



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 8, August 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Manufacturing of Brick Using Waste Plastic Intended to Use for Road Construction

Dr. S. S. Saraf¹, Ms. Kanchan A. Gulhane², Prof. A. R. Bijwe³

¹Head of Dept., Department of Civil Engineering, P. R. Pote Patil College of Engg. & Management, Amravati, Maharashtra, India

PG Student, Department of Civil Engineering, Dr. Rajendra Gode Institute of Technology & Research, Amravati, Maharashtra, India²

³ Assistant Professor, Department of Civil Engineering, Dr. Rajendra Gode Institute of Technology & Research, Amravati, Maharashtra, India

ABSTRACT: Plastic waste is one such resource, a major component of solid waste which is abundantly available and disposed of without proper treatment. India generates 1,88,000 tons of garbage every day. Plastic Waste in different forms is found to be almost 9% to 12% in municipal solid waste, which is toxic in nature. It is a common sight in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. Due to poor biodegradability it creates stagnation of water and associated hygiene problems. There is now a significant world-wide interest to solve the environmental problems caused by waste plastic and other materials by including such materials in the manufacture of paving blocks, bricks etc. Advancement in utilization of wastes in paver block as main ingredient to reduces pollutants in environment and maximizes usage of natural resources.

Plastic is now a day very much popular. It is routine part of the life. Since it have certain unique property. But they have few such properties those make plastic a serious environmental as well as disposal problem because it is non degradable. So the intense search is launched. The technical solution to this problem was found a substitute material which is eco-friendly and affordable. Since these material can be easily degradable hence poses to environmental and solid waste management pollution.

This project aims to study the possibility of using plastic waste as paver block. Tests are been conducted to study the strength by adding saline bottle which is nothing but High Density Polyethylene (HDPE) or polyethylene (PE).

I. INTRODUCTION

Plastic is a relatively cheap, durable and versatile material and its products have brought benefits to society in terms of economic activity, jobs and quality of life. Plastics as waste, when not properly managed, imposes negative environmental externalities, European Commission (2011), because most of it is non-biodegradable and therefore can remain as waste in the environment for a very long time; imposing risks to human health as well as the environment. Because of its demand and use, plastic waste generation has continued grow.

It is amazing that while the industrialized countries find numerous alternative uses for waste plastic materials many Asian countries are seeking legislations for limiting uses or total ban on plastics. It is the aim of this study to highlight alternative uses of waste plastics, 'an environmental nuisance', which many Asian countries can utilize to reduce costs of construction materials, create jobs and sustainable environments in addition to supply of energy to built environments.

The waste plastic will be large in household time. In Environment the plastics are not decompose easily and also not allow the water to percolate in to the soil and they are also poisonous. The large volume of materials required for construction is potentially a major area for the reuse of waste materials, it reduce environmental impacts.

The amount of plastic required for use in road construction is large & it gives us the environmental benefits. One of the largest component of plastic waste is polyethylene which is followed by polypropylene. 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.

1.1 Problem Definition

India consumes an estimated 16.5 million tonnes, as per this June 2018 report of Down to Earth. Additionally, according to industry body FICCI, 43 per cent of India's plastics are used in packaging and are single-use plastic. Consequently almost 80 percent of total plastic produced in India is discarded. Some of it is either burnt leading to air pollution, ends up in landfills or clogs drains. It chokes animals who eat plastic bags, etc. Plastics found in fields blocks germination and prevent rainwater absorption.

1.2 Objectives of the Study

- To study the effect of the compressive strength after the application of plastic waste materials. This study was primarily concerned with the use of plastic materials like saline bottles (Polypropylene and High Density Polyethylene).
- To conduct the primary tests such as water absorption test, Compressive Test and heat resistance test to determine the various properties of the samples.
- To study the results drawn from compressive strength test for the brick made with plastic waste with different ratios of plastic with fine sand and course sand like 1:1, 1:2 & 1:3.
- To compare the difference of strength of standard paver block with plastic brick and to draw the conclusion for compressive strength.
- To identify the optimum proportion of waste plastic to be added in the mix for getting the required strength.
- To reduce the disposal problem of plastics.

1.3 Methodology used for the Study

The framework of methodology for this study is comprises in following states:

- Material collection
- Preparation of plastic with fine and course sand blocks.
- Performing water absorption test, compressive strength test and heat resistance test.

