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Experimental Performance of Recycled Plastics as Coarse Particle of Concrete

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ABSTRACT

Solid waste management is one of our country's key environmental issues these days. The current research focuses on the utilisation of recycled plastics as a replacement for coarse particles in concrete. The primary goal of the research is to look at how the mechanical properties of concrete change when plastics are added to it. Along with mechanical qualities, the thermal properties of the resulting concrete are investigated. It has been discovered that using plastic particles leads in the creation of lightweight concrete. With the addition of plastics, the compressive and tensile strength of concrete decreases. The most significant alteration brought about by the use of plastics in concrete is that the heat conductivity of concrete is lowered. As a result, recycled plastics may be utilised for thermal insulation in structures.

INTRODUCTION

Scientists have been researching the use of by-products to improve the properties of concrete for many years. Construction sector by-products such as fly ash, ground granulated blast furnace slag (GGBS), glass cullet, and others have been used in civil projects in recent decades. Industry by-products can be utilized as partial aggregate replacement or partial cement replacement in concrete depending on their chemical makeup and particle size. Because of the environmental constraints involved with their safe disposal, these components are used in concrete.

The environment, as well as the preservation of natural resources & trash recycle materials, are gaining a great deal of attention. In fact, many businesses manufacture a large number of items that contain scrap (residues). Many studies on the use of various types of municipal trash in the manufacturing of building materials have been published in the previous 20 years. Many studies have been expanded to include additional types of trash and in-depth examinations of certain elements. Aside from the environmental benefits, the inclusion of wastes has a positive impact on the characteristics of finished goods.

Recycled plastic is one of the new waste items utilized in the concrete industry. Reusing huge amounts of recovered plastic garbage in concrete manufacturing is the most cost-effective way to dispose of it. In concrete, recycled plastic can be utilized as coarse aggregate. However, waste re-use is currently not commercially viable due to high transportation costs and their impact on overall production prices. It's also crucial not to overlook additional expenditures that are directly related to the type of waste, such as the requirement to identify gas emissions during a fire and the presence of hazardous or poisonous chemicals.

MATERIALS AND METHODS

Cement

Cement is a fine grey powder that may be made into a paste by combining it with water. Concrete is made by combining cement with additional ingredients such as sand, gravel, and crushed stone. As the concrete dries, the cement and water combine to produce a paste that holds the other components together. Ordinary cement consists of two major components: argillaceous and calcareous. In argillaceous materials, clay predominates, whereas calcium carbonate predominates in calcareous materials.

Fine Aggregates
The sand used in the experiment was obtained locally and complied with Indian Standard Specification IS: 383-1970. To remove any bigger particles, the sand was sieved with a 4.75 mm sieve and then rinsed to remove the dust. Fine aggregates were assigned to Zone III.

Coarse aggregates
The material retained on BIS test sieve no. 480 is coarse aggregate. Broken stone is frequently used as a coarse aggregate. The maximum size of coarse aggregate is determined by the kind of operation. We used locally available coarse aggregate with a maximum size of 20 mm in this investigation. The aggregates were cleaned and dried to a surface dry condition after being washed to remove dust and dirt. Indian Standard Specifications IS: 383-1970 was used to test the aggregates.

Plastics Aggregates
Concrete examples were made with recycled plastic instead of coarse particles. As illustrated in Fig. 1, these aggregates were available in three distinct sizes. These aggregates were sieved separately, and the results are shown in Tables 6, 7, and 8 for coarse, medium, and small size aggregates, respectively.

Fig. 1: Types of Plastic Aggregates (Smaller, Medium & Coarser Size)

Water
Concrete can usually be made with water that is safe to drink. Lake and stream water with marine life is typically appropriate. There is no need for a sample when water is received from the above-mentioned sources. If water is suspected of containing sewage, mine water, or waste from industrial facilities or canneries, it should not be used in concrete until testing show it is safe. Water from these sources should be avoided because the quality of the water may fluctuate owing to low water levels or the occasional release of hazardous pollutants into the stream. Casting is done with drinkable tap water in this trial operation.

Methods of Recycling and construction applications
Some modification and processing procedures are used in the recycling of plastic before it is used in concrete, and they include the following methods:-

A) Chemical modification. Chemical modification or depolymerization can be used to recycle the plastic. Hydrolysis and pyrolysis are the two methods for depolymerization (thermal decomposition).

B) Mechanical recycling.
Mechanical recycling includes the melting, shredding, and granulation of discarded plastics. Plastics must be sorted before they may be mechanically recycled. Among other ways, plastics are automatically sorted using X-ray fluorescence, infrared and near-infrared spectroscopy, electrostatics, and flotation. After sorting, the plastic is either melted and moulded into a new form, or it is heated and treated into granules known as re granulate after being shredded into flakes. These recycled materials were compared to equivalent products made from virgin resins in terms of chemical and physical characteristics.

