KWARA STATE POLYTECHNIC

DESIGN FABRICATION AND PERFORMANCE EVALUATION OF HORIZONTAL VIBRATED MODULAR TWIN-MOULD SANDCRETE BLOCK MAKING MACHINE

BY

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CERTIFICATION

The undersigned certify that this project report titled **DESIGN FABRICATION AND PERFORMANCE EVALUATION OF HORIZONTAL VIBRATED MODULAR TWIN-MOULD SANDCRETE BLOCK MAKING MACHINE** was prepared by **AJIBADE OLUWATOBI EMMANUEL** matric no **HND/23/MEC/FT/0010** meets the requirement for the award of Higher National Diploma (HND) in the department of Mechanical Engineering, Kwara State Polytechnic, Ilorin, and was approved for its contribution to knowledge and literacy presentation.

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DEDICATION

To God Almighty be the glory for giving me life, strength, and purpose. I dedicate this project to my parents Mr&Mrs AJIBADE, whose love and belief in my dreams never wavered. I also dedicate this work to the future generation of engineers who strive to create a cleaner, greener planet.

ACKNOWLEDGEMENT

In the name of God, the Most Gracious and the Most Merciful. All praises to God and His blessing for the completion of this thesis. We thank God for all the opportunities, trials and strength that have been showered on me to finish writing the thesis. First and foremost, we would like to sincerely thank our supervisor **Engr. AYANTOLA A.A.** for his guidance, understanding, patience and most importantly, he has provided positive encouragement and a warm spirit to finish this thesis. It has been a great pleasure and honour to have him as our supervisor.

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Nomenclature

M_{bp}= mass of ram base plate

W_{bp}=weight of ram base plate

P= density

M=mass

V=volume

l=length

b=breath

t= thickness

g=Acceleration due to gravity

r=radius

h=height

WRss= weight of ram sleeper rod

T= Torque

F= ramming load

R= dept of rammming

N=rpm of vibrator

F=total load

π = pie

Hp=horse power

CHAPTER ONE

1.0 INTRODUCTION

Sandcrete block is a large rectangular material used in construction. It is an undisputed fact that shelter is one of the basic human necessities making it the third after food and clothing. Block were first known to have been in user at the river basin region of those of ancient Egypt and Greece. So instead of using stones and marbles, clay, mud, silt and straw were used to make blocks that were baked before use (sjostrom et Al. 1996). However, the durability became possible when blocks were fired in kilns.

1.1 HISTORY OF BLOCK MAKING MACHINE

Excavations have uncovered perfectly fired blocks as far back as 5000BC. Many other similar materials were used leading to the discovery of Portland cement in Mesopotamia as early as about 10,000BC (spence,1979). In 1900, Harmon S. Palmer invented the first commercially successful concrete block machine, but there were many reasons concrete block became widely used during the first half of the 20th century.

In general, the history of contemporary building material begins with the innovation in block machinery that took place at the turn of the 20th century. However, the history of block much earlier than these innovation building materials account for over 60percent of the total cost of building construction projects therefore, their quality is of primary concern for their reliabilities and efficient performance in building (Webb,1983).in Nigeria and other developing countries in Africa, over 90percent of building structures are constructed using Sandcrete block (Glanville and veville,1997).

Sandcrete technology is becoming the backbone of infrastructural development of every country (Anosike,2011). Sandcrete blocks comprise of natural sand, water and binder. Oyetola and Abdullah (2011) added that cement, as a binder, is the most expensive input in the production of Sandcrete blocks.

1.2 TYPE OF BLOCK MOLDING PROCESSES

Concrete block molding (Using molds to cast materials like copper alloys).

Block moulding machines are generally categorized by their operating system into manual semi-automatic, and fully automatic, types.

Within these categories there are Variations based on the method of block production, such as hydraulic vibrator or a combination of both. Additionally, machines can be classified by their mobility with mobile and stationary options available.

Sandcrete blocks are building materials made from a mixture of sand, cement, and water, molded into block shapes and then cured. They are a widely used, cost-effective option for both load-bearing and non-load-bearing walls in construction.

1.3 FABRICATION PROCESS

1. Mixing: Sand and cement are combined in a specific ratio, typically 1:6 or 1:8 (cement to sand), along with water.

2. Molding: The mixture is placed into molds, often using a hydraulic press machine, to achieve the desired block shape and size.

3. Compaction: The mixture is compacted within the mold, either manually or through vibration, to eliminate air pockets and increase density.

4. Curing: The molded blocks are cured, typically by sprinkling with water, to allow the cement to hydrate and the blocks to gain strength.

Key Considerations:

Mix Ratio: The cement-to-sand ratio is crucial for the block's strength. A common ratio is 1:6, but this can vary.

Water-Cement Ratio: The appropriate amount of water is also important for proper hydration of the cement.

Compaction: Proper compaction ensures a dense and strong block.

Curing: Adequate curing is essential for the blocks to achieve their full strength.

Standard Sizes: Common sizes for hollow sandcrete blocks include 450mm x 225mm x 225mm, 450mm x 150mm x 225mm, and 450mm x 125mm x 225mm.

Strength: Sandcrete blocks have relatively low compressive strength compared to concrete and are susceptible to seismic activity.

Environmental Concerns: The use of dredged sand for sandcrete production can have negative environmental impacts.

1.4 METHOD OF MOLDING BLOCK

The process of moulding concrete blocks involves mixing cement, aggregates (like sand and gravel), and water, then placing the mixture into molds where it's compacted and allowed to cure. The method can range from manual tamping in simple molds to automated systems with vibrating and pressing mechanisms.

Detailed Process:

1. Mixing: The first step is to combine the concrete ingredients (cement, sand, water, and potentially admixtures) to achieve a consistent mix.