II. MATERIALS & METHODS

2.1 Sand

Sand is a granular material composed of finely divided rock and mineral particles. Sand has various compositions but is defined by its grain size. Sand grains are smaller than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO₂), usually in the form of quartz. Calcium carbonate is the second most common type of sand, for example, aragonite, which has mostly been created, over the past 500 million years, by various forms of life, like coral and shellfish. For example, it is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years.

Sand is a non-renewable resource over human timescales, and sand suitable for making concrete is in high demand. Desert sand, although plentiful, is not suitable for concrete. 50 billion tons of beach sand and fossil sand is used each year for construction. The natural fine aggregate is the river sand which is the most commonly utilized natural material for the fine aggregates that is utilized, but the recent social factors that created a shortage of the material created a great problem in the construction sector. For the study the river sand is utilized in all the references. Coarse sand and fine sand are part of quarry like other materials that excavated from the ground such as rock, stone, riprap, aggregate, slate or gravel. Sand is actually some grainy materials made by mineral and rock particles, much coarser than silt and finer when compared to gravel, when it is measured by size. Sand cannot be renewed and it is defined as non-renewable resources and sand is highly demanded for concrete making. Sand has the capability of improving the plastic mechanical properties such as rigidity and characteristic strength. Another study showed that clay particles; due to their large surface area, sand was found to better bind with plastics.

Coarse sand: Its fineness modulus is 3.7-3.1, the average particle size is over 0.5 mm.

Fine sand: Its fineness modulus is 2.2-1.6, the average particle size is 0.35—0.25 mm.

2.2 Polyethylene plastic

In solid form, polyethylene plastic is harmless, but it can be toxic in liquid form or when inhaled as a vapor or absorbed through the skin. Low- and high-density versions of the plastic melt at 230 and 266 degrees Fahrenheit. Polyethylene costs more than polypropylene to make and comes in second behind polypropylene as a material choice for living hinges, a type of flexure hinge made from the same material as the rigid pieces it binds together.

Plastic, polymeric material that has the capability of being molded or shaped, usually by the application of heat and pressure. This property of plasticity, often found in combination with other special properties such as low density, low electrical conductivity, transparency, and toughness, allows plastics to be made into a great variety of products. These include tough and lightweight saline bottles made of HDPE and PE.



Fig. 2.1: High Density PolyEthylene saline bottle used in the study

2.3 TESTS CONDUCTED

2.3.1 Water absorption test

Water absorption is used to determine the amount of water absorbed under specified conditions. Factors affecting water absorption include: type of plastic, additives used, temperature and length of exposure. The data sheds light on the performance of the materials in water or humid environments. Water absorption is expressed as increase in weight percent.

$$\text{Percent Water Absorption} = \frac{(\text{Wet weight} - \text{Dry weight})}{\text{Dry weight}} \times 100$$

Test Procedure

The samples are dried for a given time at specified temperature and placed in a desiccator to cool for the test. The samples are measured immediately after cooling. Then the material is placed inside water under specified conditions, usually at 23°C for 24 hours or until it reaches an equilibrium. Finally, the samples are removed from the water, patted dry with a lint-free cloth, and weighed.

2.3.2 Compressive Strength Test

Compressive strength is the capacity of material or structure to resist or withstand under compression. The Compressive strength of a material is determined by the ability of the material to resist failure in the form cracks and fissure. In this test, the push force applied on the both faces of concrete specimen and the maximum compression that concrete bears without failure is noted.

2.3.3 Heat Resistance Test (Melting Point Test)

Heat resistance is a proportion of the heat resistance of plastic materials. It depicts the capacity of a test specimen to bent or turn into a predetermined shape under a predefined load or to disfigure just inside indicated limits at a predetermined test temperature. Heat resistance issues can be resolved by different state-sanctioned test techniques, for example, Vicat and the Heat resistance temperature. It tends to be performed in labs and businesses utilizing a Hot Air Oven.

III. IMPLEMENTATION

3.1 Mixing Procedure

Waste (saline bottles) were collected from various hospitals. The bottles are cut and were clean, free from other ingredients inside the bottles. These bottles were heated till it turns to viscous form. About 1500C to 1600C heat was required to melt.

