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Development of Pervious Paver Block Using Sugarcane Bagasse Ash & RAP Aggregates

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Abstract: This particular kind of concrete is distinguished by its interconnected pore structure and significant void content or porosity, which typically varies from 15 to 35% by volume. Pervious concrete may lower the danger of flooding, diminish storm-water runoff, reduce noise when in contact with automobile tires, and avoid glare and skidding during rainy seasons by allowing water to easily infiltrate through its pores and replenish the ground water table. Considering the condition of the neighboring roadways, a modest effort is undertaken to construct the least amount of porous paver concrete. For the planned Mix proportions, compression strength, void ratio, and infiltration tests were conducted. In the current study, 60mm thick pervious paver blocks for medium traffic with different RAP aggregate percentages and sugarcane bag ash are cast. This improves the compressive strength. RAP aggregates are a suitable material that may be utilized in place of natural and artificial aggregates in construction projects. The thesis shows how discarded sugarcane ash may be used again. Several experiments were conducted to evaluate the compressive strength, density test, porosity, and permeability of the planned paver block as well as its durability.
Keywords: Pervious Paver Blocks, Sugarcane Bagasse Ash, Reclaimed Asphalt Pavement (RAP), Sustainable Construction, Mechanical Properties, Water Infiltration, Waste Utilization.

I. INTRODUCTION

The rapid urbanization and growth in infrastructure development have led to an escalating demand for construction materials, often resulting in the depletion of natural resources. Additionally, the construction industry is one of the significant contributors to landfill waste, which aggravates environmental concerns. Thus, there is an increasing need for sustainable alternatives in construction materials that are both economically viable and environmentally friendly. The study aims to address two significant issues: waste management and sustainable construction. By utilizing sugarcane bagasse ash, a byproduct of the sugar industry, and RAP aggregates, waste from road renovation or construction, the study aims to reduce landfill waste. Secondly, by developing pervious paver blocks, the study aspires to contribute to the sustainability of urban infrastructure by allowing better water management and utilizing waste materials that are usually considered non-recyclable.

By integrating waste materials into the construction of pervious paver blocks, this study aims to develop a comprehensive solution that addresses both environmental concerns and infrastructural needs. Through rigorous testing and analysis, the study intends to prove the viability of these sustainable construction materials for real-world applications the present study aims to explore sustainable alternatives in construction materials by developing pervious paver blocks using sugarcane bagasse ash and reclaimed asphalt pavement (RAP) aggregates. Sugarcane bagasse ash serves as a partial replacement for cement, while RAP aggregates substitute for traditional aggregates. These blocks are designed to offer efficient water infiltration and thus contribute to groundwater recharge, mitigating surface runoff and reducing the risk of urban flooding. By examining mechanical properties such as compressive strength, water absorption, and permeability, the study evaluates the performance of these sustainable paver blocks against traditional ones. Through this research, we intend to prove the viability of incorporating waste materials into construction, aiming for a comprehensive solution that fulfills both environmental and infrastructural needs.

A. Pervious Concrete Pervious Concrete

A unique kind of concrete called pervious concrete is made of cement, large aggregates, water, and, if necessary, admixtures and other cementitious elements. The concrete matrix's higher void content, which results from the absence of fine particles, enables water to pass more easily through the material's body. Permeable concrete and porous concrete are other names for pervious concrete. The field of pervious concrete is the subject of much study. Due to its porosity and voids, pervious concrete has a lower compressive strength than ordinary concrete. Because of this, even though pervious concrete has several benefits, its use is restricted. A greater range of applications for pervious concrete are possible with enhanced compressive and flexural strengths. Pervious concrete is currently exclusively used on roadways with low traffic volumes.

It may also be utilized for inflexible pavements with medium and high traffic if the characteristics are upgraded. Additionally, pervious concrete prevents storm water runoff from surfaces, enables groundwater recharging, and maximizes the use of land.

Our project's primary goal is to enhance pervious concrete's strength properties. However, it should be observed that the permeability of pervious concrete will decrease as strength increases. Therefore, because the permeability quality serves a function, the development of strength shouldn't have an impact on it.

It has been discovered that pervious concrete, also referred to as no-fines, porous, gap-graded, and permeable concrete, and enhance porosity concrete, is a dependable storm water management strategy. Gravel or granite stone, cement, water, and little to no sand (fine aggregate) are the main components of pervious concrete, according to definition. Storm water may seep through pervious concrete pavements and into the soils underneath thanks to the open cell architecture. In other words, pervious concrete contributes to the preservation of the environment and the pavement's surface.

II. DESIGN OF PAVER BLOCK

Utilizing waste products in unconventional ways helps ease the strain on the environment and current resources. The utilization of diverse wastes with the repolymerization process may be readily utilized in the manufacturing of paver blocks, which can result in the preservation of high-quality resources. Additionally, this will lead to savings and sustainable practices. The qualities of cement concrete with RAP aggregates have been the subject of several investigations; however, in this study, we are combining two kinds of waste materials in different proportion combinations with RAP aggregates and sugarcane bag ash.

A. *Dimension of the Paver Blocks*

First, the dimensions for paver block manufacture are chosen in accordance with the producer, as shown beneath:

- Shape: I section
- Length: 200 mm
- Width: 160 mm
- Thickness = 80 mm
- Aspect ratio (L/T**)** = 200/80 = 2.5 < 4.0 as in step with IS 15658: 2021

Area shall be calculated by as per IS 15658: 2021 their method and regard is given under.

