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A-REVIEW ON STUDY OF THE PARTIAL REPLACEMENT OF NATURAL COARSE AGGREGATE WITH WASTE PLASTIC AGGREGATE

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Abstract

In this study the properties of concrete that can be modified using Plastic are its Compressive Strength, Split Tensile Strength, Flexural Strength and there are some other important properties of concrete will also be under consideration such as workability, compaction, bleeding and segregation of concrete. The plastic aggregate were replaced by 0%, 2.5%, 5%, 7.5% and 10% by weight of Natural Course aggregate.

Keywords: *High Density Polyethylene (HDPE), CONPLAST-SP430, Plastic Aggregate.*

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1. INTRODUCTION

Concrete is the mostly used man made material used in construction industry and is the second after water as the most utilized thing on the Earth. In simple words it is defined as a mixture off our ingredients as **coarse aggregates** that form the largest proportion of the mix, **fine aggregates** such as sand that act as filler material in the voids, **binding material** such as lime or Portland cement that binds this material together and **water** that reacts with binding material. The mixing of these four materials gives us a paste that is called as matrix. At this stage it is called as fresh concrete or green concrete and get hardened like a stone, as the water reacts with binding material. This reaction is called as hydration of concrete. In fresh state concrete can be casted into any desired shape by placing it in forms. This property of concrete help in using the concrete in most efficient manner. **Plastic** needs no introduction as it is the widely used material now a days on our Earth. Due to its properties like strength, durability and easy processing it can be used for many purposes. Studies show that plastic is nearly inert that is it gets very less affected by the chemicals and have higher durability. Disposal of plastic waste is a huge problem as due to absence of organic compounds it is non decomposable material and proves to be a threat to our environment as it has many health hazards. As decomposition of plastic is a serious problem as it takes very long time and adversely affection the environment in many ways. So, we can use it in construction, where we need life of structure to be improved and use of waste plastic after small processing can help us to reduce the waste in the environment which is new motto of civil engineering.

The utilization of waste in the construction industry has two glaring dividends, one, environmental impact is addressed by disposal of the waste and second, the economic impact and this waste has the edge of being available large quantity, everywhere and at low value. Concrete being the widely used construction material in the world estimated up to 11 billion metric tons every year. Typical concrete ingredients are cement, sand and coarse aggregate which are used universally for producing concrete. Due to the great utility of concrete, with the passing of each day these materials are getting deficient thus demanding for the alternatives. It is off course a matter of serious concern for the civil engineers who are on the search of suitable materials which can fully or partially replace the typical concrete materials. Keeping in view the disposal issues of plastic waste, its utility in concrete is studied and experimented by various researchers. They have worked on the 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. Testing was conducted on the samples casted by using plastic waste in the laboratory to study the variation of concrete properties from normal concrete.

The behavior of concrete is studied under various combination of plastic waste material with regard to effect on various concrete properties. This paper is based on the review of literature which gives the idea of utilizing various plastic waste materials in the concrete.

2. LITERATURE REVIEW

Elango A et. al(2018) performed study concrete with plastic fine aggregates. They used OPC 53 grade, River sand and crushed aggregates. They used plastic in place of fine aggregates in proportion of 10%, 20% and 30%. They test mechanical and durability properties on their concrete samples. They found the decrease in strength of concrete. But found that the concrete shows good results against acid attacks and increase in elasticity. So they concluded that the plastic aggregate concrete can be used in place where we need less compressive strength but more durability.

LhakpaWangmoet. al. (2017) performed experiment on Plastics in Concrete as Coarse Aggregate. They performed the testing of mechanical properties of concrete containing Plastic aggregates They use plastic aggregates in proportion of 10%, 15%, and 20%. They found marginal reduction in strength and suggested the optimum result as 15% replacement.

