KWARA STATE UNIVERSITY, MALETE

...the Green University for Community Development and Entrepreneurship

The Twenty-Second (22nd) Inaugural Lecture

Title:

From Rubble to Resilience: Gathering the Fragments for a New Structural Paradigm

By

Professor Samson Olalekan ODEYEMI

B.Eng., M.Eng., Ph.D (Ilorin), R.Eng., MNSE, MNICE

Professor of Structural and Material Engineering,

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Members of the administrative and technical staff,
My Lords, Spiritual and Temporal,
Distinguished students of Civil and Environmental Engineering (Greatest NICESITES),
Great students of the Kwara State University (Greatest KWASUITES),
Members of my family, nuclear and extended,
Gentlemen of the print and electronic media,
Esteemed invited guests,
Friends and relations,
Distinguished ladies and gentlemen,

Preamble
Mr. Vice-Chancellor, Sir, I stand before you today with a heart brimming with profound gratitude to the Almighty God, by whose singular grace I am empowered to stand at this podium. It is a rare and humbling privilege to present this inaugural lecture — *"From Rubble to Resilience: Gathering the Fragments for a New Structural Paradigm"* — at this specific juncture in my career and the history of our institution.

The timing of this occasion is a testament to divine favour. To reach the pinnacle of one's academic career as a Professor is a significant feat; however, to be granted the platform to deliver an inaugural lecture in the very same year of the approval and announcement of that elevation is a rare honour that I do not take for granted.

I am deeply mindful of the burgeoning legacy I represent today. Within the broader context of the Faculty of Engineering and Technology, this marks the fourth inaugural lecture—and the 22nd in the University—continuing a growing tradition of excellence set in motion by Professor Leonard F. Daniel, who delivered the Faculty's first and the University's No. 1 inaugural lecture on May 3, 2017, titled "Aeronautics and Astronautics: The Paradigm Shift in Nigeria's Future Space Exploration and Development"; followed by Professor Abdulganiyu Funsho Alabi, who delivered the second in the Faculty and 5th in the University on March 27, 2019, titled "Striving for Global Relevance on the Platform of Minerals, Metals and Materials". Within my immediate constituency, the Department of Civil and Environmental Engineering, I am humbled to be the second person to stand in this capacity, following in the illustrious footsteps of Professor Bilyamin Adeoye Ibitoye, who delivered the third lecture in the Faculty and 12th in the University on July 12, 2023, titled "Living with Death Trap: Way Forward to Safer Life on Nigerian Roads". It is this profound lineage of engineering scholarship that I am deeply proud to advance today.
I must express my sincere appreciation to the University Management for providing the enabling environment and the distinct privilege to share my journey, my research, and my vision for the future of structural engineering. It is through this support that we move from the fragments of inquiry to the solid foundations of impact.

From the Rubble of Career Choice

Mr. Vice-Chancellor, Sir, every structure begins with a blueprint, but as any seasoned engineer will tell you, the site conditions often force us to deviate from our original plans. My life's blueprint was clear from the onset: I was to be a Medical Doctor.

This was not merely a childhood whim; it was a vision nurtured by my parents and fueled by a relentless dedication to my studies. At Adeola Model School, Offa, I poured my heart into my books, eventually graduating in 1992 with the best results in my set and the honour of serving as Head boy. My academic performance opened the doors of the Federal Government College, Jos, which became my home and my forge from 1992 to 1998.

My resolve to wear the white coat was further solidified by the footsteps of a giant. Senior Ayo Ogunmodede (now Professor Ogunmodede), a family friend, a former head boy of my primary school, and an academic icon, had gained admission to study Medicine. I wanted to follow that path. I wanted to heal; I wanted to save lives.

However, the "site conditions" of my life began to shift. Despite passing my WAEC in one sitting, my first encounter with JAMB ended in heartbreak. I was just two marks short of the cut-off mark for Medicine. I pivoted, applying for Anatomy, but the door remained shut. Frustration led me to the Nigerian Defence Academy to study Biological Science. I reached the final stage of the interview, but when the names of the six successful candidates from my state were called, mine was not among them.

I tried again. Even with a good JAMB score and the presence of my guardian as a Principal Officer at the University of Jos, the doors remained barred. The University had lost a session and was dealing with a backlog. My dream of Medicine was becoming a "rubble" before my very eyes.

It was at this crossroads that my father told me about the 'Remedial' program at the University of Ilorin. When I learned that Medicine was off the table even through that route, I told my father, "I am not interested."

But a father's vision often sees further than a son's frustration. He pleaded with me to consider Civil Engineering. He looked at me and said words I will never forget:
"Your dream of being a Doctor can still be achieved. You will be a Doctor of Philosophy — an academic doctor."

With the gentle persuasion of my mother, I reluctantly stepped onto this new path. I moved from the dream of healing human bodies to the mission of building the bodies of our cities.

Mr. Vice-Chancellor, Sir, with the benefit of hindsight, I see now that it was the Great Architect of the Universe who was ordering my steps. Though both of my parents have since passed on to glory, my heart finds peace in knowing that they both stood by me to witness my convocation as a PhD holder in Civil Engineering (Figure 1). The dream did not die; it was simply repurposed. The "rubble" of my initial disappointment became the very "fragments" God used to build the Professor who stands before you today.



Figure 1: The Inaugural Lecturer with his late parents

Foundations and Frameworks: The Genesis of a Structural Mind

Mr. Vice-Chancellor, Sir, if my entry into Civil Engineering was reluctant, my discovery of its heart, Structural Engineering, was a journey from trepidation to transformation.

In the corridors of the Faculty, Structural Engineering was often spoken of in hushed, fearful tones. It was the "Goliath" of the Civil Engineering options, notorious for its rigorous calculations and abstract concepts that seemed designed to baffle the mind. To many, it was a path to be avoided; to me, it was a challenge waiting for a catalyst.

That catalyst arrived through divine providence and the company of a bosom friend, Oladapo David Abolarin (OBJ). While scouting for a place for our Industrial Training (IT), we stumbled upon BAL Engineering Ltd. A senior colleague who had gone before us gave us a candid warning: *"You will be exposed to the true practical rudiments of structural design, but do not expect a kobo in stipends."*

At that crossroads, we made a decision that would define our careers: we chose learning over money. We traded the comfort of a stipend for the richness of the drafting board. It was within the walls of BAL Engineering that the abstract became tangible. The "fragments" of classroom theory began to coalesce into the "foundations" of practical design. It was there that I first shook hands with Computer-Aided Design and Drafting (CADD), a tool that transformed my approach to engineering.

However, the leap from a practitioner to a researcher required a different kind of guidance. This was provided by my mentor and supervisor at the postgraduate level, Professor Adeola Abdullah Adedeji. He did not just teach me how to design; he introduced me to the "Deep Research" of structural materials.

He challenged me to look beyond the form of the structure and investigate the substance of the material itself. It was under his tutelage that my flair for Materials Engineering was born. I realised that to solve real-world problems, one must understand the very DNA of the structures we build, specifically concrete.

