STUDY ON THE PROPERTIES OF CONCRETE USING WASTE BOTTLE CAPS AS INGREDIENT

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Abstract - *This paper is concerned with the effect on the properties of concrete by using waste bottle caps as an ingredient. Metal caps with plastic backing is used for glass bottles, which is harmful for the environment when disposed off. As well as during their recycling process various harmful and greenhouse gases are generated, along with consumption of high amount of energy. On the other hand we know that concrete is strong in compression but weak in tension. Also some drawbacks of concrete like low ductility, low energy absorption, & shrinkage can be improved by using waste bottle caps as a fibre reinforcement in the concrete. The scope of the project also includes the increasing effect on the Compressive as well as on the Flexural strength of the concrete after reinforcement. A generic 21-tooth crown cork bottle caps were cut into three pieces and mixed with dry concrete mix. Comparison of results of tests like Compressive strength test, Split tensile strength test & Flexural strength test for 0.5%, 1%, 1.5% fibre reinforcement by total weight of concrete mix with respect to 0% fibre reinforcement is along with plotting of load deflection curve is done.*

Key Words*: *Steel fiber reinforcement , Compressive strength test , Split tensile strength test & Flexural strength test.

1. INTRODUCTION

[1]Concrete is one of the most important ingredient of the construction materials. As various properties of concrete includes:

•Ability to cast into shapes:

Fresh concrete is flow able and is in liquid state. Concrete can be hence poured into various formworks or shuttering configurations to form desired shapes and sizes at construction site. Concrete can be cast into complex shapes and configurations by adjusting the mix

•Excellent Water Resistance Characteristics:

Though chemical in water can induce corrosion. Compared to wood and steel, concrete can withstand in water without serious deterioration. Due to this property, it is ideal to underwater and Submerged applications like for building structures, pipelines, dams, canals, linings and waterfront structure.

•High-temperature resistance:

Concrete can withstand high temperatures better than wood and steel. Calcium silicate hydrate, C-S-H, which is the main binder in concrete can withstand until 910 deg C. Concrete is a bad conductor of heat it can store considerable amount of heat from the environment. Concrete can withstand heat for 2–6 hours enabling sufficient time for rescue operations in case of fire.

•Low or Zero Maintenance Required:

Concrete structures do not require coating or painting for regular applications as protection for weathering compared to steel or wooden structures where it is inevitable. Coating are to be replaced and redone on a routine basis making the maintenance cost for concrete much lower than that for steel or wood.

But due to sudden increment in the design load, failure of many reinforced structure (Beam, column) can occur. This has created an urgent need for the implementation of any such material which can take load even without further increment in cost as well as other restrictions like spacing criteria of bars, number and size of bars. Having a large number of strengthening options like fibre reinforcement, increasing the amount of reinforcement would give a great financial burden.

A promising new way resolving this problem is to selectively use advanced fiber reinforcement method like:

1.1 Experimental Investigation:

The following concrete specimens were casted and tested in the laboratory. The variations considered were the percentage of bottle cap fibers with respect to the total weight of casting material:

Table- 1: No. of specimens with varying %age of fiber reinforcement

% of Fiber	No. of Cubes cast	Number of cylinders cast)	No. of Beams cast
0	3	3	3
0.5	3	3	3
1.00	3	3	3
1.50	3	3	3

1.2 [4] Steel fiber reinforcement

1. Steel Fibers are generally distributed throughout a given cross section whereas reinforcing bars or wires are placed only where required

2. Steel fibers are relatively short and closely spaced as compared with continuous reinforcing bars of wires.

3. It is generally not possible to achieve the same area of reinforcement to area of concrete using steel fibers as compared to using a network of reinforcing bars of wires.

4. Steel Fibers are typically added to concrete in low volume dosages (often less than 1%), and have been shown to be effective in reducing plastic shrinkage cracking.

5. Steel Fibers typically do not significantly alter free shrinkage of concrete, however at high enough dosages they can increase the resistance to cracking and decrease crack width.

