International Journal of Recent Trends in Engineering & Research
ISSN (ONLINE) : 2455 – 1457
IMPACT FACTOR : 4.101

Use of PET bottles in Rigid Pavement – A Review

Shubham Satish Kabra[1], Dr. Saswati Datta[2]

[1]PG Student, Civil Engineering Department, D. Y. Patil College of Engineering, Akurdi, Pune-411044,
[1]Associate Professor, Civil Engineering Department, D. Y. Patil College of Engineering, Akurdi, Pune-411044,

Abstract— Now a day's plastic waste is becoming curse to the human society. Generating disposable plastic bottles is becoming a major problem in many countries. PET bottles use has increase in day-to-day life. So, we will find out method to disposal of PET bottles. PET bottles were proposed to be used as either reinforcement in concretes or being casted as blocks. We will use PET (Polyethylene Terephthalate) bottles as reinforcement to the concrete road to determine its strength and develop a way of disposal of PET bottles. Various types of PET bottles are used along its variation like strip of bottles, plain bottles and neck of bottles. These variation will effectively use in the whole project to determine the strength and will try to get positive outcome. Using waste plastic as a secondary material in construction projects would be a solution to overcome the crisis of producing large amount of waste plastics in one hand and improving the structure characteristics such as resistance against cracking on the other hand. To investigate the effects of adding plastic bottles in road pavement. Besides, the mixtures containing waste plastic showed significantly greater fatigue resistance than the conventional mixture.

Keywords— *Bottles, concretes, PET, plastic, replacement, road, waste.*

I. INTRODUCTION

The rapid urbanization and industrialization all over the world has resulted in large deposition of waste polymer materials. The world's annual consumption of plastic materials has increased from around 7 million tons in the 1960s to 196 million tons in 2005 and continue reaching over 365 million tons in2015,540 million tons in 2020. A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as 'Plastic'. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Plastics, a versatile material and a friend to common man become a problem to the environment after its use. Plastic waste materials consist of surplus, obsolete, broken, old plastic furniture, different household plastic materials, equipment, antistatic packaging materials and devices made of plastic. These polymer wastes are almost non-degradable in the natural environment even after a long period of exposure. In Asia and the Pacific, as well as many other developing regions, plastic consumption has increased much more than the world average due to rapid urbanization and economic development. India's consumption of plastics will grow 20 million tons by 2020 and is set to be the third largest consumer of plastics in the world.

Plastics also have become an inseparable and integral part of our lives. Its low density, strength, user-friendly designs, fabrication capabilities, long life, light weight, and low cost are the factors behind such phenomenal growth. Plastics have been used in packaging, automotive and industrial applications, medical systems, artificial implants, other health care applications, water desalination, land/soil conservation, flood prevention, preservation and distribution of food, housing, communication materials, security systems, and other uses. With so large and varying applications, plastics contribute to an ever increasing volume in the solid waste stream. The production and

consumption of plastic and the rate at which solid plastic waste (SPW) is created have increased considerably since the first industrial scale production of synthetic polymers (plastics).

Plastics can be divided in to two major categories: Thermosets and Thermoplastics. Thermoplastics are plastics that can be repeatedly soften and melt when heat is applied and they solidify into new shapes or new plastics products when cooled. Thermoplastics include Polyethylene Terephthalate (PET), Low Density Poly Ethylene (LDPE), Poly Vinyl Chloride (PVC), High Density Poly Ethylene (HDPE), Polypropylene (PP) and Polystyrene (PS) among others. Plastic is hazardous material it increase the risk of heart disease & the respiratory ailments such as asthma and emphysema get affected. It start rashes, nausea, or headaches, damages in the nervous system. The high doses of styrene affect eye& mucous membrane.

II. LITERATURE REVIEW

The idea of using plastic bottles in concrete building construction was originated by Andreas Froses in Eco-Tec in 2001 where PET bottles are installed within the walls along with mortars to shape a structure. 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. In India approximately 40 million tons of the municipal solid waste is generated annually, with evaluated increasing at a rate of 1.5 to 2% every year. In 2013, the researcher Dora Foti presented research on use of recycled waste pet bottles fibers for the reinforcement of concrete. Dora Foti stated that plastic bottles are used as reinforcement in concrete in• the substitution of steel. From this paper the results of some tests performed on concrete specimens reinforced with fibers made from waste polyethylene terephthalate (PET) bottles are reported. The fibers have been obtained by simply cutting the bottles; the fibers are then added to the mix concrete or they are used as discrete reinforcement of specimens and little beams in substitution of steel bars. The tests are to be considered as an approach to a more extensive investigation on the use of PET as a reinforcing material for concrete and masonry structures. The results that have been obtained are very interesting, especially regarding the adherence between PET and concrete, suggesting a possible use of this material in the form of flat round bars, or networks for structural reinforcement.

