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An Experimental Study of Polyproprylene Concrete

Dabadgavkar Kedar Makarand
Dr. D. Y. Patil College of Engineering And Innovation, Varale,Talegaon, Pune.

Dode Tushar Ravindra
Dr. D. Y. Patil College Of Engineering And Innovation, Varale, Talegaon, Pune

Irase Shubham Bhimrao
Dr. D. Y. Patil College Of Engineering And Innovation, Varale, Talegaon, Pune

Sontakke Saurabh Vishnu
Dr. D. Y. Patil College Of Engineering And Innovation, Varale, Talegaon, Pune
Corresponding Author:

Y. D. Nagvekar
(Hod)
Department Of Civil Engineering

Abstract
Polypropylene is a thermoplastic polymer utilized as a part of wide assortment of uses including bundling, materials (e.g., ropes, warm clothing and covers). Polymer cement is a piece of gathering of cements that utilizes polymers to supplement bond as a cover. The sorts incorporate polymer-impregnated solid, polymer cement, and Polymer-Portland-bond concrete. The aim of the study was to achieve maximum strength of concrete by using optimum weight of polypropylene. Polypropylene in concrete mix design is used for multiple purposes that includes rigid pavement, self-compacting concrete and other applications. 18 cubes of polypropylene concrete were casted and tested for 7- and 28-days' strength for compressive strength. It was concluded that the significant improvement was observed in ultimate compressive strength after 7 and 28 days. The optimum percentage of Polypropylene was obtained to be 10 percent of cement by volume. The addition of small amount of polypropylene improved the mechanical properties of concrete.
Keywords: *Polypropylene, Polymer-Portland-Bond, Thermoplastic Polymer*

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I. INTRODUCTION

Cement is an essential construction material around the world. This material that is so vital for construction industry should be endued with most ideal properties (Zhang, Zhang et al. 2016). The standards on which strengthened cement basic outlines were constructed depend on solid material utilized along with quality of steel. Strand in solid enhances the quality of the solid. Concrete, as typical cement-based composite, is composed of cement as binder, coarse aggregate as framework, fine aggregate and fly ash as filler, as well as water and other agents. However, cracks and fissures usually appear on the surface of concrete when it is subjected to tensile or flexural loading due to its poor toughness, thereby resulting in the failure of concrete (Lura and Terrasi 2014). Polypropylene (PP) is a thermoplastic polymer utilized as a part of a wide assortment of uses including bundling materials (e.g., ropes, warm clothing and covers), stationery, plastic parts and reusable compartments of different sorts, research facility gear, amplifiers, car segments, and polymer banknotes. Therefore, in recent years, chopped synthetic fibers, such as polyethylene (PE) (Wang, Le et al. 2016), polyvinyl alcohol (PVA) (Sahmaran and Yaman 2007), polyethylene terephthalate (PET) (Foti 2011) and polypropylene (PP) have been added to concrete as reinforcement to enhance the mechanical and engineering properties of concrete.

Mechanical properties of concrete, such as residual strength, tensile splitting strength, and flexural strength after heating may also change by including fibers (Peng, Yang et al. 2006; Tanyildizi 2009) Micro- and macro-synthetic fibers deal with micro- and macro-cracks, respectively, and some research has been performed to introduce macro-synthetic fibers as a steel fiber-replacement in shotcrete and other structural applications (Oh, Park et al. 2005; Oh, Kim et al. 2007; Suji, Natesan et al. 2007). Depending on their shape and geometry, the fibers are capable of considerably enhancing the ductility, impact resistance, fracture energy, fire resistance, and durability of concrete (Oh, Park et al. 2005; Oh, Kim et al. 2007). Due to their low modulus of elasticity relative to that of steel fibers as well as their crimped shape, macro-synthetic (macropolymeric) fibers demonstrate higher deformation atpeak load, toughness, post-cracking load carrying capacity, and reduced crack width (Yang, Min et al. 2012). Among various fibers, macro-polymeric and polypropylene fibers as synthetic fibers have been attracting increasing attention of researchers due to their lower cost and weight, resistance against corrosion and acids, excellent toughness, and enhanced shrinkage cracking resistance (Alhozaimy, Soroushian et al. 1996; Banthia and Gupta 2006).Various researchers have discussed the mechanism of fiber matrix interaction by using various models to compute the bonding between the fibers and cement matrix. The bonding of fiber and the cement matrix plays a major role in the composite behavior. The fibers can interfere and cause finishing problems. Thirumurgan at el. (Thirumurugan and Sivakumar 2013) reported that workability of concrete decreases with increase in polypropylene fibers but it can be overcome by addition of high array water reducing admixtures.