B Jaivigneshet. al (2017) performed Study Properties of Concrete with Plastic Waste as Aggregate. They used the plastic place of fine aggregates as well as coarse aggregates in proportion of 10%, 15 % and 20%. They also added steel fibre to the concrete. Their research concludes to the reduction in strength but suggested its use in favor of reduction of waste material and eco-friendly materials.

MB Hossain et. al. (2016) performed work on Use of waste plastic in concrete as a constituent material. They replace coarse aggregates in proportion of 5%, 10% and 20. They found that the concrete was lighter in weight. But the compressive strength was lesser than that of conventional concrete. They also found that the concrete with

10% plastic aggregates shows strength nearly similar to the conventional concrete. So, the optimum result was 10% plastic aggregates.

Raghatate et. al (2012) performed study on use of plastic bags in form of fiber in concrete and test it properties. He adds fiber in proportion of 0.2%, 0.4%, 0.6%, 0.8% and 1% by weight of concrete. He found that there was reduction of com-pressive strength with increase in plastic content, but there was increase in tensile strength with optimum strength at 0.8% addition.

Praveen Mathew et. al. (2013) study the use of Recycled Plastics as Coarse Aggregate for Structural Concrete. They per-formed test on concrete with various proportions of plastic aggregates in replacement of coarse aggregates and found the optimum result at 22% replacement of coarse aggregates with plastic aggregates. They further performed the test for other properties on concrete with 22% plastic aggregates and found that concrete with plastic aggregates was weaker in fire re-sistance.

S. Vanitha et al. (2015) performed studies on use of waste plastic in Concrete Blocks. Paver Blocks and Solid Blocks of size 200 mm X 150 mm X 60 mm and 200 mm X 100mm X 65 mm were casted for M20 grade of concrete and tested for 7, 14 and 28 days strength. Plastic was added to a proportion of 2%, 4%, 6%, 8% and 10% in equal replacement of aggre-gates. They found the optimum result for paver block at 4% replacement of aggregates with plastic aggregates. And 2% of plastic in case of solid blocks.

Baboo Rai et. al. (2012) study of Waste Plastic in Concrete with Plasticizer. They prepared M30 grade of concrete with varying proportion plastic pallets and then test the concrete with and without plasticizers. They add plastic pallets in pro-portion of 5%, 10% and 15% by weight of concrete. They found that there was reduction in density that can help in achieving low density or light weight concrete. they also found that there was reduction in slump and hence affects the workability but addition of plasticizers resolves the problem. They found reduction in compressive and flexural strengths but it was very low and can be allowed.

Daniel Yaw Osei (2014) performed experiments on plastics aggregate in concrete. He replace the coarse aggregates in concrete of ratio 1:2:4 by 25%, 50%, 75% and 100% with plastic. He found that there was reduction in strength of con-crete as well as density of concrete. They suggested that replacement of aggregates more than 36% is not suitable for struc-tural concrete. They also suggested plastic as a medium for production of light weight concrete.

T.Subramaniet. al (2015) performed an experiments on plastic waste as coarse aggregatesin concrete. They prepared the concrete with 5%, 10% and 15% replacement of aggregates in concrete with plastic. They found the optimum results at 10% replacement of aggregates with plastic. Further increase in plastic content decreases the strength of concrete.

NabajyotiSaikia et. al (2012) study use of plastic in cement mortar and concrete. They found that workability decreases on use of angular plastic aggregates but increases with use of smooth aggregates. Irrespective of type of plastic, there was reduction of compressive strength, but the reduction of flexural and tensile strength was low as compared to compressive strength.

Amalu.R.Get. al. (2016) performed the study the use of waste plastic as fine aggregate in concrete. They use plastic as sub-stitute of fine aggregates in proportion of 10%, 15%, 20% and 25%. They found reduction in strength of concrete but sup-port the use of plastic in non structural concrete for the reason it shows higher work-ability and reduce environmental waste.

Manhal A Jibrael et. al (2016) studies the Strength and Behaviour of Concrete Contains Waste Plastic. They replace fine aggregates in concrete with plastic bottles and plastic bags in varying proportions from 0% to 5%. They concluded the re-sults to use the plastic in concrete for non structural purposes as it reduces the strength in both cases.

