

# Study of Concrete by Using Waste Plastic Bottle Caps as Partial Replacement of Coarse Aggregate

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**Abstract** - Concrete is most widely used construction material in the world. To solve environmental issue like deposition of waste product, recycling or reuse of waste product, I am using waste product bottle caps to make eco-friendly concrete. A standard proportionate mixing of bottle caps in concrete in replacement of aggregate gives best results. Due to growing environmental awareness, the world is increasingly turning to researching properties of waste and finding solutions on using its valuable component parts so that those might be used as secondary raw material in other branches. Green building is an increasingly important global concern and a critical way to conserve natural resources and reduce the amount of materials going to our landfills. Large quantities of waste are generated from empty cans and bottle caps of juices and soft drinks. This is an environmental issue as plastic waste is difficult to biodegrade and involves processes either to recycle or reuse. Today the construction industry is in need of finding effective materials for increasing the strength of concrete structures with low cost, and with less environmental damage. This research is aimed at addressing such issues by investigating the possibility of using waste bottle caps to partially substitute for coarse aggregate in concrete production. The compressive strength, split tensile strength and flexural strength properties at different percentages replacement of coarse aggregate with waste bottle caps were investigated in the laboratory. By replacing coarse aggregate with 0%, 5%, 10%, 15% and 20% of the waste plastic bottle caps in concrete is studied.

**Key Words:** Landfills, Waste Bottle caps, Green building, Compressive strength, Split tensile strength, Flexural strength.

## 1. 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 decoarsed 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.

Plastic is a very versatile material. Due to the industrial revolution, and its large scale production plastic seemed to be a cheaper and effective raw material. Today, every vital sector of the economy starting from agriculture to packaging, automobile, electronics, electrical, building construction, communication sectors has been virtually revolutionized by the applications of plastics. Plastic is a non-biodegradable material and researchers

found that the material can remain on earth for 4500 years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste. The health hazard includes reproductive problems in human and animal, genital abnormalities etc., Looking forward the scenario of present life style a complete ban on the use of plastic cannot be put, although the waste plastic taking the face of devil for the present and future generation. We cannot ban use of plastic but we can reuse the plastic waste. Quantities of plastic wastes has increased rapidly throughout this decade due to its beneficial properties of low density, light weight and strength. Other important factors such as low cost and friendly design were the reason polymer product becomes an inseparable part of our lives.

### 1.1 Significant of the Study

- To reduce the space required for the landfill of polypropylene cap.
- To diminish the pressure on exploiting the natural resources.
- To introduce the potential of polypropylene cap as coarse aggregate.

### 1.2 Objectives of the Project

- To determine the suitability of polypropylene cap as partial replacement of coarse aggregate in concrete.
- To Manage industrial waste.
- To find the alternative of basic materials which are used in construction from past many years.
- To compare the mechanical properties of polypropylene cap in concrete with control concrete.

## 2. METHODOLOGY

### 2.1 MATERIAL USED

#### a) Cement

The cement used in this study was 43 grade Ordinary Portland Cement (OPC) confirming to IS 8112-1989. Cement is a binder material which sets and hardens independently, and can bind other materials together. The standard consistency is 34% whereas, the initial setting time and final setting time is 80 min and 350 min respectively.

#### b) Coarse Aggregate

Coarse aggregate used was 20mm and down size and specific gravity 2.93. Testing was done as per Indian Standard Specification IS: 383-1970. The size of the aggregate bigger than 4.75 mm is considered as coarse aggregate.

#### c) Fine Aggregate

Locally available sand confirming to zone II with specific gravity 2.62 was used. The testing of sand was done as per Indian Standard Specification IS: 383-1970. The size of the aggregate lesser than 4.75 mm is considered as Fine aggregate.

#### d) Natural Sand

Natural river sand is the cheapest resource of sand. However, excessive mining of riverbeds to meet the increasing demand for sand in construction industry has led to ecological imbalance in different states. The manufactured sand, obtained from crushing of hard rock, boulders, etc. using state-of-the-art international technology.

#### e) Water

Water is used for mixing, curing purpose should be clean, portable, fresh and free from any bacteria and desire matter confirming to IS 3025-1964 is used for mixing. Water is a key ingredient in the manufacture of concrete.

#### f) Waste plastic bottle caps

Waste plastic bottle caps obtained from Scrap Market of Jalgaon City. Waste Plastic Bottles Caps is an ideal material for recycling. The use of recycled Waste Plastic Bottles Caps saves lot of energy and the increasing awareness of Waste Plastic Bottles Caps recycling speeds up focus on the use of Waste Plastic Bottles Caps with different forms in various fields.

