A PROPOSAL FOR THE PRODUCTION OF BRAKE PADS FOR VEHICLES

WRITTEN BY

BRAKE PAD PROJECT TEAM

SUBMITTED TO

THE OVERSEEING OFFICER

PROTOTYPE ENGINEERING DEVELOPMENT INSTITUTE ILESA

SEPTEMBER. 2025

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This project concerns the development of brake pads intended for motor vehicles. The research investigates the production and evaluation of a composite brake pad utilizing basalt as a primary raw material. The objective is to enhance mechanical, thermal, and tribological properties, while simultaneously improving environmental sustainability and cost-effectiveness relative to conventional brake pad materials.

The proposed methodology involves the selection of pulverized basalt reinforcement in varying ratios, combined with specified percentages of friction modifiers, abrasives such as alumina or iron oxide, lubricants such as graphite, binders, and fillers, including barites to produce a composite material. The composite mixture and back plate are hot pressed in a prepared die mould at a controlled temperature between 150 and 180 degrees Celsius, followed by preheating to ensure homogenization of particles within the matrix.

The total estimated budget for the project is ₦3,711,250 (Three Million, Seven Hundred and Eleven Thousand, Two Hundred and Fifty Naira). This amount includes costs for materials, material testing, transportation, and other logistical requirements.

Prototype production will be conducted in collaboration with the National Automotive Design and Development Council (NADDC), Zaria, and tertiary institutions such as Obafemi Awolowo University ile-ife, and Federal University of Technology, Akure

The anticipated market for the project encompasses all vehicular equipment utilizing brake pad systems, including commercial fleet operators, private vehicle owners, and government fleets.

The project will have a giant positive impact on the Automobile and Agricultural sectors of the Nigerian Economy.

This project is deemed feasible and marketable, and it is therefore recommended to the Management for funding.

1.0 INTRODUCTION

1.1 **Background Information**

Traditional brake pads have historically relied on materials like asbestos, metal, aramid (Kevlar), and glass fibers as reinforcing agents. In the quest for higher performance, improved environmental sustainability, and reduced health risks, basalt fiber has emerged as a superior alternative. Basalt fiber is produced from molten basalt rock, an abundant volcanic material.

Basalt is obtained from volcanic igneous rock which are rich in silicate minerals and offers high mechanical strength, excellent thermal resistance, and corrosion resistance. Processed basaltcan be use asreinforcement or base matrix in composite materials. making them a promising candidate for use in brake pads.

This study focuses on the production of brake pads using basalt as a key raw material. The objective is to develop a composite brake pad formulation incorporating basalt powder or fibers, and to evaluate its physical, mechanical, and tribological properties in comparison with conventional materials.

With increasing demand for high-performance and eco-friendly vehicles delved into as one of the NASENI lunch pad, there is a need for improved brake pads that balance performance, cost, and environmental impact. in view of the environmental impact, a non-carcinogenic material such as basalt rock a subset of volcanic igneous rock which are rich in silicate minerals and offers high mechanical strength, excellent thermal resistance, and corrosion resistance. Will be considered for the production of the brake pad

Brake pads are composite materials made of four main phases:
Binders (to hold everything together)

Reinforcements (to provide strength and wear resistance)

Friction modifiers (to stabilize braking performance)

Fillers (to improve manufacturability, density, and cost control)

1.2 Aim of the Research

Develop a brake pad using basalt rock as the major component with excellent wear resistance, thermal stability, and frictional performance.

Objectives of the Research

The objectives of this research are to:

a. minimize environmental hazards by avoiding asbestos-based materials;

b. utilize locally available raw materials to reduce cost; and

c. establish a scalable production process suitable for industrial application.

1.3 Justification for Project

The need for alternative materials in brake pad manufacturing has become increasingly urgent due to health, environmental, and performance-related concerns associated with traditional materials. Producing brake pads in Nigeria is justified by huge local demand, raw material availability, employment creation, cost savings, reduction of imports, industrial growth, and environmental benefits.