Table 1: Design shape of paver block mould

Shape	Zigzag	I- shape
Thickness (mm)	80	80
Plane Area (m2)	0.0281	0.0289
Length (mm)	225	200
Width (mm)	112.5	163

1) *Plan Area (A_{sp}) (Method 1)*

The test sample must be weighed while hanging on a metal wire and immersed entirely in water. The weight must be reported in N and is accurate to the closest 0.01N (Wa). They must be taken out of the water and set on a 10 mm coarser wire mesh to drain for one minute. With a moist towel, any visible water on the specimen may be removed. Each specimen must be immediately weighed, with the burden being reported N times to the nearest zero.The volume of the example will be calculated as follows: 01N (WW):

$$\text{Volume} = (Ww - Wa)\ 10^{-3}\ m^3$$

The volume has to be divided using thickness to achieve an arrangement in mm^2.

For I-Section
Ww = 4.690 kg
Wa = 2.440 kg
Volume = 0.002250 m^3
Thickness = 0.08 m
Area= 0.028125 m^2 = 28125 mm^2

For Zig-Zag Section
Ww = 4.902 kg
Wa = 2.590 kg
Volume = 0.002285 m^3
Thickness = 0.08 m
Area= 0.028900 m^2 = 28900

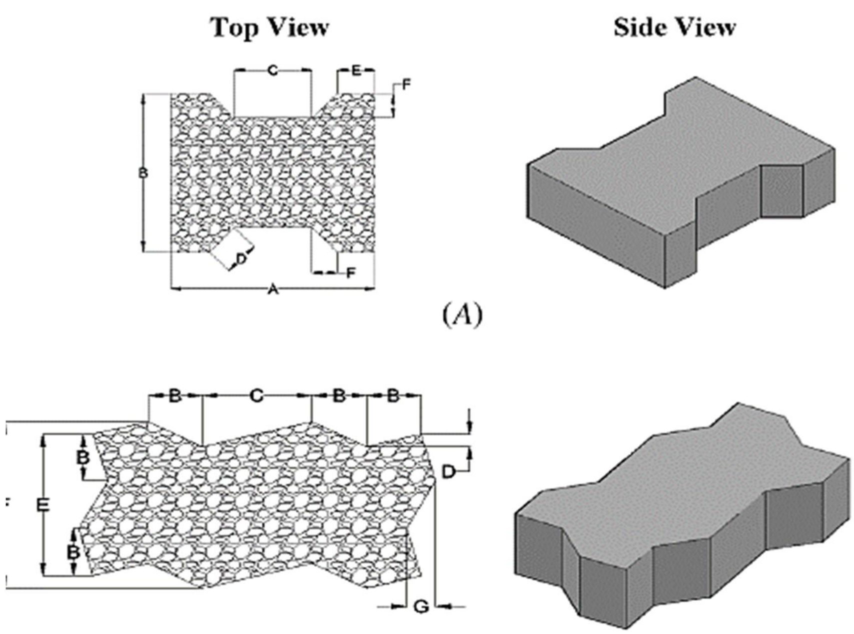
2) Plan Area (Asp) (Method 2)

The specimen should be set up on cardboard, sporting side up, and the perimeter should be sketched with a pencil. With the aid of the scissors, the shape must be precisely reduced, weighted to the nearest 0.0001N, and the result recorded as mass (msp). The plan area for the block must be determined using the formula, and a rectangle measuring 200 mm by 100 mm cut out of similar cardboard shall also be weighted to the closest 0.0001 N, and result recorded as mass (mstd):

$$A_{sp} = \frac{20000 m_{sp}}{m_{std}} mm^2$$

For I-section
Msp= 0.3091 N
Mstd= 0.220 N
Area (Asp) = 28100 mm^2

For Zig-Zag section
Msp= 0.3179 N
Mstd= 0.220 N
Area (Asp) = 28900 mm^2



(B)
Figure 1: Paver Block Area calculation

Table 2: Dimensions and area of different blocks

Shape	A	B	C	D	E	F	G	Surface Area mm2
Dumble	200	163	76	35.4	37	25		28100
Zigzag	225	37.5	75	10	112.5	132.5	20	28900

III. METHODOLOGY

This section shows detailed methodology adopted for this project. In this chapter how paver block is manufactured for experimental work is defined. 60 mm thick Paver block of M-30 grade is stable for the experimental work. For manufacturing of paver blocks sure Steps is accompanied that is given below.

A. Mixing of Materials

1) Concrete Mix Design (M30)

Design Mix For this research, a mix design has been implemented. In general, dry, low slump mixes are required for the production of precast concrete paver blocks. Using the IS code 10262: 2009 and the specifications from the IS code 15658: 2021, a control mix of concrete of the M30 grade was designed.

a) Properties of Materials

- Grade designation : M 30
- Type of cement : OPC 43 confirming to IS 1489 Part (I):1991
- Maximum nominal size of Aggregate: 10 mm
- Minimum cement content: 400 kg/m3
- Workability required: Medium
- Slump needed : 20- 80 mm
- Exposure condition: Severe
- Maximum water cement ratio: 0.40
- Type of aggregate: Crushed angular

b) Target strength for mix proportioning

F'ck = fck + t x sd
Standard deviations – 4 N/mm2
Assuming t = 1.65
Target strength = 30 + 1.65 x 5 = 38.25 N/mm2

c) Selection of water- cement ratio

Maximum water cement ratio = 0.40

d) Selection of water content

From IS – 10262:2009,

Table 3: Mixing proportion of materials

S.no	Natural Aggregates	RAP Aggregates	Cement	Sugarcane Baggase	Sample Remarks
1	100%		100%		S0
2		100%	100%		S1
3	50%	50%	100%		S2
4	100%		90%	10%	S3
5	100%		80%	20%	S4

6		100%	90%	10%	S5
7		100%	80%	20%	S6
8	50%	50%	90%	10%	S7
9	50%	50%	80%	20%	S8

M30 concrete mix design -Steps|IS-10262:2009 |IS-456:2000

2) For Mix Proportions

The specific mix proportion was chosen to examine the performance and applicability of pervious concrete paver blocks (PCPB).