2. Molding: The mixed concrete is then placed into molds, which are typically made of metal and come in various sizes and shapes.

3. Compaction: The concrete within the mold is compacted to eliminate air pockets and ensure the block achieves the desired density and strength. This can be done manually by tamping or through vibration using specialized machines.

4. Curing: After molding, the blocks are cured, which involves keeping them moist and at a suitable temperature for a specific period (typically 14 days) to allow the concrete to gain strength.

5. Demolding and Storage: Once cured, the blocks are carefully removed from the molds and stored in a suitable location for further use.

1.5 TYPES OF MOLDING METHODS

Manual Molding: This involves hand mixing the concrete and compacting it within the mold using hand tools like a tamper.

Semi-Mechanized: This method uses a machine to mix the concrete and a vibrating table to compact it within the molds.

Fully Mechanized: This involves automated systems that mix, mold, compact, and demold the blocks.

Key Considerations:

Mix Ratio: The ratio of cement to aggregates (e.g., 1:6) is crucial for the strength and durability of the blocks.

Molds: The quality and design of the molds affect the final shape and dimensions of the blocks.

Compaction: Proper compaction ensures that the concrete is dense and free of voids, leading to stronger blocks.

Curing: Adequate curing is essential for the concrete to gain strength and durability (Barry, 1969).

1.6 MATERIALS FOR SANDCRETE BLOCK MAKING MACHINE

Mild steel is as low - Carbon Steel that goes by the name "Low Carbon Steel" Mild steel normally has a carbon Concentrate of 0.05 percent to 0.25 percent by weight whereas higher carbon steels typically have a carbon content of 0.30 percent to 2.0 percent. Anymore Carbon and the steel becomes cast iron (Hughes, E. 2010).

- unlike high carbon and other steels it is more ductile, machine able and weldable.
- During heating and quenching, it is nearly impossible to harden and strengthen the material.

1.7 AIM OF THE PROJECT

To Design, fabricate and evaluation the performance of horizontal vibrated modular twin mould sandcrete block machine.

1.8 OBJECTIVES

- We want to produce mobile block making machine.

- To meet minimum standard.

- To be cost effective.

- The Machine to be powered by electric vibrator.

- The machine to be more efficient than the previous

- To produce the machine with quality and Economical material.

1.9 PROBLEM STATEMENT

- There is problem in term of collapse.

- There is Challenges in production in terms of quality and availability.

- On site, production of block is a means of ensuring quality under close supervision.

- Challenges of installing block making machine on site lead manying to purchase block from Outside; the quality of such cannot be grantee.

CHAPTER TWO

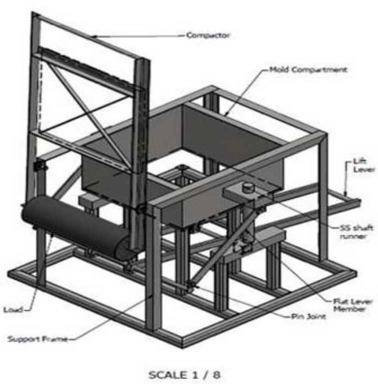
2.0 LITERATURE REVIEW

2.1 AUTHOR'S NAME AND YEARS

Rufus et al (2008) in their work DESIGN MODELING AND SIMULATION OF BLOCK MOULDING MACHINE. Use gantt chart in scheduling in manufacturing of a more efficient and versatile block molding machine. The block moulding machine was designed to operate at 151.8 rad/s (speed of vibrator) which compacted with the strength of 0.99nlmm^2 the production rate was 500 block in 8hour working day.

2.2 QUALITY ASSESSMENT OF SANDCRETE BLOCK PRODUCED IN ADETA, KWARA STATE NIGERIA

In the work of Odeyemi et al., (2018) the work They find experimentally that the absorption rate of the sandcrete block were higher than 12% specification. The compressive strength of the block which ranges from 0.19nlmm^2 to 0.40nlmm^2 fall below the minimum specification of 2.5nlmm^2. In adequate mix ratio is a factor that resulted in the poor quality sandcrete block produced in the area.



Anthony et al., (2018) in their work on how SANDCRETE BLOCK AND BRICK PRODUCTION IN NIGERIA. Evaluate sandcrete block and brick are produce for use in Nigeria. A case study survey of about 15 block production factories was conducted to find out how block manufacturer produce sandcrete block and brick for use in Nigeria.

2.3 INNOVATIVE CONNCEPTUAL DESIGN OF MANUAL -CONCRETE – MAKING- MACHINE

Diana S.O. (2016) worked on this project was aimed to complete a conceptual design of an innovative undemanding stationary manually -operated concrete block -machine that molds concrete block at a fraction of a cost in comparison with power-operate option.

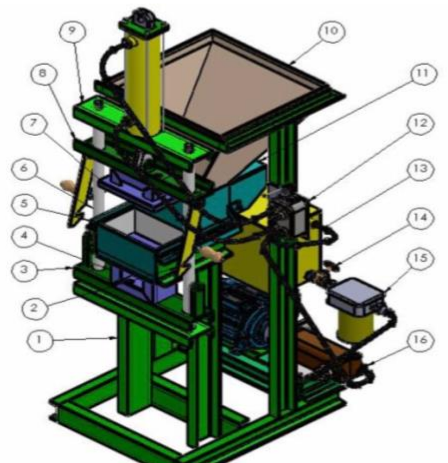


Fig. 2.1 Multipurpose Brick/Block Moulding Machine (3D CAD)
1. Main frame 2. Ejector latch 3. Ejector bar 4.Ejector
5. Mould 6. Guide rod 7. Rammer 8. Rammer Bar
9. Hydraulic cylinder bar 10. Hopper 11. Feeder 12. Control valve
13. Hydraulic oil tank 14. Oil supply valve 15. Oil filter 16. Hydraulic pump

2.4 DESIGN AND PROTOTYPE OF SEMI-AUTOMATIC MOVABLE CONCRETE BLOCK MAKING MACHINE

Debre B. et al., (2018) in their work aims in achieving some of the design constrain by designing a semi-automatic movable concrete block making. Before concept generation and selection, characteristics, type of block was analyzed to facilitate the next design phase, different concepts were proposed using generation method and the best concept were selected. From the selected concept the design was developed in accordance with technical and economic criteria and general arrangement, component shapes and material were determined. The project involved by integrating a hydraulic system in to the design for efficient mobility and optimizing the equipment design.