I began to ask: How do these materials behave under stress? How can we make them better, cheaper, and more sustainable? My structural understanding was no longer just about keeping a building standing; it became about innovating the very elements that hold our world together. I had moved from being a reluctant student of the discipline to a dedicated seeker of its secrets.

Lifecycle, Utility, and Failure of Infrastructure

Mr Vice-Chancellor, Sir, before addressing the "fragments" that define my research, we must first appreciate the "whole" of the structural world we inhabit. A building is far more than a mere assembly of blocks and mortar; it is an artistically and aesthetically created space designed to provide a sanctuary for human existence, shielding us from the harsh extremities of our

natural and artificial ecology (Anne, 2025; Odeyemi et al., 2015). Whether we are considering residential structures that house the family unit, or the institutional and commercial edifices that drive our economy, every building is designed with the singular goal of stability. Similarly, if buildings are the destinations, then bridges (Figure 2) are the vital lifelines of our nation's circulatory system (*Gonzalez et al.,* 2020; Odeyemi, 2014). These structures, whether categorised as beam, arch, truss, or suspension, represent the triumph of engineering over geographical barriers, turning rivers and valleys into pathways of progress. A bridge is not just a crossing; it is a critical artery whose health is directly tied to the social and economic vitality of the community it serves (*Gonzalez et al.,* 2020).

When we speak of "Rubble", we are speaking of the ultimate betrayal of engineering intent. Building collapse occurs when the internal strength of a structure's components can no longer withstand the external loads imposed upon it, representing a malfunction of constituent materials where elements like columns and beams fail to perform their original function (Figure 3) (Singh & Bhandari, 2024).



Figure 2: A Bridge



Figure 3: Collapsed Building

While Nigeria is blessed with a relatively stable environment, we are nonetheless haunted by a man-made "natural disaster" fueled by poor design, unskilled workmanship, and a lack of quality management. Bridge collapse, though perhaps less frequent, is infinitely more catastrophic, as it severs the economic ties of entire regions (Dulin et al., 2025). The effect of these failures on human existence is devastating; beyond the billions of Naira lost in economic investments, we face the irreplaceable loss of human lives. In 2016 alone, our nation witnessed its deadliest year in terms of structural failure, with 3 building collapses and 35 lives lost, leaving behind shattered families and a public psyche scarred by the fear of the very roofs meant to protect them. Every aspect of the building process, from architectural vision to structural, electrical, and mechanical engineering, requires meticulous professional supervision to prevent such tragedies.

My foray into this "rubble" was not merely to observe, but to provide a forensic audit of our national crisis. In my research covering the decade between 2009 and 2019 (Odeyemi et al., 2019), I sought to move beyond anecdotal evidence to identify

the patterns of our structural vulnerability. This study revealed that structural defects are the primary executioners of our buildings ' failures, with the South-West region emerging as the epicentre, accounting for over 60% of total collapses. This geographic concentration of rubble suggests that in areas where development is fastest, the shortcuts are often the deepest. To mitigate this, I have advocated for the Standards Organisation of Nigeria (SON) to ensure that only certified materials reach the market and that soil tests and structural analyses are treated as sacred mandates rather than optional luxuries.

Extending this quest for resilience to our lifelines, my work has also addressed the seismic vulnerability of bridges. Nigeria is often mislabelled as "seismically inactive," yet tremors in Ijebu-Ode, Ibadan, and Lagos, with magnitudes reaching 4.5, warn us of a looming threat (Akpabot et al., 2018; Odeyemi et al. 2025b; Omodasola & Elabor, 2025). In my simulations of the Iyemoji Bridge in Nigeria (Odeyemi, 2014; Odeyemi & Adedeji, 2013) and the Matsurube Bridge in Japan (Odeyemi & Adedeji, 2018), I explored the integration of "Smart Materials" such as Shape Memory Alloys (SMA) (El-Sokkary, 2025; Zareie et al., 2020). By utilising the time-history method of seismic analysis and SAP2000 software, my findings revealed that a hybrid reinforcement of 75% steel and 25% SMA in bridge columns can reduce seismic deflection by a staggering 65.66%. While traditional steel provides stiffness, the super elasticity of SMA allows the bridge to adapt to dynamic forces and return to its original shape. These studies collectively revealed a hard truth: there must be a shift in the way we manage our infrastructure to achieve resilience.

The Role and Nature of Cement in Infrastructure

Mr. Vice-Chancellor, Sir, at the heart of every resilient structure lies a binder. Cement (Figure 4) is arguably the most significant

manufactured material in human history, serving as the essential "glue" that binds aggregates, sand, gravel, and crushed stone into a monolithic mass known as concrete or sandcrete. It is a hydraulic binder, meaning it sets and hardens through a chemical reaction with water known as hydration, rather than simply drying out (Odeyemi et al., 2021). In the Nigerian construction industry, cement is the primary constituent in the production of sandcrete blocks, which remain the most common walling unit for residential and commercial buildings. Beyond blocks, its use extends to reinforced concrete columns, massive bridge piers, and high-performance pavements. There are various types of cement, ranging from Ordinary Portland Cement (OPC), used for general construction, to Rapid Hardening Cement and Sulfate Resisting Cement, each engineered for specific environmental demands and structural requirements.



Figure 4: Stack of Cement Bags

Despite its utility, the production of cement presents a profound paradox: we build to protect human life, yet the process of creating the material contributes to the degradation of our global environment. The manufacturing of cement is a thermal-intensive process occurring in massive kilns at temperatures as high as 1450°C (Odeyemi et al., 2022e). This high energy demand is not merely a financial cost but also an ecological one. The process involves the "calcination" of limestone, a chemical reaction that releases massive amounts of Carbon Dioxide (CO_2) into the atmosphere. It is estimated that for every tonne of cement produced, nearly an equivalent tonne of CO_2 is emitted, making the cement industry responsible for approximately 8% of global greenhouse gas emissions. In an era where climate change threatens the very stability of our coastal cities, the structural engineering profession faces an ethical and technical imperative to reduce this carbon footprint.

The search for resilience has led us to the concept of partial replacement, the utilisation of Supplementary Cementitious Materials (SCMs). These are materials that, while not necessarily binders on their own, possess pozzolanic properties; they react with the calcium hydroxide released during cement hydration to form additional strength-giving compounds. This is where my philosophy of "Gathering the Fragments" finds its most practical application. By identifying and refining agricultural and industrial wastes that are currently clogging our landfills and polluting our landscapes, we can reduce our reliance on clinker-heavy cement. In Nigeria, we are blessed with a bounty of agricultural residues that, when properly processed, become high-performance engineering materials. Wastes such as Rice Husk Ash (RHA), Corn Cob Ash (CCA), Sugar Cane Baggase Ash, and even Palm Oil Fuel Ash have been investigated as viable options. Utilising these "rubble" fragments of the agricultural sector does more than just lower the cost of construction; it

addresses the energy crisis by reducing the heat required for binder production and mitigates the environmental impact by sequestering waste into the very bones of our buildings. This transition from virgin materials to waste-integrated binders represents the "New Structural Paradigm" that my research seeks to establish, a future where our structures are not just strong, but sustainable.

