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A Review on Utilization of Plastic Waste as Aggregate in Construction Materials

Balvant Swaroop[1], Vaibhav Dubey[2]

[1]M.tech, Department of Civil Engineering Rama University Kanpur UP

[2]Assistant Professor, Department of Civil Engineering Rama University Kanpur UP

Abstract:

In a construction material in a modern construction if we look the major component includes concrete and steel reinforcement. However, in recent studies it showed the replacement of steel bars by the different material like bamboo etc. and in concrete there is fiber, red mud and fly ash is been deployed as the replacement for the binding material say cement.In today's scenario the utilization of plastic in day-to-day life is showed the substantial growth but the associated problem with the plastic is their environmental impact as they cannot get easily decomposed. So, if we utilize this plastic waste in a construction works as a construction materialmay lead to the significant reduction in its waste foot print. In recent literature, significant strides have been made in the development of concrete mixtures that integrate plastic waste as a partial substitute for traditional aggregates during the concrete manufacturing process. Some recent studies show that it can be used construction industry due to some of its properties like inert behaviour, resistance to degradation etc. Also, use of waste plastic can help in reducing plastic waste. This emerging trend reflects a broader commitment to sustainability, aiming to mitigate plastic pollution while fostering environmentally conscious construction practices.

Introduction:

The fundamental components constituting the concrete mix include cement, fine aggregate, coarse aggregate, water, chemical admixtures, and mineral admixtures. Furthermore, concrete utilized in construction may incorporate reinforcing bars, welded wire fabric (wire mesh), and assorted reinforcing fibres. The excellence of these ingredients, their precise proportions, and the manner in which they are amalgamated all exert a profound influence on the strength and resilience of the concrete.

Plastic requires no introduction, being one of the most extensively utilized materials in contemporary society. Its widespread adoption stems from its inherent attributes such as strength, durability, and ease of processing, rendering it versatile for myriad applications. Research indicates that plastic exhibits remarkable inertness, rendering it minimally affected by chemical interactions and endowing it with heightened durability. However, the disposal of plastic waste poses a formidable challenge. Lacking organic compounds, plastic is non-decomposable, posing a significant threat to our environment and harbouring numerous health hazards.

The decomposition of plastic presents a critical challenge, as it occurs over an extensive timeframe and inflicts adverse effects on the environment across multiple dimensions. However, a viable solution lies in its utilization within construction practices. By integrating waste plastic, subjected to minimal processing, into construction materials, we can enhance the longevity of structures. Moreover, this approach aligns with the emerging ethos of civil engineering, aiming to mitigate environmental waste through innovative strategies.

Objective:

We get most of the aggregates by quarrying the stones and then crushing. As quarrying of stones cause change in geological aspects of the area, crushing causes the entry of dust particles in the environment. So, causing bad impact to the environment in dual manner. To minimize this researcher focused on the usage of waste materials that were also adversely affecting the environment. Some of these are already in use such as Iron slag, Crusher Dust, etc. and many others are under research. So,usage of these waste materials helping in dual role by minimizing the usage of raw material of concrete and by using the waste materials that are affecting the environment. The other advantage of using these waste materials is that they are helping in improving the properties of concrete. The waste materials we have taken for our study is Plastic. Plastic has very bad impact on our environment but due to some of its properties it can be used in concrete.

Specific objectives of this work include:

- To determine the properties of plastic aggregate.
- To conduct a comparative study of plastic aggregate (PAC) and natural aggregate (NAC).
- To study the effect of replacing natural aggregate with plastic aggregate on workability, compressive strength,
- Splitting tensile strength and flexural strength of concrete.
- To study the effect of replacing natural aggregate with plastic aggregate on weight of concrete.
- This can help the environment and earth from being polluted and can reduce further pollution also reducing its rate of pollution.
- The weight of concrete per unit volume will be reduced resulting in light weight concrete.
- The cost of constructing concrete can be reduced resulting on economical concrete.
- The area required for the landfilling will be less.
- This can open a new scope for reusing of disposable materials

Literature Review:

1. ***Utilisation of plastic waste as aggregate in construction materials: A review***

(Nur Hanis Zulkernain, Paran Gani , Ng Chuck Chuan , Turkeswari Uvarajan)

The reuse and recycling of plastic waste in construction materials has been one of the main research topics of interest in recent decades due to the increasing concern about environmental problems caused by the abundant amount of plastic waste. In order to determine the viability and efficiency of cement composites and construction materials containing plastic waste, a myriad of research studies have been carried out. Different kinds of plastic waste were tested and used as building materials in different amounts to replace the standard aggregate. The properties of construction materials incorporating various types of plastic waste, including unit weight, density, mechanical and durability properties were thoroughly reviewed in this paper. As a result, the following conclusions can be drawn:

- Construction materials containing plastic waste exhibited lower unit weight and density as compared to the materials without plastic replacement. This has reported that the lower density of produced composite is ascribed due to the low density of plastic waste and the higher porosity of the materials produced.
- The mechanical properties of construction materials containing plastic decrease with increasing of plastic waste added into the mixture. It was attributed that low adhesive strength between plastic waste and cement paste could cause a reduction in compressive strength. Due to the hydrophobic nature of plastic, theweak interfacial bonding

between plastic aggregates with a cement matrix has impeded the process of cement hydration on the plastic surface.

