EXPERIMENTAL STUDY ON PLASTIC MODIFIED PAVER BLOCK

Project Report submitted by

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CERTIFICATE

This is to certify that the project report on ***"Experimental study on plastic modified paver block"*** is a bonafide record of the project presented by ***Sudeep Surendran (Reg. No.: MBI15CE079)*** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Civil Engineering of APJ Abdul Kalam Technological University**, Thiruvananthapuram during the academic year 2019.

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CHAPTER 1
INTRODUCTION

1.1 GENERAL BACKGROUND

The composition of waste is different in different areas based on the socioeconomic characters, waste management programs and consumption patterns but the amount of plastic in the overall waste composition is high. The major constituents of plastic waste are polyethylene and polypropylene. There are several methods available to recycle and reuse the waste effectively. Since plastic has long service life, they can be recycled effectively. The biggest problem with plastic bags is that they don't readily breakdown in the environment. It takes 20 – 1000 years based on their composition. The average plastic waste produced in India per year is 15432 tonne among which 6000 tonne remains uncollected. In India the plastic waste are majorly disposed by burning and only less amount of plastic waste is recycled. In order to reduce the amount of plastic waste, we introduce a new idea that is plastic paver block of two different categories. They are plastic with M-sand and plastic with coarse aggregate. Molten state of plastic is used to mix with aggregates. The large volume of materials required for construction is potentially a major area for the reuse of waste materials. Recycling the plastics has advantages since it is widely used and has a long service life, which means that the waste is being removed from the waste stream for a long period. Because the amount of clay required to make bricks is large, the environmental benefits are not only related to the safe disposal of bulk waste, but also to the reduction of environmental impacts that arise due to burning of plastics. This project aims in conducting experimental study on paver blocks to know the features and properties.

1.2 ADVANTAGES

The generation of plastic waste is the main issue that faced by the whole world. The accumulation of plastics on the surface of earth adversely affects the wildlife, wildlife habitat and humans. By the usage of plastic paver block, this wastage can be reduced. This will allow recycling of waste plastic in a new way which needs less energy intensive than recycling into another form. The plastic paver blocks are more economic due to the usage of plastic waste as a main ingredient and avoid the usage of cement, any one aggregate, and water. Plastics are light in weight, so that the plastic M-sand paver blocks are also light in weight. Plastic paver blocks have high insulating property due to the

presence of plastics. This type of paver blocks can withstand up to 17 strength. Any colour and shapes can be adopted.

1.3 DISADVANTAGES

In the manufacturing of plastic paver block the main problem is the melting process. High temperature is needed for the proper melting and mixing, that is from 150°C. But if it is melted in open air, the toxic gas like dioxin will be produced. This is very harmful to human body as well as wild life. Plastic paver blocks may appear strong after processing, but it would deform under high pressure.

1.4 SOLUTIONS FOR THE DRAW BACKS

An apparatus called Zecoplast Recycling LLP can be used for the solution of melting problem. The shredding, melting and mixing process are done in a single apparatus. Here, a closed container is used for the melting and mixing process. At last, through the outlet valve provided, the mixture of plastic and sand can be collected in a required mould, and hand compaction by using metal rod is needed at the time of moulding. Fig 1.1 shows the Zecoplast Recycling LLP apparatus. The exhausted gas at the time of melting can be used for the production of bio diesel, and petroleum products.

