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Utilization of Waste Plastic in Tiles

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Abstract: ***As we humans are continuously developing ourselves for a better livelihood for ourselves and the next generation. For this ability, we continuously and intensively increase the use of plastic in our routine. This has a profoundly hazardous effect on all living things and also increasingly affects the environment, as well as the ecosystem and its inhabitants. Nowadays, the problem of plastic waste is increasing immensely, causing hazardous effects on the environment. Therefore, it is necessary to think outside the box to minimise plastic waste by exploring every possible solution. On this basis, we are exploring the use of plastic waste as a construction material, specifically in the form of plastic tiles. This research paper focuses on manufacturing floor tiles using waste plastic without the addition of any additives, such as sand or fly ash, and without the use of cement. It then analyses these tiles alongside regular tiles. By using this method, plastic waste is reduced to some extent. However, plastic consumption is increasing day by day, and there are few methods for disposing of it. The plastic tiles are compared with the regular tiles to assess the different physical and mechanical properties. The tests conducted on plastic tiles include compressive strength and vertical flammability tests, among others. The results obtained from these tests on plastic waste are far better than those of standard tiles. According to this study, it is recommended to use plastic waste as a binding material instead of floor tiles, as it proves to be economical.***

Keywords: Waste Plastic, LDPE Tiles, Floor tiles.

I. INTRODUCTION

The scenario that has been observed is that plastic is used in numerous sectors, such as manufacturing, marketing, and transportation, among others. But the disposal of plastic is not that easy, as it is a non-biodegradable substance and remains on land and in the environment for numerous years [1]. After the use of plastic, it proves to be a hazardous material to the environment and its inhabitants [2] [3]. Wastes are categorised into municipal waste, hazardous waste, medical waste, and radioactive waste. Recently, various methods have been used to dispose of plastic waste and utilise it in multiple ways. Plastic is also used in the construction industry as a new engineering material [4]. The researchers are more interested in investing their time and also money because they think that plastic will prove to be the best construction material in the future years [5]. Talking about the properties of plastic, the properties of plastic are so unique that they can mix with any kind of material and prove useful [6]-[7][8][9]. Plastic can be remoulded into any solid form; therefore, they are malleable and ductile [10] [11]. Nowadays, many methods have been introduced to dispose of plastic, but there is still a need to find more advanced techniques and strategies to manage this non-biodegradable substance. If we do not find ways to dispose of plastic waste adequately, then it will prove very hazardous to us in the future. Plastic waste can also be recycled [12]- [13]-[18][26]. Plastic recycling is the process of recovering plastic waste and turning old or scrap plastic into usable products that can re-enter the manufacturing chains [17]. The technique that has been used for a long time to dispose of wasted incinerators, in which the plastic waste is burned at high temperatures [18]-[21]. But the gases that emerge during this process prove to be very harmful to human beings as well as pollute the air and water [20]. Many people also get affected due to these gases, and they get prone to many diseases [22].

The researchers say that if the plastic waste is not disposed of as soon as possible, then it will remain on earth for more than 5000 years without getting degraded [11]-[18]. Hence, the use of plastic waste is increasing in the construction industry these days. Plastic waste is used to manufacture paver blocks, tiles, and is also used in road construction, etc. [19]-[21] [23]. The primary focus of this research work is to manage the problem of plastic waste through recycling in a comparatively less capital-intensive manner, with the main aim of utilising waste plastic bags composed of LDPE. The tiles that are manufactured from plastic waste prove to be very durable and economical as compared to standard tiles [24]

A tile is a manufactured piece of hard-wearing material such as ceramic, stone, metal, or even glass. Tiles are generally used for covering roofs, floors, walls, or other objects Plastic tiles prove to be significantly cheaper as all people can afford them [25]. Additionally, it proves to be a convenient and efficient method for disposing of plastic waste. As regular tiles cannot be recycled, but plastic tiles can be recycled further when not in use [26].

