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Asphalt Plasto A Brick from Waste Plastic

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***Abstract*— This paper mainly focuses on the plastic waste management and recycling technique to reduce the cost of various raw-materials used for pavements and building construction. Various tests were conducted with different materials and different composition to find out a better paving brick with maximum usage of shredded plastic as an aggregate. Different types of plastic wastes can be used for this purpose as an aggregate mixture. Bitumen is used as a binding material in the mixture. The mixed plastic waste can reduce the weight of the brick, increase the strength, reliability and other physical properties when compared with a normal brick. Small aggregates of metal chips, Msand, Aluminium mesh sheets are used to increase the strength of the brick. The mixture is heated and raised to a higher temperature in a controlled atmosphere at a temperature range of 150 to 300 degree Celsius and obtained a semi fluid material which is poured in the designed mould. The brick is obtained after cooling from the mould. Then the compressive strength test are done and the results are discussed to conclude with the best possible solution to deal with the great mess of plastic waste disposal.**

Keywords*— *Waste plastic, Pavment Brick, Metal chips.

I. INTRODUCTION

Humans have always produced trash and disposed of it in some way so solid waste management is not a new issue.

What has changed are the types and amounts of waste produced, the methods of disposal, and the human values and perception of what should be done with it. Recently plastics were used to prepare the coarse aggregate there by providing a sustainable option to deal with the plastic waste. Therefore, recycling of plastic waste is an important topic in order to decrease environmental pollution and prevent waste of resources. It can be used as a component of a composite construction material, as an inorganic filling material, and aggregate of concrete. Use of waste plastic in concrete has advantages since it is widely used and has long life. Plastic is an essential component of many items, including water bottles, combs, and beverage containers. Knowing the difference, as well as the SPI codes, will help us to make more informed decisions about recycling. The seven types of plastic include:

- Polyethylene Terephthalate (PETE or PET)
- High-Density Polyethylene (HDPE)
- Polyvinyl Chloride (PVC)
- Low-Density Polyethylene (LDPE)
- Polypropylene (PP)
- Polystyrene or Styrofoam (PS)

Miscellaneous plastics (includes: polycarbonate, polylactide, acrylic, acrylonitrile butadiene, styrene, fiberglass, and nylon). For the sake of the environment, it's important to know the different types of plastic and their uses, as well as the resin identification codes found on each. It's important to become familiar with an item's SPI (Society of the Plastics Industry) code, which is also known as a resin identification number and is used to classify the different types of plastic. This information will help you sort plastic materials more effectively for recycling.

PETE plastics make up 96% of all plastic bottles and containers in the United States, yet only 25% of these products are recycled. HDPE is the most commonly recycled plastic because it will not break under exposure to extreme heat or cold. According to the EPA, 12% of all HDPE products created are recycled in a year. PVC is one of the least recycled materials; generally, less than 1% of PVC plastic is recycled each year. It has been called the "poison plastic" because it contains numerous toxins and is harmful to our health and the environment. Packaging and containers made from LDPE make up about 56% of all plastic waste, 75% of which comes from residential households. Fortunately, many recycling

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programs are evolving to handle these products. Only about 3% of Polypropylene products are recycled in the US, but interestingly enough, 325 million pounds of non-bottle plastics were collected for recycling over a year. The pollution in the ocean is mostly from plastic, and it has a terrible impact on marine species. As a result, it can hurt the economy and food supply for communities that rely on fishing. The toxins work their way up the food chain and can even be present in the fish people eat. On land, wind can carry plastic waste or litter throughout the environment. It can get stuck in trees, fences, traffic lights, or other structures. When animals come into contact with this plastic waste, they risk consuming the toxins or becoming entangled in the plastic and suffocating. If an animal consumes a piece of plastic, the plastic can clog its stomach while also poisoning it with toxins. Almost 200 different species of animals are known to ingest plastic debris. Air pollution is another issue for humans and animals. Before any plastic waste is recycled, it needs to go through five different stages so that it can be further used for making various types of products.

- Sorting
- Washing
- Shredding
- Identification and Classification of Plastic
- Extruding

It is very difficult to sort different types of plastics from big bunch of garbage's. It is a time and cost consuming process. This paper aims to develop a method that can recycle the plastic by eliminating the sorting procedure from the conventional recycling method.

