

Light Weight Geopolymer Paver Blocks

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Abstract

Geopolymer paver blocks are paving blocks made from geopolymer concrete, an eco-friendly alternative to conventional Portland cement concrete. Geopolymer concrete is made from industrial byproducts like fly ash and ground granulated blast furnace slag (GGBS). Geopolymer concrete is made by reacting an aluminosilicate source material with an alkaline solution. The source material can be natural minerals like kaolinite or clays, or by-product materials like fly ash, slag, silica fume, metakaolin, rice husk ash, or red mud. The activator solution is a combination of Na_2SiO_3 and NaOH . Geopolymer paver blocks are more resistant to corrosion, acid attack, and chemical attack than Portland cement concrete. They are more environmentally friendly because they consume less energy and don't release CO_2 during production.

Geopolymer concrete is also used in precast slabs, pipes, bricks, and tiles.

Key words: Geopolymer concrete, granulated blast furnace

Introduction

Geopolymer blocks represent a significant advancement in sustainable construction practices. Geopolymer concrete is a novel alternative to traditional Portland cement concrete, offering a more environmentally friendly option for various applications like street roads and construction sites. These concrete are produced using materials made from industrial byproducts like ground granulated blast furnace slag, fly ash and other aluminosilicate materials, reducing the reliance on Portland cement that emits large amounts of CO_2 and consumes substantial energy during production. Geopolymer concrete has been developed to address the

environmental challenges posed by cement production, which is a major contributor to CO_2 emissions globally. By utilizing geopolymer technology, these concrete provide a durable and eco-friendly solution that minimizes the carbon footprint associated with conventional concrete production. Geopolymer concrete consists of Fly ash, Ground granulated blast furnace slag, Crusher dust, Super plasticizer, Sodium hydroxide & Sodium silicate. with paver or concrete sealer every two years to prevent stains. The individual cellular structure is narrow and hollow, with thick walls of cellulose. It is pale in colour at immature stage but with age becomes hardened and yellow with deposition of lignin layer. Each cell is about 1mm long with diameter 10-20 μm . Generally length of fibre is found between 10 to 30 cm. Coconut coir has about 48% of lignin which adds strength and elasticity to the cellulose based fibre walls. Since lignin resists biodegradation, high lignin content also imparts longevity to outdoor applications. Coir fibre nearly takes more than 20 years to decompose.

LITERATURE SURVEY

Design and Classification of Paving Blocks Normally,

Ismail et.al (2014) found that the cementation phenomena of geopolymer concrete is caused by the polycondensation of aluminosilicate. Based only on indications, the microstructures of fly ash and alkali-activated slag geopolymers have been extensively investigated. Due to the chemical and physical differences between fly ash and slag ingredients, as well as the effects of varying activator concentrations and chemistries, significant structural, mechanical, and physical differences, have been found in activated binders using precursors from different sources.

2. Radhakrishna (2015): give examples of the many techniques used to create mortar specimens in order to determine the ideal dry density. Experimental data was

used to examine strength qualities utilizing different factors. In order to build geopolymer blocks with the appropriate strength of outcomes, it helps to develop a phenomenal model to create with various combinations of materials. The models' validity was assessed using a collection of diverse experimental data. The result displays the same expected values when compared to the experimental data.

3. Tawalare et al. (2018) concluded that the requirement for greener concrete for sustainable development is unquestionably being addressed by the study on geopolymer concrete. To create the geopolymeric binder phase, which binds the aggregate to create geopolymer concrete, fly ash can be utilized. The influence of the concentration of the NaOH solution revealed that when the alkaline to fly ash ratio increased from 2 to 2.5, the compressive strength likewise increased. The compressive strength of various geopolymer concrete mixes improves with an increase in alkaline solution. The geopolymer paver block's compressive strength rises as the ratio of $\text{Na}_2\text{SiO}_3/\text{NaOH}$ increases. The geopolymer concrete paver block with natural aggregate had a water absorption that was within tolerance. Geopolymer paver blocks with natural aggregate had lower abrasion resistance **Need for the study**

Geopolymer is considered as a well-liked substitute for conventional cement. Decreases the need for OPC, which increases CO₂ emissions. To locate substitute materials for cement in order to regulate and decrease the amount of carbon dioxide released into the atmosphere during the manufacturing of cement. Fly ash is created significant amount by all thermal power plants and is discarded into the ground. Waste materials like ground-granulated blast furnace slag and fly ash can be used as an exceptional substitute for cement. It has great strength and durability qualities, is inexpensive, and is environmentally friendly. Researching ways to create paver blocks with diverse colors, textures, and patterns to enhance the visual appeal of paved areas.

