

Experimental Investigation of Steel Fibre Reinforced Concrete with Partial Replacement of Coarse Aggregate by Waste Plastic Bottle Caps

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ABSTRACT: Concrete is most widely used building material in the world, as well as the largest user of natural resources with annual consumption of 12.6 billion tons. Basically it consists of aggregates which are bonded together by cement and water. The major part of concrete besides the cement is the aggregate. Aggregate include sand and crushed stone / Gravel. Use of these conventional materials in concrete is likely to deplete the resources unless there is a suitable substitute. Plastic caps are very light weight and generated in large quantities as waste does not have useful disposal till now. Only the 10% of the plastic caps being recycled,90% of the plastic caps are still being wasted. But plastic caps are found to possess properties that are required for viable replacement of coarse aggregate in concrete. Hence we in this project have aimed to study the effectiveness of plastic caps and steel fibres as substitute for coarse aggregate. Aggregate properties viz., specific gravity, water absorption were conducted to ascertain the properties of concrete specimens and has been casted and tested for concrete mix with various percentage of replacement (5%,7.5%&10%) and its viability for replacement were discussed.

KEYWORDS: Plastic caps, steel fibres, specific gravity, water absorbtion etc.,

I.INTRODUCTION

Due to rapid industrialization & urbanization in the Country, lots of infrastructure developments are taking place. This process has in turn led questions to mankind to solve the problems generated by this growth. The problems are acute shortage of constructional materials, increased dumping of waste products. Hence in order to overcome the above said problems waste products should be employed as construction material. The threat of disposal of plastic will not solve until the practical steps are not initiated at the ground level. It is possible to improve the performance of bituminous mixed used in the surfacing course of roads. Studies reported in the used of re-cycled plastic, mainly polyethylene, in the manufacture of blended indicated reduced permanent deformation in the form of rutting and reduced low temperature cracking of the pavement surfacing. The field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems.

II.MATERIAL PROPERTIES

2.2 Plastic caps

Plastic has become something that we cannot live without, but it is based on finite resources such as petroleum. Consequently, if plastic waste can be used again as a resource, it should be possible to solve this problem in terms of both resource saving and waste processing. Progress in the development of recycling technologies over many years has led to techniques like mechanical recycling and feedstock recycling that are now widely used for reusing post-use plastic as plastic products, as fuels for use in the chemical industry, etc. In this publication we consider the question of waste from a number of angles and present the very latest data on processing of waste plastic and its use as a raw material. Environmental and waste issues are composed of a great number of factors, which makes a scientific,

multifaceted approach essential to their solution. The reader, we hope, will find that “An Introduction to Plastic Recycling” throws light on waste problems and in particular on the issues of plastic waste.

Table 2.1: Properties of Plastic caps

S.No	Physical properties	Result
1.	Specific gravity	0.959
2.	Physical form	Solid plastic
3.	Size	28mm(neck size)
4.	Color	Green



Figure 2.1 Plastic caps

2.3 Steel fibres

Steel fibres actually increases the mechanical properties such as material toughness and durability. Steel fibres play a vital role in reducing crack as well as maximum resistance to withstand heavy loads either dynamic or static .It provides better ductility compared with conventional concrete. The properties of steel fibres are shown in Table 2.2.

Table 2.2: Properties of Steel fibre

S.No	Physical properties	Result
1.	Specific gravity	2.57
2.	Physical form	Hooked end fibre
3.	Size	30mm length,0.75mm



Fig. 2.2 Steel fibre

2.4 Super plasticizers

In this project we are using Conplast SP430 as super plasticizer. It helps in improving the compression strength and workability of concrete by dispersing cement particles, and it will also reduce the water content in the mixing of concrete up to 30%. The Sulphonated Naphthalene Formaldehyde based super plasticizer (Conplast Super Plasticizer – SP 430). The properties of super plasticizers are shown in the Table 2.3.

Table 2.3 Properties of super plasticizer

S.NO	Physical Property	Value
I.	Solid content	42%
II.	Specific gravity	1.21



Fig. 2.3 Super plasticizer
III. MIX DESIGN

3.1 GENERAL

The process of selection suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability therefore becomes of vital importance.

3.2 MIX PROPORTIONS

Cement	= 350 kg/m ³
Water	= 140 kg/m ³
Fine aggregate	= 778 kg/m ³
Coarse aggregate	= 1198kg/m ³
Chemical admixture	= 7kg/m ³

IV. EXPERIMENTAL PROGRAM

4.1 MECHANICAL PROPERTIES

4.1.1 Compression Test (Ref: IS: 516-1959)

Compression test is the most common test conducted to determine almost all the characteristics of concrete. compressive test of concrete depends upon water cement ratio ,quality of concrete material,quality control during the process of making concrete. compressive strength test normally carried in both cube and beam .In our project we have tested cubes for compression with size of 150mm x150mm x 150mm.The properly mixed concrete is poured in the moulds and tamped properly to avoid voids after 24 hours the moulds are removed and the specimen is put in the water for curing.After that the specimens are tested at 7, 14 and 28 days at compression testing machine as per I.S.516-1959.

