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Research Paper

An Experimental Investigation on Strength of Cement Concrete Roads by using different types of Waste Materials

Rohit Limbraj Ikhe[1] G.N. Shete[2.]
[1] *MTech Student, Department of Civil Engineering, M.S. Bidve Engineering College, Latur, India*
[2] *Head of Department, Department of Civil Engineering, M.S. Bidve Engineering College, Latur, India*

ABSTRACT: *Advancements in technology enhances not only human comforts but also damages the environment. Use of metals as containers has become popular and safe now, especially to carry the liquids. Inspite of the inherent advantages and disadvantages existent in its disposal. Today the construction industry is in need of finding cost effective materials for increasing the strength of concrete structures. Hence an attempt has been made in the present investigations to study the influence of addition of waste materials like lathe waste, soft drink cans, bottle caps, broken glass bottles, steel powder from workshop at a dosage of 5%, 10% and 15% of total weight of fine aggregates as aggregate. The lathe waste, soft drink cans, bottle caps, broken glass bottles, steel powder from workshop were deformed into the fine aggregates. Experimental investigation was done using M40 mix and tests were carried out as per recommended procedures by relevant codes. The results were compared with conventional concrete it was observed that concrete blocks incorporated with steel powder increased its compressive strength. Bottle caps reinforced blocks exhibited an increase in flexural strength of concrete.*

KEYWORDS: *waste materials, concrete, aggregates, compressive strength, workability*

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I. INTRODUCTION

The most desirable and the most commonly used material in construction industry is Concrete. This is due to the flexibility it offers in being able to cast it into any shape. In present scenario safe disposal of Industrial wastes is a great problem. These waste materials create environmental pollution in the vicinity because many of them are non- biodegradable. Studies reveal that in recent years, industrial wastes were successfully used in road construction in many developed countries. The use of these materials in road making is based on technical, economic, and ecological criteria. India has a vast network of industries located in different parts of the country and many more are to come in the near future. Million metric tons industrial wastes are produced in these Industries. The pollution and disposal problems may be minimized by properly utilizing these materials in highway construction. It is important to test these materials and to develop a methodology and specifications to enhance the use of these industrial wastes for their effective utilization in road construction in India. The probable use of these materials should be developed for construction of low-volume roads in different parts of our country. A review of various Industrial wastes to be used in the construction of highway has been discussed in this paper. The common waste materials are soft drink cans, bottle caps, waste steel, broken glasses, fly ash, blast furnace slag, cement kiln dust, waste plastic bags.

To sustain the environment, it is crucial to find solutions to deal with waste, pollution, depletion and degradation resources. In construction, large amounts of concrete from buildings' demolitions made up 30-40 % of total wastes. Expensive dumping cost, landfill taxes and limited disposal sites give chance to develop recycled concrete. Recycled aggregates were used for reconstructing damaged infrastructures and roads after World War II. However, recycled concrete consists fly ash, slag and recycled aggregate, is not widely used because of its poor quality compared with ordinary concrete. This research investigates the possibility of using recycled concrete in construction applications as normal concrete. Methods include varying proportion of replacing natural aggregate by recycled aggregate.

Objective of Project

1. Investigate the strength of concrete by using waste materials such as bottle caps, empty waste tins, waste steel, broken glass bottles as partial replacement of aggregates.
2. To study the properties of materials by conducting basic tests on cement, coarse aggregates & waste materials used.
3. Find the percentage of waste material replaced to cement that makes the strength of concrete maximum.
4. Develop suitable mix design
5. To study the strength parameters like compressive strength & flexural strength in concrete by partially replacing of aggregates with respect to weight of aggregate.
6. Comparison of structural characteristics of normal concrete and concrete made using lathe soft drink cans, bottle caps, broken glass bottles, steel powder from workshop.

