EXPERIMENTAL STUDY ON USAGE OF WASTE IN PAVER BLOCKS

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ABSTRACT

Nowadays in India, usage of paver blocks has become important as it is durable, and if they are interlocked perfectly they can sustain the huge vehicular load for about 20-25 years. India is the largest generator of waste which includes both industrial waste and e-waste, where generation of plastic waste and rubber waste has become serious concern. India generates 9.46 million tones of plastic waste annually in which nearly 40% of the waste remains uncollected. This waste piles up in landfills, rivers, drains, further flows into sea, leaches into soil and ground water. According to central pollution control board India is struggling to dispose its plastic wastes and has ranked third largest producer of plastic waste. The generation of rubber waste which is second largest waste generated in India and directly dumped into the landfill. In the present study an attempt has been done designing a paver block by using plastic and rubber waste as the alternative material for concrete paver block. The wastes are combined with different ratios to find a suitable and economical combination of materials.

Keyword: - *Interlocking paver block, Plastic waste, Industrial rubber waste, HDPE, M-sand, Portable plastic melter, Paver Design*

1. INTRODUCTION

Annually the world generates 2.01 billion tones of solid waste, in which 33% of that is not managed in a safe manner. The waste generated worldwide per person per day averages about 0.74 kilogram but ranges widely, from 0.11 to 4.54 kilograms. According to the recent study the production of the waste can grow up to 3.40 billion tones by the year 2050, more than double the population growth over the same period. Though 16% of the world's population is accountable, high income countries generate around 34% of the world's waste. The world's biggest problem is plastic pollution disaster. More than half of the waste is dumped into landfills and only 9% of it is recycled. Plastic that is not recycled or dumped into landfills reach oceans and settle in waster bodies. Plastic and its waste have significant impacts on the environment and climate. Plastic has become a serious challenge for the natural world. Plastic waste is not being handled in a suitable manner as the world is not being serious and showing interests towards it. From the research the economic growth of the world, the speed of urbanization affects the consumption and waste generation at the same rate. To overcome this problem wastes is utilized in different proportions in interlocking paver block to reduce harmful, hazardous and adverse effect on the environment, ecosystem and human health.

2. LITERATURE REVIEW

1. Ambrish N P, Abhishek Y et al. The main aim of this paper is to use plastic waste and river sand in different proportions for the construction of paver block and conducted different tests on the blocks. Waste plastic bags were collected cleaned, washed and dried and later heated in a container. River sand was added to the molten plastic and homogenously mixed. Plastic mortar was poured into the moulds and this procedure was repeated for three different proportions i.e. 1:2, 1:3, 1:4 (plastic, river sand respectively) and compacted using steel rod. The prepared blocks were tested for compression, water absorption, efflorescence, fire resistance and hardness. It was concluded that plastic paver blocks showed high compressive strength, low water absorption, and low alkaline content making them more economical and cost effective.

2. Mohan D.M.S, Vignesh J et al. This paper compares the experimental study of paver blocks made of plastic with fine aggregates and quarry dust. To find the workability different proportions of cubes were casted and the proportion was fixed. Three blocks of 1:3 proportion of material plastic with and without quarry dust were casted. Blocks made of conventional blocks were compared with blocks having quarry dust. Compressive strength, tensile strength, water absorption, acid resistance of both composition blocks was compared for blocks after curing it for 3,7 and 14 days. The analysis concluded that compressive strength was same as conventional block, light weight, cost effective.

3. S. Dinesh et al. This paper aims to study the different properties of paver block made of plastic, fine aggregate and with added colour compound red oxide. The mix proportion of ratio 1:2, 1:3, 1:4, 1:5, 1:6 (plastic and river sand respectively) were mixed by melting the plastic and simultaneously river sand was added to it and poured into moulds, later dried and cured. Properties such as compressive strength, water absorption, fire resistance and hardness were tested. The cubes of ratio 1:4 and 1:5 showed high compressive strength, low water Experimental study on usage of waste in paver block absorption concluding that cubes were of high quality compared to other cubes.

