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An Experimental Study on Strength Behaviour of Cement concrete with Use of Plastic Fibre

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Abstract
Concrete is a basic material for all civil works which is made from cement sand and stones. Now a days collecting sand from natural beds of rivers and aggregates is becoming difficult due to environmental clearances. Replacement of fine aggregate or coarse aggregates in cement concrete with some industrial by-product is highly desirable. Due to its lower cost, it makes an attractive alternative if adequate performance can be obtained. This paper presents the results of experimental study on the use of polyethylene hand cut macro fibre on the mechanical properties of cement concrete. The polyethylene in fibre form with size 120 mm length and 4 mm width have been replaced by fine aggregate. The fine aggregate was replaced by plastic fibre with 1% by weight. The compressive strength and tensile strength of controlled specimen and treated specimen have been evaluated at 7 days and 28 days. It was observed the compressive strength of cement concrete decreased after the inclusion of plastic fibre. The inclusions of plastic fiber have no significant effect on tensile strength. It has been seen that there is a zilch chemical reaction of plastic fibre with the matrix during the hydration process. This was due to the density difference in fine aggregate and polyethylene. The compressive strength significantly decreased by 50.42% at 28 days. The tensile strength decreased by 8.52% which is nominal as compare to the compressive strength decrement rate.

Keywords: plastic fiber reinforced cement concrete, waste polyethylene, cement concrete

I. INTRODUCTION

Now a days, plastics in its various form used in daily life. Plastic products have become an integral part in our daily life as a basic need. It is used in almost all industry for their daily functioning, manufacturing, packaging, transporting. The use of plastics has a various advantages; such as preservation of food and beverage become easy by the use of plastic bags and bottles beside of that merits it also has numerous demerits. One of the major demerits of plastic is very low biodegradability and requirement of vast land for waste plastic accumulation by which land pollution increased and further hinders the percolation of water into the soil which impose a negative impact on fertility. The contamination of toxic substance with the water effect the marine life. The hazards that plastic pose are numerous. They frequently block the blocked drains provide excellent breeding grounds for disease causing mosquitoes and water borne diseases besides causing flooding, drainage system.[1] [2] [3] various research works have been done for finding out the safe and environment friendly disposal of Plastics. India generates 56 lakh tons of plastic waste annually, Delhi accounting for staggering 689.5 tons a day. Approximately 60% of total plastic waste is collected and recycled in the country per day and remain is uncollected and littered. Besides of that concrete all over the globe has been utilized for the required infrastructure. Both materials consumptions are increasing day by day in their respective field. The inclusion of waste plastic in concrete by replacing or adding the concrete ingredients is one of the appropriate ways to dispose it. However the fresh and mechanical properties of cement concrete paramount importance and not be negotiated. A vast work has already been done for the utilization of waste plastics in cement concrete. In the recent past research the replacement and addition have been done with the direct inclusion of polyethylene or plastic fiber [4], PET bottles in shredded form, chemically treated polyethylene fiber, PET in aggregate form by replacing natural coarse aggregate [5]. Most of replacement have been done by volume calculation.[4] Reported that the fiber prepared by polyethylene less than 20 micron thickness could be suitably used for the non structural works, where the strength is not a prime concern. [5] Replacement of natural coarse aggregate with plastic coarse aggregate with 22% replacement was found to be of increased compressive strength. [6] Concluded that the compressive strength of the concrete is affected by addition of plastic pieces and it goes on decreasing as the percentage of plastic increases addition of 1% of

plastic in concrete causes about 20% reduction in strength after 28 days curing. It was observed that the surface of plastic fibre not taking part in strength improvement of cement concrete. To conquer this behaviour of plastic a novel use of HDPE plastic in concrete as soft filler was used. Plastic treated with water, Bleach and alkaline bleach before mix in concrete ingredients. The highest compressive strength was achieved when the plastic was treated with alkaline bleach and the lowest when treated with bleach alone [7]. The effect of chemical treatment also studied in cement mortar, treated with HCL acid, NH_4Cl,H_2SO_4 acid and 10% $(NH_4)_2SO_4$ solutions [6].