2.5 DESIGN SIMULATION AND ANALYSIS OF MANUAL BLOCK MAKING MACHINE

Martin N.N et al (2016) in their work analysis of various component that make up the final design was done in order to establish the forces, stresses and dimension. The studies include dynamic simulation frame analysis and stress examination. Finite element analysis was conducted on the component that could have failed during the normal operation of the machine, as such two analyses were done, one to investigate the effect of member components weight due to gravity and the second to investigate the effect of the return load on the frame members.

2.6 DEVELOPMENT OF MOBILE BLOCK MOLDIND MACHINE TO AMELIORATE SHELTER CHALLENGES IN NIGERIA

Ejiko, S.O et al., (2022) worked on the advancement of a machine for making three hallow sandcrete block, by laying the across a platform and moving on to lay another set of blocks in batches. The machine is engineered to solve the glitches encountered in the existing sandcrete hollow block making machine by optimizing the formulation of basic component increasing the construction rate and minimizing damages incurred during transfer. The compacted block measuring 460mm x150mm x 230mm, was generated at a production rate of 33 block per hour with a cycle time of 5.25 minute per batch.

2.7 DEVELOPMENT AND EVALUATION OF A DUAL-BLOCK MACHINE

Oladimeji S.T et al., work on this research focused on construction and testing of a dual-block mould machine that produces high quality block for low cost housing. The construction of a twin block making machine was carried out as an improvement of the manual production of single block locally with a lot of ergonomic problem. The machine was evaluated for physical and mechanical properties like bulk density, durability and compressive strength. The average bulk density for wet block was obtained to be 1927 (+47.37) kglm^{3} while the dry blocks gave 1838(+40.35) kglm^{3}.

CHAPTER THREE

3.0 MATERIAL AND METHOD

3.1 Material selection

Sandcrete blocks, a common building material, require careful material selection to ensure strength, durability, and cost-effectiveness. Key criteria include the quality of cement, sand, and water, as well as the mix proportions. Adhering to standards like the Nigerian Industrial Standard (NIS) is crucial for achieving the desired compressive strength and other properties.

Here's a breakdown of the material selection criteria:

1. Cement:

3.1.1 Type

Portland cement is typically used, but other binders like pozzolanas or rice husk ash can be added to reduce cement content according to Wikipedia.

3.1.2 Quality

The cement should be fresh and free from lumps, ensuring it is properly hydrated and contributes to the block's strength.

3.1.3 Quantity

The cement-to-sand ratio is a critical factor. Common ratios are 1:6 or 1:8 (cement:sand), but some studies suggest that leaner mixes (1:9) can still produce blocks meeting minimum strength requirements.

3.2 Sand

Type: Sharp, clean, and well-graded sand is essential. It should be free from clay, silt, and organic matter, as these impurities can weaken the block.

Grading: The sand particles should be properly sized to provide a dense and strong matrix when combined with cement.

Quantity: The sand content is determined by the desired mix ratio with cement.

3.3 Water

Quality: Clean, potable water is necessary.

Quantity: The water-cement ratio is crucial for proper hydration of the cement. A ratio of 0.5 (water-binder ratio) is commonly adopted.

3.4 Supplementary Materials

Micronized laterite: Some studies explore replacing cement with micronized laterite to reduce costs.

Pozzolanas and Rice Husk Ash: These can be added to reduce cement content and improve block properties.

3.5 Mix Proportions

Cement-to-sand ratio:

The ratio affects the block's strength and workability. Common ratios are 1:6 and 1:8, but some research suggests leaner mixes are adequate.

Water-cement ratio:

Adequate water is needed for hydration and workability, but excessive water can weaken the block.

3.6 Other Considerations

Compressive Strength:

Sandcrete blocks should meet minimum compressive strength standards, which can vary by region and application (load-bearing vs. non-load-bearing).

3.7 Density

The density of the block affects its strength, thermal insulation, and durability.

Water Absorption:

Excessive water absorption can weaken the block and affect its performance in wet conditions.

3.8 Dimensions

Standard dimensions for sandcrete blocks are 450mm x 225mm x 225mm and 450mm x 150mm x 225mm. (Dieter, G.E., & Schmidt, L.C., 2016)

1. Mild steel plate

2. angle iron

3. channel iron

4. Hollow metal pipe

6. springs

7. bearing

8. Welding electrodes

9. fasteners (nuts, bolts, washers)

3.9 MATERIAL SELECTION FOR THE MACHINE

3.9.1 MATERIAL

Component(s)

Justification for Selection

3.9.1.1 Mild Steel Plate

Frame, mold box, lever arms, compression plate

High tensile strength, excellent weldability, cost-effective, widely available dimension

2440 x 1220 x 1.5 (2440 x 1220 x 3mm)

3.9.1.2 Angle Iron

Frame structure, vertical and horizontal supports

Provides rigidity, ease of assembly, suitable for structural framing dimension

(50.4 x 50.4 x 5mm)

3.9.1.3 Channel Iron

Base frame, mold track guides

High bending resistance, suitable for load-bearing applications dimension

(100 x 50 x 6mm)

3.9.1.4 Hollow Steel Pipe

Handles, guide shafts

Lightweight and strong, ideal for moving or rotating parts

3.9.1.5 High Carbon Steel

Compression springs

High elasticity and fatigue resistance, returns mold to original position

3.10 SANDCRETE BLOCK TESTING PROCEDURE

Primarily involves determining its compressive strength and water absorption capacity. Compressive strength is measured using a compression machine, while water absorption is determined by immersing the block in water for a specified time and then calculating the percentage increase in weight.

