IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

An Experimental Investigation on Partial Replacement of Cement by PET Fibre in Cement Concrete

Pritesh Salunke[1], Shravan Tingre[2], Saqlain Misrtry[3], Prof. Y R Suryavanshi[4], Prof. Dr. N. V. Khadake[5]

B. E Student, Department of Civil Engineering[1,2,3]
Associate professor, Department of Civil Engineering[4]
Professor & Head of Civil Department, Department of Civil Engineering[5]
JSPM'S Imperial College of Engineering and Research, Wagholi, Pune, Maharashtra, India
priteshsalunke11@gmail.com, saql313ain@gmail.com

Abstract: *Despite efforts to curb its usage, plastic is being used more and more frequently. Here, the benefits of using plastic pet bottle fibre instead of sand in concrete are examined. Solid waste management is severely hampered by plastic bottle disposal. Due to faulty waste management practises, several inventions that were made to make our lives more convenient have contributed to environmental pollution. Water bottles and bottles for carbonated beverages are made of polyethylene terephthalate (PET). This is a problem for the environment because used plastic bottles can't easily biodegrade and need to be recycled or reused. The building industry is looking for low-cost materials to increase the strength of concrete structures in the modern world. The purpose of this study is to determine whether trash PET bottles may substitute some of the fine aggregate in regular Portland cement. For determining the other qualities, such as flexural strength test, the percentage substitution that yields better compressive strength was used.*

Keywords: Concrete, Cement, Fine Aggregates, Coarse Aggregates, Plastic Pet Bottle Fiber

I. INTRODUCTION

During the resent years, awareness is increased regarding environmental pollution due to domestic and industrial waste. When once environment is allowed to degrade, it will take huge amount of public exchequers to clean it so in view of this, it is better to prevent than searching of solution for concrete. Concrete is in general, cement based, which meets special performance requirement with regards to workability, strength and durability, that cannot always be obtained with techniques and materials adopted for producing convention cement concrete. Fine aggregate is important construction materials, which is widely used in construction works. Concrete is widely used materials in the world. Based on global uses it is placed at second position after water. River sand is one of the constituent used in the production of the concrete has become highly expensive and also scare. In the backdrop of such a bleak atmosphere, there is large demand for alternative materials from the industrial and household waste. Similarly the waste plastic pet bottle can be used as the alternative materials for the partial replacement of the sand.

1.1 Main Objectives

The main objective of this study is to evaluate the possibility of using plastic pet bottle fiber as partial replacement of fine aggregate (sand) in concrete. Specific objectives of this work include:

- To determine the properties of plastic fiber.
- To conduct a comparative study of plastic pet fiber and sand.
- To study the effect of replacing sand with plastic pet bottle fiber on compressive strength and flexural strength of concrete
- To study the effect of replacing sand with plastic pet fiber on weight of concrete.
- To find the optimum percentage of replacement of sand using plastic pet fiber.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

II. REVIEW OFLITERATURE

One of the most significant environmental, economic, and social problems worldwide is how to dispose of and manage solid waste. To address the growing issues with garbage disposal, a comprehensive waste management system that incorporates source reduction, reuse, recycling, land-filling, and incineration must be put into place. Products created from recycled plastic are frequently not recyclable since a plastic is typically not recycled into the same type of plastic. Biodegradable polymers are being used more frequently. Because of the differences in characteristics and melt temperatures, reclaimed plastic cannot be recycled if any of it is combined with other polymers for recycling. The purpose of this project is to evaluate the possibility of using granulated plastic waste materials to partially substitute for the fine aggregate (sand) in concrete composites. The polyethylene (PET) bottle which can easily be obtained from the environment with almost no cost is shredded and added into ordinary concrete to examine the strength behaviour 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. The PET concrete blocks which can be used for masonry works will have more commercial value like Hollow blocks ad Fly ash blocks. Also the light weight wall panels and balusters will attract more attention of the construction industry.