### 2.2 Casting of Specimen

The concrete mix design is done in accordance with IS: 10262 (1982). The materials were tested for their physical properties as per the relevant Indian Standards. The concrete mix of ratio 1:1.5:3 is used and constant water to cement ratio of 0.5. Moulds were properly fixed with screws and oil is applied on the surface for easy demoulding.

The 150mmx150mmx150mm concrete cubes were cast for compressive strength, 150mmx300mm concrete cylinders were cast for split tensile strength and 150mmx150mmx700mm concrete beams were cast for flexural strength according to the mix proportion and by replacing coarse aggregate with waste bottle caps in different proportion. Figure-1 shows bottle caps added to concrete.



Figure-1 Bottle caps added to concrete

Specimens casted for investigation purpose are listed in table 1.

Table-1: Number of cubes, cylinders and beams casted for 7 days and 28 days.

% of bottle caps	To be tested for 7 days			To be tested for 28 days		
	No. of cube cast	No. of cylinders cast	No. of beams cast	No. of cubes cast	No. of cylinders cast	No. of beams cast
0	3	3	3	3	3	3
5	3	3	3	3	3	3
10	3	3	3	3	3	3
15	3	3	3	3	3	3
20	3	3	3	3	3	3

Total No.	15	15	15	15	15	15
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### 2.3 Testing of specimen

After 24 hours, the specimens were removed from the mould and subjected to water curing for 7 days and 28 days. After curing, the specimens were tested for compressive strength, split tensile strength and flexural strength. Using a compression testing machine of capacity 2000KN in accordance with the provisions of the Indian Standard specification IS: 516-1959, strength of specimens were tested at 7 days and 28 days.

## 3. PRESENTATION OF RESULTS, ANALYSIS AND DISCUSSION

### 3.1 Compressive strength

On 10% replacement of bottle caps, the compressive strength of modified concrete is increased by 9.72% than the conventional concrete tested after 7 days of curing. On 10% replacement of bottle caps, the compressive strength of modified concrete is increased by 5.97% than the conventional concrete tested after 28 days of curing. Table-2 shows the average compressive strength at 7 days and 28 days. Chart-1 shows the variation of compressive strength with percentage of bottle caps replacement.



Figure-2 Testing of concrete cube specimen

Table-2 Average compressive strength at 7 days and 28 days.

% of bottle caps	Compressive Strength (N/mm <sup>2</sup> )	
	Average strength at 7 days	Average strength at 28 days
0	21.18	26.44
5	21.92	26.88
10	23.24	28.02
15	14.38	24.52
20	13.37	18.52

curing. On 15% replacement of bottle caps, the split tensile strength of modified concrete is increased by 53.69% than the convectional concrete tested after 28 days of curing. Table-3 shows the average split tensile strength at 7 days and 28 days. Chart-2 shows the variation of split tensile strength with percentage of bottle caps replacement.



Figure-3 Testing of concrete cylinder specimen

Chart-1 shows the variation of compressive strength with percentage of bottle caps replacement.

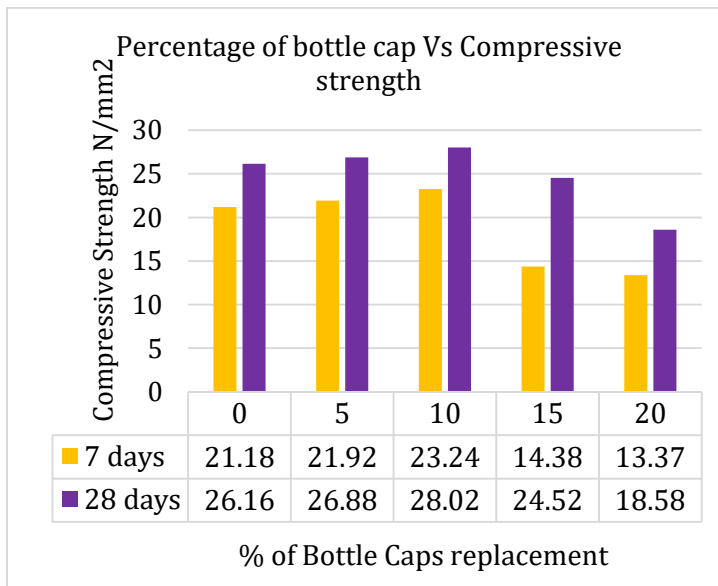


Table-3 Average split tensile strength at 7 days and 28 days.

