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PET as a novel material in construction industry

Aneesa Mushtaq

Integral University Lucknow (India)

ABSTRACT

PET (polyethylene terepthalate) production is increasing day by day .It has become an important part of our day life. With the significant increase in using plastic on daily basis, there disposal problem have also been increased. Disposing of PET waste has always been an issue of great concern from environmental point of view because of theirnon-biodegradable properties. The only solution to this problem is either to reuse or recycle this plastic waste. Construction industries are always looking for the cheap and effective material to enhance various hardened properties of concrete like tensile strength and compressive strength. Use of PET waste in concrete not only come as a rescue to environmental problems but also as a strategy to produce more economic and sustainable building materials in the future. In this paper we will have an overview of various researches that have been done in using PET as enhancing material.

Keywords: concrete, compressive strength, flexural strength, tensile strength, PET waste

I.INTRODUCTION

As we all are aware of the fact that our environment is degrading at a faster rate. Various researches have been done on developing eco-friendly materials. During 20th century plastic was one of the major invention that cause a revolution in human life. But with the improvement in living standard plastic has been used at such a faster rate, that it is has caused severe environmental problems. Plastic waste management is a big challenge in present world. Plastic waste is generated numerously by the manufacturing processes, service industries and municipal solid wastes (MSW). The world's annual consumption of plastic materials has increased from around 204 million tons in the 2002 to nearly 300 million tons in 2013. Major sources of PET waste are bottles, foils and cords from tires. Recycling of bottles and foils is a small problem while recycling of cords from tires is a huge problem. Using plastic waste in concrete mainly arises from environmental perspective. As plastic waste is not biodegradable there decomposition is a major threat to environment, either we dump them in open land fields or in water bodies. Disposing of plastic waste in water bodies has adversely affected aquatic life. Dumping in open land fields causes soil sickness. The worldwide production of PET exceeds 6.7 million tons/year and shows a dramatic increase in the Asian region due to recent increasing demands in China and India[1]. Plastics comprise 12.3% of total waste produced most of which is from discarded PET water bottles[2]. Its (PET) light weight characteristic, hygienic and strong makes it preferable in food processing factories[3][4].PET belongs to the thermoplastics with excellent physical properties. It constitutes around 18% of the total polymers produced worldwide and over 60% of its production is used for synthetic fibers and bottles. Which consume about 30% of the global PET demand [3].

II .UTILIZATION OF PET WASTE IN CONCRETE

Concrete is used worldwide. Concrete is a manmade stone made of cement, sand, aggregates, plasticizers, water etc. Though it is good in compression which is an advantage, but it is weak in tension, its ductility is low, its heavy weight. Thus advantages and disadvantages goes side by side. These disadvantages are major concern for civil engineers. They always look for materials that will enhance its mechanical properties. Using fiber in concrete is not new. It has been used since centuries. Fiber addition in concrete makes its resistant to cracks, wear and tear, enhances tensile strength, improves ductility and impact strength [3][5].R-PET cut in various shapes like short or long and in various size like circular fibers has been utilized in the concrete mix obtained by cutting waste bottles orthogonally to their longitudinal axis[6].Concrete reinforced with PET fiber shows better performance than normal concrete[7][8][9][10].Use of PET fiber has significant effect on improving ductility and energy absorption of the axially compressed concrete samples[11]. To improve mechanical properties waste PET bottles have been used in making lightweight aggregates [12]. The need for utilizing environmentally friendly, cheap and lightweight construction materials in construction industry demands searching more novel, flexible and versatile composites [13].) PET waste granules as aggregate in lightweight concrete. Plastic bottles in shredded form can be used successfully as an alternative for aggregates in cementinous concrete composites[14]. Polyethylene terephthalate can be used as polymer additives in Bituminous Mix[15]. There was an improvement of asphalt when modified with polyethylene (PE).Determination of the best type of PE to be used and its proportion in the asphalt mixture was also studied[16].

PET fibers (synthetic fibers) have gained much importance in practical applications than ordinary fiber because of:

- They are resistant to chemical attack
- They are corrosion proof
- As compared to steel fiber they are light in weight
- They are cheap and easily available within locality

Hence reusing of PET wastes in the construction industry is an effective approach from both perspectives, Preventing environmental pollution and designing economical buildings.

