International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-10, Issue-5, September 2022
https://doi.org/10.55524/ijircst.2022.10.5.19
Article ID IRPV1060, Pages 133-137
www.ijircst.org

Application of Waste Plastics in Manufacturing of Bricks and Paver Blocks

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ABSTRACT- Plastics are important resources in the circular economy, and the best way to manage them sustainably is to recycle them after their useful lives with minimal environmental harm and the generation of economic value. The initiative clarifies how plastic is used in civil construction.. The component used include everything from plastic screws and hanger to bigger plastic parts that are used in decoration, electric wiring, flooring, wall covering and water proofing. There has been a considerable imbalance between the availability of conventional building materials and their demand in the recent past. On the other hand, laterite quarry debris is widely available, and disposing of waste plastics (PET, PP, etc.) is the biggest difficulty because only a small percentage of PET bottles are recycled and because continuous recycling of PET bottles could result in it becoming a carcinogenic material. In order to meet the rising need for traditional construction materials, the manufactured bricks have qualities like smooth and even finishing, minimal water absorption, and adequate compressive strength as compared to laterite stone.

KEYWORDS- Poly-ethylene Terephthalate (PET), Plastic Waste, Compressive Strength, PlasticSand Bricks.

I. INTRODUCTION

Plastic is a material that is both dangerous and more helpful. Plastic proves to be quite helpful when needed, but it is frequently discarded after usage, posing a variety of risks. Plastic is a hazardous material that won't biodegrade and has been around for ages. Municipal solid waste (msw) contains an increasing amount of plastic garbage. According to estimates, the rate of expansion doubles every ten years. This is due to rapid growth of population, urbanization, developmental activities and changes in life style leading to wide-spread landscape polluting Researchers have discovered that plastic materials can persist on Earth for 4500 years without degrading despite the fact that they are non-biodegradable. An estimated 40 million tonnes of municipal solid garbage are produced in India each year, with estimates growing at a pace of 1.5 to 2% annually. Hence, these waste plastics are to be effectively utilized. Any essential industry nowadays cannot function effectively without the use of plastic, from manufacturing to agriculture. Thus, we cannot outlaw the use of plastic, but it is thought that the most practical applications for plastic trash are in the building and construction and industrial sectors.

II. LITERATURE REVIEW

The polyester family of polymers is one of the biggest and most diversified of the polymer families, according to the technical periodical "Focus on PET." Poly ethylene terephthalate is a member of this family. Although the ester (-COO-) link in the main chain unites this family of polymers, the diversity of polyester materials is perhaps the broadest of any polymer family. Additionally, the PET's chemical structure only contains the three atomic species of carbon, hydrogen, and oxygen. Because of this, melting PET won't release any harmful gases, and its characteristics indicate that a melting temperature of 260 degree C is needed. Additionally, it is clear from the PET's characteristics that it has good chemical resistance and better resistance to UV rays [9]. The methods for utilising waste plastic in the construction of roads and flexible pavements, which were created by many researchers, have been examined in the publication "A review on waste plastic utilisation in asphalting of roads" [1]. Additionally, we emphasise as a group the idea of using waste plastic in the creation of flexible road pavement. Bitumen serves the purpose of holding the aggregate together by coating it over when creating flexible pavements. Additionally, it contributes to the durability and strength of road paving. However, it has a low water resistance. Modifying bitumen's rheological characteristics by combining it with synthetic polymers like rubber and plastic is a typical way to raise its quality. Better binding properties, stability, density, and water resistance are all displayed by this bitumen mixture. Findings from studies on "The Use of Recycled Materials in Highway Construction [5] & [6] and "Utilization of Waste Plastic in Bituminous Concrete Mixes" [7] were used to assess the suitability of plastic waste modifier in the construction of bituminous mixes, where heated aggregates are transported on conveyor belts and shredded plastic is sprayed on them. Later, hot, molten bitumen was mixed with the plastic-coated aggregate to create plastic-modified bitumen, which has a coat of plastic on it. The study came to the conclusion that using waste plastic in bituminous concrete mixes increased the mixture's resistance to water absorption, improved bonding, and reduced susceptibility to stripping. The material is categorised as Thermo softening plastics (Thermo plastics) and Thermo setting plastics in "Useful products from oil and organic chemistry"[8] (Thermo set plastics). Thermo setting plastics can only be made bendable and plastic once at high temperatures. The softening temperature range for contemporary thermoplastic polymers is 65 to 200 degree C. They differ