Cost-effectiveness:

Investigating methods to reduce production costs by exploring alternative materials and manufacturing processes.

Studying the behavior of paver blocks under different loading conditions, such as freeze-thaw cycles, to ensure their long-term performance.

Application suitability:

Identifying the optimal paver block design for specific applications like pedestrian walkways, parking lots, driveways, or low-traffic roads.

Areas of study on paver blocks:

Material properties:

Analyzing the impact of different aggregate types, cement variations, and additives on the strength, durability, and water absorption of paver blocks.

Manufacturing techniques:

Investigating different molding methods and curing processes to optimize quality and consistency.

Mechanical testing:

Conducting compressive strength tests, flexural strength tests, and abrasion resistance tests to assess the performance of paver blocks.

Environmental impact assessment:

Evaluating the carbon footprint of paver block production and exploring ways to minimize it.

Performance Analysis & Testing

The **experimental program** in a research study involving construction materials, such as lightweight concrete, focuses on systematically investigating the physical, chemical, and mechanical properties of the materials used and how they perform under different conditions. The goal of such a program is to assess the suitability of the materials for specific applications and to evaluate how various factors, such as material composition, curing methods, and environmental conditions, impact the properties of the concrete. The following outlines the experimental program for material characterization and property testing in a study on lightweight concrete.

Objective

The primary objective of paver blocks is to provide a durable, aesthetically pleasing, and easily maintainable surface for walkways, driveways, roads, and other outdoor areas, primarily due to their interlocking design which allows them to withstand heavy loads and weather conditions while offering flexibility in installation and design options.

Durability:

They are made from high-quality concrete, enabling them to resist cracking and withstand heavy traffic.

Interlocking mechanism:

The design allows blocks to interlock with each other, distributing weight evenly and preventing shifting.

Aesthetic appeal:

Paver blocks come in various shapes, sizes, and colors, allowing for customization in design.

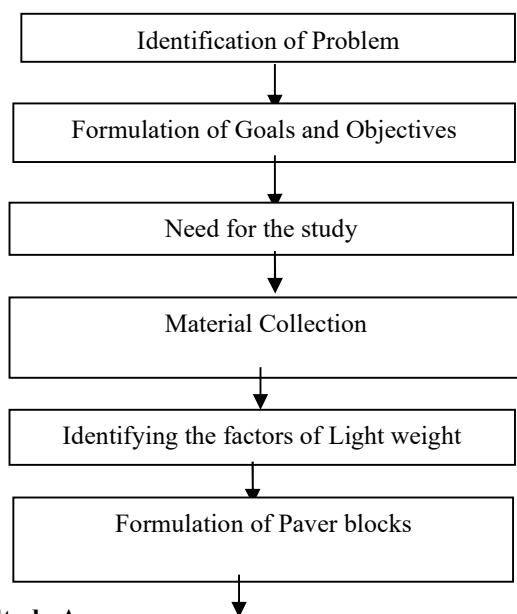
Ease of installation and maintenance:

Compared to other paving materials, paver blocks are relatively easy to install and repair.

Water permeability:

Some paver blocks are designed to be porous, allowing rainwater to drain through and reducing surface runoff.

Methodology



Study Area

The best part about the paver block market is that it serves a variety of sectors, and as such, paves the way for tapping into numerous applicable segments (including residential and industrial).

Usually, paver blocks are made from concrete that is poured into forms. These blocks can be used to create any type of surface, including brick pavers, flagstone pavers, stamped concrete, etc. For that reason, they are

available in various sizes and shapes, and they have different textures to them.

Software Used

- The model of the paver block interaction using the FDM printer (FDM) approach has been implemented in the '3D printer'.
- The modeling tool which is an object-oriented simulation environment allows the development of interaction models with significantly less effort than using traditional programming languages.
- It has a user-friendly graphical interface and supports modular program development.

