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Utilization of Waste Plastic In Concrete - A Review

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ABSTRACT

Iraq industrial activities related to huge amounts of solid, non-biodegradable waste, waste low density Polyethylene (LDPE) plastic being among the well-known. So in this study, the scarped LDPE food boxes were transformed into fine particles and used as a sand for cement mortar and concrete. LDPE wastes were utilized to alter 0 to 25% of fine aggregates in mortar mixtures and 0% to 30% in concrete mixes at an increment of 5%. Compressive strength and dry density were tested for all mortar and concrete specimens. In addition, splitting tensile strength and ultrasonic pulse speed were tested for specimens of concrete. Results show that mass, pulse speed of ultrasonic, splitting and compressive tensile strengths were lowered as the size of LDPE raised. The lowest value of dry density, compressive strength and splitting strength was 2240 kg/m3, 18.7 MPa and 1.68 MPa, respectively, for 15% replacement of sand by the LDPE waste in concrete specimens. Whilst, the value of ultrasonic pulse velocity of LDPE concrete mixtures tends to decline lower than the reference values, but it remains nearly to the stander concrete mixtures and can be classified as excellent quality concrete. The density and compressive strength were decreased by using LDPE waste in mortar mixes for all replacement ratios reaching 12% and 42% respectively for 25% substitute. The use of plastic is increasing day by day, although steps were taken to reduce its consumption. This creates substantial garbage every day which is much unhealthy. A healthy and sustainable reuse of plastics offers a host of advantages.

This paper presents review of literatures related to utilization of waste material.

Keywords : concrete additive, concrete mixture; plastic waste; HDPE, plastic lamellar particle, Environmental Pollution, Economical, LDPE, Plastic paver bricks, Poly bags

I. INTRODUCTION

With the increase in industrialization and urbanization plastic has placed its footprint in all aspects of life. Plastic being used in electrical appliances, household materials, for packaging, as insulators, automobiles, electronic appliances, furniture and also building appliances like piping and plumbing equipment, as a result plastic has become an unavoidable thing in this world.

But only 25% of the waste plastic is recycled and the rest of 75% ends up in the landfills, oceans etc polluting the environment to an adverse extent. Improper disposal of plastic leads to release of hazardous chemical gases affects human health causing impaired immunity, infertility and may cause asthma. Plastic also harms birds and animal habitat. Hence these materials must be rightly disposed of or economically recycled. Some of these waste materials may be used in construction activities. The usage of industrial leftover materials for construction reduces the consumption of natural resources, and formulates an economical disposal method for the waste material as well. Plastics can be majorly classified into two different types based on their density namely high density polyethylene and low density polyethylene. Both HDPE and LDPE can be shredded to granular form and added to replace fine aggregate of concrete. Presence of these plastics in too much manner in gravel mining and stream sand causes the river degradation. Sand mining also affects the adjoining groundwater system and the uses that local people make of the river. In-stream sand mining results in the destruction of aquatic and riparian habitat through large changes in the channel morphology. Hence plastic granules can be used as aggregate replacement to a certain extent that serves the purpose of proper disposal of plastic and also to save nature's resources.

Plastic is a common material which finds its application in day today life. Lack of proper disposal methods for plastic waste is one of the main hazards faced by present the world. It affects the ecological system very badly as plastic is a non-biodegradable material. Various researches are ongoing in the world to make use of plastic waste in concrete. Plastic is of manmade material and is a stable polymer which is light in weight. The reduction of waste plastic is essential as it creates various environmental problems. If we make utilize the waste plastic as substitution of fine aggregate in concrete it will be greatly reducing the pollution caused by them. Thus the concrete can be made more eco-friendly.

