An Experimental study on total Replacement of fine aggregate with plastic waste and crusher dust in paver blocks

Dr.S.Thilagavathi[1]
Principal
Sri Bharathi Engineering College for Women
Pudukkottai – 622303, India
padmaraniramesh@gmail.com

R.Padma Rani[2]
Assistant Professor
Department of Civil Engineering
Sri Bharathi Engineering College for Women
Pudukkottai – 622303, India
flora.dennis7@gmail.com

Abstract
Recent urban infrastructure growth in India has led to an increase in the use of paved surfaces around buildings and along roads. Traditional concrete pavers are the most appropriate, affordable, and locally accessible material for this paving surface. As a result of increased industrialization and urbanisation, the Indian concrete industry must now satisfy the need for cost-effective and efficient building materials in order to meet the country's growing infrastructure demands. They are commonly used on sidewalks, garden paths, courtyard pavers, bus stop shelters, parking lots, and work spaces in industry. Increasing infrastructure development is concurrently accompanied by a rise in construction waste production. This project is comprised of three sets of concrete paver blocks cast using an M20 mix design. In the first batch of paver blocks, sand is completely replaced by crusher dust and plastic waste in proportions of 15%, 30%, and 45%; however, coarse aggregate is not utilized. In the second batch of paver blocks, sand is completely replaced by crusher dust and plastic waste in proportions of 15%, 30%, and 45%; however, coarse aggregates are still utilized. 7-day, 14-day, and 28-day tests were conducted on the compressive strength behaviour of paver block specimens. In addition to the compressive strength and water absorption tests, these blocks were also employed for the compressive strength test. Utilizing waste materials helps to address the problems of scarcity, reduction of disposal costs, low prices, and available quantity of construction materials. Safeguard the environment by lowering production costs and resolving the problem of building waste disposal.

Keywords: Paving surface, Paver block, Compressive Strength, waste disposal.

I. INTRODUCTION

For many years, concrete paving blocks have been widely employed in many nations as a problem-solving technology to supply pavement in locations where conventional forms of building are less durable due to several operational and environmental restrictions. Initially implemented in India's building industry several decades ago to meet a specific need (footpaths, parking lots, etc.), the technology is now being widely used in a variety of contexts where the fabrication of pavement utilizing bituminous combination or cementitious technology is neither possible nor desirable.

Large infrastructure demands owing to rising industrialization and urbanisation provide the greatest issue now facing the Indian concrete sector. Because of this, it is essential to utilise high-quality concrete that maximises strength, durability, and other desired concrete attributes while minimising the usage of resources like lime stone, energy, and money.

The aggregates needed to make conventional concrete blocks for sidewalks, highways, and airport runways have been depleted in recent years due to rising global demand. Since local supplies have been depleted by the massive quantities of aggregate previously used, the only option for filling the gap is to import resources from outside. Spoil heaps are an unpleasant reality in most cities, occupying valuable real estate that cannot be developed.

II. LITERATURE STUDY

In this article, researchers Sarang Shashikant Pawar and Shubhankar Anant Bujone present their findings from an experiment with fly ash, plastic drooping strip, and plastic wire. The plastic bags used in the production of paver block concrete may be reduced, and the tensile qualities of the concrete itself can be improved by using recycled plastic. You may save money on paver blocks by mixing in some of this plastic and fly ash. The article reaches the conclusion that plastic may be used to enhance the qualities of concrete, making it a potential plastic reusing technique. Up to 40 percent less plastic might be produced utilising recycled plastic in paving blocks. The boost in power might go as high as 35 percent. Shanmugavalli, Gowtham, Jeba, Nalwin, and Eswara Moorthy explains that the goal of the initiative is to make paver blocks cheaper by using recycled plastic instead of cement. In this study, they combined plastic trash with stone dust, coarse aggregate, and ceramic trash in varying percentages. There may be financial and environmental benefits to using plastic trash in cement production. Tests indicate that polyethylene terephthalate may be recycled into plastic paver blocks by combining it with 50% quarry dust and 25% fly ash.