The majority of past researches show that the direct inclusion of plastic neither significantly increased nor maintained the characteristic compressive strength of cement concrete but as far as tensile strength concerned, the plastic fibre maintained or impart small increment in this mechanical property. In present work the replacement have been done by weight calculation instead of volume calculation. Fibres were used in macro sizes to evaluate the effect of it on cement concrete hardened property. The significant effects on strength property after the plastic inclusion in concrete were found in this experimental study.

II. EXPERIMENTAL PROGRAM

2.1 Cement

Portland pozzolana cement was used for the experimental study. The PPC cement was in fine powder state and free from lumps and moisture. The various physical properties of cement tested as per IS 1489-1991 part (1) are listed Table 2

2.2 Coarse Aggregate

Locally available crushed coarse aggregates of 20 mm were procured for the experimental study. Before using it for experimental study, tests were performed. The values of tests are shown in Table 1.

2.3 Fine Aggregate

The fine aggregate for the experiment was locally arranged and conformed to Indian standard specification IS 383-1970.The sand was sieved through 4.75mm sieve to remove the particle greater than 4.75mm IS sieve and then was washed to remove the dust. The physical properties of sand are shown in a Table 3.

2.4 Plastic Fiber

The waste plastic polyethylene's were collect and washed prior to use. After drying the polyethylene, it was cut into macro fiber sizes with 120 mm long and 4mm wide. The replacement has been done by weight with the fine aggregate. The plastic macro fibers are shown in Figure 1.

2.5 Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Clean and fresh water was used for casting and curing the specimens in the experimental study.

Table 1: Properties of Coarse Aggregate

Sr. No.	Characteristics	Value
1	Fineness Modulus	6.8
2	Specific gravity	2.60
3	Water absorption%	1.92

Table 2: Properties of Cement

Sr. No.	Characteristics	Test values	Values specified by IS 1489-1991
1	Standard Consistency	32	----------
2	Initial Setting time (min)	122	30 min (minimum)
3	Final Setting time (min)	285	600 min (maximum)
Compressive Strength			
1	7 days	26 N/mm^2	22 N/mm^2 (minimum)
2	28 days	36 N/mm^2	33N/mm^2 (minimum)

Table 3: Properties of Fine Aggregate

Sr. No	Characteristics	Value
1	Type	Natural sand
2	Specific Gravity	2.52
3	Water absorption	1.03 %
4	Grading Zone	III
5	Fineness Modulus	2.34

Fig 1: Plastic Hand Cut Fiber

III. Mix Proportions for the Experimental Study

The concrete mix was designed as per the guidelines given in the various Indian standards namely IS 10262 – 1982, IS 456-2000 and SP 23 [8] [9] [10] [11] [12]. Table no. 3 gives the materials required for the M20 grade concrete.

IV. Mixing Casting and Curing

The utmost supervision has been done for proper mixing. First of all the dry mixing was done for 1 to 2 minute. After the proper mixing in dry state, the water has been put for preparing the cubes and cylinder. The 150 x150 x 150 mm cubes and 300mm x 150mm cylinder were prepared for testing the compressive strength and tensile strength. The assessment of compressive and tensile strength has been done at 7 days and 28 days respectively.

Fig 2: Plastic Fiber Cement Concrete Cubes Curing

V. Results and Discussion

Total 12 controlled specimen cubes were prepared for the compressive strength evaluation as shown in Fig 2. Six cubes for 7 days strength and 6 for the 28 days strength evaluation. Twelve more cubes were casted by replacing the fine aggregate with the polyethylene fiber. Six treated specimens for 7 days and another 6 for 28 days strength evaluation. Same foresaid pattern was followed for tensile strength evaluation.