II. EXPERIMENTAL FACILITY

A. Setup

The standard size as recommended by the Bureau of Indian Standards IS: 2691:1988 revision 2 sub–clause 4 of page 1 is 190mm x 90mm x 90mm, which has been used as specimen size for testing. For the convenience of tapping procedure handles were designed as shown in the image Fig. 1.

Fig. 1: Mould design

Fig. 2: Metal Chips

Table.1: Properties of metal chips

Property	Crushed Stones
Natural Moisture content (%)	0.54
Water Absorption (%)	0.25
Specific Gravity	2.68
Density (Kg/m^3)	1855

The following materials were selected for finding out better composition and conducting experiment.

1. Metal Chips (size less than ¼ inch) – Fig. 1, 20mm metal chips are used to strengthen the mixture as an aggregate. The properties of metal chips are shown in Table.1. It is a usual construction raw material.

2. M Sand – Fig.2, Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. The properties of different types of msand are shown in Table.2. Manufactured sand is produced from hard granite stone by crushing.

Fig. 3: M sand

Table. 2: Properties of different types of msand

M Sand Types	Sieve Size/ Granule Thickness	IS Codes	Water Absorption	Specific Gravity	Density (KN/m3)
Concrete M Sand	150 microns - 4.75 mm	IS - 383: 1970	2.2	2.59	15.1
Plastering M Sand	150 microns - 2.36 mm	IS - 1542: 1992	2.1	2.63	15.1

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3. Bitumin (VG 30) – Fig.4, VG-30 is primarily used to construct extra heavy duty Bitumen pavements that need to endure substantial traffic loads. The properties of different types of bitumin are shown in Table.3. It can be used in lieu of

Fig. 4: Bitumin

60/70 Penetration grade.

Table. 3: Viscosity grade (vg) bitumen specification as per is 73:2006

Characteristics	VG-30
Kinematic Viscosity, 135˚C, CST, min	2400
Flashpoint, C, min	350
Flashpoint, C, min	220
Solubility in trichloroethylene, %, min	99.0
Penetration at 25˚C	50-70
Softening point, C, min	47
I. Viscosity ratio at 60˚C, max	4.0
II. Ductility at 25˚C, cm, min	40

4. Shredded Plastic (size 5-10mm) – Fig.5, Plastic waste are needed to be shredded for this purpose which can be used as an aggregate in this mixture to enhance the physical properties of a pavement brick. The Specification of the shredding machine used for plastic shredding is shown in Tab.4. Plastic shredders play a key role in plastic recycling plants and production facilities. It offers several benefits in addition to processing plastics that are used as raw materials for other products like storage containers, toys, packaging bags, and consumer electronics. Plastic shredders not only help with size reduction, but also with recouping waste plastic.

Shredders are an indispensable component of efficient and cost-effective operations in the recycling and waste management industry. Plastic shredders are designed for shredding a wide variety of plastics and so, they vary from low speed to moderate speed with high torque and come in varying specifications and blade sizes.

Available in different makes and models, plastic shredders typically range from single shaft machines to an advanced

Fig. 5: Shredded plastic of size 4-10mm

four shaft mechanism that includes grinders, granulators, hammers, and cutters along with sorting and shaking functionality. Plastic shredders can typically drive from 50HP to 1,250HP and their key features include:

- A rugged structure
- Screen and vibration classifiers
- Discharge conveyors
- Heavy-duty gear
- Auto-reverse functionality
- Low noise level
- Single, double and four shaft mechanisms
- Advanced customization for altering the shape and size of materials

Table. 4: Specification of the shredding machine used for plastic shredding

Shredding Machine	
Specification of the Machines	150 × 150 × 75 in cm
No. of Blades	6
Motor	15HP
Capacity	1 ton/day
Blade Grinding Machine	
Specification of the Machines	100 × 30 × 100 in cm
Motor	2HP

5. Aluminium Mesh (size 18.5 x 8.5 cm) – Fig. 6, sheet of mesh 20*20 is used as a reinforcement in the specimen. It is used to increase both the compressive and tensile strength of the brick.