Nigeria has abundant raw materials like steel dust, basalt rock, copper, graphite, and resins that can be processed into friction materials for industrial Growth, technology transfer, and market opportunity. Brake pad production can strengthen the automotive and manufacturing sectors while stimulating research in materials science, especially in composites and nanomaterials. Local production encourages collaboration between universities, research institutes, and industries, boosting technological innovation. Considering the market opportunity, Nigeria has one of the largest vehicle populations in Africa, with millions of cars, buses, and motorcycles in daily use. Brake pads are high-turnover consumables that require frequent replacement, creating a steady demand. At present, over 70% of brake pads are imported, which not only drives up prices but also makes supply dependent on foreign exchange fluctuations.

Establishing local production ensures consistent availability at competitive prices, while meeting the needs of both the domestic and regional markets.

Local sourcing of raw materials significantly reduces production costs. This creates room for higher profit margins while allowing products to be competitively priced against imports. Reduced reliance on foreign currency and protects the business from exchange rate volatility.

A brake pad manufacturing facility would create jobs across multiple sectors, including manufacturing, supply chain logistics, marketing, and retail distribution. Beyond direct employment, alignment with future trends in electric vehicles (EVs) requiring low-noise, durable, and eco-friendly braking systems, strengthens Nigeria's automotive supply chain by supporting local vehicle assembly plants such as NASENI Keke production plant (NKPP), NASENI electric vehicle production center (NEVPC) and Innoson Vehicle Manufacturing (IVM) and others. This creates opportunities for strategic partnerships and bulk supply contracts. Furthermore, asbestos-free production aligns with global health and safety standards, making Nigerian-made brake pads suitable for export markets.

1.4 **Statement of Research/Production Problem**

With increasing demand for high-performance and eco-friendly vehicles, there is a need for improved brake pads that balance performance, cost, and environmental impact. However, automotive brake pad market in Nigeria suffers from lack of regulation and standardization, leading to widespread availability of substandard and counterfeit brake pads. These pose significant safety risks and undermine consumer trust.

Most of our roads often rough, littered with debris, steep, and poorly maintained, cause increased stress on the braking system. Overloading (especially in commercial vehicles) further exacerbates wear. Frequent hard braking, heat buildup, and stop-and-go driving in traffic urban areas also shorten brake pad lifespan.

More importantly, basalt rock with other reinforcement in the matrix will proffer solution to air or Moisture in Brake Lines & Contaminated Fluid which causes reduced braking efficiency.

High heat from repeated braking reduces friction coefficient and accelerates brake pad wear. It also causes hot spots and uneven pad-disc contact, lowering braking efficiency and

lifespan. Finally, environmental and Health Concerns to the people, brake pad dust contributes to particulate air pollution. Some pad materials especially non-asbestos organic and hybrid-ceramic may release toxic particles harmful to lung health. When choosing brake pad types, consider environmental and health impacts; low-dust or less toxic pad materials are preferable.

1.5 Scope of Research/Production

This research explores the potential of basalt rock as a major constituent in brake pad production, focusing on its performance, sustainability, and industrial applicability. The scope of the study is outlined as follows:

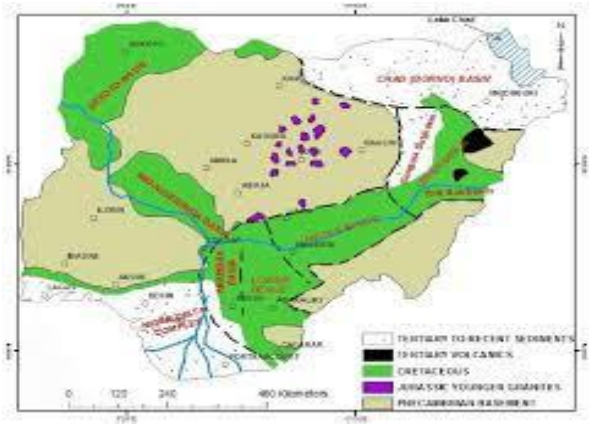
Utilization of basalt rock in various forms (fibers, powder, or hybrid fillers) for friction composite development.

Characterization of basalt's physical, thermal, and mechanical properties relevant to braking applications.

Development of brake pad composites incorporating basalt in different proportions and processing conditions.

Optimization of resin, basalt, additive interactions to achieve desired hardness, density, porosity, and wear resistance.