III. ENHANCED COMPRESSIVE AND TENSILE STRENGTH OF CONCRETE

A. Compressive Strength

R.N. Nibudey et. at.2013 studied that PET fibers obtained from waste PET bottles used for concrete reinforcement were efficient. The experiment conducted shows that there was an increase in compressive strength by 7.35% in concrete reinforced with PET fiber (PFRC) when compared to concrete without fiber for M20 grade of aspect ratio 50 for 1% fiber volume fraction and after that for further increases in percentage of fiber there was decrease in strength, as it was noted that there is fall in compressive strength by 27% for 3% fiber volume fraction for the same grade and aspect ratio. The rise in compressive strength for M30grade concrete is very little and the fall in strength on increasing the fiber volume fraction was low. For higher aspect ratio increase in compressive strength of PFRC was higher. In the analysis of tests done by Ms. K. Rama devi et. al. 2012 for a mix design of M25 grade concrete an appreciable increase in compressive strength is observed till 2% replacement of fine aggregate by PET bottle fibers and then the compressive strength gradually decreases (R. Kandasamy et. al.2011) .Sahil Verma et. al. 2015 reported that there was an increase in compressive strength by 12% for 2% replacement of fine aggregates for conventional concrete (M25 grade concrete). Hence 2% replacement of fine aggregate is found to be reasonable. B.Harini & K.V. Ramana 2015 carried out experiment on partial replacement of fine aggregate with 20% of plastic waste in concrete, it was found that there was decrease in compressive strength by 14.89% when compared to normal concrete . To enhance the least compressive strength, apart from partial replacement of plastic for fine aggregate, a partial replacement of cement of silica fume was also made by 5%,10%,and 15%. At 15% of silica fume used as binding material, there was increase in compressive strength by22.5% when compared to the mix with no silica fume and plastic percentage of 20%.Brajesh Mishra 2013 carried out experiment and concluded that there was increase in compressive strength for upto, 2% replacement of the fine aggregate with PET bottle fibers and there was gradual decreased in strength for 4% and 6% replacements.

B. Tensile Strength

The experiments by J. M. Irwan et. al. 2013 shows that PET fiber can enhance the tensile strength of concrete cylinder. There was an in strength by 0.5% -1.5% in concrete reinforced with PET fibers when compared to normal concrete at all ages. At 28 days the increment of splitting tensile strength of concrete containing PET fibers at 0.5%, 1.0% and 1.5% was by 9.1%, 15.5% and23.6% respectively. Dora Fotiet. al. 2010 carried out the experiment and shows that the tensile strength increased with the addition of PET fiber reinforcement at 8.19KN compared to normal concrete specimen at 7.88KN tensile strength. R.Kandasamy and R.Murugesan 2011 in their experiment concluded that there was an increase in split tensile strength upto 2% replacement of fine aggregates with PET bottle fibers and then with further increase in replacement with PET bottle strength starts decreasing gradually. As the role of adding PET fiber in concrete is bringing across the crack and improving the bonding of its element in concrete, we can conclude that the PET fiber added will improve the bending strength as well as the splitting tensile strength. P. GANESH PRABHU et. al. 2014 showed that tensile strength of cylindrical specimen increases to a value of23% by addition of 0.5% PET fiber.

C. Flexural Strength

Brijesh mishra 2013 reported that there was an in increase in flexural strength for 2% replacement of the fine aggregate with PET and then for 4% it decreased and remains the same for 6% replacements. B.Harini&K.V.Ramana reported that, as plastic waste and aggregate ratio increase in concrete mix, there is decrease in the flexural strength at each curing age. This is due to decrease in adhesion between the surface of waste plastic particles and the cement paste.

IV.CONCLUSION

Contextual analyses in light of explores and trial works and logical reports have demonstrated that waste PET might be connected for the change of cements. The consolidation of PET container strands as support in concrete has appeared, on the premise of various tests on its mechanical properties, that there is a critical change in the adjusted cement. The utilization of PET filaments as fortification of concrete composites is a promising procedure for creating maintainable materials to be connected in the common development industry. Furthermore, consequently concrete with squander PET jug fiber can be utilized not just as a viable plastic waste administration rehearse additionally as a methodology to create more financial and practical building materials in the future.

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