EXPERIMENTAL ANALYSIS OF COMPOSITE PAVER BLOCKS UTILIZING PLASTIC MATERIAL

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A B S T R A C T

Paver blocks/bricks are one of the most important structural equipment in the field of civil engineering. The durability and aesthetic aspects of paver blocks made them as an excellent material choice for construction of driveways, walkways, retaining walls, patios and other flat outdoor spaces. Block Pavement has been extensively used in a number of countries as a specialized problem-solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. Composites are exclusive and versatile area in field of construction as it offers better properties compared to pure materials. Hence in the present work composite paver blocks are made out of plastic and sand materials. Paver block composites have been performed experimentally. Formed of composite plastic materials and sand particles in various ratios. Structural tests are performed such as compression test as well as water absorption test. Five specimens are used they are M1, M2, M3, M4 and M5 with the ratio of 1:2, 1:3, 1:4, 1:5 and 1:6. Best result has been obtained from M3 with the ratio of 1:4.
Keywords: Paver block, Plastic, Sand, Compression test, Water absorption test

1. INTRODUCTION

Interlocking Concrete Block Pavement (ICBP) has been extensively used in many countries for quite some time as a specialized problem-solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. ICBP technology has been introduced in India in construction, a decade ago, for specific requirement namely footpaths, parking areas etc. but now being adopted extensively in different uses where the conventional construction of pavement using bituminous mix or cement concrete technology is not feasible or desirable.

Concrete paver blocks were first introduced in Holland in the fifties as replacement of paver bricks which had become scarce due to the post-war building construction boom. These blocks were rectangular in shape and had more or less the same size as the bricks. During the past five decades, the block shape has steadily evolved from non-interlocking to partially interlocking to fully interlocking to multiply interlocking shapes. Consequently, the pavements in which non-interlocking blocks are used are designated as Concrete Block Pavement (CBP) or non-interlocking CBP, and those in which partially, fully or multiply interlocking blocks are used are designated as 'Interlocking Concrete Block Pavement (ICBP).

CBP/ICBP consists of a surface layer of small-element, solid un-reinforced pre-cast concrete paver blocks laid on a thin, compacted bedding material which is constructed over a properly profiled base course and is bounded by edge restraints/kerb stones. The block joints are filled using suitable fine material. A properly designed and constructed CBP/ICBP gives excellent performance when applied at locations where conventional systems have lower service life due to a number of geological, traffic, environmental and operational constraints. Many number of such applications for light, medium, heavy and very heavy traffic conditions are currently in practice around the world.

2. LITERATURE SURVEY

(Kanawade, 2018) Concrete paving blocks are ideal materials on the footpaths for easy laying, better look and finish. It was found that rapid deterioration occurred on new pavers and the blocks became unserviceable within three years. This was a matter of grave concern and there was a need to identify the problem. The aim of this paper is to determine the properties of those blocks that deteriorated rapidly in contrast with those that had provided long-term satisfactory service, to identify test methods and specifications that will ensure that blocks are durable.

(Velumani and Senthilkumar, 2018) Waste management plays a vital role in the reuse of industry wastes in to useful conversions. The treatment of effluents from the combined textile effluent treatment plant and hypo sludge from the paper industry results in sludge generation, which poses a huge challenge for its disposal. Therefore, an eco-friendly attempt is made to utilize them in the production of paver blocks. Paver blocks are construction units that have vast applications in street roads, walking paths, fuel stations, and so on. In this study, an innovative attempt has been made to manufacture paver blocks incorporating textile effluent treatment plant sludge and hypo sludge, to utilize them in suitable proportions. The effect of adding silica fume and polypropylene fibre in paver blocks has also been studied. Paver blocks containing sludge with different proportions were cast based on the recommendations in Indian Standards (IS) 15658, and the test results were compared with the nominal M20 grade and M30 grade paver blocks. The outcomes of the paver block combinations were studied and found to be an effective utilization of sludge with substantial cement replacement of up to 35%, resulting in effective waste management for specific industries. Implications: Presently, paver blocks are construction units that have vast application in street roads and other constructions like walking paths, fuel stations, and so on. Also, paver blocks possess easy maintenance during breakages. Based on this application, an innovative attempt has been made to manufacture paver blocks incorporating textile effluent treatment plant sludge and hypo sludge to utilize them in suitable proportions.

(Pawar and Bujone, 2017) Use of concrete paver block is now a day becoming popular, they are used for paving of approaches, paths and parking area and also the pre-engineering building and pavements. This paper discusses the result of an experimental study conducted on fly ash, plastic sag strip and wire plastic. The concrete for paver block which is made up by adding plastic in concrete help to reduce plastic bag and also improve the tensile properties of the paver block. Using this type of the plastic and fly ash will reduce the cost of the paver block.