3.10.1 Compressive Strength Test

3.10.1.1 Apparatus

Compression machine, steel plates, weighing balance, and the sandcrete block samples.

Procedure:

- Weigh the block and record its weight.
- Place the block on the compression machine with steel plates on top and bottom to distribute the load evenly.
- Apply load gradually and continuously until the block fails.

- Record the maximum load the block can withstand before failure.

3.10.1.2 Water Absorption Test

Procedure:

Weigh the dry block.

Immerse the block in clean water at room temperature for 24 hours.

Remove the block from the water and allow it to drain for a minute.

Weigh the wet block.

Calculate the water absorption percentage using the formula: (Wet weight - Dry weight) / Dry weight * 100.

3.10.1.3 Other Tests

Dimension Measurement: Measure the length, width, and height of the block.

Density: Determine the mass and volume of the block to calculate its density.

Important Considerations:

3.10.1.4 Curing

Sandcrete blocks should be properly cured (typically by spraying with water for a specific duration) to ensure adequate strength development.

3.10.1.5 Mix Ratio

The mix ratio of cement, sand, and water significantly impacts the compressive strength of the block.

3.10.1.6 Standard Compliance

Sandcrete blocks should meet the standards set by relevant authorities (e.g., NIS 87:2007 in Nigeria).

3.10.1.7 Quality Control

Regular testing and quality control measures are crucial to ensure that sandcrete blocks meet the required specifications and prevent building failures.

3.11 SANDCRETE BLOCK TESTING CRITERIA

Sandcrete block testing criteria primarily focus on compressive strength, water absorption, and dimensional accuracy. These tests help ensure the blocks meet minimum quality standards for construction, as specified in standards like the Nigerian Industrial Standard (NIS) 87:2000.

Here's a breakdown of the key testing criteria:

3.11.1 Compressive Strength:

This test measures the block's ability to withstand compressive forces, a crucial factor for load-bearing walls.

The Nigerian Industrial Standard (NIS) 87:2000 specifies a minimum compressive strength of 2.5 N/mm^2 for non-load-bearing walls and 3.45 N/mm^2 for load-bearing walls.

Blocks are typically tested at 28 days after production.

A compressive testing machine (CTM) is used to apply pressure until the block fails, and the maximum load is recorded.

The compressive strength is then calculated based on the block's cross-sectional area.

3.11.2 Water Absorption

This test evaluates the block's ability to resist water penetration, which is important for durability and preventing structural damage.

The test involves measuring the amount of water absorbed by the block after a specific immersion period.

The ASTM C140 standard recommends a maximum water absorption capacity of 240 kg/m^3.

3.11.3 Dimensional Accuracy

This involves verifying that the block's dimensions (length, width, and height) conform to specified standards.

Sandcrete blocks are produced in standard sizes, such as 450mm x 225mm x 225mm and 450mm x 225mm x 150mm.

Deviations from these dimensions can affect the overall structural integrity and aesthetic appearance of the building.

3.11.4 Other Tests (Optional)

Density: This test measures the mass of the block per unit volume.

Visual Inspection: A visual check for cracks, defects, and proper shape.

Sound Test (Ring Test): Acoustic assessment by knocking two blocks together.

Weight Test: Feeling the weight of the block to assess its density and material composition.

Drop Test: Assessing the block's resistance to impact by dropping it from a certain height.

3.11.5 Importance of Testing

Ensuring Structural Integrity:

Meeting minimum strength and water absorption requirements is crucial for the stability and longevity of structures.

3.11.6 Compliance with Standards

Adhering to standards ensures that buildings are safe and meet regulatory requirements.

3.11.7 Preventing Failures

Testing helps identify and prevent the use of substandard blocks, reducing the risk of construction defects and failures.

3.11.8 Quality Control

Testing provides a means of quality control throughout the production process, ensuring consistent and reliable block production.

By adhering to these testing criteria, sandcrete block manufacturers can ensure the production of high-quality blocks that meet the demands of the construction industry.

3.12 METHOD

3.12.1 DESIGN CONSIDERATION

Design Considerations for Sandcrete Block Moulding Machines

The design of sandcrete block moulding machines requires careful consideration of several factors to ensure efficient, reliable, and high-quality block production. These considerations span material selection, structural integrity, compaction mechanisms, and operational ergonomics.

3.12.2 Material Selection and Durability:

The choice of materials significantly impacts the machine's lifespan and performance. High-stress components like the mould box and compaction table should be constructed from hardened steel (e.g., AISI 1045 or equivalent) to resist wear and deformation. The frame should be made from structural steel (e.g., ASTM A36) to provide adequate support and rigidity (DeGarmo, E.P., & Black J.T., 2003).

3.12.3 Structural Design and Vibration Resistance

The machine's structural design must withstand continuous vibrations and dynamic loads. Finite Element Analysis (FEA) can be employed to optimize the frame design, ensuring stress distribution is within acceptable limits. Welding joints should be designed and executed according to AWS standards to prevent fatigue failures. (Budynas, R.G., & Nisbett, J.K, 2014)

3.12.4 Compaction Mechanism

Efficient compaction is crucial for producing dense, strong blocks. Vibration frequency, amplitude, and distribution must be optimized. Eccentric vibrators are commonly used, and their placement should ensure uniform compaction across the mould box. Pneumatic or hydraulic systems may be integrated for applying additional pressure (Handa, V.K, 2008)

3.12.5 Mould Design

The mould design should facilitate easy block removal and maintain dimensional accuracy. Tapered mould walls and a smooth internal finish can reduce friction. Quick-release mechanisms should be incorporated to minimize cycle time (Dieter, G.E., 2016)

3.12.6 Ergonomics and Safety

The machine should be designed for ease of operation and maintenance. Control panels should be intuitive, and safety features such as emergency stop buttons and guards should be integrated to protect operators. Noise levels should be minimized to comply with occupational health and safety standards. (Sanders, M.S., 1999).