Manufacturing of plastic paver blocks had to be done in open places. A metal tin with fire under it was arranged to heat the plastic. The plastic bags were heated according to the proportion given in the design. While heating care had taken by wearing gloves to hands, a long rod used for mixing the plastic waste. When the plastic changes to viscous form fine sand added into the mixture. The both materials are mixed thoroughly. The mixing process should be done fast. The procedure repeated for coarse sand according to ratio. Oil was applied on the mould to get friction resistance when the block removed after placing. The mixture of plastic and sand then poured into a mould and kept for drying for 24 hours. After completion of 24 hours, the block gets hardened and it is removed from the mould. Total 78 samples are prepared for further tests.



Fig 3.1: Weighing of the sample



Fig 3.2: Prepared sample for test



3.2 Water Absorption Test

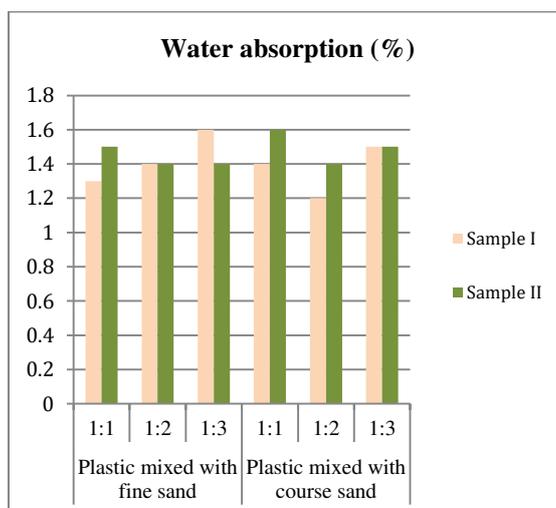
In this test, paving block are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth. Then, block is weighed in wet condition. The difference between weights is the water absorbed by paver block. The percentage of water absorption is then calculated.



Fig 3.3: Water absorption test

Table 5.1: Water absorption by standard and plastic paver block

| Material | Ratio | Water Absorption (%) | | |
|--------------------------------|-------|----------------------|-----------|------|
| | | Sample I | Sample II | Avg. |
| Plastic mixed with fine sand | 1:1 | 1.3 | 1.5 | 1.4 |
| | 1:2 | 1.4 | 1.4 | 1.4 |
| | 1:3 | 1.6 | 1.4 | 1.5 |
| Plastic mixed with course sand | 1:1 | 1.4 | 1.6 | 1.5 |
| | 1:2 | 1.2 | 1.4 | 1.3 |
| | 1:3 | 1.5 | 1.5 | 1.5 |



Graph 3.1: Water absorption percentage of paver blocks

3.3 Compressive Strength Test

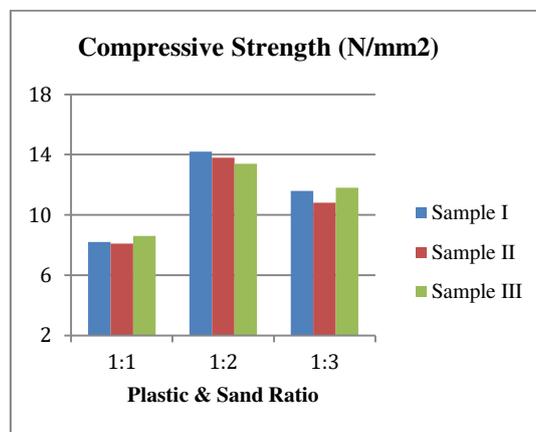
If a material is introduced in construction field, the main aspect to be considered is strength. To find the resistance of this plastic paver under compression, compressive strength test has to be done by using UTM (Universal Testing Machine). The surface of the paver block should be plane in all the sides, so that the load can distributed evenly. The importance of finding compressive strength is to measure the load bearing capacity of the block. The table below shows the compressive strength of different mix ratios for 7, 14 & 28 days resp. The analysis of the strength parameters and the results for the same has been tabulated as given in tables.