YoucefGhernouti et al. (2014)The study present the partial replacement of fine aggregate in concrete by using plastic fine aggregate obtained from the crushing of waste plastic bags. Plastic bags waste was heated followed by cooling of liquid waste which was then cooled and crushed to obtained plastic sand having finesse modulus of 4.7. Fine aggregate in the mix proportion of concrete was replaced with plastic bag waste sand at 10%, 20%, 30% and 40% whereas other concrete materials remain same for all four mixes. In fresh properties of concrete it was observed from the results of slump test that with increase of waste content workability ofconcrete increases which is favorable for concrete because plastic cannot absorb water therefore excessive water is available. Bulk density decreases with increase of plastic bags waste. In harden state, flexural and compressive strength were tested at 28 days and reductions in both strengths with increasing percentage of plastic bag waste sand in concrete mix. Plastic waste increases the volume of voids in concrete which on other hand reduce the compactness of concrete simul-taneously speed of sound in concrete is also decreased. Strength reduction in concrete mix was prime concern; however they recommend 10 to 20% replacement of fine aggregate with plastic aggre-gate. Use of admixtures to address the strength reduction property of concrete with addition of plastic aggregate is not em-phasized.

Raghatate Atul M. (2012)The paper is based on experimental results of concrete sample casted with use of plastic bags pieces to study the compressive and split tensile strength. He used concrete mix by using Ordinary Portland Cement, Natu-ral River sand as fine aggregate and crushed granite stones as coarse aggregate, portable water free from impurities and containing varying percentage of waste plastic bags (0%, 0.2%, 0.4%, 0.6% 0.8% and 1.0%). Compressive strength of con-crete specimen is affected by the addition of plastic bags and with increasing per-centage of plastic bag pieces compressive strength goes on decreasing (20% decrease in compressive strength with 1% of addition of plastic bag pieces). On other hand increase in tensile strength of concrete was observed by adding up to 0.8% of plastic bag pieces in the concrete mix afterward it start decreasing when adding more than 0.8% of plastic bags pieces.

He concluded that utility of plastic bags pieces can be used for possible increase in split tensile strength. This is just a basic study on use of plastic bags in concrete. More emphasis was required by varying the shape and sizes of plastic bags to be use in concrete mixes.

Praveen Mathew et al. (2013)They have investigated the suitability of recycled plastic as partial replacement to coarse aggregate in concrete mix to study effect on compressive strength, modulus of elasticity, split tensile strength and flexural strength properties of concrete. Coarse aggregate from plastic was obtained by heating the plastic pieces at required tem-perature and crushed to required size of aggregate after cooling. Their experimental results shown that plastic aggregate have low crushing (2.0 as compare to 28 for Natural aggregate), low specific gravity(0.9 as compare to 2.74 for Natural aggregate), and density value(0.81 as compare to 3.14 for Natural aggregate), as compare to Natural coarse aggregate. Their test results were based on 20% substitution of natural coarse aggregate with plastic aggregate. Increase in workability was reported when slump test for sample was carried out. Volumetric substitution of natural aggregate with plastic aggre-gate was selected best in comparison with grade substitution. At 400 centigrade temperature Plastic coarse aggregate shown considerable decrease in strength as compare to normal concrete. An increase of 28% was observed in compressive strength but decrease in split tensile strength and modulus of elasticity was observed. They recommended that with use of suitable admixture @0.4% by weight of cement will improve the bonding between matrix and plastic aggregate; however they demand more research to address the tensile behavior of concrete prepared with 20% plastic aggregate.