4. K. Goutham et al. The aim of this study is to replace plastic waste with different proportions of quarry dust, ceramic waste and coarse aggregate. Waste plastic was collected cleaned and melted in a container. Later the quarry dust, ceramic waste and coarse aggregates of 3 different proportions were mixed to the melted plastic. The mixture was poured to the respective moulds, compacted and left for drying. Plastic paver blocks of ratio PPB1 - 1:0.75:0.75:0.75, PPB2 - 1:1.5:2:0.75, PPB3 - 1:1.5:2:0.75 (plastic waste, quarry dust, coarse aggregate, ceramic waste) were tested for compressive strength and oven test. PPB3 blocks showed higher compressive strength than compared to other blocks, making them more suitable and sustainable for usage.

5. Anusuri Uma, L. Srinuswamy et al. The primary objective of this paper is to study the different proportions of plastic waste and sand to find a suitable ratio for the paver block. Five paver blocks of ratio 1:1, 2:1, 3:1, 4:1 (plastic and river sand respectively) were prepared Experimental study on usage of waste in paver block by mixing sand to melted plastic which was collected from the local plastic waste vendor and poured into the moulds. The results of compressive strength, waster absorption, acid resistance, and fire resistance test. It was conclude that water absorption abruptly increases for ratios 3:1, 4:1 and compressive strength increases up to 3:1 and decreases thereafter. The plastic paver blocks were not affected to acid attack up to 2:1. However, the plastic paver block has more beneficial than concrete paver blocks by reducing the plastic disposal problem and is cost efficient.

3. METHODOLOGY

The main objective of the experimental program was to obtain the best replacement level of plastic, M-sand and rubber waste in making of interlocking paver blocks instead of concrete paver blocks without affecting the strength properties such as compression strength, water absorption, and heat resistance. The experimental work is carried out on different ratios of plastic with rubber and M-sand in the paver block to find the effect of these materials on various mechanical properties.

3.1 Materials

Plastic

HDPE is used having density of 0.94-0.96 g/mm^2 and melting point of 120-140˚C.

Fine Aggregates

M-sand having 4.75mm is used as fine aggregates. The test made on fine aggregates are Specific gravity – 2.64% and Water absorption test – 0.32%.

Industrial rubber waste

Prior to the use in the experiment, basic tests were carried out to determine the properties and behavior of the rubber. Tests carried out are Specific gravity test – 0.52 and Bulk Density of rubber – 360.6 kg/m^3.

Fig 1: Industrial rubber waste

Fig 2: Recycled plastic pellets

3.2 Portable Plastic melter

For this study, a simple and small plastic melting machine was designed. As the machines used in recycling industry for melting plastic is way bigger and it cannot be a mobile machine. A small machine compared to industrial machine was designed A cylindrical container, one indicator box is cladded on the top. The cylindrical container of diameter 250-300 mm and height of 300-450mm has an inlet of diameter 30-40mm at the top, through which the plastic material is poured and an outlet at the bottom of the container to which can be controlled by a valve to collect the melted material. The heat inside the container can be regulated by opening the pressure valve, this allows the fume out of the container. An electrical box is placed beside the container which has a power switch, three regulators for the three different coils placed inside the cylindrical container and their temperature can be altered by a temperature indicator. The container has a capacity of holding 10-12 kilograms of plastic in it and the temperature can be varied up to 850-900° C. The equipments works with three phase power supply, which is connected to electrical box and coils.

