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INNOVATIVE SOLUTIONS FOR URBAN LITTER: UTILIZING CIGARETTE BUTTS IN FOOTPATH PAVER BLOCKS

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ABSTRACT-

Innovative urban environmental protection strategies are being explored, one of which involves the incorporation of cigarette butts into concrete. This approach not only addresses the issue of cigarette waste but also mitigates the urban heat island effect caused by concrete.

The study focuses on understanding the impact of the cigarette butt content on the mechanical properties of footpath paver block. The cigarette butts are first cleaned, dried, and then hardened using bitumen. They are then mixed into the concrete cubic block at varying concentrations 0%,5%,7.5%and 10% of the total volume of concrete.
A uniaxial compression test is performed to assess the strength of the footpath paver block. The findings suggest a decline in concrete robustness with an escalating proportion of cigarette butt content .However, the decrease in strength is gradual if the cigarette content does not exceed 10%, with the maximum strength loss being 12%. Beyond a cigarette content of 10%, the strength reduction is more pronounced, reaching a 25% loss at a cigarette butt content.

Interestingly, the failure pattern of the concrete shows improved ductility with the increase in cigarette butt content. In contrast, concrete without any cigarette content shatters into many pieces upon failure. This study provides valuable insights into the potential of using cigarette butts in concrete for urban environmental protection.

INTRODUCTION

Urban environments are grappling with two significant issues: the accumulation of litter, particularly cigarette butts, and the need for sustainable construction materials. This research paper explores an innovative solution that addresses both these challenges: the use of cigarette butts in the production of footpath paver blocks.

Cigarette butts, a common form of urban litter, pose a significant environmental problem due to their non-biodegradable nature and the toxic chemicals they contain. On the other hand, the construction industry is constantly seeking sustainable and cost-effective materials. This study proposes a novel approach that not only helps manage cigarette waste but also contributes to the production of sustainable construction materials.

The paper will delve into the process of incorporating cigarette butts into the production of footpath paver blocks. It will examine the impact of this incorporation on the properties of the paver blocks, including their strength and durability.

The research aims to provide a comprehensive understanding of the potential benefits and challenges of this innovative approach.

By bridging the gap between waste management and sustainable construction, this research hopes to contribute to the development of urban environments that are not only cleaner and more sustainable but also more resilient and adaptable to changing environmental conditions. The findings of this study could pave the way for more such innovative solutions that turn urban waste into valuable resources. Addressing cigarette butt litter through proper disposal methods and awareness campaigns is crucial to preserve the environment, protect wildlife, and safeguard ecosystems from the detrimental effects of this prevalent form of litter.

LITERATURE REVIEW

Urban litter, particularly cigarette butts (CBs), poses a significant environmental challenge. However, recent studies have proposed innovative solutions to this problem by incorporating CBs into construction materials. This literature review focuses few studies.

Utilizing Cigarette Butts in Concrete

The first study, conducted by Luo Tao, Zhang Zhaojing, Zhang Jinliang, Sun Chaowei, and Ji Yanjun from the Shaanxi Key Laboratory of Safety and Durability of Concrete Structures, Xijing University, China, explored the potential of utilizing CBs in the construction of footpath paver blocks.

The researchers incorporated CBs into concrete at varying concentrations and conducted a uniaxial compression test on the concrete cubes. The results indicated that as the amount of CBs increased, the strength of the concrete decreased. However, the addition of CBs enhanced the plastic behavior of the concrete, indicating stronger ductility.

Despite the decrease in strength, the researchers observed that the integrity of the concrete during destruction was better with the increase in the content of CBs, showing improved ductility. This study provides a promising avenue for the utilization of CBs in the construction of footpath paver blocks.

Recycling Cigarette Butts in Stone Mastic Asphalt :The second study, carried out by Md Tareq Rahman and Abbas Mohajerani from the School of Engineering, RMIT University, Melbourne, Australia, investigated the recycling of CBs in stone mastic asphalt (SMA) using bitumen encapsulated CBs.

The researchers prepared SMA samples with different percentages of bitumen encapsulated CBs as aggregate. The results showed a significant improvement in the strength when CBs were incorporated in the SMA mix.

Performance tests like the asphalt resilient modulus test were performed on the samples at different temperature conditions. A notable increase in the resilient modulus was found when samples were prepared with bitumen encapsulated CBs.

The incorporation of 2% of encapsulated CBs in SMA could recycle about 15 kg of CBs in each cubic meter of stone mastic asphalt. The results found in this study were promising and demonstrated the possibility of recycling bitumen encapsulated CBs in stone mastic asphalt.

