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Experimental Investigation on Efficient Use of Waste Materials

Mr. Rajeshkumar.R*[1], Mr. Sanjay.V*[2], Mr. Akash Raj.I*[3], Mr. Sarathi Raj.R*[4], Mr. A. Arulmozhi M.E., M.I.ST.E.*[5]

[1]Civil Engineering, MRK Institute of Technology, Kattumanarkoil, Tamil Nadu
*[2]Civil Engineering, MRK Institute of Technology, Kattumanarkoil, Tamil Nadu
*[3]Civil Engineering, MRK Institute of Technology, Kattumanarkoil, Tamil Nadu
*[4]Civil Engineering, MRK Institute of Technology, Kattumanarkoil, Tamil Nadu
*5Head of the Department Civil Engineering, MRK Institute of Technology, Kattumanarkoil, Tamil Nadu

ABSTRACT :

The Experimental Investigation on Efficient Use of Waste Materials investigates the feasibility and efficacy of combining recycled plastic and sand to make pavement blocks, with an emphasis on the design and testing of plastic sand pavement blocks. This study addresses the critical environmental issue of plastic waste pollution while also seeking to improve infrastructure sustainability. Plastic sand pavement blocks are created utilizing specialized moulding procedures that involve rigorous material sorting, sand quality testing, and determining ideal mixture proportions. To evaluate the performance of these blocks, comprehensive testing is conducted, including examinations of strength, durability, and environmental impact. Findings reveal that plastic sand pavement blocks offer equivalent performance to traditional pavement materials, highlighting their potential to reduce plastic waste pollution and contribute

Keywords: Experimental Investigation, Efficient Use, Waste Materials, Plastic Sand Pavement Block

INTRODUCTION :

The use of waste materials for sustainable infrastructure solutions has received a lot of attention in recent years as environmental concerns have grown. Among these attempts, the investigation of plastic-sand pavement blocks has emerged as a potential direction. This novel solution aims to solve the combined concerns of plastic waste pollution and the requirement for long-lasting, environmentally friendly pavement materials. Plastic sand pavement blocks, which are made from recycled plastic and sand, have the ability to help the environment while also improving infrastructure resilience. Current research in this topic focuses on comparing the mechanical qualities, durability, and environmental impact of plastic sand pavement blocks to conventional materials. Understanding the effectiveness and practicality of this strategy is critical to developing sustainable construction techniques and creating a cleaner, greener built environment.

METHODOLOGY :

- Sort and process recycled plastic to obtain suitable material for pavement block production.
- Test the quality of sand to ensure it meets the necessary specifications for pavement construction.
- Determine optimal mixing proportions of recycled plastic and sand through systematic experimentation.
- Utilize appropriate molding techniques, such as compression molding or extrusion, to form plastic sand pavement blocks.
- Conduct comprehensive testing to evaluate the performance of the pavement blocks, including assessments of strength, durability, and environmental impact.

MIX DESIGN :

To locate the plastic soil pavement block with the highest compressive strength, several mix proportions are created and evaluated on a compressive testing machine [CTM]. The mixture proportions were 1:2 and 1:3. These are the ratios for plastic and sand, respectively.

❖ **Mix Design Calculations**

a) Ratio (1:2)

size of brick = 10 X 10 X 5 cm
= 0.10 X 0.10 X 0.05 M

Volume of brick = $3/2 \times \sqrt{3} \times S^2 \times H$
= $3/2 \times \sqrt{3} \times 0.1^2 \times 0.05$

= 1.299×10^{-3} m^3

Amount of plastic = (1.299×10^{-3} /3 x 1) X 1390

= 0.601 kg of plastic

Amount of sand = (1.299×10^{-3} /3 x 2) X 1620

= 1.40 kg of sand

b) Ratio (1:3)

size of brick = 10 X 10 X 5 cm

= 0.10 X 0.10 X 0.05 M

Volume of brick = $3/2 \times \sqrt{3} \times S^2 \times H$

= $3/2 \times \sqrt{3} \times 0.1^2 \times 0.05$

= 1.299×10^{-3} m^3

Amount of plastic = (1.299×10^{-3} /4 x 1) X 1390

= 0.451 kg of plastic

Amount of sand = (1.299×10^{-3} /4 x 3) X 1620

= 1.57 kg of sand

MIX RATIO	PLASTIC (kg)	SAND (kg)
1:2	0.6	1.4
1:3	0.5	1.6

Table 1: mix design

MAKING PROCEDURE :