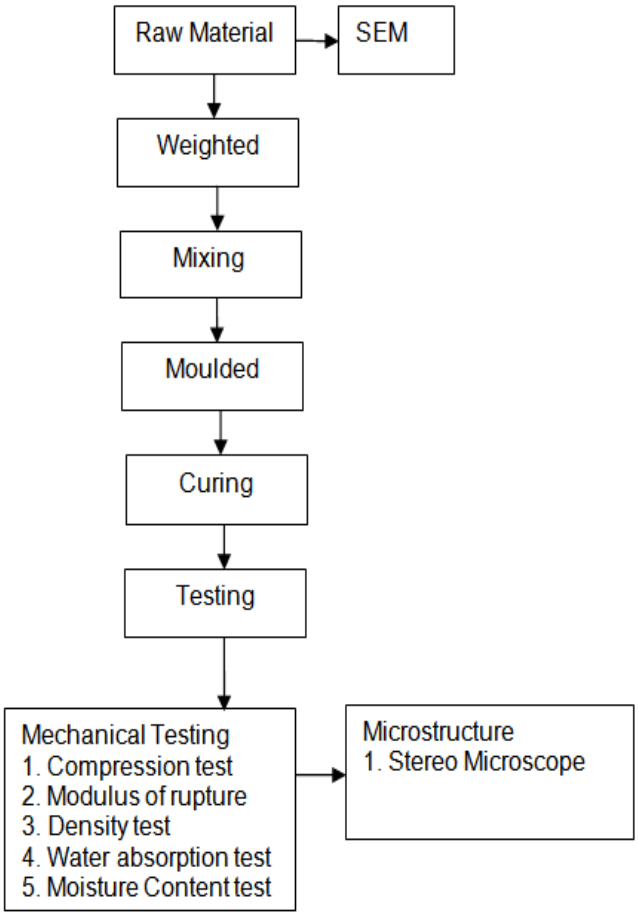
III. MATERIALS

1. PET plastic fibers: Plastic bottles of Aquafina brand were collected from different local sources around the Hyderabad, Sindh vicinity and then a detail procedure was adopted to get fibers. Since the Preparation of PET plastic Fibers involve several stages like collection of Aquafina drinking water bottles, removal of brand sticker, and removal of top and bottom portion of bottles. After done with this work, bottles are cut down into large portion of required sizes by scissors and then small fiber sizes like AR-20, AR-40 and AR-60 were obtained by cutting large fibers into small piece as designed for research work. Having done with this, the Fibers were dipped in bucket and washed properly for 10minutes and finally these fibers were let to dry properly before using them in laboratory for research work. Figure 1 and 2 explains this process.
2. Cement: Ordinary Portland cement is one the common cementitious product which is being used in construction industry of Pakistan so under this tag, Lucky star OPC is taken throughout for research work. The chemical composition and Mechanical Properties
3. Fine Aggregates: This material was obtained from local sources of Jamshoro i.e. Petaro and required tests were performed to know characteristics of fine aggregates. The Sieve analysis of Fine Aggregates were carried out under BS 882 designation whose details are shown in Table No 03 and Figure No 3. Moreover, specific Gravity, Apparent Specific gravity and Water absorption were spilt out by using ASTM C128 procedure.
4. Coarse Aggregates: Similar to fine Aggregates, the source of collection of coarse aggregates was the Petaro, Jamshoro. Two Samples having different grading limits were used to prepare a single blend with a ratio of 70% and 30% where former represents the multiple sized aggregates and later represents the single sized aggregates.

IV. METHODOLOGY

To gather the PET bottles needed for study, to buy the tools, and more. Breaking apart the used bottle waste
Casting and curing of the fundamental test specimens (cubes, cylinders, and prisms) for determining strength; • Granulating the pieces to smaller sizes like that of sand;
The structural elements' casting and curing.
To evaluate the outcomes of the structural models (RC beams with varying amounts of plastic waste).
The project's methodology is depicted in the flow chart in Figure 1.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023