% of bottle caps	Split tensile Strength (N/mm <sup>2</sup> )	
	Average strength at 7 days	Average strength at 28 days
0	1.02	2.03
5	1.47	2.31
10	1.75	2.71
15	2.03	3.12
20	1.70	2.17

### 3.2 Split tensile strength

On 15% replacement of bottle caps, the split tensile strength of modified concrete is increased by 99.01% than the convectional concrete tested after 7 days of

Chart-2 shows the variation of split tensile strength with percentage of bottle caps replacement.

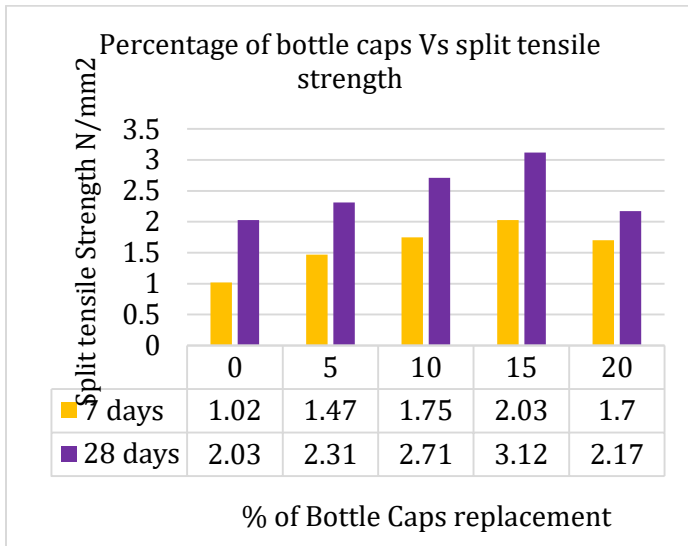


Table-4 Average flexural strength at 7 days and 28 days.

% of bottle caps	Flexural Strength (N/mm <sup>2</sup> )	
	Average strength at 7 days	Average strength at 28 days
0	2.88	5.26
5	4.89	5.48
10	5.67	6.26
15	5.26	5.87
20	4.10	5.13

### 3.3 Flexural strength

On 10% replacement of bottle caps, the flexural strength of modified concrete is increased by 96.87% than the conventional concrete tested after 7 days of curing. On 10% replacement of bottle caps, the flexural strength of modified concrete is increased by 19.01% than the conventional concrete tested after 28 days of curing. Table-4 shows the average flexural strength at 7 days and 28 days. Chart-3 shows the variation of flexural strength with percentage of bottle caps replacement.

Chart-3 shows the variation of flexural strength with percentage of bottle caps replacement.

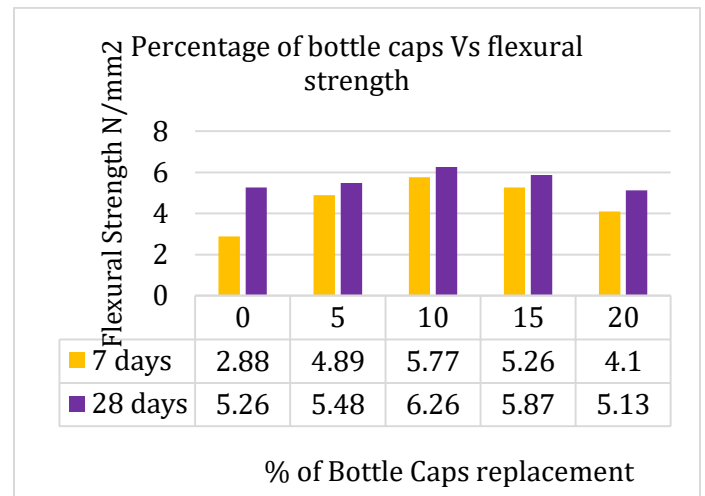


Figure-4 Testing of concrete beam specimen

### 4. CONCLUSIONS

From the test results and codal provisions, the following conclusions were drawn.

1. Compressive strength increase with the increase in percentage of bottle caps. The maximum strength obtained at 10% replacement of bottle caps increase by 9.72% and 5.97% at 7 days and 28 days over the conventional concrete.

2. Split tensile strength increase with the increase in percentage of bottle caps. The maximum strength obtained at 15% replacement of bottle caps increase by 99.01% and 53.69% at 7 days and 28 days over the conventional concrete.
3. Flexural strength increase with the increase in percentage of bottle caps. The maximum strength obtained at 10% replacement of bottle caps increase by 96.87% and 19.01% at 7 days and 28 days over the conventional concrete.
4. The test results of this study indicate that there is great potential for utilization of bottle caps in concrete mixes up to 10%.
5. With the utilization of bottle caps in construction industry the waste disposal problems can be solved.

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#### BIOGRAPHIES



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