Investigation of hybrid composites combining basalt with graphite, rubber, and metallic fillers for balanced performance.



Map of Nigeria (Area with green notation indicate states with good deposit of basalt)

2.0 METHODOLOGY

The methodology adopted for the production and testing of basalt-based brake pads includes the following:

a) The production: this follows a standard dry-mix molding process, with the key difference being the use of basalt fiber as the primary reinforcement.A precise mixture is created, typically consisting of: **Basalt Reinforcement (40-60wt%), Friction Modifiers (15-250wt%)** Abrasives (alumina/iron oxide), lubricants (graphite), and other materials to fine-tune the friction coefficient and wear rate, **Binder (10-20wt%):** Thermoset resin, usually phenolic resin, Fillers (5-15wt%) Barites/ vermiculite,

a) Mixing: The dry raw materials are blended in a large mechanical mixer (e.g., a ploughshare mixer) to achieve a completely homogeneous mixture. This is critical for consistent performance.
b) Pre-forming: The mixed powder is poured into a mold and often lightly compressed into a "pre-form" or "cake" to make handling easier and ensure accurate volume for the final pressing stage.
c) Hot Pressing and Molding: The pre-form is placed into a heated mold (typically at 150-180°C). A hydraulic press applies high pressure (e.g., 200-500 kg/cm²) for a set duration (e.g., 2-10 minutes). This process simultaneously forms the pad to its exact shape (including shim pockets and chamfers) and cures the phenolic resin, transforming the powder mix into a solid, cohesive composite.
d) Post-Curing (Baking): The pressed pads are placed in an oven and heated to a specific temperature profile (e.g., several hours at 180-250°C). This completes the polymerization of

the resin, enhancing the pad's thermal stability, hardness, and structural integrity, and preventing outgassing later.

2.1 Materials, Equipment and Method for the Production

MATERIAL	FUNCTION
Friction Modifiers	These adjust the coefficient of friction and wear.
Graphite	lubricant, reduces wear and noise
Metallic powders	copper, brass, bronze, aluminum, iron – improve thermal conductivity and friction stability; though copper is being phased out due to regulations
Oxides e.g., zirconia, alumina, silica	increase hardness and wear resistance
Binders (Matrix Phase)	They hold everything together under high stress and heat. Phenolic resin (most common binder with good thermal resistance). Modified resins (cashew nut liquid resins, epoxy modified phenolics, melamine resins for higher performance
. Fillers (Performance Enhancers & Cost Reducers)	They improve manufacturability, strength, and control wear. Barium sulfate (barite) – density control, thermal stability
Vermiculite	lightweight, heat-resistant filler
Mica	improves compressibility and stability
Calcium carbonate	clay, quartz – cost control and wear resistance

Fibers (Reinforcement	They provide strength, toughness, and crack resistance.
Aramid fibers (Kevlar)	high strength, heat resistance
Glass fibers	reinforcement, dimensional stability
Ceramic fibers	thermal resistance
Steel fibers	increase mechanical strength and friction stability

A typical eco-friendly brake pad with basalt powder would contain:

Major: Basalt powder and phenolic resin binder.

Reinforcement: Aramid, glass, or steel fibers

Friction modifiers: Graphite and small metallic powders/oxides

Fillers: Barite, vermiculite, mica, $CaCO_3$

2.2 Methodology (Work Plan)

Table 1: The proposed work plan for the project is itemized below.

STEP	ACTIVITY	DURATION
1	Background Study	5 days
2	Material planning and evaluation	2 days
3	Engineering Design, Including modification of component parts	1 day
4	Purchase of material	1 day
5	Material preparation (crushing, grading and pulverization)	5days
6	Composite fabrication	4 days
7	Assembly of the composite and the metal plate	1 day
8	Testing of the brake pad, including performance evaluation	1day
9	Modification where necessary, including performance evaluation	1day
10	Testing (coefficient of friction, wear rate, fade and recovery, noise, and thermal stability)	3day
11	Modification where necessary	1 day
12	Final testing of the brake pad on load	2 days
13	Documentation	2 days
14	Delivery	1 day
15	Total	30days

D Direct and Indirect Benefits

Spin-off activities	With the successful development and completion of the proposed project a number of spin activities are expected such as increased direct and indirect labour
Intellectual Property rights	The improved prototype of the system developed by the Engineers from our Institute would be patented and the IPR will be added to NASENI's research output database
Human capital development and	After the successful completion of this project and ceding to SME, its mass-production and sales would involve the engagement of a number of people

new Knowledge	who would learn as well as earn good living within the process
National economic Benefit(Import reduction, etc.)	With the current socio-economic impact of the NASENI lunch pad, the production of an improved brake pads that balance performance, cost, and environmental impact to the SMEs would help increase the country's GDP.