Fig 5.4: Compressive strength test

Table 3.2: Compressive strength of plastic with fine sand (7 days)

| Material | Ratio | Compressive strength (N/mm ²) | | | Avg. |
|------------------------------|-------|---|-----------|------------|------|
| | | Sample I | Sample II | Sample III | |
| Plastic mixed with fine sand | 1:1 | 8.2 | 8.1 | 8.6 | 8.3 |
| | 1:2 | 14.2 | 13.8 | 13.4 | 13.8 |
| | 1:3 | 11.6 | 10.8 | 11.8 | 11.4 |

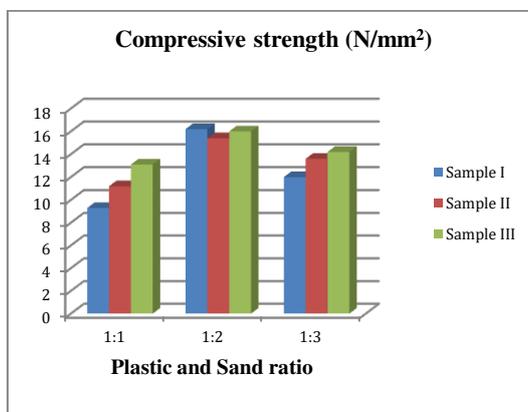


Graph 3.2: Compressive strength of Plastic & fine sand with defined ratio for 7 days



Table 3.3: Compressive strength of plastic with fine sand (14 days)

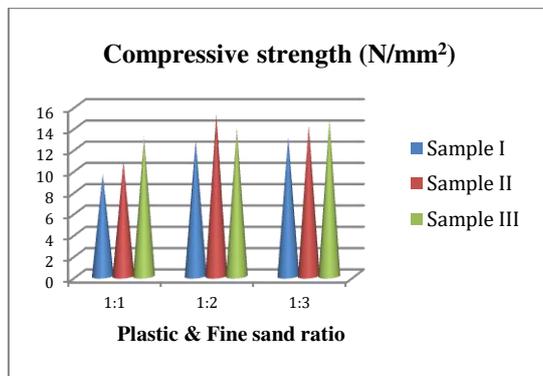
| Material | Ratio | Compressive strength (N/mm ²) | | | Avg. |
|------------------------------|-------|---|-----------|------------|------|
| | | Sample I | Sample II | Sample III | |
| Plastic mixed with fine sand | 1:1 | 9.3 | 11.2 | 13.1 | 11.2 |
| | 1:2 | 14.2 | 15.4 | 16.0 | 15.8 |
| | 1:3 | 12.0 | 13.6 | 14.2 | 13.3 |



Graph 3.3: Compressive strength of Plastic & fine sand with defined ratio for 14 days

Table 3.4: Compressive strength of plastic with fine sand (28 days)

| Material | Ratio | Compressive strength (N/mm ²) | | | Avg. |
|------------------------|-------|---|-----------|------------|------|
| | | Sample I | Sample II | Sample III | |
| Plastic with fine sand | 1:1 | 9.6 | 10.8 | 13.1 | 11.2 |
| | 1:2 | 12.8 | 15.2 | 13.9 | 13.9 |
| | 1:3 | 13.1 | 14.2 | 14.8 | 14.0 |

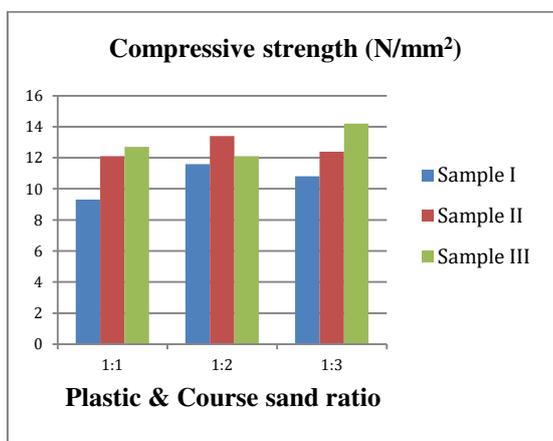


Graph 3.4: Compressive strength of Plastic & fine sand with defined ratio for 28 days



Table 3.5: Compressive strength of plastic with course sand (7 days)

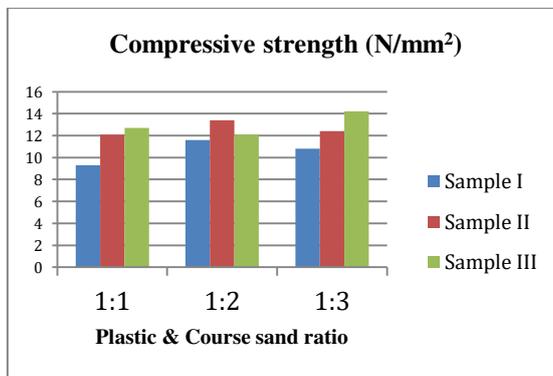
| Material | Ratio | Compressive strength (N/mm ²) | | | Avg. |
|-----------------------|-------|---|-----------|------------|------|
| | | Sample I | Sample II | Sample III | |
| Plastic & course sand | 1:1 | 9.3 | 12.1 | 12.7 | 11.4 |
| | 1:2 | 11.6 | 13.4 | 12.1 | 12.4 |
| | 1:3 | 10.8 | 12.4 | 14.2 | 12.5 |



