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A COMPARITIVE STUDY OF RECYCLED PLASTIC ASH IN JALI BLOCKS

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ABSTRACT

Plastic waste poses a significant environmental challenge due to its non-biodegradable nature and harmful disposal methods. To address this issue, an innovative approach involving shredding plastic waste and repurposing it into useful materials is done this research work. The study explores the potential of using shredded plastic residue in the production of eco-friendly Jali blocks. Furthermore, an experimental work on Jali blocks produced from plastic ash, which is sourced from non- recyclable thermoplastic granules and comprises 0 to 20% by weight, mixed with 4 kg of fly ash, cement, and sand. The Jali blocks underwent drying under natural sunlight for periods of 7, 14, and 28 days, followed by baking at temperatures between 90°C and 110°C. In contrast to incineration methods that generate high carbon emissions, this approach is non- destructive, as the blocks are simply baked at low temperatures to melt the waste plastic, which integrates into the structure. The results reveal that compressive strength of the Jali blocks using plastic ash, having a low compression strength while compared to normal Jali blocks.

Keywords: *Plastic Ash, Jali block, Compressive Strength.*

1. Introduction

Solid waste management for plastic waste encompasses a range of practices aimed at effectively addressing plastic waste and reducing its environmental impact. As the prevalence of plastics in daily life continues to rise, the management of plastic waste has emerged as a pressing concern. Plastic is a very common material that is now widely used throughout the world [2]. Plastic plays a predominant role in reusable in this era, as it is compact and light in weight. Common plastic items that are used are covers, bottles, and food packages [3]. Only few amounts of plastic waste are recycled, and others are disposed in the forest or nearby lakes, river beds, and sea [6]. Effective strategies include the segregation of plastic waste at its source, efficient collection and transportation to processing facilities, and the application of recycling methods to transform waste into reusable materials [5]. Public awareness initiatives and educational campaigns are crucial in fostering the principles of reduction, reuse, and recycling of plastic products. Furthermore, governments have implemented regulations and policies, such as Extended Producer Responsibility, to hold producers accountable for the entire lifecycle of their plastic products. Through the adoption of these measures, society seeks to lessen the environmental damage caused by plastic waste and progress towards a more sustainable future. According to recent estimates 79% of the plastic waste ever produced now sits in landfills dumps or in the environment while 12% has been incinerates and only 9% has been recycled. When discarded in landfills or in the environment, plastic can take up to a thousand years to decompose [1] [4] [7].

Plastic ash is the by-product generated from the incineration of plastic waste. Although incineration effectively decreases waste volume, it can also yield harmful by-products, including plastic ash. This ash frequently harbors toxic elements such as heavy metals and persistent organic pollutants, which can threaten both environmental and public health if not properly managed. The disposal of plastic ash necessitates meticulous handling and specialized treatment to avert soil and water contamination. Tackling the challenges posed by plastic ash underscores the urgent need for more sustainable waste management strategies and alternatives to plastic to lessen environmental harm. The use and advantages of "Jali," a traditional Indian architectural element characterized by its perforated lattice design, are explored through the innovative application of burnt plastic ash.

This study focuses on creating Jali blocks from burnt plastic ash, utilizing the residual material after the combustion of PET bottles, which also yields oil and gas. The Jali blocks are evaluated for their hardness, wear resistance, crushing strength, and water retention capabilities. Optimally designed Jali blocks can enhance ventilation, aesthetics, and solar exposure in interior spaces, while the research demonstrates a dual approach to effectively manage plastic waste and its ash through their productive use and enhancement.

The incorporation of plastic ash in the manufacturing of Jali blocks is on the rise, significantly improving their strength and longevity. Jali blocks, which are frequently utilized in construction for ventilated walls and decorative screens, gain enhanced compressive strength and reduced water absorption through the addition of plastic ash. This process entails blending plastic ash with materials such as fly ash, lime, and sand to produce a robust and environmentally friendly building material. This approach not only aids in the management of plastic waste but also leads to the creation of cost- effective and durable construction solutions. Many technologies are in practice to use the plastic waste in blocks, in the present study; an attempt has been made to Utilize plastic ash as a by-product obtained from waste plastic to develop eco-friendly Jali blocks, investigate the feasibility of using shredded plastic residue in the production of durable and sustainable Jali blocks, to evaluate the strength of plastic waste based Jali blocks and finally to compare the strength between normal Jali block and Jali block using the plastic ash.