3.13 DESIGN SPECIFICATION

Design Specification of Sandcrete Block Moulding Machine.

The design specification for a sandcrete block moulding machine encompasses various critical parameters that ensure the machine's efficiency, effectiveness, and safety in producing quality sandcrete blocks. The specifications can be categorized into mechanical, electrical, and operational requirements.

3.13.1 Mechanical Specifications

- Frame Material: Structural steel (e.g., ASTM A36) with a minimum thickness of 5 mm to ensure rigidity and durability.
- Mould Dimensions: Adjustable mould sizes to produce blocks of standard dimensions (e.g., 400 mm x 200 mm x 200 mm) and custom sizes as required.
- Compaction Mechanism: Eccentric vibration system with a frequency range of 50-60 Hz and adjustable amplitude for optimal compaction.
- Production Capacity: Capable of producing 200-300 blocks per hour, depending on the block size and mix design.
- Weight: Total machine weight should not exceed 500 kg for portability while ensuring stability during operation.

3.13.2 Electrical Specifications

- Power Supply: Three-phase electric motor with a power rating of 5-7.5 kW for the vibration mechanism.

- Control System: PLC (Programmable Logic Controller) for automated operation, including start/stop controls and safety interlocks.

- Safety Features: Emergency stop button, overload protection, and safety guards around moving parts to ensure operator safety.

3.13.3 Operational Specifications

- User Interface: Intuitive control panel with digital displays for monitoring operational parameters such as vibration frequency and production count.

- Maintenance Requirements: Designed for easy access to all components for routine maintenance, including lubrication points and electrical connections.

- Noise Level: Operating noise should not exceed 85 dB(A) to comply with occupational health standards.

3.14 DESIGN CALCULATION

Ramming force = Mg

Mram = mass of vibrator (mv)+ mass of Rammer + mass of Ram Bass plate + Rammer stepper rods (Falade, F. 1999).

$M = \rho \times v$ ……………………………………………………….....(3.14.1)

$\rho_{steel} = 1875 kg/m^3$

$V = L \times b \times t$

$508 \times 508 \times 10 = 0.01$

$= 0.00258064 m^3$

For the Mass of Ram Base Plate

$MBp = (L \times b+t)(p)$ ……………………………………………(3.14.2)

$= Vp$

$= 0.00258064(1875)$

= 4.8387kg

Wbp=MBp x g ………………………………………………… (3.14.3)

= 4.8387 x 9.81

= 47.4676N

For Ram Sleeper Rod

11^{11} x 25.4 =279.4mm

= 0.2794m

WRss = (pv)g ……………………………………………...(3.14.4)

P = 1875kg/m^3

V = πrh ………………………………………………………. (3.14.5)

Where; r = rod radius

= 10mm

= 0.01m

h = length of rod = 0.2794m

g = acceleration due to gravity = 9.81m/s^2

WRss = p(πr^2h)(g) …………………………………………..(3.14.6)

= 1875(3.142$(0.01)^2$(0.279) x 9.81

WRss = 1.61N

Power Requirement

T = Torque

F = Ramming load

T = 60/2πN

T = P/w ……………………………………………………….. (3.14.7)

FR = P/w ……………………………………………………. (3.14.8)

F = Total Ramming load.

R = Dept of Ramming (max)

= 2^{11} x 25.4=50.8mm

=0.0508m

Since T=60p/2πN …………………………………………... (3.14.9)

Also; T = FR ……………………………………………….. (3.14.10)

FR = 60p/2πN

P = (FR)(2πN)/60

F = Total load=90.79N

R = Max Ramming Dept = 0.0508m

π = 3.142

N = rpm of Vibrator

= 800rpm

P = (90.79)(0.0508)(2)(3.142)800/60

= 386.43w

Since 1hp = 74.5w

- Approximately ½Hp selected.

3.15 FABRICATION PROCESS

Sandcrete blocks are building materials made from a mixture of sand, cement, and water, molded into block shapes and then cured. They are a widely used, cost-effective option for both load-bearing and non-load-bearing walls in construction.

Fabrication Process:

3.15.1 Mixing

Sand and cement are combined in a specific ratio, typically 1:6 or 1:8 (cement to sand), along with water.

3.15.2 Molding

The mixture is placed into molds, often using a hydraulic press machine, to achieve the desired block shape and size.

3.15.3 Compaction

The mixture is compacted within the mold, either manually or through vibration, to eliminate air pockets and increase density.

3.15.4 Curing

The molded blocks are cured, typically by sprinkling with water, to allow the cement to hydrate and the blocks to gain strength.

3.15.5 Mix Ratio

The cement-to-sand ratio is crucial for the block's strength. A common ratio is 1:6, but this can vary.

Water-Cement Ratio

The appropriate amount of water is also important for proper hydration of the cement.

3.15.6 Compaction

Proper compaction ensures a dense and strong block.

3.15.7 Curing

Adequate curing is essential for the blocks to achieve their full strength.

3.15.8 Standard Sizes

Common sizes for hollow sandcrete blocks include 450mm x 225mm x 225mm, 450mm x 150mm x 225mm, and 450mm x 125mm x 225mm.

3.15.9 Strength

Sandcrete blocks have relatively low compressive strength compared to concrete and are susceptible to seismic activity.

