EXPERIMENTAL INVESTIGATIONS ON LIGHT WEIGHT CONCRETE USNG WASTE PLASTIC FIBER

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ABSTRACT:

Lightweight Concrete (LWC) is the most common material for human beings to use in construction. In this study, the effect of the waste plastic fiber on the strength and durability of lightweight concrete has been investigated. Lightweight concrete contains polyethylene terephthalate (PET) plastic fiber obtained from a waste plastic bottle. The reason for choosing PET bottles is to solve environmental pollution as a result of dumping the tons of plastic waste by developing a novel method of transferring it into a valuable product. The main objective of this investigation is, therefore, to compare the strength of hardened lightweight concrete containing plastic fiber with control mix of lightweight concrete. In this investigation, the strength of M30 lightweight concrete has been taken. In addition, workability tests such as slump test, compaction factor test and vee-bee consistency tests were conducted on the fresh concrete. Moreover, compressive strength, tensile strength, flexural strength and water absorption tests were evaluated to determine the strength properties of hardened lightweight concrete. A finding of the study shows that workability, compressive strength and water absorption has increased by addition of waste plastic fiber. To improve strength performance, the weight of plastic fiber added to the lightweight concrete is 1% of the weight of the cement. the results are compared and conclusions are made.

Key Words: - LWC, Waste plastic fiber, Compressive strength, Perlite aggregate, Durability

I. INTRODUCTION

In concrete construction, structural lightweight concrete is an important and give solves weight and durability problems in building. It many items around the characteristic of lightweight aggregate for building and the effect of material regarding the durability. The compressive strength, water absorption and workability are significant for the structural lightweight aggregate concrete. One of the ways to reduce the weight of structure is the use of lightweight aggregate concrete (LWAC). The benefit of LWAC as structural material was recognized as far back as romans days. Lightweight concrete has strength comparable to normal weight concrete, yet is typically 25% to 35% lighter. Structural lightweight concrete offers design flexibility and substantial cost savings by providing less dead load, improved seismic structural response, longer spans. Lightweight aggregate concrete is usually defined as a concrete having an air-dry density of below 1850 kg/m³ (115 lb/ft³) as opposed to a normal concrete having a density of about 2300 kg/m³ (145 lb/ft³) but a finite limit is undesirable. The lightweight concrete has its obvious advantages of high strength/weight ratio, good tensile strength, low coefficient of thermal expansion, and superior heat and sound insulation characteristic due to air voids in lightweight aggregates.

Plastic is one of the most significant innovations of 21th century material. The amount of plastic consumed annually has been growing steadily and becomes a serious environmental problem. For solving the disposal of large amount of recycled plastic material, use of plastic in concrete industry is considered as feasible application.

Lightweight aggregate is an important material in reducing the unit weight of concrete. A work has already been done on the use of plastic waste as polyethylene terephthalate (PET) bottle such as Lightweight aggregates. This study aims at examining the effect of waste plastic in light weight concrete as a fiber material. For a better understanding the behavior of recycled plastic in light weight concrete structures, experimenting fresh and hardened concrete mixtures containing recycled waste plastic.

II. MATERIALS AND METHOD

A. Cement

Portland Pozzolana cement of 53 grades available in local market is used in the investigation. The cement used has been tested for various proportions as per IS 4031-1988 and found to be conforming to various specifications of IS 12269-1987. The specific gravity was 3.15.

B. Coarse aggregate

Crushed angular aggregate 10 mm size from a local source was used as coarse aggregate. The specific gravity of 2.76 and Moisture content 1.3 was used.

C. Fine Aggregates

Portland Pozzolana cement of 53 grades available in local market is used in the investigation. The cement used has been tested for various proportions as per IS 4031-1988 and found to be conforming to various specifications of IS 12269-1987. The specific gravity was 3.15.

D. Perlite aggregate

Expanded perlite (EP) is an amorphous volcanic glass that occurs naturally and produced after expanding of its original volume more than 35 times due to heating at high temperature (700 °C to 1100) was used in the investigation.

E. Water

Crushed angular aggregate 10 mm size from a local source was used as coarse aggregate. The specific gravity of 2.76 and Moisture content 1.3 was used.

F. Waste Plastic Fiber

Rectangular shape of waste plastic fiber with dimension (10mm × 2 mm) and thickness of (4mm) made from polyethylene terephthalate (PET) was used in this research. The waste fibers were produced by cutting plastic and water bottles by hand cut. The specific gravity of these fibers was 1.12.

III. MIX PROPORTIONS FOR THE TEST

The concrete mix is designed as per the guidelines given in the various Indian standards. the materials required for the M30 grade concrete. The water cement ratio was maintained at 0.44 and mix proportions are 1:1.6: 2.13.

IV. TEST RESULTS

A. Fresh Concrete

The tests of fresh concrete are Slump Cone test, Compaction Factor, Vee Bee Consistency test for this investigation and the results are as follows.