2. MATERIALS

a. SOIL

Fig 2.1: Soil Sample

The soil sample used had a moderate to high clay content, as clay helps in binding the particles together. The soil used is moist but not too wet to ensures that the blocks can be compressed effectively. Figure 2.1 shows the soil sample used for the Jali block. Table 2.1 depicts the properties of soil sample.

Table 2.1: Properties of Soil

Sl. No	Texture composition	(% by weight)
1	Coarse sand (4.75-2.0mm)	6.6 2
2	Medium coarse sand (2.00-0.425 mm)	73.6
3	Fine sand (0.425-0.075 mm)	19.8

b. FLY ASH

Fly ash bricks are known for their superior strength and durability. They are generally cheaper to produce than traditional bricks. Fly ash bricks offer good insulation properties, making them energy-efficient. Fly ash is a residue resulting from combustion of pulverized coal or lignite in thermal power plants. About 80% of the total fly ash is in finely divided form which is carried away with flue gases and is collected by electrostatic precipitator or other suitable technology. The balance 20% of ash gets collected at the bottom of the boiler and is referred to as bottom ash. Fly ash got into a fine powder in the comparable to cement, however some particles have size less than 1 micron in equivalent diameter [3]. Chemical composition of Fly ash is as shown in table 2.2.

Table 2.2: Chemical Composition of Fly Ash

Sl. No	Components	Percentage (%)
1	Sio_2	35 to 39
2	Fe_2O_3	0.5 to 2
3	Al_2O_3	20 to 33
4	CaO	5 to 16
5	MgO	1 to 5.5
6	SO_3	0.5 to 1.5

2.3 WATER

The water used if free from impurities such as silt, oil, acid, alkali, salts, organic matter, or other harmful substances. The pH of the is 7.2. Water that is too acidic or too alkaline can affect the setting and strength of the cement.

2.4 PLASTIC ASH

A common ratio around 10-20% of the total aggregate content is considered. Mixing Process of the plastic ash is finely ground and mixed thoroughly with the soil, cement, and water to ensure uniform distribution. Figure 2.2 shows the plastic ash used and table 2.3 depicts the properties of plastic ash.

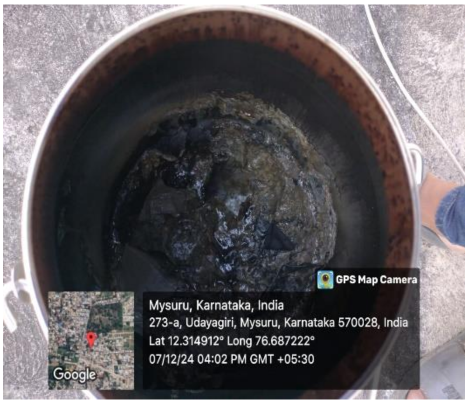

Fig 2.2: Plastic Ash

Table 2.3: Properties Of Plastic Ash

Sl. No.	Experiments	Values
1	Density	0.958
2	Elastic modulus	9
3	Tensile cube strength	8
4	Bending creep modulus	1
5	Tensile strength	2

2.5 CEMENT

Portland Pozzolana Cement is used for the experiment. Figure 2.3 shows the cement used for the experiment.

Fig 2.3: Cement

3 METHODOLOGY

- Collection of Materials.
- Sieving and preparation of Materials.
- Mixing process.
- Moulding the Block.
- Drying process.
- Quality testing.

3.1 Collection of Raw Materials

Plastic Ash, gather plastic waste such as bags, bottles, and packaging materials are collected and burnt in a controlled environment to obtain ash.

3.2 Sieving and Preparation of Materials

Plastic ash is Sieved to remove large particles and unburned residues. This ensures uniform mixing. Mud, break down lumps and remove debris stones, sticks, etc. to achieve a smooth texture.

3.3 Mixing Process

Adjust ratios based on required strength and durability. Combine plastic ash and mud in a dry state to ensure even distribution. Gradually water is added while mixing until a workable consistency is achieved. Care is taken that the mixture is neither too dry nor too wet.

3.4 Moulding the Blocks

After Mixing process pour the prepared mixture into moulds of desired block sizes (8x8x2 cm). It is Ensured that moulds are well-greased to prevent sticking. Compaction is done by applying pressure manually to compact the mixture and remove air bubbles which improves the strength of the blocks. Finally shaping, finishing and smoothing the surface is done using a trowel for a uniform look.

3.5 Drying Process

During Initial Drying Keep the molded blocks in a shaded place, well-ventilated area for 24-48 hours to prevent cracking.

3.6 Quality Testing

Compression tests are conducted as per IS standards to check the strength of the blocks.