METHODOLOGY

A. Material Used: - There are mainly 4 types of materials that we have used for Utilizing Cigarette Butts in Footpath Paver Blocks: -

I. **Cement**: Cement is a binding material used in construction that sets, hardens, and adheres to other materials, binding them together. It is often mixed with sand and water to create concrete. In the context of the research, cement would be used as a primary binding agent in the creation of footpath paver blocks.

II. **Aggregates**: Aggregates are solid materials found naturally and are highly used in construction for providing base. In the research, aggregates varying between size 1.9cm to 5.1cm were used. The vital properties of aggregates include strength, durability, toughness, and hardness.

III. **Sand**: Sand is a granular material composed of finely divided rock and mineral particles. It is a common ingredient in concrete and is used to fill the spaces between aggregate particles, helping to reduce the amount of cement required and thus reducing the overall cost of the concrete.

IV. **Bitumen**: Bitumen is a semi-solid type of hydrocarbon that is highly viscous and waterproof, making it an ideal binder for asphalt. In the research, a 60/70 grade of bitumen was used. Bitumen's vital properties include adhesion, resistance, strength, ductility, and its economics. The researchers prepared stone mastic asphalt (SMA) samples with different percentages of bitumen-encapsulated cigarette butts as aggregate. The results showed a significant improvement in the strength when cigarette butts were incorporated in the SMA mix.

Test for bitumen:

S.No.	Test	Result
1	Penetration test	74mm
2	Ductility test	66mm
3	Flash point test	193.22 c
4	Fire point test	202 c

B. Procedure

We establish dedicated programs to gather discarded cigarette butts from public spaces like hotels and restaurants. We develop treatment methods to process collected cigarette butt fibers. This includes processes to remove toxins, clean, and prepare the fibers for integration into construction materials like concrete. W selected the types of concrete mix that will be used in the experiment. The selection was based on the compatibility of the mix with the treated cigarette butt fibers. We selected the materials that will be used in the concrete mixture. This includes aggregates, cement, sand, and treated cigarette butts. We ensure that the materials are clean, properly sized, and ready for mixing. We encapsulated the treated cigarette butts with the concrete mixture. And distributed the cigarette throughout the mixture to ensure a uniform composition. Then we prepared and conditioned samples of the mix with the selected materials, including the encapsulated cigarette butts. The samples were prepared at varying concentrations of cigarette butts (0%, 5%,7.5%, 10%) of the total volume of concrete to test the effect of different concentrations on the properties of the concrete. We allowed the prepared samples to cure. Curing is a process that involves maintaining the moisture content and temperature conditions of concrete for hydration reaction. We conducted laboratory testing on the cured samples. This could include tests for compressive strength, water absorption, and other relevant properties. Finally, we analyzed the results of the laboratory tests. Also, the properties of the samples with different concentrations of cigarette butts to determine the optimal concentration for the desired properties.