Supplementary Cementitious Materials

Guinea corn, or Sorghum, is not merely a staple of the Nigerian diet; it is a symbol of our agricultural heritage, grown in almost every corner of our nation. Nigeria stands as one of the world's leading producers of this resilient grain, with an annual production often exceeding 6.5 to 7 million metric tonnes. While the grain provides vital nutrition and health benefits to millions, its processing generates a significant volume of husks. These husks are inedible for human consumption and are frequently discarded in open fields or burnt in uncontrolled environments, where they constitute a persistent environmental nuisance. However, in the eyes of a structural engineer, this "waste" is a dormant resource waiting to be awakened. My research (Odeyemi et al., 2020a; Odeyemi et al., 2020b; Odeyemi et al., 2022b; Odeyemi et al., 2022f) focused on the transformation of this agricultural residue into Guinea Corn Husk Ash (GCHA), a viable supplementary cementitious material. Unlike the production of traditional cement, which requires temperatures upward of 1450°C, we found that Guinea Corn Husk can be calcined at a significantly lower temperature of 650°C. This reduction in thermal demand represents a major stride in energy conservation and a decrease in the carbon intensity of building materials. When processed at this optimal temperature, the chemical profile of the ash undergoes a fascinating metamorphosis, resulting in a mineral composition that is highly compatible with the chemistry of concrete. The efficacy of any pozzolan lies in its oxide

composition. Our laboratory analysis revealed that GCHA is remarkably rich in Silicon Dioxide (SiO2), which is the primary driver of secondary hydration in concrete. The oxide composition of the GCHA used in my research is presented in Table 1:

Table 1: Oxide Composition of GCHA

Oxide	Content Percentage (%)
Silicon Dioxide (SiO_2)	66.06
Aluminum Oxide (Al_2O_3)	4.44
Iron Oxide (Fe_2O_3)	4.36
Calcium Oxide (CaO)	2.90
Magnesium Oxide (MgO)	0.00
Potassium Oxide (K_2O)	10.79
Sodium Oxide (Na_2O)	0.00
Sulfur Trioxide (SO_3)	1.74
Manganese (Mn)	0.05
Zinc (Zn)	0.42

Source: (Odeyemi *et al.*, 2020a)

The significance of these figures becomes clear when we apply international engineering standards. According to BS EN 197-1 (2011), for a material to be classified as an effective supplementary cementing material, the summation of its primary oxides, SiO2, Al2O3, and Fe2O3, must meet specific thresholds to ensure pozzolanic activity. In the case of GCHA, this summation reaches 74.86%, with Silicon Dioxide alone possessing the lion's share of the composition. This chemical

"fingerprint" confirms that Guinea Corn Husk Ash is not merely a filler; it is a reactive agent that enhances the mechanical properties of concrete. By gathering these discarded husks and integrating them into our structures, we do more than just clean our environment; we add immense value to the construction industry, proving that the "rubble" of our harvests can indeed become the "resilience" of our homes.

Mr. Vice-Chancellor, Sir, alongside Guinea corn, rice stands as a pillar of Nigerian food security. Our nation has seen a remarkable surge in rice production, with annual yields currently estimated at over 8 million metric tonnes. However, for every tonne of rice harvested, approximately 200 kg of husk is generated. In many milling clusters, these husks form massive, smouldering mountains that pollute the air and occupy valuable land.

We (Ige et al., 2018) investigated the transformation of this environmental liability into a structural asset. We found that when rice husks are burnt at a controlled temperature of 650°C, they yield Rice Husk Ash (RHA) with exceptional pozzolanic properties. The resulting ash is a silica powerhouse, making it a formidable partial replacement for cement in concrete, particularly when optimised for compressive strength.

Our quest did not stop at grain residues. We turned our attention to the arboreal "waste" of our environment: Bamboo (*Bambusoideae*) and the Tropical Almond (*Terminalia catappa*). Bamboo is celebrated for its rapid growth and carbon sequestration, but its fallen leaves are often regarded as forest floor debris. Similarly, the Almond tree, ubiquitous in our neighbourhoods for its shade, drops vast quantities of leaves that are typically gathered and burnt as trash.

Our investigations revealed that when Bamboo leaves are calcined at 700°C, they undergo a chemical reorganisation that makes them highly reactive. The same was found for Almond leaves. By subjecting these "fragments" to controlled thermal treatment, we unlocked their hidden engineering potential, proving that the leaves we sweep away today could be the very binders that hold our structures together tomorrow.

The viability of these three agricultural wastes, Rice Husk Ash (RHA), Bamboo Leaf Ash (BLA), and Almond Leaf Ash (ALA), is rooted in their chemical "DNA." To provide a clear comparison of their potential, Table 2 summarises the oxide compositions obtained from our laboratory analyses and those of cement:

Table 2: Oxide composition of RHA, BLA and ALA

Oxide (%)	**Rice Husk Ash (RHA)** (Ige *et al.*, 2018)	**Bamboo Leaf Ash (BLA)** (Odeyemi *et al.*, 2022d)	**Almond Leaf Ash (ALA)** (Odeyemi *et al.*, 2024c)	**Cement** (Neville, 2011)
Silicon Dioxide (SiO_2)	73.50	72.81	56.00	17 - 25
Aluminum Oxide (Al_2O_3)	3.22	3.49	7.10	3 - 8
Iron Oxide (Fe_2O_3)	1.75	2.00	10.10	0.5 - 6
Calcium Oxide (CaO)	4.35	2.50	7.61	60 - 67
Phosphorus Oxide (P_2O_5)	8.75	8.57	-	-
Potassium Oxide (K_2O)	5.35	2.09	9.90	-
Magnesium Oxide (MgO)	-	0.17	10.00	0.1 – 4.0
Sulfur Trioxide (SO_3)	0.15	0.15	2.01	1 - 3
Titanium Oxide (TiO_2)	0.26	0.23	-	-
Manganese Oxide (MnO)	0.67	0.20	0.08	-
Zinc Oxide (ZnO)	0.10	-	0.02	-

Mr. Vice-Chancellor, Sir, a cursory look at Table 2 reveals a profound technical truth. Both the Rice Husk and Bamboo Leaf ashes exceed the 70% threshold for combined silica, alumina, and iron oxides, marking them as premium-grade pozzolans. While the Almond Leaf Ash possesses a lower silica content, its high iron and magnesium oxide levels suggest unique durability characteristics that warrant further structural exploration.

By gathering these disparate fragments, from the milling floors of the North to the bamboo groves and almond-lined streets of the South, we are not just finding cement replacements. We are developing a localised, sustainable, and low-carbon materials library that ensures the "Resilience" of our future infrastructure is built on the foundations of our own ecological abundance.

The Frontier of Low-Thermal Activation: The Updraft Co-Gasifier Reactor

Breaking the Thermal Barrier

Mr. Vice-Chancellor, Sir, while my earlier research established the viability of agricultural wastes at temperatures between 600°C and 700°C, our quest for true resilience demanded that we push even further into the realm of energy efficiency. In a bid to drastically reduce the carbon footprint of structural materials, we designed and fabricated an Updraft Co-Gasifier Reactor (Figure 5). This innovation has allowed us to develop high-performance pozzolans at a peak temperature of only 305°C, a significant departure from the 450°C to 800°C range typically cited in global literature. By slashing the required thermal energy, we have moved from the "rubble" of energy-intensive manufacturing toward a truly eco-friendly structural paradigm.