5.1 Effect on Compressive Strength

Fig 3 and Fig 4 represents the strength behaviour of concrete prepared with (Treated specimen) and without plastic fibre (Controlled specimen), after 7 and 28 days. The average compressive strength values of controlled specimen were of order of 15.3 Mpa. Whereas that of waste plastic concrete mixture shows decrease trend in strength of up to 50.4%, which is in confirmation with the previous studies. The probable reason of reduction in compressive strength could be the presence of the macro fibres in the concrete, may have interrupted the bonding and complete hydration of the cement paste and aggregates This decrease may be due to lack of binding properties of plastic fibre.

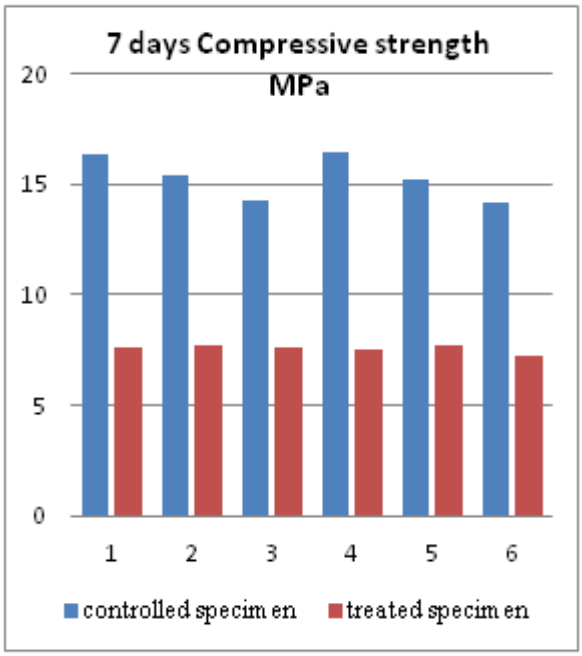

Fig 3: 7 days compressive strength

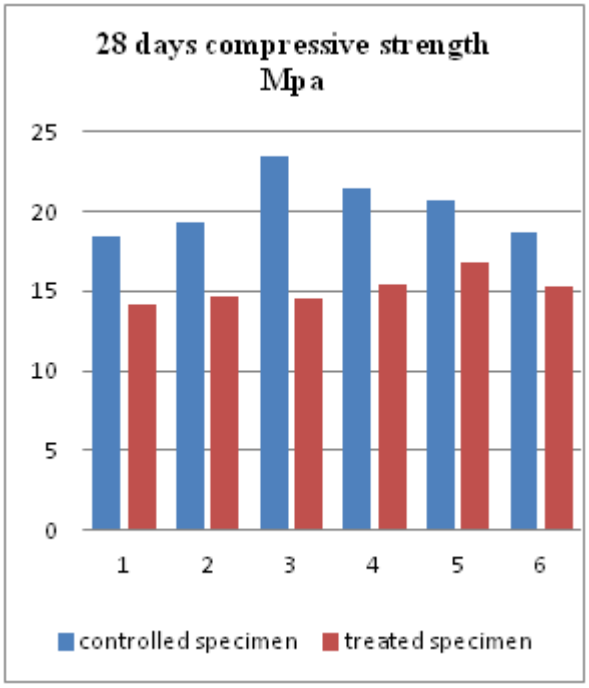

Fig 4: Compressive Strength of Controlled And Treated Specimen

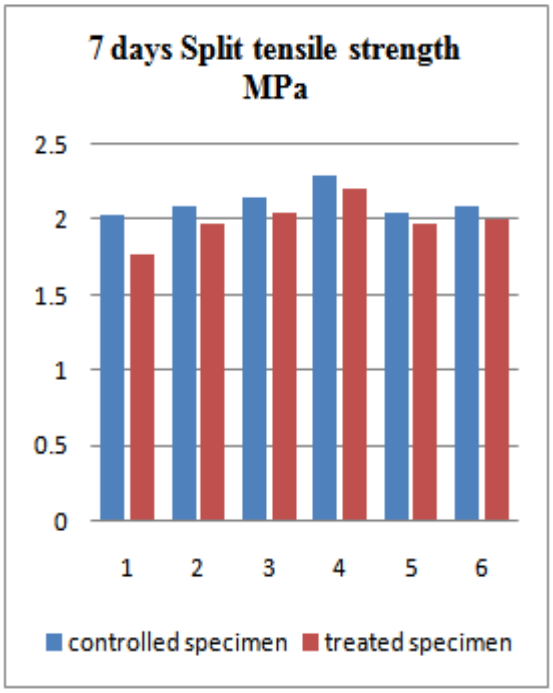

Fig 4: 7 days split tensile strength test

5.2 Effect of Curing period

The treated and controlled specimens were further tested for compression after 28 days to study curing effect of plastic fiber. The results show that average compressive strength of controlled specimens was 20.3 Mpa. The average strength of treated concrete specimens was 7.2 Mpa. This again shows previous trends of reduction in strength. It was noticed that rate of decrease was 25.6 %, which shows long term strength gain. This indicates that plastic fiber have no impact on hydration process.

5.3 Effect on Split Tensile strength