3.15.10 Environmental Concerns

The use of dredged sand for sandcrete production can have negative environmental impacts.

3.16 BILL OF ENGINEERING MEASUREMENT AND EVALUATION (BEME)

A Bill of Engineering Measurement and Evaluation (BEME) for sandcrete block making or moulding outlines the quantities and costs of materials, labor, and other resources needed for the production of sandcrete blocks. It serves as a detailed breakdown for estimating costs, tendering, and evaluating work progress. The BEME includes specifications for site preparation, material proportions (sand, cement, water), mixing, moulding, curing, and quality control, as well as labor and equipment requirements.

Key Components of a BEME for Sandcrete Block Production:

Site Preparation:

Clearing the site of vegetation, debris, and topsoil.

Excavation and leveling of the ground.

Compacting the base for block production.

Materials:

Sand: Specify the type (river sand, pit sand), quantity, and quality (e.g., particle size distribution).

Cement: Specify the type (OPC, PPC), quantity, and grade.

Water: Specify the quantity and quality (potable water).

Admixtures: If used, specify the type and quantity.

Mixing:

Proportions of sand, cement, water, and admixtures (e.g., 1:6 cement-sand ratio).

Method of mixing (manual or machine).

Moulding:

Specify the type and dimensions of the sandcrete blocks.

Number of blocks to be produced.

Method of moulding (manual or machine).

Curing:

Specify the method of curing (wet curing, etc.).

Duration of curing.

Quality Control:

Specify the testing procedures (e.g., compressive strength testing).

Acceptance criteria for blocks.

Labor:

Number and types of workers required (e.g., mixer, moulder, carrier, etc.).

Labor rates.

Equipment:

Specify the type and quantity of equipment needed (e.g., mixers, wheelbarrows, moulds, etc.).

Equipment rental rates or ownership costs.

Transportation:

Cost of transporting materials to the site.

Cost of transporting blocks.

Other Costs:

Contingency for unforeseen issues.

Profit margin.

3.17 IMPORTANCE OF A BEME

Cost Estimation: Provides a detailed breakdown for accurate cost estimation for the project.

Tendering: Used by contractors to prepare bids and tenders.

Progress Measurement: Used to measure and value work done for payment purposes.

Contractual Agreement: Provides a clear basis for the contractual agreement between the client and the contractor.

Variation and Extra Work: Helps in negotiating and valuing variations and extra work.

Dispute Resolution: Provides a documented basis for resolving disputes.

3.18 LAB TEST

3.18.1 PHYSICAL PROPERTIES OF SANDCRETE BLOCKS

Jackson & Dhir (1980) asserted that 'The physical properties of sandcrete hollow block depend to a varying degree on the type and proportion of the continent material, the manufacturing process , and the mode duration of curing employed, as well as on the form and size of the sandcrete block: All of these can vary greatly and subsequently affect the properties of sandcrete blocks.

3.18.2 COMPRESSIVE STRENGTH

Compressive strength is the most common measure for judging the overall picture of the quality of sandcrete hollow blocks as a waling and load bearing in building structure, Frank (1982). The Portland (PCA) (1980) said that the compressive strength of sandcrete hollow block is influenced principally by the type and amount of cement, the type and grading of aggregate degree of compaction, age of the specimen curing procedure and moisture content at the time of test.

The PCA (1980) stated that different types of cement have different strength producing characteristics and that the strength of sandcrete block increase with the cement content. It usually depend on the strength of cement paste and the bond between the cement and the aggregate. This bond is affected greatly by the texture and cleanliness of aggregated. The strength also decrease as the amount of sand in a mix aggregate because of increased water requirement and then effect on the water-cement ratio.

3.18.3 DENSITY

Orchard (1996) said the maximum density is obtained when the mix used is of adequate work ability. Nasa (1980), said there is a close correlation between the strength at a given age (for a particular aggregate/ cement ratio) and the density.

He said they both increase as the proportion of fine aggregate is increased. Jackson & Dhir (1996) stated that the typical range for dry density sandcrete block is usually given as 500-2100kg/m2 , but BS EN 771-3:2006, specifies that the block density of type A block whether solid, hollow or cellular shall not be less than 1500kg.m3 when determined according to the standard, and similarly the density of type B and C block shall be less than 1500kg/m3 .

3.18.4 DRY SHRINKAGE AND MOISTURE MOVEMENT

This is another important property of sandcrete hollow block, it is dimensional change occurring sandcrete block owing to variation in the ambient moisture and temperature condition, according to Jackson & Dhir(1996).

The drying shrinkage is the reduction in length obtain when a saturated sample is dried under certain condition, while the moisture movement is the increase in length of the sample when again saturated.

According to NEVILLE (2012) said that cement deficient in gypsum can exhibit high shrinkage. He also said entrainment of air has virtually no effect on shrinkage. Dry shrinkage and moisture movement can be controlled by through or proper production and handling of the blocks. When produced, the block should be properly cured to avoid dimensional change that may cause crack on wall.

3.18.5 FIRE RESISTANCE

Sandcrete blocks are generally good for resistance properties. However, shettima (2006), mention in his write up that, the actual fire-endurance is controlled by numerous factor, which include: the type and grading of aggregate cement content in the mix, weight and thickness of the block and its moisture content.

Jackson and Dhir (1996) stated that as a general rule, most sandcrete block of 100mm thickness can provide an adequate resistance to fire for up to two hours if load – bearing or up to four hours if non-load bearing

3.18.6 THERMAL CONDUCTIVITY

The thermal conductivity of a concrete block is largely dependent on its density. It is observed that aerated concrete and light weight concrete block have relatively low thermal conductivities. The lighter and more porous the blocks, the better will be its insulating value obende (1990).