from thermoset polymers in that they can be heated back up to their plastic form, where they may then be moulded in a variety of ways. Then, they are totally recyclable. PET, which was employed in this research, is a thermoplastic. Different from other polymers, thermo-set materials cannot be moulded. During the initial moulding process, powerful cross connections are created, giving the substance a reliable structure. They are more frequently utilised when thermal stability is necessary. They can be fragile and tend to lack tensile strength. This category includes materials like polyester resin and urea formaldehyde. An effort has been made to use the laterite wastes, which are present in large quantities in the laterite quarry, to create laterite soil bricks using cement as a stabilising agent [2]. In place of the typical laterite stone, this can be utilised. A laterite quarry next to Sullia provided the soil made of laterite [3]. According to the study, laterite soil stabilised with 7% cement produced interlocking bricks with an excellent compressive strength of 4.72 N/mm2. The use of interconnecting bricks with dimensions of 30x20x18 cm led to a construction that was affordable [2]. According to the study "Use of Cement-Sand Admixture in Laterite Brick Production for Low Cost Housing" [4], there are several lateritic soil deposits in Makurdi (Nigeria) and other areas of Benue State that can be used for brick production. The findings indicated that the laterite employed in this study could not be stabilised for brick manufacturing within the Nigerian requirements for economic cement content of 5%. The compressive strength of 1.80 N/mm2 achieved by laterite bricks manufactured with 45% sand and 5% cement, however, is higher than the required minimum strength value of 1.65 N/mm2.

III. METHODOLOGY

In first step we should collect the waste plastic. Next the collected plastic materials (plastic bottles, polyethylene, plastic cans etc..,) are cleaned with water and crushed with help of crusher to enable easy heating. Then dried to remove the water present in it after this the plastics are burn out in furnace under controlled temperature. The plastic pieces and sand are taken in different proportions. The sand is added, mixed thoroughly using rod and trowel before it hardens. The mixing process must be quick because the combination has a very short setting time, but it also needs to be finished. To create a dark red colour, red oxide is used (less than 10% of the total weight). Following that, these combinations are poured into the brick and paver block moulds. Steel rod is used to compact them, and a trowel is used to smooth the surface. The sides of the mould are greased before the liquid is added to make removing the bricks easier.

IV. PROCEDURE OF CASTING PLASTIC SAND BRICKS

A. Batching

The waste bags that have been collected are cleaned with water, dried to get rid of the water that remains inside the plastic, and then weighted. A 600 micron filter was used to separate the sand shown in (table no 1). Sand and plastic bags were weighed in a variety of ratios shown in (table no 2), with the plastic being selected for burning. The sand & plastic used in this project has specific properties which are mentioned in table no: 3 & table no: 4

Table 1: Sieve Analysis of sand

Sieve size	Weight retained (gm)	% age retained	Cumulative %age retained	Cumulative % agepassed
4.75 mm	65	6.5	6.5	93.5
2.36 mm	99	9.9	16.4	83.6
1.18 mm	152	15.2	31.6	68.4
600 µ	294	29.4	61	39
425 µ	165	16.5	77.5	22.5
300 µ	203	20.3	97.8	2.2
150 µ	19	1.9	99.7	0.3
75 µ	.5	0.05	99.75	0.25
pan	0	0	-	-
	∑ = 997.5		**∑ = 490.25**	

Table 2: Batching of Plastic Sand Bricks

Mix ratio	Zone 1 sand	Zone 2 Sand	Plastic	No. of bricks and paver block	Weight of Brick(kg)	Weight of Paver block(kg)
1’2	4.6kg	-	2.4kg	1 brick+1 paver block	3	3
1:3	3kg	-	1kg	1 brick	3.7	-
1:3	-	6kg	2kg	1 brick + 1 Paver Block	3	3
/1:3	6kg	-	2kg	1 paver block+1 brick	2.8	2.56
1:4	-	4.25	1.75	1 brick +1 paver block	2.62	2.1

B. Properties of Sand

Table 3: Properties of Sand

S.NO.	TESTS	RESULTS
1.	Specific Gravity	2.62
2.	Bulk Density	1690 kg/m3
3.	Fineness Modulus	2.92

C. Plastic Properties

Table 4: Properties of Plastic

S. No.	Properties	Results
1.	Density at 23˚C	.958 Kg/m^3
2.	Elastic modulus	9 N/m^2
3.	Tensile creep strength	8
4.	Bending creep modulus	1
5.	Tensile strength at 23˚C	2
6.	Elongation at break (%)	>600
7.	Thermal conductivity	0
8.	Ignition temperature	3

D. Melting

Plastic bags were taken after batching for melting, where they were dropped into a pan one at a time and left to melt. Setting up the pan and gas stove is the first step in the melting process. To remove the moisture that is inside the plastic, it is heated.