Fig 3: Portable plastic melter

3.3 Design of Paver Block

Length - 180mm
Breadth – 180mm
Thickness – 60mm

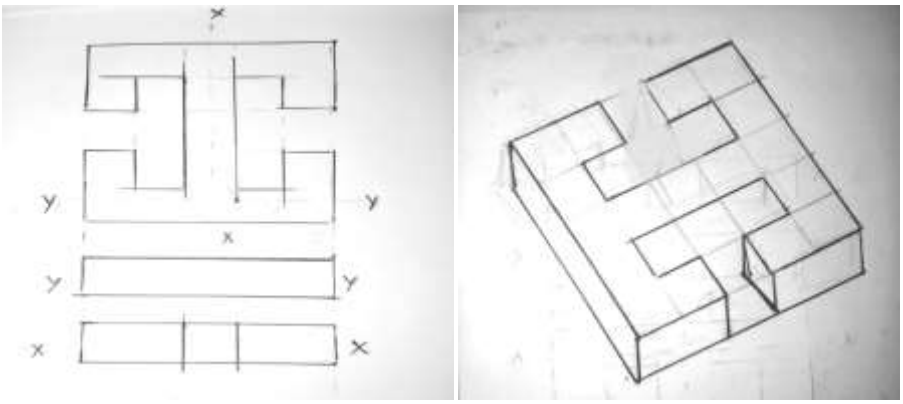

Fig 4: 2D and 3D dimensional view of paver block

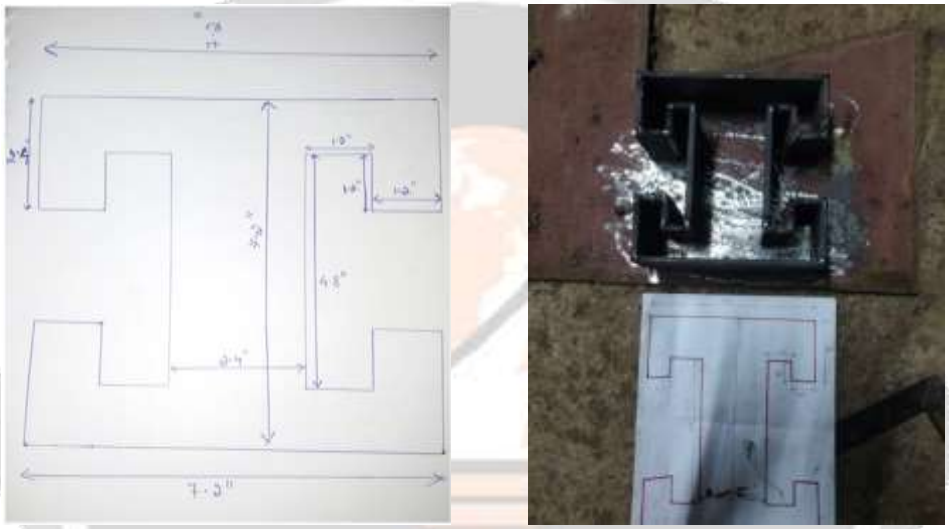

Fig 5: Dimensions and shape of the paver block

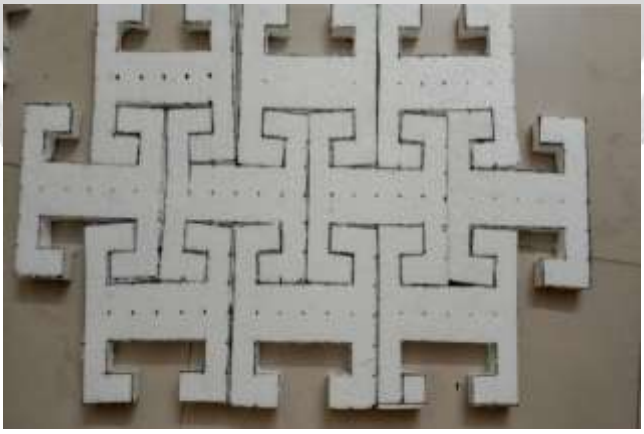

Fig 6: Model of interlocking system

3.4 Working

The plastic pellet of 3-6 kg is poured into the cylinder and the inlet is closed tightly. The electrical box is connected to the power system. After switching on the power temperature is set around 250-400° C, once the coil is heated the plastic inside the container starts melting. It would take around 30-45 minutes to melt 2 kilogram of plastic. In this study we have used plastic pellets that are formed by recycling. The plastic pellets are HDPE type of plastic, these

plastic are the cheapest of all other recycled. The melted plastic slurry is collected into the moulds of required design and allowed to cool for 2 hours. Later it is de-moulded and left for air drying for 24 hours. Series of plastic mixes are prepared and 180x180x60 mm interlocking paver blocks are casted in every mix series. Plastic melter is used to melt the plastic and mixed with the other material. The mix prepared is filled in well prepared moulds by vibrating for some seconds to remove the air voids. The surface is finished off at the top portion of the mould using trowel. The specimens are detached after 24 hours and dried for 7 days.