Sina Safinia, Amani Alkalbani in 2016 in their research on use of recycled plastic water bottles in C]concrete blocks shows 57%• improvement of strength by using plastic bottles compared to local concrete blocks. This study verifies the compressive study of plastic bottled concrete blocks used with local materials. In 2016 Sampada Chavan, Pooja Rao provides research on utilization of waste PET bottle fibers in concrete as an innovation in building materials in International Journal of Engineering Research . Sampada Chavan, Pooja Rao, report states that the properties of concrete• when waste PET bottles are used in fiber form as aggregates in reinforced plain concrete. The aim of the paper is to analyze and study the different experiments, case studies based on researches and experimental works and scientific reports to determine the improvement in selected properties of PET fiber reinforced concrete. Also to convey that the use of PET fibers as reinforcement of cement composites is a promising technique for developing sustainable materials to be applied in the civil construction industry. And hence concrete with waste PET bottle fiber can be used not only as an effective plastic waste management practice but also as a strategy to produce more economic and sustainable building materials in the future.

Plastic (polymers) used for applications in bitumen modifications, can be subdivided into two main types depending on their behavior after exposure to heat. In 2018 Abhishek Kumar & Dr. Sanjeev Kumar Suman, M. Tech Student, Department of Civil Engineering, National Institute of Technology Patna, Bihar, India presents research on evaluation of the effect of geometry of recycled PET fiber on the properties of concrete for rigid pavement. Abhishek Kumar & Dr. Sanjeev Kumar Suman stated

that PET bottles are one of the major components of plastic waste, which can be used as reinforcing material in cement concrete pavement as fibers. The scope of these fibers is less due to its non-bonding behavior with concrete. It can be modified by changing its shape. In this paper, five different shapes of PET fibers were obtained by waste PET bottles and used in additive M30 concrete. Different tests were performed on this fiber reinforced concrete, which are relevant to cement concrete pavement. Results showed enhancement in the properties of concrete, which leads to reduce the depth of pavement.

Recycling of waste PET plastics can make significant contribution to environment and economy from different aspects. It helps to reduce the exploitation of natural resources to reduce the environmental pollution level, saving energy and money, and it contributes to modifying the physical and engineering properties of construction materials such as asphalt and building concrete. In 2014, researchers M.L.Anoop Kumar, Dr.I.V. Ramana Reddyand & Dr. C. Sasidhar provide their experimental investigations on the Flexural Strength of PET reinforced concrete in International Journal of Emerging Technology and Advanced Engineering. M.L.Anoop Kumar, Dr.I.V.Ramana Reddyand, Dr.C.Sasidhar presented research studies on resolving the issue of PET bottles in a beneficial way. By the usage of PET bottle waste at suitable scale as concrete reinforcement for constructional works, the present research aims at waste management, by use of PET waste in improvement of concrete. The non-biodegradable PET bottle waste is used as reinforcement for concrete and the flexural strength of hardened concrete at 28days was tested and compared with conventional concrete and steel reinforced concrete. In this study, there are four types of concrete beam specimens with steel reinforcement, without steel reinforcement; with PET reinforcement and combined steel and PET reinforcement tested for 28 days' flexural strengths and the detailed analysis of the results are reported.

Poly(ethylene terephthalate) (PET) is the most commonly used thermoplastic polyester. It is often called just "polyester," which often causes confusion, because polyester resins are thermosetting materials. PET is a transparent polymer, with a good mechanical properties and good dimensional stability under variable load. In 2016 the researchers M. Sulyman, J. Haponiuk, and K. Formela provides research on utilization of recycled polyethylene terephthalate (PET) in engineering materials. M. Sulyman, J. Haponiuk, and K. Formela provides a summary of experimental efforts on the utilization of polyethylene terephthalate (PET) in civil engineering projects, mainly in road pavement, cements and concretes. Present data indicate that use of waste PET for modification of asphalt, cement and concretes improved their selected properties, which makes economical this approach. Furthermore, using of waste PET in building materials reduce usage of new polymeric materials, which has significant effect one environment pollution (e.g. emission of carbon dioxide, waste disposal problems, etc.)

III. OBJECTIVES

The following objectives are covered is this paper:

- Preparation of mix proportions for concrete mix design.
- To study the effects of waste plastic bottles on the rigid Pavement.
- To compared the Flexural strength and compressive strength between Conventional Concrete and using PET bottles in concrete.
- To optimize the cost of conventional concrete and by using PET bottles in concrete.

