International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 5, Issue 2, pp: (47-52), Month: October 2017 - March 2018, Available at: www.researchpublish.com

Feasibility Study on Plastic Wastes in Concrete: A Review

Logachandran D[1], Kalaivani M [2]

[1]M.E. Structural Engineering Student, [2]Assistant Professor
[1,2]K.S.Rangasamy College of Technology, Tiruchengode, Namakkal, India

Abstract: **Plastic waste is serious threat to the environment and their disposal is a major problem in solid waste management. Different plastic products like plastic polyethylene bags, High density polyethylene, Low density polyethylene and Polyethylene terephthalate bottles are widely used and cause major impact to the environment. To overcome this issue many efforts were taken to recycle and reuse of plastics waste. On the other hand concrete is the most widely used construction material is facing problem due to unavailability of construction material of cement, sand and coarse aggregate. Various experimental investigations were made to check the effective use of plastic waste partially in concrete with respect to various properties of strength, workability, durability and ductility of concrete. This paper discusses about the various literature reviews in which the waste plastic material incorporated with the concrete and impingement on the various properties of concrete when partially replacing with waste plastic.**

Keywords: **Plastic waste, Recycle, Impingement, Reuse, Polyethylene terephthalate.**

I. INTRODUCTION

Due to rapid industrialization & urbanization the amount of plastic waste generation is increasing day by day. However due to vast manpower very small amount of plastic waste is recycled and used and remaining waste are going into landfills which cause serious environmental problems. If the production of waste cannot be prevented it is necessary to create an alternative use in waste disposal. From the disposal problems of plastic waste, many Government agencies, private organizations and various researches have completed or in the process of completing a wide variety of studies and research projects concerning the feasibility, environmental suitability and performance of using waste plastics in construction field. The possible use of pulverized plastic in concrete as partial replacement of fine aggregate and use of waste plastic in concrete as partial replacement of coarse aggregate. Laboratory tests were conducted to the samples casted by using different combination of plastic waste material incorporated in the concrete and to determine the behaviour of concrete and its properties.

The development of concrete with nonconventional aggregate such as LDPE, HDPE, polyethylene terephthalate (PET), and other plastic materials has been investigated for use in concrete in order to improve the properties of the concrete and reduce cost. This paper is based on the review of literature which gives the idea of various forms of plastic waste materials utilized in the concrete.

II. LITERATURE REVIEW

Rahmani et al (2013) have studied the waste polyethylene terephthalate particles can be reused as fine aggregate in concrete mix. Different concrete mix with two water cement ratio of 0.42 & 0.54 for effective concrete and 5%, 10% &15% substitution of sand with PET processed particles have been investigated .In this study the 5% replacement of fine aggregate with PET particles yielded optimum compressive strength and workability of fresh concrete was decreased as amount of PET content was increased in the concrete mix. From this result shows that both compressive strength and flexural strength of two water cement ratio 42% & 54% has similar pattern and waste PET bottles in form of particles can be used as aggregate replacement in concrete technology.

Suganthy et al.(2013) have investigate pulverized fine crushed plastic (high density polyethylene) as partial replacement of fine aggregate. Replacement of natural sand in concrete was replaced by pulverized plastic sand with 0%, 25%,50%,75% and 100% respectively. With increase replacement of sand increase in water cement ratio and to achieve desired 90mm concrete slump. From the results observed that gradual decrease in concrete strength of 25% replacement of plastic fine aggregate and afterwards rapid decrease in concrete strength of further increase in replacement of plastic fine aggregate.

Ankur C.Bhogayata et al (2017) have represents the test results of fresh and hardened properties of concrete reinforced with metalized plastic waste (MPW) by discarded food packaging industries. In this study,the feasibility of MPW fibers as reinforcing constituent in concrete for evaluating the slump and strength properties. Films of MPW were shredded into 5mm, 10mm and 20mm long fibers and mixed in concrete from 0% to 2% by volume of concrete mix. The test results shows that inclusion of MPW fibers in concrete improves the ductility & crack resistance capacity of concrete and improves the deformation capacity at higher loads subjected to axial compression. Finally the incorporation of MPW fibers of 1% will be acceptable alteration of the concrete property.

Youcef Ghernouti et al (2014) have studied that plastic fine aggregate obtained from crushing of waste plastic bags as partial replacement of fine aggregate. Plastic bags were heated and cooled then further crushed to plastic sand. Fine aggregate in concrete was replaced with 10%, 20%, 30%& 40% of plastic bag waste sand. Fresh and harden properties of concrete mix were determined and increasing percentage of plastic bag waste sand in concrete mix reduction in strength is observed. From this results show that 10 to 20% replacement of fine aggregate with plastic fine aggregate probable strength property is observed. They suggest future research scope on plastic aggregate with use of admixture to address the strength improvement property of concrete.