2. [2] MATERIAL AND MATERIAL PROPERTIES

a) Cement

Ordinary Portland cement of 53 grade was used throughout the experimental program. The specific gravity of cement was found out to be 3.14.

b) Coarse Aggregate:

Crushed hard stone of maximum size 20 mm has been used for concreting purpose. The specific gravity of the aggregates was found out to be 2.65

c) Fine Aggregate

Fine aggregate used for the entire investigation was river sand. The specific gravity of sand was found to be 2.65.

d) Water

Potable water has been used for casting as well as curing purpose.

e) Bottle cap as Fiber:

Bottle caps were cut into 3 equal and uniform pieces and the rubber was removed. After that it was mixed uniformly in concrete during dry mix. Fig- 1 shows bottle cap fibers ready for mixing in concrete.

C.M.D.:

I.S. Code Method is used (IS.10262-1982 & I.S.10262-2009). Grade of concrete was taken as M25

Water Cement Ratio 0.45. Hence Cement Amount is 425.77kg/m3

Based on mix design calculations the Mix proportion was found to be:-

0.45: 1: 1.86: 2.34

W: C: F.A: C.A.

Fig-1: Casted specimens

2.1 [3]Casting of specimen:

Moulds of cube, cylinder, and beams were cleaned properly and made dust free. After fixing with screws tightly oil was applies thoroughly for easy stripping. Freshly mixed concrete added with calculated amount of bottle caps was placed in the moulds with proper tamping. After the casting it as vibrated on the mechanical vibrated for proper compaction. Next day the specimens were demoulded and put in the curing tank for curing.

Fig-1&2 shows the curing of specimens and the mixing of concrete.

Fig-2: Mixing of concrete

Fig-3: Curing of specimen

3. TESTING:

The curing period was given of 28 days. Cubes and Cylinders were tested on Compression Testing Machine and beams were tested on Universal testing machine.

3.1 Compressive strength:

Table- 2: Test results of peak load for specimens with varying %age of reinforcement

	COMPRESSIVE FORCE (KN)			
% fiber by wt.	**0%**	**0.50%**	**1%**	**1.50%**
	746.8	719.1	792.6	788.3
	711.2	685.3	697	796
	675.2	758	709	729.3
AVG:	**711**	**720.8**	**732.8**	**771.2**

Table- 3: compressive strength values for Specimens with varying %age of reinforcement

	COMPRESSIVE STRENGTH (KN/mm^2)			
% fiber by wt.	**0%**	**0.50%**	**1%**	**1.50%**
	33.19	31.96	35.22	35.03
	31.06	30.45	30.97	35.37
	30	33.68	31.51	32.41
AVG:	**31.6**	**32.03**	**32.56**	**34.27**

From the above test results it is clear that when bottle caps are added, the compressive strength is found to be increasing. This may be due to the fact that the bond between mortar with fiber in concrete is stronger than that of plain concrete.

The percentage increase in compressive strength of 0.5%, 1.0%&1.5% w.r.t 0% fiber reinforcement was 1.37%, 3.06% & 8.43% respectively.

Graph related to the values are plotted as below :-

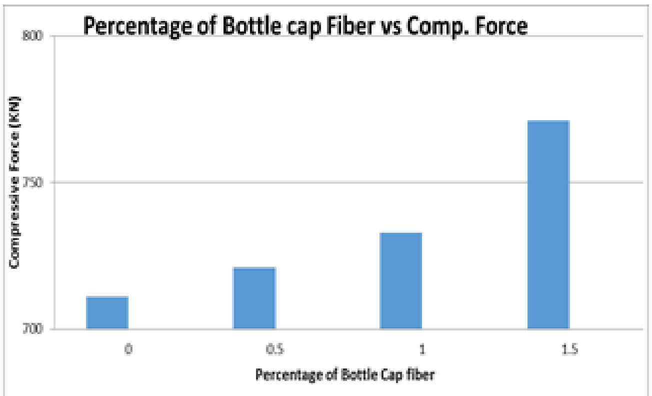

Chart 1: Comparison of Comp. Force

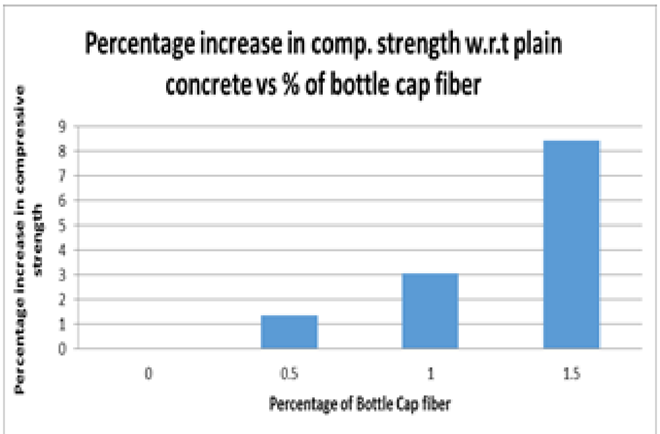

Chart 2: Comparison Of Compressive Strength

3.2 Split TensileStrength:

Table- 4: Test results of peak load for specimens with varying %age of reinforcement

