Analysis And Structural Behaviour of Plastic Waste in Manufacturing of Paver Blocks

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Abstract- *Presently 56 lack tones of plastic waste dumped in India in a year. The dumped waste pollutes the surrounding environment and all the living beings and ecology. The replacement of plastic waste for cement pavements provides potential, environmental as well as economic benefits. In this study cement, sand, coarse aggregate, and ground plastic were used. Paver block made using plastic waste, quarry dust, coarse aggregate and ceramic waste. Modified pavement block is applicable in the construction of rigid pavement. The plastic waste in the paver blocks has a significant change in the permeability and the general disposal technique of waste plastics namely, land filling and incineration which have certain burden on ecology. In this current thesis the paver blocks are analysed and are subjected to various tests and the structural behavior of the paver blocks is studied.*

Keywords- paver blocks, incineration, land filling

I. INTRODUCTION

Pavement in construction is an outdoor floor or superficial surface covering. Paving materials include asphalt concrete, stone such as flag stone, cobblestone, and sets , artificial stone, bricks, tiles, and sometimes wood. In landscape architecture pavements are part of the hard scrape and are used on sidewalks, road surfaces, patios, courtyards. Paver block technology has been introduced in India in construction a decade ago for a specific requirement namely footpath and parking areas etc. Now paver block is being adopted extensively in different use. In this investigation various properties such as compressive strength, split tensile strength and water absorption of paver blocks consisting of plastic wastes, unconventional materials such as quarry dust and fine aggregate of various percentage replacement are used.

Cement concrete tiles and paving blocks are precast solid products made out of cement concrete. The product is made in various sizes and shapes viz. rectangular, square and round blocks of different dimensions with designs for inter locking of adjacent tiles blocks. The raw materials required for manufacture of the product are Portland cement and aggregates which are available locally in every part of the country.

This pavement are less susceptible to rutting, minimum fatigue or thermal cracking, low stripping due to moisture and offers great durability, little or no impact on processing and also produces eco friendly construction and costs less. Road surface or pavement is the durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as road or walk way. In the past, gravel road surfaces, cobble stone and granite sets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete laid on a compacted base course. Road surfaces are frequently marked to guide traffic. Today, Paving methods are beginning to be used for low impact roadways and walkways. Block tiles and paving blocks find applications in pavements Plastic waste used in this work was brought from the surrounding areas. Currently about 56 lack tones of plastic waste dumped in India in a year. The dumped waste pollutes the surrounding environment. As the result it affects both human beings and animals in different ways

Hence it necessary to dispose the plastic waste properly as per the regulations provided by our government. The replacement of plastic waste for cement provides potential environmental as well as economic benefits. With the view to investigate the behavior of quarry rock dust, recycled plastic, production of plastic paver block from the solid waste a critical review of literature was taken up. An attempt was made by Nivetha C et.al1 to reuse the solid waste quarry dust fly-ash and PET with an aim not to lose the strength far from original Paver blocks. From the observations of test results, PET can be reused with 50% of quarry dust and 25 % of fly-ash in Plastic Paver block. The physical and mechanical

properties of materials used in Plastic Paver block were investigated. For the test 6 cubes cube were cast for measuring Compressive strength. Satish Parihar et.al2 used recycled plastic aggregate in various proportions in concrete mix and check there stability. Amount of waste plastic being accumulated in 21st centuries has created big challenges for their disposal, thus obliging the authorities to invest in felicitating the use of waste plastic coarse aggregate in a concrete is fundamental to the booming construction industry.Three replacement levels of 10 %, 20%, 30 by weight of aggregates were used for the preparation of the concrete Poonam Sharmaet. al. discussed about cement concrete paver blocks for rural roads. The study of Joel Santhosh and RavikantTalluri4 indicated that fly ash and waste glass powder can effectively be used as cement replacement without substantial change in strength foot paths, gardens, passenger waiting sheds, bus- stops, industry and other public places. The product is commonly used in urban areas for the above applications. Hence, the unit may be setup in urban and semi-urban areas, near the market. A lot of face-lift is being given to roads, footpaths along the roadside Plastic waste used in this work was brought from the surrounding areas. Currently about 56 lakh tonnes of plastic waste dumped in India in a year. The dumped waste pollutes the surrounding environment.

As the result it affects both human beings and animals in direct and indirect ways. Hence it necessary to dispose the plastic waste properly as per the regulations provided by our government. The replacement of plastic waste for cement provides potential environmental as well as economic benefits.