Figure 1: Melting of Constituents in Furnace

E. Mixing

The process of mixing is done in two ways:

- Plastic bags are put to the pan one at a time until the complete amount needed to make one mix proportion of bricks is present. Before the mixture solidifies, it is thoroughly stirred with a trowel while the plastic melts. The plastic is converted into a molten state and added to the mixture, which has a very short setting time. Therefore, the mixing process shouldn't take too long.
- The sand is first heated and then the plastic is added in a controlled manner. The ingredients are added according to the design mix.

We adopted the two processes for mixing in order to find out any difference that may occur in the properties or in any other way. (shown in figure no: 1)
At last we concluded that it does not affect the properties of the end product but it shortens the manufacturing time.

Figure 2: Moulded Shape of Brick and Paver Block After 24 Hours

F. Moulding

After that, the slurry is poured into the brick mould and crushed using a steel rod or tamping rod. The trowel is used to polish the surface. The sides of the mould are greased before the liquid is added to make removing the bricks easier. Mould was eliminated 24 hours later. The final shape of brick & paver block are shown in (Figure no: 2).

V. OBJECTIVES

- To create a practical method of utilizing waste plastics, which pose a serious threat to the maintenance of ecological balance.
- To lessen the use of clay, an earth-based substance, in the production of brick, which contributed to the depletion of resources and the pollution of the environment.
- To lessen the amount of waste plastic in the air, water, and land to prevent air, water, and land contamination.
- To lessen the area where used plastics are dumped.
- To create construction materials that are affordable.
- To safeguard people's health against dangerous diseases.
- To check various parameters of plastic brick and paver block through different tests with the conventional brick and concrete paver block.
- To compare various engineering characteristics of different mix proportions i.e. (1:2, 1:3, 1:4 of plastic: sand

A. Compression Test

The purpose of this test is to figure out the specimen's compressive strength. After seven days of curing and a compressive strength test on five different brick specimens, the specimen's compressive strength will be determined.

Place the specimen flat-side down on the compressive testing machine's base; while testing, plywood sheets are used to maintain the brick in the proper position. After that, gradually add axial loads to the specimen at a rate of 14 N/mm2 (140 kg/cm2) per minute until the brick specimen begins to break given in figure no: 3.

Figure 3: Compression Testing

As we have compared the compressive strength of paver block & plastic bricks with two different zones of sand which is shown in figure no: 4 where P represents the paver block and B represents the brick.