Khilesh Sarwe (2014) have examined the results of addition of waste plastic along with steel fibers in concrete. Two different concrete mixes were casted in cubes. One with different percentages of plastic wastes of 0.2%,0.4%,0.6%,0.8% & 1% by weight of cement and another mix of plastic waste and steel fibers (0.2 & 0.1%, 0.4 & 0.2%, 0.6 & 0.3%, 0.8 & 0.4%, 1 & 0.5%) by weight of cement to study the compressive strength. From this observed that plastic waste and steel fiber concrete mix has shown more strength as compared to plastic waste concrete mix and concluded that plastic waste and steel fiber of 0.6% & 0.3% by weight of cement has shown maximum compressive strength.

Yun Wang Choi et al (2009) have examined that the development of light weight aggregate concrete by recycled waste polyethylene terephthalate bottles as fine aggregate in concrete. Three series of concrete mixture were prepared with water cement ratio of 0.45, 0.49 &0.53.For each concrete mix, the WPLA replacement by mass of fine aggregate was 0%, 25%,50%&75% respectively. The result shows that the slump of WPLA concrete mix increased proportionally to the increase in proportion of WPLA in the concrete mix. For a water cement ratio of 0.49 the structural efficiency of the concrete containing 25% of WPLA was higher than the reference concrete mix.

Zainab Z.Ismail et al (2007) have examined the feasibility of reusing plastic sand as partial replacement of fine aggregate in concrete and determine its compressive strength, flexural strength, toughness and dry/fresh density of concrete samples. The collected waste plastic consists of 80% polyethylene and 20% polystyrene which was crushed and converted into pulverized particles. The results indicate that increasing the plastic waste ratio there is slight decrease in compressive and flexural strength. However load deflection of plastic waste concrete shows the arrest of propagation of micro cracks and high toughness in concrete mix. The study has shown good workability in low slump value but water cement ratio content kept constant in all concrete samples.

Ninoslav Pesic et al (2016) have investigated the potential engineering benefits of recycled high density polyethylene plastic fibers in structural concrete. Two fiber diameter of 0.25mm & 0.40mm and three series of 0.40%, 0.75% and 1.25% volume fraction of fibers are incorporated in the concrete specimen to determine the mechanical and serviceability properties of concrete. From the results the tensile strength and flexural modulus were increased 3% to 14% in concrete with the presence of HDPE fibers without affecting the compressive strength and elastic modulus of the concrete. The durability of HDPE fibers was assessed by means of scanning electron microscope (SEM) imaging that shows no signs of chemical deterioration in the concrete.

Ramesh et al (2009) have examined the usage of Low density polyethylene plastic waste as partial replacement to coarse in concrete to determine its harden properties. Various concrete mix were prepared by 0%,20%,30%& 40% of recycled plastic aggregate obtained by heating treatment of waste plastic in plastic recycling machine. A concrete mix design of 1:1.5:3 proportion & water cement ratio of 0.5 was used. By replacing plastic waste up to 30% an 80% strength is achieved and after clear reduction in compressive strength with further increase in percentage of plastic aggregate. The research

shows that the application of recycled plastic aggregate in light weight aggregate & future research scope on plastic aggregate and its durability aspects for columns and beams.

Raghatate Atul M (2012) have studied the experimental results of concrete mix casted with plastic bag pieces to determine its compressive & split tensile strength. Concrete mix of ordinary Portland cement, natural river sand as fine aggregate and coarse aggregate & containing varying percentage of waste plastic bags of 0.2%, 0.4%, 0.8% &1% .Compressive strength of concrete is decreased by increasing the percentage of plastic bag pieces. A 20% decrease in compressive strength with 1% addition of plastic bag pieces and increase in tensile strength of concrete by adding 0.8% of plastic bag pieces in concrete mix and afterward it starts decreasing when adding more than 0.8% of waste plastic bag pieces. From this study concluded that utility of plastic bag pieces can be used for increase in split tensile strength in concrete and by varying the shape & size of plastic bags used in concrete mix its performance is analyzed in further research.

Shutong Yang et al (2015) have studied the effect of incorporating recycled modified polypropylene plastic particles on self-compacting light weight concrete to determine the workability and mechanical behavior of concrete. Four replacement levels of 10%, 15%,20%&30% of fine aggregate by plastic particles. Microscopic study was carried out on plastic-paste interfacial bonding. Slump flow value is improved with an increase in sand substitution and passing ability is improved with the replacement level up to 15%.From the study, results shows that compressive strength, split tensile strength& flexural tensile strength are increased with replacement level up to 15%.SEM imaging shows plastic paste interface bonding with less voids and proper adhesion with replacement level up to 20% in the concrete.