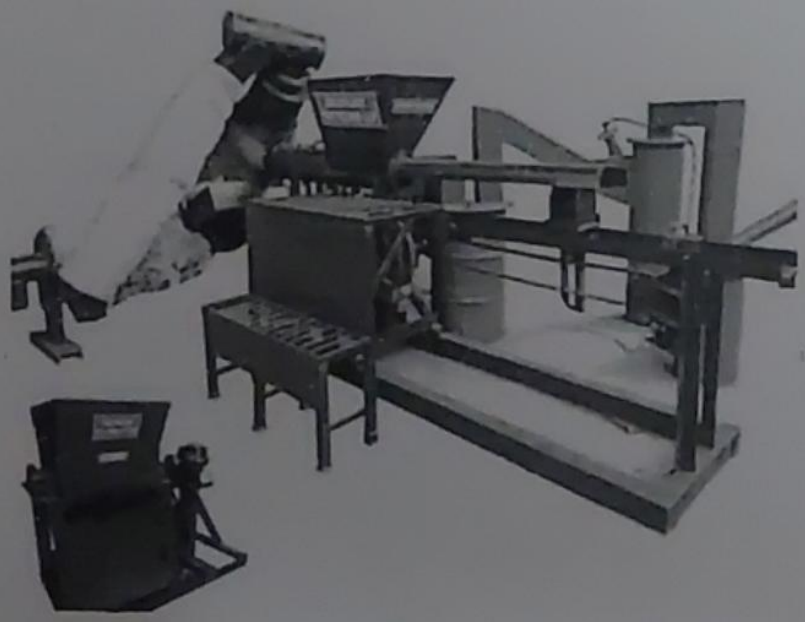

Fig.1.1 Zecoplast Recycling LLP

1.5 APPLICATIONS

- Can be used for pedestrian movement that is in footpath
- Can be used as garden pavement
- Variety of colours can be adopted, so that it provides a good aesthetic appearance. There for it can be used in housing pavement
- Can be used for drainage purpose
- Different shapes can be adopted, so that it can be used as interlock paver block

1.6 NEED OF STUDY

Plastics are rapidly growing segment of the municipal solid waste.Disposal of waste materials including wasteplastic bags has become a serious problem. Amount of waste plastic bags being accumulated in 21st centuryhas created big challenges for their disposal. Plastic wastes are non-biodegradableand the burning of plastic causes environmental problems. In order to reduce the wastage of plastics, it is used as a binding material in manufacturing of plastic paver block.Cement block construction need high cost and large amount of sand, clay, etc. By using plastics, usage of large amount of sand and construction cost can be reduced. Thereby reduce the environmental impacts.

1.4 OBJECTIVES

Following are the main objectives of this project

- To reduce the amount of plastic waste
- To produce cost effective paver blocks
- To construct light weight blocks

CHAPTER 2

LITERATURE SURVEY

2.1 THEORETICAL INVESTIGATIONS

Manufacturing of paver block has been done by various methods. The present investigation has focused on reducing the amount of plastic wastes in the environment by the manufacturing of paver blocks by using plastic wastes and aggregates.

2.1.1 Optimization studies

RJayasankar et al. [2018] This study present the manufacturing of paver block by using river sand and plastics. Their main aim is to reduce the amount of plastics as well as the emission of CO2 at the time of manufacturing of concrete. Here they give the correct proportions for the sand and cement, that are 3:1, 4:1, 5:1, & 6:1. Also the conduct some tests for detecting the strength of plastic paver block. Compressive strength of block without hydraulic press is 1 N/mm^2., and with hydraulic press is 5N/mm^2. Water adsorption is 2.2%. Plastic in paver block provide insulation. Plastic paver blocks are light in weight and cost effective.

Mohan D M S et al. [2018] This study presents the comparison of plastic paver block and ordinary concrete block. Here they explain about the mix proportions of sand with plastics and they conclude that the excellent proportion is 3:1. Here they use plastic bags, quarry dust and fine aggregate for the construction of paver block. Quarry dust include stone, rock, sand, gravel has been excavated from the ground. They also conduct some tests on the plastic paver block, that are compression test, water absorption test, split tensile strength test and acid resistance test. At last they conclude that it is a cost effective, light weight, and long lasting paver block.

B Shanmugavalli et al. [2018] The aim of this project is to replace cement with plastic waste in paver block and to reduce the cost of paver block when compared to that of convention concrete paver blocks. At present nearly 56 lakhs tonne of plastic waste is produced in India per year. The degradation rate of plastic waste is also very slow process. Hence the project is helpful in reducing plastic waste in useful way. In this project we have used plastic waste in different proportions with quarry dust, coarse aggregate and ceramic waste. The paver blocks were prepared tested and the results were discussed.

