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Experimental Investigation on Strength Characteristics of Concrete Cubes Using Waste Plastic

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Abstract: This report outlines the utilization of municipal plastic waste (MPW) in construction industries. Plastic is a non-bio-degradable substance which takes thousands of years to decompose that creates land as well as water pollution to the environment. The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of usage is double for every 10 years. The Plastic usage is large in consumption and one of the largest plastic wastes is polyethylene (PE). The utilization of earth-based clay material resulted in resource depletion and environmental degradation.

I. INTRODUCTION

Plastics are a wide range of synthetic or semi-synthetic materials that use polymers as a main ingredient. Their plasticity makes it possible for plastics to be moulded, extruded or pressed into solid objects of various shapes. This adaptability, plus a wide range of other properties, such as being lightweight, durable, flexible, and inexpensive to produce, has led to its widespread use. Plastics typically are made through human industrial systems.

Most modern plastics are derived from fossil fuel-based chemicals like natural gas or petroleum; however, recent industrial methods use variants made from renewable materials, such as corn or cotton derivatives.

A. Properties of Plastic Concrete Cubes

When exposed to ambient solar radiation the plastic procedure two greenhouse gases, methane and ethylene. Due to its low-density properties (branching) it breaks down more easily time, leading to higher surface areas. Key properties include:

- They are light in weight and are chemically stable.
- Easily moulded into different shapes and sizes.
- Good insulation and low thermal conductivity.
- Good impact resistance and they do not rust.
- Good transparency and wear resistance.
- Poor dimensional stability and can be easily deformed.
- Low processing cost.

II. LITERATURE REVIEW

"Fabrication and testing of Plastic sand Concrete Cubes" by S S Chauhan, Bhushan Kumar, Prem Shankar Singh, Abizaid Khan, Hrithik Goyal, Shivank Goyal (2019). They mixed the river sand and the PET plastic (molten form) in the ratio of 1:2, 1:3, 1:4 for mould size of (230*100*75) mm for which they found maximum compressive strength on the ratio of 1:2 mixture for the same size of the Concrete Cubes. The water absorption of these Concrete Cubes was observed less than 5% that is less than conventional clay Concrete Cubes i.e., 15-20%. However, they failed in maintaining fire resistance property of these Concrete Cubes.

"Utilization of plastic waste in manufacturing of plastic sand Concrete Cubes." By Arvind Singhal, Dr. Om Prakash Nebula (2018). They used the mixture of plastic and stone dust in the molten form in the ratio of 3:7 in standard Concrete Cube mould for which stone dust was sieved through 4.75 mm using sieve analysis and conducted test on water absorption to be found as 0%. Compressive strength of plastic sand Concrete Cubes is 5.6 N/mm2 at the compressive load of 96 KN.

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III. OBJECTIVE

1) To compare strength of plastic Concrete Cubes with normal clay Concrete Cubes.
2) To vary the percentage of plastic in Concrete Cubes to determine the strength performance.
3) To determine the optimum ratio of plastic and sand in Concrete Cubes.
4) To compare water absorption value of Concrete Cubes casted with mixture of liquid form of waste plastic and natural soil to Burnt Concrete Cubes and fly ash Concrete Cubes.

IV. COMPONENT AND SPECIFICATION

Cement is made by heating limestone (calcium carbonate) with small quantities of other materials (such as clay). In this project Ultratech cement of 53 grades conforming to IS 456-2000 was used. Natural river sand was used as a fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part-1). Plastics are commonly used substances which play an important role in almost every aspect of our lives. The widespread generation of plastics waste needs proper end of-life management. The highest amount of plastics is found in containers and packaging's (i.e. bottles, packaging, cups etc.), but they also are found in durables (e.g. tires, building materials, furniture, etc.) and disposable goods (e.g. medical devices).

V. METHODOLOGY

A. Process Flow

LITERATURE REVIEW → MATERIAL COLLECTION → MOULD PREPARATION → BATCHING → MIXING → CONCRETE CUBE FORMATION → CURING → TEST CONDUCTED

Process of Casting Concrete Cube

- First, we need to collect the plastic waste and separate it from other wastes.
- Second, we should dry the plastic waste if it is wet and has a content of moisture. We have to use dry plastic waste.
- Then, we crush the plastic waste in small particles by crushing machine.
- Then, the small particles crush into fine size particles.
- The ratio of plastic and stone dust which we use is 3:7..
- The fine particles of plastic waste also heated till it is in a liquid form.
- Then, we can mix it properly and make a mix.
- Then, we poured the mix into moulds.
- Then keep it the mould for dry and demould it on a next day.
- The weight of the Concrete Cube is 8.1 Kg.
- Add admixture

B. Batching and Mixing

Measurement of materials is known as batching. The waste bottles are rinsed with water and then dried after which the weights of bottles are measured. Sieving of sand is done by 4.75-micron sieve and this sand will be used for making Concrete Cubes. Various proportions of
plastic bottles with sand is taken for Concrete Cubes. The different ratios we used are 1:2, 1:3 and 1:4.

