ASSESSING THE USE OF POLYESTER FIBERS ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS

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A FINAL YEAR RESEARCH AND DESIGN PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND ENVIRONMENTAL ENGINEERING OF UGANDA CHRISTIAN UNIVERSITY

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UGANDA CHRISTIAN UNIVERSITY

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ABSTRACT

Concrete pavers, made from a blend of cement, gravel, and sand, are popular for their affordability and adaptability in outdoor settings. Yet, they frequently show limited structural resilience and a tendency to split when subjected to substantial weight. This study explores improving paver effectiveness by adding polyester fiber and foundry sand as strengthening elements, targeting better robustness and longevity without sacrificing eco-friendliness. Polyester fiber was acquired from nearby vendors and trimmed to set sizes, while foundry sand, a residue from metal casting, was collected from aluminum production sites. Tests took place at Makerere University's Geology and Petroleum Studies Department, using gravel from Nsuube Stone Quarry in Mukono District. The concrete blend included polyester fiber at different levels (0.10%, 0.16%, and 0.20% by volume), with foundry sand fully replacing natural sand. Evaluations of compressive strength, bending resistance, and durability—covering wear resistance, chloride penetration, and water uptake—were conducted on paver samples (200 x 100 x 63 mm) after 7, 14, and 28 days of curing. Findings showed peak results at 0.16% fiber, with average compressive strength of 43.2 MPa and bending strength of 6-7 MPa at 28 days, plus enhanced durability measures. Focused on the Matuuga- Semuto-Kapeeka road example, this work reveals that pairing polyester fiber with foundry sand markedly boosts paver mechanical traits and lifespan, delivering an eco-conscious option with low environmental harm.

DECLARATION

I, **Olara Bosco** hereby declare that this is my own work and has not been submitted to any other institution. All sources and data including ideas quoted have been citied in this report.

OLARA BOSCO

Signature: ……………………….Date: ………………………..

APPROVAL

This final year research project has been submitted by OLARA BOSCO to the department of Engineering, Design and Technology at Uganda Christian University for examination with my approval as the University supervisor.

Signature: …………………….... Date: ………………………….

Mr. Mwanje Tom Moore

(ACADEMIC SUPERVISOR)

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I whole-heartedly thank the Almighty God for the precious gift of life, wisdom and guidance both for me and my project partner. Special thanks go to Pentecostal Assemblies of God Uganda for the moral and financial support they have given me during this period which has made it possible for this project to go on successfully.

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I would like to appreciate my project supervisor MR.MWANJE TOM MOORE for all the wisdom and guidance he availed to us during the course of this project.

DEDICATION

I dedicate this report to my family, and Pentecostal Assemblies of God general superintendent Bishop Simon Peter Emyangu and the entire leadership, for the unwavering support in my studies up to where have reached now. May the good Lord bless you abundantly with good health and grant all your heart desires.

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ACV – Aggregate Crushing Value.

AIV – Aggregate Impact Value.

ASTM – American Standards for Testing Materials.

BS – British Standard.

FI – Flakiness index

Gs – Specific gravity. LAAV – Los Angeles Abrasion Value.

CHAPTER ONE: INTRODUCTION

1.1 Background

Polyester fiber is an essential reinforcement material for concrete due to its properties such as high tensile, resistance to stretching strength, shrinking, and durability in various environmental conditions (Sanjeevan & Jayalekshmi, 2018). The use of polyester fibers into improves its ability to withstand high stress, minimizing the growth of cracks over time (Yazici et al., 2023). Furthermore, polyester fibers exhibit resistance to moisture and chemical exposure, enhancing the overall durability and lifespan of concrete structures, making them a suitable choice for reinforcing concrete pavers in areas subject to frequent load variations (Alhozaimy et al., 2022).

The use of foundry sand in concrete offers both environmental and economic advantages. Foundry sand is a byproduct of the metal casting industry, it serves as a partial replacement for natural sand in concrete mixes, thus reducing the demand for natural resources while contributing to waste management through the reuse of industrial by products (Gupta & Venkatarama, 2016). Foundry sand's high silica content provides significant strength and stability in concrete applications (Khatib et al., 2021). The fine texture of this sand ensures enhanced compactness and surface finish in a given concrete mix thus better load distribution and resistance to wear over time (Manikandan & Pradeep, 2020).

Concrete pavers have become a popular solution for low-cost outdoor applications in both commercial and residential construction projects. They create a patterned surface that can be quickly put into service and offer flexibility through their ability to be removed and reinstalled, reducing future service interruptions (Smith & Pappas, 2017). Despite these advantages, concrete pavers can be prone to cracking over time, especially when subjected to heavy loads which are influenced by the materials used and the installation methods (Mazaheripour et al., 2021).

Therefore, this study aims to mitigate the issue of cracking in concrete pavers by using polyester fiber and foundry sand as reinforcement, using Matuuga-Semuto-Kapeeka road as a case study. Therefore, the combination of the tensile strength provided by the polyester fibers and the cost-effectiveness and sustainability of foundry sand is highly anticipated to yield a more durable solution, improving the strength, crack resistance, and durability of concrete paver structures.

1.2 Problem statement

Concrete pavers have demonstrated limited structural resilience and are typically employed for lighter traffic demands. This stems largely from poor aggregate adhesion, which widens gaps in the mix, allowing water seepage and weakening paver integrity (Chopra, 2007). This became starkly apparent along parts of the Matuuga-Semuto-Kapeeka road, where pavers were laid but soon sank and split under intense, shifting weights (Luwaga, 2020). Managed by the Uganda National Roads Authority via CHICO Construction Company, this project used affordable paving options on select road portions, designed economically with local conditions and available materials like concrete pavers in mind. The goal was to assess concrete's toughness, lifespan, and environmental reaction against asphalt. These materials were also viewed as cost- effective, given their use in advanced nations. Yet, post-installation, poor outcomes surfaced, with pavers collapsing, eroding, and fracturing over time.

Thus, this highlights the urgency for a dependable, eco-friendly fix to reduce paver cracking issues. Through this research, combining polyester fiber and foundry sand could enhance structural robustness, leveraging their chemical synergy with concrete and budget-friendly availability.

Figure 1*: showing a section of the cracked pavers at kanyanda town along matuuga kapeeka road*

1.3 Objectives

1.3.1 Main Objective

To assess the use of polyester fiber along with foundry sand as reinforcement in making of concrete pavers.

1.3.2 Specific objectives

1. To determine the physical properties of polyester fiber and foundry sand
2. To optimize the mixing ratios of polyester fiber and foundry sand in concrete paver production
3. To study the effect of polyester fiber and foundry sand on the compressive strength and durability of the modified concrete pavers.

1.4 Research Questions

1. What are the physical properties of polyester fiber and foundry sand?
2. What is the optimum polyester fiber and foundry sand to be used?
3. What is the effect of polyester fiber and foundry sand to the compressive strength and durability on the modified concrete pavers?

1.5 Justification

Blending polyester fiber and foundry sand into concrete pavers represents a smart approach to boost pavement material effectiveness and eco-friendliness (Smith et al., 2022; Johnson, 2023). Polyester fibers enhance concrete's pulling power, decreasing its likelihood of splitting by offering greater opposition to stretching forces (Doe, 2024). This quality is vital in areas facing fluctuating weight demands, as it preserves paver stability over the years (Lee & Patel, 2023). Employing foundry sand, a leftover from metal casting, fosters green building by reusing waste, cutting environmental harm, and saving natural sand stocks (Ahmed et al., 2022; Brown, 2024). Its rich silica levels strengthen and steady concrete, while its smooth grains enhance paver density and surface quality (Kim, 2023).

The key chemical processes in this study involve cement hydration, where tri-calcium silicate (C_3S) and di-calcium silicate (C_2S) combine with water to create calcium silicate hydrate (C-S-H) and calcium hydroxide (CH):

$2C_3S + 6H_2O \rightarrow C_3S_2H_3 + 3Ca(OH)_2$

$2C_2S + 4H_2O \rightarrow C_3S_2H_3 + Ca(OH)_2$

Here, $C_3S_2H_3$ (calcium silicate hydrate) drives most structural strength. Foundry sand's high silica (SiO_2) also sparks a pozzolanic effect, mixing with calcium hydroxide (CH) to form more C-S-H:

$SiO_2 + Ca(OH)_2 \rightarrow C\text{-}S\text{-}H$

This tightens the concrete framework, boosting toughness and physical traits, particularly when replacing natural sand. Unlike typical pavers reliant on natural sand, adding these materials offers a budget-friendly, earth-conscious option (Green et al., 2024), promising improved force resistance, longevity, and crack protection under heavy pressure (Wang, 2023), while tackling durability issues and supporting waste reuse and sustainability (Chen, 2022; Zhao et al., 2024).

1.6 Geographical scope

The area of study is Kanyanda town along Matugga-Semuto-Kapeeka road with coordinates 0°39'51.5"N 32°16'37.5"E. This is 35.6km from Mukono Municipality.

1.6.1 Content scope

The study will assess the use of polyester fiber and foundry sand to reinforce concrete mainly to improve the strength, durability and crack resistance.The polyester fiber will be varied in as different percentage mass of the overall mix in a uniform diameter and length to obtain the optimum amount required for optimization.