B. Materials Used

1) Aggregates

- Natural Aggregates (NA)
- Recycled Asphalt Pavement Aggregates (RAP)

2) Supplementary Material

- Sugarcane Bagasse Ash (SCBA)

3) Binder

- Cement

4) Mix Proportions

- The aggregates were mixed in three different proportions: NA-RAP (0-100), NA-RAP (50-50), and NA-RAP (100-0).
- SCBA-Cement mixture ratios were: SCBA-Cement (0-100), SCBA-Cement (10-90), and SCBA-Cement (20-80).

5) Aggregates Gradation

- Aggregate gradation used was G1 with a range of 9.75mm to 6.3mm.

6) Manufacturing Process:

- Pervious concrete paver blocks were manufactured using a standard factory method.
- The manufacturing process involved mixing the aggregates (NA and RAP) and the SCBA-Cement mixture based on the chosen ratios.
- The process also incorporated insights from previous research and guidance in the field.

C. Objective

The primary objective of this experiment appears to be to assess the performance and applicability of pervious concrete paver blocks made from a combination of recycled asphalt pavement aggregates, sugarcane bagasse ash, and cement. This assessment would likely involve evaluating factors such as infiltration, strength, density, porosity and other relevant properties of the PCPB under different mix proportions.

D. Preparation of Mould

Prepare the mould: Ensure that the mould is clean and free of debris. Apply a release agent to the mould to help the finished product release from the mould.

1) *Mix the Concrete:* Mix the concrete according to the manufacturer's instructions, ensuring that the mixture is well-combined and free of clumps.
2) *Fill the Mould:* Pour the concrete mixture into the mould, ensuring that it is evenly distributed throughout the mould.
3) *Consolidate the Concrete:* Use a vibrating table or other consolidating tool to remove any air pockets and ensure that the concrete is evenly distributed.

4) *Smooth the Surface:* Use a trowel or other tool to smooth the surface of the concrete, ensuring that it is level and free of any bumps or ridges.
5) *Cure the Concrete:* Allow the concrete to cure in the mould for the recommended time, typically 24 to 48 hours.
6) *Release the Finished Product:* Once the concrete has cured, carefully remove the finished paver block from the mould.

Figure 2: Preparation of paver block mould

E. Design of Moulds

Moulds design using I block mould and zigzag block mould

Table 4: Designed mould samples quantity

Moulds	No. of samples
I block Pervious Paver block Mould	108
Zigzag Pervious Paver block Mould	108

We have designed 4 replica sample for one mix and there are 9 mixes selected for designing the paver block. The testing was done at 7, 14 & 28 days. So finally, We have designed 108 total samples for zigzag and 108 total samples for I section. The average values are reported in the manuscript.

For I- section	For Zigzag Section
Cement : 1.16 kg	Cement : 1.25 kg
Aggregates : 3.44 kg	Aggregates : 3.48 kg
Water : 0.160 ltr	Water : 0.160 ltr
Volume of I section = 0.002255 m^3	Volume of Zigzag Section = 0.0022850 m^3

Water Content as per IS code 10262 : 2009

Figure 3: aggregate test

IV. RESULTS AND DISCUSSION

The use of sugarcane bagasse ash in combination with RAP aggregates offers several potential benefits. Firstly, sugarcane bagasse ash is an industrial waste product that is currently underutilized and can be used as a sustainable alternative to traditional cementitious materials. Secondly, the use of RAP aggregates in the paver block can help reduce the demand for virgin aggregates, thereby reducing the environmental impact associated with their extraction and transportation.

Furthermore, the developed pervious paver block offers potential benefits for stormwater management. The water permeability of the paver block allows rainwater to infiltrate into the ground, reducing the amount of stormwater runoff and helping to prevent flooding and erosion. While the results of our investigation are promising, further research is needed to assess the long-term performance of the pervious paver block in actual field conditions. Additionally, the cost-effectiveness of the developed material should be evaluated to ensure its practical feasibility for widespread use.

In conclusion, our study suggests that the use of sugarcane bagasse ash and RAP aggregates in pervious paver block construction has the potential to offer a sustainable and environmentally friendly solution for managing stormwater runoff in low-traffic pavement applications.

A. *Workability of Concrete*

The result of the slump cone test for each grade of concrete has been tabulated in table 5 for each grade of concrete.

Table 5: Workability of Concrete Material mix for paver block

RAP Aggregates	Natural Aggregates	Cement	Sugarcane Bagasse	Workability of material mix (mm)
	100%	100%		89
100%		100%		84
50%	50%	100%		82
	100%	90%	10%	80
	100%	80%	20%	76
100%		90%	10%	71
100%		80%	20%	68
50%	50%	90%	10%	64
50%	50%	80%	20%	60