Praveen Mathew et al (2013) have investigate that the possibility of recycled plastic waste as partial replacement to coarse aggregate in concrete mix to determine its mechanical properties. Coarse aggregate from plastic waste are obtained by heating the plastic pieces at required temperature and cooled to get required size of aggregate. From this study shows that 20% substitution of natural coarse aggregate with plastic aggregate and increase in workability was reported that slump test of sample was carried out in concrete. An 28% increase in compressive strength and slight increase of split tensile strength and modulus of elasticity was observed. However they recommended that use of suitable admixture of 0.4% by weight of cement will improve bonding between matrix and plastic aggregate which enhance the properties of concrete mix.

Guendouz et al (2016) have investigated the implementation of two types of waste plastic in concrete from Polyethylene Terephthalate (PET) and Low Density Polyethylene (LDPE) as a fiber and fine aggregate. Different volume fractions of sand 10%, 20%, 30%& 40% were substituted by the same volume of plastic aggregate and various amounts of plastic fibers 0.5%, 1%, 1.5% &2% were introduced by same volume in concrete mix. The physical and mechanical properties of the concrete are determined. From the result the workability of concrete increases about 40% with plastic powder. By replacing plastic powder and plastic fibers up to 20% &1.5% a clear increase in compressive strength and flexural strength is achieved effectively. This study further suggests that reusing waste plastic in concrete give ecofriendly way to reduce cost and some environmental problems.

Prahallada (2011) had evaluated the strength and workability results of waste plastic fiber reinforced concrete (WPFRC) produced from recycled aggregates. The different percentages of waste plastic fiber reinforced concrete are 0%, 0.5%, 1%, 1.5%, 2%, 2.5% and 3% by volume fraction with an aspect ratio of 50.The results conclude that higher strength and workability characteristics of waste plastic fiber reinforced concrete using recycled aggregates and conventional aggregates can be obtained with 1% addition of fibers into concrete.

Fernando Fratemali et al (2011) have investigated the experimental study of thermal conductivity, compressive strength, first crack strength and ductility indices of recycled PET fiber-reinforced concrete (RPETFRC). PET filaments are industrially extruded from recycled PET bottle flakes with different mechanical properties and profiles. The optimum fiber usage of 1%, it was observe that marked improvements in thermal resistance, mechanical strength and ductility of RPETFRC, as compared to reference concrete. From the results indicates that RPETFRC has high performance than polypropylene fiber reinforced concrete in terms of compressive strength and fracture toughness. Hence the researches on the optimization of recycled PET (RPET) fibers for construction materials, as well as theoretical and experimental studies on the durability and fire resistance of RPET-reinforced materials to future work.

Mariaenrica Frigione et al (2010) conducted experiments to compare compressive strength, flexural strength and ductility performance of plain concrete and WPET concrete. The waste polyethylene terephthalate aggregates manufactured from recycled PET bottles and substituted in concrete of 5% by weight of fine aggregate. Specimens were casted with different cement content and water cement ratios. From the results concluded that increase in workability and ductility of WPET concrete when compared to plain concrete.

Charudatta P.Thosar et al (2017) have carried out an experimental investigation on replacement of natural river sand by using plastic waste recycled from PET or PP waste. Partial replacement of sand by waste plastic material up to 20%, 40% & 60% in M20 grade of concrete mix and tested after 28 days for compressive strength, tensile strength, flexural strength and modified density of concrete. From the experiment results revealed that the partial replacement of plastic waste material can be done to a limit of 20% to 40% for the satisfactory properties of concrete which is acceptable limit for the constructional purpose and an alternative research in civil projects.

Pramod S.Patil et al (2011) experimentally investigated the use of plastic recycled aggregate as replacement of coarse aggregate in concrete. Different plastic percentages of 0%, 10%, 20%, 30%, 40% and 50% are used as replacement of coarse aggregate in concrete mixes. Various tests were conducted and observed decrease in density of concrete with increase percentage of replacement of recycled plastic aggregates. From the result conclude that feasibility of replacing 20% of recycled plastic aggregate will satisfy the permissible limits of strength of concrete.