SITE WORK: Site work is performed at Dolakha,Nepal

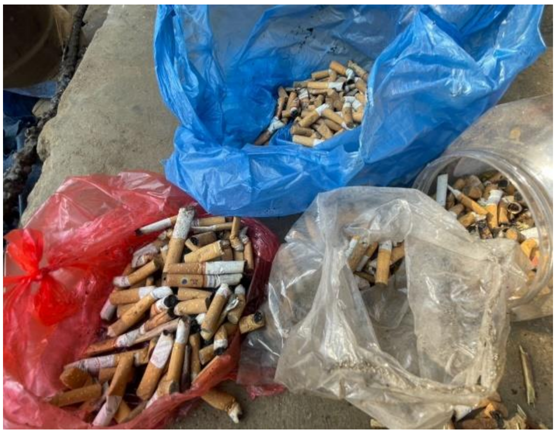


Fig 1: Collection of Cigarette butts

Fig 2: Heating Bitumen

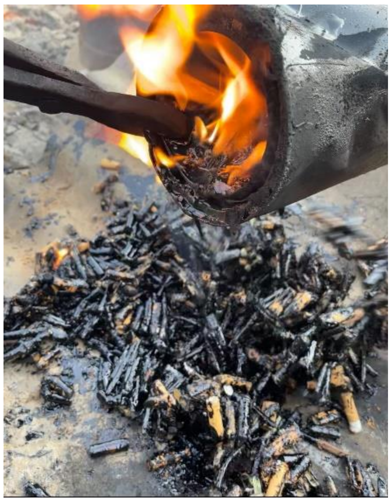


Fig 3: Pouring and mixing Cigarette butt and bitumen

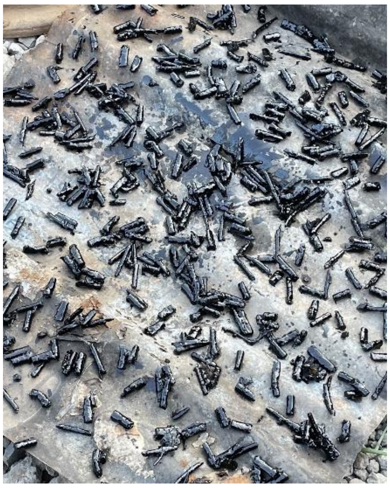


Fig 4: Drying Encapsulated Cigarette butt

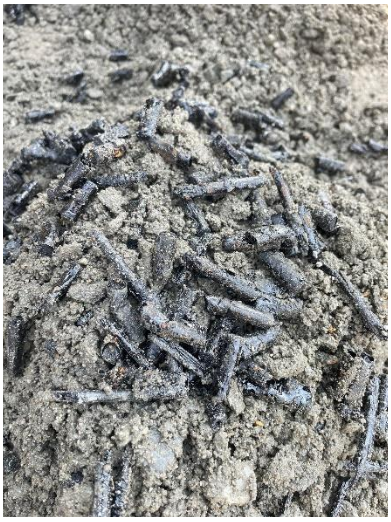


Fig 5:Mixing cigarette butt and concrete

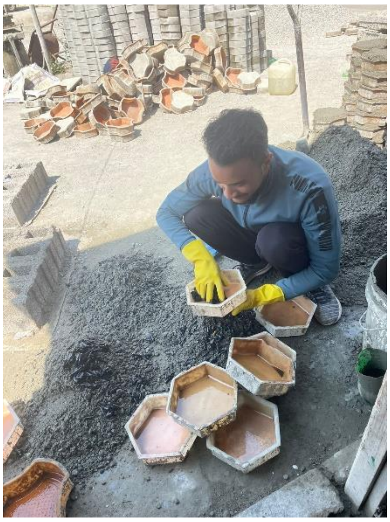
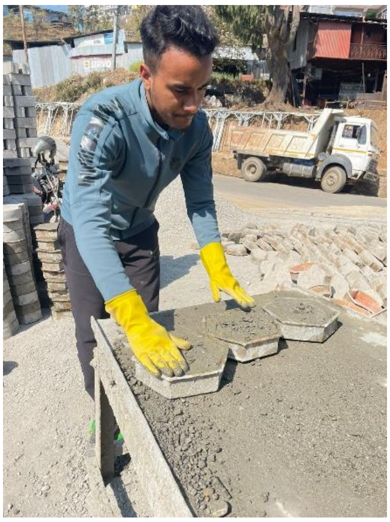


Fig 6: Oiling the paver block mould



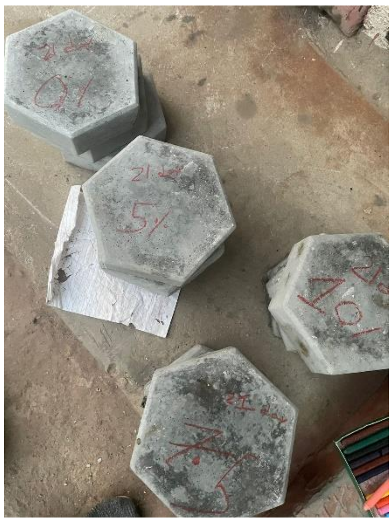


Fig 6: Pouring the mix in mould

Fig 7: Using table vibrator for proper distribution of mix

Fig 8: Hexagonal Paver block with encapsulated cigarette butt

RESULTS:

Table No:1

The table presents the test results for the materials used in M35 grade paver block. These include the fineness, setting times of 53 grade Ordinary Portland Cement, as well as the particle size distribution, crushing value, impact value, and water absorption of coarse aggregate and sand. These values are in accordance of quality of the materials used in the paver block.

Material	Property	Standard Value	Unit
Cement (53 grade OPC)	Fineness	225	m²/kg
	Setting Time (Initial)	30	minutes
	Setting Time (Final)	600	minutes
Coarse Aggregate	Particle Size Distribution	20 mm max. size	-
	Crushing Value	30% max.	-
	Impact Value	30% max.	-
	Water Absorption	2% max.	-
Sand (Fine Aggregate)	Silt Content	4% max.	-
	Water Absorption	1% max.	-

Table No.2:

The table presents the estimated compressive strengths of M35 grade concrete at 3, 14, and 21 days with the addition of 5%, 7.5%, and 10% cigarette butts. The compressive strength is a key property of concrete that determines its ability to withstand loads without breaking. The addition of cigarette butts to the concrete mix can affect the compressive strength.