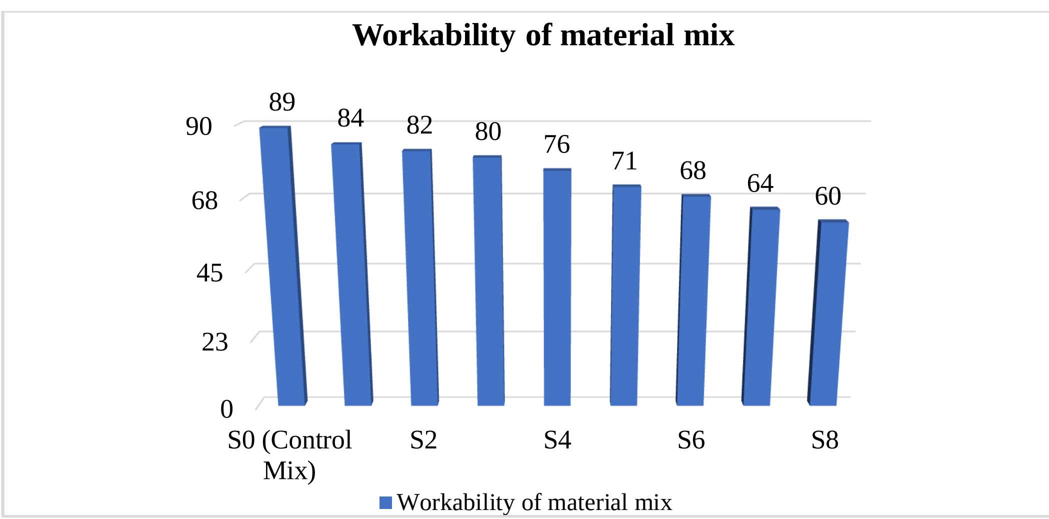


Figure 4: Workability variation at different mixing for samples

Based on the table data, it can be seen that as the amount of sugarcane bagasse ash and recycled aggregate increases, the workability of the material mix decreases. The control mix (S0) had the highest workability with a value of 89 mm, while S8 had the lowest workability with a value of 60 mm. This suggests that higher amounts of these materials in the mix make it more difficult to work with and may require additional efforts to achieve the desired consistency for the paver block. However, it is important to note that other factors such as the water-cement ratio and the use of admixtures can also affect the workability of the concrete material mix.

B. Density of Concrete

The test was conducted to study the variation of density of paver blocks for each grade of concrete. The results have been tabulated in Table 6.

Table 6: Density variation of concrete for paver block

Samples	RAP Aggregates	Natural Aggregates	Cement	Sugarcane Bagasse	Density of paver block for I section (kg/m^3)	Density of paver block for Zigzag (kg/m^3)
S0 (control)		100%	100%		2109	2125
S1	100%		100%		1975	1991
S2	50%	50%	100%		1983	1988
S3		100%	90%	10%	2034	2071
S4		100%	80%	20%	2011	2017
S5	100%		90%	10%	1898	1904
S6	100%		80%	20%	1880	1892
S7	50%	50%	90%	10%	1976	1982
S8	50%	50%	80%	20%	1971	1978

The density variation for the I section paver block represents that which was made using sugar cane bag ash. The control mix (S0) had a density of 2109 kg/m^3. The other samples (S1-S8) had varying densities ranging from 1975 kg/m^3 to 1971 kg/m^3.

The density variation for the Zigzag section paver block is made using sugar cane bag ash. The control mix (S0) had a density of 2125 kg/m^3. The other samples (S1-S8) had varying densities ranging from 1991 kg/m^3 to 1978 kg/m^3. It appears that as the amount of sugar cane bag ash in the mix increased (from S1 to S8), the density of the paver blocks decreased. The control mix (S0) had the highest density, while S5 and S6 had the lowest densities. However, it's important to note that without additional information about the composition of each sample, it's difficult to draw definitive conclusions about the effect of sugar cane bag ash on paver block density. Other factors such as the particle size and shape of the ash, the mixing procedure, and the curing process could also be influencing the results.

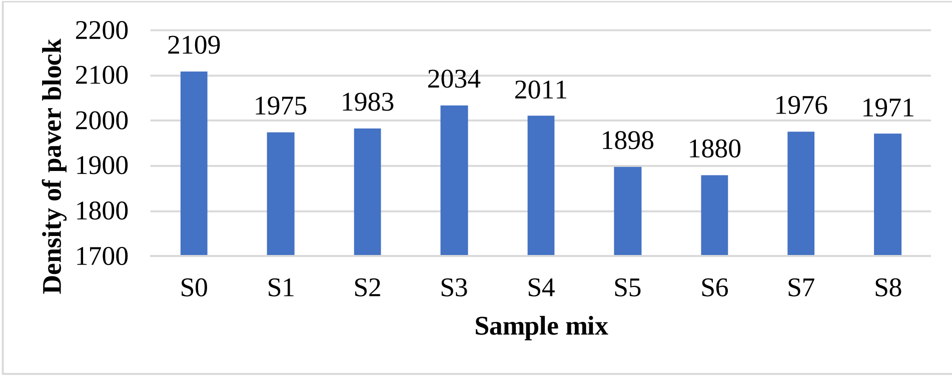


Figure 5: Density variation of paver block concrete

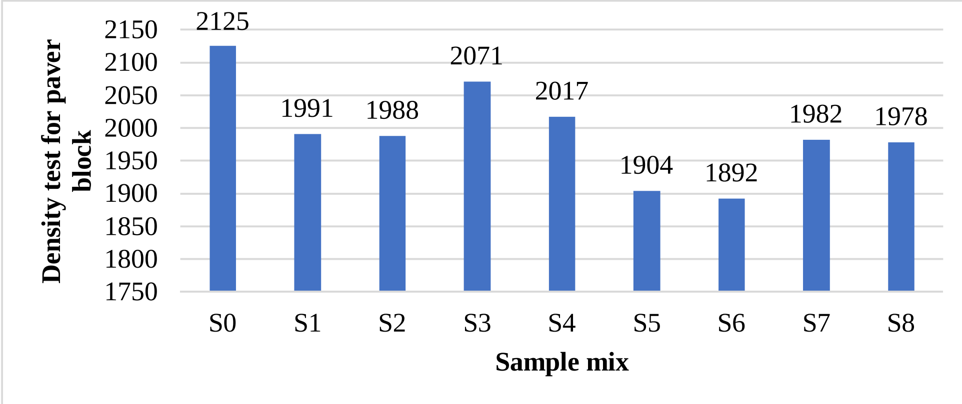


Figure 6: Density variation of paver block concrete

C. Water Absorption

The exam Table 7 lists the results of the water absorption test. Table 7 shows that water absorption of paver blocks of all shapes increases up to a replacement rate of 5% before falling again at a replacement rate of 10% for cement. The biggest reduction in water absorption, however, happens with a 10% cement substitution. Water absorption for all paver block forms is greater than control mix for 5% cement substitution. The highest water absorption occurs at 5% replacement, which is lower than the 6% maximum limit defined in IS 15658-2021.