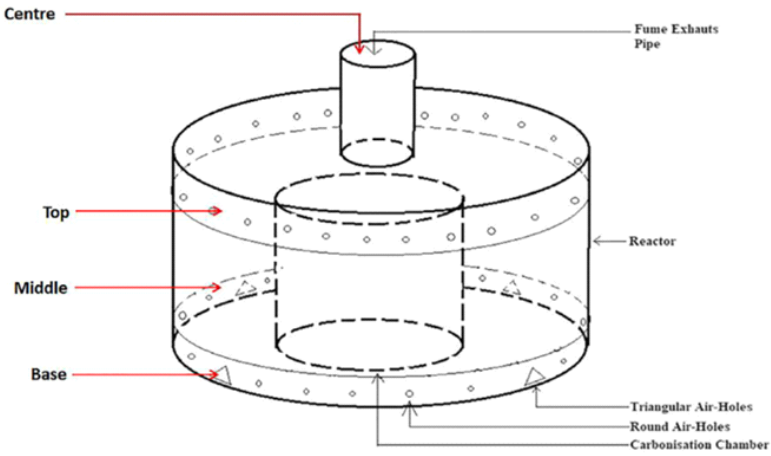


Figure 5: Model of the reactor used for gasification (Adeniyi et al., 2022)

Synergy in Waste: Goat Bones and Wooden Scaffolds

Using this specialised reactor, we explored the synergy between diverse waste streams that currently plague our urban and rural environments. Nigeria consumes approximately 360,000 tonnes of goat meat annually, a figure that results in massive quantities of discarded abattoir waste. Improper disposal of goat bones often leads to water pollution and foul odours, while discarded wooden scaffolds from construction sites contribute to the growing global waste management crisis. In our study (Odeyemi et al., 2025a), we subjected a blend of these two materials to our co-gasifier. Through Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDX), and Fourier-Transform Infrared Spectroscopy (FTIR) analyses, we characterised the resulting ashes, finding that a ratio of 1:0.67 of goat bone to wooden scaffold ash exhibited optimal pozzolanic properties. The low-temperature gasification successfully transformed these disparate biological and industrial "fragments" into a reactive

mineral resource, proving that the synergy of animal and plant waste can produce a binder of exceptional quality at a fraction of the traditional energy cost.

The Potential of Animal Keratin and Bamboo: Cow Horns

Our investigation into co-gasification extended to another challenging waste stream: cow horns. The construction industry's reliance on carbon-heavy cement has escalated costs, yet the solution may lie in the combination of animal by-products and rapid-growth plants. In a recent study published in Chemistry Africa (Odeyemi et al., 2025c), we evaluated the pozzolanic potential of ashes derived from this unique pairing.

The analytical results were illuminating. SEM and FTIR spectroscopy revealed a diverse and highly reactive microstructure in these ashes, characterized by spongy, porous, and granular textures. These micro-architectural features are essential for binding reactivity, as they provide a high surface area for chemical interaction. We discovered that the optimal ratio of cow horn to bamboo ash demonstrated superior pozzolanic performance, effectively proving that animal-derived waste, when gasified with bamboo in our novel reactor, creates a blueprint for sustainable material science. By repurposing these fragments through low-temperature gasification, we maintain the potential for structural excellence while fundamentally reducing the environmental price of our infrastructure.

Quality Assessment and the Sandcrete Block Crisis

Mr. Vice-Chancellor, Sir, in the hierarchy of Nigerian construction materials, the sandcrete block (Figure 6) reigns supreme. According to the Nigerian Industrial Standard (NIS), these blocks are categorised primarily as load-bearing or non-load-bearing, with specific mandates for their physical

properties to ensure the safety of the occupants they shield (Odeyemi et al., 2015). However, my extensive field assessments across different geopolitical zones have revealed a disturbing divergence between policy and practice.



Figure 6: Typical Sandcrete Blocks

In our study of block factories in Adeta, Ilorin West (Odeyemi et al., 2018), we found that the durability of our buildings is being systematically compromised at the source. The NIS specifies a minimum compressive strength of 2.5 N/mm² for load-bearing blocks, yet the samples we tested yielded values ranging from a dismal 0.19 N/mm² to 0.40 N/mm². Furthermore, the water absorption rates far exceeded the 12% limit, suggesting a porous, weak internal structure. This failure is largely a result of inadequate mix ratios, where the pursuit of profit overrides the principles of structural integrity.

This crisis is not localised to the North-Central region. Moving further north, our quality evaluation in the Kaduna Metropolis (Wilson et al., 2024), encompassing Kaduna North, Kaduna South, Igabi, and Chikun, confirmed a widespread negligence of standard codes of practice. Our laboratory tests showed mean compressive strengths between 0.21 N/mm² and 0.62 N/mm², failing to meet even the more modest 1.6 N/mm² threshold provided by NIS 87:2000.

Perhaps more alarming than the physical failure was the human factor. Our interviews with 32 block industries revealed a pervasive "culture of ignorance." We discovered that standards are often determined by market forces rather than engineering requirements. Only 3% of the industries complied with the recommended mix ratio of 20–25 blocks per bag of cement, and a staggering 90% failed to perform any form of quality assurance, such as the routine inspection of moulds. In the entire metropolis, only one industry could provide evidence of certification from the Standards Organisation of Nigeria (SON). This underscores an urgent need for the enforcement of industry standards to prevent the "rubble" we so often see on our news cycles.

In seeking a path toward resilience, we must also look at the "how" of production. My research shows that the method of compaction significantly influences the final strength of the block. In a comparative study of manual versus machine compaction (Odeyemi et al., 2015), We utilised prominent Nigerian cement brands to test 32 samples over a 28-day curing period. The results of this investigation were definitive in establishing the technical superiority of mechanised production. While blocks produced manually achieved respectable average strengths of approximately 2.83 to 2.89 N/mm², those produced via machine compaction reached significantly higher average strengths, ranging from 2.96 to 3.03 N/mm². This data clearly demonstrates that the mechanical application of pressure and vibration ensures a

more robust structural unit than traditional manual methods. The mechanical vibration and uniform pressure of a machine ensure a more cohesive arrangement of the "fragments"—the sand and cement—resulting in a denser, stronger building unit.

Sustainable Wall Systems: Advanced Waste Applications in Sandcrete Blocks

The Innovation of Glasscrete: Solving the Spalling Crisis

Mr. Vice-Chancellor, Sir, a significant challenge in the durability of Nigerian buildings is the "spalling" effect, the progressive breaking or chipping of the block surface, often caused by moisture ingress and salt attack in waterlogged areas. In our study presented at the 2023 International Conference on Science, Engineering and Business for Sustainable Development Goals (SEB-SDG),) (Atoyebi et al., 2023), we proposed a solution rooted in the "fragments" of our urban waste: Glasscrete.