1.1.1 Fractionation Section

Due to its high tensile and pull-out strength, the PP fibers even reduce the early plastic shrinkage cracking by enhancing the tensile capacity of fresh concrete to resist the tensile stresses caused by the typical volume changes. The fibers also distribute these tensile stresses more evenly throughout the concrete.

1.1.2 Polypropylene

The polypropylene waste material which consists of mainly, waste packaging material was collected, shredded and washed and then taken to a Polythene Recycling Plant, M/S Europlus Nig. Ltd. Sagamu, Ogun-State, Nigeria. The collected polypropylene waste material was heated in an industrial plant until the material becomes crispy and hard, this was then passed in mechanical blender and grounders which breaks it down into smaller grains. About 500 g of the grain sized polypropylene were sieved with a B.S. sieve of size 600 micron – 4.75 mm this was to determine the particle size distribution of the material. Figure showed the polypropylene grain sample.

Properties	Value
Length	4.75mm
Diameter	2.35mm
Aspect ratio (length /Diameter)	1.9 to 2.1
Specific Gravity	1.33
Tensile Strength	308

Table - 1.1 Properties of polypropylene

Figure 1: polypropylene

1.2 SCOPE OF WORK

- Getting high strength form concrete using POLYPROPYLENE, or PP, is used in concrete.
- Re-using the POLYPROPYLENE, or PP, i.e., Non-Biodegradable Plastic form.
- Saving nature from pollution.
- Reduced dependency on any other harmful admixtures.

1.3 RESEARCH METHODOLOGY

In this study mixes, we are planned to make with fiber with varying proportion of 5%, 10% and 15%. Control mix was taken with 0%fiber.

1.4 APPLICATIONS

1.4.1 Crack Resistant Structures –

- The cracks are classified according to its damage level for load bearing masonry.
- In order to repair cracks up to a width of 5mm, either cement grouting can be used or steel wire meshes can be inserted into the cracks. But it is found that when fiber reinforced concrete is used, crack formation and propagation is very much reduced since fibers can form a strong bond with the concrete mix and can bridge the cracks to some extent.
- Examining the concrete specimens after the tests, it is found that only hair line cracks were formed after the compressive strength tests cracks in specimens with hair fiber when compared with concrete specimens without hair fiber content.
- When fibers are added to concrete, it becomes homogeneous, isotropic and transforms it to a ductile material.
- These fibers will act as secondary reinforcement in concrete and reduces crack formation and propagation. the bridging effect by this fiber leads to the improvement in the tensile and flexural strength.
- Safety against seismic forces is a combination of both structural stability and adoption of suitable construction techniques. It is well known that it is not the earthquake that kills people but the collapse of structures that causes the havoc.

II. Literature Review

1. Nila V. M, Raijan K. J, Susmitha Antony, Riya Babu M, Neena Rose Davis, according to the test performed it is observed that there is remarkable increment in properties of concrete according to the percentages of hairs by weight of concrete. There was an overallincrease of 1 – 12% in the compressive strength of concrete and up to 5% in the flexural strength of concrete test specimens by the addition of hair fibers in different quantities. It is well observed that the maximum increase is noticed in the addition of 2% hair fiber, by weight of concrete, in all the mixes. It is concrete mixes, making the hair fiber reinforced concrete best suitable to u the applications with those concrete mixes. Crack formation andpropagation are very much reduced showing that FRC can have its applications in seismicresistant constructions.