R L Ramesh et al.(2015)They have used waste plastic of low density poly ethylene as replacement to coarse aggregate to determine its viable application in construction industry and to study the behavior of fresh and harden concrete properties. Different concrete mix were prepared with varying proportions (0%, 20%, 30% & 40%) of recycle plastic aggregate ob-tained by heat treatment of plastic waste (160-200 centigrade) in plastic granular recycling machine. A concrete mix de-sign with 1: 1.5: 3 proportions was used having0.5 water/cement ratio having varying proportion of plastic aggregate as replacement of crushed stone. Proper mixing was ensured and homogeneous mixture was prepared. A clear reduction in compressive strength was reported with increase in percentage of replacing plastic aggregate with crushed aggregate at 7, 14 and 28 days of casted cubes (80% strength achieved by replacing waste plastic up to 30%). The research highlights the potential application of plastic aggregate in light weight aggregate. Their research was narrowed down to compressive strength of concrete with no emphasis given to flexural properties of concrete. They suggest future research scope on plas-tic aggregate with regard to its split tensile strength to ascertain its tensile behavior and its durability aspects for beams and columns.

Zainab Z. Ismail et al. (2007)they have conducted comprehensive study based on large number of experiments and tests in order to determine the feasibility of reusing plastic sand as partial replacement of fine aggregate in concrete. They con-ducted tests on concrete samples for dry/fresh density, slump, compressive and flexural strength and finally toughness indices on room temperature They have collected waste plastic from plastic man-ufacture plant consist of 80% polyeth-ylene and 20% polystyrene which was crushed (varying length of 0.15-

12mm and width of 0.15-4mm). Concrete mix were produce with ordinary Portland cement, fine aggregate (natural sand of 4.74mm maximum size), coarse aggregate (max size below 20mm) and addition of 10%, 15% and 20% of plastic waste as sand replacement. Their test results indicate sharp decrease in slump with increasing the percentage of plastic, this decrease was attributed to the presence of angular and non uniform plastic particles. In spite of low slump however, the mixture was observed with good workability and de-clared suitable for application. Their tests also revealed the decrease in fresh and dry density with increasing the plastic waste ratio; however increase was reported in dry density with time at all curing ages. Decrease in compressive and flexural strength was observed by increasing the waste plastic ratio which can be related to decrease in adhesive strength between plastic waste particles with cement. However, load-deflection curve of concrete containing plastic waste showed the arrest of propagation of micro cracks which shows its application in places where high toughness is required. The study has shown good workability in spite of low slump but w/c content kept constant in all samples. They should have reduced the water content in order to improve the strength when workability was not an issue.

P. Suganthy et al. (2013) This study investigate the application of pulverized fine crushed plastic (produce from melting and crushing of high density polyethylene) as replacement of fine aggregate in concrete with varying known percentages. Their mainfocus was on optimum replacement of natural sand by pulverized plastic sand. Five concrete mixes were pro-duced from specified concrete materials having replacement of fine aggregate (sand) by 0, 25, 50, 75 and 100% respec-tively to study the test graph results of various concrete properties. The results showed increase in water/cement ratio with increase replacement of sand with plastic particles to achieve desired 90mm concrete slump. They have also observed from the results that gradual decrease in strength of concrete specimen for plastic replacement up to 25% but afterward the decrease in strength is rapid which shows suitable replacement up to 25% of sand with plastic pulverized sand. They have also concluded after testing of specimen (having different proportion of plastic replacement) for Ultimate and yield strength that both strength decreases with increase replacement of sand with pulverized plastic particles. Their study lacks detailed testing of properties of concrete because only compressive strength and w/c ratio tests will not be sufficient to study the matrix as a whole to be suitable for construction. No efforts were made to explore the use of admixtures in con-trolling of compressive strength reduction in a mix containing pulverized plastics.