Graph 3.5: Compressive strength of Plastic & course sand with defined ratio for 7 days

Table 3.6: Compressive strength of plastic with course sand (7 days)

| Material | Ratio | Compressive strength (N/mm ²) | | | Avg. |
|-----------------------|-------|---|-----------|------------|------|
| | | Sample I | Sample II | Sample III | |
| Plastic & course sand | 1:1 | 9.3 | 12.1 | 12.7 | 11.4 |
| | 1:2 | 11.6 | 13.4 | 12.1 | 12.4 |
| | 1:3 | 10.8 | 12.4 | 14.2 | 12.5 |

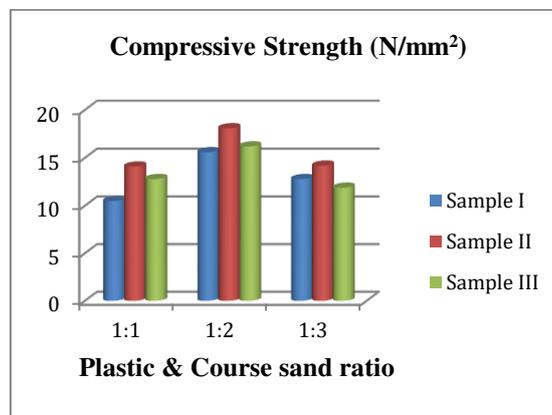


Graph 3.6: Compressive strength of Plastic & course sand with defined ratio for 14 days



Table 3.7: Compressive strength of plastic with course sand (14 days)

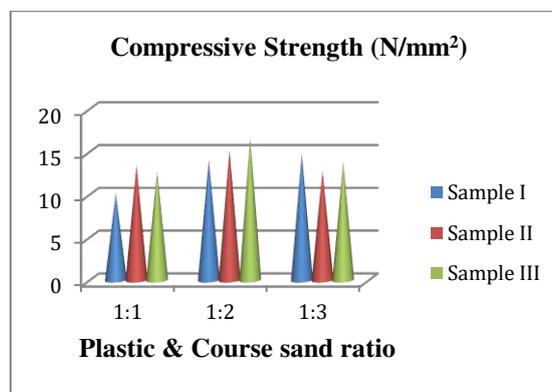
| Material | Ratio | Compressive strength (N/mm ²) | | | Avg. |
|-----------------------|-------|---|-----------|------------|------|
| | | Sample I | Sample II | Sample III | |
| Plastic & course sand | 1:1 | 10.5 | 14.1 | 12.8 | 12.5 |
| | 1:2 | 15.6 | 18.1 | 16.2 | 16.6 |
| | 1:3 | 12.8 | 14.2 | 11.9 | 13.0 |



Graph 3.7: Compressive strength of Plastic & course sand with defined ratio for 14 days

Table 3.8: Compressive strength of plastic with course sand (28 days)

| Material | Ratio | Compressive strength (N/mm ²) | | | Avg. |
|-----------------------|-------|---|-----------|------------|------|
| | | Sample I | Sample II | Sample III | |
| Plastic & course sand | 1:1 | 10.2 | 13.5 | 12.8 | 12.2 |
| | 1:2 | 14.1 | 15.2 | 16.7 | 15.3 |
| | 1:3 | 14.8 | 12.8 | 13.9 | 13.8 |



Graph 3.8: Compressive strength of Plastic & course sand with defined ratio for 28 days



3.4 Heat Resistance Test (Melting Point Test)

As paver blocks were made from melting of plastic waste, it is necessary to know the melting point so oven test is performed. The heat resistance is an essential parameter to be known as the paver blocks have been casted using waste plastics. Table 5.8 shows behavior of each specimen in different temperature maintained in a controlled system (oven).