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II. PLASTIC WASTE

There are three major forms of plastic that contribute to plastic pollution: micro plastics as well as mega- and macro-plastics. Mega- and micro plastics have accumulated in highest densities in the Northern Hemisphere, concentrated around urban centers and water fronts. Plastic can be found off the coast of some islands because of currents carrying the debris. Both mega- and macro-plastics are found in packaging, footwear, and other domestic items that have been washed off of ships or discarded in landfills. Fishing-related items are more likely to be found around remote islands

Micro debris

Micro debris is plastic pieces between 2 mm and 5 mm in size. Plastic debris that starts off as meson- or macro debris can become micro debris through degradation and collisions that break it down into smaller pieces. Micro debris is more commonly referred to as hurdles. Hurdles are recycled to make new plastic items, but they easily end up released into the environment during production because of their small size. They often end up in ocean waters through rivers and streams. Micro debris that come from cleaning and cosmetic products are also referred to as scrubbers.

Macro debris

Plastic debris is categorized as macro debris when it is larger than 20 mm. These include items such as plastic grocery bags. Macro debris is often found in ocean waters, and can have a serious impact on the native organisms. Fishing nets have been prime pollutants. Even after they have been abandoned, they continue to trap marine organisms and other plastic debris. Eventually, these abandoned nets become too difficult to remove from the water because they become too heavy, having grown in weight up to 6 tons.

Thesis Organization

Chapter 1 gives the introduction to the project: the problem identified the objective, proposed outline of the project and scope of the project on dealing with the stated problem.

Chapter 2 gives the summary of the literature review and the final conclusions drawn from them.
Chapter 3 gives the procedures of the tests done on materials used in thepaver blocks
Chapter 4 gives the description of the mix design,
Chapter 5 gives the results and their analysis. From these results we have plotted the graphs and analyzed the results
Chapter 6 gives the summary, final conclusions on the course of the project and the future scope of work that can be further carried out.

	TS 2824	ASTM C 936	BS 6717 Part 1
Dimensional Requirements	Length/Thickness<4	Length/Thickness<4 Surface Area<0.065m^2 t_{min}>60mm	Surface Area<295 mm^2
Compressive Strength	———	Average Str>55MPa Individual Str.>50MPa	———
Indirect Tensile Str.	Average Str.>3.5 MPa Individual Str.>2.8MPa (Tensile Splitting Str.)	———	Average Str.>3.9 MPa Individual Str.>2.9MPa (Three Point Bending)
Abrasion Resistance	V. Loss< 15cm^3/50cm^2 (Exp. to Severe Abr.)	V. Loss<15cm^3/50cm^2 Average Thick. Loss<3mm	For A_2 Abrasion Class: Dgr. of Abr.< 23mm
Resistance to Frz-Thw.	Weight Loss< 0.5kg/m^2	Weight Loss< %1 (Subject to 50 cycles)	W_2 Weathering Class: Mass Loss < 1kg/m^2 Ind. Loss<1.5 kg/m^2
Absorption	Individual Unit Abs<%6	Average Absorption<%5 Individual unit<%7	———
Skid Resistance	———	———	For S_2 Class C scale units>35 For S_3>45

III. MATERIALS USED

Following are the materials use in our Pavement block production. They are as follows:

Plastic bagsA plastic bag, poly bag, or pouch is a type of container made of thin, plastic film, nonwoven fabric, flexible, or plastic textile. Plastic bags are used for containing and transporting goods such as powders, foods, produce, ice, chemicals, magazines, and waste. It is a common form of packaging. Some stores charge a nominal fee for a bag. Heavy duty reusable shopping bags are often considered environmentally better than single use paper or plastic shopping bags. Open bags with carrying handles are used in large numbers. Stores often provide them as a convenience to shoppers. Because of environmental and litter problems, some locations are working towards a phase out

Quarrydust

A quarry is a place from which dimension stone, rock, construction aggregate, riprap, sand, gravel, or slate has been excavated from the ground. A quarry is the same thing as an open pit mine from which minerals are extracted. The only difference between the two is that open pit mines that produce building materials and dimension stone are commonly referred to as quarries. It can be used as substitute to sand fully or partially. It offers a comparatively good strength compared to sand with or without admixtures in concrete. The advantages of quarry dust are cost effective, easily available, consumption reduces the pollution in environment and effectively used as replacement material for river sand

FINE AGGREGATE

Fine aggregate are basically sand own from the land or the marine environ0ment. Fine aggregate generally consists of natural sand or crushed stone with most particles passing through a 9.5mm sieve. Fine aggregate are intergranular materials such as sand, gravel or crushed stone that are an end product in the own right

CHINA CLAY

China Clay is also known as kaolin & white clay. Primary clay formed by natural kaolinisation process. it is formed by decomposition of some part of feldspar mineral. White in color , Used in ceramic slip casting process, Pressing processes and forming process as a body former and filler.

