RECYCLING PLASTIC WASTE INTO PAVING BLOCKS

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ABSTRACT

The aim of the project is to recycle the plastic waste into a paver block and to reduce the cost of the paver block when compared to that of a convention concrete paver block. Plastic waste has become a major problem these days. As plastic is non bio degradable material it blocks drains, pollutes rivers and wreaks havoc on the environment. At present nearly 56lakhs tones of plastic waste is produced in India per year. As the degradation of the plastic waste is a very slow process so here is an idea of mixing sand into melted salvaged plastic to make a solid, durable material as a paving slab. Hence, we have a “eco-friendly” paving block.

INTRODUCTION

PLASTIC: "Plastic is a wide range of synthetic (or) semi-synthetic organic solid material suitable for the manufacturing industrial products".

- Plastic are polymers of high molecular weight.
- Plastic includes materials composed of various elements such as carbon dioxide, hydrogen, oxygen, nitrogen, chlorine and sulphur.

IDENTIFYING OF PLASTIC:

Make a collection of food packaging, milk bottle, a carbonated drink bottle, a supermarket carrier bag, a near-transparent lidded container for food a margarine container.

Note how plastic bottles have replaced, glass for soft drinks, milk, ketchup, etc. One trip plastic bottles are essential for the sales of bottled water, while they have replaced metal cans for many products Ever containers apparently made from paper (such as Tetra-pack) rely on an inner polythene layer to product the paper from the liquid contents.

When working with plastics there is often a need to identify which particular plastic material has been used for a give product. This is essential to get an ideal often cost and likely properties of the products.

The identification of plastic is generally very difficult due to

- The wide range of basic polymers that is available for use.
- The wide range of additives that can be used to modify the properties of the basic polymer.
- The wide range of mixture or compounds of polymers that can be manufactured to meet the required properties.
- The basic tests are apply are:
- Look at the sample.
- Feel the sample.
- Cut the sample.
- Burn some of the sample.

These tests will give you a fair ideal of what the basic polymers.

NOTE: The tests given here are not necessity definitive and the presence of certain additives (For instance flame retardants can significantly change the behavior of a product).

WHY TO RECYCLE PLASTIC WASTE?

Plastics are a versatile material that can be a valuable asset to your corporate Green recycling program. Your business can greatly reduce destructive waste output and cut costs associated with waste management fees through a Green recycling program with Complete Recycling.

Because plastic is a versatile recyclable, you can zero in on the benefits that result from the many markets that Complete Recycling is able to sell your materials to. Plastics are often recycled to make items such as clothes, carpet, containers, bottles, plastic lumber, films, grocery bags, molding materials, and lawn and garden products, to name a few.

MAIN TYPES AND SOURCES OF PLASTIC

It is important for you to know what kind of plastic you generate t o plan a recycling scheme or discuss your requirements with recycling contractors.

Plastic waste falls into two main categories:

- Pre-Use plastic (production scrap).
- Post -Use plastic.

PRE-USE PLASTIC

Pre use plastic waste likely either to be plastic to be plastic that has not met the specification required for its designed use, or off -cuts arising during assembly or installation. Examples of off-cuts arising during assembly installation. Examples off-specifications materials might include material that has the wrong color, wrong hardness, or wrong color or wrong processing characteristics. Although this material is not suitable for its intended use it may be suitable for other applications and has the potential to be recycled into the same or alternative applications for examples, off cuts from the forming of cups from polystyrene sheet can be recycled into cups, or into cassette cases.

Pre-Use plastic waste is likely to be the main source of plastics suitable for reprocessing from manufactures of plastic products; in many instances off-cuts can be reprocessed in house. It is typically more valuable than post-use plastic waste as it generally requires, little processing to use in a new product.

Pre-use plastic waste does not count to words plastic recycling targets. Under procedure Responsibility (packaging waste) Regulations and you cannot claim PRNS or PERNS on this material.

POST-USE PLASTIC:

Post -use plastic waste suitable for recycling generally falls into one of five main categories;

- Plastic bottles, pots, tubes, and trays.
- Plastic film.
- Rigid plastics, such as creates pipes and moldings.

- P lastic forms, such as expande d polystyre ne (EPS).
- Flexible plastic such as strapped and cable sheeting.