Table 5.8: Melting point of plastic paver block

| Material | Samples | Temp in °C | Result |
|--|------------|------------|-----------|
| Plastic with fine sand with 1:1, 1:2 & 1:3 ratio | Sample I | 50 | No change |
| | Sample II | 100 | No change |
| | Sample III | >140 | Melt |
| Plastic with course sand with 1:1, 1:2 & 1:3 ratio | Sample I | 50 | No change |
| | Sample II | 100 | No change |
| | Sample III | >140 | Melt |

IV. RESULTS & DISCUSSION

Comparatively normal and plastic paver blocks have similar properties and durability characteristics that can give a good performance in paved areas, though not showing more improved parameters than normal paver blocks it appears to be a way to reuse plastic wastes (Saline bottles). Plastic with fine sand and course sand (1:2 ratio) shows optimum strength and higher heat bearing ability among other two mixes making it perfect combination for making blocks.

There were two methods used to produce specimens for paver block, which were heating and compression. Both methods are analysed and observed before the full scale casting of paver block. The most efficient method is then selected in the production of the paver block. The observations are considering the complexity of preparation and its effects on the environment. The challenges were controlling the temperature when mixing with sand as melted plastic harden quickly and hence causes segregation in the mixture. The following results were observed during test.

4.1 Water Absorption Test

1. Average water absorption percentage of the plastic paver block with fine sand with 1:1 ratio is found to be 1.4.
2. Average water absorption percentage of the plastic paver block with fine sand with 1:2 ratio is found to be 1.4.
3. Average water absorption percentage of the plastic paver block with fine sand with 1:3 ratio is found to be 1.5.
4. Average water absorption percentage of the plastic paver block with course sand with 1:1 ratio is found to be 1.5.
5. Average water absorption percentage of the plastic paver block with course sand with 1:1 ratio is found to be 1.3.
6. Average water absorption percentage of the plastic paver block with course sand with 1:3 ratio is found to be 1.5

4.2 Compressive Strength Test for Plastic with Fine Sand for 7 Days

1. Average Compressive strength of the plastic paver block with fine sand with 1:1 proportion is found to be 8.3 N/mm².
2. Compressive strength of the plastic paver block with fine sand with 1:2 proportion is found to be 13.8 N/mm² which is the optimum.
3. Compressive strength of the plastic paver block with fine sand with 1:3 proportion is found to be 11.4 N/mm² which is the lower than previous proportion.

4.3 Compressive Strength Test for Plastic with Fine Sand for 14 Days

1. Average Compressive strength of the plastic paver block with fine sand with 1:1 proportion is found to be 11.2 N/mm².
2. Average Compressive strength of the plastic paver block with fine sand with 1:2 proportion is found to be 15.8 N/mm² which is the optimum.

3. Compressive strength of the plastic paver block with fine sand with 1:3 proportion is found to be 13.3 N/mm² which is the lower than previous proportion.

4.4 Compressive Strength Test for Plastic with Fine Sand for 28 Days

1. Average Compressive strength of the plastic paver block with fine sand with 1:1 proportion is found to be 11.2 N/mm².
2. Average Compressive strength of the plastic paver block with fine sand with 1:2 proportion is found to be 13.9 N/mm² which is higher than previous proportion
3. Average Compressive strength of the plastic paver block with fine sand with 1:3 proportion is found to be 14.0 N/mm² which is the optimum.

4.5 Compressive Strength Test for Plastic with Course Sand for 7 Days

1. Compressive strength of the plastic paver block with course sand with 1:1 proportion is found to be 11.4 N/mm².
2. Compressive strength of the plastic paver block with fine sand with 1:2 proportion is found to be 12.4 N/mm² which is more than previous.
3. Compressive strength of the plastic paver block with fine sand with 1:3 proportion is found to be 12.5 N/mm² which is the optimum proportion.

4.6 Compressive Strength Test for Plastic with Course Sand for 14 Days

1. Compressive strength of the plastic paver block with course sand with 1:1 proportion is found to be 12.5 N/mm².
2. Compressive strength of the plastic paver block with fine sand with 1:2 proportion is found to be 16.6 N/mm² which is the optimum.
3. Compressive strength of the plastic paver block with fine sand with 1:3 proportion is found to be 13.0 N/mm² which is the lower than previous proportion.