However, the rate of plastic waste generation has increased tremendously, and Management has become a serious issue [27]. Consequently, researchers have suggested the use of plastic wastes in concrete Production for two primary reasons: first, to resolve the environmental problem associated with their disposal and second, to reduce construction costs since they are available in significant quantities [28].it is an industrial waste product available in abundance. It is being widely explored as a filler material for various applications due to some valuable characteristics like lightweight, easy availability, low density, surface morphology, chemical inertness, thermal resistance, excellent workability and large surface area [28]-[30].

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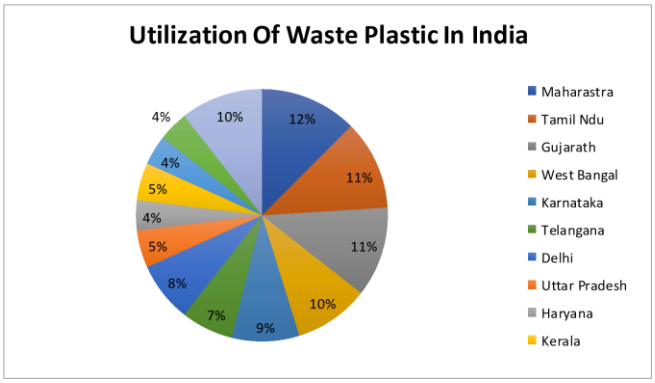

Fig. 1 - State-Wise Waste Plastic Generation

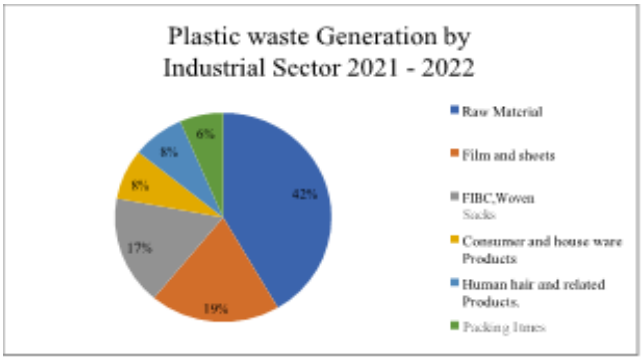

Fig. 2 - Industry-Wise Waste Plastic Generation

1) Objective

1. To recycle waste LDPE plastics.
2. Increase the strength of Tile.
3. To manufacture plastic tiles from the used plastic bags
4. Reduced cost of Tiles
5. To utilize the plastic waste in a smart way to create something useful, such as tiles

II. METHODOLOGY

Steps for manufacturing Plastic Tiles are given below:

1. Collecting Plastic:

It is essential to select the correct type of plastic. There are different types of plastic with varying properties, including chemical and physical.

LDPE is a very versatile plastic and is often used in flexible films and bags. It is also widely used to make PET bottles, food bags, wrappings, toys, rigid trays, stretch wrap, as well as water and ice bags.

- Only LDPE type of plastic is used for this experiment, because other types of plastic are harmful to our health.
- For the experimental point, it requires all types of waste plastic, which is commonly available at the doorstep. These collected wastes are then cleaned with tap water to remove impurities such as stones and dust.
- From the melting point perspective, the waste plastic needs to be of the same size. Therefore, the collected waste plastic is shredded into a uniform shape and size to avoid the coagulation of the slurry.

Fig 3. Waste Plastic Collection

2) Shredding:

It is the second step of the plastic manufacturing process. After selecting one of the plastic collections or the correct type of plastic, we cut the plastic into smaller sizes or pieces using scissors and cutters, as this makes the melting process easier. If we can't cut plastic into smaller sizes or pieces, then it can't melt properly. Therefore, it is directly affected by the manufacturing of plastic tiles.

3) Weight the Material:

Weigh the plastic material using a weighing machine.