Formation of China Clay:

Many theories are put for the Formation of China clay , some of them are accepted widely. we will see some of the theories in details: 1) The igneous emanation theory. 2) The surface weathering theory.3)The bog or moor

The igneous emanation theory:

As per Igneous emanation theory igneous gases from the center of the earth and superheated steam, fluorine compounds, carbon dioxide and boron are the active agents to decompose some part of feldspar. Clay formed by this theory will be in deep depth from the Surface. Clays Found in china supports this theory

Figure: Red oxide

Iron(III) oxide which can be used as a pigment in the name of “pigment brown 6”,"pigment brown 7","pigment red 101”. for example, pigment brown and the pigment red are used in food and drug administration and also in cosmetics The properties of red oxide is to make coloring to the paver blocks. They are red, odourless and their density is 5.26 g/cm3. their melting point is also at 2851 degrees Fahrenheit.

Paint and Primer

Red oxide is used in paints and primers as a rust preventive. If traces of rust are present on an iron surface, red oxide paint will still adhere, because it interacts with the surface by forming chemical bonds.

Reaction

Red oxide, also called red lead, reacts with iron and iron oxides to form insoluble compounds called plum bates, in which lead is part of the anion, (PbO?)?². For instance, ferrous plum bate has the formula Fe(PbO?), in which the cation is Fe?².Falling Into Disuse: Red oxide paint is falling into disuse due to concern over lead poisoning.

IV. MIX DESIGN

In order to find the plastic soil blocks that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine. The mix proportion were in the ratio of (1:2,1:3, 1:4, 1:5, 1:6)These are the ratio which represent the plastic, river sand respectively. In first step we should collect

the waste plastic bags and the polyethylene bags are sorted out and remaining are disposed safely. Next the collected waste bags are cleaned with water and dried to remove the water present in it after this the plastics are burned out by using stones and firewood. The stones are arranged to hold the drum and the firewood is placed in the gap between the stones and it is ignited. The drum is placed over the above setup and it is heated to remove the moisture present in it. Then the plastic bags are added to the drum one by one and the river sand is added to the plastic when it turns into hot liquid. The sand is added is mixed thoroughly using rod trowel before it hardens. The mixture has a very short setting hence mixing process must not consume more time on the other hand the process should be complete. In case of Paver blocks, Red oxide is added less than 10% of thetotalweight

mix design block

V. TEST PROCEDURES

To know the quality of plastic sand paver blocks following tests can be performed. In these tests some are performed in laboratory and the rest are on field.

COMPRESSIVE TEST

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material. Generally five specimens of blocks are taken to laboratory for testing and tested one by one. In this test a paver block specimen is put on crushing machine and applied pressure till it breaks. The ultimate pressure at which block is crushed is taken into account. All five paver block specimens are tested one by one and average result is taken as paver block's compressive strength. The plastic sand paver blocks of different ratios are tested one by one and in this the high compression.

Fig 5.2: Compressive strength for plastic sand paver blocks

S.NO	TYPE OF PAVER BLOCK
1	Plastic Sand blocks(without hydraulic press)
2	Plastic Sand blocks(with hydraulic press)

WATER ABSORPTION TEST

In this test, paver blocks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth. Then paver block is weighed in wet condition. the difference between weights is the water absorbed by the paver block. the percentage of water absorption is then calculated. The less water absorbed by the paver block the greater its quality. Good quality paver block doesn't absorb more than 5% of its own weight. Water absorption of test specimen = 2.2 %

As per IS 15658:2006 water absorption percentage within 5%, the result of specimen is 2.2% hence it is satisfied.

FIRE RESISTANCE TEST

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

HARDNESS TEST

In this test a scratch is made on block surface with steel rod (any hard material can be used) which was difficult to imply the blocks were hard. This shows the brick possesshighquality.

