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To Study the Behaviour of Concrete by partial replacement of coarse aggregate with the plastic waste (Plastic Chips)

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Abstract-*The use of various types of plastic has increased in recent years as a result of growing manufacturing and other human activities. The majority of plastic garbage is discarded, necessitating a vast landfill space for storage. More significantly, plastic's limited biodegradability presents a significant danger to environmental protection. To reduce the detrimental impact of plastic on the environment, many techniques of plastic disposal have been devised. To limit plastic exposure to the environment, several types of plastic have lately been mixed into concrete. The goal of this study is to examine the properties of concrete. including the use of polymers such as polyethylene terephthalate (PET) and high density polyethylene (HDPE) to replace coarse aggregate in some circumstances (CA). The influence of adding waste plastic to concrete's mechanical properties is investigated in this study. According to test results, 10% PET plastic substituted concrete has a minimum drop in compressive strength of 35%, but splitting tensile strength has improved by 21% when compared to control concrete. Furthermore, as compared to control concrete, the fresh unit weight of plastic waste-containing concrete was reduced by 4%.*

Key Words— Plastic waste, Plastic chips, Coarse aggregate, Slump, Compressive strength, Flexure tensile strength.

1. INTRODUCTION

Plastics have become inextricably linked to our daily lives. Its meteoric rise is due to its low density, strength, user-friendly designs, production capabilities, extended life, light weight, and less cost. Plastics have been used in crime prevention, food preservation and distribution, housing, communication materials, security systems, and a variety of other applications, including water desalination and other packaging, vehicle and industrial purposes, and land-soil conservation. Plastic is intricately interwoven to our everyday lives.. Its meteoric rise is due to its low density, strength, user-friendly designs, production capabilities, extended life, less weight, and less cost. Packing of auto parts and industrial uses, medical tools packing, manmade implants, and other pharma uses, Plastics are used in a variety of applications, including water desalination, land/soil conservation, flood control, house hold purpose, communication systems, security systems, and other applications. The fast growth in the usage of plastic bottles in India has exacerbated the country's solid waste problem. It's general knowledge that discarded plastic bottles take a long time to decompose naturally (more than a hundred years). In past few years, recycling of plastic waste has become one of India's most thinkable issues. In our country, we now have a range of plastic manufacturing factories. They recycle a lot of plastic and put it to good use in a variety of ways. Researchers have looked into a number of materials, including employing waste plastic chips as lightweight aggregate in lightweight concrete construction. Lightweight aggregates can be used instead of regular aggregates to reduce the unit weight of concrete. In today's literature, there are a variety of lightweight concrete uses that use natural or manufactured lightweight particles. Rebeiz et al. (1991), Rossignolo and Agnesini (2002), Silva et al. (2005), Marzouk et al. (2007), and Choi et al. (2008) are just a few of the studies that have looked at the usage of recycled Polyethylene Therephtalate (PET) as a light aggregate (2008). (2005). PET and other plastic wastes (PE and PP) were combined in concrete by Koide et al. (2002), who largely replaced mineral aggregates with PET and other plastic wastes (PE and PP). To investigate the mechanical behaviour of waste PET concrete, Albano et al. (2009) adjusted the water-cement ratio from 0.52 to 0.6, the PET aggregate concentration (10 and 20% by volume), and particle sizes of 2.5mm and 11.5mm. As the volume percent and particle size of PET aggregate start to move up, the concrete's CS, STS, ME and UPV all decreased. Furthermore, there is a improvement in water absorption ratio. Because the sample cube of concrete were not thoroughly compacted, honeycomb development occurred, which had a major impact on the strength values. Frigione is a fictional character created by Frigione (2010)attempted to substitute % of the natural sand in concrete & PET aggregates found from discarded unwashed PET bottles (WPET). Various cement and water-cement ratios were used to create the specimens. To investigate the impact of substituting WPET for fine aggregate in concrete, rheological characterization on fresh concrete and mechanical testing on WPET/concrete as well as reference concretes containing only natural fine aggregate were performed at the ages of 28 and 365 days.. The WPET concretes exhibited comparable workability, slightly lower compressive and splitting tensile strengths, and somewhat better ductility than the reference concrete, according to him. The goal of this study was to explore if waste PET aggregate could be utilised as a substitute for

coarse aggregate in concrete. Different percentages of plastic aggregate by volume were used to evaluate various physical and mechanical qualities of concrete. Plastic aggregate's effect on concrete characteristics has also been studied and debated.