II. LITERATURE SURVEY

Ibrahim Almeshal et al. (2020), the study aimed to investigate the effects of utilising poly-ethylene terephthalate (PET) as a partial substitute for sand in concrete. The effects of this material on the physical and mechanical properties of concrete were examined. Result concluded the approach reduces the self-weight of concrete in structures and helps conserve natural resources such as sand. Although the mechanical properties of concrete decreased by increasing the replacement ratio of PET and plastic had a negative effect on the fire resistance of concrete, plastic particles can be encapsulated from other materials and produce environmentally safe concrete.

Renji Xavier C and Nidhin B Parappattu(2016), included two stages were in the first stage fine aggregate is replaced with 4%,8%,12% plastic granules in an M30 grade of concrete and its percentage was optimized and in the second stage, the residual strength of the above mixes were found out by heating the specimens to2000 c,3000 c and 4000 c for one hour duration.Result concluded that the flexural strength was also found to be higher for some plastic mix and up to 8% replacement of fine

aggregate can be done successfully. From thermal results, it can be seen that all the plastic mixes of some plastics have retained about 75% of their original strength when heated to 4000 c.

Aakash garg and Suprakash Biswas (2020), the paper study was about the usage of E-waste for field add-ons in the concrete mix M20 separately and then we measured the level of stress, flexure intensity and tensile resistance at the percentage of E-waste with coarse aggregates from 0%, 3%, 7.5%, 12% and 15% respectively. Using e-waste as building material seems right when we look at the amount of aggregate required for making concrete and if we are able to reduce that amount it will be very beneficial as it reduces the load from the natural resources. Result concluded The e-waste can be disposed of effectively and makes the concrete light weight and therefore reduces the weight of the structure. Allows it robust so that seismic loads can comfortably carry. The burden on natural capital is rising. It makes concrete more workable. Saves the land used for e-waste disposal. It reduces the risk of damaging e-waste materials.

Arivalagan.S (2016), in this study tests were conducted to determine the properties of plastic aggregate such as density and specific gravity. As 100% replacement of natural fine aggregate with plastic fine aggregate is not feasible, partial replacement at various percentages were examined. Result concluded that As percentage of plastic increases, workability also increases because the plastic which is used as aggregate is smooth .As well as water absorption capacity of plastic is also low. The density of concrete decreased when plastic content increased because plastic has more water tightness capacity when compared to natural aggregate this can help in arresting micro cracks. By using recycled waste plastic in concrete can reduce the landfill and environmental issues.

MB Hossain et al. (2016), the present study did selected waste PET, a polymer compound of Polyethylene Terephthalate, to investigate its possible use as plastic aggregate in concrete application. The shredded waste plastic was used in concrete with partial replacement of 5%, 10% and 20% by volume of conventional coarse aggregate. Four types of concrete specimens including one without plastic aggregate, for comparison purpose, were prepared.

Result concluded that the concrete containing 10% PET aggregate can be effectively used in producing lightweight concrete. The density of concrete containing different percentages of plastic aggregate was lower than the fresh concrete and However, further study is required to understand the durability aspects of the concrete containing PET aggregate. The modulus of elasticity of concrete containing 10% volume of PET indicated higher performance than fresh concrete.

Suryakanta Panigrahi and Nagarampalli Manoj Kumar (2021), in this paper low density polyethylene (LDPE) granules used for coarse aggregate for producing concrete cubes and cylinders has been investigated and reported and also present study was aimed at concrete mix with partial replacement of coarse aggregate by LDPE granules (0%, 10%, 20% and 30%) that will provide an advantage in reducing the deadweight of structure. Result concluded that the properties of concrete containing various percentage of plastic (0%, 10%, 20%, and 30%) were tested for its physical properties and compressive strength. This research also had potential application for the production of lightweight concrete, for minimizing the amount of polymer wastes in landfills, and the creation of decorative, attractive landscaping products.

Aliyu Usman (2018), the paper presented a detailed review about waste recycled plastics and research published on the effect of non-irradiated recycled

plastic on the mechanical properties of cement mortar and cement concretes as either fillers or aggregates and the application of gamma radiation on the recycled plastic waste. The effect of recycled waste plastic on compressive strength, flexural strength and splitting tensile strength is discussed in this paper. Result concluded that, it was discovered that the strengths of mortars and concrete were not enhanced effectively when plastic wastes are added to the mixtures.

