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Rebuilding of Plastic Waste to Pavement Bricks

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Abstract: ***Plastics are the most widely used artificial polymers in the world, by their specific characteristics, such as simple manufacturing, molding, cheaper costs and low density. The main problem is the non-biodegradable properties. In doing so, we focus on recycling the rich plastics. The type of plastic used in this project is polyethylene. Electric heaters are designed to melt plastics and mix various types of sand, such as river sand, M sand or fly ash to bricks. This heating machine is also aimed to recycle the used plastic brick itself at almost 700°C. The heating components used in this project is "Nichrome typeA1", which melts at around 1400°C. The insulating film used can withstand 1400°C and more.***
Keywords: ***Sand or Fly ash, Electric heater, Reusable plastic brick.***

I. INTRODUCTION

Plastic is a non-bio-degradable substance which takes thousands of years to decompose and hence creating land pollution as well as water pollution [2]. Recent research is concentrating on re-cycling or Effective Re-using of dumped plastics. There are roughly more than 172 types of plastics that are been recognized by us, in the field of recycling the plastic waste we have come up with an Idea of constructing Reusable pavement bricks that is stronger and more cost efficient than the normal concrete bricks. The natural resources consumed for the manufacturing of Plastic sand bricks and Paver blocks are very much less when compared to its counterparts [1]. Plastic sand bricks/tiles give an alternative option of bricks/tiles to the customers on affordable rates. Water absorption of plastic sand brick is zero percent. Compressive strength of plastic sand brick is 5.6 N/mm2 at the compressive load of 96 KN [3]. In this project, the type of Heating coil used is Nichrome type A1 which has melting point about 1440°C this heating coil is fixer in its position over the ceramic chamber with the help of furnace cement. Over this furnace cement there is an insulation foam that prevents the heat loss, insulation foam can withstand about 1600°C without any damage. There are three different types of sand used like River sand, M-sand, Fly ash. Using these types of concrete highly reduces the harmful effect of plastic in the environment and its cost is very low. Using the foundry sand brick in a building, total cost will be reduced from 20% to 25% [7]. The quantity of post-consumer plastics recycled has increased every year since at least 1990, but rates lag far behind those of other items, such as newspaper (about 80%) and corrugated fiberboard (about 70%). Overall, U.S. post-consumer plastic waste for 2008 was estimated at 33.6 million tons; 2.2 million tons (6.5%) were recycled and 2.6 million tons (8%) were burned for energy; 28.9 million tons, or 86%, were discarded in landfills. As of 2015, approximately 6.3 billion tons of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment. In 2016 only 14% of plastic waste was recycled globally.

II. MATERIAL PROPERTIES

A. Furnace Cement

A ready to use, premixed, air setting, high temperature refractory and retort cement for mortar facing, caulking or coating. Furnace cement can be used on oil, gas, coal, and wood burning heating systems. Adheres to most building materials and when cured makes positive non-porous, fireproof, acid proof seals that will not shrink, crack or crumble.

B. Heating Coil

The Richards NWA or Type A Nichrome Heater Wire has a composition of 80% Nickel and 20% Chromium. In addition, the Type A wire has a lower temperature coefficient of resistance in comparison to the Type C Nichrome Wire. The Type A Nichrome Wire has a high temperature range up to 1150°C or 2100°F. Richards NWC or Type C Nichrome Heater Wire has a composition of 60% Nickel, 16% Chromium, and the balance of 24% Iron.

C. Sheet metal

GI sheet (Galvanized iron sheet). 2mm which is very easy for working it also allows heat to flow through it thus certain metals can only be used. This sheet is also known as corrugated galvanized sheet this is by applying a protective zinc coating on steel or iron that prevents from rusting. Zinc weathers at a very slow rate, so the coating generally has a long life.

D. Thermocouple

A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming electrical junctions at differing temperatures. A thermocouple produces a temperature-dependent voltage as a result of the thermoelectric effect, and this voltage can be interpreted to measure temperature. Thermocouples are a widely used type of temperature sensor.

E. Ceramic Chamber

The crystalline of ceramic materials ranges from highly oriented to semicrystalline, vitrified, and often completely amorphous (e.g., glasses). Most often, fired ceramics are either vitrified or semi-vitrified as is the case with earthenware, stoneware, and porcelain. Varying crystallinity and electron composition in the ionic and covalent bonds cause most ceramic materials to be good thermal and electrical insulators.

F. Insulation Foam

Foam insulation is typically a low-density elastomer or polymer in the form of a thermal insulating foam that provides a thermal barrier around a component or between an interior space and a heat or cold source.

III. SPECIMEN REQUIREMENTS

A. M-sand

MSand has minus 150 micron less than 10% and minus 45 micron less than 2% only. This helps the concrete to maintain water absorption rate of concrete less than 2% which helps to produce concrete of consistent quality.

