KWARASTATEPOLYTECHNIC

DESIGN FABRICATION AND PERFORMANCE EVALUATION OF HORIZONTALVIBRATEDMODULARTWIN-MOULDSANDCRETE BLOCK MAKING MACHINE

BY

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HND/23/MEC/FT/0015

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF MECHANICALENGINEERING,INSTITUTEOFTECHNOLOGY(IOT), KWARA STATE POLYTECHNIC, ILORIN

INPARTIALFULFILLMENTOFTHEREQUIREMENTSFORTHEAWARDOF HIGHER NATIONAL DIPLOMA (MECHANICAL ENGINEERING) POWER&PLANT OPTION

JULY,2025

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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 DESIGN FABRICATION AND PERFORMANCE EVALUATION OF HORIZONTAL VIBRATED MODULARTWIN-MOULDSANDCRETEBLOCKMAKING MACHINE** was prepared by **FATAI SODIQ OLAMILEKAN** with matriculation number: **HND/23/MEC/FT/0015** meets the requirement for the award ofHigher 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

Thisprojectisdedicatedto Almighty God forgranting metheprivilegetostart this program and see the end of it. I also dedicate this project to parents.

ACKNOWLEDGEMENT

InthenameofAllah,theMostGraciousandtheMost Merciful.

All praises to Allah and His blessing for the completion of this thesis. I thank God for all the opportunities, trials and strength that have been showered on me to finish writing the thesis.

First and foremost, I would like to sincerely thank my supervisor **Engr. Ayantola Abdulwaheed A.** for his guidance, understanding, patience and most importantly, he has provided positive encouragement and a warmspirit to finish this thesis. It has been a great pleasure and honour to have him as oursupervisor.

If I refuse to appreciate the effort of my parents, I am definitely an ingrate. I therefore, acknowledge the spiritual support, financial support and moral support given to me from prenatal stage of my life till the present moment. I say jazakumullahu khairan to you sir/ma.

I also acknowledge the support of all my friend both in the campus and off campus. I love you all.

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Nomenclature

M_{bp}= mass of ram base plate

W_{bp}=weightoframbaseplate P=

density

M=mass

V=volume

l=length

b=breath

t=thickness

g=Accelerationduetogravity

r=radius

h=height

WRss=weightoframsleeperrod T=

Torque

F=rammingload

R=deptoframmming

N=rpm of vibrator

F=total load

л = pie

Hp=horsepower

ABSTRACT

This study presents the design, fabrication, and performance evaluation of a horizontal vibrated modular twin-mould sandcrete block making machine aimed at improving block production efficiency and consistency in developing regions. Traditional manual andsingle-mould machines oftensufferfromlow output, inconsistent blockquality, and high labor intensity. To address these limitations, a modular twin-mould configuration was designed, incorporating a horizontal vibration mechanism to enhance material compaction. The machine consists of key components including a steel frame, dual mould chambers, an eccentric cam vibration system, and a detachable mould designthat allows for easy size variation and maintenance. Locally sourced materials wereused to reduce cost and encourage local manufacturing adoption. The machine was fabricated using standard workshop tools and tested under various operational conditions. Performance evaluation focused on block uniformity, compressive strength, production rate, and energy efficiency. Results indicate that the machine produced blocks with compressive strength ranging from 2.8 to 3.5 N/mm², meeting standard requirements for non-load bearing walls. The production rate was significantly increased to approximately 250–300 blocks per 8-hour workday, nearly double that of conventional single-mould manual machines. The horizontal vibration system demonstrated improved compaction and dimensional accuracy across the twin-moulds. This innovation offers a cost-effective, scalable, and user-friendly solution for small-and medium-scale block producers, promoting local entrepreneurship and contributing to sustainable construction practices.

Keywords: *Sandcrete block, horizontal vibration, twin-mould, compaction, machine design, local fabrication, performance evaluation.*

CHAPTER ONE

INTRODUCTION

Sandcrete block is a large rectangular material used in construction. It is anundisputedfactthatshelterisoneofthebasichumannecessitiesmakingitthethirdafterfood and clothing. Block werefirst knownto have beenin userat the riverbasin 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.

HISTORY OFBLOCKMAKING MACHINE

Excavations have uncovered perfectly fired blocks as far back as 5000BC. Manyother similar materials were used leading to the discovery of Portland cement inMesopotamia as early as about 10,000BC (spence,1979). In 1900, Harmon S. Palmerinvented 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 innovationin 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.

TYPEOFBLOCKMOLDINGPROCESSES

Concrete blockmolding(Usingmoldstocastmaterialslikecopper alloys).

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

WithinthesecategoriesthereareVariationsbasedonthemethodofblockproduction,suchas hydraulic vibrator or a combination of both. Additionally, machines can be classified bytheir 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.

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:Themixtureisplacedintomolds,oftenusingahydraulicpressmachine,to achieve the desired block shape and size.
3. Compaction:Themixtureiscompactedwithinthemold,eithermanuallyorthrough vibration, to eliminate air pockets and increase density.
4. Curing:Themoldedblocksarecured,typicallybysprinklingwithwater,toallowthe cement to hydrate and the blocks to gain strength.