Significance of Study

7. To study workability of some commonly available waste materials as partial replacement in concrete used for road constructions
8. To introduce potential of waste materials as aggregates
9. To study experimentally disposal of waste materials in concrete without compromising required strengths

II. METHODOLOGY

Materials Used

a) CEMENT

Cement is a well-known building material and has occupied an indispensable place in construction work. There is a variety of cement available in market and each type is used under certain condition due to its special properties such as colour and composition of cement. The function of cement is, first to bind the sand and coarse aggregates together, and second to fill the voids. Although cement constitutes only about 10 percentage of the volume of the concrete mix, it is the active portion of the binding medium and the only scientifically controlled ingredient of concrete. Locally available cement is used. Like OPC 43 (Birlashakti Cement).

b) FINE AGGREGATE

Fine aggregate includes the particles that all passes through 4.75 mm sieve and retain on 0.075 mm sieve. Locally available river sand will be used as fine aggregate. The sand will first sieve through 4.75 mm sieve to remove any particles greater than 4.75mm and then washed to remove the dust.

c) COARSE AGGREGATE

The broken stone is generally used as a coarse aggregate. Aggregate occupies most of the volume of the concrete. Locally available coarse aggregate having nominal size 20 mm was used. The aggregates were washed to remove dust and dirt

d) WATER

Water is used for mixing, curing purpose should be clean, portable, fresh and freefrom any bacteria. Water is a key ingredient in the manufacture of concrete.

e) WASTE MATERIALS

For this experimental study we have used 4 different types of waste materials converted into fine aggregates for usage in concrete and compared it with normal concrete.

1) **Waste Steel**: Steel waste from lathe machine is taken and it is converted into size suitable to use it as aggregates.
2) **Soft Drink Cans:** Soft Drink Cans are crushed and cutted into small pieces so that they can be used in concrete as fine aggregates.
3) **Broken Glass Bottles:** For using glass bottles as aggregates in concrete they are crushed into fine size.
4) **Bottle Caps:** Bottle caps are crushed and made into small pieces so that they can be used as aggregates.

Physical Properties of Materials
A)CEMENT

Table 1: Physical Properties of cement

Sr. no.	Properties	Test results
1	Normal consistency	31%
2	Specific Gravity	3.15
3	Initial setting time	150
4	Final setting time	210
5	Soundness Test	1.00

Sr. no.	Properties	Results
1	Specific Gravity	2.63
2	Fineness modulus	3.75
3	Grading zone	2
4	Bulk density: loose compact	1450Kg/m^3 1710Kg/m^3

C) COARSE AGGREGATE

Table 3: Physical properties of coarse aggregate

Sr. no.	Properties	Results
1	Specific Gravity	2.68
2	Fineness modulus	7.13
3	Grading zone	2
4	Bulk density: loose	1350kg/m^3
	Compact	1600kg/m^3

D) WATER

Table 4: Physical properties of water

Sr.no.	properties	result
1	Hardness	62mg/L
2	Turbidity	4TU
3	PH	6.14

Sr. No.	**Item**	**For 1 m^3 Concrete**	**Mix Ratio**
1	Cement	442 kg	1
2	Fine Aggregate	678.25 kg	1.53
3	Coarse Aggregate	1266.67 kg	2.68
4	Water	197 lit	0.45

Casting Of Specimens

Test specimens of Cubes of size 150mm x 150mm x 150mm, beam with 700mm x 150mm x 150mm will prepared using the standard moulds. The samples are cast. The samples are demoulded after 24 hrs of casting and kept in a water tank for 7 and 28-days curing. A total of 48 specimens cast for testing the properties such as compressive strength and flexural strength cube samples of size 150mmx150mmx150mm for different percentages of waste materials in partial replacement of coarse aggregate will casted. The concrete mixes are 0%, 10%, 20%, 30% crushed waste materials with partial replacement of coarse aggregate. All cubes will casted in one lift and consolidated using machine vibrator. After final setting of cubes, the cube moulds will beremoved and cubes will keep in water tank for curing up to 7 and 28 days.