Design Procedure:

Types of plastic bags = PE, PP, PS,
Temperature of heating = 1400 F -1600
Exposure condition =Moderate
Degree of supervision = Good
Size of fine aggregate = 1.7mm
Specific gravity of fine aggregate = 2.65
Specific gravity of PS = 1.05
Specific gravity of PB = 0.6 Specific gravity of PP = 0.9-0.92
Specific gravity of LDPE = 0.91-0.93 Specific gravity of HDPE = 0.96-0.97

S.NO	RATIO (P:F.A)	QUARRY DUST In %	STRESS N/m^2
1	1:3	10	12
2	1:3	20	13
3	1:3	30	15

PLASTIC PROPORTION

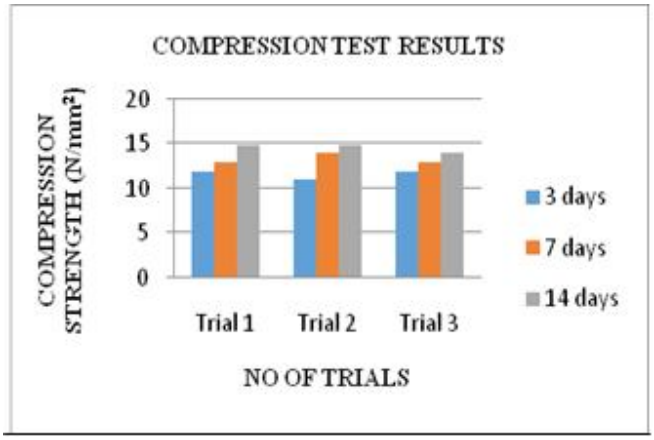
When plastic is heated at 1400 to 1600 F it is meltedinto a liquid form and this liquid is calculated into a ml. if 1/2 kg of plastic bags is heated up to a 450ml of liquid is obtained. Similarly the mix proportion of plastic ratio is denoted by liquid (ml).

DESIGN MIX PROPORTION

In order to check the workability of the plastic mix we made a trial and error method. After some trails it is found that by fixing plastic liquid quantity constant and the quantity of fine aggregate keeps altering. Finally, a designed mix of excellent workability is obtained. Then a cube of50mm×50m×50mm is casted and the compressive strength is found from the table below the stress of various mix is tabulated

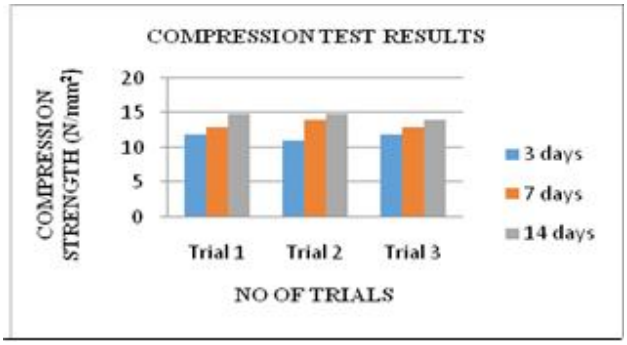
COMPRESSION STRENGTH OF PAVEMENT BLOCK

The tests are required to determine the strength of Specimen and therefore its suitability for the job. Out of many test applied to the Paver, this is the utmost important which gives an idea about all the characteristics of specimen. By this single test one judge that whether specimen has been done properly or not.



Size of the cube = 50mm×50mm×50mm Ratio of mix without quary dust of 30% (P : F.A)

Figure: Graph between number of trails and compression strength = 1 : 3.



S.NO	TRIALS	COMPRESSIVE STRENGTH N/mm²		
		3days	7days	14days
1.	Trial 1	13	12	14
2.	Trial 2	12	13	14
3.	Trial 3	11	12	13

S.N O	SPECI MEN	DRY WEIGHT (GR)	WET WEIGHT (GR)	% OF WATER ABSORPTION
1	A	710	720	1.40
2	B	705	713	1.13
3	C	708	715	1.00

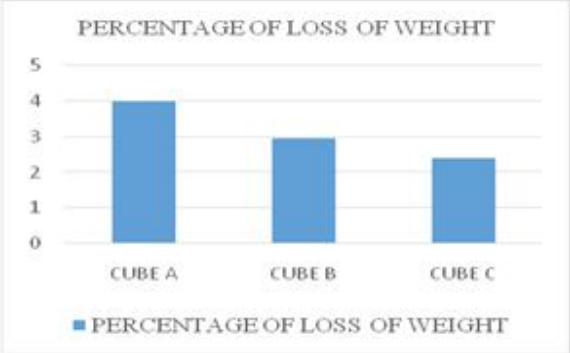
S.NO	SPECIMEN	INITIAL WEIGHT (gm)	FINAL WEIGHT (gm)	% OF LOSS OF WEIGHT
1	A	750	721	3.89
2	B	745	722	3.00
3	C	748	728	2.68