Testing and Evaluation

Brake pads are subjected to a range of physical and mechanical tests as per standard automotive testing protocols (e.g., SAE, ASTM, or IS standards):

- Density and Hardness: Measured using Archimedes' principle and Rockwell hardness tester.
- Flexural Strength: Evaluated using three-point bending test.
- Wear Resistance: Tested using a pin-on-disc apparatus under dry sliding conditions.
- Coefficient of Friction: Measured to determine braking performance under various loads and speeds.
- Thermal Stability: Assessed through thermogravimetric analysis (TGA) or heat fade tests.

2.1.1 Prototype Production

The prototype of the basalt brake pad will be produced subject to the experimental and validation of different samples varying different concentration ratio of basalt and the other mix materials. Twenty of the test samples will be produced and subjected to different validation tests for standardization.

3.0 COST ANALYSIS

Table 2: Cost Estimate of the Project

S/N	ITEMS / DISCRIPTION	COST
1	Material planning	0
2	Market survey	20,000.00
3	Purchase of steel plate (200mm x 70mm x 1000mm) and (4mm)	850,000.00
4	Mold preparation	520,650.00
5	Purchase of basalt rock and other reinforcements materials	950,550.00
6	Material preparation (crushing, grading pulverization and optimization)	745,000.00
7	Testing (coefficient of friction, wear rate, fade and recovery, noise, and thermal stability	525,000.50
	Simulation and modeling	100,000.00
8	Contingency	371,125,00
9	**TOTAL**	**3,711,250.00**

4.0 MARKETABILITY

4.1 Importance of Project

The proposed production of brake pads using basalt as the primary composite material represents a forward-thinking approach to strengthening Nigeria's industrial base through local innovation and resource utilization. Basalt, an abundant volcanic rock found in various regions of Nigeria, offers excellent thermal resistance and mechanical strength—making it a viable, cost-effective alternative to imported materials traditionally used in brake pad manufacturing.

By leveraging this locally sourced material, Nigeria can reduce its dependence on imported automotive components, conserve foreign exchange, and stimulate domestic manufacturing. This initiative has the potential to create skilled jobs, enhance value addition in the mining and automotive sectors, and position the country as a competitive player in the regional and global automotive parts market.

4.2. Market Space

The proposed production of basalt-based brake pads targets a growing segment within Nigeria's automotive aftermarket, currently dominated by imported components. With over 12 million registered vehicles and rising demand for affordable, durable brake systems, the local brake pad market presents a significant opportunity—especially in urban centers like Lagos, Abuja, and Port Harcourt. The primary market includes private vehicle owners, commercial transport operators (buses, taxis, trucks), and fleet service providers who require frequent and reliable brake replacement. With proper marketing and pricing, the basalt-based brake pads can replace a significant share of the imported and substandard products in the Nigerian market.

4.3 Strategy and Collaborations for Marketing

The marketability of basalt brake pads in Nigeria is a realistic approach due to the high usage of automobile vehicle in Nigeria ranging from the commercial state to other less traffic state uses the brake pads.

Our team focus to establish multi-faceted approach to build a trusted brand, create market pull, and establish a dominant position for a premium, locally manufactured product.

The NASENI has lunched the branding innovations of her products and NASPAD K25 is the branded identification for the product which is locally mined and produced for Nigerian roads.

The adoption of advanced technology employed will make NASPAD K25 outperforming the conventional pads.

Obtaining the ECE R90 certification (the global standard for brake pad homologation) after product tests and validations for credibility to meets stringent international safety and performance benchmarks.