Plastic Bottles:-

Plastic bottles and posts, tubes and trays are found mainly in the house hold waste stream; however they may also be one of the main plastic applications suitable for recycling from SME's

PLASTIC FILMS:-

Plastic films is a thin gauge packaging used as a bag or wrap. Examples include plastic shopping bags, rubbish bags, bubble wrap and plastic or stretch wrap. Plastic films compose a broad category of material that can be relatively simple or complex, depending on the demand of a particular product or plain, single or multi -layered, thus the only thing that all plastic films really has in common is that it is flexible in nature.

TYPES OF PLASTIC WASTE:

- Poly Ethylene Terrapthalate (PET).
- High Density Poly Ethylene (HDPE).
- Poly Vinyl Chloride (PVC).
- Low density poly Ethylene (LDPE).
- Polystyrene (PS)
- Poly Propylene (PP).

POLY ETHYLENE TERRAPTHALATE

Polyethylene terrapthalate, commonly abbreviated PET, PETE or the PET-P, is the most Common thermoplastic polymer resin of the polyester firmly and is used in fiber for clothing

HIGH DENSITY POLY ETHYLENE

High density poly ethylene (HDPE) or poly ethylene high density is a poly ethylene thermo plastic made from petroleum. Known for its large strength to density ratio, HDPE is commonly used in the production of plastic bottles, corrosion -resistant more... "

POLY VINYL CHLORIDE

Poly vinyl chloride, also known as poly vinyl or vinyl commonly abbreviated PVC is the world's third most widely produced synthetic plastic polymer, after polyethylene. PVC comes in two basis forms; rigid and flexible.

POLY PROPYLENE This is also known as poly propane is a thermo plastic polymer used in a wide variety of applications.

POLYSTYRENE: A synthetic resin which is polymer of styrene used chiefly as weight rigid foams and films "these plaques are mould in block polystyrene".

Polystyrene is a synthetic aromatic polymer made from the monomer styrene. Polystyrene can also be of solid form. General purpose polystyrene is clear, hard, and rather brittle. It is an inexpensive resin per unit weight.

LOW DENSITY POLY ETHYLENE

Low density poly ethylene is a

LDPE branching structure

thermoplastic made from the monomer ethylene. It was the first grade of poly ethylene, produced in 1933 by imperial chemical industries using a high pressure process via free radical polymerization.

LDPE is widely used for manufacturing various container dispensing bottles, wash bottles, tubing, plastic bags for computer components, and various mol

PROPERTIES OF LOW DENSITY POLY ETHYLENE

- LDPE is defined by a density range of 0.910 to 0.940 G/cm cube.
- It is not reactive at room temperatures, except by strong oxidizing agents, and some solvent cause swelling.
- It can with stand temperatures of 80°c continuously and 95°c for a short time. Made in translucent or opaque variations it is quite flexible and through.
- LDPE has more branching (on about 2% of the carbon atoms) than HDPE. So its intermolecular forces (instantaneous-dipole included -dipole attraction) are weaker, its tensile strength is lower and its resistance is higher. Also because, its molecules are less tightly packed and less crystalline due to the side branches.

CHEMICAL RESISTANCE:

- Excellent resistance (no attack /no chemical reaction) to dilute and concentrated acids, alcohols, bases and esters.
- Good resistance (minor attack/very low chemical reactivity) to aldehydes, ketones and vegetable oils.
- Limited resistance (moderate attack /significant chemical reaction, suitable for short use only) to aliphatic and aromatic hydrocarbons, mineral oils and oxidizing agents.
- Poor resistance, and not recommended for use with halogenated hydrocarbons.

APPLICATIONS

LDPE is widely used for manufacturing various containers, dispensing bottles, wash bottles, tubing plastic bags for computer components, and various moulded laboratory equipment. Its most common use is in plastic bags, other products made from it include.

- Trays and general purpose containers.
- Corrosion resistance work surfaces.
- Parts the head to be weld able and machinable.
- Plastic that requires flexibility, for which it serves very well.
- Very soft and pliable parts such as snap -on lids.
- Six pack rings.
- Juice and milk cartons are made of liquid packing board, a layer of aluminum foil (thus becoming aseptic packaging).

- Packaging for computer hard ware, such as hard diskdrives, screen cards, and optical disk drives.
- Play ground slides.
- Plastic wraps.

SOURES OF PLASTIC WASTES

- DISCARDED FISHING GEAR: Responsible for up to 90% of plastic debris.
- LAND FILLS: Leaks toxins and contaminates the nearby soil and water.
- PLASTIC THROWN ON LAND: Enter into drainage lines and chokes them resulting into floods as experienced in Mumbai, India, in 1998.