Fig 1: Curing of Cube and Beams

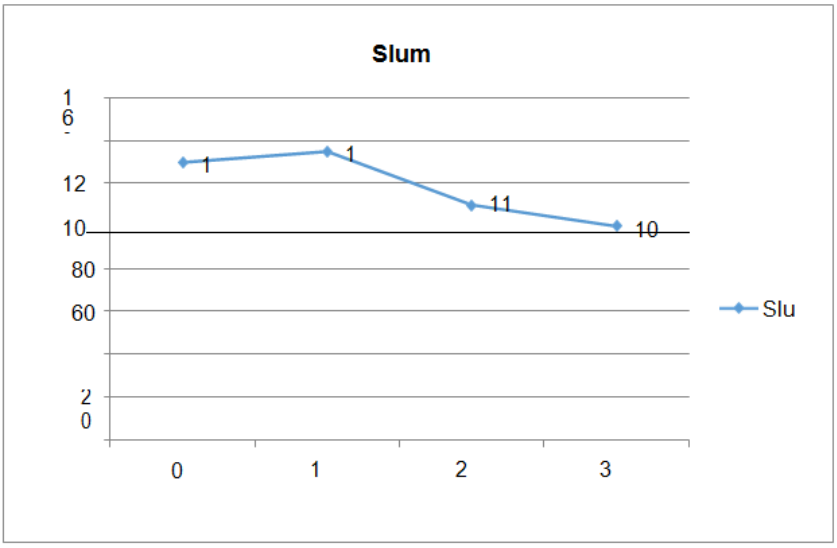
Testing of Specimens

After 24 Hours, specimens were removed from the mould and subjected to curing for 7 and 28 days. Using Compression Testing Machine of capacity of 2000KN in accordance with IS 516-1959, strengths were tested for 7 & 28 days.

III. WORKABILITY

Table 9: Slump values for different percentage of mix

% of coarse replaced by crushed over burnt bricks	Slump value (mm)
0%	130
10%	135
20%	110
30%	100



Graph 1: Slump values

IV. Experimental Methodology

Compressive Strength Test

The result of compressive strength After 7 days and 28 days are recorded. Result indicates that for some waste materials strength increases as we increase them from 10% to 20% and so on. But for some waste materials it decreases drastically. That means we can replace coarse aggregate by some materials in appropriate proportions to increase its strength.

Flexural Strength Test

Testing of all beam specimens with two points loading for flexural strength. The results of flexural strength were plotted in below table for 28 days. Result indicates that if we increase percentage of waste coconut shell from 0 to 15% will give us good results and help to increase flexural strength of concrete

V. Experimental Results

Table 10: Compressive Strength at 7 days For Steel Waste

Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
0%	1	700	31.556
	2	710	
	3	720	
10%	1	780	35.11
	2	800	
	3	790	
20%	1	790	35.55
	2	790	
	3	820	
30%	1	800	36
	2	810	
	3	820	

For soft drink cans

Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
0%	1	700	31.556
	2	710	
	3	720	
10%	1	720	31.85
	2	720	
	3	710	
20%	1	750	31.85
	2	700	
	3	700	
30%	1	690	31.4
	2	720	
	3	710	

For waste glass

Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
	1	700	

0%	2	710	31.556
	3	720	
10%	1	740	32
	2	700	
	3	720	
20%	1	720	32.14
	2	730	
	3	720	
30%	1	740	31.7
	2	700	
	3	700	

For bottle Caps

Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
0%	1	700	31.556
	2	710	
	3	720	
10%	1	550	24.59
	2	560	
	3	550	
20%	1	550	23.85
	2	540	
	3	520	
30%	1	560	
	2	540	
	3	550	

Table 11: Compressive Strength at 28 days For Steel Waste

Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
0%	1	1270	56.593
	2	1290	
	3	1260	
10%	1	1190	54.22
	2	1220	
	3	1250	
20%	1	1200	54.37
	2	1240	
	3	1230	
30%	1	1290	57.037
	2	1260	
	3	1300	

For soft drink cans

Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
0%	1	1270	56.593
	2	1290	
	3	1260	
10%	1	1150	51.259
	2	1160	
	3	1150	
20%	1	1200	52.741
	2	1180	
	3	1180	
30%	1	1170	51.852
	2	1150	
	3	1180	

For waste glass

Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
0%	1	1270	56.593
	2	1290	
	3	1260	
10%	1	1200	54.371
	2	1240	
	3	1230	
20%	1	1280	55.259
	2	1150	
	3	1300	
30%	1	1190	54.222
	2	1220	
	3	1250	