To make the concrete, we employed three different aggregate replacement rates: 10%, 20%, and 30% by weight. Over 150 degrees heat is used to melt plastic trash in this process. 215mm*115mm*6mm plastic paving blocks.Peak Maximum load at fracture was measured, and crushing strength was then determined. Recycling plastic into paver blocks is an effective method of disposing of unwanted plastic. Compared to concrete paver block, the price of paver block is more reasonable. It is suitable for usage in areas with low traffic volumes or on roads that see minimal foot and vehicle volume. One more seeks to investigate substituting plastic waste for cement in the production of paving blocks.

The focus of this research is on polyethylene terephthalate-based polymers. Waste plastic is transported to a melting facility, where it is combined with other materials, such as fly ash and stone dust (weighted at 25% PET, 25% fly ash, and 40-50% quarry dust, accordingly). Improvements in recycling practises have allowed paver blocks to use waste materials as a primary component, cutting down on environmental pollution while making the most of available materials. Cement manufacturing is a major contributor to climate change because of the carbon dioxide (CO2) emissions. The usage of cement may be reduced, saving the planet. Plastic paver blocks made from 50% dust and 25% fly ash may be recycled from PET. PPB-2, with its 30% PET content, 25% fly ash, and 45% quarry dust, is the most powerful of the tested mixtures. Based on the findings, this research concludes that waste material (Quarry dust, Fly ash, and PET) may be utilised as key constitutions in the production of paver blocks with improved durability. The authors (Nivetha C. and Rubiya M.)

The aggregates were replaced at 10, 20, and 30% of their original weight in the concrete mix. Including post-consumer plastic trash in concrete not only provides a secure means of disposing of this material, but it also has the potential to enhance the concrete's mechanical properties, chemical resistance, drying shrinkage, and creep qualities. Given that the amount of aggregate in concrete is between 60 and 70, it is calculated that using 20% Recycled plastic material in concrete, which does not alter the characteristics of concrete, is feasible. The plastic can replace up to 20% of the coarse aggregate by weight in a concrete mixture. By replacing some of the water in the concrete with plastic, we can cut the weight of each cube by 15 percent. Their research led them to the conclusion that using Recycled plastic aggregate in concrete is the most effective method of disposing of plastic, which in turn helps to lessen environmental degradation caused by trash.

A. Materials Study:

Cement: Paving blocks are made with cement that meets the standards set out by the Indian Standard (IS) as either good mechanical properties ordinary Portland

cement (IS: 8112) or Portland Pozzolana cement (IS: 1489).

Polyvinylchloride: After polyethylene and polypropylene, polyvinyl chloride (abbreviated PVC) is the synthetic plastic polymer that is mass-produced in the third largest quantity worldwide. There are two primary types of PVC, rigid and flexible.

Rigid PVC is used for piping and profiles like those seen in doors and windows. Bottles, non-food packaging, and greeting cards are additional common uses for it. The most common type of plasticizer utilised is a phthalate, which makes the material softer and more flexible. As a rubber substitute, it finds widespread usage in these forms, as well as in the plumbing, electrical wire insulation, imitation leather, signs, phonograph records, and inflatable product industries. Polyvinyl chloride in its purest form looks like a white, crumbly solid. While it doesn't dissolve in booze, tetrahydrofuran is a little more forgiving.

TABLE 1 - PROPERTIES OF LDPE

Si No	Particulars	Value
1	Melting point	150°
2	Thermal coefficient of expansion	100-200X10^{-6}
3	Density	0.910-0.940
4	Tensile strength	0.20-0.40(N/mm^2)

Quarry dust : An often-observed by-product of the mining and quarrying industry is crusher dust. Crusher dust, which contains tiny particles like soft sand, may be used as a filler and filling material around water tanks, and it can be used with natural sands to increase the durability of the concrete and decrease the amount of water needed to set the concrete. Rock is broken down in state-of-the-art crushing machines to generate crushed sand with a particle size smaller than 4.75 millimeters. Quarry fines are a byproduct of stone cutting and processed in a nearby quarry.