Table 3 Workability Test Results

Mix No	Slump (mm)	Compaction factor (%)	Vee bee (sec)
M plastic	60	0.86	10
M nominal	68	0.84	8.7

B. Hardened Concrete

1, Compressive Strength

The influence of the addition of 1% plastic fiber on the mixes tested is compared with plain concrete mix and the results are tabulated in Tables 4, A maximum compressive strength of 29.68 N/mm2 was obtained plastic fiber mix and it is slightly higher than the nominal mean strength of 28.27 N/mm2. It is seen from the Tables that the compressive strength is increased by 9.02%. It is well established that addition of fibers contributes much to improvements in the compressive strength of lightweight concrete.

Table 4.4 Compression Strength result

Grade of concrete	Average compressive strength at 7 days, 14 days,28 days (N/mm^2)					
	Plain concrete			1% with waste plastic fiber		
	7 days	14 days	28 days	7 days	14 days	28 days
Sample 1	18.7	25.8	28.3	19.5	27.8	29.5
Sample 2	18.6	26.1	28.27	19.8	27.4	29.7
Sample 3	19	26.93	27.87	19.8	27.83	29.68
Average	18.76	25.94	28.14	19.7	27.67	29.63

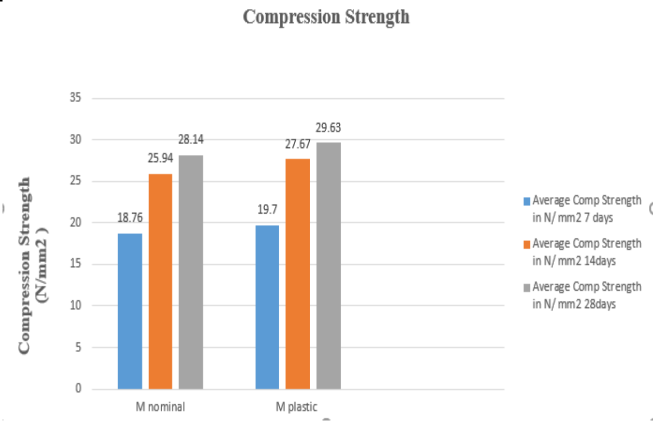

Fig 4.1 Comparison of cube compressive strength test results.

2, Split Tensile Strength Test Result

Normally, hardened concrete is known capable to withstanding a large amount of both directly and indirectly applied pressure. Thus, one objective is to enhance the tensile strength of lightweight concrete mixtures because concrete is, in fact, a brittle material. The splitting tensile strength results were evaluated at 7 days 14 days and 28 days of cure. In table (4.5) and figure (4.2) the effect of adding waste plastic fiber was illustrated. From the data presented we can see that the behavior is similar to the compressive strength, attributing it to the same reasons mentioned above. For 3.2 kg/m3 volume of plastic material could improve the tensile strength by up to 15%. Significant increase in tensile strength has reached 15.72%.

Table 4.5: Split Tensile Strength test results

Grade of concrete	Average split tensile strength at 7 days, 14 days,28 days (N/mm^2)					
	Plain concrete			1% with waste plastic fiber		
	7 days	14 days	28 days	7 days	14 days	28 days
Sample 1	1.65	1.8	2.8	1.8	2.5	2.97
Sample 2	1.6	1.84	2.7	1.83	2.34	2.9
Sample 3	1.7	1.96	2.65	1.82	2.4	3
Average	1.65	1.9	2.72	1.82	2.41	2.95

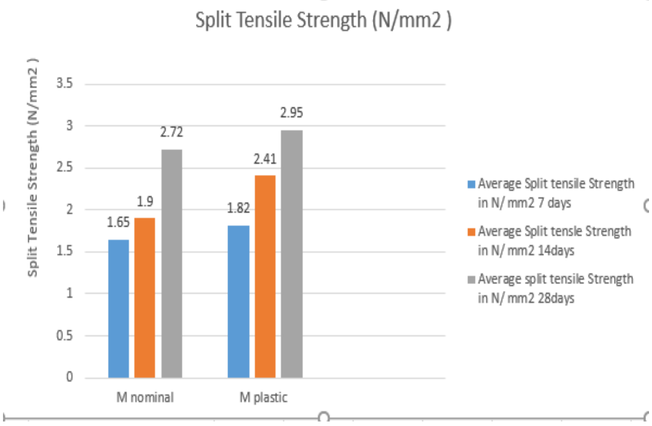

Fig 4.2 Comparison of cylinder tensile strength test results.

3. Flexural Strength Test Results.

Flexural strength can be described as a concrete beam's ability to withstand applied loads without failure. The results of the flexural strength tests for waste plastic fiber lightweight concrete mixtures 0% and 1% are illustrated in table (4.6) and figure (4.3).These results show that the flexural strength of waste plastic fiber lightweight concrete mixtures at 7 days 14 days and 28-days curing age is prone to increase with the addition of 1% of waste plastic fiber ratio in these mixtures. The adding an amount of waste plastic fiber equal to 1% of the weight of cement could enhance the flexural strength up to 15%.