The combination of plastic and rubber waste was a failure, as plastic and rubber did not form a homogenous mixture.

Fig 7: Uneven mixture of plastic and rubber

3.5 Test on plastic paver block

3.5.1 Compressive strength test

The compressive strength of the cube specimen is determined at 7, 14 and 28 days after drying. The compressive strength test of three plastic specimens from each batch at each selected period is done. The specimens are tested in a compressive testing machine of capacity 3000KN which is upgraded with control unit and touch screen display unit. Both load values and stress values displayed on the screen. The specimen is positioned in the machine so that load is applied on the opposite sides of the block casted. The load is applied at rate of 140kg/cm^3/min until the grater load is sustained by the specimen. The maximum stress value is noted and it gives the compressive strength of the specimen. According to the review of the latest literature on these materials these are the expected values.

Compression Strength (N/mm^2) = Ultimate load in N / Area of cross section in mm^2

Table 1: Compressive strength blocks

Sl No.	Ratio	Compressive Strength
1	1:1	25.42 N/mm^2
2	1:2	29.26 N/mm^2
3	1:3	26.64 N/mm^2

3.5.2 Water absorption test

The water absorption test for the specimen blocks is determined at after the specimen is soaked in water for 24 hours at room temperature. The specimen shall than be weighed, while suspended by a metal wire and completely submerged in water. Then removed from water and drained allowed to dry for 1 min and visible surface water is removed and immediately weighed. According to the review of the literature on these materials these are the expected values.

Table 2: Percentages of water absorption

Sl No.	Ratio	Percentage of water absorption
1	1:1	2.03%
2	1:2	3.50%
3	1:3	3.80%

3.5.3Heat resistance test

The plastic is highly susceptible to fire but in case of plastic sand bricks or paver blocks and here sands acts as insulation. There is no visible change in structural properties of block up to 180° C, above which visible cracks may be seen and blocks deteriorate with increase in temperature.

4. RESULTS

Results from the basic test obtained were accurate and satisfied the design standards. Design of paver blocks and plastic melter were done innovatively and experimental procedure was carried out to determine the behavior of the blocks. Compressive strength of the blocks of 1:2 ratio showed higher strength compared to other mixes. Water absorption increases as the ratio of the sand increases and no such changes were found in heat resistance strength.

5. CONCLUSIONS

The plastic sand blocks posses more advantages such as cost efficiency, recycling of plastic waste, reducing the plastic waste disposal problem. The natural resources consumed in manufacturing of these blocks are less compared to conventional paver block. The cost of paver block is reduced when compared to concrete paver blocks and has good heat resistance. Even though the compressive strength is low when compared to conventional paver blocks it can be used in gardens, pedestrian path and cycle ways etc. It can be used in non traffic and light traffic road. Having numerous advantages further research would improve the quality and durability of plastic sand paver blocks.

6. REFERENCES

[1] Mohan D.M, Vignesh.J et al.“Utilization of plastic bags in pavement” International Journal of Pure and Applied Mathematics, Volume 119 No. 15 2018.
[2] Ambrish N Pandey, Abhishek Yadav et al. “Waste Plastic Used In Paving Block: A Research” International Journal of Scientific Research and Review, Volume 07, Issue 03, March 2019.
[3] J.Sriram , M.Mohamed Bashith et al. “effective use of waste plastic as manufacturing of paver block” International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST), Vol.4, Issue.5, May 2018.
[4] K.Gowtham, P. Jeba Nalwin et al. “Reuse of Plastic Waste in Paver Blocks” International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 02, February-2017.
[5] Pooja Bhatia, Nupoor Dewangan et al.“Paver blocks made of Recycled plastic-bonded sand” Journal of Environmental Engineering and its Scope. Volume-2. Issue-2 2019.