3.18.7 EFFLORESCENCE

Efflorescence usually occur at the time the wall are drying out after construction. It is the formation of salt deposit on the surface of the block wall because of a reaction between the free calcium hydroxide (Ca (oH)2) brought to the surface and atmospheric carbon dioxide to form a white deposit of calcium carbonate. Neville (2012) stated that efflorescence Is the salt coating on the surface of sandcrete hollow block which may appear in due course as a white deposit on the surface of the block hollow.

CHAPTER FOUR

4.0 TEST RESULTS AND DISCUSSION

4.1 TEST AND RESULT

After constructing a sandcrete block-making machine, a series of tests are crucial to evaluate its performance and the quality of the resulting blocks. These tests typically include compressive strength, water absorption, density, and dimensional accuracy. The discussion of results should focus on comparing these properties against established standards and benchmarks for sandcrete blocks, highlighting any deviations and potential causes.

1. Compressive Strength:

Test:

Blocks are subjected to a compressive force until they fail, and the maximum load they can withstand is recorded.

Example:

If the machine produces blocks with an average compressive strength of 3.0 MPa, and the required strength for the application is 2.5 MPa, the machine passes this test.

2. Water Absorption:

Test:

Blocks are weighed dry, then immersed in water for a set period (e.g., 24 hours), and re-weighed. The difference in weight, relative to the volume, indicates water absorption.

Example:

If the blocks absorb more than 10% of their weight in water, this could be a concern for durability in wet climates.

3. Density:

Test:

The density of the blocks is determined by measuring their mass and volume.

Example:

A density of 2000 kg/m^3 for a standard sandcrete block is considered within the acceptable range.

4. Dimensional Accuracy:

Test:

The length, width, and height of the blocks are measured to ensure they meet specified dimensions.

Example:

If the blocks are supposed to be 400mm long and they are consistently measuring 405mm, this deviation should be addressed.

5. Other Considerations:

Mixing and Molding:

The uniformity of the mix and the efficiency of the molding process can significantly impact block quality. Variations in these processes can lead to inconsistent results.

Curing:

Proper curing (maintaining moisture and temperature) is vital for the cement to hydrate and the blocks to gain strength. Poor curing can lead to lower compressive strength and increased water absorption.

Material Quality:

The quality of the sand, cement, and any additives used will affect the final properties of the blocks.

By thoroughly analyzing the test results and addressing any identified issues, the sandcrete block-making machine can be optimized for producing high-quality blocks that meet the required standards for construction.

4.2 DISCUSSION

The compressive strength of the blocks should be compared with the minimum required strength for their intended application (e.g., structural or non-structural walls). If the strength is below the required level, factors like the cement-to-sand ratio, water content, curing process, and aggregate quality should be investigated.

High water absorption can lead to issues like increased susceptibility to weathering, freeze-thaw damage, and efflorescence. The results should be compared to industry standards, and adjustments should be made if the absorption is too high.

Density impacts the overall weight and structural characteristics of the blocks. The density should be within the acceptable range for the type of sandcrete blocks being produced.

Accurate dimensions are essential for proper alignment and bonding during construction. Significant deviations can lead to difficulties in laying the blocks and affect the overall structural integrity of the wall.

CHAPTER FIVE

5.0 CONCLUTION AND RECOMMENDATION

5.1 CONCLUSION

In conclusion, sandcrete block making machines are essential for producing affordable building materials, but achieving quality and efficiency requires careful attention to mix design, machine maintenance, and operational practices. Addressing issues like mould bulging through proper techniques ensures durable and structurally sound blocks, contributing to safer and more sustainable construction.

5.2 RECOMMENDATION

* Mix Design: Stick to the right proportions of cement, sand, and aggregates. Less water is better to avoid weak blocks.
* Machine Maintenance: Keep the machine clean and well-lubricated. Regularly check for wear and tear on the mould and vibrating parts.
* Compaction: Make sure the machine compacts the mix evenly and thoroughly.
* Curing: Properly cure the blocks by keeping them moist for at least 7 days to gain strength.
* Quality Control: Regularly check the dimensions, strength, and density of the blocks to meet standards.
* Training: Properly train machine operators to follow best practices and spot potential issues.

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APPENDIX

POWER REQUIREMENT

1. Electric Motors

* Mixing Unit: The motor for the mixer needs to be powerful enough to handle the heavy load of sand, cement, and water. Power can range from 5 HP to 20 HP (3.7 kW to 15 kW) depending on the mixer's capacity.
* Vibrating System: Vibrator motors are essential for compacting the concrete. Each vibrator motor might range from 1 HP to 3 HP (0.75 kW to 2.2 kW), and the machine may have multiple vibrators.
* Hydraulic System: The hydraulic pump is driven by an electric motor, which can range from 3 HP to 10 HP (2.2 kW to 7.5 kW) depending on the size and pressure requirements of the hydraulic system.
* Material Feeding System: If the machine has a conveyor belt or screw feeder, the motor for this system might range from 1 HP to 5 HP (0.75 kW to 3.7 kW).

2. Hydraulic System:

* The hydraulic pump's motor is a significant power draw. The power requirement depends on the system's pressure and flow rate. A typical range is 3 HP to 10 HP (2.2 kW to 7.5 kW).

3. Control System and Auxiliary Components:

* The control panel and any auxiliary components (e.g., sensors, lights) will have a smaller power requirement, typically less than 1 HP (0.75 kW).

4. Total Power Requirement:

* Small-Scale Machines: Total power might range from 10 HP to 25 HP (7.5 kW to 18.5 kW).

* Medium-Scale Machines: Total power might range from 25 HP to 40 HP (18.5 kW to 30 kW).

* Large-Scale Machines: Total power might exceed 40 HP (30 kW).