	TENSILE FORCE (KN)			
% fiber by wt.	0%	0.50%	1%	1.50%
	156.68	188.04	212.5	196.7
	183.56	171.23	199.1	202.4
	173.36	204.36	170.6	221.7
AVG:	**170.2**	**187.92**	**194.06**	**206.93**

Table- 5: Split Tensile Strength values for Specimens with varying %age of reinforcement.

	SPLIT TENSILE STRENGTH (KN/mm^2)			
% fiber by wt.	0%	0.50%	1%	1.50%
	2.216	2.66	3.006	2.78
	2.596	2.422	2.816	2.86
	2.413	2.89	2.41	3.136
AVG:	**2.408**	**2.657**	**2.744**	**2.925**

Split tensile strength of concrete specimen without bottle cap fibre addition was found to be 170.2 KN/mm2. .From the above test results, the percentage increase in the split tensile strength of the specimen for 0.5%, 1% & 1.5% w.r.t 0% fiber reinforcement was found to be 10.4%, 14.02%, & 21.58% respectively.

Flexural strength of concrete specimen without bottle cap fiber addition was found to be 15.22 KN/mm2. .

The percentage increase in Flexural strength with 0.5%,1% &1.5% over 0% fiber reinforcement were found to be 3.153%, 5.98% & 9.26% respectively.

Below are the graphical representation of the experimental values obtained:

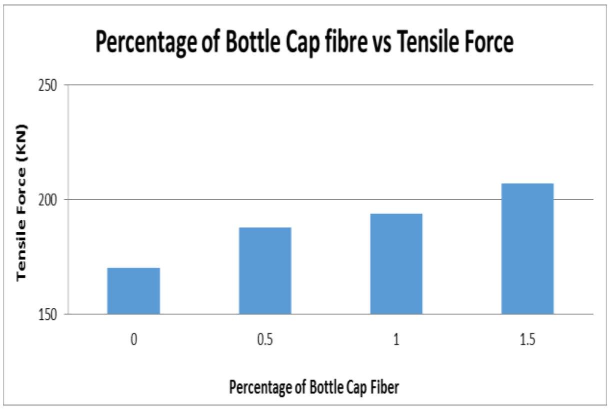

Chart 3: Comparison Of Force Acting On Specimen

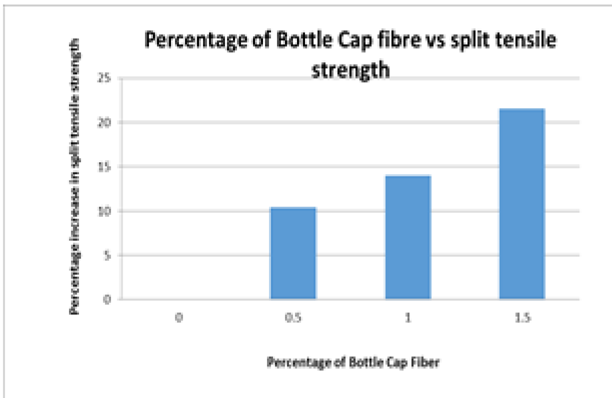

Chart 4: Comparison of Tensile Strength Of Specimen

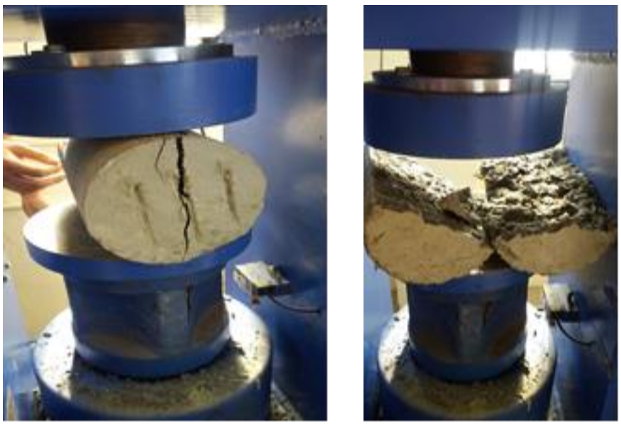

Fig-6: Testing For Split Tensile Strength

3.3 Flexural Strength Test:

Table- 6: Test results of peak load for specimens with varying %age of reinforcement.