Glass waste is a non-biodegradable environmental pollutant that currently clogs our landfills. However, its inherent properties—zero water absorption and high durability—make it an ideal candidate for partial replacement of traditional aggregates like sharp sand and stone dust. We investigated the production of 6-inch hollow blocks using replacement levels of 0%, 25%, and 50% to determine the optimal mix for a zero-spalling effect.

The experimental results were remarkable and challenged traditional assumptions about sandcrete production. We discovered that the highest compressive strengths were not found in the control samples, but in the mixes containing waste glass. Specifically, we recorded peak strengths of 102.33 kN in the 50% waste glass/sharp sand mix, and 100.67 kN in a hybrid mix of 50% waste glass, 25% sharp sand, and 25% stone dust. Conversely, the control samples with no glass replacement showed the lowest compressive strength.

Crucially, for buildings in damp environments, the water absorption tests revealed that the hybrid mix (50% glass, 25% sand, 25% stone dust) had the lowest absorption rate. While stone dust on its own performed poorly when combined with glass, the synergy between sharp sand and glass powder created a dense, impermeable matrix.

The implications of this research are profound for our coastal and flood-prone regions. Based on these findings, we recommend a mix ratio incorporating 50% waste glass for the production of glasscrete blocks. These units are not merely "eco-friendly" alternatives; they are engineered for a zero-spalling effect, providing a robust defence against the moisture-related decay that plagues conventional sandcrete. By gathering the fragments of our discarded bottles and windows, we can build structures that stand firm even in the most challenging environmental conditions.

Maize Straws in Sandcrete Production

Moving from the non-biodegradable fragments of urban glass, we also investigated the structural potential of organic agricultural residues that often go to waste after the harvest. In our study published in the Advanced Engineering Forum (Odeyemi *et al.,* 2022c), we addressed the dual crisis of environmental depletion caused by the over-mining of river sand and the skyrocketing cost of conventional building materials, which has collectively led to a chronic shortage of decent housing in Nigeria.

Maize is one of the most widely cultivated crops in our nation, but after the golden kernels are harvested, the stalks and straws are typically left to rot or are set ablaze, contributing to atmospheric pollution. Our research sought to incorporate these maize straws directly into the matrix of sandcrete blocks, measuring 450 by 150 by 225 millimetres, using a standard mix proportion of one part cement to four parts sand. By doing so, we aimed to create a

lightweight, more affordable, and eco-friendly walling unit that repurposed these agricultural remains.

Through the production and testing of 36 sandcrete blocks, we monitored compressive strength at 7, 21, and 28-day intervals to assess the performance of the straw-incorporated matrix. The results revealed that the 28-day compressive strengths for mixes containing 0, 5, 7.5, and 10 percent by volume of maize straws were 3.35 N/mm², 2.57 N/mm², 2.27 N/mm², and 1.90 N/mm², respectively.

It is highly significant that the strength of the blocks at both the 0 and 5 percent maize straw inclusion levels generated the highest compressive results, both of which successfully met the strength recommendations stipulated by the Nigerian Industrial Standard (NIS 87:2004, 2004). This confirms that we can reduce the volume of river sand required and find a constructive use for agricultural "rubble" without compromising the safety or integrity of our buildings. This integration of organic fragments into the sandcrete matrix offers a sustainable pathway toward affordable housing, proving that resilience can be found in the very fields that feed our nation.

Treated Polyethylene in Sandcrete Blocks

Beyond the agricultural and glass "fragments" previously discussed, our research expanded into the realm of synthetic waste, specifically addressing the global menace of plastic pollution. Expanded Polyethylene (PE) (Figure 7) is one of the most common plastic wastes found in our urban environment, yet its inherent hydrophobic properties offer a unique opportunity to address a major structural headache: seepage and dampness. In building construction, dampness in walls is not merely an aesthetic issue; it can lead to serious structural failures and costly remedial fixes. In our study (Odeyemi *et al.*, 2024a), we

investigated the effects of solvothermal-treated polyethylene on the mechanical properties of both concrete and sandcrete blocks.



Figure 7: Expanded Polyethylene

Our research aimed to evaluate whether the addition of treated polyethylene, at concentrations ranging from 0 to 1.0 percent, could mitigate water ingress while maintaining structural integrity. By treating the polyethylene solvothermally, we were able to enhance its compatibility with the cementitious matrix. The results revealed that as the polyethylene content increased, there was a slight increase in the density of the sandcrete blocks, which remained well within the limits specified by the Nigerian Industrial Standards. Although there was a reduction in the compressive strength and water absorption capacity as the

additive percentage rose, the structural performance remained reliable.

Despite the observed reduction in strength as the percentage of polyethylene rose, the performance of the blocks remained structurally viable. Specifically, sandcrete blocks incorporated with up to 1 percent of solvothermal-treated polyethylene maintained compressive strengths that were consistently higher than the 2.5 N/mm² minimum required by the Nigerian Industrial Standards (NIS 87:2004, 2004) for load-bearing walls. This demonstrates that we can successfully introduce synthetic waste into the block-making process without falling below the safety thresholds mandated for Nigerian buildings.

The most significant achievement in this application was the dramatic improvement in moisture resistance. Our experimental data showed a 61 percent reduction in water absorption over a 48-hour period. This represents a breakthrough for building construction in humid or coastal regions where seepage and dampness are chronic problems. By transforming the "rubble" of our plastic waste into a treated additive for sandcrete blocks, we have engineered a cost-effective and promising solution that shields our walls from the capillary action of water, thereby preventing the structural and aesthetic damage traditionally caused by dampness.

Modelling the Strength of Agricultural-Waste Sandcrete Blocks

In our study, 'Comparative Analysis of Statistical Models for Predicting the Properties of Agricultural Waste-Enhanced Sandcrete Blocks' (Odeyemi et al., 2024b), we conducted a comparative analysis to establish statistical models that can predict the compressive strength of sandcrete blocks enhanced with various agricultural residues.

Mr. Vice-Chancellor, Sir, the production of "low-cement" blocks is an economic necessity in our current climate, yet it must be balanced against the environmental risks of improperly managed waste in rural areas. Our research investigated sandcrete blocks reinforced with four distinct waste streams: rice husk, guinea corn husk, maize straw, and a hybrid combination of sorghum husk and straw.

We observed a consistent physical trend across these materials: as the quantity of fibre increased, the density of the blocks decreased, and consequently, the compressive strength followed a downward trajectory. However, the performance of these "fragments" varied significantly when measured against national benchmarks. We achieved compressive strengths of 2.41 N/mm² for rice husk, 1.90 N/mm² for guinea corn husk, and 2.40 N/mm² for maize straw. Most notably, the combination of sorghum husk and straw reached a compressive strength of 3.01 N/mm², making it the only agricultural-waste reinforced block in this specific investigation to fully meet the Nigerian Industrial Standard (NIS 87:2004, 2004) specifications for load-bearing units.

A critical contribution of this work was the determination of an optimal water-binder ratio of 0.4, which proved to be the optimal ratio for maintaining workability and strength across all the investigated agricultural wastes. More importantly, we successfully generated four statistical models with precision values higher than 4.0.

