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STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATE WITH RECYCLED PLASTIC GRANULES IN HYBRID FIBER REINFORCED CONCRETE

RENJI XAVIER C[1], NIDHIN B PARAPPATTU[2]

[1] P G SCHOLAR, CIVIL ENGINEERING DEPARTMENT, M A COLLEGE OF ENGINEERING, KERALA, INDIA
[2] ASSISTANT PROFESSOR, CIVIL ENGINEERING DEPARTMENT, M A COLLEGE OF ENGINEERING, KERALA, INDIA

Abstract – *Disposal of used plastics is one of the major problems faced in the present era of world. The usage of plastic is growing day by day. The non-biodegradability of plastic makes it very harmful to the environment. In this work, partial replacement of fine aggregate by recycled plastic granules at 4%, 8% and 12% in M30 grade of concrete containing steel and polypropylene fibers was done. The steel fibers were added at 0.5%, 1% and 1.5% by volume of concrete. Various steel and polypropylene fractions, 70:30, 75:25 and 80:20 were considered for the study. The compressive, split tensile and flexural strengths are determined after 7 day and 28 days of water curing.*

Key Words: *Compressive strength, Split tensile strength, flexural strength*

1. INTRODUCTION

Concrete is an ancient material of construction, first used during Roman Empire. Although wide varieties of construction materials are available in the market, concrete has able to fix one of the top positions among them. The different variety of concrete is found day by day in the present world. We all know that, the plastic is a non-biodegradable material causing pollution to the environment. The use of waste plastic in concrete has greater significance because of the reduction in pollution caused by them.

1.1 Hybrid Fiber Reinforced Concrete

The term fiber reinforced concrete is very familiar to us. the use of two or more type of fibers results in hybrid fiber reinforced concrete. The different types of fibers are added into the concrete for enhancing the various properties of concrete. Each fiber has its own effect on concrete, which is different from one another. Combination of these fibers results in enhancement of various properties of concrete. Hybrid fiber reinforced concrete possesses better properties compared to single fiber reinforced concrete. Many studies have been conducted in the field of hybrid fiber reinforced concrete. Steel and polypropylene were found to be the most successful among various combinations studied. According to Vikrant S Vairagade the steel and polypropylene combination of 80:20 was found to be successful. 25% increase in strength was observed in case of Selina Ruby, whom studied the hybrid fiber reinforced concrete containing crimped steel fiber and polypropylene fiber. M. Gunavel and Sudheer also conducted studies on hybrid fiber reinforced concrete and they obtained 75:25 fraction as the optimum.

1.2 Plastic

Plastic is a very common material in our day to day life. Lack of proper disposal methods for waste plastic is one of the hazards faced by the present world. Because of the non-biodegradability it causes the environmental pollution. The use of waste or recycled plastic in concrete in an effective manner can reduce the pollution to a certain extent. According to the studies conducted in the related field it was observed that there was slight increase in strength of concrete with addition of small amount of plastic. R. Manju in her study says that up to 6% addition of plastic has resulted in increase in the strength. In another study, it concludes that up to 15% addition is possible. Also other studies, conducted by Sathish and Pugal say that about 8% increase in strength was observed when 10% of plastic replacement was done.

2. MATERIALS USED

2.1 Cement

53 grade Ordinary Portland Cement of brand Deccan was used for the entire study. The specific gravity of the cement was foundout as 3.14 and the initial setting time was observed as 40 minutes. The standard consistency of the cement is determined as per standard procedure as 32%.

2.2 Fine Aggregate

It should pass through 4.75mm. Fine aggregate used for the study was M-Sand and it was properly graded to give the minimum void ratio. Fine aggregate selected was free from clay, silt and chloride contamination. Specific gravity was determined as 2.62

2.3 Coarse Aggregate

It is the strongest and least porous component of concrete. Angular aggregates are preferred. It was ensured that elongated and flaky aggregated are not included for the study. Aggregate crushing value obtained as 30% and specific gravity as 2.67.

