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Comparison and Utilization of Plastic Waste for Manufacturing of Laterite Soil Paving Blocks

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Abstract: Most of the developing nation lack a proper solid waste management system owing to the difficulties faced during the sample collection and treatment phases. Improper disposal of waste in the form of landfilling can not only cause environmental impact but also negatively harm the surrounding soil and water bodies. We have to create alternative method to minimize the effect of plastic on our environment. This project is based on concept the idea to make the utilization of plastic in paving blocks. So, we have proposed a project to utilize the plastic in cement and laterite soil to make laterite soil paving blocks by using plastic. Compare these blocks with cement paving blocks and laterite soil paving blocks in compressive strength and water absorption of blocks.

Keywords*:* Laterite Soil, Compressive Strength, Water Absorption.

I. INTRODUCTION

Paver block paving is versatile, aesthetically attractive, functional, and cost effective and requires little or no maintenance if correctly manufactured and laid. Most concrete block paving constructed in India also has performed satisfactorily but two main areas of concern are occasional failure due to excessive surface wear, and variability in the strength of block. Natural resources are depleting worldwide at the same time the generated wastes from the industry and residential area are increasing substantially. The sustainable development for construction involves the use of non-conventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment.

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 sand provides potential environmental as well as economic benefits. With the view to investigate the behaviour of quarry rock dust, recycled plastic, production of plastic paver block from the solid waste a critical review of literature was taken up.

Generally, the level of plastics in waste composition is high. The largest component of the plastic waste is polyethylene, followed by polypropylene, polyethylene Terephthalate and polystyrene. Considerable researches and studies were carried out in some countries like USA and UK on this topic. However, there have been very limited studies in India on plastics in concrete. Hence an attempt on the utilization of waste Polypropylene Plastic (PP) as partial replacement of coarse aggregate is done and its mechanical behaviour is investigated. The purpose of this project is to evaluate the possibility of using plastic waste materials to partially substitute for the fine aggregate composites.

II. OBJECTIVES

1. To prepare light weight Laterite Soil Paving Blocks.
2. To determine Compressive Strength of Laterite Soil Paving Blocks.
3. To conduct Water Absorption Test of Laterite Soil Paving Blocks.
4. To study cost comparison between Laterite Soil Paving Blocks, Cement Paving Blocks and Laterite Soil Paving Blocks by Using Plastic.

III. EXPERIMENTAL WORK

Properties of used materials

1. Cement

OPC 53 Grade cement is required to conform to BIS specification IS:12269-1987 with a designed strength for 28 days being a minimum of 53 MPa or 530 kg/sq cm. 53 Grade OPC provides high strength and durability to structures because of its optimum

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particle size distribution and superior crystallized structure. Being a high strength cement, it provides numerous advantages wherever concrete for special high strength application is required, such as in the construction of skyscrapers, bridges, flyovers, chimneys, runways, concrete roads and other heavy load bearing structures. Further, by substituting lower grade cement with OPC 53, overall savings can be obtained through reduced quantity of cement that would be required to be used. A savings of 8-10% can be achieved with the use of 53 Grade OPC in place of any other grade.

Table 1: Properties of Cement

Property	Result
Fineness	4%
Normal consistency	30%
Initial setting time Final setting time	35 min 600min

2. Coarse Aggregate (10mm)

10mm Recycled Aggregate is comprised of deposits of mainly, block, rock, tiles and demolition concrete, that are crushed and screened to a nominal size of 10mm. It is known as a minimal fines product as the screening process separates most of the fine residue from the aggregate.10mm recycled aggregate is known to be versatile and easy to shovel, therefore it is a popular size of aggregate for backfilling trenches, around PVC and Ag-Pipe, for drainage behind retaining walls and even as a base for pouring concrete. As it is a recycled product, we do not recommend using 10mm Recycled aggregate for pathways and driveways etc.

