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Research Article

EFFECT ON PROPERTIES OF CONCRETE WITH ADDITION OF WASTE STEEL BOTTLE CAP FIBRES

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ABSTRACT

This paper discusses the effects on the properties of the concrete with addition of the steel fibres obtained from waste steel bottle caps. Concrete, the most popular construction material has some limited properties out of which low tensile strength are a major one. Hence an attempt has been made in the present investigations to study the influence of addition of waste soft drink bottle caps at a dosage of 0.25%, 0.50% and 0.75% of total weight of concrete as fibres. The soft drink bottle caps were flattened and after removing the inner rubber they were cut into rectangular strips of 3mm width and 30mm length. Experimental investigation was done using M25 concrete mix and tests were carried out as per recommended procedures by relevant codes. In this investigation no other chemical admixture was used. The concrete was subjected to compressive strength and split tensile strength tests after 7 days, 14 days and 28 days.

INTRODUCTION

In the construction industry and improvement of whole civil engineering and infrastructure development, concrete has played an extensive role. The great strength, durability and veracity of concrete are the properties that are utilized in construction of all infrastructural projects. However concrete being a brittle material has low tensile strength and low strain capacity, so to overcome these shortcomings of concrete, Fibre Reinforced Concrete (FRC) has been developed which is defined as concrete containing randomly oriented and dispersed fibres.

On the other hand metals being used as for making caps of containers, preserve liquids in the bottles very well, but the disposal of caps particularly soft drink bottle caps had become a problem for the environmental engineers. Also today the construction industry is in need of finding cost effective materials for increasing the strength of concrete structures without extra increase in the cost of the construction. To overcome this serious defect, partial incorporation of fibres is practised. The main objective of this study is to improve tensile strength of concrete. In this experimentation fibre reinforced concrete mix was prepared by adding the steel bottle cap strips having length of 30mm and diameter of 0.35mm, workability and strength test were conducted and their results are compared with ordinary concrete mix. The resulting compressive strength and split tensile strength of the mixture depends on the type of cement, size and type of aggregate, period and type of curing adopted.

MATERIAL USED

Cement- Ordinary Portland cement of grade – 53 (source Birla plus cement) conforming to Indian standard IS: 12269-1987 has been used in the present study. The various physical properties of the cement are given in Table 2.1.

Table 2.1 Physical properties of Portland cement

Sr. No.	Characteristics	IS-specifications (IS : 12269-1987)
1.	Setting time in minutes	
	(i) Initial Setting Time	> 30
	(ii) Final Setting Time	< 600
2.	Specific Gravity	3.15
3.	Compressive Strength in N/mm^2	
	(i) 3 days	> 27
	(ii) 7 days	> 37
	(iii) 28 days	> 53
4.	Fineness, minimum specific surface area (m2/kg)	225

Fine Aggregate- Sand confirming to Zone-II requirements has been used as fine aggregate properties are given in Table 2.2.

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Also other foreign matters present in the sand were separated before use.

Table 2.2 Physical characteristics of fine aggregates

Sr. No.	Characteristics	Test Results
1.	Specific Gravity	2.56
2.	Percentage Water Absorption	0.80
3.	Fineness Modulus	2.15

Coarse Aggregate- Locally available crushed stone aggregate of maximum size 20 mm had been used. The physical properties are listed in Table 2.3. Coarse aggregate has been sieved through IS: 150-micron sieve to remove dirt and other foreign materials.

Table 2.3 Physical characteristics of coarse aggregates

Sr. No.	Characteristics	Test Results
1.	Specific Gravity	2.61
2.	Maximum Size	20 mm
3.	Percentage Water Absorption	1.8%
4.	Fineness Modulus	6.9

Fibres- Steel fibres obtained from waste steel bottle caps were used. Inner rubber cover from the caps was removed and they were flattened and each cap was cut into pieces having 30 mm length and 0.35 mm diameter, the diameter was found out using a wire gauge. The aspect ratio of fibre was found to be 85.7. The fibres have been cut manually to an accurate size. Three different proportions of fibres (0.25, 0.50 and 0.75%) by weight of concrete mix have been used. Properties of steel fibre used are mentioned in Table 2.4.