KhileshSarwe. (2014)This study presents the results of addition of waste plastics along with steel fibers with an objective to seek maximum use of waste plastic in concrete. Two different categories of mix were casted in cubes (150mm x 150mm x 150mm), one with varying percentages of plastic wastes (0.2%, 0.4%, 0.6%, 0.8% and 1% weight of cement) and another mix of plastics waste/steel fibers (0.2/0.1, 0.4/0.2, 0.6/0.3, 0.8/0.4 and 1/0.5 % by weight of cement) to study the compressive strength at 7 and 28 days strength. The combine mix of plastic waste and steel fibers has shown more strength as compare to concrete mix prep only with plastic waste. He has reached to conclusion that a plastic waste of 0.6% weight of cement when used with steel fiber of 0.3 % (weight of cement) has shown the maximum compressive strength. This study has really focused on addressing the issue of reduced compressive strength with addition of plastic waste. Steel fibers when used along with plastic wastes will affect

all the properties of concrete but the researcher only focused on compressive strength property which is insufficient to give clear picture of concrete behavior.

A Bhogayata et al. (2012) they have studied the environment friendly disposal of shredded plastic bags in concrete mix to be use in construction industry which have dire need for alternative material to be use in lieu of conventional materials. Different test results were analyzed after testing on 48 x concrete cubes(150mm x 150mm x150mm) prepared from vary-ing percentage of polyethylene fibers (0.3, 0.6, and 0.9 to 1.2% of volume of concrete) with conventional concrete materi-al to prepare mixes. Two type of plastic bag fibers were used, one cut manually (60mm x 3mm) and another shredded into a very fine random palette. Cubes were tested for 7&28 days compressive strength and compaction. They concluded that good workability was shown by the mix added with shredded fibers due to its uniform and higher aspect ratio evenly sprayed in the mix. Addition of plastics up to 0.6% is considered suitable after which reduction in compressive strength and compaction is seen affected. They observed that strength loss was less in concrete having shredded fibers of plastic as compare to hand cut macro fibers. Their research focus was only on comparative study of compressive strength but no work was carries out on other concrete properties like tensile strength, modulus of elasticity and density of concrete.

M. Elzafraney et al. (2005)this study has incorporated use of recycled plastic aggregate in concrete material for a building to work out its performance with regards to thermal attributes and efficient energy performance in comparison with nor-mal aggregate concrete. The plastic content concrete was prepared from refined high recycled plastics to meet various re-quirement of building construction like strength, workability and finish ability etc. Both buildings were subject to long and short term monitoring in order to determine their energy efficiencies and level of comfort. It was observed that recycled plastic concrete building having good insulation used 8% less energy in comparison of normal concrete; however saving in energy was more profound in cold climate in building with lower insulation. They recommended that efficiency of energy can further be increase if recycle plastic of high thermal capacity is used. They have suggested the use of recycle plastic aggregate concrete being economical and light weights are having high resistance to heat. The author should also incorpo-rate the comparison of both buildings with regards to durability and strength.

Pramod S. Patil.et al (2014) This study presents the use of plastic recycled aggregate as replacement of coarse aggregate for production of concrete. They used forty eight specimen and six beams/cylinders casted from variable plastic percent-ages (0, 10, 20, 30, 40 and 50%) used as replacement of coarse aggregate in concrete mixes. They have conducted various tests and observed decrease in density of concrete with increase percentage of replacement of aggregate with recycle plas-tic concrete. They also reported decrease in compressive strength for 7 and 28 days with increase in percentage of re-placement of coarse aggregate with recycle plastic aggregate. They have recommended feasibility of replacing 20 % will satisfy the permissible limits of strength. Again these researchers limited their research to only compressive strength proper-ty and no work was carried out to study the other important properties of concrete. Their research also lacks use of various admixtures in concrete to cater for the loss in strength.

3. CONCLUSION

As per the above various research it is very clear that the waste plastic aggregates may used as some fraction in place of Natural Coarse aggregate. It is also suggested that the use of waste plastic as Plastic aggregate may helps to reduce the plastic waste which ultimately securing environment neat and clean.

As per the strength of concrete is concern 0 % to 15% of Replacement of Natural Coarse Aggregate with Plastic Aggregate is recommended, which gives satisfactory results of strength of concrete.

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