Cigarette Butt Addition (%)	Compressive Strength (3 days)	Compressive Strength (14 days)	Compressive Strength (21 days)	Cost (NPR)
0	14	31	32.5	60
5	12.18	27.405	28.623	57
7.5	11.55	25.9875	27.1425	55.5
10	10.92	24.57	25.77	54

The addition of up to 7.5% cigarette butts to M35 grade paver blocks can potentially reduce material costs without significantly compromising their compressive strength, making it a feasible and economical solution for non-traffic areas. However, the process needs to be optimized to minimize the additional manpower needed for mixing the cigarette butts into the concrete.

CALCULATIONS:

Volume of the Hexagonal Paver Block:

Length (L) = 226 mm = 0.226 m

Width (W) = 200 mm = 0.2 m

Thickness (T) = 60 mm = 0.06 m

Volume = L x W x T = 0.226 x 0.2 x 0.06 = 0.00271 m³

Concrete Mix Design for M35 Grade:

The recommended mix ratio for M30 concrete is 1:0.5:1 (cement:sand:aggregate).

This means for every 1 part cement, you need 0.5 parts sand and 1 parts aggregates.

Calculation of Cement, Sand, and Aggregate: Let's assume the total weight of the hexagonal paver block is W kg. The volume of concrete in the block is 0.00271 m³. Therefore, the weight of concrete in the block is

W = 0.00271 x density of concrete.

Density of Concrete: The density of concrete varies based on the mix design and aggregates used. A typical value is around 2400 kg/m³.

Weight of Concrete:

W = 0.00271 x 2400

= 6.504 kg

Cement Weight:

Cement weight = (1/2.5) x W (since the sum of ratios is 2.5).

Cement weight = (1/2.5) x 6.504

= 2.602 kg

Sand Weight:

Sand weight = (0.50/2.5) x W. Sand weight

= (0.50/2.5) x 6.504

= 1.301 kg

Aggregate Weight:

Aggregate weight = (1/2.5) x W. Aggregate weight

= (1/2.5) x 6.504

= 2.602 kg

Cigarette Butt Volume: Adding 5%, 7.5%, and 10% of cigarette butts to the overall volume. Calculating the volume of cigarette butts for each percentage:

For 5%: 0.05 x 0.00271 = 0.000135 m³

For 7.5%: 0.075 x 0.00271 = 0.000203 m³

For 10%: 0.1 x 0.00271 = 0.000271 m³

Adjusted Concrete Volume: Subtract the cigarette butt volumes from the original concrete volume:

For 5%: Adjusted concrete volume = 0.00271 - 0.000135 = 0.002575 m³

For 7.5%: Adjusted concrete volume = 0.00271 - 0.000203 = 0.002507 m³

For 10%: Adjusted concrete volume = 0.00271 - 0.000271 = 0.002439 m³

Adjusted Weights: Recalculate the weights of cement, sand, and aggregate based on the adjusted concrete volume.
Since the weight of the standard size block, as calculated earlier, is approximately 6.504 kg. If we remove 5%, 7.5%, and 10% of the weight, the weights would be as follows:

For 5% Deduction:
Weight of block = 6.504 kg
Weight of cigarette butt = 0.03 kg
Reduced weight = 6.504 kg - (5/100) * 6.504 kg - 0.03 kg = 6.149 kg
Difference = 6.504 kg - 6.149 kg = 0.355 kg

For 7.5% Deduction:
Weight of cigarette butt = 1.5 * 0.03 kg = 0.045 kg
Reduced weight = 6.504 kg - (7.5/100) * 6.504 kg - 0.045 kg = 5.971 kg
Difference = 6.504 kg - 5.971 kg = 0.533 kg

For 10% Deduction:
Weight of cigarette butt = 2 * 0.03 kg = 0.06 kg
Reduced weight = 6.504 kg - (10/100) * 6.504 kg - 0.06 kg = 5.794 kg
Difference= 6.504 kg -5.794 kg = 0.71 kg

CONCLUSION:

The above findings suggest that up to 7.5% of cigarette butts can be used in the production of M35 grade paver blocks without significantly compromising their compressive strength, making these blocks suitable for non-traffic areas. This innovative solution contributes to the economy and circular economy in several ways. It provides a sustainable method for managing cigarette butt waste, potentially resulting in cost savings in paver block production, and could create jobs in the waste management and construction sectors. Furthermore, it reduces the environmental impact associated with the disposal of cigarette butts.

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