Table 2.4 Physical properties of steel fibres

Characteristics	Value Obtained
Diameter, mm	0.35
Length, mm	30

Fig 2.1 Fibres cut out from waste steel bottle caps

Water- According to IS: 456-2000, water used for concrete should be of portable quality (PH- 6.8 to 8.0). Ordinary tap water, which is fit for drinking, has been used in preparing all concrete mixes and curing in this investigation.

Experimental Work

In order to carry out the following research work M25 concrete Mix was prepared for slump range of 50-75 mm, as per the design procedure outlined by IS 10262:2009, and the ratio of various ingredients is as shown below in table no.3.1

Table 3.1 Weight and Ratio of all concrete components per cubic meter

Components	Cement	Fine aggregate	Coarse aggregate	Water
Weight for $1m^3$ (kg)	348.8	679.46	1192.58	197.40
Ratio	1	1.77	3.10	0.51

Further, to find out the effect of the waste steel bottle cap fibres on the properties (Slump, Compressive Strength and Split Tensile Strength) of the concrete the steel fibre were added in the different percentages of 0.25%, 0.50% and 0.75% by weight of total weight of concrete. And for each case a total of 9 cubical specimens of 150*150*150mm and 6 cylindrical specimens of 300*150mm were casted. The various tests along with their results are described below

Workability- The workability of plain concrete and waste steel bottle cap fibre reinforced concrete has been measured by slump test as per I.S. 1199-1959. The test results have been tabulated in Table 3.2 and shown in figs. 3.1. It is clear from the table and figure that as the percentage of fibres (0.25, 0.50 and 0.75 percent) increases, the workability of the mixture decreases, because of the introduction of steel fibre result in apparent increases the stiffness of the mixture.

Table 3.2 Slump for plain concrete and steel fibre concrete

Type of Concrete Mix	Slump
Plain Concrete	60
0.25% Waste steel bottle cap fibre reinforced concrete	32
0.50% Waste steel bottle cap fibre reinforced concrete	23
0.75% Waste steel bottle cap fibre reinforced concrete	14

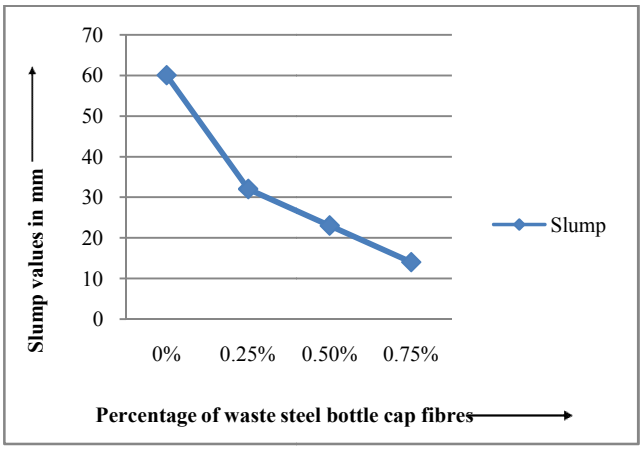

Fig 3.1 Slump results

Compressive Strength- The compressive strength of plain concrete and waste steel bottle cap fibre reinforced concrete having different percentages of fibres had been measured by compression test as per IS: 516-1959, and have been summarized in Tables 3.2. The results have also been graphically represented in figure 3.2. Moreover, it is evident from these figures that the addition of steel fibres (waste bottle caps) in cement by 0.25%, 0.50% and 0.75% percentage of total weight of concrete, increases the compressive strength of plain concrete by 0.12 to 0.52, 0.76 to 2.76 and 0.77 to 3.24 per cent for 7, 14 and 28 days testing.