It is important to investigate tensile strength behavior of concrete due to different loading conditions. For this split tensile strength tests were conducted on both kind of samples (Controlled and Treated). The average value of split tensile strength for controlled specimen was 6.0 Mpa. The treated samples were showing 5.5 Mpa strength, under identical test conditions. The decrement rate was 8.2%, which is not very much significant. It can be concluded that the reduction in split tensile strength was observed for substitution as the percentage of PET aggregated incorporated the weak binding interfacial binding between the plastic, aggregates and cement paste. Fig 4 and Fig 5 shows the results of split tensile strength.

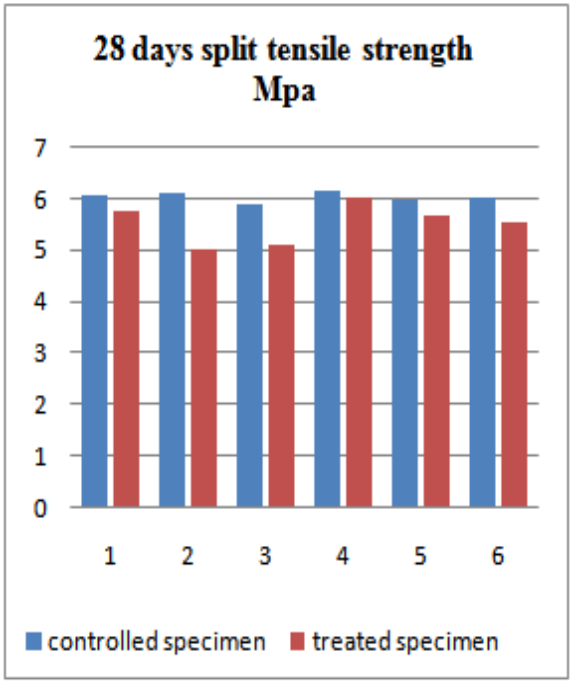

Fig 5: 28 Days Split Tensile Strength Test

Fig 6: 28 days split tensile strength

VI. CONCLUSION & FUTURE SCOPE

The PET fibre reinforced concrete has been successfully used in Hishikari mine (Gold Mine) located in Kagoshima, Japan. Evaluation of sprayed surface with the PET fibre showed no crack, no uplifting and deviation, and the surface was relatively smooth. PET fibre reinforced concrete was applied to a bush road between Hayatogawa and Kanazawa, kanagawa prefecture, Japan. 0.75% of volumetric content of fibre was used in this application. Although, State of Art work has been done on various structural parts made by plastic containing concrete now but for the worldwide friendly uses of plastic in construction field without compromising the strength parameter still evolving and need more deep and deterministic research for the utilization in concrete. More work needs to be done in order to fully understand and how to mitigate or eliminate its effect.

Following distinct parameter need to be focus for the future study

- The surface property of plastic need to be transform into some extent for improving the bond behavior between plastic fibers and matrix.
- Need to focus for matrix hydration and plastic effect on it.

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