Collaborations

a) PEDI will partner with various Universities and Engineering departments to Conduct joint performance tests (on a dynamometer) and publish white papers validating the product's superiority in fade resistance and durability under Nigerian conditions.
b) Collaborations with Nigerian Society of Engineers (NSE) & Council for Registered Engineers of Nigeria (COREN) for endorsement from the highest technical authority by engage them to review the technology and manufacturing process and with a formal endorsement for "Innovation in Local Content" provides immense technical credibility that counters "cheap local product" skepticism.
c) Collaboration with Leading Auto Workshops & Franchises in Nigeria by host certified training sessions on the benefits of advanced friction materials.
d) Collaboration with National Automotive Design and Development Council (NADDC) with access to policy support and incentives by positioning NASENI product as a flagship success story for their local content agenda. Explore opportunities for grants, subsidies, or inclusion in government procurement programs for official vehicles.

Digital Marketing: NASENI will create compelling video content showing performance comparisons of basalt pads technology with the existing pads via social media

Traditional Marketing: Radio & Podcasts: Advertise on popular traffic-heavy radio stations and automotive podcasts.

Point-of-Sale: Provide branded displays and technician training to partner auto parts stores and workshops across major cities.

Guarantee: NASENI will offer a no-questions-asked warranty within a period of time to overcome initial fear of the new product which will demonstrates supreme confidence.in purchasing NASENI products.

4.4 SWOT ANALYSIS

STRENGTHS (INTERNAL ADVANTAGES)

1. Quality and Safety regulation: A strong track record of producing high-quality durable, eco-friendly, non- carcinogenic and safe brake pads can foster customer trust.
2. Customer Loyalty: Established relationships with workshops NURTW, RTEAN, MSPDAN mechanics and Fleet Managers to provide a steady customer base.
3. Skilled workforce: A team with deep knowledge of brake pads manufacturing processes and materials offers a significant advantage.
4. Efficient production processes: Streamlined manufacturing can reduce cost and increase output, leading to a competitive stage.

WEAKNESES: (INTERNAL DISADVANTAGES)

1. Outdated Technologies: Lack of modern manufacturing equipment can lead to higher costs and lower production efficiency.
2. Limited product range: Not offering specialized pads (e.g for electric vehicles, high performance cars, trucks and the heavy duty vehicles) can be a disadvantage.
3. High Production Costs: Insufficient processes or other expensive composite can erode profit margin (if not on commercial purpose).
4. Small Human Resources Department: An insufficient HR can hinder effective recruitment, training and employee management.

OPPORTUNITIES (EXTERNAL FACTORS TO LEVERAGE)

1. Growing vehicles sales: Rising number of vehicles on the road particularly, in-emerging markets, drive demand for brake pads.
2. Technological Advantages: The development of new friction materials such as advanced applications of basalts, create demand for innovative product.
3. Electric vehicle (EV) market growth: The rise of EVS presents a significant opportunity for specialized brake pads designed for their unique development.
4. Favourable Government Regulations: While they can be a threat, Regulations that mandate higher safety standards and put more stringent measures on importation of brake pads that are carcinogenic can greatly encourage eco-friendly development of product, reducing importation and capital fleece thereby increasing the GDP and improve economy.

THREATS (EXTERNAL FACTORS TO MITIGATE)

1. Intense competition: A competitive market with numerous players, including established global brands and local manufacturers can threaten market share.
2. Fluctuating Raw materials prices: Volatility in the prices of materials like metals and components can impact profitability.
3. Stricter safety standards: increased regulatory requirements for vehicles safety can raise production costs and compliance burdens.
4. Economic downtowns: A general economic downtown can reduce vehicle sales and aftermarket services affecting demand.