R Mahadevi et al. [2018] This paper is based on the experimental investigation on concrete paver block by using PVC plastic material. Here instead of fully replacement of cement, they partially reduce the amount of aggregate and cement by adding PVC material. The mix design is based on IS 15658-2006. And the plastic is replaced the sand in percentage of 10,20 and 30. Here they also explain the complete replacement of cement by plastic waste. They conduct some tests on the block samples that are, compression test , water absorption test. Last they conclude that the compressive strength for plastic paver block is greater than concrete block. And the water absorption is less than 7%.

M Muhammad Bashith et al. [2018] In this study they decided to utilise plastic waste effectively in the manufacture of paver blocks.They added M-sand to the molten state of plastic at different percentages to obtain high strength paver blocks that pocess good thermal properties and compressive strength.The mix proportion used were in the ratio of **1:2,1:3,1:4,1:5,1:6.** This ratios represents the plastic to river sand respectively.To know the quality of plastic paver blocks, they performed various tests like compression test, water absorption test ,fire resistance test and hardness test.

Zoe Lenkiewicz et al. [2017] They have investigate how to transform plastic waste in to paving block. In this study they explain about the construction of paving block by replacing cement by plastic wastes. Here they use low density polyethylene (LDPE) as plastic materials. For a good paving block the best mix proportioning is 3:1 (sand : plastic). This type of paver block having more strength than ordinary block. The ingredients used in here are fine dry sand, LDPE. There is no need of any PVC or foam. By careful work we have to make an eco friendly, cost effective and market valuable paver block.

SarangshashikantPawarat et al. [2017] 7 This study is based on evaluating the performance of plastic waste of paver block.As compressive and durability are the most significant properties for concrete paver blocks, the same have been studied for various concrete mixes with varying percentages of materials.Here they use plastic wastes,stone chips, dust, sand as the ingredients. They also conduct some experimental investigations on plastic paver blocks.They conclude that plastic paver blocks are eco friendly,economical, light weight and strength increases upto 30-35%.

K Gawtham et al. [2017] 8 This paper is based on reuse of plastic waste in paver blocks.In this study they reveal the idea of using plastic in paver blocks by conducting tests like compressive

strength test, and oven test.By experimental procedure the properties of plastic waste (LDPE) are melting point -150 degree,thermal coefficient of expansion as100-200X10^-6, tensile strength - .02 to .40 N/mm^2..They concluded that the cost of paver block is reduced as compared to cost of paver blocks.

Mike Webster et al. [2017] 9 They have investigated theconversion of plastic waste into useful and valuable paver block. The LDPE plastic film is melted in a barrel over a wood fire. After melting, it is mixed with sand and this mixture is transferred into an oiled mould for cooling. The paver blocks thus made has benefits like cheaper, light weight, quick setting and very strong. To get more aesthetic apperarence, they add colourants such as iron. They concluded that the paver block act as a fire retardant.

M Mahesh et al. [2016] 10 This investigation aims to reduce the plastic waste materials by replacing cement by different types of plastic at the manufacturing time of paver blocks. They explain the increasing strength of plastic paver blocks as compared with convectional paver block.Here they use plastic bags for the manufacturing of paver block.Waste plastic can be effectively reused without affecting the mechanical properties of paver block.

Nivetha C et al. [2016] 11 This study presents the possibility of using plastic waste as a binding material instead of cement in the manufacturing of paver block. Here they use quarry dust, fly ash, and polyethylene terephthalate as plastic wastes instead of using cement. They made 6 plastic cubes for property testing, and compare the result with concrete cube. The measurement of physical and mechanical properties show that the plastic waste paver blocks and these gives better result than concrete paver block. In here the conclude that the plastic waste can be used as the binding material, and this type of blocks can be used in paving as well as in construction of slab, beam, column.

Kirubakaran K et al. [2016] 12 This study presents the utilization of waste plastic in manufacturing of bricks and paver blocks.A large amount of plastic is being brought into tourist trekking regions are discarded or burned which leads to the contamination of environment and air.Hence these waste plastic are utilized effectively.High density polyethylene(HDPE) and' polyethylene such as bags,cups,furnitures and food containers are used instead of cement.With this plastics they used river sand as aggregate.Some tests are conducted in here,that are compression test, water absorption test and hardness test.The water absorption is less than 8%.The plastic reduces the total weight of paver block as compared with conventional block.