Data Collection

Concrete blocks are mass manufactured to standard sizes. Hence, they can be easily interchanged. A typical concrete block has two surfaces - one is smooth, and the other is a rough surface. The concrete paving blocks are most suitable for heavy-duty applications, able to support substantial loads and resist shearing and braking forces. The concrete blocks come in various colors. The colors typically come from metallic oxides. However, there is a possibility of these colors to fade away. Hence one needs to be very careful while choosing the color of the block. Concrete paving blocks are the most preferred choice for laying of pavements, driveways, etc.

Analysis of paver blocks

Paving block is one of the materials used as the top layer of road structure besides asphalt and concrete. Paving block is usually made of mixed material such as Portland cement or other adhesive material, water, and aggregate. People nowadays prefer paving block compared to other pavement such as concrete or asphalt. Their interest toward the use of paving block increases because paving block is an eco-friendly construction which is very useful in helping soil water conservation, can be done faster, has easier installation and maintenance, has a variety of shades that increase the aesthetic value, also costs cheaper than the other. Preparation of the specimens with a mixture of Sinabung ash and a mixture of Sinabung ash and lime are implemented with a mixture ratio of cement : sand : stone ash is 1 : 2 : 3.



Fig 1 Paver Blocks

GRADE	CLASSIFICATION	Compressive strength (N/mm ²)	
		AVERAGE	MINIMUM
A	Road	40	13
B	Parking	20	17
C	Walkway	15	12.5
D	Garden or playground	10	8.5

Fig 2 Classification of Paver Blocks

Building Blocks of model

There could be 2 things that happened here. If water is puddling, the base may not have been installed at the proper pitch and may have had a slight low spot OR the base was not compacted enough and it has settled over time. Solution: The way to fix it is to pull up the area that has settled, add more base, compact it and reinstall the pavers. Paver blocks are the most sort after solution for exterior pavement or driveways. These paver blocks not only make the exterior pathways look clean and neat but are also safe for walking on. Paver blocks are a definite solution for a low maintenance pathway. Paver blocks do not need special maintenance as compared to concrete or asphalt surfaces. A simple water washing can help keep the blocks clean and bright.

Paver blocks are very durable, and if they are adequately interlocked, they can easily last for about 20 years. Paver blocks can withstand hefty vehicular load as well. Paver blocks are available in different shapes and colors, making it very versatile. These blocks can be used at residential as well as commercial premises. Paver blocks are slip-resistant and skid resistant. Paver blocks can be used in any weather conditions. These paver blocks are very easy to install and do not need any special equipment for its installation. The most important advantage of paver

blocks is that they can be easily replaced. If one of the blocks gets damaged, it can be easily removed and replaced with another one.

The company was looking to automate the task which involved moving of finished Paver Blocks presented on the conveyors from the drying chamber to the FG store area. After studying the site condition and requirement Fine Handling design team suggested Automatic Elbow LIFTTM with a pneumatic gripper which could clamp the paver blocks with its high compression force.

Model Verification

Pavers are to be stacked in 20 layers on the conveyor. To achieve this 20 proximity sensors were provided to sense 20 different heights and levels. Also limit switches were provided for the telescopic movement of the gripper.

Ensuring highest safety for the Operators and equipment

Limit switches were provided to avoid over-travel of the System during the operation to ensure highest safety for the operator and the equipment.

Benefits

Earlier the manual process required a minimum of 5 labours and at least 20-30 mins to complete the operation. The entire Additional benefits of the solution included safer operations, lesser product wastage due to damage, lower operational complexity and significantly higher throughput. acceptable.

Model Conceptualization

In system dynamics modeling after defining the problem the next vital stage is model conceptualization. In this stage the complete concept based on which the model is built is derived. A causal loop diagram is a visual representation of cause and effect of variables in a system. beginning with the development of a model and afterward collecting the data to populate it and to validate its dynamic behavior. Statistical models must rely on mathematical tests because models can only describe correlations. Any casualty between variables must be inferred from the correlation and that only close correlation supports such influences.

CONCLUSIONS:

The effect of paver blocks on high strength should be studied and thus the use of CFRC can be extended to industrial and commercial buildings. Paver blocks are a popular choice for construction because they are durable, low maintenance, and versatile. However, they also have an environmental impact.

Durable: Paver blocks can withstand heavy loads and last for at least a decade.

Low maintenance: Paver blocks are easy to install and require minimal upkeep.

Versatile: Paver blocks can be used for driveways, patios, walkways, and more.

Slip-resistant: Paver blocks are a good choice for driveways.

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