1. 1.Slump Test. A representative composite sample was obtained in line with SANS 5861–2 [31] from the freshly mixed concrete sample. The slump after demoulding was measured to the nearest 5 mm in accordance with the SANS standard.
2. Rebound Hammer Test. A rebound hammer test was carried out on the fabricated FRCC using a rebound hammer. The hardness test gave an indication of the quality and strength of concrete. This test ascertains the inplane uniformity of concrete to delineate regions of poor quality.
3. Compressive Strength Test. A compressive test was carried out on the FRCC to determine the yield stress and compressive strength. e standard used for the compressive tests on the concrete was SANS 5863: 2006 [34]. A steel cubemould (150 mm × 150 mm X 150 mm) was used for castingcubes. The samples were cured for 28 days in the water tankand thereafter tested. e ultimate load at failure and stresswere recorded, and the compressive strength was calculated.
4. Flexural Strength Test. e FRCC flexural strength and modulus were determined on a Versa tester beam press machine in accordance with ASTM C78 [35] test uses a simple beam with four-point loading mould used for this flexural test was of dimensions of 150 mm × 150 mm X 510 mm. e modulus of rupture was then calculated.
5. Split Tensile Strength Test. split tensile test was carried out using the universal model number 1887B0001 ELE machine. test was carried out in accordance with ASTM C496–10 [36]. maximum load was divided by the geometric dimensions of the test specimen to calculate the splitting tensile strength. rate of loading used was 690 kPa/min, and the splitting tensile strength was then calculated.

V. OBJECTIVES

This study's main goal is to determine whether plastic pet bottle fibre may partially substitute fine aggregate (sand) in concrete. The following are the specific goals of this work:

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

1. To ascertain the plastic fiber's characteristics.
2. To compare sand and plastic pet fibre in a comparison research.
3. To examine the impact on concrete's compressive strength and flexural strength of substituting plastic bottle fibre for sand.
4. To investigate how the weight of concrete would change if sand were replaced with plastic pet fibre.
5. To determine the ideal replacement rate for sand with plastic pet fibre

VI. SCOPE OF THE PROJECT WORK

Future Work Admixtures can be used to improve bonding of fibres. Utilization of fibres in plastic concrete in various proportions to improve the strength. Plastic fibres along with steel fibres can be used to improve the strength of concrete. A better way of grinding plastic bottles may be adopted to produce fibres in large scale.

VII. CONCLUSION

1. The inclusion of fibers content increases the flow properties of concrete. The density was also affected but made concrete slightly lighter weight.
2. The slump value was observed to decrease with incremental amounts of PET fibre. The use of lower amounts of fibres less than 0.5% gave acceptable workability of the FRCC. Therefore, it is recommended to maintain less than 0.5% fibre content to have acceptable concrete workability.
3. The addition of 0.5% PET fibre to the FRCC increased the compressive strength to 28 N/mm2However, further fibre addition exceeding this percentage resulted in a decrease in compressive strength.
4. The addition of PET fibre only decreased the split tensile strength of the FRCC. Unreinforced concrete had a split tensile strength of 2.06 N/mm2, which dropped marginally to 1.82 N/mm2 with the addition of 0.5% PET fibre. addition of 1.0% PET fibre gave a split tensile strength of 1.16 N/mm2is was a drop of 44% from the split tensile strength of unreinforced concrete. Further addition of PET fibre to 2.0% resulted in a reduction in split tensile strength to 0.92 N/mm2.
5. The addition of PET fibre to the FRCC gave a decreasing rebound number with an increase in fibre content. This was in line with the trend observed for the destructive test.
6. The developed PET fibre reinforced concrete is suited for use in ceiling slabs and paving slabs at a fibre addition of 0.5% for optimum strength.

REFERENCES

[1]. "Mechanical and structural characteristics of PET fibre reinforced concrete plates," Smart Science, vol. 9, pp. 1–15, 2021. L. S. Rasheed, A. M. Shaban, and A. T. Abdulrasool.
[2]. S. Aji and R. K. Rohman, "Effect of fly ash on compressive strength of concrete containing recycled coarse aggregate," in AIP Conference Proceedings, 2014, no. 1, article ID 020097, 2018.
[3]. A. Caporale, L. Feo, and R. Luciano, "Limit analysis of FRP strengthened masonry arches via nonlinear and linear programming," Composites Part B: Engineering, 43, no. 2, 439–446 (2012).
[4]. "Sustainable fibre reinforced concrete for repair applications," Construction and Building Materials, vol. 67, 2014, pp. 405–412. N. Banthia, C. Zanotti, and M. Sappakittipakorn.
[5]. N. Banthia and R. Gupta, "Polypropylene Fibre Geometry Influence."
[6]. V. C. Li, “On engineered cementitious composites (ECC),” Journal of Advanced Concrete Technology, vol. 1, no. 3, pp. 215–230, 2003.
[7]. X. Cui, G. Liu, C.-l. Wang, and Y. Qi, “Effects of PET fibers on pumpability, shootability, and mechanical properties of wetmix shotcrete,” Advances in Civil Engineering, vol. 2019, pp. 1–14, Article ID 2756489, 2019.
[8]. W. Cheng, G. Liu, and L. Chen, “PET fiber reinforced wet-mix shotcrete with walnut shell as replaced aggregate,” Applied Sciences, vol. 7, no. 4, pp. 14–23, 2017.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