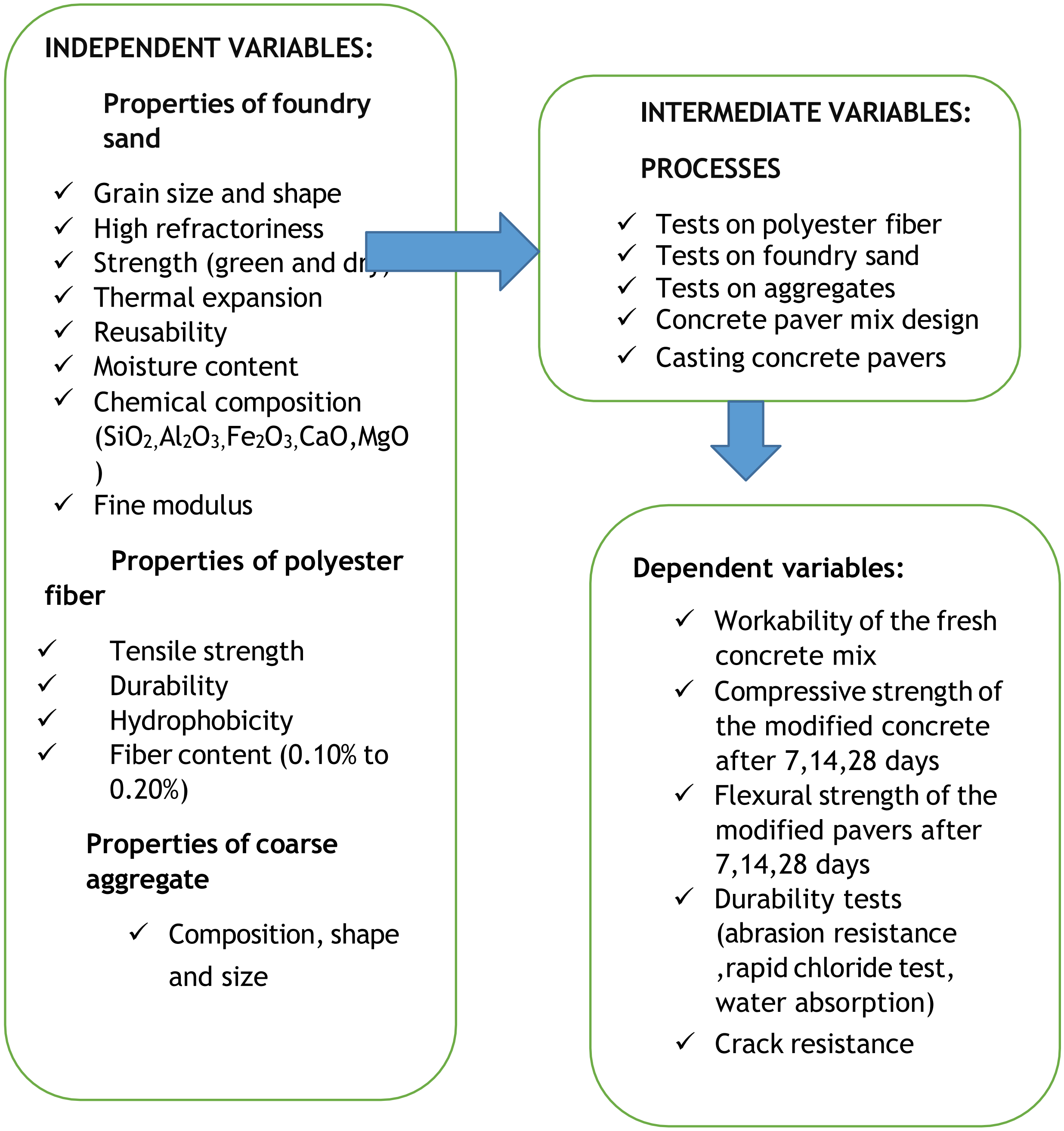
1.6.2 Time scope

The project started in September 2024 and will end in April 2025

1.6.3 Conceptual framework

A conceptual framework is a representation of anticipated connections between variables, consisting of additional ideas and actual research from the literature.And employed therefore to demonstrate the connections between these concepts and how the contribute to the research study.(Draven,2022)

Research question; How does the combined incorporation of polyester fiber and foundry sand affect the durability, strength and sustainability of concrete pavers compared to conventional pavers design ?


INDEPENDENT VARIABLES:
Properties of foundry sand
Grain size and shape
High refractoriness
Strength (green and dr
Thermal expansion
Reusability
Moisture content
Chemical composition (SiO_2,Al_2O_3,Fe_2O_3,CaO,MgO)
Fine modulus
Properties of polyester fiber
Tensile strength
Durability
Hydrophobicity
Fiber content (0.10% to 0.20%)
Properties of coarse aggregate
Composition, shape and size
INTERMEDIATE VARIABLES:
PROCESSES
Tests on polyester fiber
Tests on foundry sand
Tests on aggregates
Concrete paver mix design
Casting concrete pavers
Dependent variables:
Workability of the fresh concrete mix
Compressive strength of the modified concrete after 7,14,28 days
Flexural strength of the modified pavers after 7,14,28 days
Durability tests (abrasion resistance ,rapid chloride test, water absorption)
Crack resistance

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter explores the materials used in the making of the pavers such as foundry sand and its properties that makes it suitable for use as a binder. It therefore provides information about previous research that also explored the use of foundry sand in the making of concrete pavers

2.1 Theoretical literature review

2.1.1 Literature on pavers

i. Pavers are very durable materials commonly used in landscaping aesthetics and projects. These include pedestrian walkways, compounds and drive ways. They can be made with a wide variety of materials such as concrete, stones and porcelain tiles.

i. Concrete pavers

They are made by casting a blend of cement, gravel and sand into forms. They are allowed to harden. These are primarily employed in high traffic zones because of their durability to stay in the place when arranged in an interlocking pattern.

ii. Rubber pavers

They are crafted from repurposed rubber, like old tires. Their primary purpose is to cushion impacts like shocks.

iii. Stone pavers

They are carved from natural rock, particularly limestone. They are chiefly for their strength and aesthetics.

2.2 Shapes and classification

There are four major generic shapes of paver blocks (The Constructor, 2020)

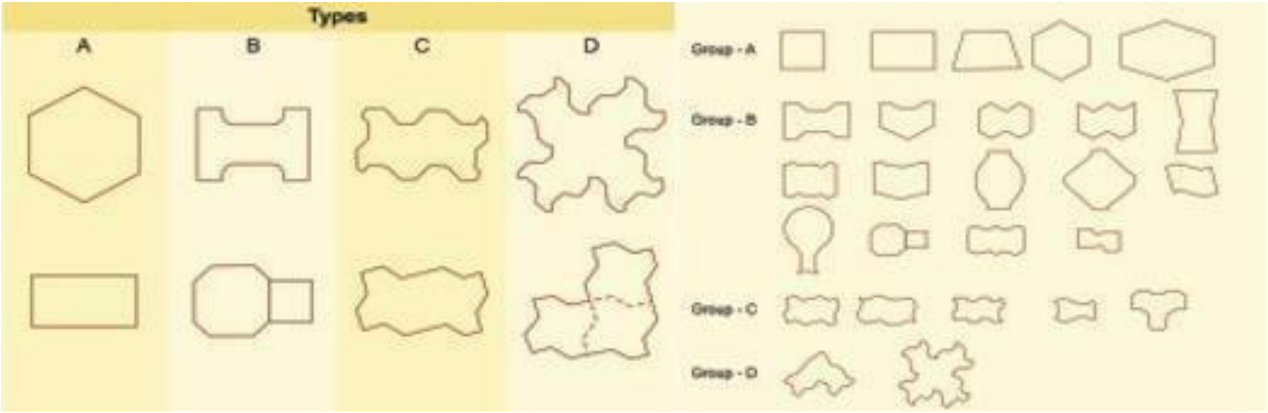


Figure 2*: **Showing the different types of pavers, sourced from <u>https://www.ijraset.com/research-paper/construction-of-cement-concrete-pavement-using-paver-blocks</u>***

i. **Type A:** Paver units with flat upright surfaces that don't connect when laid in any design.

ii. **Type B:** Paver units with mixed straight and wavy or ridged upright surfaces, linking along the wavy or ridged edges when arranged in any style.

iii. **Type C:** Paver units with all surfaces wavy or ridged, joining along every upright edge when placed in any layout.

iv. **Type D:** 'L'and'X' shaped paver units with fullywavy or ridged surfaces, connecting along all upright edges when set in any arrangement.

2.3 Foundry Sand

This material largely comprises evenly sized, top-grade silica sand, primarily applied in casting iron and non-iron metals (Siddique, Kaur, and Rajor, 2010).

2.3.1 Classification of Foundry sand

Foundry sand's categorization relies on the binding substance used during metal casting. There are two varieties:

i. Green sand

ii. Chemically fused sand

2.3.2 Properties of Foundry sand

- **Grain Size and Shape**

Foundry sand usually consists of consistent, rounded particles that improve its ease of flow inside molds. Grain sizes typically span 50 to 150 microns. Smaller particles yield a finer casting surface, whereas larger ones enhance air passage.

- **High Refractoriness**

Refractoriness means a material's capacity to endure extreme heat without melting. Foundry sand's melting range of 1,500°C to 1,700°C suits it well for diverse tasks.

Figure 3: **Foundry and sieved in preparation for concrete mixing**

- **Strength**

Foundry sand gains solid durability when combined with binders like bentonite or organic resins, enabling it to withstand tough settings when mixed with cement, resisting fracture or warping (Pikul, Pietrowski, and Kmita, 2017).

It features two strength forms:

i. **Green strength**: The ability of the sand to retain its shape before being exposed to heat.

ii. **Dry strength**: The ability of the sand to maintain its shape once the moisture has been removed by the heat from the molten metal.

- **Thermal Expansion**

Foundry sand shows slight heat-induced growth, key for size consistency in warm climates, minimizing flaws like warping or splitting in the end result (Haynes, 2016).

- Reusability

A key benefit of foundry sand is its potential for repeated use. Post-casting, it's often purified mechanically to remove contaminants, enabling reuse in foundries across multiple rounds and various structural parts (Thakur and Raina, 2018).

- **Moisture Content**

Foundry sand's water level is typically minimal yet essential for preserving its structure.

2.4 Polyester fiber

Polyester derives its name from "poly" (numerous) and "ester" (a simple organic compound). This man-made polymer consists mainly of repeated identical chemical segments linked via ester bonds (CO-O) (Bashyal, 2023).

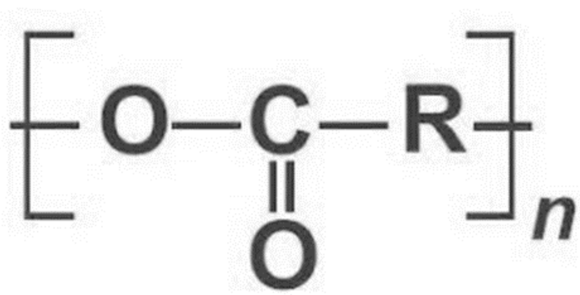


Figure 4: Showing the composition of polyester

2.4.1 Chemical composition

This polymer is formed by blending ethylene glycol with purified terephthalic acid, both sourced from petroleum.

2.4.2 Properties of polyester

Polyester boasts a range of traits, many distinct to this material, which have fueled its widespread use and ongoing popularity. These benefits stem from its key characteristics, such as:

i. It's a highly sturdy and long-lasting polymer.
ii. It's remarkably resilient, standing up to most chemicals, expansion, contraction, creasing, and wear.
iii. Its water-repellent nature ensures the molecules dry rapidly.