C) Thermal reprocessing. It is the process of heating thermoplastic to extremely high temperatures in order to make it flow. As the plastic cools, it gets transformed into a new product. This technique does not change the chemical makeup of the polymers in any way. PET, for example, may be heated and reprocessed into construction panels, fence posts, or carpet fibres since it is a thermoplastic polyester. This procedure cannot be done forever since frequent heat reprocessing may cause the plastic characteristics to deteriorate.

EXPERIMENTAL RESULTS

This chapter discusses the parameters investigated on the control and plastic-replaced concrete. The characteristics of unit weight, compressive strength, splitting tensile strength, and thermal conductivity of control and plastic-added concrete are compared, as are the characteristics of unit weight, compressive strength, splitting tensile strength, and thermal conductivity of control and plastic-added concrete.

Dry Density

Just before the compressive strength test, the dry density of the cubes retrieved from the curing tank is calculated. For all water-cement ratios, the value of dry densities obtained for the control mixes and plastic concrete is presented in **Fig.2**. The plastic-free concrete has a considerably lower unit weight than control concrete without plastic replacement, according to the study.

The water cement ratio has just a minor impact on concrete unit weight, but the amount of plastic used as particles can have a significant impact. It has been discovered that substituting plastic for concrete decreases the unit weight of concrete, making it suitable for usage as a lightweight material.

A minimum of three samples of control concrete and three samples of plastic-replaced concrete were cast and evaluated for accuracy, with an average of three being used. The density reduction in all of the mixes is about 35%.

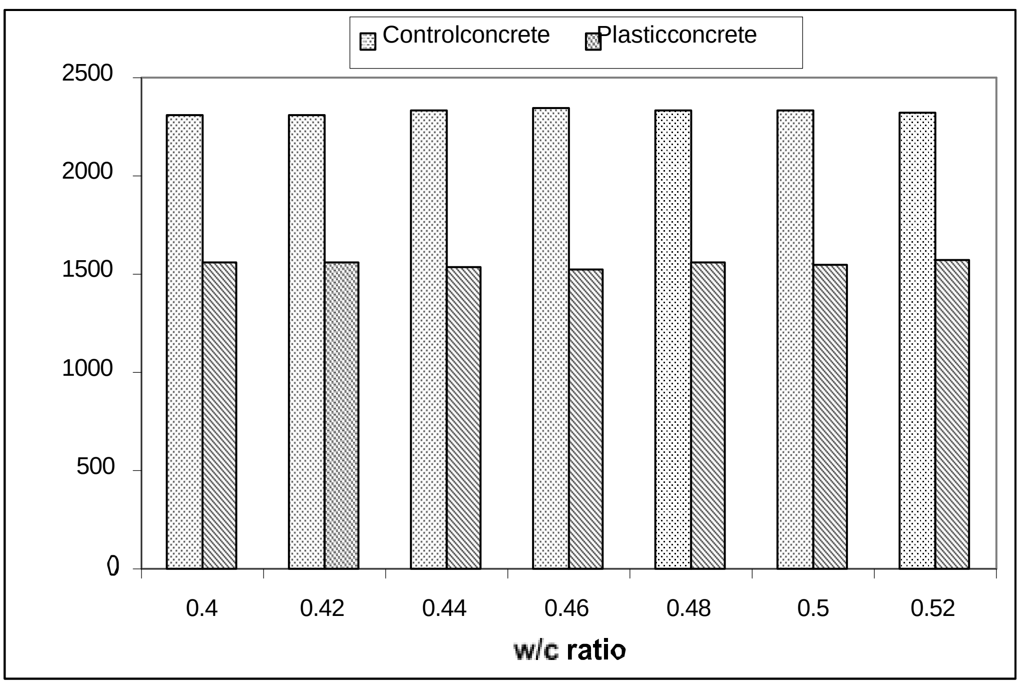

Fig.2: Graph between w/c ratio and dry density of concrete and plastic concrete

Compressive Strength

Figure 3.shows the compressive strength of plastic-added concrete and control concrete after 28 days using compressive strength testing equipment. 0.4, 0.42, 0.44, 0.46, 0.48, 0.50, and 0.52 were the water cement ratios. Each water cement ratio is represented by three cubes, with the accuracy of the findings determined by the average of three test results. The concrete cubes were cured at ambient temperature.