4.7 Compressive Strength Test for Plastic with Course Sand for 28 Days

1. Compressive strength of the plastic paver block with course sand with 1:1 proportion is found to be 12.2 N/mm².
2. Compressive strength of the plastic paver block with fine sand with 1:2 proportion is found to be 15.3 N/mm² which is the optimum.
3. Compressive strength of the plastic paver block with fine sand with 1:3 proportion is found to be 13.8 N/mm² which is the lower than previous proportion.

Here we can say that plastic paver block with course sand of 1:2 proportion for 14 days is having the highest average compressive strength i.e. 16.6 N/mm². So it can be used as paver block in road construction.

4.8 Heat Resistance Test (Melting Point Test)

1. Both samples of plastic paver block with Plastic & course sand as well as plastic with fine sand (1:1 ratio) found no change at 50⁰C.
2. Both samples of plastic paver block with Plastic & course sand as well as plastic with fine sand (1:2 ratio) found no change at 100⁰C.
3. Both samples of plastic paver block with Plastic & course sand as well as plastic with fine sand (1:3 ratio) melt at temperature 140⁰C.

V. CONCLUSION

The results obtained from the tests clearly indicate that the block having 1:2 ratio of plastic waste and sand possess high compressive strength than that of other mixtures and all the test blocks melts at a temperature greater than 140⁰C. It can be used in walking pavements where there is no action of heavy loads. The plastic paver blocks are economical than conventional paver blocks. This method of using recycled plastic waste in paver block serves the best way to reduce the impact of non-biodegradable plastic in the environment. The preliminary study explored the possibility of producing soil-based paver blocks. From this study, the following conclusion can be drawn:

1. The initial test to determine the suitable method for the development of recycled plastic for pavement block indicated that the compression method is the best option.
2. The mix design involved selection of appropriate mix proportion and optimum ratio of replacement to produce paver blocks. Based on the compressive strength and water absorption tests, mixture 1:2 is the most suitable



composition. The highest average compressive strength of plastic with course sand is recorded at 1:2 proportion i.e 16.6 N/mm² and the strength gradually decreases at 1:3 ratio. For economical consideration 1:2 ratio (plastic with course sand) was selected for the production of pavement block.

3. The paver block passed the minimum requirement of heat resistance.

As we know the main theme of this project is to reduce the environmental pollution produced by the plastic waste. Environmental factors depend upon how the blocks are used.

REFERENCES

- 1) Zoe Lenkiewicz and Mike Webster, "How to transform plastic waste into paving tiles", Illustrated by Susan Hatfield, October 2017
- 2) Arun A, Madhan M B , Sagar Gotur, Sethupathy G, Divya Nair, "Comparison of River Sand and Iron Ore Slag Sand", International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 05 | May-2018
- 3) Pooja Bhatia, Nupoor Dewangan, Abhyuday Titiksh, "Paver blocks made of Recycled plastic-bonded sand", HBRP Publication, Vol. 2, Issue 2, 2019.
- 4) Shweta N. Rokdey, P. L. Naktode, M. R. Nikhar, "Use of Plastic Waste in Road Construction", International Journal of Computer Applications, International Conference on Quality Up-gradation in Engineering, Science and Technology, 2015.
- 5) Owolabi Wahab Amadi, Akobundu Nwanosike, "Production of Pavement Blocks from Plastic Waste", Geology Department, Federal University of Technology, Minna, Nigeria, November 2020.
- 6) P.Suresh, Md.Azam, B.Harish, "Recycling Plastic Waste Into Paving Blocks", Journal of Architecture & Technology, Volume XI, Issue XI, 2019.
- 7) B. Shanmugavalli, K.Gowtham, P. Jeba Nalwin, "Reuse of Plastic Waste in Paver Blocks", International Journal of Engineering Research & Technology (IJERT), Vol. 6, Issue 02, February-2017, ISSN: 2278-0181.
- 8) Loganayagan, Keerthana, Abishek, Amudhan Vetrivel, "Study on plastic pet bottles characteristics to develop eco-friendly plastic paver blocks", IOP Conf. Series: Materials Science and Engineering, 2021.
- 9) Ab. Raouf Dar, Sukhdeep Singh, "Use of Recycled Materials in Pavement Construction", International Journal of Scientific Development and Research (IJS DR), Volume 5, Issue 8, August 2020.
- 10) Manu Sasidharan, Dr Mehran Eskandari Torbaghan & Dr Michael Burrow, "Using waste plastics in road construction", International Conference on Advancements in Civil, University of Birmingham, May 2019.



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details