Fig. 4 - Weighing of Waste Plastic

4) Melting the Plastic:

Continue mixing the melted plastic until it forms a black liquid with no lumps. First, take a pan and heat it over a small fire or a low flame. After that, add plastic material. A minor fire or heat source helps to melt the plastic. Keep mixing it. Continue adding plastic until it forms a black, liquid-like substance. Take care to avoid the gases released into the air, as they are harmful to your health. Also, take care of instruments that aren't too hot. Don't stand close to the setup. Take care to follow safety precautions when performing this process.

Fig. 5- Melting Mix Waste Plastic

5) Moulding:

In the manufacturing of LDPE tiles, it is crucial to handle molten LDPE plastic carefully, as it can pose a risk to life. We then pour an appropriate quantity of molten LDPE plastic into the mould to produce tiles properly. Ensure the mould inner surface will be coated with oil or oil-like material so it is easy to demold the tile for further procedure

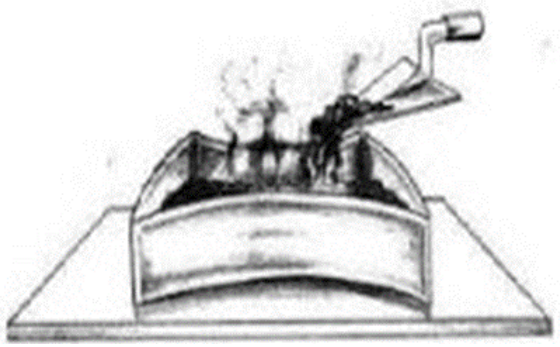

Fig. 6 - Pouring Melted Waste Plastic into Mould

6) Shaping:

Press the mixture tightly into the mould, which reduces the air cavity created by the melted waste plastic. Air gaps will reduce the quantity of your finished tile. By using a hammer, we can tap, press or apply force to compact material properly. For uniform compaction, apply a significant weight to achieve uniformity.

Fig. 7- Compaction of Melted Plastic

7) Settle Down of Melted Plastic:

Once the melted waste plastic has spread properly and achieved the required shape, try to tile it off the mould with a good surface of plastic tile. Initially, the surface was not finished; it required smoothing by any means, such as with varnish or paper.

Fig. 8 - Settled Waste Plastic Slurry

8) Final Set:

After all the processes, the mould will be placed as it is to cool the material. This also allows for the recycling of plastic tiles, requiring only a few hours. At this level of settlement, the plastic achieves the properties of virgin material.

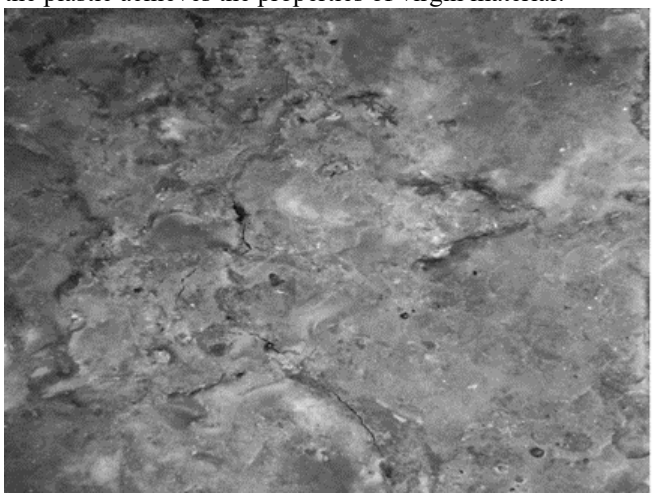

Fig. 9 - Final Product Tile

III. TEST ON MATERIAL

1. Compressive Test

The ASTM D695 standard conducted a compressive test. The specimen is placed in a compression testing machine. The maximum load is recorded. The equipment used in this test is the Introns universal tester and extensometer. The extensometer is extensively used in materials testing. Compressive strength was calculated using the following equations:

$$Compressive\ strength = maximum\ compressive\ load \div minimum\ cross\ sectional\ area$$