TABLE 2-PROPERTIES OF QUARRY DUST

SLNo	Description	Value
1	Specific gravity	2.62
2	Grading zone	Zone II of soil
3	Fineness modulus	2.952
4	Water absorption	1.80

TABLE 3- MIX PROPORTION FOR PAVER BLOCKS

Material	Percentage of Replacement of Fine aggregate used		
PVC powder	15%	30%	45%
Crusher dust	85%	70%	55%

Fig. 1.Images of PVC powder & Quartz sand

III MIXING AND CASTING TECHNIQUES

Mixing concrete is simply defined as the "complete blending of the materials which are required for the production of a homogeneous concrete". The moulds for making concrete paver block specimen were of 130*130*70mm in size, conforming to IS 15658:2006. All the materials were mixed by means of weigh batching in the pan and the concrete was filled in the moulds. The moulds were compacted by using table vibrator in order to avoid air voids in the concrete paver blocks.

Fig. 2. Mixing and Mould for Paver Blocks

A. COMPRESSIVE STRENGTH AND WATER ABSORPTION

The sample should be dried in a 50 °C oven at a low humidity until its bulk is somewhat stable. If the item is too hot to touch, it must be cooled to room temperature before its weight may be taken. For 24 hours at 27 °C rehydrate a thoroughly dry specimen in clean water. Taking the item out of the water, wiping off any remaining moisture with a wet cloth, and then weighing it is the standard procedure.

Fig. 3. Testing of Specimen

TABLE 4- COMPRESSIVE STRENGTH

Pavement block	Compressive strength-Conventional (MPa)	Compressive strength-Without Coarse Aggregate (MPa)			Compressive strength-with coarse aggregate (MPa)		
		15%	30%	45%	15%	30%	45%
7days	33.8	30.96	38.2	45.8	55.73	55.96	56.02
14days	36.4	30.4	35.4	39.2	55.97	57.84	57.91
28days	42.8	34.4	36.24	42.44	56.96	57.88	58.56

Low permeability, especially in regards to freezing and thawing, is a crucial feature of high-quality concrete. Low-permeability concrete is more impervious to water and hence less vulnerable to the damaging effects of temperature swings caused by freezing and thawing. Water can seep through the aggregate and into the cement paste.Drying a specimen to a consistent weight, weighing it, submerging it in water for a certain length of time, and measuring it again are all part of the standard test method for concrete pavers. Weight gain is expressed as a percentage of starting weight (in percent). No sample's average absorption rate may exceed 5%, and no single unit's absorption rate may exceed 7%.