These models serve as a valuable mathematical compass for the construction industry, allowing engineers and block manufacturers to predict the compressive strength of a mix before the first block is even moulded. By quantifying the relationship between fibre content and structural performance,

we are providing the technical framework necessary to transition these environmentally friendly materials from the laboratory to the construction site. Through these models, we ensure that the use of agricultural "rubble" is not a matter of guesswork, but a precise science of resilience.

The Nano-Evolution of Sandcrete Blocks

The introduction of nanoscale "fragments" into building materials allows us to address structural weaknesses at their point of origin—the microscopic voids within the cementitious matrix. By incorporating nanoquartz, we moved beyond simple waste recycling into the realm of advanced material engineering. Our research (Atoyebi et al., 2024) focused on the fabrication of nano-sandcrete blocks using various mix ratios of sharp sand, quartz sand, and nanoquartz particles. Particle size analysis confirmed that while the coarser sands provided the necessary stability and skeleton for the blocks, the finer nano-particles acted as a sophisticated filler and reactive agent.

The physical transformation of these blocks was profound. We observed that higher percentages of sharp sand and nanoquartz contributed to a significant increase in bulk density, with values reaching as high as 2660 kg/m³ after 28 days of curing. This densification had a direct impact on the blocks' permeability; the finer nanoquartz particles effectively reduced the porosity of the matrix, bringing water absorption rates as low as 10.56% in optimized mixes.

The mechanical results of this "nano-enhancement" far exceeded conventional expectations. After 28 days, the compressive strengths ranged from 3.7 N/mm² to a remarkable 8.22 N/mm². To put this in perspective, the highest strength recorded is more than three times the minimum requirement of 2.5 N/mm² set by the Nigerian Industrial Standard. Scanning Electron Microscopy (SEM) micrographs provided the visual proof of this success,

showing well-dispersed nanoquartz particles and a highly effective particle-matrix interaction.

Our comprehensive analysis identified the optimal composition for these high-performance units as 80% sharp sand, 5% quartz sand, and 15% nanoquartz. This specific formulation offers a sustainable yet superior solution for construction applications where extreme longevity and strength are paramount.

The Geopolymer Synthesis from Glass Waste

While the use of nano-scale particles addresses structural voids, we also investigated the complete chemical transformation of waste into a binding agent through geopolymerization. In our study, Strength and Durability Assessment of Glass-Alkaline Activated Geopolymer Sandcrete Blocks (Atoyebi et al., 2025), we explored the potential of Glass-Alkaline Activated Geopolymers as a radical alternative to conventional Portland cement, which is responsible for substantial carbon emissions.

Geopolymer technology offers a tremendous possibility to reduce the environmental footprint of the construction industry by utilising industrial and urban "fragments" that would otherwise remain in landfills. In this research, we created a geopolymer by activating waste glass powder with an alkaline solution. This geopolymer, combined with a superplasticizer (SP), was used to replace cement in the production of sandcrete blocks at rates of 0, 5, 10, 15, and 20 percent. This process essentially turns non-biodegradable glass into a reactive adhesive that bonds the sand matrix together.

The physical properties of these geopolymer-enhanced blocks showed a marked improvement in structural compactness. After 28 days of curing, the densities of the various mixes ranged from 1808 to 2102 kg/m^3, with the 20 percent replacement level

achieving the maximum density. This indicates that the geopolymer binder creates a more substantial and less porous block than traditional cement alone.

The mechanical performance was equally encouraging. We discovered that the inclusion of a superplasticiser was a critical factor in enhancing the blocks' compressive strength. The mix containing 15 percent cement replacement and 15 percent SP inclusion demonstrated a maximum compressive strength of 3.4 N/mm^2 after 28 days. This result is significant as it exceeds the 2.5 N/mm^2 requirement for load-bearing blocks. The synergy of glass-based geopolymers and superplasticizers not only enhances the mechanical qualities of sandcrete blocks but also provides a sophisticated, low-carbon pathway for the future of the Nigerian building industry.

Beyond the Ordinary: Understanding High-Performance Concrete (HPC)

High-Performance Concrete represents a sophisticated evolution of traditional building materials, specifically engineered to provide enhanced durability and mechanical properties that go far beyond the capabilities of standard mixes. While conventional concrete is primarily measured by its compressive strength, High-Performance Concrete is defined by a combination of performance requirements such as high workability, superior modulus of elasticity, and exceptional resistance to environmental stressors. One of the fundamental differences lies in the water-binder ratio, where conventional concrete usually operates at a higher range while High-Performance Concrete maintains a significantly lower ratio to ensure a dense and impermeable structure.

The internal architecture of this material is further refined through the "particle packing effect," which is achieved by

incorporating fine pozzolanic "fragments" like those derived from the agricultural wastes explored in my research. These micro-particles fill the tiny voids between cement grains, effectively strengthening the Interfacial Transition Zone, which is typically the weakest point where the cement paste meets the aggregate. This structural refinement makes the concrete nearly impervious to harmful substances like chloride ions and sulfates, which are the leading causes of reinforcement corrosion in marine and industrial environments.

The practical applications of High-Performance Concrete are essential for the most demanding engineering projects, including high-rise skyscrapers that require smaller but stronger columns and long-span bridges that must withstand severe weather. It is also the material of choice for nuclear containment structures and heavy-duty industrial floors where abrasion resistance and chemical stability are non-negotiable. By integrating localized waste-derived pozzolans into these high-end mixes, we are not only achieving these superior technical standards but also promoting a more sustainable and cost-effective approach to modern infrastructure.

Mr. Vice-Chancellor, Sir, having established these definitions, I will now present my specific research contributions to the development of High-Performance Concrete using our indigenous waste materials.

From Waste Paper to Structural Power: Waste Paper Pulp Ash (WPPA) in High-Performance Concrete

The pursuit of high-performance infrastructure requires us to look beyond the farm and into the bins of our offices and schools. Paper waste represents a significant portion of urban refuse, yet through controlled thermal treatment, it can be transformed into Waste Paper Pulp Ash (WPPA), a potent mineral additive for

High-Performance Concrete. In my study on the Effect of Pozzolanic Properties of Waste-Paper Pulp Ash in High Performance Concrete (Anifowose et al., 2025), we investigated how the pozzolanic qualities of this ash could enhance the mechanical profile of concrete designed for a characteristic strength of 50 N/mm².

Following the COREN Mix Design Manual, we replaced Portland Limestone Cement with WPPA at levels of 5, 10, 15, and 20 percent. Our laboratory findings indicated that as the proportion of paper pulp ash increased, the fresh concrete became progressively stiffer, resulting in lower slump and compacting factor values. However, the true value of the ash was revealed during the strength development phase across a 56-day curing period. We discovered that at a 5 percent replacement level, the concrete reached a compressive strength of 56.56 N/mm², successfully exceeding the target mean strength. Even at a 10 percent replacement level, the concrete met the design target of 50 N/mm², though higher levels of inclusion began to show a decline in mechanical performance.

