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# Waste Plastic Use in Floor Tiles & Renewable Energy Generation

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***Abstract***

*Large amount of plastic which is discarded or burned is leading to the contamination of environment and air. Many efforts are made to reduce use of plastic or use plastic waste in many ways to reduce its impact on environment. An experimental investigation is made to use plastic waste in floor tiles. The plastic used can replace cement and hence a possibility of reduced use of cement in making of floor tiles. In the methodology adopted, Low-Density Poly Ethylene (LDPE) and High Density Poly Ethylene (HDPE) plastic bags/covers which are cleaned are obtained in the shredded form. This is heated and added with M-Sand. The various percentage of waste plastic is cast to obtain the optimum mix results for required strength of floor tiles. Over the layer of optimum mix of M-sand with plastic, the tile is finished with a layer of cement mortar to preserve the aesthetics of flooring tile. The floor tile is cost effective with the replacement or reduction of cement. It is also, environmental friendly with the reduction of cement use and utilization of waste plastic in a better way. In the study an attempt is also reported for generation of electrical energy. Flooring using piezoelectric material is suitable for places of foot traffic. This technology of using flooring tiles to generate electricity with mechanical pressure mechanism is attempted. Using this, harvesting of electricity from movement of foot traffic/automobiles can be thought of.*

***Keywords:*** *Environment, Plastic waste, Floor tiles, Piezoelectric flooring.*

## Introduction

Renewable energy is obtained from renewable resources. These resources are sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy production is useful in four important applications such as; electricity generation, water heating or cooling, transportation and off grid rural electrical energy supplies.

A flooring tile may be used with piezoelectric material and this flooring is suitable for places that receive heavy foot traffic. A methodology to utilize waste plastic in flooring tiles in efficient way and the possible generation of electricity by incorporation of piezoelectric material in the flooring tiles is reported.

## Plastic and Origin

Plastic is widely used material. It has distinct advantage of compactness, light in weight, easy availability and carries sufficient weight. Common plastic items that are used are bags, bottles, containers and food packages. The problem with plastic is when it is disposed, after its use. Plastic is made of polymer chemicals. The important aspect is that they are not bio degradable. Plastic has different origin [1] and has different applications.



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**Recycling of Plastic**

Recycling is a process of waste use as new products thus reducing generation of waste to the environment. The use of plastic waste, primarily leads to material resources use reduction, because instead of expensive materials, we use waste that is practically free. This also results in savings of space required for storage of waste materials and reduces environmental pollution.

Waste plastic used for the production of flooring tiles is an optimal method to solve the problem of storing waste materials and to optimize the cost for the production of building materials.

In this study, plastic bottle and other plastic waste is used in shredded form. This along with sand and partial use of cement is used to produce paver tiles. The paver tiles are investigated for some of its engineering properties to check its suitability as paver tiles. Also, cost economics is also done to check its effective cost of production for further use.

**Background:**

One of the area of utilization of the waste plastic is in bituminous road construction. The idea of utilization of waste plastic in construction of flexible road pavement started during 2000 in India. The use plastic in bituminous mixtures required no modification to existing plant facilities [2]. This bitumen is used for flexible Road pavement [3,4] in India. Studies are made to determine the suitability of plastic waste in construction mixes [4, 5, 6]. The use of plastic will reduce the bitumen content by 10% and increases the strength and performance of the road. This new technology is eco-friendly [7]. Also, plastic cement by using 40% of plastic and 60% cement is possible [8].

Electricity generation from floors can be made through transduction of stress generation by walking of humans on these floors thus producing electricity [9]. Significant energy from piezoelectric material results in use of this energy in sports venues. We can have access to harnessing of large amounts of kinetic energy. This has the potential to be an alternate source to harvest energy.

**Materials used:**

Waste plastic available in the market which are in the form of covers and bags are procured in the shredded form as in Figure(1).

**Figure 1**: Waste plastic and it's shredded form

The other materials used for the preparation of paver tiles include M-Sand and Cement for preparation of cement mortar for filling. The top 3/4 portion of mould is filled with M-sand with plastic and 1/4 of top portion of mould is filled with cement mortar using M-Sand for aesthetic finish of the top surface. The materials are shown as in Figure 2.



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**Figure 2:** M- Sand & Cement

**Methodology:**
The Plastic waste is used as plastic mortar for the preparation of paver tile. The exact proportion of plastic and mortar to be used is ascertained by checking the crushing strength of plastic mortar block and to recommend its use in the construction industry, the strength comparison is made with the cement mortar blocks.

**Crushing strength of Plastic mortar & cement mortar blocks:**
Crushing strength tests were conducted for Plastic and cement mortar blocks by considering different proportions such as 1:2, 1:3, 1:4, 1:5 and 1:6. The Plastic and cured mortar blocks were tested for its strength as in figure 3.