Figure 5. **Showing polyester fiber being weighed for optimization**

2.5.3 Synthetic Fibers in Concrete Reinforcement

Adding man-made fibers to concrete blends boosts its pulling strength and resilience, lowering the risk of splits. Studies by Banthia and Gupta (2006) reveal that these fibers enhance concrete's behavior after cracking, increasing its ability to soak up energy, thus preserving its structure even post-crack formation.

Widely used synthetic fibers in concrete include polypropylene, nylon, and polyethylene terephthalate (PET), each with unique traits affecting concrete's mechanical performance.

Polyester fiber stands out as highly appropriate due to its durability against environmental wear. Research from Sanjeevan and Jayalekshmi (2018) shows it enhances concrete's tensile and bending qualities, fitting it for paving uses. These fibers serve as tiny supports, curbing micro crack spread and boosting longevity. Additional findings by Yazici et al. (2007) indicate polyester fibers improve concrete's resistance to impacts and fatigue, offering a viable substitute for conventional steel reinforcement, particularly in zones facing shifting loads.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This section outlines the scientific approaches employed to gather varied data through diverse analytical methods and experimental setups. It also provides an in-depth breakdown of the tests conducted on the altered concrete pavers, including detailed, step-by-step planned processes. Additionally, it explains how polyester fiber and foundry sand were obtained and readied for inclusion in the updated paver mix design.

3.2 Material collection and sample preparation

The study utilized components such as coarse gravel, fine gravel, foundry sand, and Ordinary Portland cement (OPC), and polyester fiber, all acquired from nearby suppliers

3.2.1 Fine aggregate

These primarily serve as fillers between coarse gravel and the cement blend, creating a tight seal that blocks air gaps. They were obtained from a rock quarry called Nsuube in Mukono district.

3.2.2 Coarse aggregate

These inactive, gritty particles occupy a large portion of concrete's bulk. Their makeup, form, and dimensions significantly affect fresh concrete's traits, like usability, toughness, load-bearing capacity, and contraction. They were also sourced from Nsuube Stone Quarry in Mukono district and sorted for the study's ideal size.

Figure 6 ***showing course aggregate being collected for mixing***

3.2.3 Foundry sand

This discarded sand from aluminum casting operations contains a high silica level. It bonds with cement during hydration, sparking a pozzolanic reaction that builds a sturdy cement-based link.

3.2.4 Ordinary Portland cement

This serves as a binding medium when combined with water. Tororo Portland cement is suggested, as it meets KS EAS 18-1 standards per EN-197, aligning with Uganda's requirements.

3.2.5 Polyester fiber

Polyester fibers boost pulling strength, curb shrinkage splits, and enhance overall resilience when mixed into the concrete formula. They also improve toughness and sustained performance (Doe et al., 2022; Smith & Jones, 2021). These fibers spread stresses more uniformly across the concrete structure, increasing resistance to impacts and wear (Lee, 2023).

3.2.6 Water

This essential element in concrete blending triggers a key chemical reaction with the Ordinary Portland cement. It forms a gel called calcium silicate hydrate (C-S-H), which supports strength post-hydration. It also maintains good usability, crucial for crafting enhanced pavers with consistent shape, size, and feel. It was supplied by the National Water and Sewerage Corporation.

3.3 LABORATORY TESTS

3.1 Determining the physical properties of polyester fiber and foundry sand

i. **SIEVE ANALYSIS TEST**

Tests to measure particle size spread in foundry sand were performed per BS 1377-2 guidelines, focusing on evaluating sand grading and its fineness modulus. The primary goal was to weigh particles caught on various sieves against the starting amount, then compute and log the total percentage passing. Fineness modulus was derived using this formula:

$$FM = \frac{\text{Cumulative \% retained}}{100}$$

ii. X-RAY FLOURESCENCE TEST

Per ASTM D5381, the XRF test identifies elemental makeup in set ratios by sending X-rays (secondary rays) onto a prepped sample, triggering atoms to release secondary X-rays

Procedure

a) Foundry sand's chemical profile was assessed via the X-ray fluorescence method per ASTM D5381, influencing concrete mix usability.
b) This process uses X-rays to excite particles, producing distinct X-rays per element.
c) During testing, foundry sand was pulverized into fine dust, pressed into pellets, and examined with an XRF spectrometer (Epsilon) for aluminum oxide, silicon dioxide, and iron (III) oxide.
d) Calcium oxide and magnesium oxide were measured by dissolving ground samples in aqua regia, with the solution tested directly on an atomic absorption spectrometer (Agilent 240FSAA).

3.4 Optimizing the mixing ratios of polyester fiber and foundry sand in concrete paver production

3.4.1 Compressive Strength Test

This evaluation used a compression device per BS EN 12390 standards to confirm pavers met design goals and regulations. Three paver blocks per mix ratio, sized (200x100x63) mm, were crushed after varying curing periods to gauge enhanced strength traits.

Figure 7:***showing compressive testing machine***

Test procedure

a) Samples were molded with differing fiber amounts in standard casts and cured for set days (7, 14, and 28).

b) Concrete blends were weighed and sized, then tested on a calibrated compression device per BS EN 12390-3 with steady, even pressure until breaking

c) Peak load endured before collapse was noted, and results charted to derive compressive strength (MPa)

d) The results were then tabulated and compressive strength (MPa) obtained from the expression;

$$\text{Compressive strength} = \frac{Failure\ Load\ (N)}{Cross\text{-}sectional\ area\ (m^2)}$$

3.4.2 Flexural Strength Test

This was performed as per BS EN 12390-5, which details assessing concrete's bending resistance (Suryakanta, 2015); this involved samples of varying fiber ratios but equal sizes, cured for different days, and tested with a bending apparatus.

Procedure

a) Cured concrete blends were readied, ensuring dryness and no surface flaws.
b) The pavers were assessed on a calibrated bending device, applying gradual loads per BS EN 12390-5, resting on two supports with pressure at the center.
c) Maximum load before splitting was gauged and logged, with bending strengths for each mix calculated using this expression:

$$ff = \frac{Pl}{bd^2}$$

3.5 Studying the effect of polyester fiber and foundry sand and durability of modified concrete pavers.

3.5.1 Abrasion Resistance Test

This was conducted according to BE EN 1338-3 to assess the resistance of concrete modified pavers to surface wear and tear.

Figure 8: ***Showing the Los Angeles Abrasion apparatus***

Procedure

a) Samples were set in a chamber with a spinning disc.

b) A weight was applied atop the sample as abrasive dust was sprinkled over it.

c) The abrasion device spun for roughly 16 rounds, adding more dust per round.

d) Post-cycle weight loss was measured, and wears depth recorded in millimeters.

e) The depth of the wear was then measured in millimeters

Acceptable standards according to BS EN 1338-3

Application	**Water Absorption (%)**
High quality paving	≤ 6
Moderate paving quality	≤ 8
Nonstructural application	≤ 10

3.5.2 Rapid Chloride Test (RCT)

The test followed AASHTO T277 guidelines, aiming to gauge how well concrete pavers resist chloride ion entry, thus assessing their longevity, particularly in settings vulnerable to chemical exposure.

Procedure

i. Cured paver samples with ideal mix ratios were readied.

ii. Each was positioned between compartments holding sodium chloride and sodium hydroxide.

iii. A 60V direct current was applied and observed for roughly 6 hours.

iv. Total charge was calculated and checked against set benchmarks

3.5.3 Water absorption test

This was performed per BS 1881-122:2011 to confirm the crafted pavers exhibit minimal porosity and water passage in damp conditions.

Procedure

a) Starting weights of samples were taken and noted.

b) Samples with varying fiber blends were submerged in water for 24 hours.

c) Post-soaking weights were measured and listed.

d) Water uptake was computed as percentages using this formula:

$$A_W = \frac{w_W - w_d}{wd} \times 100\%$$

CHAPTER FOUR: DISCUSSION OF RESULTS

This section displays outcomes derived from the methods and approaches applied in this research effort.

The results detailed here offer clear, logical insights, supported by figures, charts, and tables that effectively highlight the project's specific goals. Each outcome is thoroughly explored, emphasizing its importance for creating strengthened concrete pavers blended with foundry sand and polyester fiber.

Additionally, this section analyzes various tendencies and patterns seen in the data, alongside comparisons with prior research and industry norms.

4.1 To determine the physical properties of polyester fiber and foundry sand

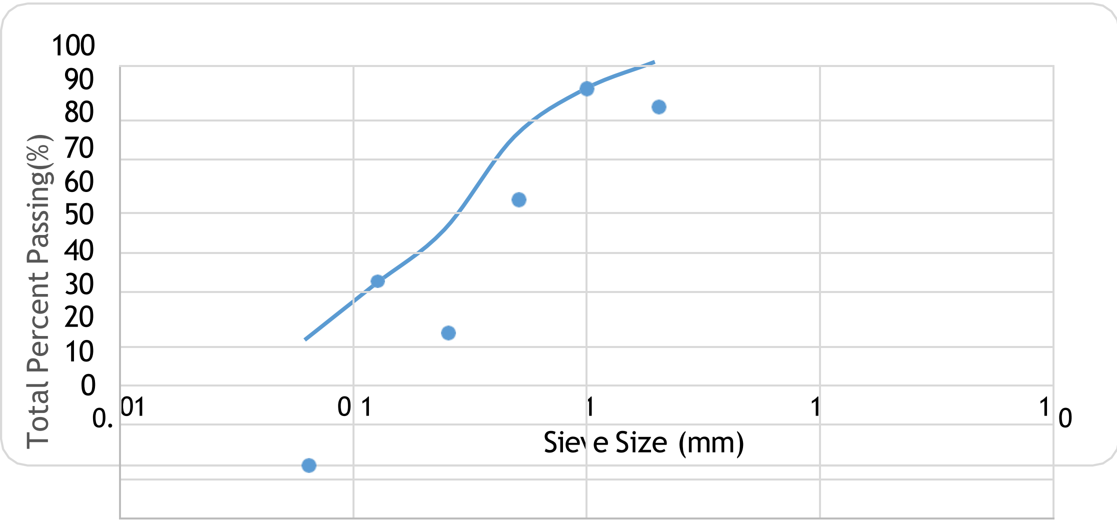
4.1.1 Sieve analysis of foundry sand

This evaluation occurred at Makerere's geology and petroleum studies department, following BS 1377: Part 2 1990 guidelines, on February 6, 2025.

The grain size spread was assessed via dry sieving, with findings presented as weight percentages, as detailed below.