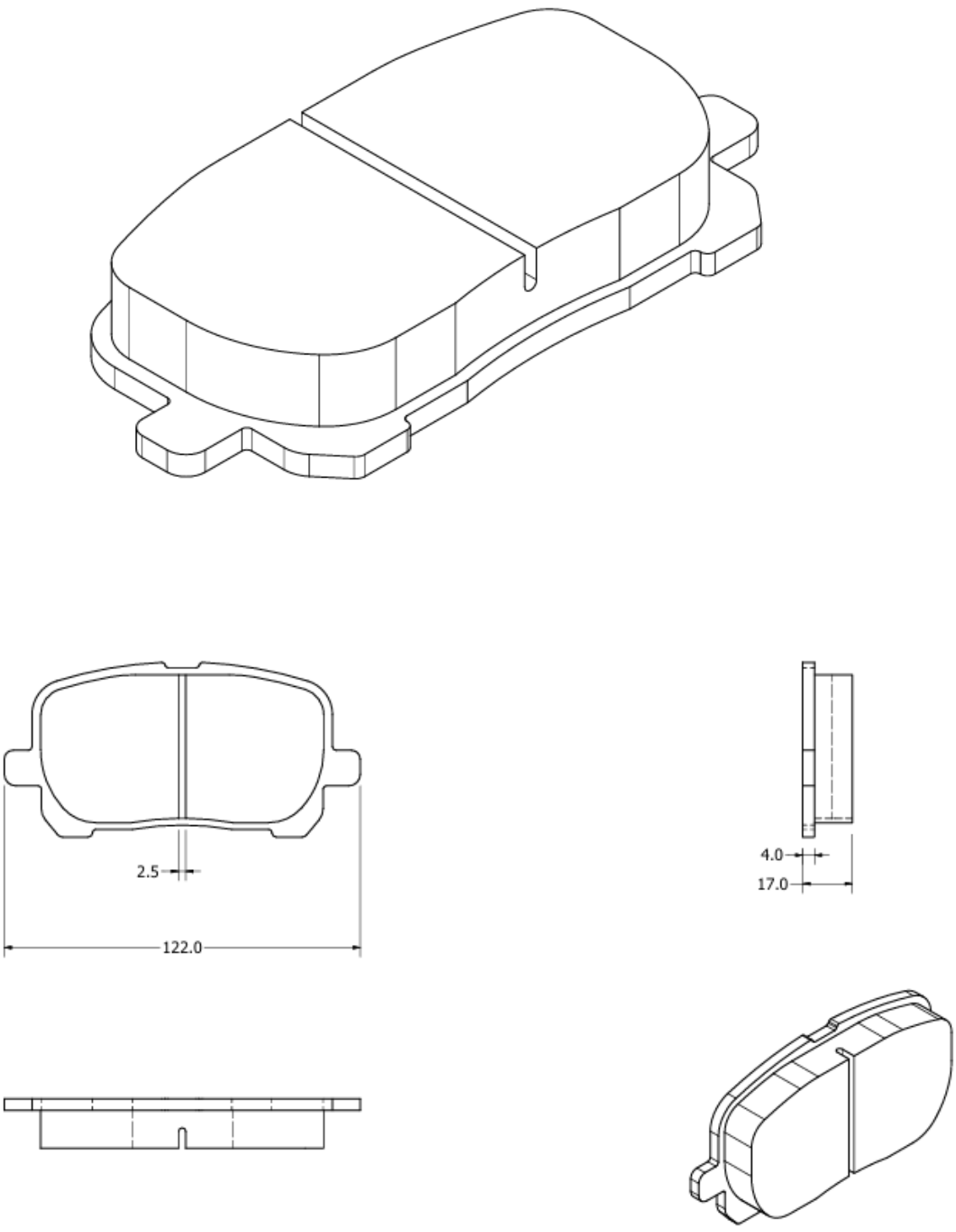
Summarily:

The major threat to this project is the importation of brake pads into the country. These pads are carcinogenic and as such not safe for our environment. But we will leverage on the opportunities of good government policies that support local manufacturing which will in turn increase the GDP and reduce capital fleece. Our weaknesses in areas of outdated production technologies can be surmounted by proper and adequate trainings and collaborations with big players in the industry. The availability of the naturally occurring raw materials which is readily and absolutely available in states like Plateau, Benue, Cross

Rivers, Kaduna, Nasarawa, Enugu will be a major edge over other players in the industry as these materials would be gotten any day anytime almost at no cost.

Mr. Ipinmoroti, F. V
Project Leader

APPENDIX



Schematic Design of Toyota Corolla Brake Pad (2003-2009 Model)

Plate 1: Basalt rock in Bachit, Riyom LGA Plateau State Nigeria.

References

Google

Saudi Arabia Journals of Engineering and Technology