[6] Avinash G B, Roja A P el at. "Utilisation of Waste Plastic in Manufacturing of Paver Blocks" International Journal of Innovative Research in Science, Engineering and Technology, Vol. 8, Issue 6, June 2019.
[7] Anusuri U M, L. Srinuswamy et al. "Experimental study on using plastic waste in manufacturing of paver blocks" International Research Journal of Modernization in Engineering Technology and Science, Volume:02/Issue:08/August-2020.
[8] Mohammad A, Neha P et al. "Utilization of waste plastic in paver blocks" International Research Journal of Engineering and Technology (IRJET) Volume: 07 Issue: 07, July 2020.
[9] Aarti Ghude , Ram Kant et al. "utilization of waste plastic in paver blocks" IJARIIE-ISSN(O), Vol-5 Issue-2 2019.
[10] Rahul Mane, Shivani Rayewar et al. "use of plastic waste as a partial replacement of aggregate in paver blocks" International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 03, Mar 2019.
[11] Present Status of Waste Management in India and Recommendations | CivilDigital |
[12] Waste management crisis in India - RECYCLING magazine
[13] Municipal Solid Waste Management — Vikaspedia
[14] Press Information Bureau
[15] Plastic Recycling
[16] How Can India's Waste Problem See a Systemic Change? | Economic and Political Weekly
[17] https://www.conserve-energy-future.com/recyclingplastic.php
[18] https://www.e-education.psu.edu/eme807/node/624
[19] https://blog.repurpose.global/recycling-facts-from-around-the-world/
[20] https://www.downtoearth.org.in/blog/waste/draft-plastic-waste-management-rules-2021-addressing-the-bigger problem-75939
[21] https://royalsocietypublishing.org/doi/10.1098/rsos.160764
[22]https://www.epw.in/engage/article/institutional-framework-implementing-solid-waste-management-india-macro-analysis
[23] https://swachhindia.ndtv.com/waste-management-india-drowning-garbage-2147/
[24]https://www.statista.com/chart/24881/companies-contributing-the-most-to-single-use-plastic-waste/
[25]https://endplasticwaste.org/en/our-stories/the-plastic-waste-problem-explained
[26] https://www.dw.com/en/plastic-waste-is-a-global-problem/av-44086260
[27]https://www.hindustantimes.com/india-news/putting-plastic-waste-to-use/story-uVW68ddZRv1q4V0eR15HfO.html
[28] https://www.in.undp.org/content/india/en/home/projects/plastic-waste-management.html
[29]http://www.plastivision.org/blog/what-makes-hdpe-one-of-the-most-popular-types-of-plastic/
[30] https://www.sidassafety.it/waste-and-recycling-machinery/
[31] https://www.environmentalpollution.in/waste-management/rubber-industry/waste-from-rubber-industry-and-its-disposal/6938
[32]https://www.nbmcw.com/product-solutions/concrete-chemicals-waterproofing-repairs/concrete-articles/interlocking-concrete-paver-blocks.html
[33] https://cpcb.nic.in/rules-4/
[34] http://www.architecture-student.com/tag/history-of-interlocking-concrete-pavers/
[35] Nivetha, C. Rubiya, M. Shobana, S. Vaijayanathi, G. (2016). Production of Plastic Paver Block from the Solid Waste. ARPN Journal of Engineering and Applied Science. 11(2).
[36] Ganesh Tapkire. Satish Parihar. Pramod Patil. Hemra, R. Kumavat. (2014). Recycled Plastic used in Concrete Paver Block. International Journal of Research in Engineering and Technology, 3(09).
[37] Poonam Sharma. Ramesh kumar Batra. (2016). Cement Concrete Paver Blocks for Rural Roads. International Journal of Current Engineering and Scientific Research, 3(1), 114-121. [38] Joel Santhosh. Ravikant Talluri. (2015). Manufacture of Interlocking Concrete Paving Blocks with Fly Ash and Glass Powder. International Journal of Civil Engineering and Technology, 6(4), 55-64.
[38] P.suresh1,MD.azam el at."Recycling plastic waste into paving blocks" Journal Of Architecture & Technology, Volume 11, 2019.
[39] https://www.bpf.co.uk/sustainability/plastics_recycling.aspx
[40] https://www.conserve-energy-future.com/recyclingplastic.php