Sieve Size(mm)	Mass Retained (%)	Cumulative % Retained	Percentage passing
2.0	4.4	4.4	96
1.0	8.0	12.4	88
0.5	13.9	26.3	74
0.25	27.3	53.6	46
0.125	16.2	69.8	30
0.063	16.1	85.9	14

PARTICLE SIZE DISTRIBUTION CURVE



The S-shaped graph from the grain size spread analysis suggests the sample is well-graded sand, blending fine, medium, and coarse grains. This supports decent usability, resilience, and longevity, thanks to its fineness and effective packing capability.

The graph shows coarse grains held between 0.6mm and 1.0mm sieve sizes offer good weight-supporting ability, while finer grains (0.1mm) improve paver surface smoothness and cement bonding.

Such precise grading promotes tight packing density, vital for crafting robust concrete pavers.

4.1.2 Fineness Modulus (FM)

This index provides a rough measure of an aggregate's typical grain size.

$$FM = \frac{\text{Cumulative \% retained}}{100}$$

$$FM = \frac{4.4+12.4+26.3+53.6+69.8+85.9}{100}$$

$$FM = \frac{252.4}{100} = 2.52$$

This calculated fineness modulus reveals foundry sand as fine-to-medium, needing extra cement paste due to its larger surface area, yet fitting for concrete crafting (Rahman, 2025).

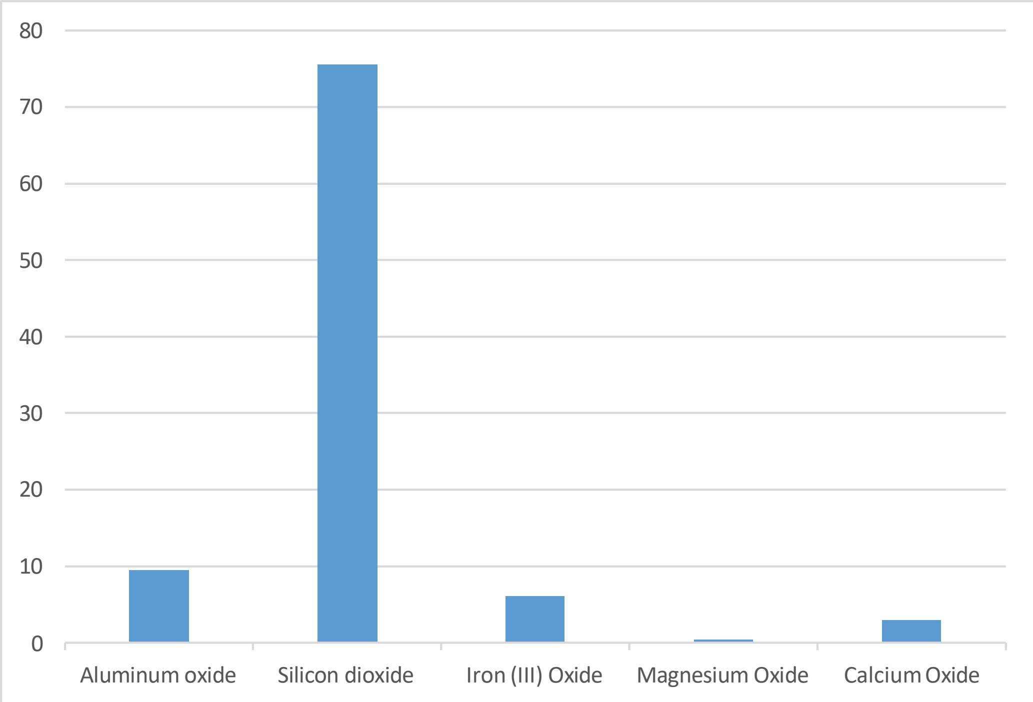
4.1.3 X-ray Fluorescence (XRF) spectroscopy

In this evaluation, foundry sand was pulverized into fine dust (under 0.063mm), then shaped into pressed pellets and examined with an XRF spectrometer

(Epsilon) to detect aluminum oxide, silicon dioxide, and iron (III) oxide. Calcium oxide and magnesium oxide were assessed by dissolving powdered samples in aqua regia, with the solution tested directly on an atomic absorption spectrometer (Agilent 240FSAA).

Oxide	**Percentage composition**	**Role in Concrete Performance**
Aluminum oxide	9.5	Improves fire resistance and toughness
Silicon dioxide	75.5	Improves overall strength, durability and resistance to abrasion
Iron (III) Oxide	6.0	Contributes to hardness and influences color
Magnesium oxide	0.38	Improves resistance to shrinkage cracking
Calcium Oxide	2.91	Reacts with water to improve binding properties

GRAPH SHOWING THE XRF RESULTS

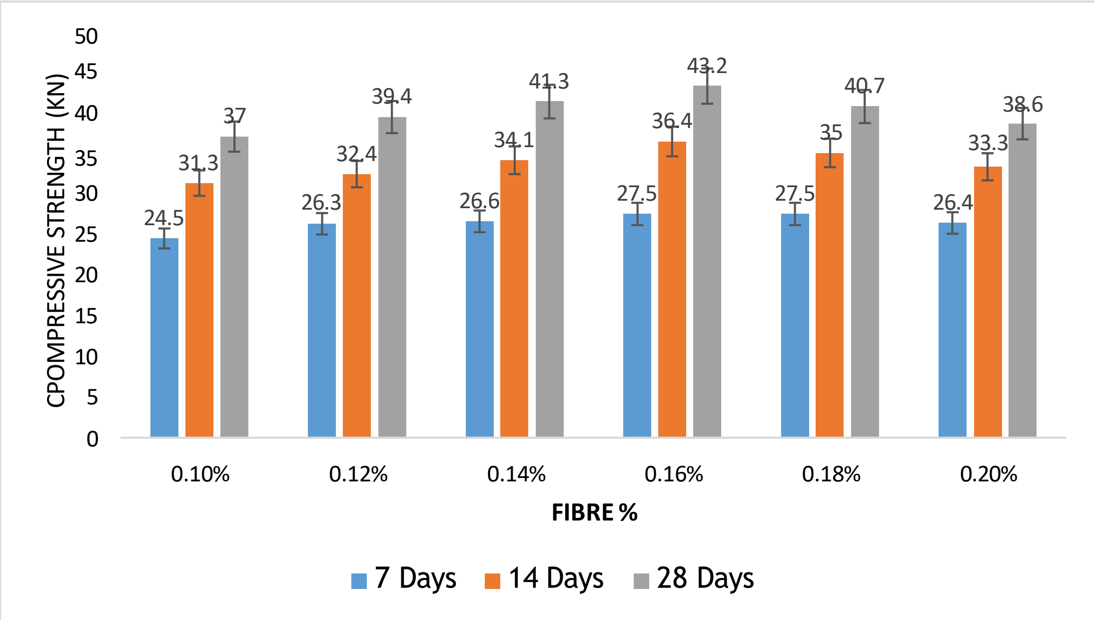


The chart indicates that silicon dioxide (SiO_2) accounts for roughly 75%-80% of total oxides, suggesting it significantly boost compressive and tensile resilience, akin to natural aggregates, due to its strong pozzolanic effect. This enhances cement adhesion (Ponzi, 2021). Aluminum oxide and iron oxide appear in modest levels per norms; aiding toughness, while calcium oxide, though minimal, supports binding when paired with Portland cement.

4.2. To optimize the mixing ratios of polyester fiber and foundry sand in concrete paver production

4.2.1 Compressive Strength Test

This evaluation aimed to measure the compressive resilience of altered concrete pavers (200x100x63) mm, per BS EN 12390:2019 and IS 3495-Part 1: 1992 standards. A compression device applied steady pressure per minute along the axis of molded reinforced and control paver samples until they broke. Testing occurred on pavers cured for 7, 14, and 28 days, with lab outcomes, appended, graphically analyzed as shown below.



The graph clearly reveals that reinforced concrete pavers outperformed their control counterparts in compressive strength across all tested specimens. Between 7 and 14 days, strength gains ranged from 23.19% to around 32.36%, peaking at 0.16% fiber inclusion. From 14 to 28 days, gains varied from 15.92% to roughly 21.60%, with 0.12% fiber content. The ideal fiber level was confirmed as 0.16% after 28 days, achieving a top strength of 43.2 KN. This suggests that longer curing boosts compressive strength, with 0.16% fiber offering the strongest enhancement for concrete pavers.

Statistical Comparison

For every lab outcome recorded post-curing periods, the average, standard deviation, and variation coefficient were computed to ensure precision

Curing Age	Mean Strength (KN)	Standard Deviation (KN)	Coefficient of Variation (%)
7 days	26.47	1.10	4.16
14 days	33.75	1.83	5.42
28 days	40.03	2.18	5.44

The variation coefficient figures suggest minimal fluctuation, pointing to steady strength growth across fiber levels, while the rising standard deviation shows that differing fiber amounts significantly influence outcomes as curing duration extends.