CHAPTER 3
METHODOLOGY

3.1 STEPS INVOLVED

- Material collection
- Mould preparation
- Separation of HDPE and LDPE plastics
- Shredding of plastics
- Casting of paver block
- Test on paver block

3.1.1 Material collection

The plastic wastes of different category are collected from the Bhoothathankettu dam site. Bhoothathankettu is one of the most polluted tourist site in Kothamangalam. Large amount of plastic wastes are deposited in this area. The required quantity of plastics is collected from the parks, boats, river banks, tourist buses, hotels and surroundings. M-sand and coarse aggregate are the another ingredients collected. Fig 3.1 shows the collection of material.

Fig.3.1 material collection

3.1.1.1 Characteristics of Plastics

- Plastics can be very resistant to chemicals and corrosion
- Plastics can be both thermal and electrical insulators
- Plastics have very high strength to weight ratio

- Plastics can be highly durable and resistant to water

3.1.2 Mould preparation

Three wooden moulds of rectangular shape (25cmx12cmx5cm) are made in the mechanical engineering work shop with the guidance of lab assistants.

3.1.3 Separation of HDPE and LDPE plastics

Plastic wastes coming under HDPE category are separated from the different category of plastic wastes. The major ingredient sorted out are plastic bottles. It includes milky white bottles and blue colored bottles.

3.1.4 Shredding of plastic

The selected plastics are subjected to shredding in a plastic shredding company situated at Myloor. Fig 3.2 shows the shredding of plastic.

Fig.3.2 Shredding of Plastic

3.1.5 Casting of paver block

3.1.5.1 Mix proportion for paver block

The selected size of mould is 250mmx120mmx50mm. For calculating the weight of plastic and aggregates needed for each proportion, initially, the volume of the mould is calculated and 20% extra of its volume is taken for avoiding the wastage occurs during the preparation. Then for each mix proportion, the weight of plastic is calculated by considering its density, because its weight varies during melting process. The density of HDPE plastic is varies from 0.9 g/cm^3 to 0.95 g/cm^3, the selected density is 0.92 g/cm^3. The proportion of plastic with respect to aggregate changes in these three ratios is due to the same mould volume.

Table 3.1 Mix Proportion for paver block

Ratio	Weight in grams
1 : 3	490 : 1350
1 : 4	392 : 1440
1 : 6	347 : 1875

3.1.5.2 Melting

For making one paver block, initially less amount of plastic wastes are taken in a metal vessel and heated. While it is half melted, M-sand is added in case of plastic with M-sand block and coarse aggregate is added in case of plastic with coarse aggregate block. Then it is thoroughly mixed using rod and trowel before it hardens. This melting process is continued till all the materials are added. Proper mixing is done during the whole process.

Fig 3.3 shows the process of melting

3.1.5.2 Moulding

The wooden mould is well cleaned by using waste cloth and the sides of the mould are oiled for the easy removal of blocks. Now the molten mixture is transferred to the mould. Then it is well compacted by using tamping rod to reduce internal pores present in it. After the whole mixture is transferred, the surface is leveled using trowel. Then the blocks are allowed to dry for 24 hours so that they harden. Fig 3.4 shows the moulded paver block.

Fig.3.4 Moulded paver block

3.1.5.3 De moulding

The moulded blocks are demoulded after 24 hours and subjected to testing. Fig 3.5 shows the demoulded paver blocks.

Fig.3.5 Demoulded Paver Block

3.1.6 Tests on paver block

For conducting different experimental studies on plastic paver block, we have casted total of fourteen blocks. In that, eight blocks are taken for compressive strength test, two blocks for hardness test, two for fire resistance and two for water absorption test and efflorescence test.

Following are the tests done on plastic paver block :-

1. Compressive strength test
2. Hardness test
3. Fire resistance test
4. Water absorption test
5. Efflorescence test

3.1.6.1 Compressive strength test

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material. Compressive strength is the capacity of a material to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate.

In this test, the paver block specimen is put on crushing machine and applied pressure till it breaks as shown in Fig 3.6. The ultimate pressure at which the block crushed is taken into account.