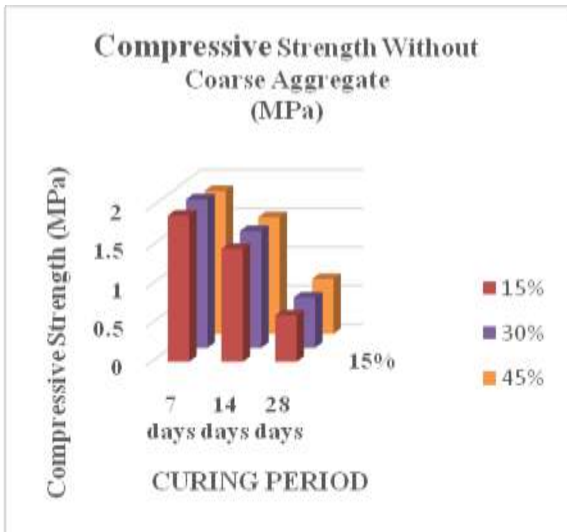

Fig.4.Compressive strength of Paver block without coarse aggregate

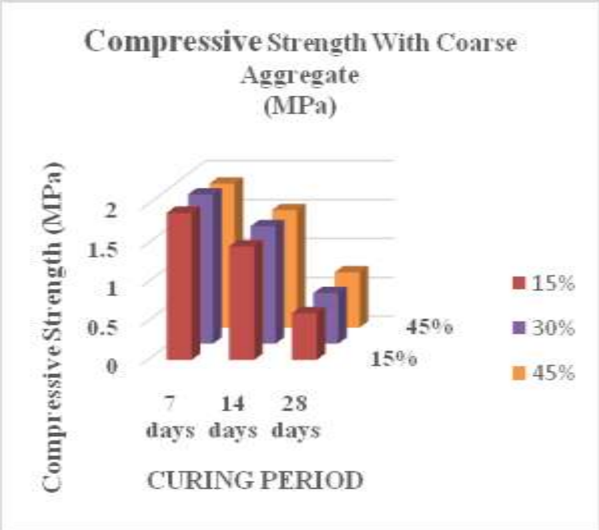

Fig.5.Compressive strength of Paver block with coarse aggregate

TABLE 5- WATER ABSORPTION OF PAVER BLOCKS

Pavement block	Water Absorption-Conventional (%)	Water Absorption-Without Coarse Aggregate (%)			Water Absorption-with coarse aggregate (%)		
		15 %	30 %	45 %	15 %	30 %	45 %
7days	2	1.6	1.27	0.61	1.89	1.46	0.60
14days	0.89	1.33	0.96	0.57	1.92	1.51	0.65
28days	0.40	1.2	0.94	0.53	1.85	1.51	0.71