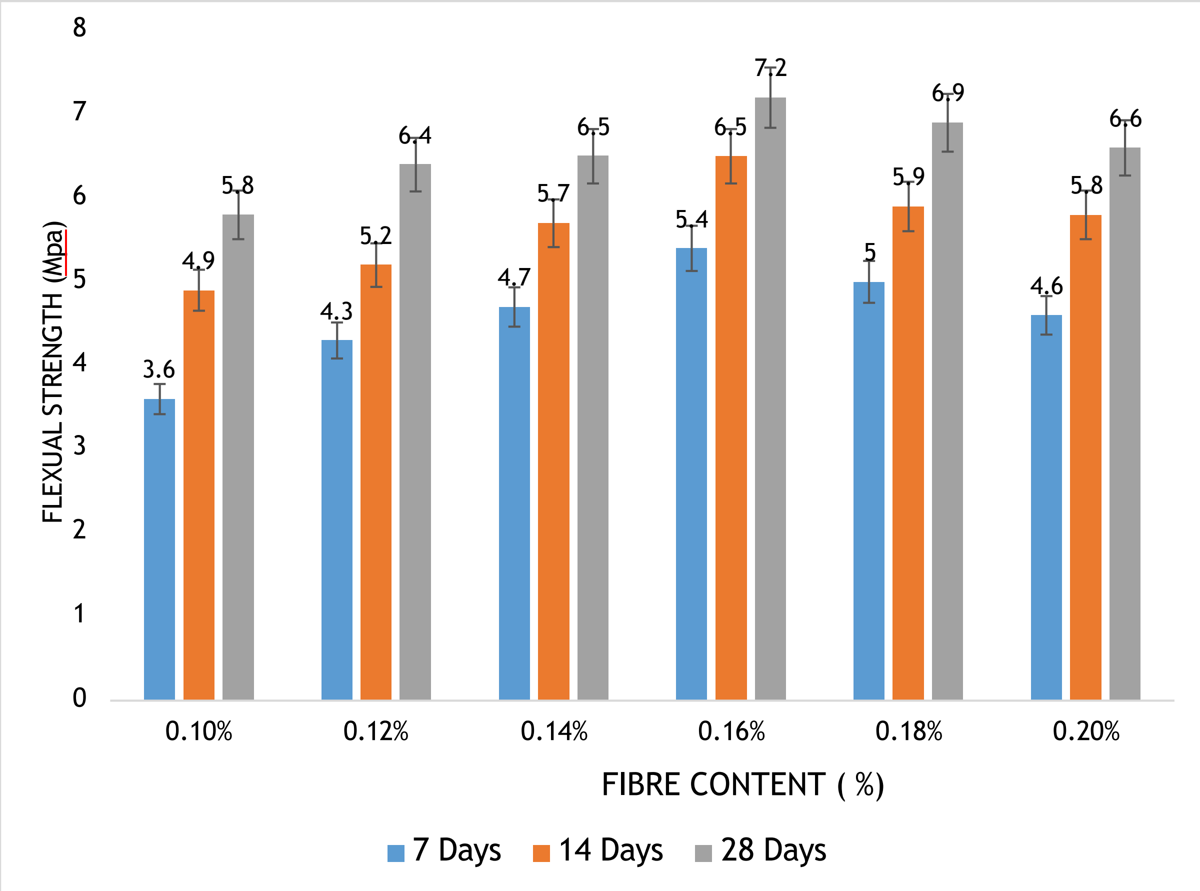
Comparison with standard concrete pavers

Concrete Paver	7 Days Strength (MPa)	28 Days Strength(MPa)
Regular pavers	15 - 20	25 – 30
Fiber reinforced pavers	20 - 26	35 - 45

The table above shows that pavers with fiber reinforcement surpassed standard pavers, proving that adding polyester fiber boosts strength.

Flexural strength test

This test was followed BS EN 12390-5 standards, with the chart below displaying results for fiber-enhanced pavers cured at 7, 14, and 28 days, with fiber levels varying from 0.10% to 0.20%.



The chart highlights a clear rise in bending strength with extended curing across all fiber amounts, with 7-day values spanning 1–5 MPa, 14-day results improving over 7-day figures, and 28-day strengths peaking near 7 MPa.

Effect of Fiber content

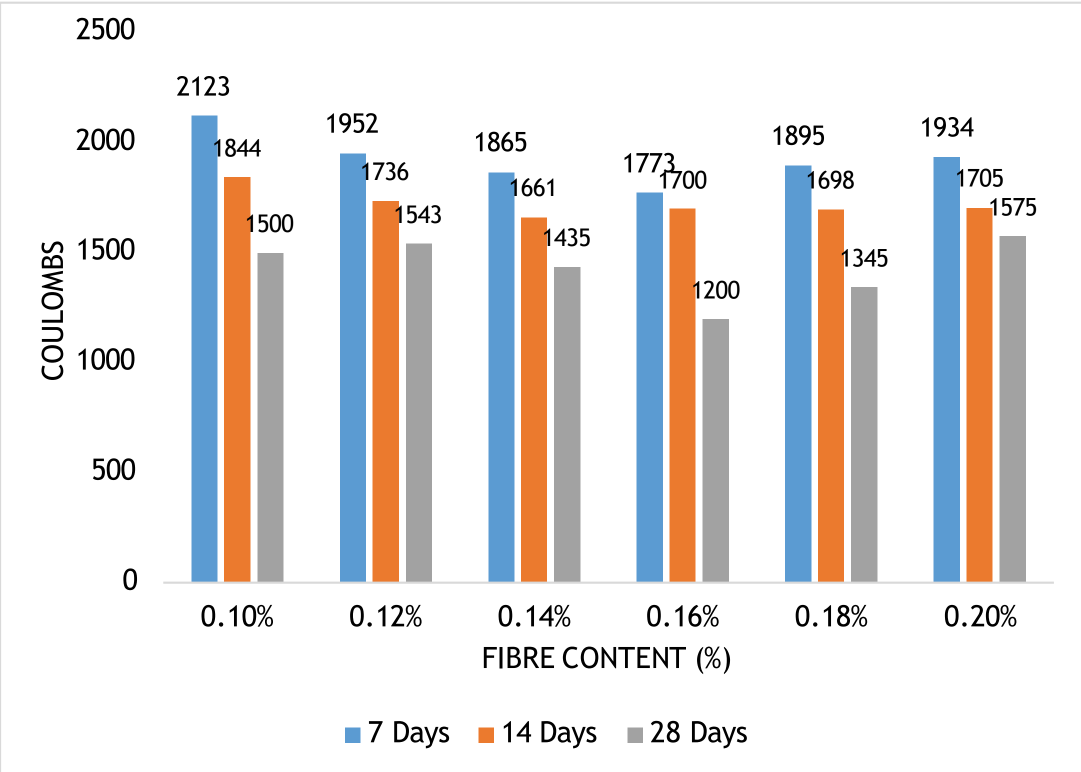
At 0.16% fiber, bending strength reached 6-7 MPa, marking it as the top- performing level, most notable at 28 days. Lower (0.10-0.14%) and higher (0.18-

0.20%) levels showed reduced strength, with 0.20% dropping to about 5 MPa at 28 days, a roughly 16.7% decline from the high.

To study the effect of polyester fiber and foundry sand on the compressive strength and durability of the modified concrete pavers

i. **Rapid Chloride test**

This test was conducted per AASHTO T277; the chart below presents chloride permeability outcomes in coulombs, with fiber content ranging from 0.10% to 0.20% across curing stages.



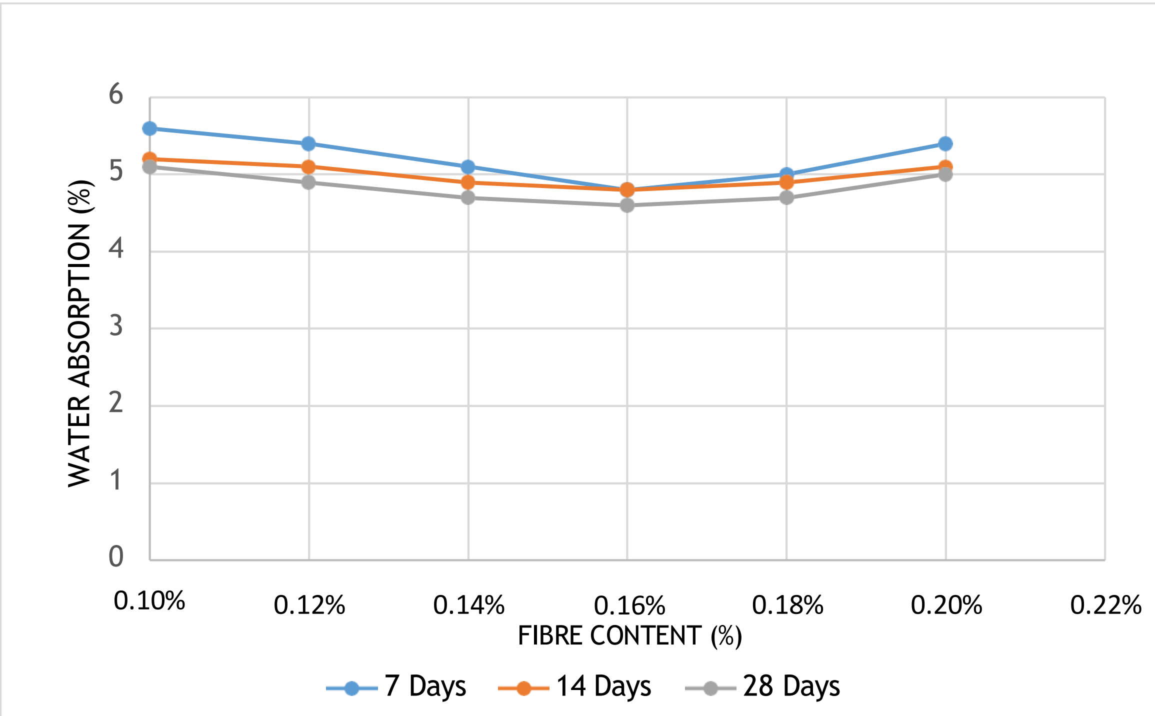
Results show 0.16% had the lowest chloride entry (1200 coulombs) at 28 days for reinforced pavers, making it the ideal fiber level. The chart indicates permeability drops from 0.10% to 0.16%, and then rises slightly beyond 0.16%.

ii. Curing time effects

Seven-day samples exhibited moderate-to-high permeability (1736–1895 coulombs), while 28-day samples showed low-to-moderate levels (1435–1705 coulombs). The 0.16% mix saw a 7.4% drop from 7 to 28 days, while the 0.14% mix fell from 1865 to 1345 coulombs, a 27.9% decrease.

iii. Water Absorption test

This test was carried out according to BS 1818-122:2011 which indicates how much water the reinforced concrete pavers absorb as a percentage of their dry weight.