Table 2: Properties of Coarse Aggregate (10mm)

Property	Result
Fineness Modulus	2.9%
Specific Gravity	2.61
Water Absorption Test	1.57%
Impact Value	14.91

3. Fine Aggregate (M Sand)

Manufactured sand or manufactured fine aggregate (MFA) is produced by reducing larger pieces of aggregate into sand-sized aggregate particles. Manufactured sands tend to be used in mixtures in areas where natural sand is not available or not cost effective to be hauled to the needed location. MFA tends to be more angular and flakier due to the crushing process. Highly angular particles tend to increase the paste content of concrete because additional lubrication is required for particles with sharp corners. Manufactured sand or M-sand is a substitute of river sand, used in construction industry mainly for concrete production and mortar mix. This is mainly crushed fine aggregate produced from a source material with suitable strength, durability and shape characteristic.

Table 3: Properties of Fine Aggregate

Property	Result
Fineness Modulus	2.75%
Specific Gravity	2.66
Water Absorption Test	4.28%

4. Laterite Soil

Laterite are shaped from the draining of parental sedimentary rocks (sandstones, dirts, limestone's); transformative rocks (schist's, gneisses, migmatites); molten rocks (stones, basalts). Laterites are soil types wealthy in iron and aluminium, framed in hot and wet tropical zones. The tropical areas incorporate the states like Tamil Nadu (Nilgiris), Kerala, Karnataka, Uttaranchal, Uttarakhand, Himachal Pradesh and different rugged spots. The gathered example is cleaned from squanders and folded into powder. This laterite soil is ruddy dark coloured shading and wealthy in iron and alumina content.

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Table 4: Properties of Laterite Soil

Property	Result
Water Content	2.75%
Specific Gravity	2.66
Unit Weight g/cc	4.28%
Shrinkage Limit	13.48%
Liquid Limit	38.50%
Optimum Moisture Content	21.40%

5. Plastic

Plastic ae typically organic polymers of high molecular mass and often contain other substances. They are usually synthetic, most commonly derived from petrochemical, however an array of variants is made from renewable materials such as polylactic acid from corn or cellulosic from cotton linters.
Type of Plastic used

i. PP (Polypropylene)

These plastics are easily available in the market. This plastic is strong and can usually resist higher temperatures. These are widely used for products like plastic chairs, cement bags, carets etc. It also works well with recycling.

Table 5: Properties of Plastic

Property	Result
Melting Point	150°C
Thermal Coefficient of Expansion	100-200 x 10-6
Density	940 kg/m^3

Casting of Blocks

A) Cement Paving Blocks

The standard proportion to make the Cement Paving Blocks is 1:1.5:3, which means 1 part of cement, 1.5 part of sand and 3 parts of aggregate. As per the proportion for total 10 nos. of blocks 8.12 kg of cement, 13.53 kg of sand and 30.44 kg of aggregate is required. This proportion of all material is mixed well with 3.65 lit of water in pan. After mortar is ready it transfers to steel mould of size 200mm x 100mm x 100mm to apply vibrations and force to create the desired shape. Then demold blocks.

Fig 1. Cement Paving Blocks

B) Laterite Soil Paving Block

The standard proportion to make the Laterite Soil Paving Blocks is 1:1.5:4, which means 1 part of cement, 1.5 part of sand and 3 parts of Laterite Soil. As per the proportion for total 10 nos. of blocks 8.12 kg of cement, 13.53 kg of sand and 31.74 kg of aggregate is required. This proportion of all material is mixed well with 3.65 lit of water in pan. After mortar is ready it transfers to steel mould of size 200mm x 100mm x 100mm to apply vibrations and force to create the desired shape. Then demold blocks.

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Fig 2. Laterite Soil Paving Blocks

C) Laterite Soil Paving Block by Using Plastic

The resulting combination was relocation into a steel mold of size 200mm x 100mm x 100mm. The mixture was compacted by the tapping hammer. It was filled again to the brim, compacted manually and the mold removed. The process was repeated for the same mix proportion. The mix proportion of plastic: cement: laterite soil ratio was varied as per percentage. Cement is used as a binding material.