Table 1. Test Result of Compressive Test

Sr. No.	Specimen	Compressive Strength MPA	Maximum Compressive strength MPA
1	Specimen 1	17.26	18.05
2	Specimen 2	18.05	
3	Specimen 3	16.50	
4	Specimen 3	17.60	

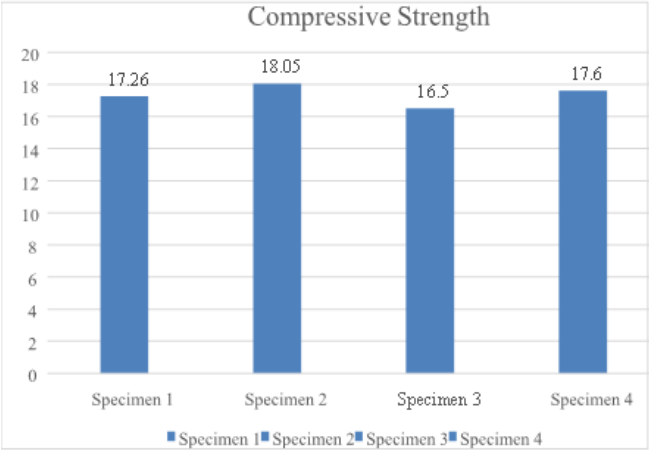

Fig. 10 Graphical Representation of Compressive Strength

2. Vertical Flammability Test

A Test specimen is positioned vertically above a controlled flame & exposed for a specified period of time. During the test, samples are held in a vertical position & and the speed of propagation of the flame over the material to be tested is determined. This test was conducted in accordance with IS 15061:2002, where the burning rate should not exceed 100 mm/min. The test was performed on the specimen, and the burning rate was found to be 55 mm/min, which is slightly above the minimum burning rate provision of the IS code. Which shows the waste plastic tile is flammable, which is not suitable as per the IS specification

3. Water Absorption Test

Table 2. Test Result of Water Absorption Test

Sr. No.	Specimen	Water Absorption %	Avg. Water Absorption% %
1	Specimen 1	3.40	3.30
2	Specimen 2	3.20	
3	Specimen 3	3.10	
4	Specimen 3	3.50	

It is observed that when carrying out a water absorption test on the test sample, the water absorption percentage is similar because the test samples are made from the same material, namely LDPE plastic. Since test samples are made with the same material and no other constituents are used, the percentage of water absorption is almost the same as that recorded. However, compared to other tiles, such as ceramic tiles, the rate of water absorption in LDPE tiles is lower, indicating that they are more waterproof and are commonly used for footpath covering, which also provides a proper view. Waterproofing is also essential in residential buildings, particularly in cases of uneven settlement caused by excessive water percolation through open spaces.

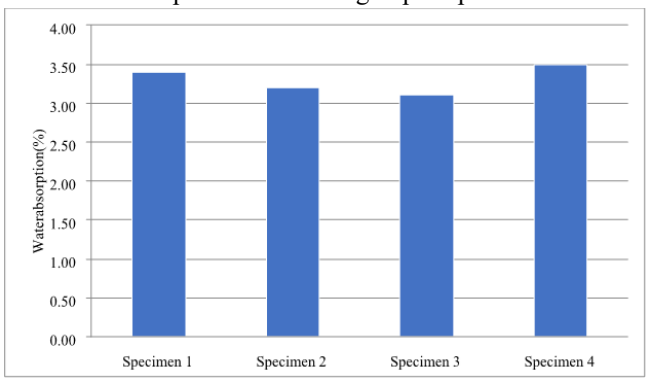

Fig. 11 Graphical Representation of Water Absorption Test

4. Static Friction Test

Table 3. Test Result of Static Friction Test

Sr. No.	Specimen	Coefficient of Static Friction	Avg. Coefficient of Static Friction
1	Specimen 1	0.47	0.48
2	Specimen 2	0.48	
3	Specimen 3	0.49	
4	Specimen 4	0.485	