AGRICULTURAL: Includes films -used from mulch, green house covers, and to warp bales, tubing and to wrap bales tubing and pipes it also includes nursery containers, pesticides containers, silage bags.

- Plastic production is 100 million tones / year.
- Plastic disposal is 25 million tones / year.
- Plastic in municipal solid Waste is 11.8% by weight.
- The total plastic waste generated every day is 15,342 tones.
- In Telangana, the amount of plastic waste generated per annum is 120,961tonnes.
  - (1tonne =20,000 bottles).
  - ACCORDING TO 2017 INDIAN STATISTICS OF PLASTIC WASTE:
  - Approximately 40,000 tones of plastic waste is generated daily in India as compared to 15,342 tones that was recorded in the year 2013, this means that since 2013, plastic waste generation per day has increased by approximately 60%.
  - A survey conducted by CPCB in 2010-2011 estimated that plastic accounts for over.
  - While these starts are 38% higher than the global average of 22% there are no comprehensive methods in place for plastic waste management. Because only 60% of plastic remain to added pollution.
  - Additionally, there is a constant increase in plastic waste generation. One of the major reasons for this that 50% of plastic is discarded as waste after single use.

This also adds to increase the carbon for print since single use plastic products increase the demand for virgin plastic products. To put this into perspective the production of a standard plastic bottle releases of carbon dioxide. Apart from this plastic waste is major contributor for:-

1. Poisoning of food chain
2. Ground Water pollution
3. Land pollution
4. Air pollution
5. Sea or ocean pollution

NEW -DELHI: India generates 5.6 million metro tones of plastic waste annually with Delhi generating the most of at Municipality 689.5 metric tons every day, according to a report from the control pollution control Board (CPCB). About 60 percent of total or 9,205 metric tons per day is recorded.

COMPARISSION BETWEEN BITUMEN AND PLASTIC:

The road constructed using waste plastic, popularly known as plastic roads, are found to perform better compared to those constructed with conventional bitumen. When mixed with hot bitumen, plastic melt to form an oily coat over the aggregate and the mixture laid on the road surface like a normal tar road.

PROPERTIES OF PLASTIC:

- Resistance to corrosion and chemicals,
- Low electrical and thermal conductivity,
- High strength -to -weight ratio,
- Colors available in a wide variety and transparent,
- Resistance to shock,
- Good durability,
- Easy to manufacture,
- Resistant to water and have low toxicity.

PROPERTIES OF BITUMEN: Bitumen is defined as "A viscous liquid, or a solid consisting essentially of hydrocarbons and their derivatives, which is soluble in tri chloral ethylene and is substantially nonvolatile and softens gradually heated". It is black or brown in color &possessed water proofing and adhesive properties

- Hardness

- Softening point
- Ductility
- Viscosity
- Specific gravity
- Durability

DESIGN OF MOULD:

In the preparation of mould we have taken the shape of "hexagonal"
Mould is made by an iron sheet under four phenomena's,

1. Measuring the iron sheet.
2. Cutting
3. Rafting
4. Welding
5. Molding

Measuring: firstly an iron sheet of 5mm thickness is taken and measured.
Dimensions of the sheet are:
Length = 3cm = 30mm
Height = 1.5cm = 150mm.

Mark these dimensions on the iron sheet and then we proceed for the next stage.

CUTTING:
After marking 3cm*1.5cm on the iron sheet, this sheet is kept under a cutter machine and the size of the sheet is cut.

RAFTING: is a process in which the sides of a material is made smooth without any rough edges
1. The iron piece which is cut into the required shape is kept in between a bench vice and it is tightened.
2. After tightening the iron sheet a rafter is taken into hand.
3. By raising the top side of a rafter in vertical direction the edges of iron sheet is smoothened.

WELDING:
In order to attach the iron pieces which were cut, welding is one of the processes which are to be done.
In this process of preparation of mold we have used "GAS WELDING" as the thickness is only 5mm.

MOULDING:
After the process of cutting, rafting and welding the required shape of the mold is molded accordingly to our design.

CALCULATIONS:
Length = 30mm
Height=150mm
Area of the hexagonal mould = area of triangle 1 + area of rectangle + area of triangle 2 =0.5*l*b + l* b+ 0.5*l*b
=0.5*30*150 + 30*50+ 0.5*30*15 =900 mm ^{2}

Therefore total area of the mould = 900 mm^2.