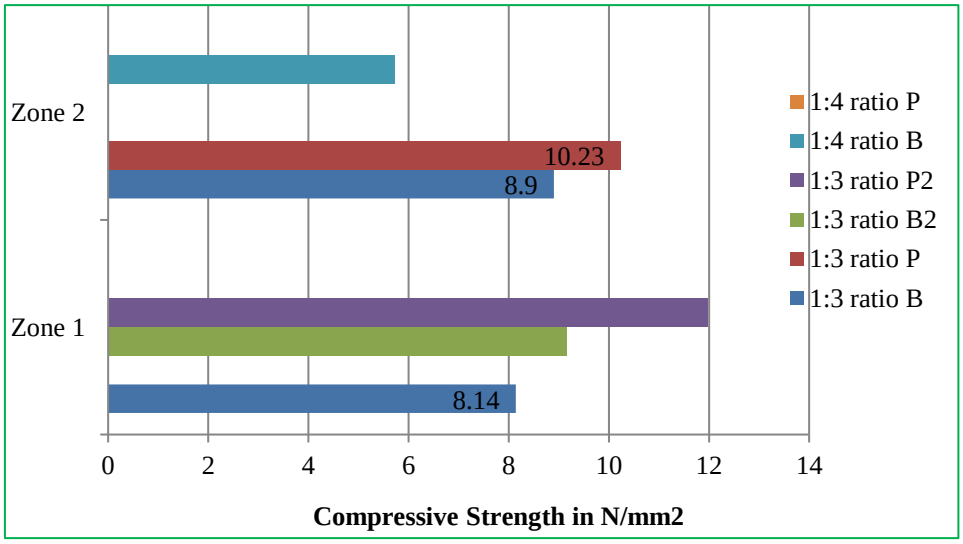

Figure 4: Compression testing results

B. Water Absorption Test

The water absorption test was carried out in accordance with IS 3495 (Part2) 1992. The brick specimen is first weighed on a digital scale (M1), dried at room temperature, and then submerged in distilled water for 24 hours at a temperature of 27+ 2 C. After the 24-hour soaking, the specimens were taken out and dried cloths were used to wipe the water off of them.(shown in figure no: 5). Additionally, each specimen is weighed (M2); using the formula, determine it. The brick's positive attributes can only support 20% of its own weight. The formula yields the percentage of water absorption.

$W = [(M2 - M1) /M1] * 100$

By the above formula it is concluded that the water absorption for plastic bricks goes from 2% to 5% only which is too less in comparison with the 1st class clay brick i.e, 15%.

Figure 5: Water absorption test

VI. DISCUSSION

As already said, there is a requirement for these plastic waste brick and paver blocks. The Municipal Control Board underlines India's existing plastic garbage situation. The most important characteristics of plastics are their affordability and practicality. Plastics have destroyed India's traditional industries through strong economies of scale while quietly preserving the country's disposable culture. The country's habit of Pepsi, junk food, and bottled water contributes to India's rising plastic garbage production. When there is ineffective end-of-life management to deal with the litter, the issue grows quite large and leads to issues with the environment, society, and the economy. The landscapes of tourist destinations are now strewn with non-biodegradable plastic bags and pet bottles, with plastic bags dominating the litter as a result of the increased use of plastics as a packing material. A large percentage of plastic garbage has value and is regularly recycled in the unofficial economy. Market leaders direct the informal sector, and by gathering waste that has value, they significantly contribute to the waste system and relieve some of the burden from the towns. Despite efforts from both the formal and informal sectors, enormous amounts of plastic waste are still not being collectedThe country's poor municipal finances and lack of public understanding humiliate waste management as well. The majority of municipalities in India lack adequate funding, which has a negative impact on the city's trash collection and disposal system. Even if finances are allocated for collection, safe disposal continues to be a major issue. Taking into account the fact that poor waste management causes numerous environmental issues In nations like India where both economic growth and urbanisation are common, the situation is even worse. The country generates 36.5 million tonnes of municipal solid garbage annually, or 36.5 kg per person. There is a considerable need for an effective effort to produce affordable and workable policy solutions for solving the waste management issues due to the limited resources and availability of land for disposal, especially in the megacities.

VII. CONCLUSION

In recent years, there has been a noticeable increase in plastic consumption worldwide, which has resulted in massive amounts of garbage related to plastic. Given its advantages in both the economy and the environment, recycling plastic waste to create new materials like concrete or mortar seems to be one of the finest ways to dispose of it. The characteristics of cement-composites using various forms of plastic waste as aggregate have been studied in detail or are currently being investigated in a number of works. The recycling of plastic trash into building material is reviewed in this paper.

Waste plastic concrete mixes can only be utilized when low-degree workability is required, according to the lowered slump values. Precast bricks, partition wall panels, canal linings, and other similar scenarios are common in civil engineering applications.

Due to their low melting point, these bricks have poor fire resistance, however this can be improved by covering both sides of the brick with a fire-resistant compound like ceramic coating.

Apart from a few drawbacks, there are a lot of benefits, as the study explains. Manufacturing of building blocks can advance significantly if gaseous dangers can be managed.

Every area of testing, including compressive strength, water absorption, hardness test, efflorescence test, soundness test, and cost analysis, produced excellent results for the Eco bricks and paver blocks.

VIII. FUTURE SCOPE

Due to its light weight and practical utility, plastic bricks can be used further in construction projects. Bricks, tiles, pavements, and other building materials all employ plastic in various forms. When plastic is employed for these construction projects, the structures will be more cost-effective and have sufficient strength and durability.

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