C. Mix Design Calculation

In order to find the plastic soil Concrete Cubes that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine [CTM]. The mix proportions were in the ratio of (1:2, 1:3, and 1:4). These are the ratio which represents the plastic, M-sand respectively.

D. Mixing

Pieces of plastic are added into drum for melting until the proportion required by us is achieved. River sand is used for addition in plastic sand mixture. When the temperature ofthe melted plastic in the drum is around 180°C-200°C then the sand is added into the drum. The river sand and the melted plastic is stirred continuously so that both gets bonded perfectly. As the plastic pieces melt it start getting bonding with the sand particles and hence the mixture required for Concrete Cube is created.

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VI. RESULT

A. Compression Strength Test (BS 5628: Part 1: 1992)

In this test, the cubical Concrete Cube specimen is placed in the compression strength testing machine. After placing it we will apply the load on the Concrete Cube without any shock. The load will be increased at a rate of 140kg/cm2 min continuously till the specimen's resistance to increasing load breaks down and it cannot withstand any greater load further. Recording the maximum load applied to the Concrete Cube specimen and the appearance and type of failure is also noted along with any unusual features.

COMPRESSIVE STRENGTH = F/A
Where, F = Maximum load applied (KN) | A = Specimen Area (mm2)

Table 6.1 Compressive strength for 1:2:1 cement to sand to plastic ratio, Plastic Sand Concrete Cube

Plastic Sand Concrete Cube	Maximum Load (KN)	Compressive Strength (N/cm2)	Average compressive strength
Specimen 1	35	2.045	
Specimen 2	40	2.339	2.202
Specimen 3	38	2.222	

Table 6.2 Compressive strength for 1:3:1 cement to sand to plastic ratio, Plastic Sand Concrete Cube

Plastic Sand Concrete Cube	aximum Load KN)	Compressive Strength (N/mm2)	Average compressive strength
Specimen 1	30	1.754	
Specimen 2	28	1.637	1.617
Specimen 3	25	1.462	

Table 6.3 Compressive strength for 1:4:1 cement to sand to plastic ratio, Plastic Sand Concrete Cube

Plastic Sand Concrete Cube	Maximum Load (KN)	Compressive Strength (N/mm2)	Average compressive strength
Specimen 1	25	1.462	
Specimen 2	20	1.169	1.228
Specimen 3	18	1.053	

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Table 6.4 Compressive strength for 1:2:1.5 cement to sand to plastic ratio,
Plastic Sand Concrete Cube

Plastic Sand Concrete Cube	Maximum Load (KN)	Compressive Strength (N/mm2)	Average compressive strength
Specimen 1	40	2.339	
Specimen 2	46	2.690	2.689
Specimen 3	62	3.625	

Table 6.5 Compressive strength for 1:1:2 cement to sand to plastic ratio,
Plastic Sand Concrete Cube

Plastic Sand Concrete Cube	Maximum Load (KN)	Compressive Strength (N/mm2)	Average compressive strength
Specimen 1	65	3.801	
Specimen 2	78	4.561	4.424
Specimen 3	84	4.912	



Fig. No. 6.1 Plotting Graph

B. Slump Test

Purpose and Importance

- Measures Consistency: Determines how easily concrete flows.
- Ensures Quality: Verifies the mix consistency between different batches.
- Checks Workability: Indicates if the concrete can be properly mixed, placed, and compacted without segregating.
- Prevents Weakness: Identifies if too much water was added, which could result in a weak, low-strength concrete.

Apparatus

- Slump Cone (Mold): A hollow metal cone with a base diameter of 8 inches, top diameter of 4 inches and height of 12 inche
- Tamping Rod: A diameter and long steel rod with a rounded end.
- Base Plate: A non-absorbent surface.

Procedure (According to ASTM C143)

- Prepare: Clean the mold and place it on a smooth, flat, moist, non-absorbent surface. Step on the handles to hold it firmly.
- Fill & Rod: Fill the cone in three layers, each roughly one-third of the volume.
- Tamp: Tamp each layer 25 times with the rounded end of the rod. Distribute strokes uniformly. For the top layer, keep an excess of concrete above the rim, adding more if needed.
- Strike off: Remove excess concrete from the top with the tamping rod, making it flat.
- Remove Mold: Lift the cone upwards slowly and vertically (within 5–7 seconds). Do not shake it or move it sideways.
- Measure: The concrete will settle (slump). Invert the cone and place it next to the concrete. Measure the distance between the top of the cone and the top of the subsided concrete.

Types of Slump Results

- True Slump: The concrete simply settles, maintaining its general shape. This is desirable.
- Zero Slump: The mix is very dry and maintains its shape completely, ideal for low-workability projects like road paving.
- Shear Slump: The top part shears off and slides down. This suggests a lack of cohesion and that the test should be redone.
- Collapse: The mixture collapses completely, indicating a very wet, high-slump, or poor-quality mix.