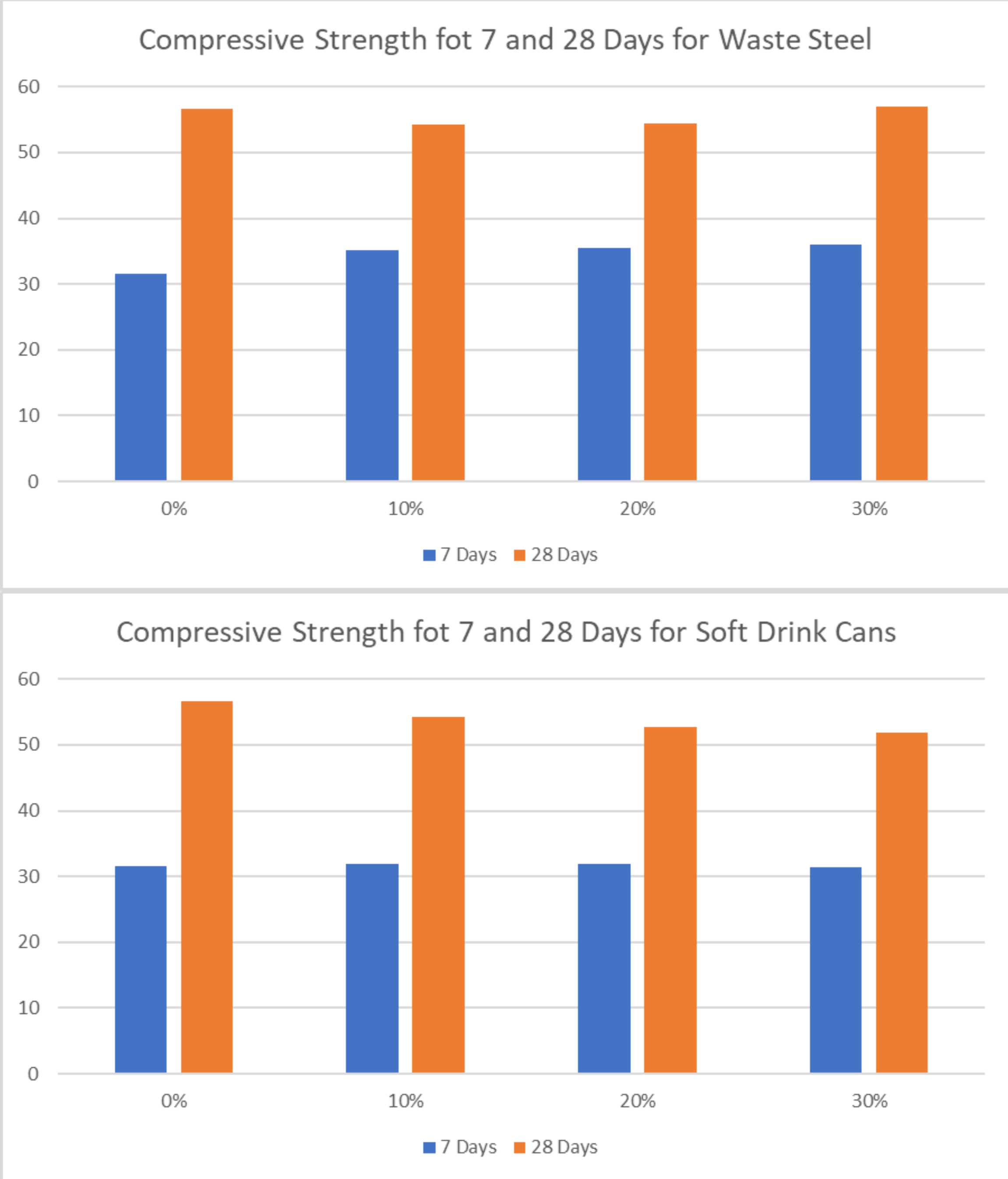
For bottle Caps

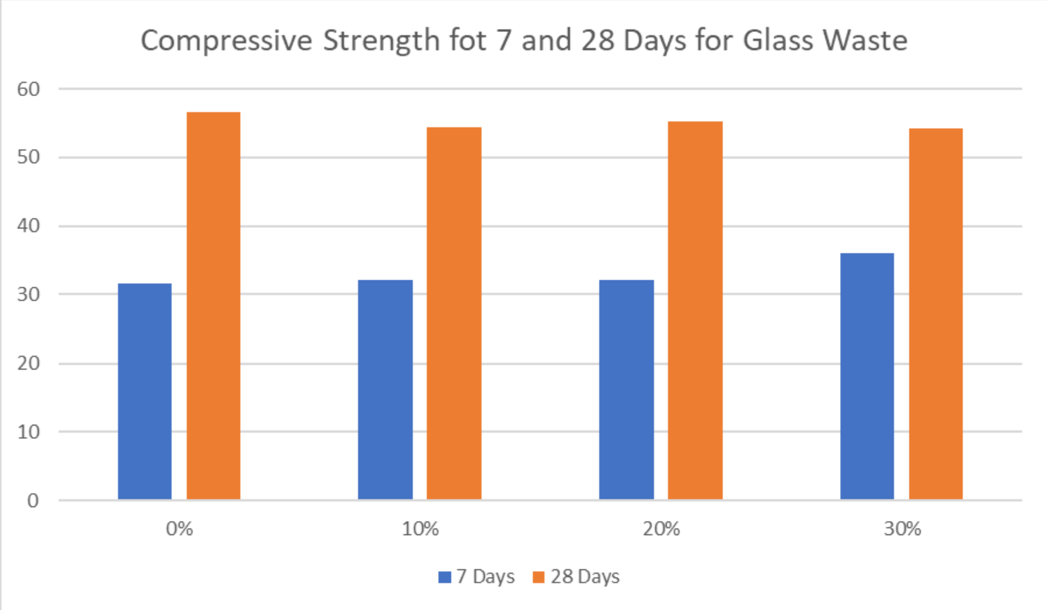
Different % Mix	Sample No	Compression Testing Reading	Average Compressive Strength
0%	1	1270	56.593
	2	1290	
	3	1260	
10%	1	880	38.815
	2	870	
	3	870	
20%	1	880	38.37
	2	850	
	3	860	
30%	1	800	35.704
	2	810	

	3	800	

Following are the graphs plotted as per the compressive strength results for 7 days and 28 days

Graph 2: Compressive Strength at 7 and 28 days.