2. Literature review

A. A. Bayasi and Zeng (1993) [1]investigated the effect of polypropylene fibres on the slump and inverted slump cone time of concrete mixtures. They observed that as the quantity of polymers utilised grew, so did the inverted slump cone time.

B. Khatib and Bayomy (1999) [2]studied the workability of rubber concrete and discovered that the slump lowers as the rubber component as a percentage of total aggregate volume increases.

C. Soroushian (2003) [3] shown that the addition of discrete reinforcing to concrete reduces air permeability. In concrete sample the rate of air was measured in the air permeability test. Poorer airflow rates indicate lower permeability and are preferred. The project utilised discrete reinforcing methods to improve concrete permeability, This might be associated to less shrinkage micro-cracking Reduced permeability benefits the long-term durability of discrete reinforcement concrete systems.

D. According to D. Ghaly (2004) [4] The modulus of elasticity falls as the plastic component of the mix increases at a certain water-cement ratio.. The relationship between the modulus of elasticity and the proportion of plastics has been discovered.. For the three w/examined, c's, there was a link between the modulus of elasticity and the amount of plastics in the concrete mix. The modulus reduces as the amount of plastics in the mix increases, which is a usual trend. The association between % decreases in modulus of elasticity..The data was found to be best suited by an exponential curve.

E. Elzafraney (2005) [5]notice that recycled content concrete produced under field conditions successfully satisfied the targeted performance requirements of the project.

F. F. M. Elzafraney [2005] [6]this study has combined the usage of recycled plastic aggregate in concrete material for a building to figure out its performance in terms of thermal characteristics and efficient energy performance in contrast to conventional aggregate concrete.To suit different requirements of building construction, such as strength, the plastic content concrete was made using refined high recycled plastics. workability and completion ability, among other things Both buildings were subjected to long- and short-term monitoring to establish their energy efficiency and comfort levels. In comparison to standard concrete, recycled plastic concrete buildings with good insulation used 8% less energy; nevertheless, energy savings were greater in cold climates in buildings with inferior insulation.

G. G. Zainab Z. Ismail [2007] [7] completed a comprehensive research based on a large number of trials and tests to establish the viability of recycling plastic sand as a partial substitute for fine aggregate in concrete.. They tested concrete samples at room temperature for dry-fresh concrete density, slump, compressive and flexural strength, and finally toughness indices.. The presence of angular and non-uniform plastic particles, according to their test results, causes a significant drop in slump as the proportion of plastic increases. Despite the low slump, the combination was found to have high workability.. Their testing also demonstrated that when the plastic waste ratio increased, fresh and dry density decreased; nonetheless, dry density of concrete sample increase with time at all curing ages. A decrease in compressive and flexural strength was seen when the waste plastic ratio was increased, which might be linked to a decrease in adhesive strength between plastic waste particles and cement.

H. H. Bhogayata [2012] [8]examined the environmentally appropriate disposal of shredded plastic bags in concrete mix for usage in building industries that require alternative resources to replace traditional materials. They determined that the mix with shredded fibres had improved workability because of the uniform and increased aspect ratio uniformly sprayed in the mix. Plastic additions of up to 0.6 percent are deemed acceptable, beyond which compressive strength and compaction are impacted. They discovered that shredded plastic fibres in concrete had less strength loss than hand-cut macro fibres.

I. [2013] [9]Mathew, Praveen They investigated the feasibility of In concrete, recycled plastic can be used as a partial replacement for coarse aggregate mixes to examine how it influenced the CS, ME, STS, and FS of the concrete. To get coarse aggregate, circular plastic pieces were heated to the correct temperature and then crushed to the requisite size after cooling.The findings of their tests were based on a 20% substitution of natural coarse aggregate for plastic aggregate. When a slump test for a sample was performed, it resulted in an increase in workability.

J. P. Suganthy, J. Suganthy [2013] [10]This study investigates the use of pulverised fine crushed plastic (made by melting and crushing high density polyethylene) as a fine aggregate substitute in

concrete at different percentages. Their primary goal was to replace natural sand with crushed synthetic sand as efficiently as possible.