- Two distinct findings were obtained for water absorptivity of construction materials containing plastic waste. Several studies have shown that the increasing degree of plastic substitution has contributed to a decrease in the absorption of water due to the reduction of material capillary voids, as plastic has less water affinity. However, some studies indicated contradict findings in which the water absorption of the materials was observed to increase with increasing plastic waste added into the concrete or brick mixture due to the increase in porosity.
- A rigorous feasibility analysis and life cycle evaluation should be conducted in order to study and to provide a more detailed understanding of environmental effects as well as other properties, such as fire resistance, frost resistance and the release of toxic smoke during burning.

2. ***Use of Plastic Aggregates in Concrete***

(Azad Khajuria, Puneet Sharma)

Plastic was added to concrete in replacement of coarse aggregates by proportion of 0, 2.5, 5, 7.5 and 10%. On the basis of the results from the present study, following conclusions were drawn

- The material used in the experiments is good and workable.
- The admixture used in the experiments gave the great impact on the strength of concrete.
- The specific gravity of plastic was lesser than that of aggregates.
- While testing the flexural strength of the beam, it is seen that beam failed in between the loading span between its two supports and hence formula that we used is 3PL/4bd2.
- It was observed while experimentthat the compressive strength of concrete initially increases at 2.5% PCA but further addition of PCA shows reduction in strength.
- The optimum compressive strength is obtained at 2.5% PCA.
- The tensile strength of cylinder shows better result as compared to other strengths.
- Flexural Strength shows similar result to that of compressive strength.

3. Study on partial replacement of plastic waste as fine aggregate in concrete
(Elango A, Ashok Kumar A)

- The Same water cement ratio the slump of concrete is found to decrease with increase in replacement of Sand by Plastic material upto20% due to the angular and non-uniform plastic waste aggregates with sharper edges, beyond 20% replacement the concrete become stiffened and it is difficult to workable.
- The Weight of the cube decreases with an increase in replacement of Sand by Plastic material. It is seen that the decrease in weight is linear with increase in replacement.
- The variation of strength with age of Conventional and concrete with 10% replacement Sand by Plastic material follows a similar pattern.
- There is Gradual decrease in compressive strength for replacement up to 20% and then the strength decreases rapidly for 30% of Sand by Plastic material, after 30% the strength variation is somewhat gradual because unlike natural aggregate plastic waste aggregate cannot interact with cement paste and therefore the interfacial transition zone (ITZ) in aggregate containing plastic waste aggregate is weaker than that in the reference concrete.
- The reductions in flexural strength and E for concrete were relatively less prominent than the reduction in compressive strength of concrete due to incorporation of plastic aggregate.

- Considering durability properties up to 20% of plastic replacement the acid attack resistance and sulphate attack resistance of concrete are getting decreased due to increasing the incorporation of plastic waste as fine aggregate in concrete. Beyond 20% the concrete can afford only small amount of resistance against acid and sulphate attack
- Considering water absorption and voids, the water absorption getting reduced due to increase of plastic waste as fine aggregate because plastic waste has less water absorbing ability compared to the natural fine aggregate. Voids are getting increased to the increase of plastic aggregate due to various shapes and different types of plastic waste materials are used as fine aggregate in concrete.
- Rapid chloride penetration test shown that the penetration of chloride is low up to 20% of plastic waste replaced as fine aggregate. Beyond 20% the chloride penetration increased due to increase in porosity of concrete and inefficient bond between the plastic and other participants in concrete.

4. ***MECHANICAL PROPERTIES OF CONCRETE BY USING PLASTIC WASTE: A REVIEW***

(Harikrishna Shapariya, Dr. J.R. Pitroda Prof. Ratansaran Panchal)

- Any aggregates in a concrete mixture may be replaced with plastics. This leads to the concrete's unit weight being reduced. This is useful in applications that call for non-bearing lightweight concrete, such as facade panels.
- Plastics in concrete help to make it ductile, improving its ability to bend dramatically before failure.
- This property makes concrete useful in conditions where it would be exposed to temperature, such as expansion and contraction or freeze-thaw cycles.
- Incorporating recycled aggregates into the concrete of the buildings under investigation has been shown to provide energy savings.
- Researchers focused mostly on the compressive strength of concrete using plastics, with little attention paid to other concrete properties.

CONCLUSION

The use of plastic waste in concrete mixtures as a partial replacement for aggregate has drawn a lot of attention since it can improve the end product's qualities while reducing plastic pollution. According to studies, concrete that contains plastic might have a lower unit weight, which makes it appropriate for lightweight applications like facade panels. Additionally, plastics increase ductility, which is advantageous in environments with temperature swings since it allows concrete to flex farther before failing. Furthermore, recycled aggregates—which include plastics—save energy by lowering the demand for virgin resources. Nonetheless, studies have mostly concentrated on compressive strength, ignoring other crucial characteristics including durability, tensile strength, and flexural strength.

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