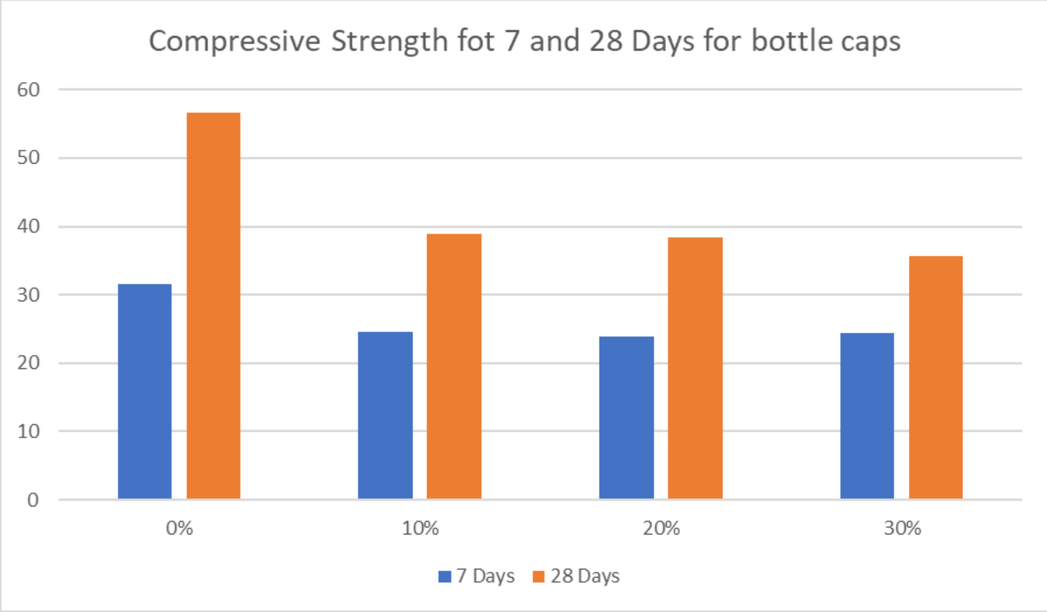


Table 14: Flexural Strength at 7days For Steel Waste

Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	24	
0%	2	22	4.14
	3	24	
	1	24	
10%	2	24	4.26
	3	24	
	1	24.5	
20%	2	23	4.29
	3	25	
	1	24	
30%	2	26	4.44
	3	25	

For Soft Drink Cans

Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	24	
0%	2	22	4.14
	3	24	
	1	24	4.11
10%	2	23.5	
	3	22	
	1	24.5	
20%	2	23	4.29
	3	25	
	1	22	
30%	2	22	4.08
	3	25	