Table 4.6: Flexural Strength Test Results

Grade of concrete	Average flexural strength at 7 days, 14 days,28 days (N/mm^2)					
	Plain concrete			1% with waste plastic fiber		
	7 days	14 days	28 days	7 days	14 days	28 days
Sample	1.82	2	2.8	1.9	2.3	2.97

1						
Sample 2	1.88	2.1	2.7	1.94	2.35	2.9
Sample 3	1.89	2.22	2.65	1.97	2.45	2.89
Average	1.86	2.1	2.72	1.94	2.4	2.93

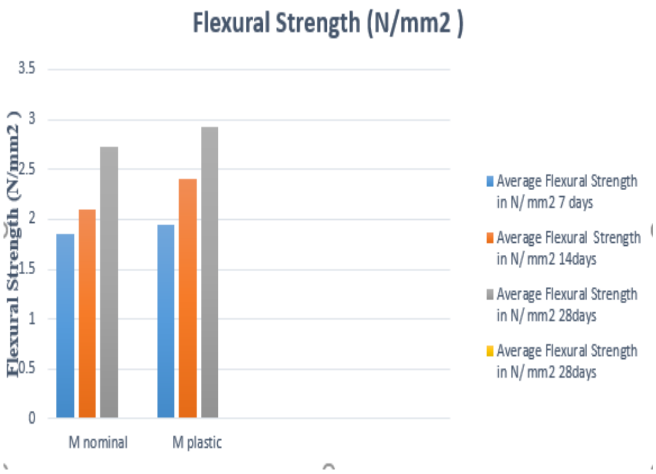

Fig 4.3 Comparison of flexural strength test results.

4. Water Absorption Test Result

Water absorption is an important factor due to the porous structure of the waste plastic lightweight concrete. The water absorption test is done using the samples prepared at the age of 7 days,14 days and 28 days. The purpose of this test is to identify the capability of the concrete to absorb water. There are three samples for each test and the average result will be taken. Table 4.7 and Figure 4.4 shows different water absorption for different percentage of waste plastic fiber. It can be seen that, water absorption decreaased at 1% of waste plastic fiber. This is because the waste plastic fiber of lightweight concrete applied in the mixture, the total voids distributed in the samples decreased. This will result higher water absorption capacity since sample are capable to absorb more water when more voids and waste plastic fiber are distributed in it. The adding an amount of waste plastic fiber equal to 1% of the weight of cement enhance the water absorption up to 10%. Significant decrease in water absorption has reached 9.05%.

Table 4.7 water absorption test result

Grade of Lwc concrete	Average water absorption	
	Plain concrete	1% with waste plastic fiber
Sample 1	1.6	1.23
Sample 2	1.7	1.3
Sample 3	1.56	1.41
Average	1.62	1.31

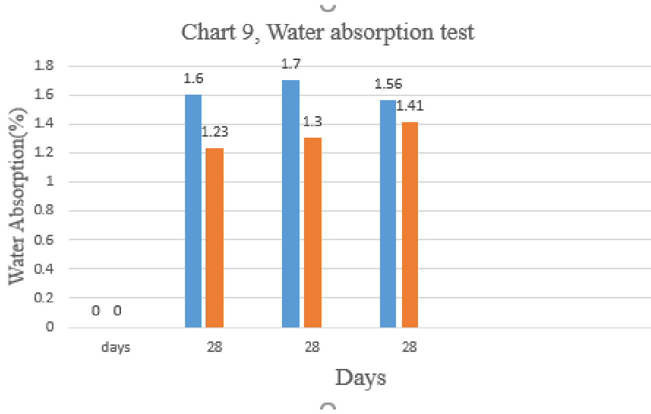

Fig 4.4 comparison of water absorption test result

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUTONS

• Recycled PET plastic can be used as a partial replacement of natural aggregate with a percentage can be reached to 45%.

• The Compressive Strength was high at 1% of waste plastic fiber and the percentage increasing was 10 % at 28 days.

• The use of the recycled plastic in the lightweight concrete increased the overall concrete bulk density when compared to conventional light weight concrete.

• Compressive strength increased with the addition of 1% of waste plastic content. Increased in the compressive strength was between 10 % and 15 % for lightweight concrete containing 1% of waste plastic fiber in the mix.

• Splitting tensile strength of concrete made with waste plastic fiber was increased with 1% of waste plastic fiber. The splitting tensile strength was found to increase by 15.72%.

• The Flexural Strength was high at 1% of waste plastic fiber and the percentage increasing was 15% at 28 days.

• The Water absorption of 1% of waste plastic fiber found low and the percentage decreasing was 9.05% at 28 days.

B. RECOMMENDATIONS

• The waste plastic fiber can be used in lightweight concrete mixes as additional material with 1% without large reduction in water absorption.

• More types and sizes of waste plastic fiber need to be taken into consideration.

• The effect of different W/C ratios on the mechanical property of lightweight concrete with waste plastic fiber needs to further research.

• Other studies are encouraged to obtain the effect of using different percent of waste plastic bottles in nonstructural elements.

• The durability performance of concrete containing waste plastic needs more studies.

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