K. Khilesh Sarwe, .[2014] [11]The findings of combining waste plastics with steel fibres in concrete are presented in this study, with the goal of increasing the use of PVC plastic chips in concrete. In comparison to a concrete mix made only of plastic waste, the combined mix of plastic waste and steel fibres demonstrated greater strength. He concluded that a plastic waste containing 0.6 percent cement weight mixed with steel fibre containing 0.3 percent cement weight had the maximum compressive strength.

3. Material Used

3.1 Cement: Cement is a key component in the concrete making process. It has the ability to adhere to any other raw material added to the concrete preparation process, particularly when in contact with water, and so forms an excellent slurry.

3.2 Fine Aggregate: Fine aggregate is assessed first to determine which zone it belongs to. Fine aggregate is divided into four categories. In this project, zone-II sand was used, with the qualities shown below. Fine aggregate is typically screened via a 4.75 mm sieve.

3.3 Coarse aggregate: Coarse aggregate is another important basic element that provides concrete its strength, hardness, and volume. The coarse aggregate is 20 mm in size and has an angular crushed form.

3.4 Plastic is a malleable organic material that can be moulded into a variety of solid things. It's made up of a number of synthetic and semi-synthetic organic compounds. Plastics are generally organic polymers with a large molecular mass, although they can also contain other substances. The majority of them are synthetic, with petrochemicals being the most common source, although several are also half natural. All materials property is plasticity that allows them to change their shape and size , but it is so prevalent in this family of mouldable polymers that it is referred to as "plasticity."

PVC Chips

3.5 Admixture: For concrete sample casting, the superplasticizer "Conplast SP 430" is employed. It is constructed of Sulphonated Naphthalene polymer, which meets IS: 9103-979 specifications and reduces water content by 20%.

3.6 Water: In the current experiment, ordinary tap water is used to prepare concrete examples.

4. TESTS ON CONCRETE

4.1 Slump Test: In a laboratory, the slump test is the most often used way of testing the 'workability' of concrete or on-site. This is fast method to determine whether the consistency of the concrete varies from batch to batch. Slump is the vertical settling of a conventional cone of freshly poured concrete.

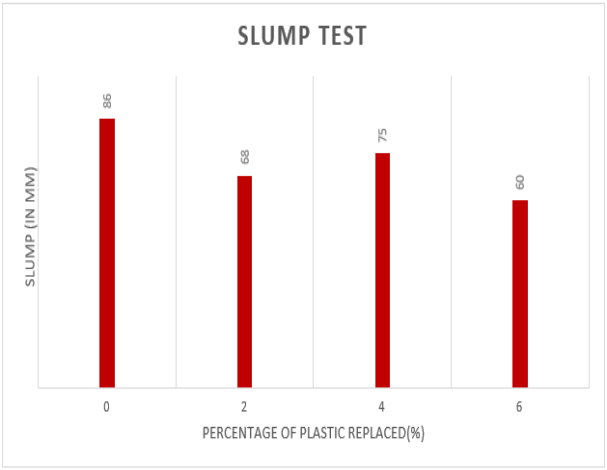

Chart-1: Slump Test

4.2 Compaction factor test: When the nominal size of aggregate does not exceed 40mm, the compaction factor is used to determine the concrete workability. It compares theoretical maximum density related to 0% air content to how dense design mix can be compacted for a given amount of energy. This may be estimated in the laboratory utilising full compaction due to vibration.