The results show that the coefficient of static friction of the waste plastic tiles we tested is moderately safe to use as floor tiles or as bathroom tiles. Waste plastic tiles have a rougher texture, which is why they provide a matte finish. A rough surface always provides more friction to moving objects, which is safer in recreational parks, bathrooms, and footpaths (where the rainy season is more prevalent compared to other locations). Waste plastic tiles also provide a solution for the safe disposal of solid waste, a common issue in rapidly developing cities. Also, it minimises the problem of land requirement. Not only in public places, but these types of tiles are also prevalent in houses, which minimises the issue related to knees. A friction test demonstrates the viability of waste plastic tiles in everyday life.

IV. CONCLUSION

Cities like Delhi require a considerable amount of land for disposing of plastic waste. Almost all hills in the middle of towns are being prepared due to the disposal problem of waste plastic. Plastic waste is an issue for both our environment and our ecosystem. At the same time, this issue can be converted into an opportunity in the construction industry to explore alternative uses of it as a construction material. As civil engineers, we have the privilege of thinking outside the box and may achieve something valuable for our society. There is a need for thinking about the 'Utilisation of waste plastic in Tiles', so that we can also make our ecosystem healthier for human life. Additionally, it is a cost-effective material for producing waste plastic tiles.

It is concluded that the use of plastic waste in construction applications will significantly improve the environmental sustainability and reduce the plastic waste generated in

surrounding areas, which causes several problems.

FUTURE SCOPE

The manufacturing of plastic tiles is more durable and economical than that of ordinary tiles. Plastic tiles are less expensive compared to other tiles, and they are easy to manufacture because plastic is readily available and inexpensive.

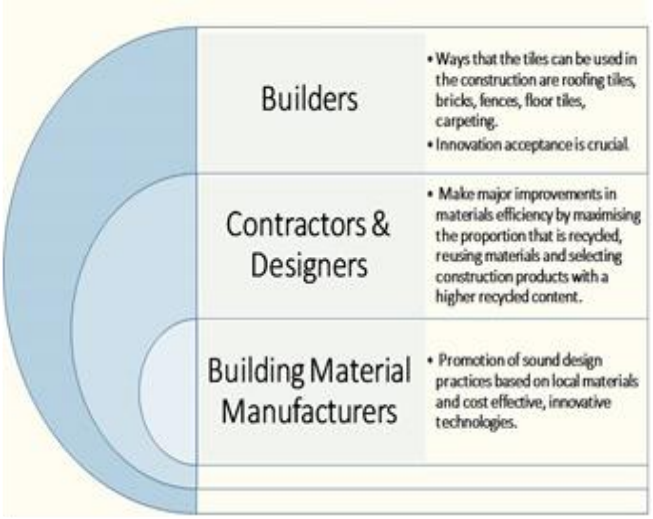

Fig. 12 Utilizaion in Various Field.

Day by day, plastic quantities are increasing, so it's essential to reduce plastic pollution and create more economical alternatives that are more useful to us. In the future, plastic tile is more usable, with several reasons for its use. First, it has a low cost, which saves our universe and protects it from pollution. If we think of it another way, plastic tiles are colourful, making them look more attractive and having more extended durability. Plastic tiles have given us hope and a way to explore creative and innovative solutions related to plastic, aiming to develop new civil engineering materials that will yield a fantastic response in the future industry and facilitate the exchange of thoughts among researchers, users, and industries. It is a present-time and beneficial method. In the current scenario, due to COVID-19, rates are increasing for every material, but plastic tiles are not expensive to buy or use.

DECLARATION

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval or consent to participate, as it presents evidence that is not subject to interpretation.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contribution	All authors have individual partnerships in this article.

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