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Plastic as Aggregates in Concrete- A Review

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Abstract: The concrete is the most widely used material by mankind. A natural resources are dwindling by industrial uses, there is a need for using alternate materials instead of using natural sand and crushed stones as fine and coarse aggregates. Plastic is now widely used by common people, next to metals. Metals are gradually replaced by plastics in various industries. Plastic wastes can be seen in every land, water bodies such as streams, rivers, ponds, seas. Hence used plastic should be recycled or reused. Plastic can replace the sand and crushed stones in concrete. Many researches are going on in this field. This paper reviews such research works.

Keywords: coarse aggregate, fine aggregate, concrete, Plastic, waste

I. INTRODUCTION

Concrete was invented by ancient Romans. It was used to build long lasting structures like Pantheon. They used lime, volcanic ash, locally available coarse and fine aggregates. Now concrete has evolved with usage of cement as binder and varieties of fine aggregates and coarse aggregates as per the requirement of the construction. But concrete is the major environmental damaging material as it consumes large quantities of natural sand and natural crushed stones, hence there is a necessity to replace these with waste materials such as plastics, fly ash, GGBS, marble dust, etc.

Plastic which has thousands of polymers under its name is widely used and evolving with types of applications. It has short useful life span and discarded indiscriminately in to the environment. We are in age of plastics. Plastic is present in every object, vehicle we use. But only less than 10% of waste plastic are recycled worldwide. Hence there is large potential to use the waste plastics in concrete as aggregates.

II. REVIEW

Researchers have primarily replaced natural aggregates of both fine and coarse sizes with plastic aggregates of various types and shapes. They have manufactured concrete with various physical properties. The following are the works

Light weight Concrete with Handmade plastic aggregates was created by Purushothama et al., [1]. The natural aggregates were replaced by plastic aggregates upto 10% by weight.

Physical properties such as porosity and water vapor [2] can be increased by using plastic aggregates of polyethylene terephthalate and Polyolefin in hydraulic mortars but there is decrease in flexural and compressive strength of these mortars.

Increase in impact resistance was found in concrete with [3] shredded PET bottles as replacement of natural aggregates in concrete upto 20% by total weight of concrete. But as in previous works there was reduction in compressive strength.

Ductile post-peak behavior was observed in concrete having plastic aggregate by Fahad, et al [4] but reduction physical properties such as slump, compressive strength, flexural strength, splitting tensile strength and elastic modulus was observed. They suggested a maximum replacement of 25% of natural aggregates by plastic aggregates.

Physical properties such as slump and passing ability was improved in self-compacting lightweight concrete with replacement of sand by plastic aggregates up to 15% by Shutong Yang, et al, [5], But the physical properties such as dry bulk density and elastic modulus decreased as replacement percentage increased. Azad Khajuria, et al [6] results also showed reduced compressive strength with plastic aggregates.

Poor bond strength between plastic aggregates and cement was observed in works done by Jaivignesh et al., [7] with mixed plastic aggregates.

Reduction in density and compressive strength was observed in lightweight and structural concrete created by Daniel Yaw Osei [8] when natural aggregates were replaced by plastic aggregates.

High value of compressive strength was observed in concrete in which natural aggregate was replaced by plastic at 20% by Umadevi et al., [9],

Platics when added to concrete improves the strain capacity of concrete and thermal conductivity also reduces as per Parvesh Kumar et al. [10]

Plastic aggregates in the sizes equal to sand gives good results and bonding improving chemicals can be added to improve bonding between aggregates and cement as per Jason [11]

Increased strength, was obtained in the 30% plastic aggregates replaced concrete. Less workability and bonding between plastic aggregates and cement were observed by Pawar et al., [12].

polybutylene terephthalate (PBT) plastics have good physical properties such as mechanical strength and low moisture absorption as per Joe Nasvik[13] thus improving the capacity to resist freeze and thaw.

Habib et al., [14], concluded that plastic aggregates concrete can be used only for non-load bearing applications as compressive strength, flexural strength and split tensile strength were reduced drastically when compared to concrete with natural aggregates.

Strain energy capacity and impact resistance of concrete was improved when recycled acrylonitrile-butadiene-styrene/polycarbonate copolymer (ABS/PC) plastic particles replaced sand by Feng et al[15],

Micro cracks propagation was reduced by waste plastic of fabri form (fibres) when it was used to replace sand by Zainab et al., [16],

Low-cost Polyester mortar(PM) made with fly ash and Polyethylene terephthalate was made Karim et al., [17], which showed good physical properties.

Usage of shredded fibres up to 0.6% with higher aspect ratio has good workability as per Bhogayata et al [18].

Recycled plastic concrete with energy-efficient building design can lowered heating and cooling loads as per the studies by Elzafraney et al [19].

The increase in volume and size of waste plastics decreased compressive strength in studies by Patil et al [20],

III. CONCLUSION

If plastic is used in concrete as a substitute for natural fine or coarse aggregates, there is reduction in compressive strength, split tensile strength, flexural strength, workability and density. But waste plastic as fibres improve the cracking resistance. Bonding between cement and plastic aggregates were addressed by many researchers. But due the impact of plastics to environment and their low recycling percentage, more studies must be done to include waste plastic in various non-structural civil engineering applications.

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