REQUIREMENTS:
MATERIALS:

1. Sand
2. Plastic

SAND: is defined as particles with a diameter of between 0.074 and 4.75 millimeters. In this procedure of paving block we have used sand of different sizes .They are:

1. 1.18mm sieve
2. 600 microns sieve.

The main function of sand in this experiment is to give a good strength to the plastic when it is mixed 600 Microns Sand

Plastic:

Plastic is a material which melts while it is heated, it changes from solid state to liquid state.

This liquid nature gives a smoothening surface and helps in binding with the sand when sand is poured in the melted plastic.

CASTING:

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify.

The solidified part is also known as casting.

In this experiment, liquid material (plastic after melting) is mixed with sand and poured into a mold which is in the shape of hexagonal, and then that mixture is allowed to sit

For 45 minutes so as to get solidified.

PROCEDURE

1. Sand of sieve sizes 1.18mm and 600 microns were sieved firstly.
2. A plastic of 20kgs was collected (LOW DENSITY POLY ETHYLENE)
3. Plastic serves to bind the materials together. But before we use the plastic it must be separated from plastic containing chlorine because it becomes toxic if it is chemically altered.
4. The proportion used in this experiment is 1: 4 ratios that is: one kilogram of plastic to four kilograms of sand is used.
5. An iron vat is used in this melting and mixing process.
6. Firstly plastic waste is placed into the iron vat and is kept for a wooden fire.
7. When the plastic starts melting at a temperature of 150 to 250°C it changes from liquid state to plastic state.
8. After getting a liquid state add 4 kilograms of sand if 1 kilogram of plastic is used.
9. By using a handle, start mixing the mixture of sand and plastic present in the iron vat thoroughly.
10. Apply oil to the mould so as to get the friction resistance when the block should be removed after placing.
11. The mixture of this plastic and sand is then poured into a mould and kept for drying for 45 minutes.
12. After the completion of 45 minutes the block gets hardened and it is removed from the mould.
13. Proper finishing is to be done to the block such that we can use it in the placing of paving mater

TESTS

After preparing the paving blocks it should be kept for tests to know about its properties and shall be compared with the properties of other similar materials.

The tests which are done in this experiment of paving blocks are:

1. Compressive strength.
2. Penetration test.

COMPRESSIVE STRENGTH TEST:

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate.

S.No	Sieve sizes	Proportion	Load (KN)	Area (mm^2)	Compressive Strength (N/mm^2)
1	1.18 mm	1:4	172	900	191.11
2	600 µ	1:4	178	900	197.77

Procedure:

i. Clean the bearing surface of the testing machine

ii. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
iii. Align the specimen centrally on the base plate of the machine.
iv Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
v. Apply the load gradually without shock and continuously at the rate of 140 kg/cm2/minute till the specimen fails
vi. Record the maximum load and note any unusual features in the type of failure.

Calculation:

Result: The Compressive strength of Paving block (1.18 mm) = 191.11 N/ mm^2

The Compressive strength of Paving block (600 microns) = 197.77 N/ mm^2

Penetration of Plastic

Penetration value test of plastic is a measure of hardness or consistency of bituminous material. An 80/100 grade plastic indicates that its penetration value lies between 80 & 100.Penetration value is the vertical distance traversed or penetrated by the point of a standard needle into the liquid plastic material under specific conditions of load, time and temperature. This distance is measured in one tenths of a millimeter

Penetration dial reading	Test 1	Test 2	
(a) Initial	0	80	
(b) Final	80	160	
Penetration Value	80	160	

This test is done to determine the penetration of plastic. The principle is that the penetration of a plastic material is the distance in tenths of an mm that a standard needle would penetrate vertically, into a sample of the material under standard conditions of temperature, load and time.

The apparatus needed to determine the penetration of plastic is
1. Penetrometer
2. Water bath
3. Bath thermometer – Range 0 to 44 C, Graduation 0.2 C
SAMPLE

Procedure:

1. Plastic (LDPE= Low density polyethylene) of 250grams is taken in this test.
2. Plastic should be just sufficient to fill the container to a depth of at least 15mm in excess of the expected penetration.
3. Soften the liquid plastic above the softening point (between 75 and 100 C).Stir it thoroughly to remove air bubbles and water.
4. Pour it into a container to a depth of at least 15mm in excess of the expected penetration.
5. Cool it at an atmospheric temperature of 15 to 30 C for 1 hour. Then place it in a transfer dish in the water bath at 25.0 + 0.1 C for 1 hr.
6. Keep the container on the stand of the penetration apparatus.
7. Adjust the needle to make contact with the surface of the sample. Adjust the dial reading to zero.
8. With the help of the timer, release the needle for exactly 5 seconds.
    a. Record the dial reading.
    b. Repeat the above procedure thrice

c.