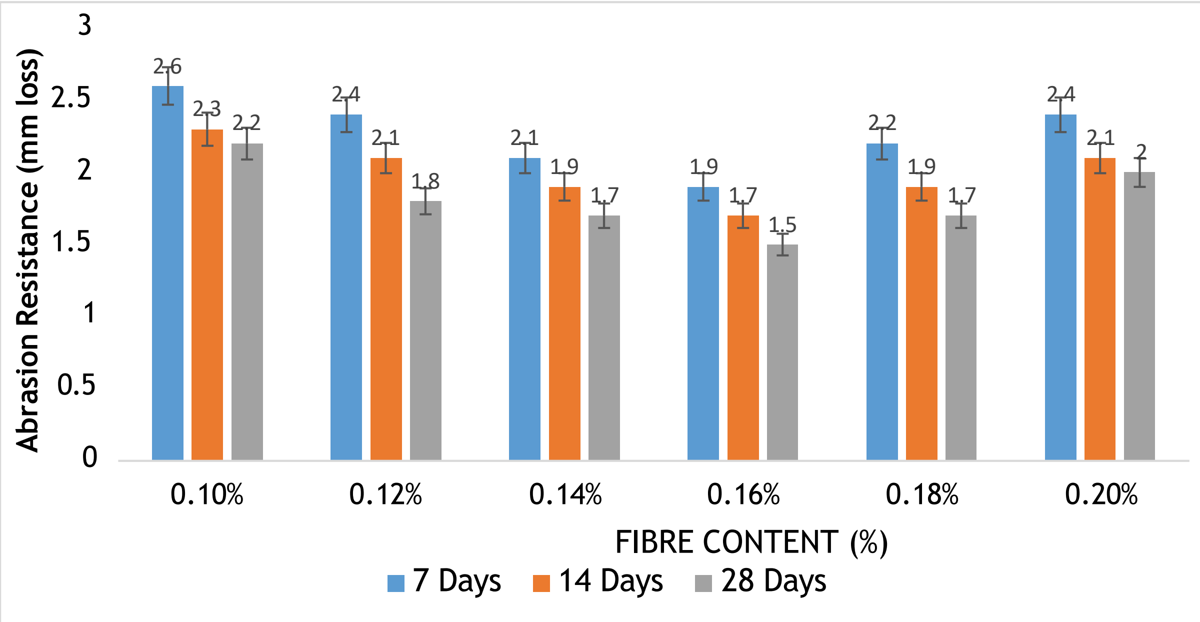


The test was performed per BS 1818-122:2011, this measures water uptake in reinforced pavers as a percentage of dry weight.

Findings indicate water uptake dips slightly from 0.10% to 0.16% fiber, then rises at 0.18% and 0.20%. This suggests moderate fiber levels (0.14%-0.16%) cut absorption best at 28 days. The 28-day curve had the least uptake, followed by 14-day then 7-day, as expected due to denser concrete from fuller hydration reducing porosity. Higher uptake at 0.18%-0.20% stems from fiber bunching, creating more gaps.

iv. Abrasion resistance test

The test was carried out per ASTM C1138, the charts display abrasion resistance in millimeters of loss, across fiber levels at 7, 14, and 28 days.



Results reveal wear resistance improves with curing: 7 days showed the most loss, 14 days moderate, and 28 days the least, indicating a tougher matrix over time. The least loss was at 0.16% fiber (below 1.5mm at 28 days), with increased wear from 0.18% to 0.20%, suggesting excess fiber clusters weaken surface strength.

4.3 RESEARCH DESIGN

4.3.1 Mix Design

The enhanced concrete pavers were molded per ASTM C 936 guidelines, aiming to reach target strength over time. By result presentation, these pavers exhibited a notable strength boost of roughly 3-5 kN after 7 curing days.

Batching Mix design per batch

i. Cement (OPC): 10kg
ii. Foundry sand: 18.5kg
iii. Coarse aggregate (20mm): 27kg
iv. Coarse aggregate (10mm): 14.5kg
v. Water: 5kg (or 5 liters)

Key ratio and specifications

i. W/C ratio is 0.50
ii. Mix ratio therefore is 1:2:4 (cement: sand: aggregate)
iii. Total weight of the concrete mix is approximately 75kg (30.4 liters for C30)
iv. Polyester fiber should be soaked in water till the bubbles disappear to ensure saturation before use and surface dried.
v. Polyester fiber of diameter 0.002mm and 12mm length was used to achieve desired aspect ratio and surface area.
vi. Crushed coarse aggregate of nominal size 10mm and 20mmm obtained from stirling laboratory in Mbalala, Mukono
vii. Hima Power rmax cement CEM II/42.4N

<u>Material preparation</u>

i. Polyester fiber must be soaked in water until bubbles disappear to ensure saturation.

ii. Polyester fiber added as fraction of the total weight of the concrete mix.

<u>Application of design</u>

Concrete pavers of grade C30 can be used in light and heavy parking lots and side walk ways in urban centers and as well can be used for compounds for homes and offices.

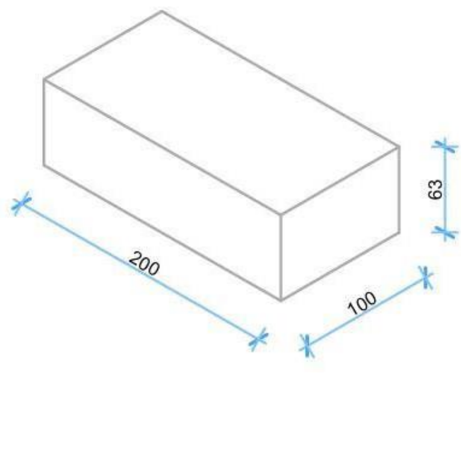
<u>Summary of design parameters</u>

i. Paver sizes align with the blueprint.

ii. Polyester fiber levels will range from 0.10% to 0.2% to assess effects on performance.

4.3.2 Design dimensions

The sizes adopted were 200 mm by 100 mm by 60 mm, reflecting practical field application. The molded reinforced paver maintained a standard form.



CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

i. The traits of polyester fiber and foundry sand demonstrate their effectiveness for strengthening concrete pavers, enhancing key qualities beyond typical pavers.

ii. These components boosted paver attributes, with 0.16% fiber volume in the mix yielding top outcomes for compressive resilience and water uptake.

5.2 Recommendation

i. Additional tuning of polyester fiber at 0.15%, 0.17%, and 0.19% should be investigated to perfect the mix of compressive strength and water uptake for peak reinforcement.

ii. Establish consistent fiber-spreading methods during blending to avoid bunching, ensuring even reinforcement for pulling strength and split resistance in pavers.

iii. Conduct rapid wear tests, covering humidity exposure and heat endurance across diverse settings.

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APPENDIX A : CERTIFIED LABORATORY RESULTS

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	Stirling

PROJECT	ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS

SUMMARY OF ABRASSION RESISTANCE TEST

LOCATION: MUKONO LAB	TECHNICIAN	
STRUCTURE: PAVER	SAMPLE No.	
	Lab. Ref. No	
CEMENT CONTENT:	Date Casted:	24/Feb/25
Test method : ASTM C1138	Date Crushed:	24/Mar/25

Fibre (%)	Days	Abrasion Resistance loss (%)
0.10%	7	2.6
	14	2.3
	28	2.2
0.12%	7	2.4
	14	2.1
	28	1.8
0.14%	7	2.1
	14	1.9
	28	1.7
0.16%	7	1.9
	14	1.7
	28	1.5
0.18%	7	2.2
	14	1.9
	28	1.7
0.20%	7	2.4
	14	2.1
	28	2.0

FOR TESTING LAB

LAB TECHNICIAN

MATERIALS ENGINEER

STIRLING CIVIL ENGINEERING LTD
2? MAR 2025
P.O.BOX 7961 KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	Stirling

PROJECT	ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS

SUMMARY OF PAVERS RAPID CHLORIDE PERMEABILITY TEST

LOCATION: MUKONO LAB	TECHNICIAN:
STRUCTURE: PAVERS	SAMPLE No.
	Lab. Ref. No
CEMENT CONTENT:	Date Casted: 24/Feb/25
Test method : AASHTO T 277.	Date Crushed: 24/Mar/25

SPEC; (100-1000 very low, 1000-2000 low, 2000-4000 moderate);

Fibre in percentages	Days	Charge passed (Coloumbs) @ different days	chloride permeability remarks
0.10%	7	2123	
	14	1844	
	28	1500	
0.12%	7	1952	
	14	1736	
	28	1543	
0.14%	7	1865	
	14	1661	
	28	1435	
0.16%	7	1773	
	14	1700	
	28	1200	
0.18%	7	1895	
	14	1698	
	28	1345	
0.20%	[illegible]	1934	
	[illegible]	1705	
	28	1575	

FOR TESTING LAB

LAB TECHNICIAN	MATERIALS ENGINEER	

STIRLING CIVIL ENGINEERING LTD
MAR 2025
P.O. BOX ... KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	**Stirling**

PROJECT:	ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS
Test Ref. No._	Lab Ref.No._
TEST:	DETERMINATION OF COMPRESSIVE STRENGTH OF CONCRETE CUBES (BS 1881 - 116:83)
Location:	RECTAGULAR PAVERS
Structure:	PAVERS
Class Of Concrete:	C30
DIMENSION	200X100X63 MM
VOLUME	0.00126
THICKNESS	63MM

TESTED AT STIRLING MUKONO LABORATORY

Cube No.	Fiber (%)	Casting Date	Testing Date	AREA	Weight (Kg)	Density (Kg/M3)	Age (Days)	Crushing Load (Kn)	Compressive Stength (Mpa)	Structure No.		Average
1	0.10%	13/Feb/25	20-Feb-2025	0.0200	3.025	2401	7	480	24.0			24.5
2			20-Feb-2025		2.965	2353		500	25.0			
3			27-Feb-2025		2.896	2298	14	625	31.3			31.3
4			27-Feb-2025		32.785	26020		625	31.3			
5			13-Mar-2025		3.025	2401	28	740	37.0			37.0
6			13-Mar-2025		2.794	2217		740	37.0			
1	0.12%	13/Feb/25	20-Feb-2025	0.0200	3.02	2397	7	535	26.8			26.3
2			20-Feb-2025		2.965	2353		515	25.8			
3			27-Feb-2025		3.121	2477	14	650	32.5			32.4
4			27-Feb-2025		2.868	2276		645	32.3			
5			13-Mar-2025		2.963	2352	28	780	39.0			39.4
6			13-Mar-2025		2.901	2302		795	39.8			
1	0.14%	13/Feb/25	20-Feb-2025	0.0200	3.15	2500	7	535	26.8			26.6
2			20-Feb-2025		3.005	2385		530	26.5			
3			27-Feb-2025		2.966	2354	14	690	34.5			34.1
4			27-Feb-2025		2.747	2180		675	33.8			
					2.886		28	825	41.3			41.3
5			13-Mar-2025		2.904	2305		825	41.3			

Testing Lab

Lab Technician

Materials Engineer

STIRLING CIVIL ENGINEERING LTD
MAR 2025
P.O. BOX ...796, KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	Stirling

PROJECT	ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS

SUMMARY OF PAVERS FLEXURAL STRENGTH TEST

LOCATION: MUKONO LAB	
STRUCTURE: PAVER	
CEMENT CONTENT:	
Test method : BS EN 12390-5	

TECHNICIAN	
SAMPLE No.	
Lab. Ref. No	
Date Casted:	24/Feb/25
Date Crushed:	24/Mar/25

PERCENTAGES OF FIBRE	DAYS	FLEXURAL STRENGTH, ft (Mpa)
0.10%	7	3.60
	14	4.90
	28	5.80
0.12%	7	4.30
	14	5.20
	28	6.40
0.14%	7	4.70
	14	5.70
	28	6.50
0.16%	7	5.40
	14	6.50
	28	7.20
0.18%	7	5.00
	14	5.90
	28	6.90
0.20%	7	4.60
	14	5.80
	28	6.60

FOR TESTING LAB

LAB TECHNICIAN	MATERIALS ENGINEER	

STIRLING CIVIL ENGINEERING LTD
2? MAR 2025
P.O. BOX 96, KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	Stirling
PROJECT	ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS	

MIX DESIGN FOR CONCRETE PAVER BLOCKS

Location: ....
Sample: ....
Lab. Ref.: ....