$$\% \text{ Water Absorption} = [(WW - DW) / DW] \times 100$$

Where, WW = Wet Weight of paver block, DW = Dry Weight of paver block

Table 7: Water Absorption test

Water absorption test		
Samples	I section	Zigzag
S0 (Control mix)	2.3	2.4
S1	2.2	2.3
S2	2.5	2.45
S3	1.8	1.6
S4	2.1	2.2
S5	1.9	1.9
S6	2.2	2
S7	2	2.3
S8	1.9	2

The table shows the results of water absorption tests for paver blocks made with sugar cane bag ash. Two types of water absorption tests were conducted: the I section test and the zigzag test. The results indicate the percentage of water absorbed by each sample after being submerged in water for a specified period.

Based on the table data, the following interpretations can be made:

- The control mix (S0) had a water absorption rate of 2.3% and 2.4% for the I section and zigzag tests, respectively.
- The samples made with sugar cane bag ash (S1-S8) had varying water absorption rates compared to the control mix.
- Sample S3 had the lowest water absorption rate of 1.8% and 1.6% for the I section and zigzag tests, respectively.
- Sample S2 had the highest water absorption rate of 2.5% and 2.45% for the I section and zigzag tests, respectively.
- The other samples (S1, S4-S8) had water absorption rates that were relatively close to the control mix, with variations of only 0.1-0.3%.

Overall, the results suggest that the use of sugar cane bag ash in paver block production may have some impact on water absorption rates, but the variations are relatively small. Additional tests and analysis may be necessary to fully understand the effects of sugar cane bag ash on the water absorption properties of paver blocks.

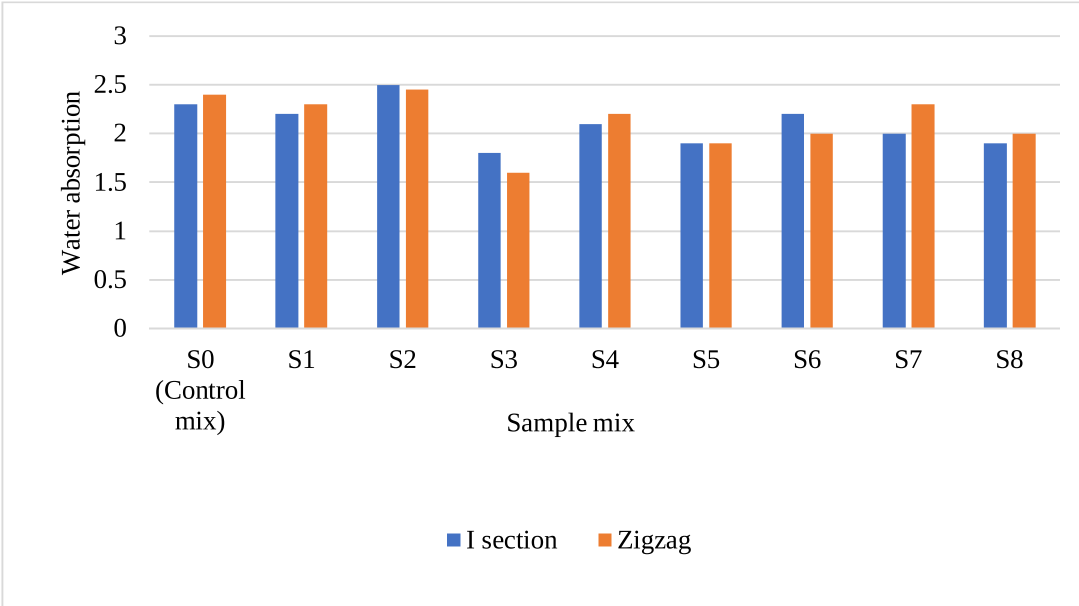


Figure 7: water absorption test for paver blocks.

D. *Strength Test Analysis for paver block*

We tested all designed paver block samples at the compression test machine. We apply KN load on the machine to check the compressive strength of the designed paver block with I section and Zigzag section.

Table 8: Compressive strength for I section pervious paver block

Strength For I section pervious paver block			
Sample Remark	7 Days	14 Days	28 Days
S0 (Control mix)	22.50	29.42	34.61
S1	18.49	24.17	28.44
S2	20.87	27.29	32.11
S3	18.93	24.76	29.13
S4	17.69	23.14	27.22
S5	17.37	22.72	26.73
S6	16.53	21.62	25.43
S7	17.60	23.02	27.08
S8	16.89	22.08	25.98