1) For 50% plastic used standard proportion to make Laterite Soil Paving Blocks by using Plastic is 1: 2: 3 which means 1 parts of cement, 2 parts of laterite soil and 3 parts of crushed plastic. As per proportion for total 10 nos. of blocks 3.45 kg of cement, 6.74 kg laterite soil and 10.19 kg crushed plastic are required. This proportion of all material is mixed well with 2.56 lit of water in concrete mixer. After mortar is ready it transfers to steel mold to apply vibrations and force by tapping rod to create the desired shape. Then demold blocks.

2) For 35% plastic used standard proportion to make Laterite Soil Paving Blocks by using Plastic is 1: 1.2: 2 which means 1 parts of cement, 1.2 parts of crushed plastic and 2 parts of laterite soil. As per proportion for total 10 nos. of blocks 5.12 kg of cement, 6.21 kg crushed plastic and 9.15 kg laterite soil are required. This proportion of all material is mixed well with 3.64 lit of water in concrete mixer. After mortar is ready it transfers to steel mold to apply vibrations and force by tapping rod to create the desired shape. Then demold blocks.

3) For 20% plastic used standard proportion to make Laterite Soil Paving Blocks by using Plastic is 1: 1.5: 3 which means 1 parts of crushed plastic, 1.5 parts of cement and 3 parts of laterite soil. As per proportion for total 10 nos. of blocks 4.08 kg of crushed plastic, 6.17 kg cement and 10.13 kg of laterite soil are required. This proportion of all material is mixed well with 4.34 lit of water in concrete mixer. After mortar is ready it transfers to steel mold to apply vibrations and force by tapping rod to create the desired shape. Then demold blocks.

Fig 3. Laterite Soil Paving Blocks by Using Plastic

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Tests on Blocks

i. Compressive Strength Test:

The block specimen was placed in compression testing machine and the load is to be applied without shock and increased continuously at a rate of approximately 140kg/cm^2 min until the resistance of the specimen to the increasing load breaks down and no greater load can be restrained. The maximum load applied to the specimen is to b recorded and the appearance of the blocks and any unusual features in the type of failure is noted.

Compressive Strength = Maximum Load
Area of the Specimen = P/A
Where, P - Maximum Load (kN)
A – Area of the specimen (mm^2)

Fig 4: Compressive Strength Test

ii. Water Absorption Test

In this test, Blocks are weighted 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, blocks is weighed n wet condition. The difference between weight is the water absorbed by block. The percentage of water absorption is then calculated. The less water absorbed by block the greater its quality, good quality blocks doesn't absorb more than 20% water of its own weight.

Water Absorption = $\frac{W2-W1}{W1}$x 100

Where, W1 - Weight of dry block (kg)

W2 - Weight of dry block (kg)

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Fig 5: Water Absorption Test

IV. RESULT AND DISCUSSION

After removing the blocks from mold, curing is done as per standard procedure. Tests were conducted on specimens for i) Compressive strength ii) Water Absorption Test. The compressive strength was achievable on 7days of curing, was 6.0 N/mm^2 in case of Cement paving block, 14.68 N/mm^2 in case of Laterite soil paving block, 9.76 N/mm^2 in case of Laterite soil paving block by using 50% plastic, 10.13 N/mm^2 in case of Laterite soil paving block by using 35% plastic and 12.8 N/mm^2 in case of Laterite soil paving block by using 20% plastic. The compressive strength was achievable on 28 days of curing, was 12.48 N/mm^2 in case of Cement paving block, 20.11 N/mm^2 in case of Laterite soil paving block, 16.34 N/mm^2 in case of Laterite soil paving block by using 50% plastic, 18.56 N/mm^2 in case of Laterite soil paving block by using 35% plastic and 19.8 N/mm^2 in case of Laterite soil paving block by using 20% plastic. The corresponding Water Absorption rate in Cement paving block was 8.10%, Laterite soil paving block was 14.95%, Laterite soil paving block by using 50% plastic was 4.75%. Laterite soil paving block by using 35% plastic was 9.37%, Laterite soil paving block by using 20% plastic was 12%.