2.4 Steel and Polypropylene Fiber

Fig -1: Steel and Polypropylene Fiber

The steel fiber used was of hooked end type with an aspect ratio of 60. Fiber was having a length of 30mm and diameter of 0.5mm. The steel fiber was having a density of 7850 kg/m^3 and modulus of elasticity 2x10^5 MPa. Monofilament type polypropylene fibers were used for the entire study. The density of polypropylene fibers is 946 kg/m^3.

2.5 Recycled Plastic Granules

Fig -2: Recycled plastic Granules

Recycled plastic granules of size 1-2mm were used for partial replacement of fine aggregate.

3. MIX DESIGN

Table -1: M30 Mix Details

MATERIAL	CALCULATED QUANTITY
Cement	388 kg
Fine aggregate	670 kg
Coarse aggregate	1200 kg
Water	167 litres
Super plasticizer	1.373 litres

4. TESTS AND RESULTS

In stage1, optimization of steel content is done. Among 0.5%, 1% and 1.5% one of them was selected as optimum. In the second stage out of three proportions 70:30, 75:25 and 80:20, optimum was foundout and it is selected as reference mix for the third stage. In stage3, fine aggregate is partially replaced with recycled plastic granules by 4%, 8% and 12%. Compressive strength, split tensile strength and flexural strength was determined at 7days in first two stages and at 28days in the third stage of work.

4.1 Stage1 Results

Table -2: stage1, 7day Compressive strength

% of Steel Fibre	Compressive Strength (7 Day, MPa)
0.5	30.87
1	38
1.5	33.47

Table -3: stage1, 7 day Split tensile strength

% of Steel Fibre	Split Tensile Strength (7 Day, MPa)
0.5	2.79
1	3.21
1.5	2.98

Table -4: stage1, 7 day Flexural strength

% of Steel Fibre	Flexural Strength (7 Day, MPa)
0.5	0.97
1	1.79
1.5	1.31

From stage1, it was obtained as 1% of steel fiber as optimum.

4.2 Stage2 Results

Table -5: stage2, 7 day Compressive strength

Proportions (Steel:PP)	Compressive Strength (7 Day, MPa)
70:30	24.4
75:25	27.6
80:20	25.8

Table – 6: stage2, 7 day Split Tensile strength

Proportions (Steel:PP)	Split Tensile Strength (7 Day, MPa)
70:30	2.86
75:25	3.50
80:20	3.21

Table -7: satge2, 7 day Flexural strength

Proportions (Steel:PP)	Flexural Strength (7 Day, MPa)
70:30	1.33
75:25	2.28
80:20	1.70

From stage2 75:25 proportion was selected as optimum

4.3 Stage3 Results

Table -8: Reference Mix Results

Proportion	Compressive Strength (28 Day, MPa)	Split Tensile Strength (28 Day, MPa)	Flexural Strength (28 Day, MPa)
75:25	38.6	4.60	3.42