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Fig. 6: Aluminium mesh of size 18.5x8.5cm

The works related to the project are conducted over a remote space to control the level of pollution. Primarily the required amount of raw materials like shredded plastic, Msand or metal chips, VG 30 bitumen are weighed in different containers and kept in appropriate proportions. Initially the steel bowl is heated and taken amount of bitumen is added. As the temperature rises the bitumen changes to fluid state and the shredded plastic is added subsequently. The mixture is stirred well and get bound each other. Later the aggregate particle like Msand or metal chips are added to the semi-fluid mixture and mixed well.

After maintaining the temperature to a higher level, it is measured using a metal tail thermometer, the mixture is poured to the prepared standard mould and tapped well to remove the air gaps. Then the mould is let to cool and brick obtained is taken out. Similarly, various composition of different materials are tried to obtain the best possible result.

Fig. 7.1.a, Fig. 7.1.b, Fig. 7.1.c, Fig. 7.1.d: Various manufacturing process in brick formation

These are the procedure working involved in this project.

B. Testing

The testing was conducted in a Compression Testing machine (CTM) with a strain gauge deflector Fig. 8.1 connected over the compressing surface. Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, prism, or cylinder, is compressed between the platens of a compression-testing machine by a gradually applied load. When a load is applied to a ductile metal, it deforms elastically up to a certain point, and then plastic deformation occurs. Increasing loads may even completely flatten a test piece without any definite fracture occurring, so that no value can be obtained for the compressive strength. The custom of quoting tensile-strength values in these cases is inaccurate but safe, compressive

Fig. 8.1.a, Fig. 8.1.b: Compressive load testing machine and dial gauge used for testing the bricks

strength being always greater. The capacities of CTM are 500 KN, 1000KN, and 2000KN.. The values are noted and the Load vs Deflection graphs are marked.

III. RESULTS AND DISCUSSIONS

A. Load verses deflection graphs

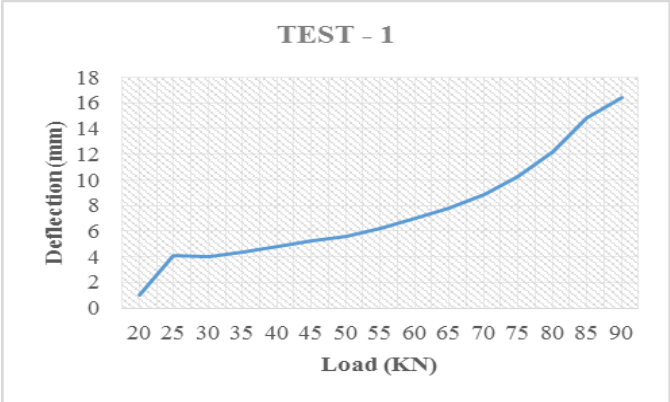

Fig. 9.1: Load vs deflection graph of test 1

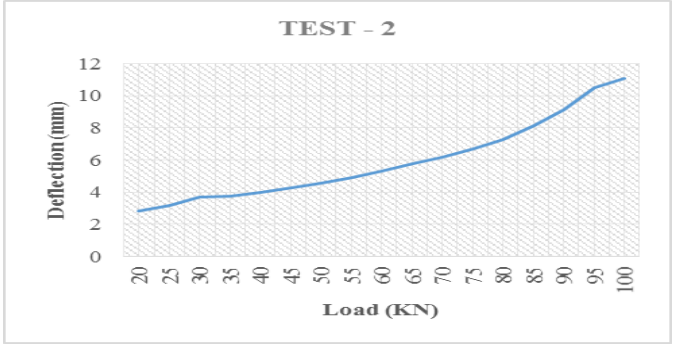

Fig. 9.2: Load vs deflection graph of test 2

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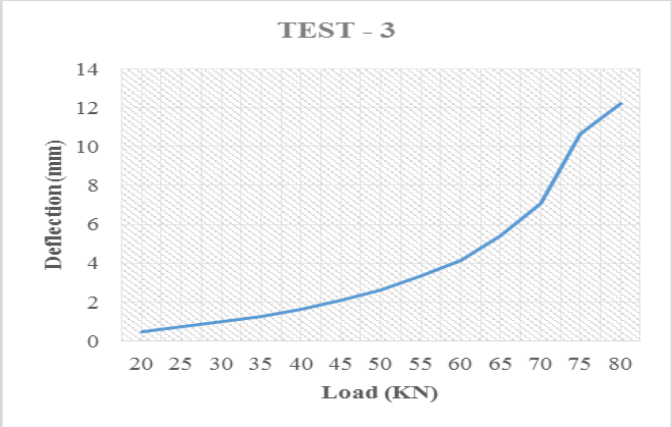