Fig:1(M-sand)

B. Plastic

The commercial applicability of polyethylene is limited by its comparably low melting point. For common commercial grades of medium- and high-density polyethylene the melting point is typically in the range 120 to 180 °C (248 to 356 °F). The melting point for average, commercial, low-density polyethylene is typically 105 to 115 °C (221 to 239 °F). These temperatures vary strongly with the type of polyethylene.

C. Fly ash

Fly ash or flue ash, also known as pulverized fuel ash in the United Kingdom, is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash.

D. River Sand

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and no tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example, aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish.

IV. SPECIMEN PREPERATION

A. Electric heater

Ceramic chamber is the inner part, there is a sheet metal inside the ceramic chamber that is used for easy motion of the molten plastic. The ceramic chamber is covered by the Nichrome wire for heating, to keep the wire in position there is the presence of furnace cement as normal cement will get cracks easily and will lose the grip. On top of the furnace cement we have applied insulation foam to avoid heat and current transfer to the outer surface or the outermost GI sheet. Thermocouple is used for measure the temperature present in the innermost chamber and the thermal regulator is used to regulate the temperature of the inner chamber and also to maintain constant temperature.

The heating chamber is maintained constantly at around 300°C for melting and mixing of plastic with sand or fly ash. In case of recycling the plastic brick, the chamber is maintained at 700°C.

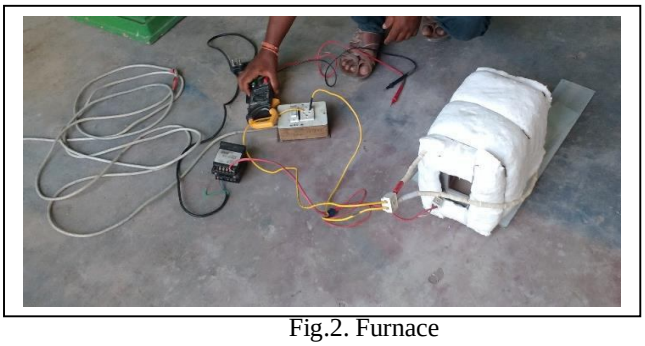

Fig.2. Furnace

B. Plastic Brick

The machine setup is used to melt and mix the plastic with sand for brick moulding. The waste plastics are collected and feed to the mixing drum. The burner is used to melt the plastic wastes. After the melting of the plastic, the m-sand is feed to the drum. The motor is coupled to the mixing drum to provide constant mixing of m-sand and the plastic. After the proper mixing the mixer is moulded as a brick by using the die.

Fig:3.different ratio

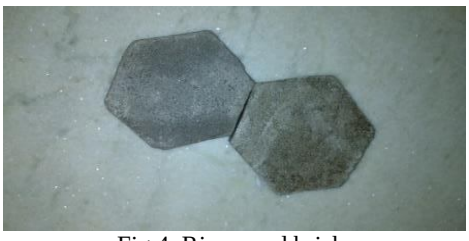

Fig:4. River sand brick

Fig5. Fly ash brick

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V. TESTING

A. Compressive test
B. Hardness test
C. Fire resistance test
D. Efflorescence test
E. Water resistance test
F. Surface test

VI.RESULT

A. Compression Test

samples	compression	plastic/sand
M- sand + plastic	17.6MPa	20% plastic 80% sand
Riversand + plastic	18.57MPa	25% plastic 75% sand
Fly ash + plastic	22.85MPa	30% plastic 70% fly ash
Concrete	17MPa 28MPa	-

Table:1 (compression test)

B. Hardness Test

Sample	Force	Diameter	BHN
Fly ash	2KN	4.9mm	6.087BHN
River sand	2KN	6.7mm	3.820BHN
M-sand	2KN	7.2mm	3.539BHN

Table: 2. (hardness test)

C. Fire Resistance Test

The Plastic is highly susceptible to fire but in case of Plastic sand bricks/Paver blocks the presence of sand imparts insulation. There is no change in the structural properties of bricks up to 180°C above which visible cracks are seen and the blocks/bricks deteriorate with increase in temperature.

D. Efflorescence test

The presence of alkalis in bricks is harmful and they form a grey or white layer on brick surface by absorbing moisture. To find out the presence of alkalis in bricks thistest is performed. In this test a brick is immersed in fresh water for 24 hours and then it's taken out from water and allowed to dry in shade. The plastic sand brick has low alkali content and so a little white patch is formed over the surface.

E. Water Resistance Test

In this the bricks first weighted in dry condition and they are immersed in water for 24 hours. After that they are taken out from water and they are wipe out with cloth. Then the difference between the dry and wet bricks percentage are calculated.

F. Surface Test

This test is to measure the surface hardness and to find the wear and tear that will take place on the brick due to continuous use.