Compressive strength(MPa)-YAxis

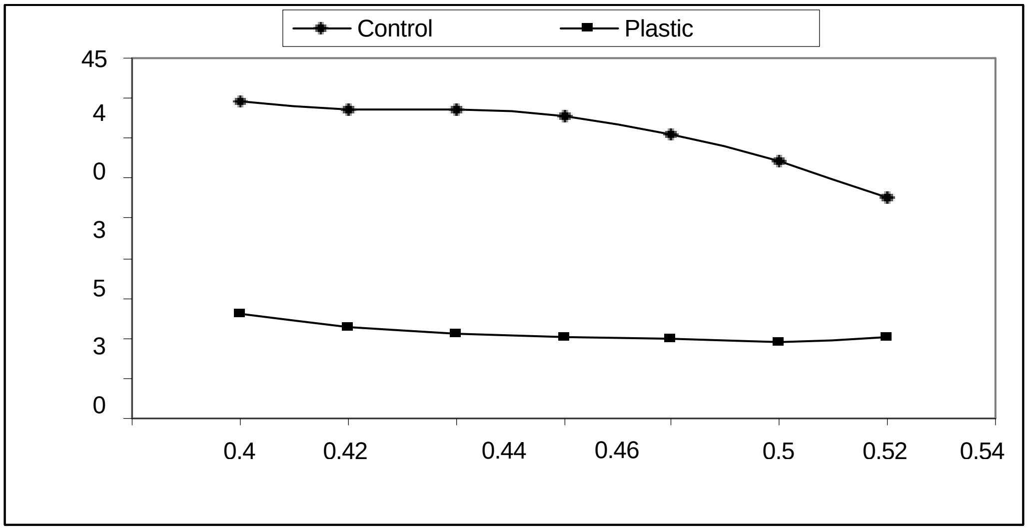

Fig. 3. Graph Between W/C Ratio And Compressive Strength Of Control & Plastic Concrete

Split Tensile Strength

For various water cement ratios, the split tensile strength of plastic added concrete and control concrete was measured at the end of 28 days. The water cement ratios were chosento be0.4, 0.42, 0.44, 0.46, 0.48, 0.50, and 0.52. **Figure 4** illustrate the outcomes. Plastic aggregates replacement concrete has lower split tensile strengththan control concrete at all water-cement ratios. This result is similar to that obtained during a compressive strength test. The split tensile strength of plastic concrete is lowered by 78 percent on average

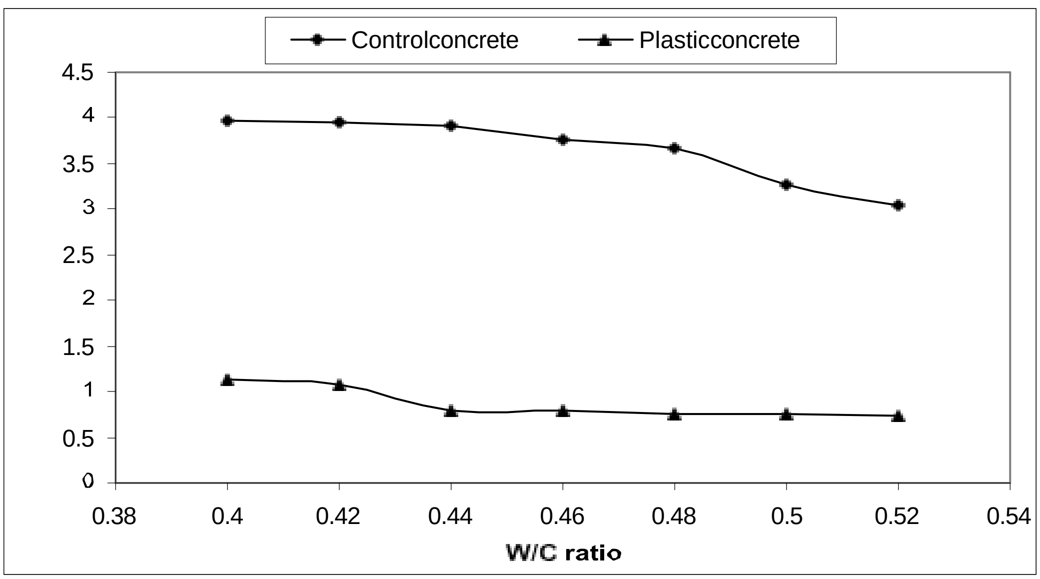

Fig.4: Graph of w/c ratio and Tensile strength of control & plastic concrete

CONCLUSIONS

The following conclusions can be formed based on the results of various studies.

1. Plastics can be used to replace some of the aggregates in a concrete mix. As a result, the unit weight of concrete is decreased. This is advantageous in situations where non-bearing lightweight concrete is required, such as facade panels.

2. For a given w/c, plastics in the mix lower concrete density, compressive strength, and tensile strength.
3. In the case of flexible concrete, the water-cement ratio has only a little impact on strength increase. The reason for this is that plastic particles diminish concrete's binding strength. As a result, the connection between the cement paste and the plastic particles fails, and the concrete fails.
4. Plastics in concrete tend to make it ductile, enhancing its capacity to flex substantially before failure. This property makes concrete helpful in circumstances whereit will be exposed to extreme weather conditions such as expansion and contraction, or freezeand thaw.

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