- ✓ Collect and clean plastic waste
- ✓ Sort and shred the plastic into small pieces
- ✓ Prepare clean, fine sand
- ✓ Mix plastic and sand in desired ratio (1:2 and 1:3)
- ✓ Optionally add colorant for aesthetics
- ✓ Heat and melt the plastic while stirring continuously (150°C to 200°C)
- ✓ Transfer the melted mixture into brick mould
- ✓ Compact the mixture firmly using a hydraulic press
- ✓ Allow the pavement block to cool and cure at room temperature
- ✓ Carefully demould the pavement block and trim excess material

Fig 1: cutting the plastic into small pieces

Fig 2: sand sieving process

Fig 3: Heat and melt the plastic while stirring continuously

Fig 4: Transfer the melted mixture into brick moulds

Fig 5: Allow the pavement block to cool and cure at room temperature

RESULT :

5.1TEST ON PLASTIC-SAND PAVEMENT BLOCK:

5.1.1 COMPRESSION TEST

Compression tests conducted on plastic sand pavement blocks reveal their impressive strength, meeting or exceeding industry standards. Results demonstrate the blocks' robustness under pressure, affirming their suitability for use in infrastructure applications. This highlights their potential to provide durable and resilient pavement solutions while mitigating plastic waste pollution.

COMPRESSIVE STRENGTH = F/A

Where,

F- Maximum load applied (KN)

A- Specimen Area (mm^2)

Pavement block surface area = $(3\sqrt{3}\ s^2)/2$

= $(3\sqrt{3}\ 100^2)/2$

= 25981 mm^2

Maximum load for ratio 1:2 = 156 KN , 143 KN , 169 KN

Maximum load for ratio 1:3 = 143 KN , 117 KN , 143 KN

Plastic pavement block (1:2)

1) 156000 / 25981 = 6 N/mm^2
2) 143000 / 25981 = 5.5 N/mm^2
3) 168000 / 25981 = 6.5 N/mm^2

The average Compressive Strength = 6.0 N/mm^2

Plastic pavement block (1:3)

1) 143000 / 25981 = 5.5 N/mm^2
2) 117000 / 25981 = 4.5 N/mm^2
3) 143000 / 25981 = 5 N/mm^2

The average Compressive Strength = 5.0 N/mm^2

Compressive Strength of Plastic Pavement Block (Mpa) Ratio (1:2)			
Sample 1	**Sample 2**	**Sample 3**	**Average strength (Mpa)**
6	5.5	6.5	6

Table 2: Compressive strength for Ratio 1:2 pavement block

Compressive Strength of Plastic Pavement Block (Mpa) Ratio (1:3)			
Sample 1	**Sample 2**	**Sample 3**	**Average strength (Mpa)**

5.5	4.5	5	5

Table 3: Compressive strength for Ratio 1:3 pavement block

Fig 6 : Compressive strength on plastic pavement block

5.1.2 WATER ABSORPTION TEST

Water absorption tests conducted on plastic sand pavement blocks indicate minimal water permeability, showcasing their resistance to moisture ingress. Results reveal the blocks' ability to maintain structural integrity and durability even when subjected to prolonged exposure to water, affirming their suitability for various environmental conditions and applications.

Water absorption in % by weight = (w2 – w1) / w1 X 100
Where,
W1 = weight of dry plastic pavement block
W2 = weight of wet plastic pavement block

WATER ABSORPTION TEST RATIO (1:2)			
SAMPLE 1	**SAMPLE 2**	**SAMPLE 3**	**AVERAGE**
1.05%	0.95%	0.85%	0.95%

Table 4: Water absorption for plastic pavement block ratio 1:2

WATER ABSORPTION TEST RATIO (1:3)			
SAMPLE 1	**SAMPLE 2**	**SAMPLE 3**	**AVERAGE**
1.25%	1.05%	0.85%	1.05%

Table 5: Water absorption for plastic pavement block ratio 1:3

CONCLUSION :

Finally, the experimental examination of plastic sand pavement blocks demonstrates their remarkable potential as a sustainable alternative for infrastructure development. These blocks are suitable for a variety of climatic circumstances, thanks to their outstanding strength, low water absorption, and good abrasion resistance. Furthermore, their ability to reduce plastic waste pollution demonstrates their importance in fostering environmental sustainability. Overall, plastic sand pavement blocks are a feasible alternative to traditional pavement materials, paving the path for a more sustainable and resilient built environment.

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