Fig. 9.3: Load vs deflection graph of test 3

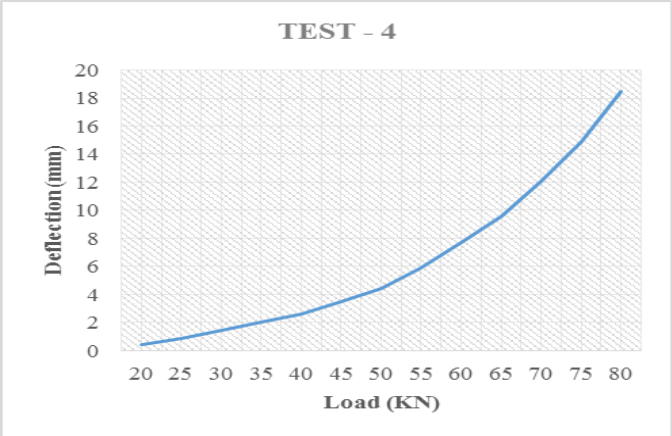

Fig. 9.4: Load vs deflection graph of test 4

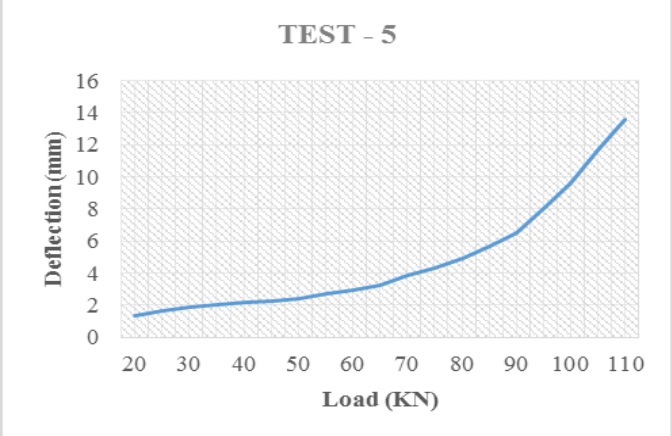

Fig. 9.5: Load vs deflection graph of test 5

The average weight of a 190*90*90mm normal brick varies between 3 to 3.5 kg. The Water absorption test for each brick was conducted, since the brick was made using VG 30 bitumen, the water absorption was very negligible because it is hydrophobic in nature. A controlled atmosphere was created using carton box and an incandescent bulb where the temperature was raised to 150-degree Celsius. It was observed using a thermo couple temperature sensor that the deformation starts at a temperature range of 90 – 100 degree celsius and the melting of VG 30 starts at 130 degree celsius. Our atmospheric temperature won't reach up to that level and hence the brick satisfies heat transfer test and is safe to use for paving purpose. The result of compression test was satisfactory and get the values of high-grade paving bricks Fig.10.