PAVERS MIX DESIGN

CLASS 30

Technician: ....
Date: ......20-2-2025..............

MIX FOR 1M³			Weight (kg)		Volume (dm³)	
CEMENT OPC	350	kg	Wt.c =	350	Vc =	111.11
WATER (W/C)	0.5		Wt.w =	175	Vw =	175
ADMIXTURE		%	Wt.a =		Va =	
AIR	2	%		20		20
					Total (1)	306.11

VOLUME AGGREGATES 1000 - (1) = 693.88889 (2)

AGGREGATES	% WEIGHT		B. SPEC. Gr. (g./cc)		ABSORPTION abs (%)	MOISTURE w (%)	Correction quantity H2O Wc = abs - w (%)
Ø 6 - 10 mm	50	c	2.606	h	0.471	0.141	0.330
Ø Cr. Sand mm	30	d	2.600	j	0.228	0.456	-0.227
Ø Nat. Sand mm	20	e	2.653	k	0.178	0.50	-0.317

$$\frac{(2)}{\frac{50}{2.606}+\frac{30}{2.600}+\frac{20}{2.653}} = \frac{693.8889}{38.26} = 18.136 \ (3)$$

AGGREGATES IN 1 M³				DRY WEIGHT dwt (kg)	REAL WEIGHT wt=dwt x (1+w/100) (kg)	Correction quantity H_2O Wc = dwt x Wc1 % /100
			(3)			
Ø 6 - 10 mm	50	% X	18.136	906.807	908.082	2.994
Ø Cr. Sand mm	30	% X	18.136	544.084	546.563	-1.237
Ø Nat. Sand mm	20	% X	18.136	362.723	364.518	-1.152
					Total	0.605

COMPOSITION OF THE MIX			BOX (*)	FOR 1 M³			IN LAB. 0.040 M3	
CEMENT TYPE: OPC	bags =		7	Wt c	350	kg	14.000	kg
WATER				Vw + Wc	175.6	dm³	7.024	dm³
ADMIXTURE								
AGGREGATES								
Ø 6 - 10 mm	50	%	15					
Ø Cr. Sand mm	30	%	11		908.082	kg	36.323	kg
Ø Nat. Sand mm	20	%	8		546.563	kg	21.863	kg
					364.518	kg	14.581	kg

REMARKS: Slump .... mm (*) Box volume = 0.036 m3 W/C = ...

CONTRACTOR M.E.: ....

STIRLING CIVIL ENGINEERING LTD
21 MAR 2025
P.O. BOX 596, KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	Stirling

PROJECT: ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS

MIX DESIGN FOR CONCRETE PAVER BLOCKS

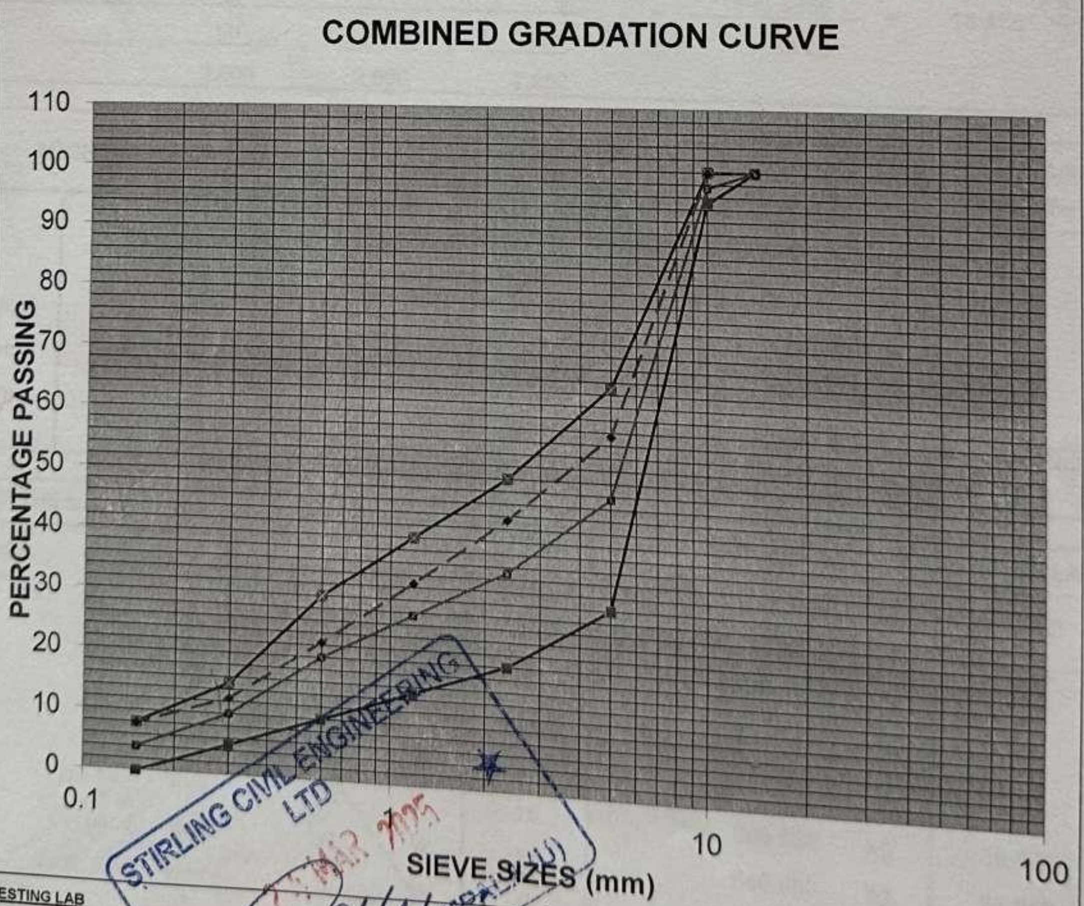
DATE: 20/Feb/25

TEST

LOCATION

SAMPLE No MIX DESIGN

	6/10MM		0/6MM		SAND		Theoretical actual	TARGET (MID-POINT)	SPEC
Propotions		42.0		38.0		20.0	100		
14	100	42.0	100	38.0	100	20.0	100	100	100
10	100	41.9	100	38.0	100	20.0	100	98	95--100
5	8	3.4	90	34.1	100	19.9	57	48	30--65
2.36	3	1.2	62	23.5	94	18.7	43	35	20--50
1.18	3	1.1	44	16.6	75	15.0	33	28	15—40
0.6	2	1.0	33	12.4	45	9.1	22	20	10—30
0.3	2	0.9	24	9.2	12	2.4	13	10	5—15
0.15	2	0.8	17	6.5	3	0.6	8	4	0—8



TESTING LAB

Lab Technician

Materials Engineer

STIRLING CIVIL ENGINEERING LTD
27 MAR 2025
P.O. BOX 793 KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	Stirling

PROJECT:	ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS
Test Ref. No._	Lab Ref.No._
TEST:	DETERMINATION OF COMPRESSIVE STRENGTH OF CONCRETE CUBES (BS 1881 - 116:83)
Location:	RECTAGULAR PAVERS
Structure:	PAVERS — DIMENSION 200X100X63 MM
Class Of Concrete:	C30 — VOLUME 0.00126 — THICKNESS 63MM

TESTED AT STIRLING MUKONO LABORATORY

Cube No.	Fiber (%)	Casting Date	Testing Date	AREA	Weight (Kg)	Density (Kg/M3)	Age (Days)	Crushing Load (Kn)	Compressive Stength (Mpa)	Structure No.	Average
1	0.16%	15/Feb/25	22-Feb-2025	0.0200	3.125	2480	7	545	27.3		27.5
2			22-Feb-2025		3.058	2427		555	27.8		
3			1-Mar-2025		2.9	2302	14	715	35.8		36.4
4			1-Mar-2025		2.896	2298		740	37.0		
5			15-Mar-2025		3.178	2522	28	862	43.1		43.2
6			15-Mar-2025		3.052	2422		865	43.3		
1	0.18%	15/Feb/25	22-Feb-2025	0.0200	2.851	2263	7	550	27.5		27.5
2			22-Feb-2025		2.903	2304		550	27.5		
3			1-Mar-2025		3.095	2456	14	695	34.8		35.0
4			1-Mar-2025		3.141	2493		705	35.3		
5			15-Mar-2025		3.05	2421	28	810	40.5		40.7
6			15-Mar-2025		3.125	2480		818	40.9		
1	0.20%	15/Feb/25	22-Feb-2025	0.0200	2.785	2210	7	525	26.3		26.4
2			22-Feb-2025		2.699	2142		530	26.5		
3			1-Mar-2025		2.927	2323	14	670	33.5		33.3
4			1-Mar-2025		2.89	2294		660	33.0		
					2.999		28	770	38.5		38.6
5			15-Mar-2025		2.914	2313		775	38.8		

Testing Lab

Lab Technician

Materials Engineer

STIRLING CIVIL ENGINEERING LTD
2? MAR 2025
P.O. BOX 796, KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	**Stirling**

PROJECT: ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS

Test Ref. No._ Lab Ref.No._

TEST: DETERMINATION OF COMPRESSIVE STRENGTH OF CONCRETE CUBES (BS 1881 - 116:83)