2. Yadollah Batebi, Alireza Mirzagoltabar, Seyed Mostafa Shabanian and Sara Fateri, Department of Civil Engineering, Babol University of Technology. Basically, most of cement-based mixtures are likely shrinking. Use of fibers is not a new idea in this case. Previously, there were evidences that horse hair, straw and cotton fibers were used in mudand mortars in ancient times. Then, utilizing these fibers in concrete mixtures mayincreases concrete workability and decreases cracks. Due to Nano cross-section of hair andits proper tensile strength this project investigates its application to reduce the shrinkage of concrete mixtures. For this purpose, human hair fibers were used in 0.4 and 0.8 and 1.2 weight percentage and the length of the fibers in each case varied between 15 and 60 millimeters. Results are shown as considerable amount of hair may reduce in the shrinkagein the hair reinforced concrete.

III. RESULT AND DISCUSSION

The results obtained are as discussed below

Mix proportions for human polypropylene fiber reinforced concrete blended with concrete (M25grade): Taking control mix proportions as reference, mix proportions for other mixeswere calculated. Here, the mix

Material	Water	Cement	Fine Aggregates	Coarse Aggregates	
				10mm	20mm
In Kg/ m³	187	356	850	420	705
Ratio	0.5	1	2.466	3.992	

Table – 1.2 Mix Proportion for 5% PP Grains

Material	Water	Cement	Fine Aggregates	Coarse Aggregates	
				10mm	20mm
In Kg/ m³	187	338	850	420	705
Ratio	0.5	1	2.466	3.992	

Table – 1.3 Mix Proportion for 10% PP Grains

Material	Water	Cement	Fine Aggregates	Coarse Aggregates	
				10mm	20mm
In Kg/ m³	187	319	850	420	705
Ratio	0.5	1	2.466	3.992	

Table – 1.4 Mix Proportion for 15% PP Grains

Casting the specimens taking the control mix design (i.e., 5% grains) as reference weights of materials are calculated as shown above. In all the concrete mixes human polypropylene fiber was varied in the percentages of 5%, 10%, 15%, by the weight of cement material content was incorporated for the w/b ratio 0.5. Total 18 Cubes (150x150x150mm for all the 3 mixes including control mix.

- Mix 1: 5% grains
- Mix 2: 10% grains
- Mix 3: 15% grains

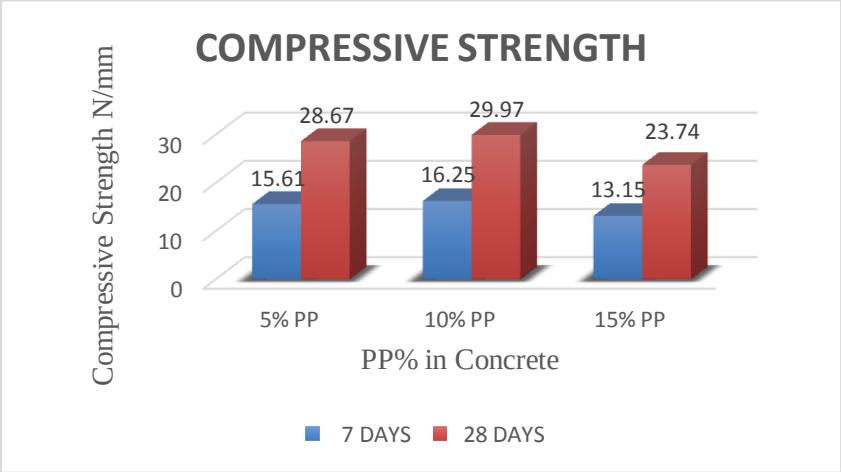

Figure 2: Compressive Strength

IV. CONCLUSION

Compressive test was carried out on concrete samples containing recycled polypropylene grains that were used in the partial replacement of cement, it can be concluded that, Polypropylene waste can be effectively managed to be utilized in replace to cement in constructions, According to the test performed it is observed that there is remarkable increment in properties of concrete according to the percentages of Polypropylene by weight of cement in concrete. The Polypropylene grains in concrete has the high compressive strength compared to the normal Concrete, It is well observed that the maximum increase is noticed in the addition of 10 % Polypropylene grains, by weight of concrete, in all the mixes. Crack formation and propagation are very much reduced showing that can have its applications in seismic resistant constructions. Polymeric fibers such as polyester or polypropylene are being used due to their cost effective as well as corrosion resistance.

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