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Increase in Strength of Concrete by using Waste Plastic Bottle Caps as Partial Replacement of Coarse Aggregate

Akash S. Awale[1], Prof. A. A. Hamane[2]

[1]*M.TECH Student, Civil Engineering Department, M.S. Bidve Engineering College, Latur, Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, Approved by AICTE, Accredited by NAAC, Maharashtra, India.*
[2]*Assistant Prof., Civil Engineering Department, M.S. Bidve Engineering College, Latur, Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, Approved by AICTE, Accredited by NAAC, Maharashtra, India.*

Abstract - *This Study serves as performance indicators concrete workability and strength be mixed using a waste plastic bottle caps as partial replacement of Coarse Aggregate, Sand, Cement, Coarse Aggregate and Water. The importance of this alternatively stone replacement to reduce plastic waste that is hard to lapse and to avoid waste of waste that can be adapted to something that can be used in the development of technology in the future. In addition the reducing the pollution of nature, it also saves cost and apply the concept of Reduce, Reuse and Recycle. 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 result. Due to growing environmental awareness, the world is increasingly turning to researching properties of waste and finding solution on using its valuable components 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 and flexural strength properties at different percentages replacement of coarse aggregate with waste bottle caps were investigated in laboratory. By replacing coarse aggregate with 0%, 5%, 7.5%, 10%, 12.5%, and 15% of the waste plastic bottle caps in concrete is studied. To ensure the success of this study, the materials to be used are as coarse aggregate, cement, sand, water and waste plastic bottle caps diameter not more than 31mm. Where will the new waste plastic bottle caps Crush form. In addition there are two trial mixes to be made i.e. 1) Ordinary Concrete, 2) Concrete with addition of crushed form plastic bottle caps for M-30 grade of concrete. These samples are compared with Ordinary Concrete with VSI Sand.*

Key Words*: *Waste Plastic Bottle Caps, Compressive Strength, Flexural Strength, Workability, Green Building.

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 de-coarse 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 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 environment problems.

Plastic is a very versatile material. Due to the industrial revolution, and its large scale production plastic seems 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 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 style a complete ban on the use of plastic cannot be put, although the waste plastic taking the face devil for the present and future generation. We cannot ban use of but we can reuse the plastic waste. Quantities of plastic waste have 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 Objectives of the Project

- Determine the suitability of polypropylene (Plastic) bottle cap as partial replacement of coarse aggregate in concrete.
- Find the alternative of basic materials which are used in construction from past many years.
- Manage industrial waste.
- Compare the mechanical properties of polypropylene (Plastic) bottle cap in concrete with control concrete.
- Study the properties of fresh and hardened concrete when coarse aggregate are partially replaced with Waste Plastic Bottle Caps.
- Produce lightweight polymer concrete for multi-purpose use.
- Develop suitable mix design.

1.2 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

2. METHODOLOGY

2.1 MATERIAL 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 color 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 PPC (Ultra Tech- Cement).

b) Fine Aggregate (V.S.I Sand):
Vertical Shaft Impactor (V.S.I.) Sand is also known as Artificial Sand or Crushed Sand. Only sand manufactured by V.S.I. Crusher is cubical and angular in shape. There is standard specification for Fine Aggregates (Sand). It is divided in four gradations Zone-I, Zone-II, Zone-III & Zone-IV. Generally the size of the aggregate lesser than 4.75 mm is considered as Fine Aggregate.

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 size of more than 12 mm was used. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. Coarse Aggregate used of 20 mm and down size. Testing is done as per Indian Standard Specification IS: 383-1970. The size of the aggregate bigger than 4.75 mm is considered as Coarse Aggregate.

d) Water:
Water is used for mixing, curing purpose should be clan and 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 manufacturer of concrete.

e) Waste Plastic Bottle Caps:
Waste Plastic Bottle Caps obtained from Scrap Market. Waste Plastic Bottle Caps is an ideal material for recycling. The use of Waste Plastic Bottle Caps saves lot of energy and the increasing awareness of Waste Plastic Bottle Caps, recycling speeds up focus on the use of Waste Plastic Bottle Caps with different forms in various fields.

