramos Roman (2012) Mechanical Properties of Recycled PET Fibers in Concrete. Materials Research.:5(4): 679-686.

4. F.J. Baldenebro-Lopeza, J.H. Castorena-Gonzalezb, J.I. Velazquez-Dimas, J.E. Ledezma-Sillasa, R. Martinez-Sancheza and J.M. Herrera-Ramireza,(2013) Mechanical properties enhancement of a concrete reinforced with recycled PET fibers: PROFAPI 2012/4

5. F.J. Baldenebro-Lopez, J.H. Castorena-Gonzalez, J.I. Velazquez-Dimas, J.E. Ledezma-Sillas, C.D. Gómez-Esparza, R. Martinez-Sanchez and J.M. Herrera-Ramirez (2014) Influence of continuous plastic fibers reinforcement arrangement in concrete

strengthened: ISSN (e): 2250-3021, ISSN (p): 2278-8719

6. G.Manikandan, D r . M . Sivaraja and R.Krishnaraja (2013) Flexural behavior of RCC beams reinforced with PET bottle waste fibres: ISSN: 2347-1964

7. Hasan Taherkhani (2014) An Investigation on the Properties of the Concrete Containing Waste PET Fibers: ISSN: 2251-8843

8. J.M. Irwan , S.K. Faisal , N. Othman, Wan Ibrahim M.H, R.M. Asyraf, and M.M.K. Annas (2014)

9. J. Simson Jose and Mr. M. Balasubramanian (2014) Experimental Investigation on Characteristics of Polythene Waste Incorporated Concrete: ISSN: 2231-5381

10. K.Ramadevi, Ms. R. Manju (2012) "Experimental Investigation on the Properties of Concrete With Plastic PET (Bottle) Fibers as Fine Aggregates" ISSN 2250-2459, Volume 2, Issue 6,

11. Nibudey. R.N, Nagarnaik. P. B, Parbat.D.K and Pande. A.M (2013) Cube and cylinder compressive strengths of waste plastic fiber reinforced concrete: ISSN 0976 – 4399

12. R. N. Nibudey,P.B. Nagarnaik, D.K.Parbat and A.M.Pande (2013) Strength and fracture properties of post consumed waste plastic fiber reinforced concrete. IJCSEIERD: 9-16

13. Swaptik Chowdhury, Aastha Tashkant Maniar, and Om. Suganya (2013)PET Waste as Building Solution: ISSN 2320 –4087

14. Siddesh pai and Kaushik Chandra. L(2013) Analysis of polyester fibre reinforced concrete subjected to elevated temperatures: ISSN 2249-6866

15. Shivam Nema, Kamlesh Keshre, Yash Soni and Ashish Nim (2014) Experimental investigation on properties of concrete by replacement of fine aggregate by grinded mixture of plastic and glass waste: e-ISSN : 2249-8303.

16. Tarun R. Naik, Shiw S. Singh, Calvin O. Huber and Brian S. Brodersen(1994) Use of post-consumer waste plastics in cement-based composites: PP. 1489-149