4.1.2 Flexure Test (Ref: IS: 516-1959)

The tensile strength of the concrete can be measured using flexural strength test.It is also known as modulus of rupture. It represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress, here given the symbol f_{cr} . The flexural strengths of the respective specimens have been obtained from the

flexural tests performed on the prism specimens of size 150mm x 150mm x 700mm. The flexural strength are tested using a two point loading frame machine as per standard .

The modulus of rupture can be determined by using the formula given below

$$f_{cr} = (P_{max} \times l) / bh^2$$

where,

f_{cr} = Flexural strength

P_{max} = maximum load in (N) kg.

b = width of the prism in mm

h = depth of the prism in mm

l = span of the prism in mm

4.1.3 Split tensile strength Test (Ref: IS: 5816-1999): Split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size 150mm x 300 mm were casting using M₂₅ grade concrete. Specimens with Conventional Concrete and SCC of two different percentages were casted. During casting the conventional concrete cubes were manually compacted using tamping rods. After 24hours, the specimens were removed from the mould and subjected to water curing for 7, 14, 28 days. After curing, the specimens were tested for compressive strength as per IS: 5816-1999 using a calibrated compression testing machine of 2000KN capacity.

$$\text{Tensile strength of concrete } f_t = \frac{2P}{\pi dl}$$

Where , P = Maximum load in N applied to the specimen

L = Measured length in cm of the specimen

D = Measured diameter in cm of the specimen



Fig 4.1 Compression test (before and after testing)



Fig 4.2 Test Set Up for Flexural Strength

V. RESULTS AND DISCUSSION

5.1 GENERAL

This chapter deals with the results obtained from the various experiments conducted to access mechanical properties. The aim of the study is to determine the compressive strength, flexural strength and split tensile strength. so the results of test specimens are presented. The discussion on the results also presented in this chapter.

5.2 MECHANICAL PROPERTIES

The mechanical properties of concrete such as compressive strength, flexural strength and split tensile strength are determined from the standard experiments. They are as follows.

5.2.1 Compressive Strength

The compressive strength of replacement of waste bottle caps is arrived. The compressive strength value for replacement of waste bottle caps with the addition of steel fibres Table 5.1 Shows compression test results.

Table 5.1: Compressive Strength of Cubes with Partial Replacement of waste plastic caps

Curing days	COMPRESSIVE STRENGTH N/mm ²			
	Mix 1(0%)	Mix 2(5%)	Mix 3(7.5%)	Mix 4(10%)
7 days	20.5	23.32	21.23	18.23
14 days	29.2	32.25	31.15	25.65
28 days	32.3	41.64	37.23	28.3

5.2.2 FLEXURAL STRENGTH

The flexural strength of replacement of waste bottle caps with the addition of steel fibres arrived.. Table 5.2 shows flexural strength test results

Table 5.2: Flexural Strength of beams with Partial Replacement of plastic caps

Curing days	FLEXURAL STRENGTH N/mm ²			
	Mix 1(0%)	Mix 2(5%)	Mix 3(7.5%)	Mix 4(10%)
7 days	8.20	11.01	10.75	7.23
14 days	15.90	20.96	18.24	14.20
28 days	22.24	25.92	23.42	19.12

5.2.3 SPLIT TENSILE STRENGTH

The variation of split tensile strength at the age of 28 days with different percentage of waste bottle caps with the addition of steel fibres from the test results, it was observed that the maximum split tensile strength was obtained for mix of 15% replacement of fly ash by waste bottle caps. Table 5.3 flexural strength test results

Table 5.3: split tensile strength of Cylinder with Partial Replacement of waste bottle caps

Curing days	SPLIT TENSILE STRENGTH N/mm ²			
	Mix 1(0%)	Mix 2(5%)	Mix 3(7.5%)	Mix 4(10%)
7 days	40.23	6.72	21.23	18.23
14 days	10.45	12.45	31.15	25.65
28 days	15.32	20.78	37.23	28.3

5.2.4 WEIGHT OBSERVATION

PERCENTAGE REPLACEMENT OF COARSE AGGREGATE	WEIGHT (Kg)
0	9.8
5	7.8
7.5	6.42
10	4.98

VI. CONCLUSION

In this project the strength of the concrete increased for M30 grade at 5% replacement of coarse aggregate by waste plastic caps with the addition of steel fibres of 0.75%. After this the strength gradually decreases. And by the above weight observation the weight also decreases at 5% replacement of waste plastic caps by 20%. The concrete attained maximum compressive strength for M30 grade of concrete. The split tensile strength of concrete is also increased when cement is replaced by waste plastic caps. The split tensile strength is maximum at 15% of replacement. The flexural strength of the concrete is also increased when the cement is replaced by metakaolin. At 15% replacement, the flexural strength is maximum.

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