2.2 Casting of Specimen
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 remoulded after 24hrs of casting and kept in a water tank for 7 and 28 days curing. A total of 54 specimens cast for testing the properties such as compressive strength, and flexural strength.

36 cube samples of size 150mmx150mmx150mm for different percentages of waste plastic bottle caps in partial replacement of coarse aggregate will casted. The concrete mixes are 0%, 5%, 7.5%, 10%, 12.5%, 15% crushed waste plastic bottle caps 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 be removed and cubes will kept in water tank for curing up to 7 and 28 days.

All specimen beams size 700mm × 150mm × 150mm will casted with optimum compressive strength for the specific mix in single lift and consolidated using tamping rods. After setting, the beams will covered with wet gunny bags. The burlap will be kept for 3days. At the end of the third day, the forms will stripped and beams will kept for curing up to 28 days.

Fig-1 Crushed Bottle Caps added to Concrete

Specimens casted for investigation purpose are listed in Table-1.

Table -1: Number of Cubes and Beam casted for 7 days and 28 days

% of Crushed Plastic Bottle Caps	No. of Cube Cast		No. of Beam Cast for 28 days
	7-Days	28-Days	
0	3	3	3
5	3	3	3
7.5	3	3	3
10	3	3	3
12.5	3	3	3
15	3	3	3

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 and flexural strength. Using a Compression Testing Machine of capacity 2000 KN in accordance with the provision of the Indian Standard specification IS:516-1959, strength of specimens were tested at 7 days and 28 days.

2. WORKABILITY

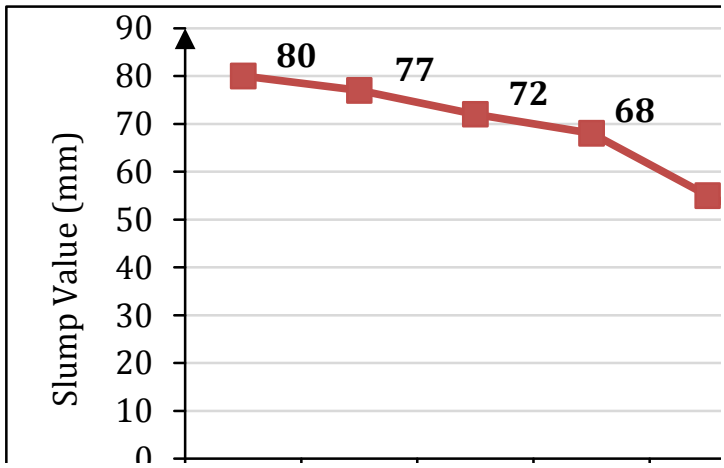
The workability of M30 grade of concrete is measured by widely used empirical test i.e. slump test with w/c ratio 0.40 for addition of different percentage waste plastic bottle caps.

Values obtain for different percentage mix is as show in following

Table -2: Slump values for different percentage of mix

% of coarse replaced by crushed waste plastic bottle caps	Slump value (mm)
0	80
5	77
7.5	72
10	68
12.5	55
15	45

Graph 1: Slump Value



4. EXPERIMENTAL METHODOLOGY

4.1 Compressive Strength Test

The result of compressive strength After 7 days and 28 days are recorded. Result indicate that as we increase percentage of waste plastic bottle caps from 0% to 15% it's compressive strength increases after further increment in percentage of waste plastic bottle caps there is loss in compressive strength. That means we can replace up to 15% natural coarse aggregate by waste plastic bottle caps.

4.2 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 indicate that if we increase percentage of waste plastic bottle caps from 0 to 15% will give us good results and help to increase flexural strength of concrete.