Here, for compression testing, we casted each blocks of 1:3, 1:4 and 1:6 ratios from the category of plastic M-sand and plastic coarse aggregate paver block. Then it is tested after 24 hours for determining the best ratio. For testing, all the three blocks from both the categories are taken to laboratory and tested one by one and the compressive strength is noted. The block showing maximum compressive strength from each category is selected as the best ratio. Then we casted one block of best ratio from each category and tested after 7 days for knowing the strength variation. Generally, plastic paver blocks needs only 24 hours after moulding to attain maximum strength.

Here, we casted total of eight blocks for compression testing which includes six blocks for best ratio determination and two for strength variation.

Fig.3.6 Compression Testing of Paver Block

3.1.6.2 Hardness test

Hardness is the property of material which enables it to resist abrasion. Hardness is determined by using Rebound Hammer. Rebound hammer test is a nondestructive testing method which provides a convenient and rapid indication of the compressive strength.

For testing, the block is placed horizontally on the floor and the Rebound hammer is kept vertically down on the surface of the block. Then the plunger of rebound hammer is pressed against the surface of block, the spring controlled mass rebounds and the extend of such a rebound depends upon the surface hardness of the block. The surface hardness and there for the rebound is taken to be related to the compressive test of block. The rebound value is read from a graduated scale and is designated as the rebound number or rebound index. The testing is done at four different points on the surface of paver block and the average of four readings is taken as the rebound number. Greater the Rebound number, greater will be the hardness. Fig 3.7 shows the Rebound hammer test done on paver blocks and Fig 3.8 shows the Rebound hammer.

Fig.3.7 Rebound Hammer Testing

Fig3.8 Rebound Hammer

3.1.6.3 Heat resistance test

The plastic is highly susceptible to fire but in case of plastic paver blocks the presence of fine and coarse aggregate imparts insulation.

In this test, the paver block is placed vertically on a leveled surface and the heat is applied to one side of the paver block by using a gas cutter. It leads to the formation of cracks on the opposite side and the temperature at the time of cracking is noted.

3.1.6.4 Water absorption test

In this test, paver blocks are weighed in dry condition and let them immersed in fresh water for 24 hours as shown in the Fig 3.9. 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.

Fig.3.9 Water Absorption

3.1.6.5 Efflorescence test

Efflorescence is the property of material which shows the chemical reactance when immersed in water. In this test, paver blocks are immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and the presence of white precipitate on the surface of paver block is noted through eye judgement.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 COMPRESSIVE STRENGTH TEST FOR BLOCK USING PLASTIC AND M- SAND

4.1.1 Determination of best ratio

For determining the best ratio, we casted each blocks of 1:3, 1:4 and 1:6 ratios from the category of plastic M-sand paver block. The best ratio is taken from the maximum compressive strength obtained. For that, the ultimate pressure at which the block crushed is noted and the compressive strength is calculated by the following equation, ·

Compressive strength =

Following are the calculations :-

For 1:3,

Breaking load = 310.30×10^3 N

Area of cross section = 250 x 120 mm

= 30000 mm^2

Compressive strength =

=

= 15.21

For 1:4,

Breaking load = 496.05×10^3 N

Area of cross section = 250 x 120 mm

= 30000 mm^2

Compressive strength =

= 16.54

For 1:6,

Breaking load = 440.16×10^3 N

Area of cross section = 250×120 mm

= 30000 mm^2

Compressive strength =

= 14.67

Result :-

Compressive strength for 1:3	= 15.21
Compressive strength for 1:4	= 16.54
Compressive strength for 1:6	= 14.67

From these results, the best ratio obtained is 1:4 which has got the maximum compressive strength as 16.54 .

4.1.2 Determination of strength variation

For knowing the strength variation, we casted one block of 1:4 ratio and tested after 7 days and the compressive strength is noted.