Observations for Penetration Test:

Actual test temperature = °C

Result of Test

Mean

Penetration Value = 120 mm.

FAILURES

At the time of meting process of plastic waste in the iron vat, due to excess amount of fire or heat the plastic in the iron vat was evaporated.
From this, we have learnt that excess amount of heating leads to evaporation of the plastic.
The plastic becomes in a powdered form and starts moving in the air.
This powdered form of plastic waste may pollute the environment and may cause health issues.
The failure was: improper melting action between plastic bottles and plastic covers.
The bonding between these materials was very poor compared to that of plastic cover and sand.
Improper mixing obviously results to failure of a material

Remedies:

- Do not over heat or over melt the plastic waste. Melt it at a temperature of 150 to 250 degree centigrade.
- This would not only results in the evaporation of plastic waste powder but also do not release any harmful gases when it is burnt in the prescribed temperature.
- Better choose the material of plastic which has identical properties but not of other materials with different properties.
- Same property of materials gives good bonding rather than dissimilar ones.

ADVANTAGES

1. Recycling plastic conserves the natural resources and energy that would be required to produce plastic from scrap. When plastic is recycled, less plastic is sent to landfill and thus, less of this material takes up room in our environment for hundreds of years. Recycling one ton of plastic can save 7.4 cubic yards of landfill space.

1. It can help you save the money; there are companies that pay cash for your trash, patronizing the recycled products saves your money because they are less expensive**.**
2. By recycling plastic, we are minimizing the use of energy that can decrease the pollution, minimize the health risk and help the economy.
3. It reduces the consumption of fresh raw materials.
4. It reduces the water pollution and the air pollution (from the land filling by reducing the need for conventional waste disposal)
5. It reduces the greenhouse gases emissions.

DIS-ADVANTAGES

1. Plastic recycling can be harmful to the environment, when the material is melted down, VOCs are released into the atmosphere, and they are harmful to nearby plant and animal life.
2. VOC (volatile organic compounds) released from plastic recycling harm the environment; they present health risks to the people who use the recycled plastic.
3. Plastic resin is manufactured from the petroleum and it can leech into the foods that are stored in the recycled plastic containers.
4. The heat is required to melt the plastic, the process generates carbon emissions,
5. The harmful greenhouse gases contribute to the global warming and they are already taking an effect on our planet's climate.

6. The plastic carries the potential health threats; much of recycled plastic will be less useful products.
7. Plastic Recycling will produce the pollutants, including the chemical stews after breaking down the waste materials; it can hurt the environment, if not planned well.
8. Plastic Recycling can increase low quality jobs, these include sorting the garbage, cleaning toxins and doing the other manual and the intensive labor.
9. Plastic Recycling can create more environmental problems, if not done right; recycling companies might abandon dump sites and leave the harmful chemicals to contaminate the land and the environment

Future scope of Plastic paving block:

For the landscaping purpose of bungalow and apartments you need spectacular entrance with lavish look of outdoor flooring, you can have various options but to increase the visible features I strongly think and recommend that paver block plays the best, economic and easiest way to fulfill the purpose. Paver block being industrial products are comparatively hard and stiff for pedestrians and vehicular traffic. These solid precast pavers are versatile, aesthetically attractive and require less or no maintenance if correctly manufactured and installed. Paver blocks are very common and have popular method of hard landscaping which is worthy for applications like, driveways, paths, municipal gardens, garages, roads, etc. After the useful life, paver blocks can be demolished and can be used as recycled aggregates also. The main advantage of using paver blocks over other materials is that individual block can be removed and replaced.

CONCLUSION:

The following conclusion was drawn from the experimental investigation.

* The utilization of waste plastic in production of paving block has productive way of disposal plastic waste.
* The cost of paving block is reduced when compared to that of concrete paving block.
* Paving block made using plastic waste, sand shown in better result.
* It also good heat resistance.
* Though the compressive strength is high when compared to the concrete paving block it can be used in gardens, pedestrian path and cycle way etc.
* It can be used in Non-traffic and light traffic road.

As a civil engineer and a citizen of our country we have the responsibility of educating people about the recycling and reusing of our resources because of the scarcity of resources and their effects.

*This attempt of recycling of plastic waste into a paving block has been made so as to reduce to the degradation of plastic waste into an "Eco-Friendly "paving block