The microstructural evidence obtained through Scanning Electron Microscopy (SEM) provided a clear explanation for these results. At a 5 percent inclusion level, the WPPA maintains a dense and cohesive microstructure, effectively filling the interstitial pores and creating a robust matrix. Conversely, when the WPPA content exceeded 10 percent, we observed an increase in porosity, which accounts for the reduction in strength. This research proves that a 5 percent replacement of cement with waste paper ash creates a concrete that is not only environmentally sustainable but actually stronger than traditional High-Performance Concrete after a longer curing period. By reclaiming the "rubble" of our paper waste, we were able to engineer a more durable and high-strength future for our built environment.

Guinea Corn and Rice Husk Ashes as Local Alternatives to Silica Fume in High-Performance Concrete

The advancement of High-Performance Concrete in the Nigerian construction industry has historically been limited by a reliance on conventional, high-cost materials, often neglecting the vast potential of locally available mineral additives. By pivoting toward the strategic use of indigenous agricultural byproducts, we can break this cycle of high production costs and forge a path toward true structural self-reliance. To achieve this, our research (Olorunfemi et al., 2025) turned toward the abundant agricultural "rubble" of our own landscape, specifically investigating Guinea Corn Husk Ash (GCHA) and Rice Husk Ash (RHA) as indigenous replacements for imported silica fume.

The potential of these local pozzolans lies in their unique chemical and physical properties. Our findings revealed that Rice Husk Ash is an exceptional performer due to its high amorphous silica content and reactive surface area, which significantly enhances the compressive, tensile, and flexural strengths of the concrete matrix. While Guinea Corn Husk Ash exhibited lower reactivity and a higher water demand that initially led to a decline in strength, the true breakthrough occurred when we developed a synergistic blend of the two materials.

By optimising the mixture to contain 8 percent Guinea Corn Husk Ash and 22 percent Rice Husk Ash, we successfully achieved a compressive strength of 50 N/mm^2 while maintaining the necessary workability for structural applications. This optimised blend proves that Nigeria does not need to look abroad for the building blocks of high-performance infrastructure. By substituting imported silica fume with these locally sourced agricultural fragments, we provide a blueprint for a cost-effective, sustainable, and truly independent construction sector that draws its strength from the very soil of our nation.

Bamboo Leaf Ash High-Performance Concrete

While several supplementary cementitious materials have been traditionally used to enhance the long-term durability of High-Performance Concrete, the potential of Bamboo Leaf Ash (BLA) remained largely unexplored. In our study, (Odeyemi et al., 2022d), we sought to establish the viability of BLA by first ensuring its chemical reactivity through controlled processing. By calcining bamboo leaves at a temperature of 700°C, we produced an ash that, upon analysis through Energy Dispersive X-ray Fluorescence (EDXRF), revealed a silica content exceeding 70 percent. This high concentration of silica is a definitive indicator of potent pozzolanic properties, marking it as a high-quality mineral additive.

This research investigated the mechanical impact of replacing Portland cement with BLA at increments of 5, 10, 15, and 20 percent. Over a 56-day curing period, we monitored both compressive and splitting tensile strengths to map the performance curve of the material. The data revealed that a 5 percent replacement level represents the optimum threshold for strength development. Beyond this point, the mechanical performance begins to diminish, suggesting that a precise dosage is required to maintain the delicate balance of the high-performance matrix.

The most compelling evidence of BLA's effectiveness was found in the microstructural analysis of the concrete. At the 5 percent incorporation level, the concrete exhibited a significantly improved interlocking of grains compared to traditional mixes. This dense micro-architecture is the result of the secondary chemical reactions between the bamboo silica and the cement hydration products, which fill internal voids and create a more unified structure. We concluded that 5 percent bamboo leaf ash is a highly effective additive for producing High-Performance

Concrete that meets the rigorous demands of modern engineering while utilising sustainable, locally sourced materials.

Optimising Superplasticisers and Water-Cement Ratios

Building upon the microstructural success of bamboo-enhanced concrete, our subsequent research focused on the meticulous balance required between the binder and the chemical admixtures that facilitate workability. High-Performance Concrete necessitates low moisture levels, which can make the mix difficult to handle without the correct application of technology. In this phase of our investigation (Odeyemi et al., 2022a), we maintained the 5 percent bamboo leaf ash replacement and varied the proportions of superplasticiser to identify the most efficient delivery method for this material.

Through the application of X-ray Fluorescence (XRF) and X-ray Diffraction (XRD), we confirmed that the mineral structure of the ash remained stable and reactive within the blended system. Our challenge was to design a mix that would surpass a characteristic strength of 41 N/mm² while remaining workable. Our experiments identified an optimal combination for this high-strength application: a water-cement ratio of 0.360 combined with 0.128 percent superplasticizer by weight of cement.

This specific combination resulted in a concrete with a slump of 49 mm and a 56-day compressive strength of 53.61 N/mm², which significantly exceeded our design targets. Additionally, the water absorption capacity was limited to only 4.77 percent, confirming that the density observed in our earlier microstructural studies translated into a highly impermeable and durable final product. By quantifying these exact ratios, we have provided the industry with a practical formula for transforming bamboo waste into a sophisticated structural asset.

The Guinea Corn Husk Ash Fortification of High-Performance Concrete

Beyond the use of paper and bamboo, we investigated another staple of the Nigerian agricultural landscape: the guinea corn. While the kernels provide sustenance, the husks often accumulate as a problematic byproduct of the harvest. In our research (Odeyemi et al., 2020a), we examined the mechanical properties of High-Performance Concrete using Guinea Corn Husk Ash (GCHA) as a mineral supplement to cement. Our objective was to engineer a concrete capable of achieving a formidable characteristic strength of 50 N/mm² while finding a high-value application for these organic fragments.

The research involved replacing Ordinary Portland Cement with GCHA at levels ranging from 0 to 20 percent, with the chemical integrity of the ash verified through X-ray Fluorescence (XRF). We monitored the behaviour of the fresh concrete through slump and compacting factor tests, but the most vital insights came from the performance of the hardened concrete samples across a 56-days curing period. We discovered that at the 56-days mark, the control mix and the 5 percent GCHA inclusion produced strengths of 56.85 N/mm² and 57.76 N/mm², respectively, both surpassing the design target mean strength of 56.56 N/mm². Furthermore, even the 10 percent replacement level successfully met the 50 N/mm² characteristic strength requirement, proving that significant portions of cement can be successfully displaced by this agricultural ash.

The structural benefits of GCHA were not limited to compressive strength alone. Our testing revealed that the 5 percent GCHA-concrete yielded the highest flexural and split tensile strengths at 56-days, suggesting a more resilient internal bond than conventional high-performance mixes. Scanning Electron Microscopy (SEM) analysis provided a clear visual justification

for these mechanical outcomes, showing a remarkably uniform distribution of filler particles at the 10 percent inclusion level. However, we also noted that at higher percentages of GCHA, the resulting composite displayed multiple distinct grains with potentially weak interfaces, which explains the decline in strength beyond the 10 percent threshold. This study confirms that integrating 10 percent GCHA as a cement replacement produces a concrete with superior strengths over time, effectively turning the "rubble" of the guinea corn harvest into a high-performance structural fortress.