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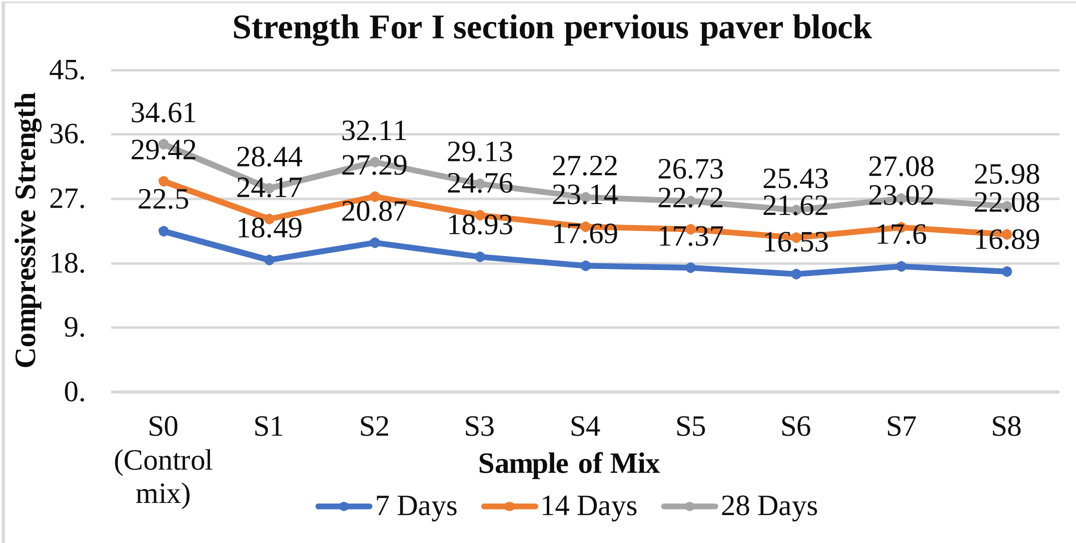

Figure 8: Compressive strength for I section pervious paver block at 7, 14, and 28 days

Based on the provided compressive strength data for the "I section pervious paver block" across different curing durations, interpretation of the results are:

The table you provided showcases the strength values of different mixes of I section pervious paver blocks at three different time intervals: 7 days, 14 days, and 28 days. Just like the Zigzag section paver blocks, this type of testing measures how the strength of a mix matures over time. Here's an interpretation of the provided data:

1) *Control Mix (S0)*
- At 7 days, it showcases a strength of 22.50.
- By 14 days, it increased to 29.42.
- At 28 days, the strength matures further to 34.61. This mix serves as the benchmark against which other mixes are evaluated.

a) *Mix S1:* The strength values at 7, 14, and 28 days are 18.49, 24.17, and 28.44 respectively. S1 consistently shows lower strength values across all the time durations when compared to the control mix (S0).
b) *Mix S2:* Strength values are 20.87 at 7 days, 27.29 at 14 days, and 32.11 at 28 days. While this mix starts weaker than the control mix at 7 days, it narrows the gap over time but remains weaker than S0 at all stages.
c) *Mix S3:* This mix demonstrates strengths of 18.93, 24.76, and 29.13 at 7, 14, and 28 days respectively. Like S1, it remains consistently weaker than the control mix across all durations.
d) *Mix S4:* The strength values for this mix are 17.69 at 7 days, 23.14 at 14 days, and 27.22 at 28 days. It continues to demonstrate lower strengths than both the control mix and most of the prior mixes at all durations.
e) *Mix S5:* Strengths of 17.37, 22.72, and 26.73 are seen at 7, 14, and 28 days respectively. S5 is relatively weaker across all intervals, only marginally stronger than S6.
f) *Mix S6:* This mix, with strength values of 16.53, 21.62, and 25.43 at the respective durations, emerges as one of the weakest mixes among all.
g) *Mix S7:* Strengths are showcased as 17.60 at 7 days, 23.02 at 14 days, and 27.08 at 28 days. S7 exhibits a slight rebound in strength when compared to S6, but it remains weaker than the control mix.
h) *Mix S8:* With strengths of 16.89, 22.08, and 25.98, this mix is among the weaker ones, especially by the 28-day mark.

2) *Summary*

a) The Control Mix (S0) is the strongest among all samples by the 28-day interval, having a strength of 34.61.
b) S2 comes close to the control mix but remains weaker throughout the testing period.
c) S6 and S8 appear to be the weakest, especially when the 28-day strength is considered.
d) There's a clear maturity in strength from 7 days to 28 days for all mixes, highlighting the importance of the curing period.

From a practical standpoint, S0 remains the most desirable mix for long-term strength. The choice between other mixes would depend on specific strength requirements and the timeframe in which those strengths are needed.

E. Compressive Strength of Zigzag section

Table 9: Compressive strength for **Zigzag** section pervious paver block

Strength For Zigzag section pervious paver block (MPa)			
Sample Remark	7 Days	14 Days	28 Days
S0 (Control mix)	19.84	31.06	36.54
S1	19.51	25.52	30.02
S2	21.57	28.21	33.19
S3	19.98	26.13	30.74
S4	18.56	24.27	28.55
S5	17.68	23.12	27.20
S6	17.43	22.79	26.81
S7	19.09	24.96	29.37
S8	17.02	22.26	26.19

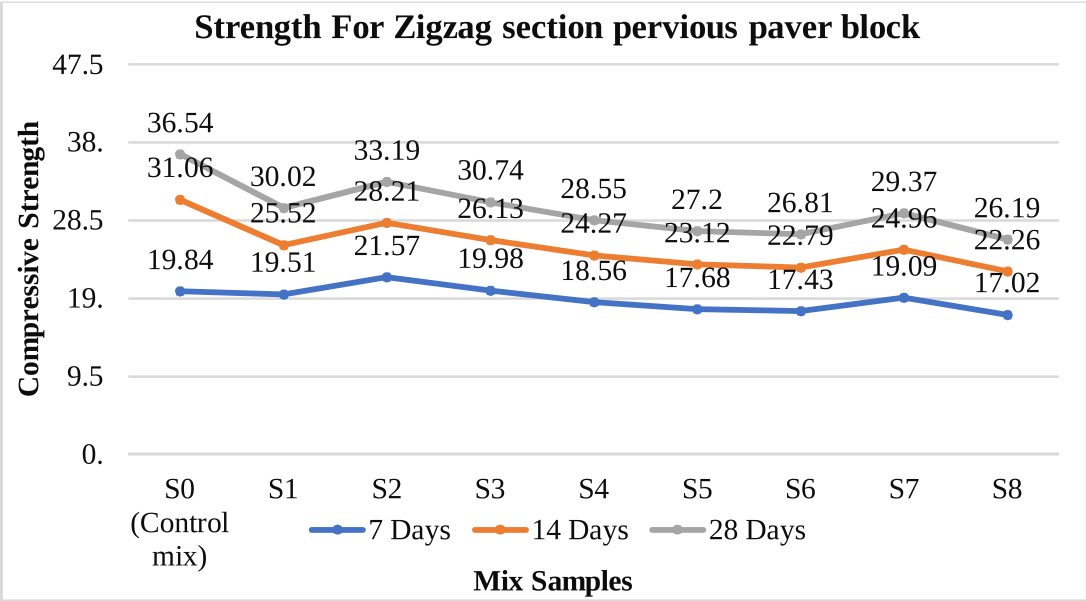

Figure 9: Compressive strength for Zigzag section pervious paver block at 7, 14, and 28 days