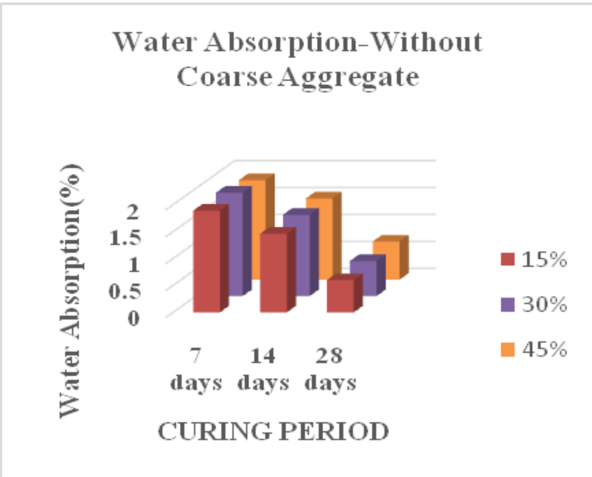

Fig.6.Water Absorption of Paver block without coarse aggregate

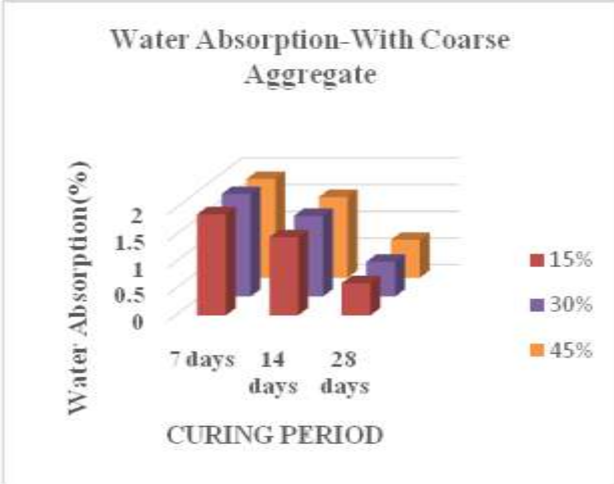

Fig.7.Water Absorption of Paver block with coarse aggregate

IV. CONCLUSION AND RECOMMENDATIONS

- Pavement block without coarse aggregate attains maximum compressive strength of 42.44MPa at 45% replacement of PVC powder and crusher dust at 28 days.
- But the paver block with coarse aggregate attains compressive strength value of 55.73MPa at 15% replacement of PVC powder and crusher dust at 7 days.
- If the replacing content increases the compressive strength with increase in curing period and reach maximum compressive strength 58.56Mpa at 28days with 45% replacement.
- But the water absorption value decreases with increase in addition of PVC powder and crusher dust. Paver block with coarse aggregate gives better water absorption properties than pavement block without coarse aggregate
- The only major limitation is the decrease in workability which can be overcome by the use of flyash or chemical admixtures such as superplasticizers which give high workability at the same water contents.
- To make PVC blocks more accessible and affordable, the use of pozzolanic materials and rubber crump is required.
- Excellent mechanical behaviour is seen after addition of waste materials in PVC blocks. Hence, the development of PVC blocks has to be evaluated using more affordable and readily accessible.

V. References

1. Sarang Shashikant Pawar, Shubhankar Anant Bujone "Use of fly ash and plastic in paver block" International Research Journal of Engineering and Technology, Volume 04, Issue11,Nov2017.

2. B.Shanmugavalli, K.Gowtham, P.JebaNalwin, B. Eswara Moorthy " Reuse of plastic waste in paver blocks" International Journal of Engineering Research and Technology,Volume6,Issue02,February2017.

3. NivethaC, Rubiya.M, Shobana.S, Vaijayanthi.R, G.Viswanathan, R.Vasanthi"Production of plastic paver block from the solid waste" ARPN Journal of Engineering and Applied Sciences, Volume11, Issue2, January2016.

4. GaneshTapkire, Satishparihar, PramodPatil, HemrajRKumavat "Recycled plastic used in concrete paver block" International Journal of Research in Engineering and Technology, Volume03, Issue09, June2014.

5. Poonam Sharma, Manoj Sharma " Utilisation of quarry dust in cement concrete paver blocks for rural roads" International Research Journal of Advanced Engineering and Science,Volume2,Issue1,2017.

6. Vishal kumar, Dr.A.K.Mishra "Utilisation of waste material in concrete paver blocks: A Review" International Journal for Research in Applied Science and Engineering Technology, Volume4, IssueIV, April2016.

7. MustafaM.Al-Tayeb, Hanafi Ismail, Osama Dawoud, SulaimanR.Wafi, Ismail Al Daoor" Ultimate failure resistance of concrete with partial replacements of sand by waste plastic of vehicles under impact load" International Journal of Sustainable Built Environment.

8. J.Thorneycroft, J.Orr, P.Savoikar, R.J.Ball "Performance of structural concrete with recycled plastic waste as a partial replacement for sand" Construction and Building materials.

9. Gireesh Mailar, Sujay Raghavendra, Sreedhara B.M, Manu D.S, Parameshwar Hiremath, Jayakesh.K "Investigation of concrete produced using recycled aluminium dross for hot weather oncreting conditions".

10. Ashwini MajunathB.T "Partial replacement of Eplastic as coarse aggregate in concrete" International conference on Solid waste management.

11. Dinesh.S, Dinesh.A, Kirubakaran.K "Utilisation of waste plastic in manufacturing of Brick sand paver blocks" International Journal of Applied Engineering Research, Volume 11, Issue3, 2016.

12. IS.383.1970, IndianStandard–Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

- IS.1237.2012, Indian Standard Cement Concrete Flooring Tiles Specification.
- IS.9103.1999, Indian Standard Concrete Admixtures-Specification.
- IS.10262.2009,Indian Standard Concrete Mix Proportioning- Guidelines.
- IS.12269.1987, Indian Standard Ordinary Portland Cement, 53Grade-Specification.
- IS.15658.2006, Indian Standard Precast Concrete Blocks For Paving-Specifications.