Table no: compression strength results

WATER ABSORPTION TEST

The casted specimen was subjected to a water absorption test, to study the character of plastic block. After the drying period is completed, the specimen was immersed in water tank is left for 24 hours. The blocks shall then be

removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth, the saturated and surface dry blocks immediately weighed.



W1=water content in saturation condition

W2=water content in dry condition

$$\frac{W1-W2}{W2} \times 100 = 0.06\%$$

FIRERESISTANCE TEST

Since the paver block is made of plastic it is required to know its heat resistance. Hence plastic paver block is placed in oven for 2 hours. After taken it out for testing results it is observed that the shape and size of paver block whether it is affected by heat which can be produced by oven and we must know that the temperature how much it resist and what temperature it undergoes melting this is basic thing we most note down when doing fire resistancetest.

Specimens	Temperature (°C)	Remarks
SPECIMEN I	50	no change
	100	no change
	150	Melts
SPECIMEN II	50	no change
	100	no change
	150	Melts
SPECIMEN III	50	no change
	100	no change
	150	Melts

VI. CONCLUSION

From the above study, the analysis concluded that the waste plastics can be used in the pavement block production. This modified pavement block is applicable in the construction of rigid pavements. The block consists of quarry dust, fine aggregate, plastics out of which the fine aggregate and quarry dust percentage is60 to 70 and from the above observation it is computed to use 20% recycled plastics, which does not affect the properties of block.

The compressive strength of a modified pavement block are as equal as conventional block The cost of construction will be reduced and also helps to avoid the disposal techniques of waste plastic namely land filling, incineration which have certain burden on ecology. By using the plastics in pavement blocks, reduces the weight upto 15 %. We also find that the plastic pavement block is economical and has several advantages when compared to concrete pavement block. The use of recycled plastics in the pavement block is the best option for the disposal of plastics and finally reduces plastic pollution in the environment. The utilization of waste plastic in production of paver block has productive way of disposal of plastic waste

The cost of paver block is reduced when compared to that of concrete paver block

Paver block made using plastic waste, quarry dust, coarse aggregate and ceramic waste have shown better result.

It also shows good heat resistance

Though the compressive strength is low when compared to the concrete paver block it can be used in gardens, pedestrian path and cycle way etc.

It can be used in Non-traffic and light traffic road

REFERENCES

[1] Miss Apurva J Chavan, “Use of plastic waste in flexible pavements” in the year 2013.
[2] BahiaRabehi,BrahimSafi,and Rabahchaid,“Use of Recycled plastic bag waste in construction field”in the year 2014.
[3] Dr.R.Kumutha and Dr.K.Vijai,“Use of waste material in paver blocks” in the year 2015.
[4] Satish Parihar, PramodPatil, Hemraj R Kumavat, “Recycled plastic used in concrete paver block” in the year2010.

[5] C K Subramania Prasad, Benny Mathews Abraham,"Plasticfibre reinforcedsoil block as a sustainable building material" in the year 2012.
[6] Vishal kumar, Dr.A.K.Mishra, "Utilization of waste material in pavement blocks" in the year 2016.
[7] S.Vanitha,V.Natarajanand M.Praba,"Utilization of waste plastics as a partial replacement of coarse aggregate in concrete blocks" in the year 2015.
[8] S F Wong,"Useof recycled plastic in a pavement system" in the year2010.
[9] P.Turgut and E.S.Yahlizadeconduct a parametric trial study for reducing paver blocks utilizing fine and coarse waste glass.
[10] Miss Apurva J Chavan, "Use of plastic waste in flexiblepavements"in the year2013.
[11] Bahia Rabehi, Brahim Safi, and Rabahchaid,"Use of Recycled plastic bag waste in construction field"in the year 2014.
[12] Dr.R.Kumutha and Dr.K.Vijai,"Use of waste material in paver blocks" in the year 2015. (13)SatishParihar, PramodPatil, Hemraj R Kumavat,"Recycled plastic used in concrete paver block" in the year2010