The table 9 shows the strength values of different mixes of pervious paver blocks at three different time intervals: 7 days, 14 days, and 28 days. This type of testing is often done to see how the strength of a mix matures over time. Here's an interpretation of the data:

1) *Control Mix (S0)*

- At 7 days, it has a strength of 19.84.
- By 14 days, it increased to 31.06.
- At 28 days, the strength matured to 36.54. This mix is the standard by which other mixes are compared.

a) *Mix S1:* The strength values at 7, 14, and 28 days are 19.51, 25.52, and 30.02 respectively. This mix shows lower strength values across all durations compared to the control mix (S0).

b) *Mix S2:* Strength values are 21.57 (7 days), 28.21 (14 days), and 33.19 (28 days). This mix started stronger than the control mix at 7 days, but ended up weaker by 28 days.

c) *Mix S3:* This mix has strengths of 19.98, 26.13, and 30.74 at 7, 14, and 28 days respectively. This mix performs similarly to S1, with strengths generally below the control mix but slightly stronger than S1.

d) *Mix S4:* The strength values for this mix are 18.56 (7 days), 24.27 (14 days), and 28.55 (28 days). This mix is consistently weaker than the control mix and most of the prior mixes at all durations.

e) *Mix S5:* At 7, 14, and 28 days, the strengths are 17.68, 23.12, and 27.20 respectively. This mix continues the trend of declining strength compared to prior mixes.

f) *Mix S6:* This mix has strength values of 17.43, 22.79, and 26.81 at the respective durations. It's even weaker than S5 across all intervals.

g) *Mix S7:* Strengths are 19.09 (7 days), 24.96 (14 days), and 29.37 (28 days). This mix rebounds slightly from the declining trend seen in S5 and S6 but remains below the control mix.

h) *Mix S8:* With strengths of 17.02, 22.26, and 26.19, this mix is among the weakest, particularly by the 28-day mark.

i) From an application perspective, the choice of mix would depend on the required final strength and the time within which the strength is desired. For instance, if one needs a strong mix quickly, S2 may be suitable. However, for long-term strength, the control mix (S0) might be the preferred choice.

F. *Porosity Test for Paver Block*

The porosity test was carried out in accordance with IS-15658-2021.

Table 10: Porosity test for paver block

Sample of Mix	Porosity Ratio (%) for 'I section'	Porosity Ratio (%) for Zigzag
S0 (Control mix)	19.8	18.7
S1	17.11	16.96
S2	18.78	17.92
S3	21.89	21.57
S4	24.05	23.22
S5	16.11	17.61
S6	20.54	19.65
S7	18.74	19.22
S8	19.21	20.18

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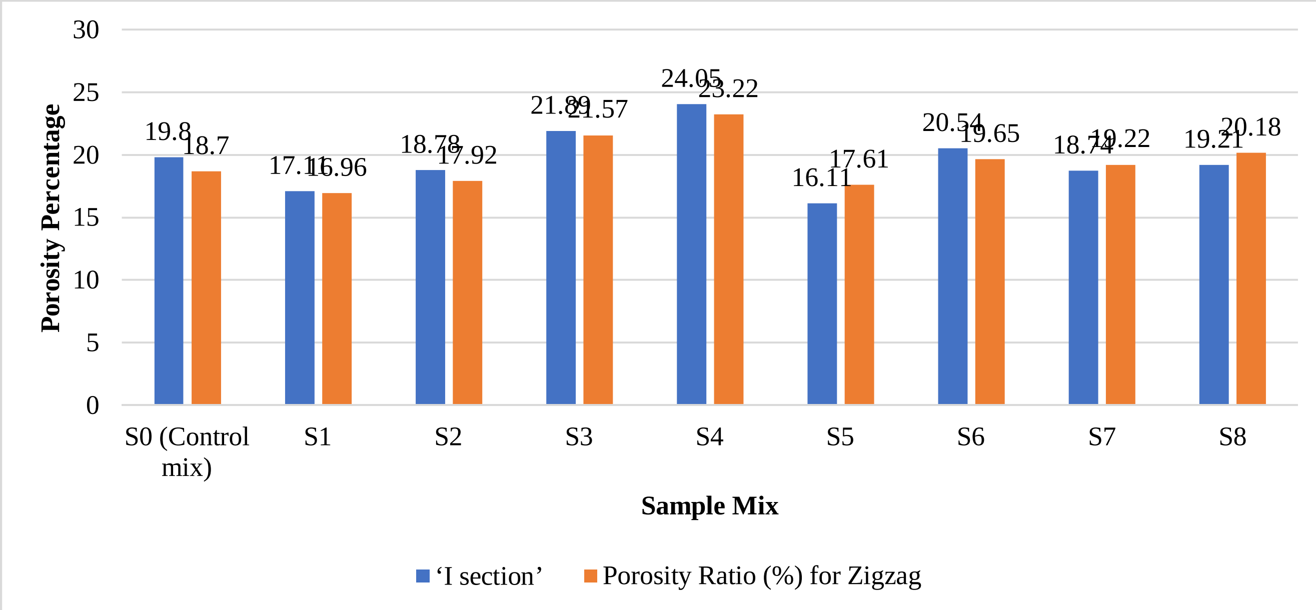

Figure 10: Porosity percentage variations for paver block

The table shows the results of a porosity test for two types of paver blocks: "I section" and "Zigzag". The control mix (S0) had a porosity ratio of 19.8% for I section and 18.7% for Zigzag. The other samples (S1 to S8) had varying porosity ratios for both types of paver blocks. The porosity ratio is the percentage of voids in a material, which indicates its ability to allow water or air to pass through. In this case, the porosity ratio represents the percentage of voids in the paver blocks.