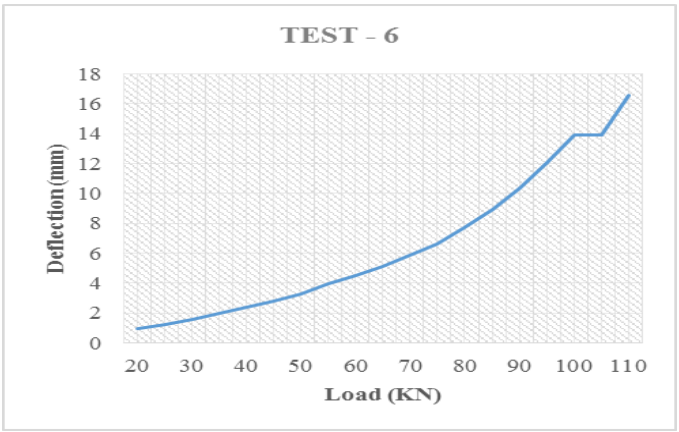

Fig. 9.6: Load vs deflection graph of test 6

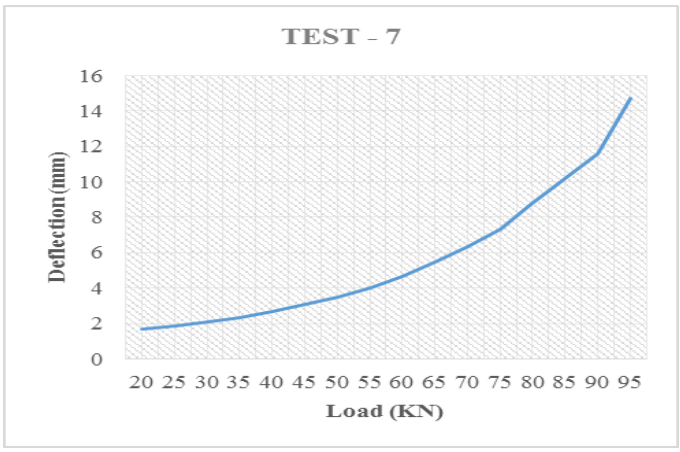

Fig. 9.7: Load vs deflection graph of test 7

Fig. 10: Test 7 brick with max compressive load capacity and plastic coated over the surface

Due to enthusiasm we had conducted two more experiments with M-15 concrete with 300g of shredded plastic in mixture, and used 20% crystalline bitumen instead of VG

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30 and 30% shredded plastic to obtain another brick. But both experiments got failure unfortunately.

Table. 7: Result of compression test

TEST NO	COMPOSITION (%)	WEIGHT (Kg)	COMPRESSIVE LOAD(KN)
1	M-sand: 50 Bitumen: 20 Plastic: 30	2.27	70
2	M-sand: 65 Bitumen: 15 Plastic: 20	2.44	75
3	M-sand: 25 Bitumen: 15 Plastic: 20 Metal: 40	2.43	77.5
4	M-sand: 25 Bitumen: 15 Plastic: 20 Metal: 40 Al Sheet: 2nos	2.48	87.5
5	Bitumen: 20 Plastic: 30 Metal: 50	2.26	110
6	M- sand: 50 Bitumen: 20 Plastic: 30 Al Sheet: 2nos	2.22	105
7	Metal: 50 Plastic: 30 Bitumen: 20 Al Sheet: 2nos	2.28	120

IV. CONCLUSIONS

From the seven tests of VG 30 bitumen and plastic conducted, three results were satisfactory with compressive load bearing of 120KN (Test 7), 110KN (Test 5), 105KN (Test 6). From the cost analysis carried out, Test 5 is obtained as the best possible solution with an average cost of Rs34.23. And it weighs only 2.2625 Kg which is comparatively less than nominal 190*90*90 mm paving brick test specimen. The normal paving brick costs averagely up to Rs 36 and is less durable and less reliable than our result. The selected specimen can accept great more load than the existing paving bricks and does not encourages abrasion from corners or edges like other bricks. This bitumen added bricks makes it hydrophobic in nature and doesn't allow water to penetrate in it. Even higher loads are applied on the brick, it doesnot break apart instead get deformed only.

This brick possesses certain other advantages like, it doesn't corrode, doesn't allow algae to grow, and possess less weight compared to concrete paving bricks, therefore easy transportation, provide extra life to tyres of vehicle. The setting time is approximately 30 minutes without any rapid cooling application. The black colour of the brick can be changed by using colour oxides, or by giving coloured plastic coating on the surface and reduces the heat absorption from sun exposure.

It can be applied over commercial pedestrian areas, parking slots, residential roads, Minor collector & bus parking. If we add titanium dioxide in the mixture of this paving brick, the pollution level in air can be reduced, because titanium dioxide nanoparticles, when exposed to UV light, can oxidise organic compounds in air and reduces the air pollution. Through this project we can reuse a large amount of various types of plastics and make it eco-friendly. This can also reduce the raw material cost of construction of pavement bricks and other building materials. Hence the Test 5 with 50:30:20 (20mm Metal Chips: Plastic: VG 30) is selected as the best possible solution.

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