(Kirubagharan *et al.*, 2017)The durability and aesthetic aspects of concrete paver blocks made them as an excellent material choice for construction of driveways, walkways, retaining walls, patios and other flat outdoor spaces. Interlocking Concrete Block Pavement (ICBP) has been extensively used in a number of countries as a specialized problem-solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. But now being adopted extensively in different uses where the conventional construction of pavement using hot bituminous mix or cement concrete technology is not feasible or desirable. Waste tires in India are categorized as solid waste or hazardous waste. It is estimated that about 60% of waste tires are disposed through unknown routes in the urban as well as rural areas. The hazards of waste tyres include air pollution associated with open burning of tires cause odor, visual impacts, and other harmful contaminants which is the major reason for green-house effect and the consequent hazards. By considering the advantages of rubber pads, in this project the rubber powder is used as a cement replacing material in Concrete paver blocks in order to increase the strength of paver and to reduce the emitted carbon di oxide percentage while casting cement concrete paver. The optimum percentage of the rubber pad is finalized from the results of the experimental work and preferred for the pavement works. By replacing 20% of rubber powder for cement is used to obtain the compressive strength of 51Mpa and impact strength of 15 blows. Therefore by replacing the cement by rubber powder is increase the compressive and impact strength of paver block upto 50%.

(Sellakutty, 2016) Plastic waste which is increasing day by day becomes eyesore and in turn pollutes the environment, especially in high mountain villages where no garbage collection system exists. A large amount of plastic is being brought into the tourist trekking regions are discarded or burned which leads to the contamination of environment and air. Hence, these waste plastics are to be effectively utilized. High-density polyethylene (HDPE) and polyethylene (PE) bags are cleaned and added with sand and aggregate at various percentages to obtain high strength bricks that possess thermal and sound insulation properties to control pollution and to reduce the overall cost of construction; this is one of the best ways to avoid the accumulation of plastic waste which is an on-degradable pollutant. This alternatively saves the quanta of sand/clay that has to be taken away from the precious river beds/mines. The plastic waste is naturally available in surplus quantity and hence the cost factor comes down. Also Coloring agents can be added to the mixture to attain desired shades. Hence in this thesis, an attempt is made to study regard the properties of the brick which is manufactured using plastic wastes.

(Nataraja and Das, 2012) Interlocking Concrete Block Pavement (ICBP) technology has been introduced in India in construction, a decade ago, for specific requirement namely footpaths and parking areas etc. Now ICBP is being adopted extensively in different uses where the conventional construction of pavement using hot bituminous mix or cement concrete technology is not feasible or desirable. In this investigation, various properties such as compressive strength, split tensile strength, bending strength and water absorption of paver blocks consisting of crushed granite, unconventional materials such as kadapa and broken paver for various percentage replacements of coarse aggregate are studied as per IS 15658:2006.

3. METHODOLOGY

3.1 MATERIALS

Plastic Sand Composite –

Sample 1 – plastic and sand are mixed in 1:2 ratios respectively.
Sample 2 – plastic and sand are mixed in 1:3 ratios respectively.
Sample 3 – plastic and sand are mixed in 1:4 ratios respectively.
Sample 4 – plastic and sand are mixed in 1:5 ratios respectively.
Sample 5 – plastic and sand are mixed in 1:6 ratios respectively.

3.2Fine Aggregates

The sand used for the experimental programme was locally procured. The sand was first sieved to remove bigger particles and then washed to remove the dust. Properties of the fine aggregate used in the experimental work are tabulated in Table 1.1. The aggregates were sieved through a set of sieves.

Table 1: Properties of fine aggregate

S. No.	Characteristics	Value
1	Type	Uncrushed(Natural)
2	Specific Gravity	2.68
3	Total Water Absorption	1.02%
4	Grading Zone	III

3.3 Compression Test

The compression test is to determine the behavior or response of a material while it experiences a compressive load by measuring fundamental variables, such as, strain, stress, and deformation. By testing a material in compression the compressive strength, yield strength, ultimate strength, elastic limit, and the elastic modulus among other parameters may all be determined. With the understanding of these different parameters and the values associated with a specific material it may be determined whether or not the material is suited for specific applications or if it will fail under the specified stresses.

3.4Procedure

Compressive strength depends on many factors such as water-cement ratio, cement strength, quality of material, and quality control during production of specimen etc. Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommend cylinder or cube as the standard specimen for the test. American Society for Testing Materials ASTM C39/C39M provides

Standard Test Method for Compressive Strength.

3.5 Calculations of Compressive Strength

Compressive strength formula for any material is the load applied at the point of failure to the cross-section area of the face on which load was applied.