Only a small amount of plastic waste incorporated in concrete yielded little or no enhancement on the tensile strength.

A.O. Sojobi and H.I. Owamah (2014), This study evaluated an alternative solid waste management option for Low commonly called "pure water sachet" as partial replacement of sand in concrete. Three mix ratios of 1:1:2, 1:1.5:3, 1:2:4 were used while the LDPE waste materials Nigeria and the pulverized LDPE plastic waste, with compacted and uncompacted bulk densities of 362.9 kg/m^3 and 403.23 kg/m^3 respectively, could be classified as an ultralight -lightweight fine aggregate in terms of bulk density.

Result concluded the three concrete mix ratios 1:1:2, 1:1.5:3 and 1:2:4 satisfied the minimum requirements for CS and fire-resistant tests for use in reinforced and plain concrete with the exception of the concrete produced with concrete mix ratio 1:2:4 at 15% sand replacement with LDPE. Hence, beyond 15% replacement of sand with LDPE plastic waste, concrete mix ratio 1:2:4 is not advisable to be used in building elements susceptible to fire due to its potential to lose CS drastically in the presence of fire or heat. vi. LDPE plastic concrete could be used in production of non-load bearing structural members such as tiles and partitions.

Ch. Sravan Kumar Reddy et al. (2019), the main theme of this paper was to reduce environmental pollution by recycling the waste Low-Density Polyethylene (LDPE) plastic bags and decrease plastic waste. In this paper the LDPE plastic bags are recycled and used as total replacement for cement to prepare plastic paver bricks. There will be no economic problems as waste plastic is used.

Result concluded the compressive strength of the plastic paver brick is higher than the conventional brick and By using this plastic paver brick there were many advantages where the cost of brick low than the conventional brick which is economical. As this cannot compete with concrete paver block, but it can be used in the places where low loads are applied like walk ways in gardens, car parking areas and in low traffic places.

Afroz Sultana.SK and K.S.B.Prasad (2012), the present study investigated the potential use of waste plastic as a modifier for asphalt concrete and cement concrete pavement.Different ratios of plastic such as Polypropylene (PP), Low Density Polyethylene (LDPE), and High Density Polyethylene (HDPE) by weight of asphalt were blended with 80/100 paving grade asphalt. Result concluded that by using plastic as a coating over aggregates, the properties of aggregates were improved. This showed that weak aggregates can be used in construction by using plastic as a binder material and by using these plastic wastes for road construction, there is a possibility of reducing disposal of waste plastic which is harmful to the environment.

Darsh Panchal et al. (2020), The aim of the experiment is to evaluate the effect of addition of shredded waste plastics on the compressive strength, density of concrete and weight of concrete. Ordinary Portland cement was mixed with the fine aggregate and coarse aggregate to produce the concrete

composites. Standard concrete mix design of M25 and 0.50 w/c ratio was used for the experiment.

Results concluded that we may have to use proper admixtures to maintain the workability of the concrete and the weight of the concrete is decreasing with increase in plastic waste content. Adding plastic waste makes concrete light weight.

Sugunadevi et al. (2019), The aim of this research is to compare the strength characteristics of conventional concrete of grade M20 with the plastic concrete. A potential application of plastic concrete is pavement base, sub base and lightweight concrete construction. Result concluded that during the research, it was observed that, workability of concrete decreased with addition of plastic due to their angular shape and irregularity and Finally the research revealed that, the plastic concrete does not increase the compressive strength, hence it cannot be used for load bearing structures , it can be for pavements, lightweight concrete structures, partition walls.