Mohsen Ahmadi et al (2017) have investigated the effect of mixed recycled aggregate as partial replacement of coarse aggregate in concrete with the addition of recycled steel fibers. The different replacement percentage of natural coarse aggregate with mixed recycled aggregate of 0%, 50% &100% with fiber percentage of 0.5% and 1% of concrete volume. The mechanical properties of normal concrete with recycled steel fibers and the concrete with recycled aggregate are investigated. From the result shows that increment of flexural strength, tensile strength and flexural toughness of concrete by increment of fibers to the concrete.

Elzafraney et al (2015) presented theoretical investigation on recycled plastic aggregate in concrete to work out its performance with regards to thermal attributes and efficient energy performance in comparison with normal aggregate concrete. The aggregates used in concrete are prepared from recycled plastics to meet various requirements of strength, workability and finish ability. It was observed that recycled plastic concrete having good insulation used 8% less energy in comparison of normal concrete. They concluded that the use of recycle plastic aggregate concrete being economical and light weights is having high resistance to heat. The figure 1 shows the various recycled plastic wastes.

Fig.1 (a) Pulverized Polyethylene Terephthalate (b) Granulated Polyethylene Terephthalate (c) PET flakes (d) Low Density Polyethylene Powder (e) High Density Polyethylene Powder (f) Polypropylene fiber

TABLE I: USE OF RECYCLED PLASTIC WASTE IN CONCRETE

SL. NO	NAME OF AUTHOR	YEAR	FORMS OF PLASTIC WASTE USED	PERCENTAGE USE IN CONCRETE
1	Rahmani et al	2013	Grinded PET bottles in the form of particles	Partial replacement of fine aggregate with PET particles by 5%, 10% and 15%.
2	P.Suganthy et al	2013	Pulverized High Density Polyethylene used in the form of granules of 1 mm size.	Partial replacement of fine aggregate with pulverized HDPE by 25%, 50%, 75% and 100%.
3	Bhogayata et al	2017	Shredded metalized	Used as fibers in concrete by 0% to 2%.

			polyethylene waste	
4	Youcef Ghernouti et al	2014	Recycled plastic bag waste in the form of sand	Partial replacement of fine aggregate by 10% to 40%.
5	Prahallada M.C	2009	Plastic fiber obtained from cutting waste plastic pots.	Addition of fiber with the 0.5% volume fraction based on distinct aspect ratios of 30, 50, 70, 90, and 110.
6	M.Guendouz	2016	Polyethylene Terephthalate and Low Density Polyethylene in the form of fiber and pulverized powder.	Addition of fiber with 0.5%, 1%, 1.5% & 2% and partial replacement of fine aggregate in concrete by 10%, 20%, 30% and 40%.
7	Fernando Fratemali et al	2011	Recycled PET and virgin polypropylene	Addition of fiber by volume with 1% for both types.
8	Ninoslav Pesic et al	2016	High Density Polyethylene used as fibers	Addition of fiber with 0.40%, 0.75% and 1.25%.
9	Zainab Ismail et al	2007	Recycled plastics of 80% polyethylene and 20% polystyrene in the form of granules.	Partial replacement of fine aggregate with granule plastic waste by 10%, 15% and 20%
10	Khilesh Sarwe	2014	Recycled fine PET particles along with steel fiber	Partial replacement of cement with fine PET particles by 0.2% to 1% and steel fiber of 0.1% to 0.5% in concrete mixes.
11	Raghatate	2012	Small pieces of plastic bags	Addition of plastics bag pieces from 0 to 1% in the concrete matrix.
12	R.L.Ramesh et al	2014	Recycled plastic granules of Low Density Polyethylene	Partial replacement of coarse aggregate with LDPE granules of 0%, 20%, 30% and 40%.
13	Saikia and Brito	2014	Three distinct types of plastic particles used Shredded fine flaky plastic particles (PF), Shredded coarse flaky plastic particles (PC), heat treated pellet-shaped spherical/cylindrical (PP)	5%, 10% and 15% replaced natural aggregate with each type (PF, PF, PC) of plastic particles
14	Charudatta et al	2017	Recycled PET or Polypropylene aggregates	Partial replacement of fine aggregate with PET particles of 20%, 40% and 60% in concrete mix.

III. CONCLUSION

These review paper suggest that different forms of plastic waste used in the production of concrete and replacement of concrete ingredients with suitable plastic waste. Thus the recycled plastic waste can be successfully used as partial replacement of fine aggregate in concrete to increase the compressive strength, split tensile strength and flexural strength and has excellent crack resistance property. The use of recycled plastics made an eco-friendly way of disposing the plastic waste. Hence the reuse of recycled plastic waste in concrete helps to reduce environmental impacts and best choice of strengthening of building.