From Laboratory to Landscape: The Kwara State University Faculty of Engineering Access Road as a Living Laboratory

Honourable Vice Chancellor, Sir, distinguished ladies and gentlemen, the technical data, SEM micrographs, and optimised ratios I have presented are not theoretical conjectures; they are proven realities. As the ultimate validation of this research and a definitive demonstration of the applicability of utilising waste, I direct your attention to the entrance road of the Faculty of Engineering and Technology, right here on the Kwara State University campus (Figure 8).

The very interlocking stones that pave this road were engineered using Rice Husk Ash and localised fibres, following the precise optimal formulations I have developed. This is not a project confined to a laboratory; it is a critical piece of operational infrastructure. This road was commissioned by the Vice Chancellor in 2024. Despite the environmental exposure and traffic load, it remains exceptionally strong and fully functional, serving as a silent but powerful testament to the structural integrity and durability that can be achieved when we strategically apply our scientific findings to localised materials. This is no longer theoretical; it is infrastructure serving our community today, demonstrating that the "rubble" of our harvest

can indeed form the "fortresses" of our future. This brings me to my final call to action and natural conclusion.



Figure 8: Entrance to the Faculty of Engineering and Technology, Kwara State University, Malete Campus

Conclusion

Honourable Vice-Chancellor, Sir, distinguished ladies and gentlemen, this final call to action serves as the natural conclusion to the evidence I have presented today. This lecture has drawn our attention to the urgent necessity of transitioning from a culture of waste to a circular economy where our legislative frameworks and industrial policies prioritise the integration of locally sourced "rubble" into the national building code. Our findings remind us of the divine principle of stewardship found in John 6:12, where we are instructed: "Now gather the leftovers, so that nothing is wasted." By establishing decentralised processing hubs across the federation to transform our abundant agricultural residues into certified mineral additives, we act upon this profound mandate while directly aligning with the targets of Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure) and Goal 11 (Sustainable Cities and Communities). Decoupling our infrastructure growth from expensive imports and carbon-heavy cement production will not only insulate our construction industry from global supply shocks but also empower our rural economies. Ultimately, this national shift ensures that the strength of our infrastructure becomes a direct reflection of our ability to innovate with the very fragments of our own soil, building a Nigeria that is as sustainable as it is structurally sound. With these fragments gathered and these fortresses built, I rest my case.

Recommendations

To ensure that the "leftovers" we have gathered are effectively utilised to build a resilient nation, I propose the following recommendations:

For the General Public

1. **A Paradigm Shift in Value:** We must move away from viewing agricultural residues like rice husks, guinea corn

husks, and bamboo leaves as "refuse" to be burned or discarded. I urge the public to recognise these as valuable industrial feedstocks that can improve the durability of our local infrastructure.

2. **Waste Sorting Culture:** To facilitate the production of Waste Paper Pulp Ash (WPPA), individuals and corporate offices should adopt deliberate paper waste separation. What we discard today in our offices can be reclaimed as the mineral strength of our future high-performance buildings.
3. **Community-Led Resource Recovery:** Local communities and farming cooperatives should be encouraged to aggregate their agricultural byproducts rather than resorting to open-field burning. By organising the collection of husks and stalks, communities can position themselves as key suppliers to the construction industry, turning an environmental hazard into a collective economic asset.

For the Government

4. **Legislative Integration:** I recommend that the relevant regulatory bodies formally integrate agro-based pozzolans into the National Building Code. Standardising these materials will provide engineers and contractors with the legal and technical framework to adopt sustainable alternatives in public works.
5. **Strategic Self-Reliance:** Rather than relying on specialised industrial additives that may be subject to global supply chain fluctuations, the government should prioritise the development of indigenous mineral additives. This will strengthen our national construction sector and protect it from external economic shocks.
6. **Decentralised Calcination Hubs:** The government should incentivise the creation of processing plants in agrarian regions. These hubs would collect and process

husks under controlled conditions, transforming "agricultural rubble" into a profitable industrial feedstock and creating new jobs for our rural communities.

7. **Support for Green Standards:** Policies should be enacted to reward or incentivise construction projects that meet a minimum threshold of recycled or sustainable material content, driving a market-led transition toward a circular economy.
8. **Investment in Research and Development:** There should be dedicated national funding for the scaling of laboratory-proven sustainable materials into large-scale pilot projects, ensuring that Nigerian innovations lead the way in African infrastructure development.

For the Kwara State University (KWASU) Community

9. **Standardising Campus Infrastructure:** Building on the success of the Faculty of Engineering access road, the University should adopt a policy where campus pavements, walkways, and minor structural works incorporate our proven pozzolan-fibre technology, making KWASU a model for sustainable campus development.
10. **Advanced Production Capacity:** To scale our research into community-wide impact, there is a need for the procurement of an industrial-scale electric furnace. A larger furnace will allow for the mass production of high-quality pozzolanic ashes, transitioning our work from laboratory samples to institutional-scale application.
11. **Laboratory Enhancement:** I recommend the provision of state-of-the-art equipment, such as high-capacity Compression Testing Machines, specifically for the Department of Civil and Environmental Engineering. This will ensure our testing remains precise and capable of handling the high-strength concrete we are now engineering.

12. **Centre for Sustainable Materials:** I propose the establishment of a Centre for Sustainable Construction Materials within the University. This would serve as a hub for testing local "fragments" and certifying them for use by external contractors and government agencies.

Acknowledgements
Honourable Vice-Chancellor, Sir, distinguished guests, while the list of those who have contributed to the tapestry of my life and career is truly inexhaustible, I must take this moment to recognise a few whose support has been pivotal. To those whose names may not be mentioned here today, please know that your impact is no less significant; it is only the constraints of time that compel me to be brief.

I start by returning all glory to my Lord and saviour, Jesus Christ, the Alpha and Omega, who made every provision available for my journey from childhood through my academic pursuits. I am eternally grateful, mindful of the words in Psalm 126:3: "The Lord has done great things for us, and we are filled with joy."

I especially appreciate my Vice-Chancellor, Professor Shaykh-Luqman Jimoh, under whose transformative leadership I was elevated to the rank of Professor, having had the singular privilege to serve under your administration both as the Sub-Dean of the School of Postgraduate Studies and as the Head of the Department of Civil and Environmental Engineering; thank you, Sir, for deliberately fostering an inclusive, exemplary, and enabling environment where academics can truly thrive, grow, and innovate, and I pray that the Almighty God will continue to grant you robust health, divine wisdom, and peace of mind. My deep appreciation also goes to the Deputy Vice-Chancellor (Administration), Professor Moshood Mahmood Jimba, under whom I served briefly as the Sub-Dean of the School of

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I dedicate this lecture to the memory of my beloved parents, the late Mr. Joseph and the late Mrs Felicia Odeyemi. Though they are no longer with us to witness this day, they saw into the future and recognised a "special child" when I was yet a fragment. They laid the architectural foundation for the man who stands before you today, and it is my greatest honour to be their son.

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