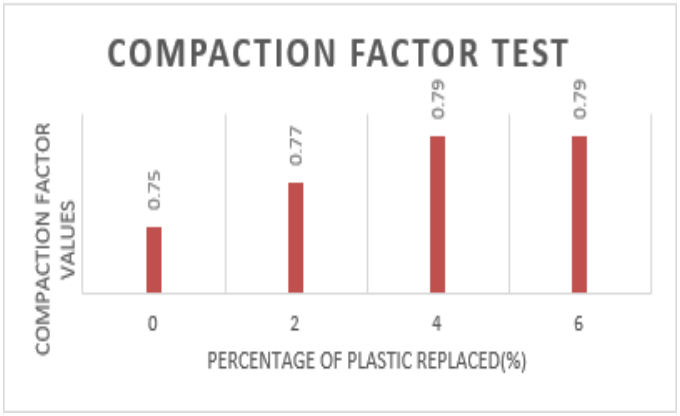

Chart-2:Compaction Factor Test

4.3 Compressive Strength Testing:

The cube specimens were put through their paces on a 3000KN compression testing equipment. The machine's bearing surface was cleaned, and sand or other debris was removed from the specimen's surface. The specimen was positioned in the machine so that the weight was applied to opposing sides of the cubes as casted, rather than top and bottom. The specimen's axis was precisely positioned at the loading frame's centre. The load was raised at a consistent rate until the specimen's failure. The greatest load that could be applied to the specimen was measured. (1) Fe-P/A, where P is the load and A is the area.

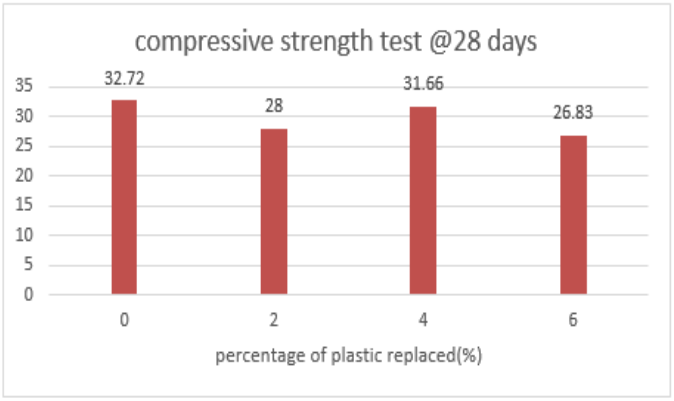

Chart-3: Compressive Strength Test

4.4 Flexure Tensile Strength testing:

For varied water cement ratios, the STS of plastic added concrete after 28 days.. Water cement ratios of 0.39, 0.41, 0.43, 0.45, 0.47, 0.49, and 0.51 were used. At all water-cement ratios, the STS of plastic chips replacement concrete is lower than that of concrete. This result is comparable to the result of a CS test. The STS of plastic concrete is reduced by 76 percent on average.

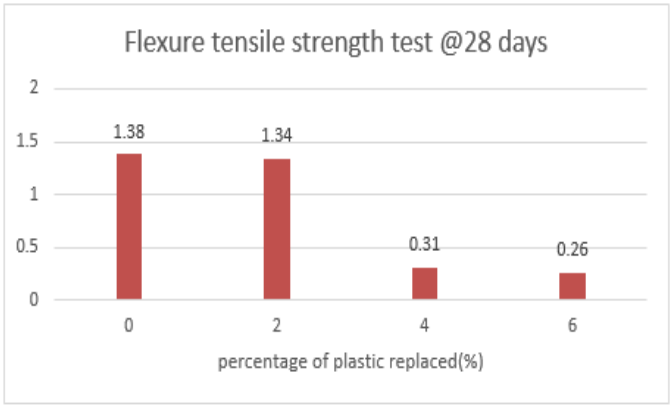

Chart-4: Flexure Tensile Strength Test

Advantages:

a. Reduces the number of original aggregates that must be formed, resulting in reduced natural resource exploitation.

b. b. While being crushed into tiny particles, a significant amount of carbon dioxide is absorbed. As a result, CO2 levels in the atmosphere are lowered.

c. c. Cost savings - Using plastic trash has been shown in a few studies to drastically cut building expenses.

d. Saves money by conserving landfill space and reducing the demand for additional landfills.

e. The recycling business creates more job possibilities.

f. Plastic aggregate can be utilised to make lightweight concrete that does not compromise strength.

g. This will lead to waste usage.

5. Conclusion

The researchers have depicted several types of plastic trash that can be used in concrete manufacturing. They recommended using acceptable plastic waste material to substitute various concrete elements (fine and coarse aggregate. They have investigated different qualities such as workability, compressive strength, tensile strength, toughness indices, and so on, utilising various types of plastic waste such as PVC, polystyrene foam waste, polyethylene terephthalate (PET), and so on. They looked at how plastic was used in increasing the needed qualities of concrete and thereby lowering the cost of typical concrete by a specific percentage replacement.

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