For Glass Waste

Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	24	
0%	2	22	4.14
	3	24	
	1	23	
10%	2	23.5	4.05
	3	22	
	1	24.5	
20%	2	23.5	4.14
	3	22	
	1	24	
30%	2	22	4.2
	3	25	

For Bottle Caps

Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	24	
0%	2	22	4.14
	3	24	
	1	24	
10%	2	21	3.97
	3	22	
	1	22	
20%	2	20.5	3.76
	3	21	

	1	20	
30%	2	21.5	3.64
	3	20	

Table 15: Flexural Strength at 28days
For Steel Waste

Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	33	
0%	2	32	5.80
	3	33	
	1	35	
10%	2	36	6.22
	3	34	
	1	34	
20%	2	36	6.28
	3	36	
	1	35	
30%	2	38	6.45
	3	36	

For Soft Drink Cans

Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	33	
0%	2	32	5.80
	3	33	
	1	35	
10%	2	32	5.89
	3	32.5	
	1	34	
20%	2	34	5.92
	3	32	
	1	35	
30%	2	32	5.86
	3	32	

For Glass Waste

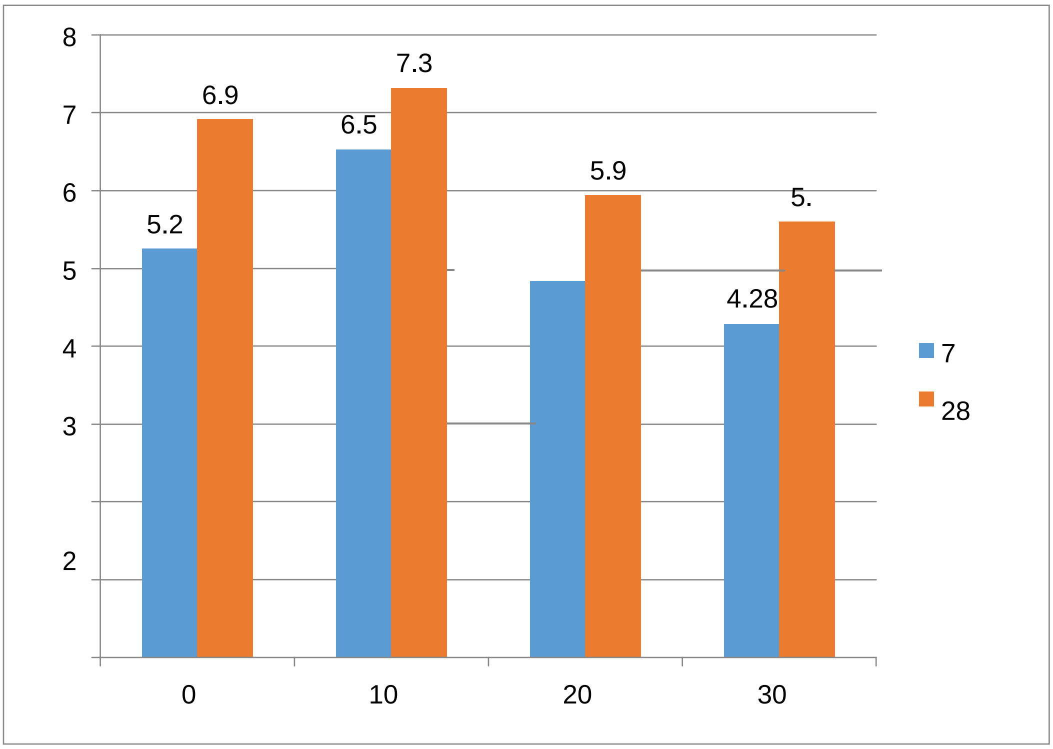
Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	33	
0%	2	32	5.80
	3	33	
	1	35	
10%	2	33	5.95