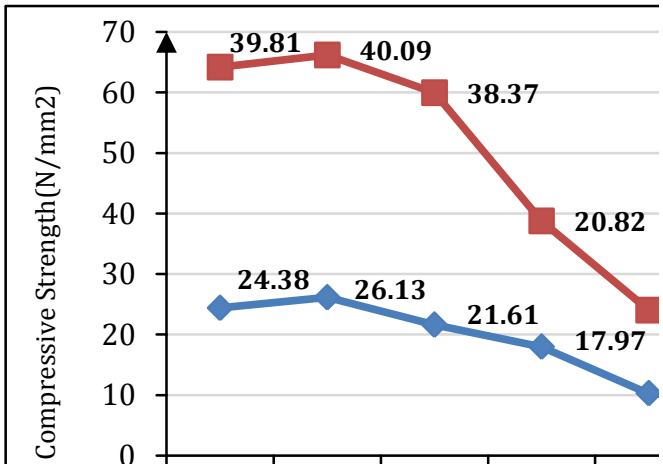
$$F_r = \frac{P \times L}{b \times d^2}$$

5. EXPERIMENTAL RESULTS

5.1 Compressive Strength Test

Table -3: Results of Compressive Strength

% of Crushed Plastic Bottle Caps	Compressive Strength (N/mm^2)	
	7-Days	28-Days
0	24.38	39.81
5	26.13	40.09
7.5	21.61	38.37
10	17.97	20.82
12.5	10.28	13.76
15	09.36	12.49

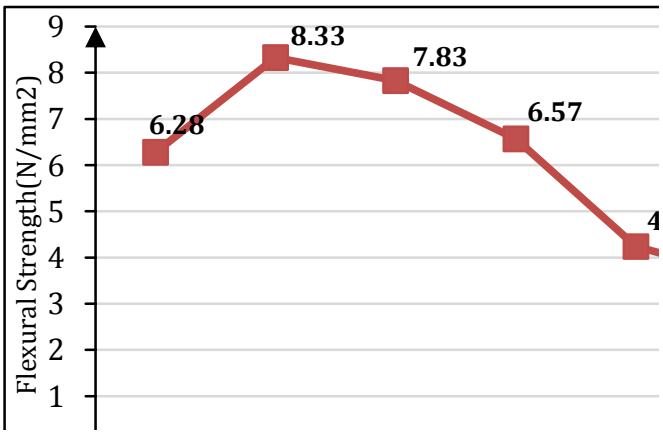


Graph 2: Compressive Strength at 7 and 28 days

5.2 Flexural Strength Test

Table -4: Results of Flexural Strength

% of Crushed Plastic Bottle Caps	Flexural Strength (N/mm²) 28 days
0	6.28
5	8.33
7.5	7.83
10	6.57
12.5	4.24
15	3.53



Graph 3: Flexural Strength at 28 days

5. CONCLUSIONS

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

1. It is observe that with increase in percentage of waste crushed plastic bottle caps workability decreases.

2. Crushed plastic bottle cap concrete is cheaper than conventional concrete.

3. Current study concluded that waste crushed plastic bottle caps can replace coarse aggregate up to 7.5%

4. 6.7% increment in the compressive strength is found for 5% replacement of coarse aggregate by waste crushed plastic bottle caps and the strength decreases by 27.6% when the 15% of coarse aggregate is replaced by waste crushed plastic bottle caps, by using aggregate cement ratio (A/C) is 4.2 and water cement ratio (W/C) is 0.40.

5. 2.05% increment in the flexural strength is found for 5% replacement of coarse aggregate by waste crushed plastic bottle caps and the strength decreases by 4.8% when the 15 % of coarse aggregate is replaced by waste crushed plastic bottle caps, by using aggregate cement ratio (A/C) is 4.2 and water cement ratio (W/C) is 0.42

6. The use of waste crushed plastic bottle caps in concrete is possible to improve its compressive strength, and flexural strength.

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BIOGRAPHIES

Awale Akash Sanjay
Student of M-TECH (M.S. Bidve College of Engineering, Latur).

Prof. A. A Hamane, completed his M.Tech in 2009 from VJTI, Mumbai and working as Asst. Professor at M.S. Bidve Engineering College, Latur.