VII. ADVANTAGES

A. The main advantage of this project is it is Eco-Friendly
B. Reusing of plastic will reduce the amount of scattered plastic present in the land and in the water bodies
C. This type of bricks can be used in sea shores as it does not absorb water and it is also not reactive towards water
D. It is not affected by the moisture content in the air so it will not get fractured that easily
E. This project can be converted into project and can build up Entrepreneurship
F. With certain changes these bricks can be used for constructing buildings This brick can be used in normal atmosphere without any harmful effect to environment and living organisms
G. As these bricks are constructed with waste materials like plastic, fly ash etc. this is considered a value product out of waste

VIII. CONCLUSION

This project reuses the plastic and prevents the environment from plastic pollutants. This project is done with different mixing ratios of sand and plastic. All the bricks with different ratio are tested and finally came up with the best ratio to construct brick and that is 70% of sand and 30% of plastic. Comparing all the bricks it is better to use the brick made with plastic and fly ash as both are obtained from waste. These produce harm separately thus this waste materials can be combined to form an eco-friendly product.

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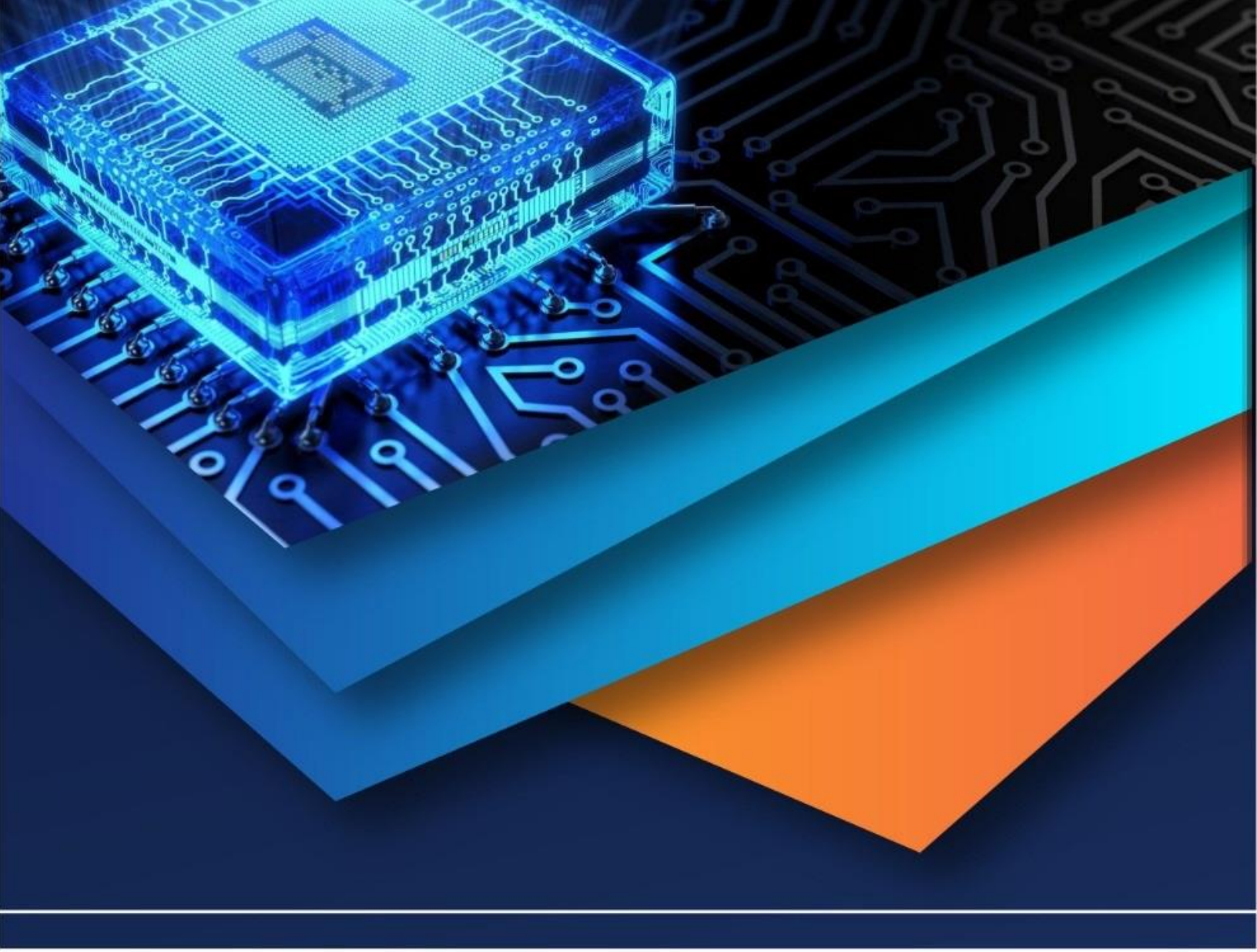

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