Looking at the data, we can see that the porosity ratio generally increases as the sample number increases, meaning that the blocks become more porous. The S5 sample had the lowest porosity ratio after the control mix, indicating that it is the least porous.

The data suggests that the type of paver block and the mix used can have an impact on the porosity ratio, with some mixes resulting in significantly more porous blocks than others. This information can be useful for determining the best mix to use for a particular application, depending on the desired level of porosity.

G. Infiltration Test

The infiltration test is a method used to determine the rate at which water can infiltrate, or penetrate, into the soil or other porous media. It is a crucial parameter for various engineering applications, especially in hydrology, agriculture, and civil engineering, where understanding water movement is critical.

Table 11: Infiltration Test for I section and Zigzag section

Sample Remark	Zigzag section, Infiltration Rate (mm/hr)	I section, Infiltration Rate (mm/hr)
S0 (Control mix)	150	152
S1	165	160
S2	155	155
S3	163	158
S4	170	163
S5	175	167
S6	180	168
S7	172	162
S8	182	170

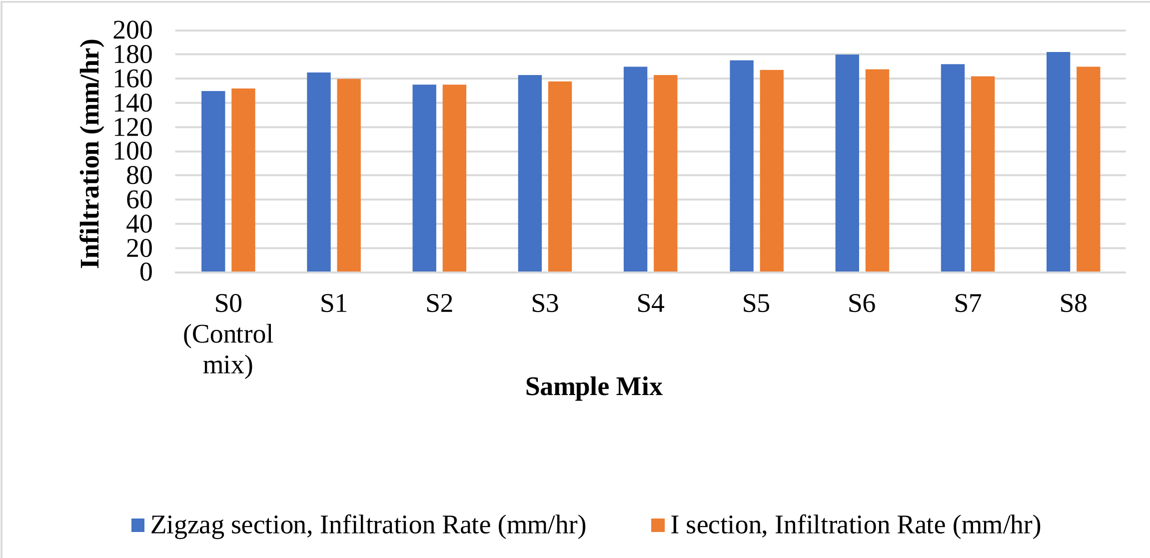

Figure 11: Infiltration test for pervious paver block

V. CONCLUSIONS

The present study aimed to investigate the viability of using sustainable materials—specifically, sugarcane bagasse ash and recycled asphalt pavement (RAP) aggregates—in the development of pervious paver blocks. A range of mix designs were experimentally analyzed to evaluate their physical properties such as permeability and compressive strength. The study also explored the performance differences between 'I section' and 'Zigzag section' paver blocks.

The control mixes (S0) for both 'I' and 'Zigzag' sections demonstrated the highest compressive strength across all curing times, providing a benchmark for the study. In general, the strength decreased as the proportion of sugarcane bagasse ash and RAP aggregates increased. However, it was observed that the strength reduction was not significant enough to entirely discount these sustainable materials as feasible alternatives for certain applications.

A. Comparative Analysis of 'I' and 'Zigzag' Sections

Both 'I' and 'Zigzag' sections demonstrated similar trends concerning compressive strength, though the Zigzag section had a slightly higher maximum compressive strength at 28 days. Specific samples, such as S2 in the 'I' section and S3 in the 'Zigzag' section, showed promising results, approaching the compressive strength of their respective control mixes. This suggests potential for optimization.

B. Practical Implications

1) *Sustainable Construction:* Utilizing sugarcane bagasse ash and RAP aggregates in paver blocks not only aligns with eco-friendly construction practices but also aids in waste management.
2) *Customization:* Different mixes offer varied compressive strength and permeability rates, allowing for customization based on the application's specific requirements.
3) *Cost-Efficiency:* While not directly investigated in this study, using recycled or waste materials could potentially lead to cost savings in large-scale manufacturing.
4) *Application-Specific Decision:* The study indicates that if compressive strength is a primary concern, the Zigzag section may be more appropriate. However, the 'I' section should not be discounted, especially when other factors such as aesthetics, ease of installation, and cost are considered.

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