	3	32.5	
	1	35	
20%	2	33	5.98
	3	33	
	1	35	
30%	2	32	6.04
	3	35	

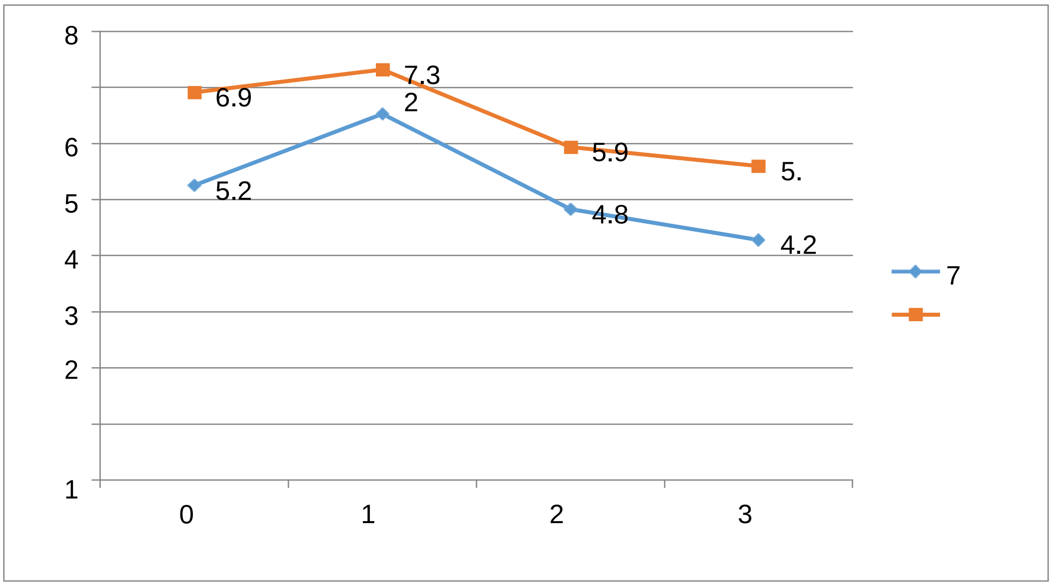
For Bottle Caps

Different % Mix	No of Samples	Flexure Testing Reading	Average Flexural Strength
	1	33	
0%	2	32	5.80
	3	33	
	1	29	
10%	2	29	5.09
	3	28	
	1	28	
20%	2	27.5	4.94
	3	28	
	1	26	
30%	2	28	4.8
	3	27	

Graph 6 : Flexural strength at 7&28 days



Graph 7 : Flexural strength at 7&28 days



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CONCLUSION

Based on results and observation made in experimental research study. The followingconclusions are drawn.

1) It is observed that with increase in percentage of waste materials for 10% workability increases by 3.7%and further increment in percentage of waste materials i.e., for 20% and 30% ,workability decreases by 15.38% and 23.07% respectively

2) For Steel Waste: It is observed that addition of steel waste as aggregate in concrete increases its compressive strength, flexural strength as well as its workability. Compressive strength of cubes made using steel waste increases with %ge of waste used. For 30% strength of concrete is maximum and is increased by 0.77% to 57.07 N/mm^2 in comparison with conventional cube.Also, flexural strength increases by 1.22% at 30% when waste steel introduced as aggregate It is increased by using w/c ratio of 0.45

3) For Soft Drink Cans: It is observed that addition of Soft Drink Cans as aggregate in concrete retains most of compressive strength, flexural strength as well workability. Compressive strength of cubes made using steel waste increases with %ge of waste used. For 20% strength of concrete is maximum and is increased by 0.10% to 55.25 N/mm^2 Also, flexural strength increases by 0.82% at 20% when Soft Drink Cans introduced as aggregate. Also, workability of concrete is improved when soft drink cans waste is used.

4) For Waste Glass: It is observed in experiment that addition of Waste Glass does not affect concrete properties as results of tests were similar to conventional cubes at 0.45 w/c ratio. At 28 days maximum compressive strength is observed at 20% of mix proportion and it is 55.29 N/mm^2. Also, workability of concrete is found to be improved.

5) For Bottle Caps: It is observed that Bottle Caps are not at all suitable to use as aggregate in concrete since it is observed in experiment that strength of concrete largely decreased with addition of this waste materials. Strength of concrete is decreased by 22% for 30% mix proportion used.

6) From all this observation it can be concluded that steel waste, glass waste, soft drink cans can be feasible partial replacements for aggregates at 30%,20%,20% respectively.While bottle caps are not suitable to be used as aggregates.

7) Use of steel waste, glass waste, soft drink cans in concrete as aggregates is possible to increase its compressive strength, flexural strength and workability.

8) Also cost will be saved by using this waste materials as partial replacements for aggerates.

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