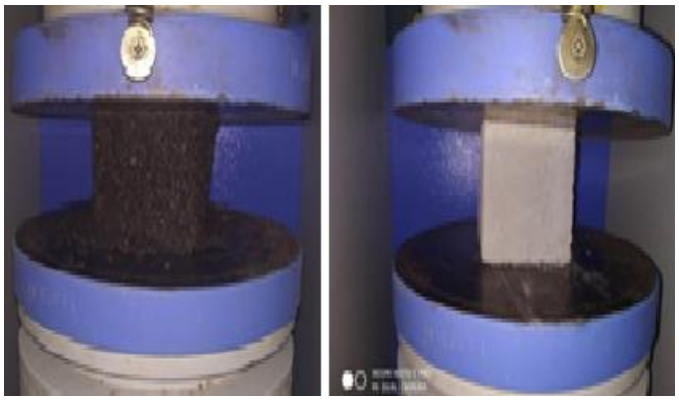

**Figure 3:** Strength of Plastic & Cement mortar blockso

The test results for different mix proportions of plastic mortar blocks and cement mortar blocks are as in Table 1.

**Table1**: Strength of Plastic & Cement mortar blocks

| Mix proportion of Plastic mortar and Mix Proportion | Compressive strength of plastic Waste plastic mortar blocks (Cooled for a day) ($N/mm^2$) | Compressive strength of cement Cement mortar blocks (28days curing) ($N/mm^2$) |
|---|---|---|
| 1:2 | 12.44 | 26.96 |
| 1:3 | 12.88 | 22.83 |
| 1:4 | 10.67 | 16.15 |
| 1:5 | 9.24 | 12.02 |
| 1:6 | **7.33** | **7.25** |



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Keeping in view of the minimum strength of paver tiless and to have uniformity of strength of plastic mortar and cement mortar, a proportion of 1:6 is used for preparation of both Plastic mortar and Cement mortar.

**Preparation of Paver tiles:**
In the present work, the mould for square paver tiles of size 30cmx30cmx2.5cm is prepared. The mould for the tile is as in figure 4.

**Figure 4: Mould for the tiles**

The paver tiles are produced by mixing waste plastic with heated M-Sand at 200°C. The hot mixture is poured and compacted to 3/4 height of the mould. The remaining 1/4 portion of tiles is filled and compacted with cement mortar and given a smooth finish. After curing the tiles are subjected to compression test to assess the strength requirement of tiles.

**Renewable Energy Generation:**
Piezoelectric sensors are tools for the measurement of various processes. The advancement in piezoelectric technology is having impact on renewable energy generation.

The modulus of elasticity of many piezoelectric materials is quite high and is up to 106 N/m². Piezoelectric sensors are electromechanical systems to resist compression and the sensing element show almost zero deflection. A typical piezoelectric sensor is as in Figure 5.

**Figure 5: Piezoelectric sensor**

**Energy generation using piezoelectric material:**
When a force is applied on piezoelectric material, a charge is generated across it. The flooring tiles with piezoelectric material can convert the pressure energy applied to it into electrical energy. The pressure application can be the weight of the people walking over it.

The piezoelectric material has output which is not steady. A bridge circuit facilitate the conversion of this variable voltage into a linear one. The provision of rechargeable battery assists in storage of output DC voltage. Combination of piezoelectric sensor can be proposed for higher power output. A



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combination of both series and parallel connection can be employed for producing about 40 Volts of output. By providing battery, and with an inverter connected to battery a provision to convert Direct Current (DC) to Alternate Current (AC) load can be made. An LCD display can also be incorporated.

**Results and Discussion**

The paver tiles after being cured are subjected to strength test and is observed to get an average strength of 5.68 $N/mm^2$ . This satisfies the strength requirement of paver tiles. A series circuit of 5 piezoelectric sensor can produce 10 volts. The circuit can be prepared to utilize this renewable energy and can be connected to AC load

**Conclusion:**

The study gives an alternative for the disposal of waste plastic in useful and efficient way. The strength of the paver tiles with the use of plastic is comparable to that of the strength of the paver tiles available in the market. In addition, without the compromise of the strength, the weight of paver tiles with use of plastic is being reduced by nearly 10%, the water absorption by nearly 2/3 that of the traditional tiles. The cost reduction is possible by nearly 40%.

The reduction in use of cement for the preparation of paver tiles reduces the usage of cement in the production of paver tiles. Thus the reduction in use of cement and use of waste plastic in Paver tiles makes use of waste plastic in a efficient way and reduces environmental pollution.

The fixing the piezoelectric panel at the bottom of the tiles with five sensors each of 2V is capable of generating 10V. Out of many type of piezoelectric material, PZT is best in characteristics. The series combination of connection of piezoelectric material is desirable. The weight applied on the tile and corresponding voltage generated can be taken for detailed studies. Use of piezoelectric material is best suited in crowded areas. Also the use in street lighting without depending on electric power can be made possible in near future.

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