[9]. R. K. Padhan and A. A. Gupta, "Preparation and evaluation of waste PET derived polyurethane polymer modified bitumen through in situ polymerization reaction," Construction and Building Materials, vol. 158, pp. 337–345, 2018.

[10]. C. Marthong and D. K. Sarma, "Influence of PET fiber geometry on the mechanical properties of concrete: an experimental investigation," European Journal of Environmental and Civil Engineering, vol. 20, no. 7, pp. 771–784, 2016.

[11]. P. A. Vaccaro, A. P. Galvin, J. Ayuso, A. Barbudo, and A. L. Uceda, "Mechanical performance of concrete made with the addition of recycled macro plastic fibres," Applied Sciences, vol. 11, no. 9862, pp. 1–13, 2021.

[12]. O. C. Sayi and O. Eren, "Physical and durability properties of recycled polyethylene terephthalate (PET) fibre reinforced concrete," European Journal of Environmental and Civil Engineering, vol. 9, 2021.

[13]. V. Patil and V. Shukla, "Use of PET fibre as constituent of concrete," IJARIIE, vol. 3, no. 2, pp. 280–284, 2017.

[14]. P. M. Europ, "Plastics - the facts 2020: an analysis of European plastics production, demand and waste data," Plastics, vol. 28, 2021.

[15]. P. O. Awoyera, O. Olalusi, and C. O. Ekpe, "Plastic fiberstrengthened interlocking bricks for load bearing applications," Innovative Infrastructure Solution, vol. 6, no. 2, pp. 1–10, 2021.

[16]. R. Sharma and P. P. Bansal, "Use of different forms of waste plastic in concrete - a review," Journal of Cleaner Production, vol. 112, pp. 473–482, 2016.

[17]. A. Ghalampour and T. Ozbakkaloglu, In New Trends EcoEfficient and Recycled concrete, pp. 59–85, Woodhead Publishing, Sawston, United Kingdom, 2019, https://www.plasticseurope.org/en/resources/publications/4312-plasticsfacts-2020.

[18]. [18] Z. Wang, Z. Ma, and L. Li, "Flow-induced crystallization of polymers: molecular and thermodynamic considerations," Macromolecules, vol. 49, no. 5, pp. 1505–1517, 2016.

[19]. M. Sahmaran and I. O. Yaman, "Hybrid fiber reinforced selfcompacting concrete with a high-volume coarse fly ash," Construction and Building Materials, vol. 21, no. 1, pp. 150– 156, 2007.

[20]. D. Foti, "Use of recycled waste pet bottles fibers for the reinforcement of concrete," Composite Structures, vol. 96, pp. 396–404, 2013.

[21]. H. Ataei, K. K. Anaraki, and R. Ma, "Mechanical properties of polyethylene terephalate particle based concrete: a review," Airfield and Highway, vol. 1, pp. 57–68, 2017.

[22]. E. Rahmani, M. Dehestani, M. H. A. Beygi, H. Allahyari, and I. M. Nikbin, "On the mechanical properties of concrete containing waste PET particles," Construction and Building Materials, vol. 47, pp. 1302–1308, 2013. [

[23]. Y.-W. Choi, D.-J. Moon, J.-S. Chung, and S.-K. Cho, "Effects of waste PET bottles aggregate on the properties of concrete," Cement And Concrete Research, vol. 35, no. 4, pp. 776–781, 2005.

[24]. S. Mukhopadhyay and S. Khatana, "A review on the use of fibers in reinforced cementitious concrete," Journal of Industrial Textiles, vol. 45, no. 2, pp. 239–264, 2015.

[25]. Z. Z. Ismail and E. A. Al-Hashmi, "Use of waste plastic in concrete mixture as aggregate replacement," Waste Management, vol. 28, no. 11, pp. 2041–2047, 2008.