	LOAD (KN)			
% fiber by wt.	0%	0.50%	1%	1.50%
	15.9	16.8	16.5	17.9
	14.4	14.9	17.1	16.5
	15.32	15.4	14.7	15.49
AVG:	15.22	15.7	16.13	16.63

Table- 7: Flexural Strength values for Specimens with varying %age of reinforcement

	FLEXURAL STRENGTH (KN/mm^2)			
% fiber by wt.	0%	0.50%	1%	1.50%
	2.82	2.985	2.93	3.18
	2.55	2.647	3.03	2.93
	2.722	2.736	2.612	2.752
AVG:	2.69	2.789	2.85	2.954

Flexural strength of concrete specimen without bottle cap fiber addition was found to be 2.69 KN/mm2.

The Flexural Strength of concrete specimen with 0.5%, 1.0% and 1.5% were found to be 2.789, 2.85, and 2.954 respectively.

The percentage increase in Flexural strength with 0.5%,1% &1.5% over 0% fiber reinforcement were found to be 3.153%, 5.98% & 9.26% respectively.

Fig 7: Bending crack in beam

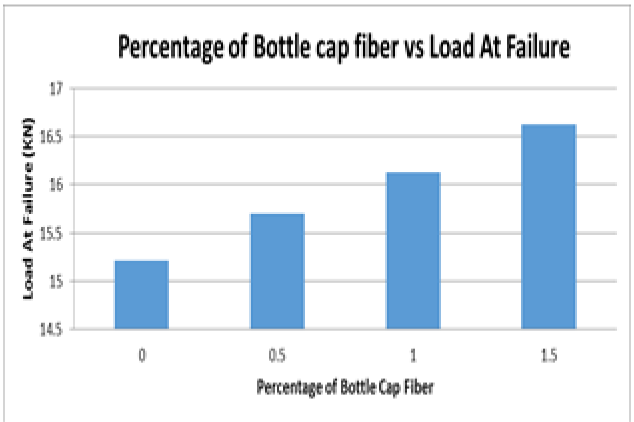

Chart 5: Comparison of Force Acting on Specimen

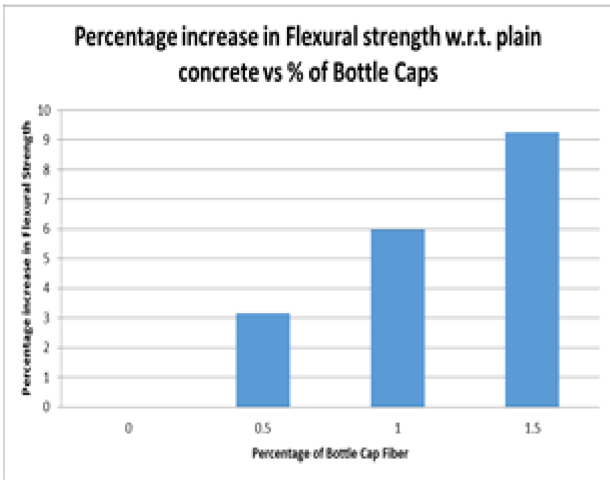

Chart 6: Comparison of Flexural Strength

Fig-8: Testing For Flexural Strength

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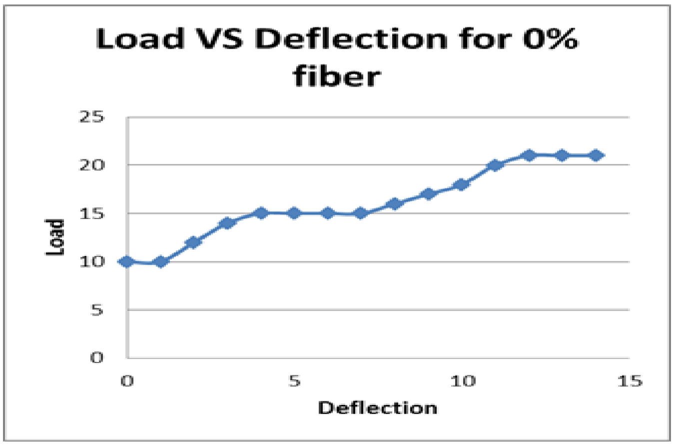
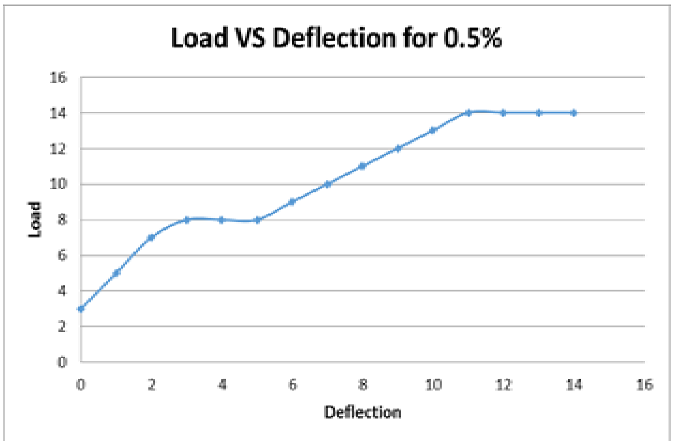
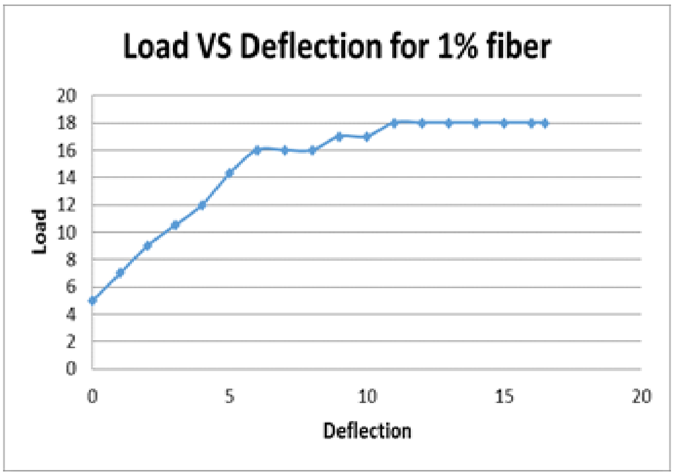
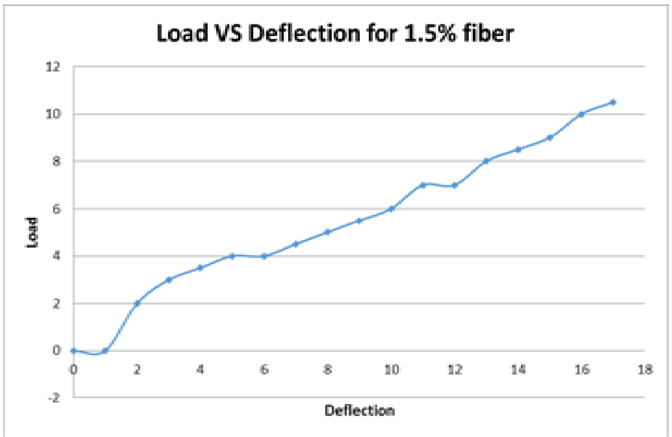
3.3.1 DEFLECTION CURVE:

Below are the Deflection Curves at various % of Bottle caps:









4. CONCLUSIONS:

Compressive strength increases with increase in percentage of bottle cap fibres. The percentage increase for 0.5%, 1.00% and 1.5% over 0% fibre reinforcement were found to be 1.37%, 3.06% and 8.43% respectively.

Split tensile strength increases with increases in percentage of bottle cap fibres. The percentage increase for 0.5%, 1.00% and 1.5% over 0% fibre reinforcement were found to be 10.4%, 14.02% and 21.58% respectively.

Flexural strength increases with increase in percentage of bottle cap fibres. The percentage increase for 0.5%, 1.00% and 1.5% over 0% fibre reinforcement were found to be 3.153%, 5.98% and 9.26% respectively.

The experimentation also shows that we can achieve good increment in the desired properties of our concrete with addition of waste bottle caps which is much preferable than to increase in the amount of steel , which in turn can affect the economy.

The experimentation also give a good alternative for an effective use of waste bottle caps rather than to spare extra efforts on their recycling and dumping.

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