Table 3.2 Compressive strength (MPa)at 7,14 and 28 days

Percentage fibre by weight	Mean Compressive strength at 7 days	Mean Compressive strength at 14 days	Mean Compressive strength at 28 days
0%	17.45	24.88	29.90
0.25%	17.47	25.18	30.17
0.50%	17.51	25.39	30.50
0.75%	17.54	25.67	30.91

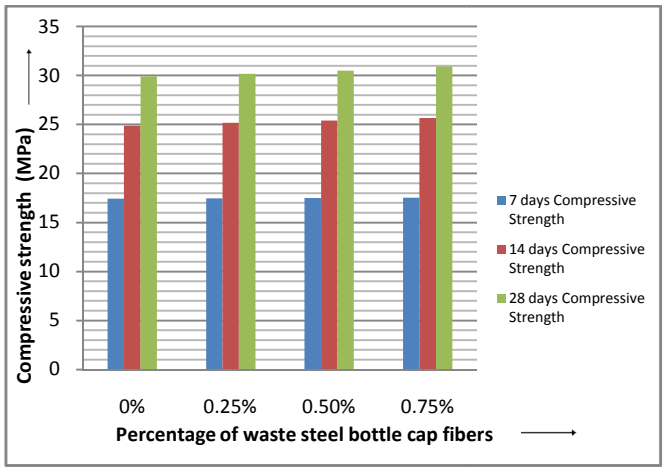

Fig 3.2 Compressive strength of waste steel bottle cap fibre Concrete

Split Tensile Strength- It is an indirect method of testing tensile strength of concrete. The results of split tensile force and split tensile strength for plain and fibre reinforced concrete are tabulated in Tables 3.3 and figure 3.3 represents the split tensile strength of different concrete mixtures at 7 and 28 days. The split tensile strength of fibre reinforced concrete increases for 0.25%, 0.50% and 0.75% of steel fibres from 3.62 to 9.42 percent (7 days) and from 5 to 12.92 percent (28 days).

Table 3.3 Split Tensile strength (MPa) at 7 and 28 days

Percentage fibre by weight	Mean *Split Tensile strength* at 7 days	Mean *Split Tensile strength* at 28 days
0%	1.38	2.40
0.25%	1.44	2.52
0.50%	1.47	2.63
0.75%	1.49	2.71

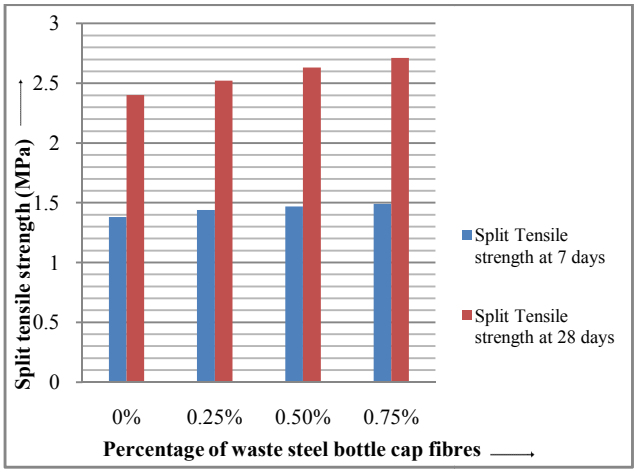

Fig 3.3 Split tensile strength

CONCLUSION

The following Conclusions can be Drawn From the Present Study.

The addition of waste steel bottle cap fibres in the concrete sharply decreases the workability of the concrete as the percentage of the fibres increases in the concrete, the reduction in the workability is due to the balling effect of the fibres in the concrete mix.

The addition of the waste steel bottle cap fibres in the concrete by volume (0.25, 0.50 and 0.75 percent) increases the compressive strength of concrete as compared to the plain concrete, although the increase in the compressive strength is of small amount. Increase is of the order of 0.12 to 0.52, 0.76 to 2.76 and 0.77 to 3.24 per cent for 7, 14 and 28 days curing period respectively.

The addition of steel fibres to concrete increases the split tensile strength of flyash concrete for all the three ages (7, 14 and 28 days). In concrete mixes with addition of 0.25, 0.50 and 0.75 percent fibres, increase is in the range of 3.62 to 9.42 percent for 7 days and from 5 to 12.92 percent for 28 days, curing period respectively.

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