After 7 days,

Breaking load = 500.46×10^3 N

Area of cross section = 250×120 mm

= 30000mm

Compressive strength =

= 16.68

Result :-

Compressive strength for 1:4after 7 day = 16.68

4.2 COMPRESSIVE STRENGTH TEST FOR BLOCK USING PLASTIC AND COARSE AGGREGATE

4.2.1 Determination of better ratio

For determining the best ratio, we casted each blocks of 1:3, 1:4 and 1:6 ratios from the category of plastic coarse aggregate paver block. The best ratio is taken from the maximum compressive strength obtained. For that, the ultimate pressure at which the block crushed is noted and the compressive strength is calculated by the following equation,

Compressive strength =

Following are the calculations :-

For 1:3,

Breaking load = 363.87×10^3 N

Area of cross section = 250 x 120 mm

= 30000 mm^2

Compressive strength =

=

= 12.13

For 1:4,

Breaking load = 353.37×10^3 N

Area of cross section = 250 x 120 mm

= 30000 mm^2

Compressive strength =

= 11.78

For 1:6,

Breaking load = 329.16×10^3 N

Area of cross section = 250 x 120 mm

= 30000 mm²

Compressive strength =

= 10.97

Result :-

Compressive strength for 1:3	= 12.13
Compressive strength for 1:4	= 11.78
Compressive strength for 1:6	= 10.97

From these results, the best ratio obtained is 1:3 which has got the maximum compressive strength as 12.13 .

4.2.2 Determination of strength variation

For knowing the strength variation, we casted one block of 1:3 ratio and tested after 7 days and the compressive strength is noted.

After 7 days,

Breaking load = 369 x10³N

Area of cross section = 250 x 120 mm

= 30000 mm²

Compressive strength =

= 12.3

Result :-

Compressive strength for 1:3 =12.3

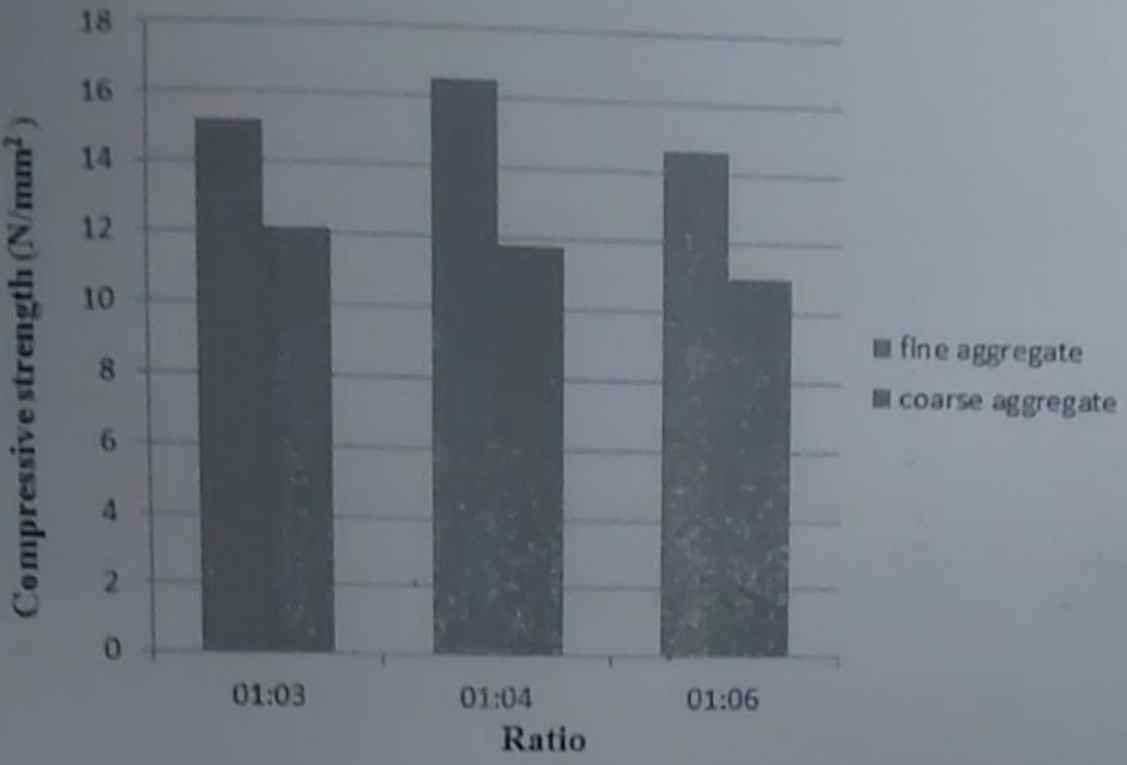

Fig.4.1 Compressive Strength Statics for different ratios

From this graph, it is obtained that, 1:4 and 1:3 is the best ratio for plastic M- Sand paver block and plastic coarse aggregate paver block respectively.