5. Voltage and Phase:

* Most industrial sandcrete block making machines operate on three-phase power, typically 380V to 415V at 50 Hz or 440V to 480V at 60 Hz. Smaller machines may operate on single-phase power (220V to 240V).

6. Power Factor Correction:

* To improve energy efficiency, power factor correction (PFC) may be employed. This involves using capacitors to reduce reactive power and improve the power factor closer to 1.

Keep in mind that these are general ranges, and the specific power requirements can vary based on the machine's design, capacity, and features.

MOULDING FORCE REQUIRED

1. Hydraulic Pressure:

* Typical hydraulic pressure in sandcrete block machines ranges from 1500 PSI to 3000 PSI (10 MPa to 20 MPa). The exact pressure depends on the block size, density, and machine design.

2. Cylinder Specifications:

* Cylinder Diameter: The diameter of the hydraulic cylinder(s) directly affects the force applied. Common cylinder diameters range from 4 inches to 8 inches (100 mm to 200 mm).

* Number of Cylinders: Some machines use multiple cylinders to distribute force evenly across the mould.

3. Force Calculation:

* The force exerted by a hydraulic cylinder is calculated using the formula:
* \(F = P \times A \)
* Where:
* \(F \) is the force in pounds or newtons.
* \(P \) is the pressure in PSI or Pascals.
* \(A \) is the area of the cylinder piston in square inches or square meters.

4. Example Calculation:

* Let's assume a machine uses a hydraulic cylinder with a diameter of 6 inches (radius = 3 inches) and operates at a pressure of 2000 PSI.
* Area \(A = \pi r^2 = \pi \times (3 \text{ inches})^2 \approx 28.27 \text{ square inches} \)
* Force \(F = 2000 \text{ PSI} \times 28.27 \text{ square inches} \approx 56,540 \text{ pounds} \)
* So, a single cylinder can exert approximately 56,540 pounds of force.

5. Total Moulding Force:

* Small-Scale Machines: Total moulding force might range from 20,000 lbs to 50,000 lbs (90 kN to 220 kN).
* Medium-Scale Machines: Total moulding force might range from 50,000 lbs to 100,000 lbs (220 kN to 440 kN).
* Large-Scale Machines: Total moulding force might exceed 100,000 lbs (440 kN).

6. Vibration Force:

* In addition to static hydraulic force, vibration plays a crucial role in compacting the sandcrete mixture. Vibration force is typically generated by vibrator motors attached to the mould.

7. Vibrator Motor Specifications:

* Frequency: Vibration frequency typically ranges from 3000 to 6000 vibrations per minute (50 Hz to 100 Hz).

* Amplitude: Vibration amplitude is usually between 0.5 mm to 2 mm.

* Force: The dynamic force exerted by each vibrator motor can range from 1 kN to 5 kN.

8. Combined Effect:

* The combined effect of static hydraulic force and dynamic vibration ensures proper compaction and density of the sandcrete blocks.

MOULD BULGING PROCESS

1. Excessive Mix Water: Too much water in the concrete mix increases the hydrostatic pressure against the mould walls.

2. Improper Mix Proportioning: An incorrect ratio of cement, sand, and aggregates can lead to a mix that doesn't compact well, increasing pressure.

3. Insufficient Compaction: If the mix isn't adequately compacted, air pockets remain, and the material exerts more outward force.

4. Worn or Weak Moulds: Over time, moulds can weaken due to repeated use and stress, making them more susceptible to bulging.

5. Overfilling: Putting too much concrete mix into the mould at once can overload it.

6. Machine Vibration Issues: If the machine's vibration system isn't working correctly, it can lead to uneven compaction and pressure distribution.

7. Inadequate Curing: Improper curing can weaken the blocks, but it's more of a consequence than a direct cause of bulging during moulding.

To prevent mould bulging:

* Use the correct water-cement ratio.

* Ensure proper mix proportions.

* Maintain the moulding machine and moulds in good condition.

* Avoid overfilling the moulds.

* Ensure effective compaction during the moulding process.

FABRICATION DETAILS

A concrete block making machine's fabrication details involve designing and constructing various components to efficiently produce concrete blocks. Key aspects include the frame structure, vibration system, mold design, material feeding mechanism, and control system. The specific fabrication details vary depending on the type and automation level of the machine.

1. Frame Structure:

The frame is typically made of steel, often Q345 steel, known for its strength and durability.

The frame dimensions and weight depend on the machine's size and capacity.

The frame provides structural support for all other components and ensures stability during operation.

2. Vibration System:

Block machines use vibration to compact the concrete mix within the mold.

The vibration system usually consists of vibrators (electric or hydraulic) attached to the mold and/or the machine's frame.

The vibration frequency and amplitude are crucial parameters that can be adjusted to achieve optimal block density and strength.

3. Mold Design:

Molds are designed to create specific block shapes and sizes, such as hollow blocks, solid blocks, or paving stones.

The mold material is often steel, and it may undergo heat treatment (like carburizing) to enhance its wear resistance and lifespan.

Molds are designed to be easily removable and replaceable, allowing for production of different block types.

4. Material Feeding System:

A hopper is used to store the concrete mix, which is then fed into the mold.

The feeding system can be manual or automated, depending on the machine's design.

Some machines use a conveyor system to transport the concrete mix to the hopper.

5. Control System:

Modern block machines often feature a PLC (Programmable Logic Controller) for automated control.

The control system manages various aspects of the production process, including vibration, feeding, and mold movements.

Full automation can significantly improve production efficiency and reduce manual errors.

6. Other Considerations:

Some machines are designed to be mobile (e.g., diesel-powered) for use in locations without reliable power supply.

Pallets are often used to support the blocks during curing, but some machines are designed to produce blocks directly on the ground (egg-laying type).

The specific fabrication details, such as the type of steel used, the vibration system's design, and the level of automation, will vary based on the machine's intended use and production capacity.