Location: RECTAGULAR PAVERS

Structure: PAVERS — DIMENSION 200X100X63 MM

Class Of Pavers C30 — NEAT (CONTROL) — VOLUME 0.00126 — THICKNESS 63MM

Cube No.	Casting Date	Testing Date	AREA	Weight (Kg)	Density (Kg/M3)	Age (Days)	Crushing Load (Kn)	Compressive Stength (Mpa)	Structure No.	Average
TESTED AT STIRLING MUKONO LABORATORY										
1	10/Feb/25	17-Feb-2025	0.0200	2.879	2285	7	550	27.5		28.0
2		17-Feb-2025		2.831	2247		575	28.8		
3		17-Feb-2025		2.831	2247		575	28.8		
4		17-Feb-2025		2.033	1613		540	27.0		
5	10/Feb/25	10-Mar-2025	0.0200	2.967	2355	28	775	38.8		37.9
6		10-Mar-2025		3.967	3148		710	35.5		
7		10-Mar-2025		4.967	3942		765	38.3		
8		10-Mar-2025		5.967	4736		780	39.0		
9		10-Mar-2025		6.967	5529		960	48.0		48.8
10		10-Mar-2025		7.967	6323		965	48.3		
11		10-Mar-2025		8.967	7117		960	48.0		
12		10-Mar-2025		9.967	7910		960	48.0		
13		10-Mar-2025		9.967	7910		950	47.5		
14		[illegible]-2025		9.967	7910		1020	51.0		
15		10-Mar-2025		10.967	8704		1015	50.8		
16		10-Mar-2025		11.967	9498		970	48.5		

STIRLING CIVIL ENGINEERING LTD
TESTING LAB
2 [illegible] 2025
P.O. BOX 786, KAMPALA (U)

Lab Technician	Materials Engineer

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	AHIMBISIBWE MELVIN & OLARA BOSCO	Stirling

PROJECT:	ASSESSING THE USE OF POLYESTER FIBER ALONG WITH FOUNDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS
Test Ref. No._	Lab Ref.No._
TEST:	DETERMINATION OF WATER ABSORPTION OF PAVERS (BS 1881-122:2011)
Location:	RECTAGULAR PAVERS
Structure:	PAVERS — DIMENSION 200X100X63 MM
Class Of Concrete:	C30 — VOLUME 0.44100 THICKNESS 63MM

TESTED AT STIRLING MUKONO LABORATORY

Cube No.	Fiber (%)	Dry Weight (Kg)	SSD Weight after soaking (Kg)	Soaked period (Days)	Water absorption %	Average Water absorption %		Fiber (%)	Dry Weight (Kg)	SSD Weight after soaking (Kg)	Soaked period (Days)	Water absorption %	Average Water absorption %
1	0.10%	2877	3452	7	5.76	5.6		0.16%	2798.0	3278.0	7	4.8	4.8
2		2961	3500		5.39				2862.0	3351.0		4.89	
3		3156	3655	14	4.99	5.2			3015.0	3501.0	14	4.9	4.8
4		2958	3501		5.43				2998.0	3473.0		4.8	
5		3028	3486	28	4.58	5.1			3152.0	3605.0	28	4.5	4.6
6		2856	3415		5.59				3057.0	3525.0		4.7	
1	0.12%	2756	3291	7	5.35	5.4		0.18%	2856.0	3358.0	7	5.0	5.0
2		2960	3505		5.45				2961.0	3462.0		5.0	
3		3142	3601	14	4.59	5.1			2757.0	3196.0	14	4.4	4.5
4		3047	3601		5.54				2805.0	3266.0		4.6	
5		2899	3400	28	5.01	4.9			2965.0	3442.0	28	4.8	4.7
6		2975	3452		4.77				2655.0	3115.0		4.6	
1	0.14%	2796	3319	7	5.2	5.1		0.20%	3158.0	3690.0	7	5.3	5.4
2		2899	3405		5.06				3024.0	3571.0		5.5	
3		3057	3562	14	5.05	4.9			2965.0	3456.0	14.0	4.9	5.1
4		3157	3630		473				2856.0	3375.0		5.2	
		3090	3562	28	4.72	4.7			3325.0	3799.0	28.0	4.7	5.0
5		2863	3326		4.63				2965.0	3485.0		5.2	

Testing Lab

Lab TECHNICIAN

Materials Engineer

STIRLING CIVIL ENGINEERING LTD
[illegible] MAR 2025
P.O. BOX [illegible], KAMPALA (U)

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College of Natural Sciences
School of Physical Sciences
DEPARTMENT OF GEOLOGY AND PETROLEUM STUDIES

Thursday, 06 February 2025

Bosco and Melvine
UCU Students

Dear Sir/Madam,

RE: ANALYSIS OF FOUNDRY SAND SAMPLE

The Department received one foundry sand to be analysed for Al_2O_3, SiO_2, CaO, Fe_2O_3, MgO and one polyfibre sample to be tested for water absorption. During analysis the foundry sample was ground to fine powder (< 0.063mm), from which a pressed powder pellets was prepared and scanned using an XRF spectrometer (Epsilon 1) for Al_2O_3, SiO_2 and Fe_2O_3, determination. While Ca and Mg were determined by digesting the ground samples with aqua regia and the resultant solution aspirated directly on the atomic absorption spectrometer (Agilent 240FSAA). Polyfibre water absorption was determined gravimetrically. The particle size distribution was carried out by dry sieving. The results below expressed in weight percentages (wt %) were obtained.

Table 1. Chemical composition data

Sample No	Al_2O_3 (%)	SiO_2 (%)	Fe_2O_3 (%)	MgO (%)	CaO (%)	Water Absorption (g/kg)
Foundry sand	9.5	75.5	6.0	0.38	2.91	
Poly fibre						1034.0

Table 2. Sieve Analysis data

	Percentage mass Retantion						
Sample no	2.0mm	1mm	0.5mm	0.25mm	0.125mm	0.063mm	<0.063
Foundry sand	4.4	8.0	13.9	27.3	16.2	16.1	14.1

Analyst:.................

KASAKA MOSES

Geochemistry Laboratory

Appendix B : LABORATORY TESTS AT STIRLING MATERIALS LABORATORY SIEVING OF FOUNDRY SAND TO OBTAIN GRANULAR SIZE FOR CONCRETE MIXING

***Figure 9:*MIXING OF COARSE AGGREGATES INTO THE CONCRETE MIX**

Figure 10: DRYING THE SURFACE OF SOAKED POLYESTER FIBER AND SORTING THEM IN DESIRED LENGTH

Figure 11:APPLICATION OF REPRESENTATIVE FRACTION OF PRE SOAKED FIBER ON THE CONCRETE MIX BEFORE CASTING

Figure 12:CRUSHED CONCRETE PAVER AFTER COMPRESSIVE STRENGTH TEST WITH COMPRESSIVE TEST MACHINE

Figure 13: OBTAINING THE WEIGHT OF THE CONCRETE PAVER USING A DIGITAL WEIGHING MACHINE

***Figure 14* FOUNDRY SAND PURCHASED FROM JINJA METAL FABRICATION WORKSHOP**

Figure 15: COLLECTION OF COARSE AGGREGATES FROM KAUGA CONCRETE WORKS FOR CASTING OF CONCRETE

Figure 16: *KAUGA CONCRETE WORKS WHERE CONCRETE PAVERS WERE CASTED FROM*

Figure 17: SIEVING OF FOUNDRY SAND TO OBTAIN GRANULAR SIZE FOR CONCRETE MIXING

Figure 18: WEIGHING OF A REPRESENTATIVE FRACTION OF THE POLYESTER FIBER FOR OPTIMIZATION OF THE CONCRETE MIX

Figure 19 CONCRETE MIXING WITH APPLIED FRACTION OF POLYESTER FIBER AS REINFORCEMENT.

Figure 20 ***Figure 21 CONCRETE MIXING WITH APPLIED FRACTION OF POLYESTER FIBER AS REINFORCEMENT.***

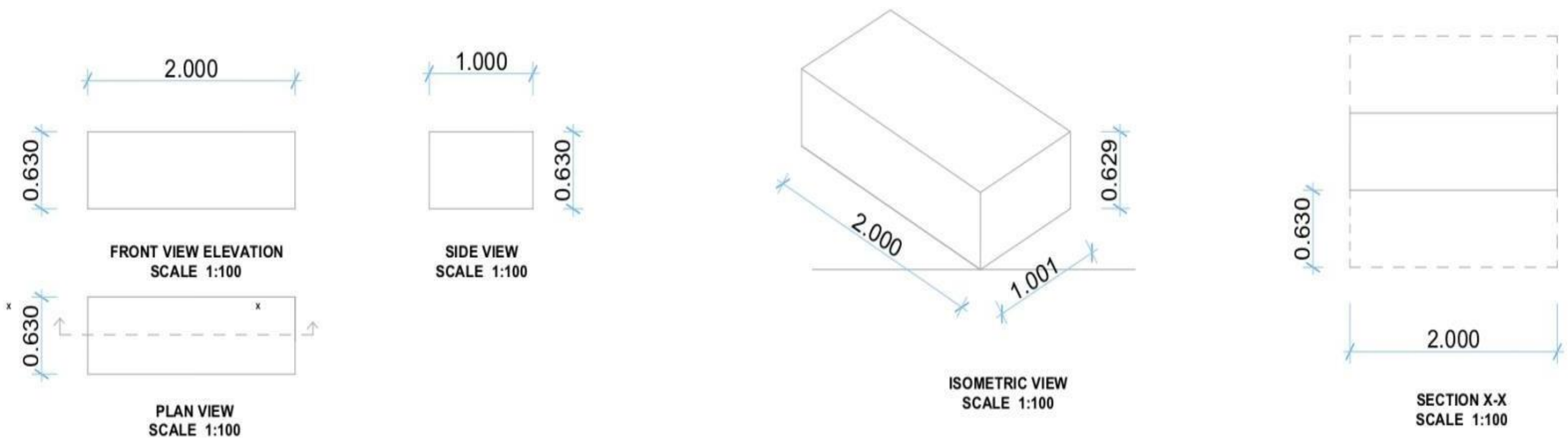
Figure 22: FOUNDRY SAND SIEVED AND READY FOR CASTING OF THE CONCRETE MIX

Figure 23: CURING GF CONCRETE PAVERS TO ENSURE HARDENING

Figure 24: FRESHLY MADE CONCRETE PAVERS WITH POLYESTER FIBER BLEND AS REINFORCEMENT

Figure 25: THE AUTHOR WITH THE PROJECT PATNER AFTER PROJECT ORAL DEFENSE

APENDIXC:ENGINEERINGDRAWING



PROJECT: ASSESSING THE USE OF POLESTER FIBER ALONG WITH FOUDRY SAND AS REINFORCEMENT IN MAKING OF CONCRETE PAVERS

AUTHOR: AHIMBISIBWE MELVIN S21B32/110

OLARA BOSCO S21B32/003