4. Mix Design of Plastic Ash Jali Blocks

In order to find the plastic ash block that they possess high compressive strength with various mix proportions as shown in table 4.1 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 ash, red soil respectively.

Table 4.1: Mix Design of Plastic Ash Jali Blocks

Sl. No	PLASTIC %	CEMENT (Kg)	FLYASH (Kg)	SOIL (Kg)
1	5	1.00	1.00	3.00
2	10	1.00	1.00	2.75
3	15	1.00	1.00	2.50
4	20	1.00	1.00	2.25

5. Results and Discussion

5.1 Soil Sample Analysis

Soil sample are analyzed for Sieve analysis, Specific gravity and Moisture Content test, the results are as shown in table 5.1. The results shows that the soil sample have met the IS standards and are suitable for the jali blocks.

Table 5.1: Test Results of Soil Sample

Experiment Name	Obtained Values	IS Standards
Sieve Analysis Test	2.08%	Zone II
Specific Gravity Test	2.61	2.73
Moisture Content Test	14.91%	10% To 45%

5.2 Compression Strength Test Result

The compression strength test results after 28 days of curing with varied percentage of plastic usage in jali blocks are as shown table 5.2 and corresponding graph is as shown in figure 5.1, the results showed that the inclusion of plastic ash has negatively impacted the strength and durability of the blocks.

Table 5.2 : 28 Days Compression Strength for varied Plastic mix proportion

Sample No	Plastic %	Compression Strength
1	0	12 N/mm^2
2	5	10.2 N/mm^2
3	10	9.3 N/mm^2
4	15	8.45 N/mm^2
5	20	6 N/mm^2

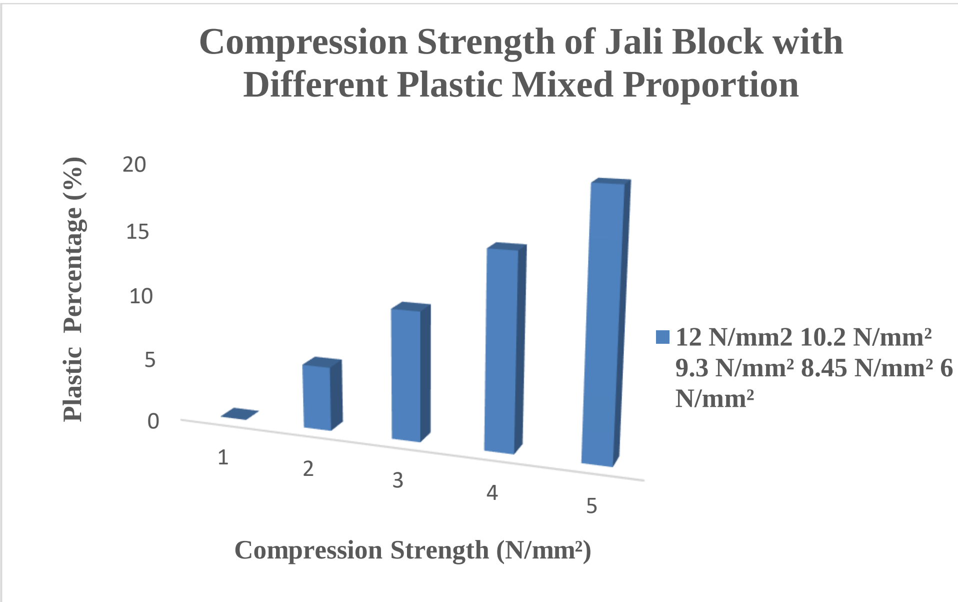

Fig 5.1: Graph Showing Compression Strength Test Results for Varied Plastic Mixed Proportion

6. Conclusions

The attempt to create Jali blocks using plastic ash faced several challenges, ultimately leading to the following results. While the idea of incorporating plastic ash aimed to enhance sustainability and reduce environmental waste. Based on the experimental results the following conclusions were drawn.

- The research work, despite facing several challenges, provided valuable insights into the limitations of using plastic ash in construction.
- Experimental results of sieve analysis, specific gravity, and moisture content yielded values that aligned with IS standards.
- Compression strength tests revealed that Jali blocks with plastic ash exhibited lower strength compared to normal Jali blocks.
- The incorporation of plastic ash adversely affected the blocks' strength and durability, rendering them brittle and prone to cracking.
- The final blocks had rough and uneven surfaces, diminishing their aesthetic appeal and practicality in construction.
- The blocks did not meet standard strength requirements, making them unsuitable for practical applications. Further, more research is required to create such type of sustainable Jali blocks. The research work may be continued with varied binding property material which may increase the strength and will result in a better product output.

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