VI. POLYETHYLENE TEREPHTALATE (PET) IN CONCRETE WORK

PET is a transparent polymer, which has good mechanical properties and good dimensional stability under variable load.

To date, there are only three major ways which have been identified to recycle waste PET bottles into construction materials. Firstly, waste PET bottles can be depolymerized into unsaturated polyester resin to produce polymer mortar and polymer concrete. It benefits include that, the polymer concrete has higher compressive and flexural strength than conventional Portland cement concrete , and that polymer concrete achieves over 80% of its ultimate strength within 1 day. However, the properties of polymer concrete are sensitive and subjected to temperature and the cost of producing polymer concrete from waste plastic is high.

The second method employs the use PET fiber to reinforce concrete. Theuse of PET fiber can enhance the ductility of quasi-brittle concrete and, therefore, reduce the cracking caused by plastic shrinkage. However, the water-resistance and low surface energy of plastic materials result in a weak mechanical bond between the fiber and the cement matrix. Poor mechanical bond strength may cause internal micro-cracks in the interfacial mechanical bond area between the fiber and the cement matrix.

The last recycling method is to substitute PET waste for aportion of the aggregate used in the production of lightweight concrete or asphalt concrete. This method provides the most economical way to accomplish two important goals: to dispose of waste plastic and to produce lightweight concrete. However, the addition of PET waste negatively affects the quality of the concrete by decreasing its compressive strength, splitting tensile strength, and modulus of elasticity Recently, a fourth method has been attempted whereby a recycled PET bottle flakes are directly used as binder. The PET plastics are heated andwith two types of soil, clay and sand, to attain a uniform fused mix named plastic-soil. Recycled PET bottles used to produce mortar, have a promising results (Zhang, 2016).

In short, blocks with PET replacement have the following features as compared to conventional blocks:

- Greater weather resistant due to chemically inert PET and HDPE;
- Less stress or load on foundation (due to lighter blocks);
- Economical foundation (since the stress on foundation is less)
- Less manual labour in making blocks (mixture is lighter);
- Less cost of transportation (due to lighter blocks)
- Good sound insulation;
- Variable strengths (dependent on size and nature of plastic aggregate)
- Better shock absorption
- Deduction in the dead load of concrete structure which allows the contractor to reduce the dimension of columns, footingsand other load bearing elements(precast strips with circular gaps) or by executing frames which have led to easy forms.

IV. CONCLUSION

Replacement of PET bottles in rigid pavement has found to be economical than steel reinforcement. Among the variations used neck bottles has come with highest flexural strength than others. Replacing PET bottles is a boon to solid waste management.

REFERENCES

I. Dora Foti. “Use of recycled waste pet bottles fibers for the reinforcement of concrete” Composite Structures 96 (2013) 396–404.
II. Sina Safinia, Amani Alkalbani. “Use of Recycled Plastic Water Bottles in Concrete Blocks-Creative Construction Conference 2016” Procedia Engineering 164 (2016) 214 – 221.

III. Sampada Chavan, Pooja Rao "Utilization of Waste PET Bottle Fibers in Concrete as an Innovation in Building Materials." International Journal of Engineering Research ISSN:2319-6890(online),2347-5013(print) Volume No.5, Issue Special 1 pp: 304-307 8 & 9 Jan 2016.

IV. Abhishek Kumar & Dr. Sanjeev Kumar Suman "Evaluation of the effect of geometry of recycled PET fiber on the properties of concrete for rigid pavement" M. Tech Student, Department of Civil Engineering, National Institute of Technology Patna, Bihar, India Abstract Number 275.

V. M.L.Anoop Kumar, Dr.I.V. Ramana Reddyand & Dr. C. Sasidhar, "Experimental Investigations on the Flexural Strength of PET Reinforced Concrete" International Journal of Emerging Technology and Advanced Engineering. Volume 4, Issue 2, February 2014

VI. M. Sulyman, J. Haponiuk, and K. Formela "Utilization of Recycled Polyethylene Terephthalate (PET) in Engineering Materials." Indian Standard Codes, IS:456-2000, IS:10262-2009, IS:516-1959, IRC:58-2002.

VII. R. Ahmad, M I Malik, M U Jan, P Ahmad, H Seth, J Ahmad Brick (2014), Masonry and Hollow Concrete Block Masonry – A Comparative Study, Vol. 1, Issue 1, pp (14-21), Month: October 2013-March 2014

VIII. A. A. Abdel-Azim, "Unsaturated polyester resins from poly(ethylene terephthalate) waste for polymer concrete," Polymer Engineering and Science, vol. 36, no. 24, pp. 2973–2977.