Common Causes of High/Low Slump

- High Slump: Too much water, improper aggregate grading, or high temperatures.
- Low Slump: Too little water, poor mixing, or fast evaporation

VII. CONCLUSION

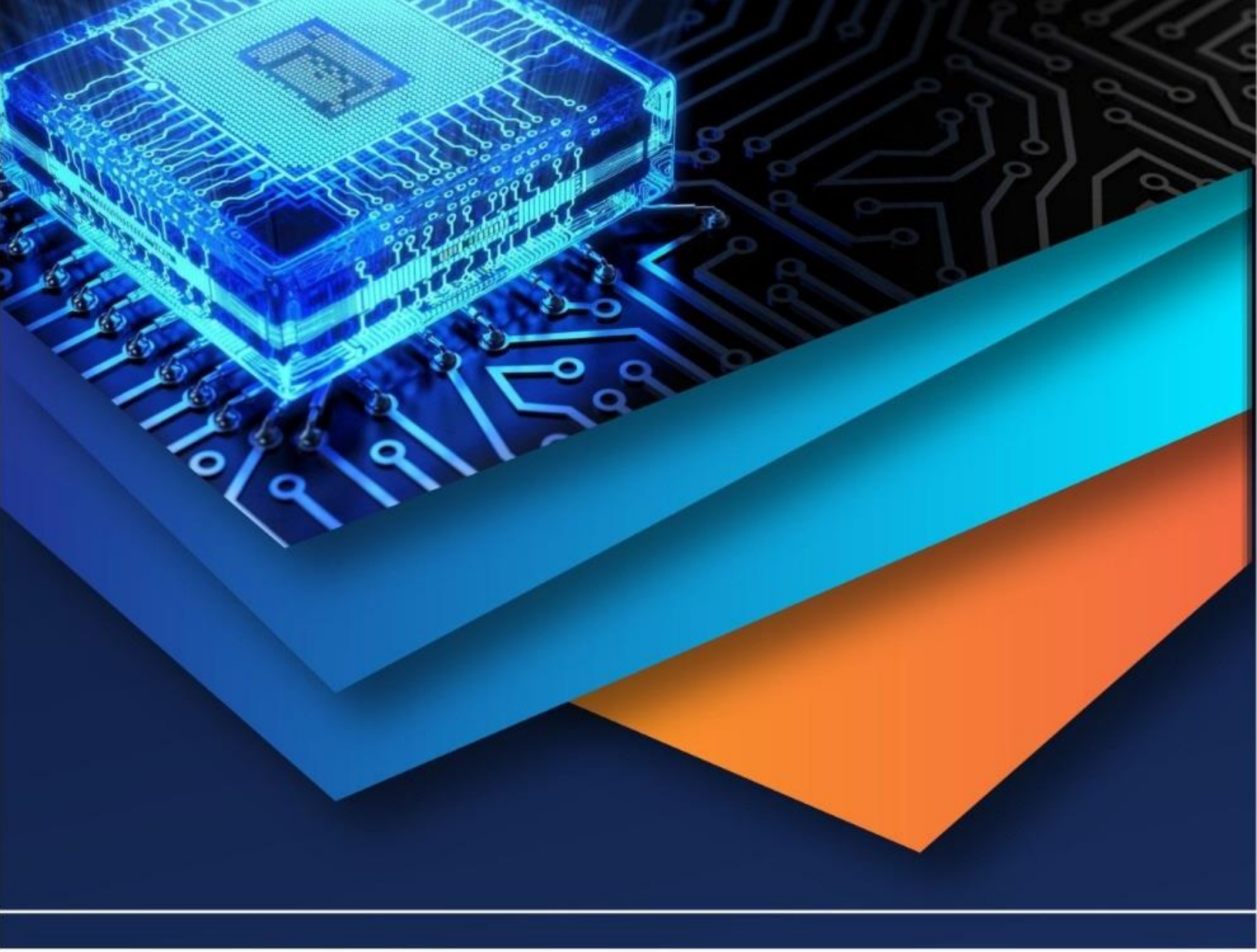
The proposed project presented above intends to resolve in reducing the plastic waste disposal problem as it utilizes the waste even in its finest form and converts that useless material into a useful construction material. Extruder machine plays a prominent role in the conversion of waste plastic into its melted form. Also, extruder does not possess any threats to the environment and hence can be used without any restriction. It also helps in reducing the usage of natural resources which are utilized during the manufacturing of burnt Concrete Cubes, also it reduces the pollution which is generated from kiln during Concrete Cube manufacturing. The final end product can be used as Concrete Cube, which is having a higher strength than conventional Concrete Cube. Also, the water absorption capacity is higher in comparison to conventional Concrete Cube with a lower weight.

By noticing all these processes of the use of plastic in the cement sand Concrete Cube, the extension of plastic in the Concrete Cube increases the Concrete Cube compressive strength up to the ratio 1:2:1 (cement to plastic to sand) but when increasing the amount of plastics more the 1:2:1 ratio then it causes difficulty in moulding as well as produce large voids in the Concrete Cube which reduces the strength of the Concrete Cube.

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