Abdulrahman S et al. (2020), in this study, the scarped LDPE food boxes were transformed into fine particles and were used as a sand for cement mortar and concrete. LDPE wastes were utilized to alter 0 to 25% of fine aggregates in mortar mixtures and 0% to 30% in concrete mixes at an increment of 5%. Compressive strength and dry density were tested for all mortar and concrete specimens. In addition, splitting tensile strength and ultrasonic pulse speed were tested for specimens of concrete. Result concluded that mass, pulse speed of ultrasonic, splitting and compressive tensile strengths were lowered as the size of LDPE raised. The lowest value of dry density, compressive strength and splitting strength was 2240 kg/m3, 18.7 MPa and 1.68 MPa, respectively, for 15% replacement of sand by the LDPE waste in concrete specimens.

M A Kamaruddin et al. (2017), This paper summarized recent progress on the development of concrete mixture which incorporates plastic wastes as partial aggregate replacement during concrete manufacturing. A collection of data from previous studies that have been researched which employed plastic waste in concrete mixtures were evaluated and conclusions are drawn based on the laboratory results of all the mentioned research papers studied. Result concluded By utilizing this waste as partial aggregate replacement, it could be inferred that these materials could be preserved inside concrete structures for ages and long-term performance of plastic waste in concrete, and their environmental impact after its service life are recommended to be explored further.

Fahad K. Alqahtani et al. (2015), it was invested, that an attempt was undertaken to produce recycled plastic aggregate (RPA) using waste plastic and red sand as filler. The physical properties of RPA are reported and an experimental investigation of concrete incorporating RPA as coarse aggregates is presented.

Result concluded that the compressive strength and chloride ion penetration for concrete made with recycled plastic aggregate and lightweight local (to Saudi Arabia) aggregate were investigated and compared and The concrete made using recycled plastic aggregate (RPA) was a little more durable compared to that made with natural lightweight aggregate.

Dawei Li et al (2019), this paper mainly tested the X-ray diffraction (XRD), different scanning calorimeter (DSC), direct current (DC) breakdown and conductance properties of low-density polyethylene (LDPE), linear low density polyethylene (LLDPE), medium density polyethylene (MDPE), and high-density polyethylene (HDPE), and further analyzes the experimental results separately.

Result showed that an increase in the density of polyethylene leads to the continuous improvement of crystallinity, and an increase in crystallinity causes a significant decrease in the conduction current at the same field strength. The field strength corresponding to the two turning points in the conductance characteristic curve increases simultaneously.

T O Ogundairo et al. (2020), the study submits that there is an opportunity for the use of plastic waste as an innovative alternative in the construction industry which can stimulate economic growth and could boost the drive of government towards the achievement of some of the sustainable development goals.

Result concluded that the plastic waste construction materials should be examined in more detail under a wide variety of conditions to promote the acknowledgement of its use in industrialized civil engineering applications. The overall research activities should not exclusively be constrained to papers. However, pilot-scale undertakings should be organized and execution assessed to guarantee industry sustainability.

Shivasharana C T and Sheetal Suresh Kesti (2019), the study was about Low Density Polyethylene (LDPE) and High Density Polyethylene (HDPE) bags collected from the plastic manufacturers Hubli, India. The bags were washed with 1% SDS solution and 70% ethanol to remove the dust particles adhered to plastic bags and used for further analysis and the LDPE and HDPE films were cut in small pieces (1mm size)) separately and crushed with Potassium bromide (KBr) in a mortar and pestle and added to the pan to make pellets.

Result concluded that the basic characteristics of LDPE and HDPE and to inculcate the same in degradation studies. Plastic pollution is the most serious environmental threat at present. The future aspects of this study will be in knowing the efficient methods for degradation by understanding the basic characters of plastics.

III.CONCLUSION

Here authors illustrated that utilization of waste material and its settlement in construction industry. Study submits that there is an opportunity for the use of plastic waste as an innovative alternative in the construction industry which can stimulate economic growth and could boost the drive of government towards the achievement of some of the sustainable development goals

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