Table 4.1 Compressive Strength of Paver Block

CATEGORY	SI NO	RATIO	COMPRESSIVE STRENGTH AFTER 1 DAY (N/mm²)	COMPRESSIVE STRENGTH OF BEST RATIO AFTER 7 DAYS (N/mm²)
Plastic with M- sand	1	1:3	15.21	16.68
	2	1:4	16.53	
	3	1:6	14.67	
	1	1:3	12.13	

Plastic with Coarse aggregate	2	1:4	11.78	12.30
	3	1:6	10.97	

On comparing these two types of paver blocks, plastic with M- sand has got the highest compressive strength. And both the categories does not shows much variation in strength when tested after 7 days.

4.3 HARDNESS TEST

Table 4.2 Determination of Rebound Number

SI NO	REBOUND NUMBER	
	PLASTIC WITH M-SAND	PLASTIC WITH COARSE AGGREGATE
1	20.5	14
2	21	15
3	21.5	13
4	21	14
AVG	21	14

Based on the Rebound Number obtained, plastic with M-sand is harder than plastic with coarse aggregate.

4.4 HEAT RESISTANCE TEST

The temperature obtained at the time of cracking for plastic with coarse aggregate paver block is 155°C, and for plastic with M-sand paver block is 177°C.

4.5 WATER ABSORPTION TEST

4.5.1 For plastic with M-sand,

Dry weight = 2.070 kg

Wet weight = 2.098 kg

Therefore, Water absorption =

=

= 1.35

4.5.2 For plastic with coarse aggregate,

Dry weight = 2.232 kg

Wet weight = 2.260 kg

Therefore, Water absorption =

=

= 1.25

Result :-

Water absorption for plastic with M-sand = 1.35

Water absorption for plastic with coarse aggregate = 1.25

The result indicates that plastic with M-sand has slightly higher water absorption than plastic with coarse aggregate.

4.6 EFFLORESCENCE TEST

After 24 hours of immersion in water, there is no white precipitate on the surface of both types of blocks. It indicates that the absence of chemical reactions between water and paver block. That means the efflorescence is absent for both category of paver block.

As regarding the different experimental studies done on plastic paver block, plastic with M-sand shows higher compressive strength, hardness and heat resistance than plastic with coarse aggregate.

Therefore, it is concluded that plastic M-sand paver block is more good. But in case of water absorption, plastic with M- sand shows higher value, which is due to the presence of M-sand. Both the blocks does not shows efflorescence, it indicates that there is no presence of any chemicals.

CHAPTER 6

CONCLUSION

- Mixes prepared using plastic with M-sand and plastic with coarse aggregate.
- By comparing two different category of plastic paver blocks, plastic with M-sand has high strength and good physical and chemical features than plastic with coarse aggregate.
- On testing the compressive strength, the best ratio obtained for plastic M-sand paver block is 1:4 and for plastic coarse aggregate paver block is 1:3.
- This paver block can withstand the strength up to 17.

- The plastic paver blocks does not shows much variation in strength as the days increases.
- Generally, plastic paver blocks needs only 24 hours after moulding to attain maximum strength.
- In case of hardness, plastic M-sand paver block is more harder than plastic coarse aggregate paver block. .
- Plastic M-sand paver block has high thermal insulating property than plastic coarse aggregate paver block.
- Plastic with M- sand shows higher value of water absorption, which is due to the presence of M-sand.
- Both the blocks does not shows efflorescence, it indicates that there is no presence of any chemicals.
- The only ingredient in plastic paver block is plastic and aggregate. So that, it is cost effective and light in weight.
- It can be used for footpaths, garden and housing pavements, and also for drainage purpose.
- In this fast growing world, it is a good initiative for reducing the plastic accumulation.

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