Compressive Strength = Load / Cross-sectional Area

Expected maximum load =f_ck x area x f.s

3.6 Apparatus for Compression test

The compressive strength of paver was carried out as per IS516- 1959. Specimens of 60mmmould were cast with blended plastic and sand composite material.

3.7Water absorption

Pore size ranges from a few angstroms to about 100 Åfor the so called 'gel pores', from 100 to 100000 Åin 'capillary pores' and a few millimeter in 'air or large pores'. In the present investigation, percentage of water absorption, percentage of permeable voids and percentage of total voids have been determined as per ASTM C 642-06.

To determine the percentage of total voids the apparent specific gravity of the specimen has to be determined. From the above data percentage of water absorption, percentage of permeable voids, percentage of total voids, and co-efficient of water absorption were determined based on Equations

- Percentage of Water absorption

$$\%\text{ of water absorption} = \frac{B - A}{A} \times 100$$

Where,
A = weight of oven dried sample in air.
B = weight of surface dry sample in air after immersion in water.

3.8Plastic Sand Composite Paver Block

In this work, a composite of plastic (LDPE & HDPE) is made with addition of sand for stabilization. This preparation of the composite is done through the method of heating the elements in single container mixed with the two materials until it melts. After this, this sludgy mixture is put into a block mould used for making pavers of about 60mm in dimensions. This mixture is incorporated by addition of sand particles for stabilization and given shape of a cuboid. Further the final mixture is left for cooling. After freezing, the specimen becomes prepared for the further testing. These types of method are quite simple and very basic to carry out without any much error.

Figure 1: Composite preparation

Figure 2: Final mould of brick composite paver

3.9 Compressive Test

Compressive strength testing is a common performance measure for specimens under compression load; it provides immediate information of the bulk strength of the specimen begun tested. It is also an essential step for gaining critical insight into the potential qualitative relationship between the desirable characteristics of specimen and its strength. It is measured by breaking cuboidal composite of plastic and sand specimen of different ratios in a compression test machine to determine the maximum pressure load the specimen can withstand.

Figure 3: Compression testing apparatus

3.10 Water Absorption test

Steps followed in water absorption test are quite simple and easily understandable. The test is performed on the cuboidal specimen of the composite formed between plastic and sand.

Figure 4: Weight of water for absorption test

Figure 5: Weight of brick after immersion in water

4. RESULTS AND DISCUSSIONS

4.1 Compression strength test

From the above given procedure, following results are obtained. These results are listed below in the table 5.1. Compressive strengths of different samples were obtained of definite ratios of plastic and sand. Among these 5 samples, M3 shows the best result with configuration of 1:4 ratios of plastic and sand. It gives the highest value of compressive strength, i.e., 5.12 N/mm^2. Other samples with different ratio of plastic and sand shows value less than the M3.

Table 2: of Compression Strength

Mix Design	**Plastic Sand Ratio**	**Compressive strength (N/mm^2)**
M1	1:2	4.65
M2	1:3	4.78
M3	1:4	5.12
M4	1:5	4.92
M5	1:6	3.17

A comparison graph between different values of 5 different samples is shown in figure 5.1.