REFERENCES

[1] Bhogayata, A, & Arora, N. K. 2017, "Fresh and Strength Properties of Concrete Reinforced with Metalized Plastic Waste Fibers", Construction and Building Materials, vol. 146, pp. 455- 463.

[2] Charudatta P. Thosar, & Husain, M. 2009, "Reuse of Plastic Waste as Replacement of Sand in Concrete", ISSN (Print): 2347- 6710, Vol. 6, Special Issue 1.

[3] Elzafraney, M, Soroushian, P, & Deru, M. 2015, "Development of energy Efficient Concrete Buildings Using Recycled Plastic Aggregate", Journal of Architectural Engineering © ASCE.

[4] Fernando Fraternali, Vincenzo Ciancia, Rosaria Chechile, Gianvittorio Rizzano, Luciano Feo & Loredana Incarnato. 2011, "Experimental study of the thermo-mechanical properties of recycled PET fiber-reinforced concrete", Composite Structures, vol. 93, pp. 2368- 2374.

[5] Guendouz, M, Debieb, F, Boukendakdji, O, Kadri, E.H, Bentchikou, M, Soualhi, H. 2016, "Use of plastic waste in sand concrete", ISSN: 2028-2508 Journal of Material and Environmental Science, vol. 7, Issue 2, pp. 382-389.

[6] Khilesh Sarwe. 2014, "Study of Strength Property of Concrete Using Waste Plastics and Steel Fibers", The International Journal of Engineering and Science, vol. 3, Issue 5, pp. 09-11.

[7] Mariaenrica Frigione. 2010, "Recycling of PET bottles as fine aggregate in concrete", Waste Management, vol. 30, pp. 1101-1106.

[8] Mohsen Ahmadi, Saeed Farzin, Abolfazl Hassani, Mana Motamedi. 2017, "Mechanical properties of the concrete containing recycled fibers and aggregates", Construction and Building Materials, vol. 144, pp. 392-398.

[9] Ninoslav Pesic, Stana Z ivanovic, Reyes Garcia, Panos Papastergiou. 2016, "Mechanical properties of concrete reinforced with recycled HDPE plastic fibres", Construction and Building Materials, vol. 115, pp. 362-370.

[10] Prahallada, M.C, & Prakash, K. B. 2011, "Strength and Workability Characteristics of Waste Plastic Fiber Reinforced Concrete Produced From Recycled Aggregates", ISSN: 2248-9622 vol. 1, Issue 4.

[11] Pramod S. Patil, Mali, J.R, Ganesh V. Tapkire, Kumavat, R. 2011, "Innovative Techniques of Waste Plastic Used in Concrete Mixture", International Journal of Research in Engineering and Technology.

[12] Praveen Mathew, Shibi Varghese, Thomas paul, Eldho Varghese. 2013, "Recycled Plastic as Coarse Aggregate for Structural Concrete", International Journal of Innovative Research in Science, Engineering and Technology vol. 2, Issue 3.

[13] Raghatate Atul, M. 2012 "Use of plastic in a concrete to improve its properties", International journal of Advance engineering Research and studies, pp. 1109-111.

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

[15] Ramesh, R L, Asharani K M, Dhiraj Katari V C, Pruthvi Sagar D S, Sahana R. 2009, "Recycled Plastics used as coarse aggregate for constructional concrete", SJB Institute of Technology, Bangalore.

[16] Shutong Yang, Xiaoqiang Yue, Xiaosong Liu, Yao Tong. 2015, "Properties of self-compacting lightweight concrete containing recycled plastic particles", Construction and Building Materials vol. 84, pp. 444-453.

[17] Suganthy, P, Dinesh Chandrasekar, Sathish Kumar, P. K. 2013, "Utilization of Pulverized Plastic in Cement Concrete as Fine Aggregate", ISSN: 2319-1163, vol. 2, Issue 6.

[18] Youcef Ghernouti, Bahia Rabehi, Brahim Safi, Rabah Chaid. 2013, "Use Of Recycled Plastic Bag Waste in the Concrete", Journal of International Scientific Publications: Materials, Methods and Technologies, vol. 8, ISSN 1314-7269.

[19] Yun Wang Choi, Dae Joong Moon, Yong Jic Kim, Mohamed Lachemi. 2009, "Characteristics of mortar and concrete containing fine aggregate manufactured from recycled waste polyethylene terephthalate bottles", Construction and Building Materials, vol. 23, pp. 2829-2835.

[20] Zainab Z. Ismail, & Enas A. AL Hashmi. "Use of waste plastic in concrete mixture as aggregate replacement", Department of Environmental Engineering, college of Engineering, University of Baghdad, Iraq.