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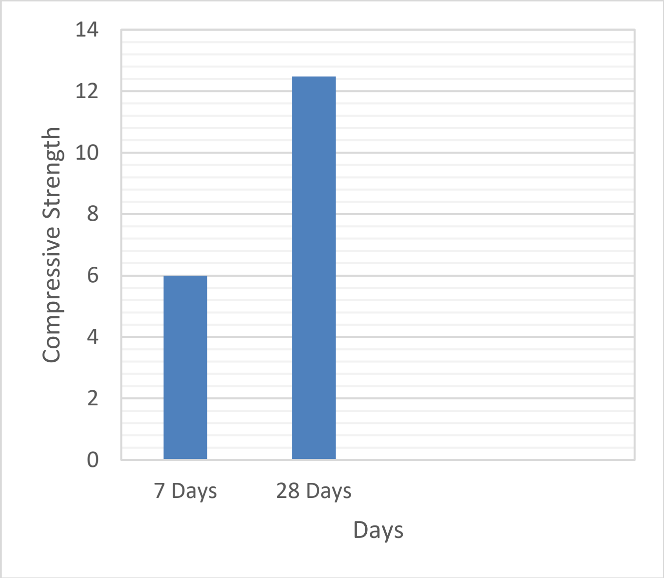

Fig 6: Compressive Strength of Cement Paving Blocks

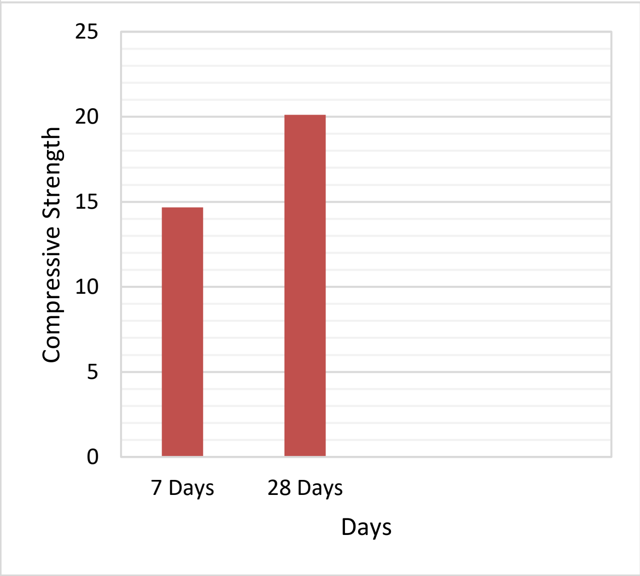

Fig 7: Compressive Strength of Laterite Soil Paving Blocks

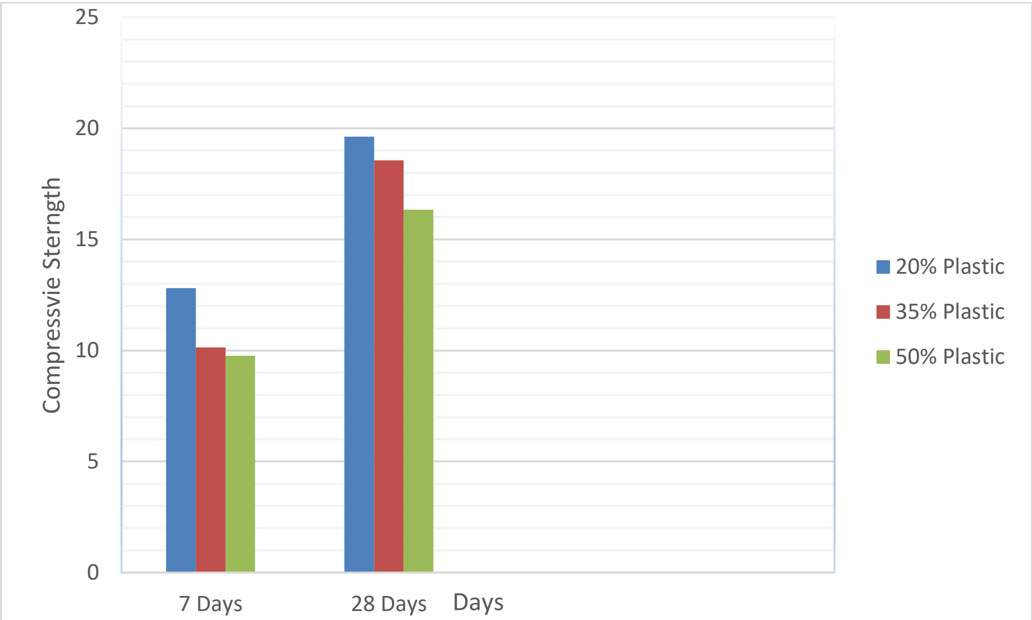

Fig 8: Compressive Strength of Laterite Soil Paving Blocks by Using Plastic

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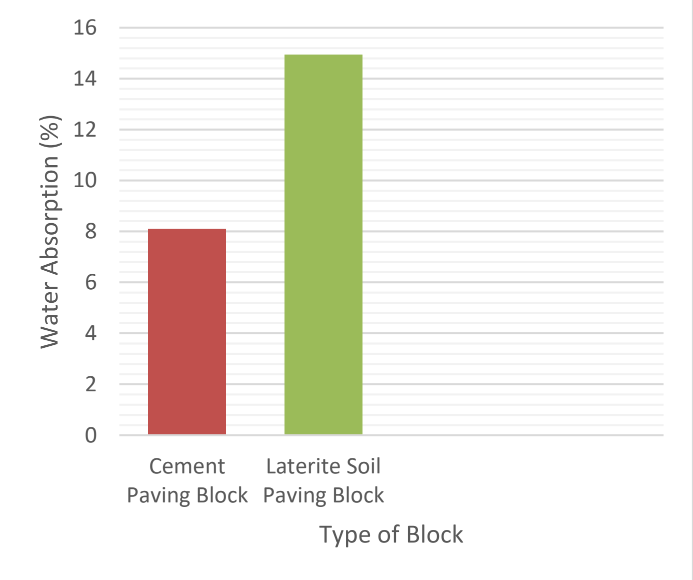

Fig 9: Water Absorption Cement Paving Block and Laterite Soil Paving Block

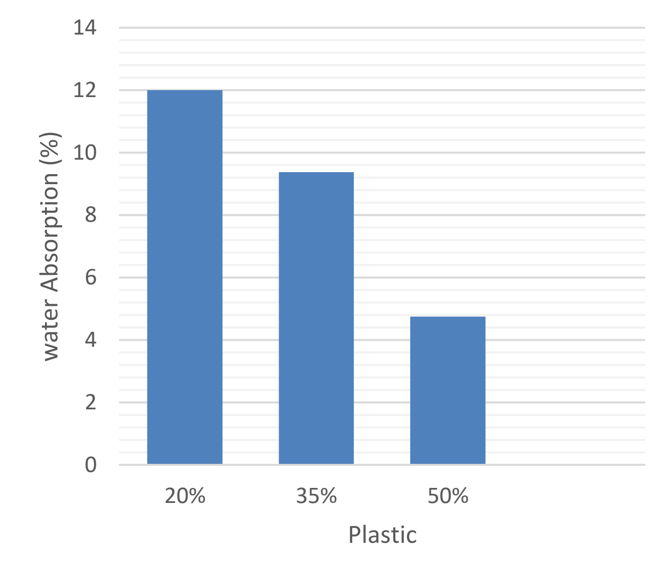

Fig 10: Water Absorption of Laterite Soil Paving Blocks by Using Plastic

V. CONCLUSION

- The utilization of waste plastic in production of paver blocks has productive way of disposal of plastic waste.
- The cost of paver blocks is reduced when compared to that of cement paving blocks and laterite oil paving block.
- Paver blocks made using 50% plastic waste, cement and laterite soil shown better result.
- Laterite soil paving blocks by using 50% plastic also light weight blocks as compare to other types of blocks.
- Though the compressive strength is low when compared to cement paving bock and laterite soil 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.
- Lesser water absorption than other paving blocks.
- Compressive strength of laterite soil paving block is very high than cement paving blocks.

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