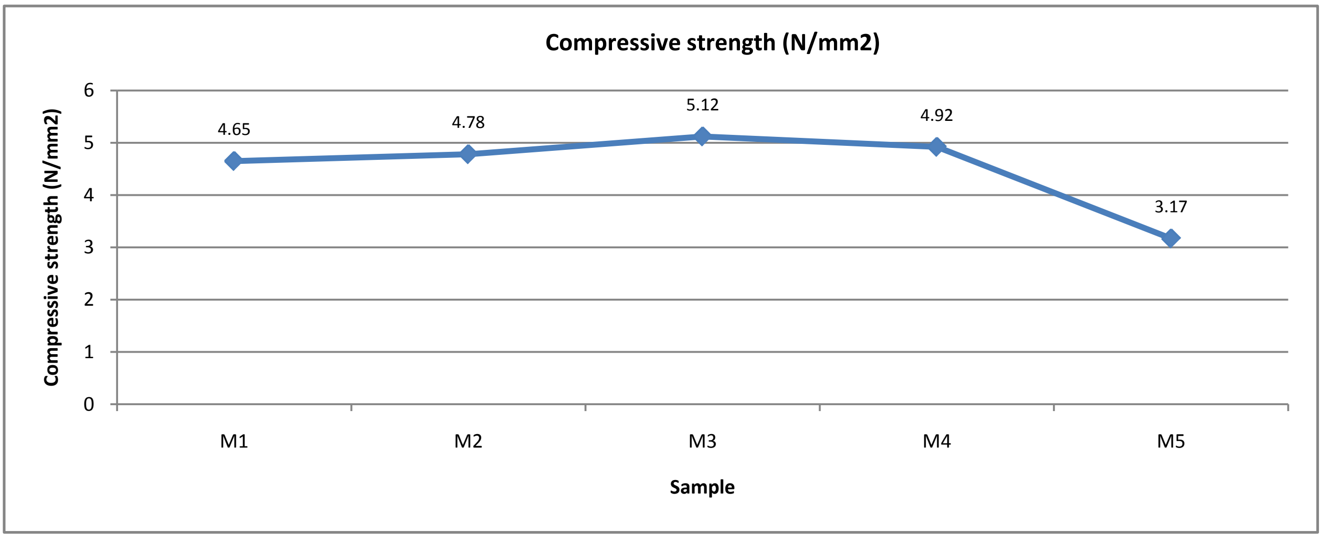

Figure 6: Comparison of compressive strength of different samples

4.2 Water Absorption Test –

With the mentioned procedure, water absorption test is conducted and following results have been obtained. These results are obtained on different samples of plastic sand composite paver block. Below table 5.2, shows that M3 is among the best in terms of water absorption. Values show the minimum percentage of value of water is absorbed by M3, i.e., 1.082.

Table 3: Result of Water Absorption System

S. No.	Mix Design of Paver Blocks	Water Absorption (%)
1	M1	1.178
2	M2	1.104
3	M3	1.082
4	M4	1.156
5	M5	1.212

A comparison graph between different values of 5 different samples is shown in figure 5.2.

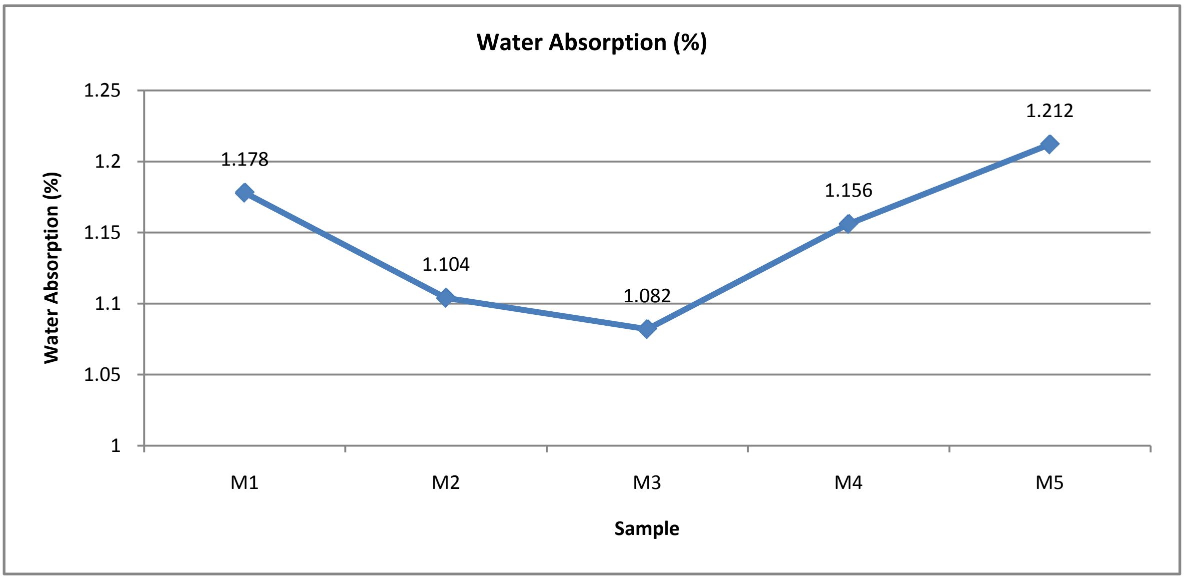

Figure 7: Comparison of Water Absorption values from test

5. CONCLUSIONS

The current research is carried out experimentally in making a composite paver brick from plastic and sand in varying ratios. Different tests such as water absorption test and compressive strength are calibrated from several specimens made. The following are the conclusions:

- The mixture ratio of 1:4 (M3) showed better and maximum value in compression strength of about 5.12 MPa and the lowest value obtained is on ratio 3.17 MPa (M5).
- The mixture ratio of 1:4 (M3) showed better and minimum value in water absorption of about 1.082 percent and the highest value obtained is on ratio 1.212 percent (M5).

Hence it can be seen that, when the compression strength is increasing the value for water absorption decreases, which shows positive sign in the ratio composition as M3 with composition of one part of sand with four parts of plastic improves the compressive strength and subsequently lowers down the water absorption due to presence of plastic material in the composition.

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