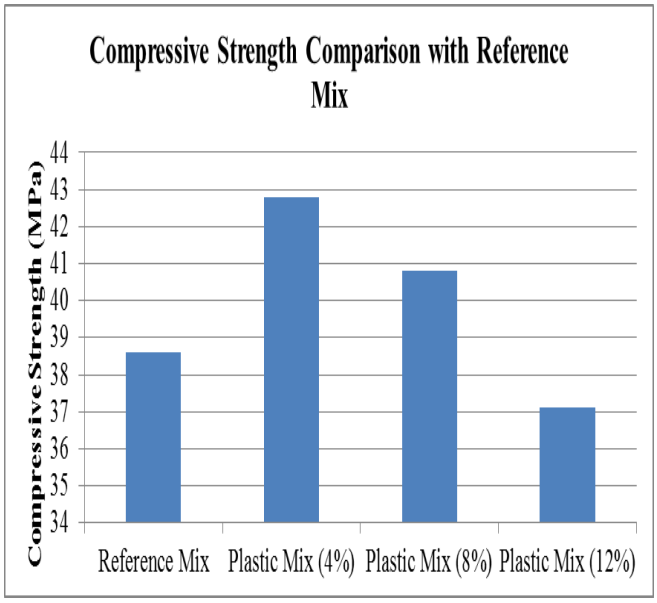

Chart 1: 28 day Compressive Strength

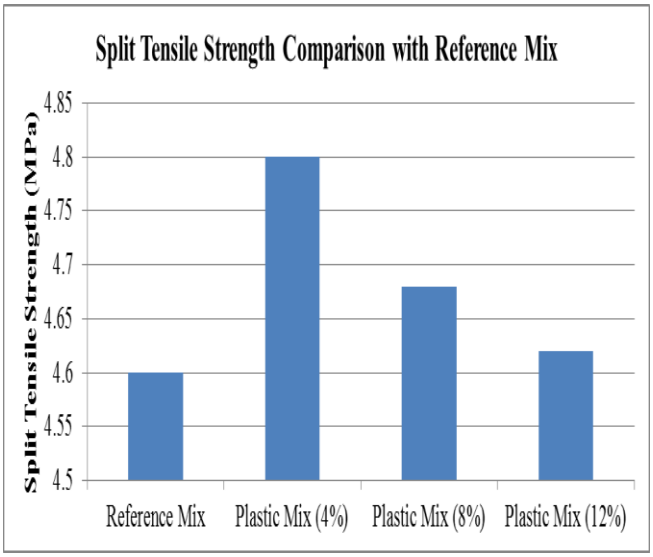

Chart 2: 28 day Split Tensile Strength

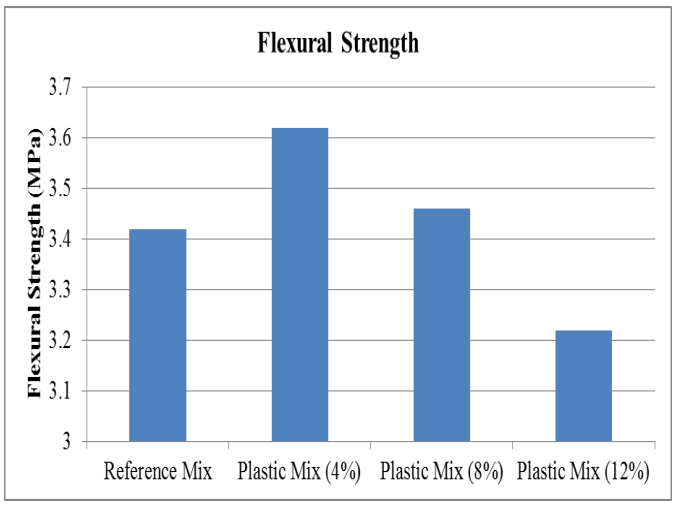

Chart 3: 28 day Flexural Strength

5. CONCLUSIONS

- In the stage1, the peak 7day compressive strength was obtained for concrete mix containing 1% of steel fibers as 38MPa
- The maximum 7day split tensile strength and flexural strength was obtained for concrete containing 1% of steel fibers as 3.21MPa and 3.88MPa respectively
- There was increase in strength up to 1% of steel fiber addition and beyond that strength gets decreased and it may be due to poor workability of the mix
- In stage2, 75:25 was obtained as optimum proportion and having 7 day compressive, split tensile and flexural strength as 27.6MPa, 3.5MPa and 4.12MPa respectively and it was selected as reference for stage3.
- In stage 3, concrete containing 4% of recycled plastic granules have shown better properties compared to other two.
- The 28 day compressive strength, split tensile strength and flexural strength was obtained for 4% mix was 42.8MPa, 4.8MPa and 5.64MPa respectively.
- It was observed that up to 8% replacement of fine aggregate can be done without any strength loss.

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BIOGRAPHIES

RENJI XAVIER C, P.G SCHOLAR
DEPT. OF CIVIL ENGINEERING
M A COLLEGE OF ENGINEERING
KOTHAMANGALAM, KERALA

Mr. NIDHIN B PARAPPATTU
ASSISTANT PROFESSOR
DEPT. OF CIVIL ENGINEERING
M A COLLEGE OF ENGINEERING
KOTHAMANGALAM, KERALA