KeyConsiderations:

MixRatio:Thecement-to-sandratioiscrucialfortheblock'sstrength.Acommonratiois 1:6, but this can vary.

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

Compaction:Propercompactionensuresadense and strong block.

Curing:Adequatecuringisessentialfortheblockstoachieve theirfull strength.

StandardSizes:Commonsizesforhollowsandcreteblocksinclude450mmx225mmx 225mm, 450mm x 150mm x 225mm, and 450mm x 125mm x 225mm.

Strength:Sandcreteblockshaverelatively lowcompressivestrengthcomparedto concrete and are susceptible to seismic activity.

EnvironmentalConcerns:Theuseofdredgedsandforsandcreteproductioncanhave negative environmental impacts.

METHODOFMOLDINGBLOCK

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. Themethodcanrangefrommanualtampinginsimplemoldstoautomatedsystemswith 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 typicallymade 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.

TYPESOFMOLDING 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 tocompact it within the molds.

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

KeyConsiderations:

MixRatio:Theratioofcementtoaggregates(e.g.,1:6)iscrucialforthestrengthand durability of the blocks.

Molds:Thequalityanddesignofthemoldsaffectthefinalshapeanddimensionsofthe 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).

MATERIALSFORSANDCRETE BLOCKMAKINGMACHINE

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 carbonsteels typicallyhave a carboncontent of 0.30 percent to 2.0 percent. Anymore Carbon and the steel becomes cast iron (Hughes, E. 2010).

- unlikehighcarbonandothersteelsitismore ductile,machineableandweldable.
- Duringheatingandquenching,it isnearlyimpossible to hardenandstrengthenthematerial.

AIMOF THE PROJECT

ToDesign,fabricateandevaluationtheperformanceofhorizontalvibratedmodulartwin mould sandcrete block machine.

OBJECTIVES

- Wewanttoproduce mobileblockmakingmachine.
- Tomeetminimum standard.
- Tobecosteffective.
- TheMachinetobepoweredbyelectric vibrator.
- Themachine tobe moreefficientthantheprevious
- Toproduce themachine withqualityandEconomical material.

PROBLEMSTATEMENT

- Thereisproblemintermofcollapse.
- ThereisChallengesinproductionintermsof qualityandavailability.
- Onsite,productionof blockisa meansofensuringqualityunderclose supervision.
- Challengesofinstallingblockmakingmachine onsiteleadmanyingtopurchase blockfrom Outside; the quality of such cannot be grantee.

CHAPTER TWO

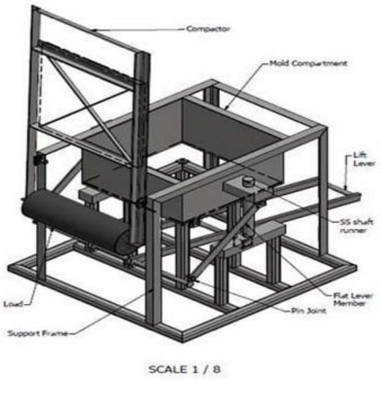
LITERATURE REVIEW

AUTHOR’SNAMEANDYEARS

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 at151.8rad/s(speedofvibrator)whichcompactedwiththestrengthof0.99nlmm^{2}the productionratewas500blockin8hourworking day.

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. Inadequatemix ratio isafactorthatresultedin the poorqualitysandcrete 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 findout how block manufacturer produce sandcrete block and brick for use in Nigeria.

INNOVATIVECONNCEPTUALDESIGNOFMANUAL-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.

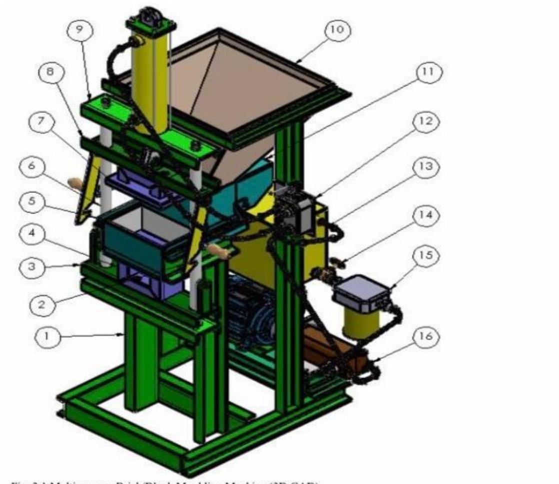


Fig. 2.1 Multipurpose Brick/Block Moulding Machine (3D CAD)
1. Main frame 2. Ejector latch 3. Ejector bar 4.Ejector
5. Mould 6. Guide rod 7. Rammer 8. Rammer Bar
9. Hydraulic cylinder bar 10. Hopper 11. Feeder 12. Control valve
13. Hydraulic oil tank 14. Oil supply valve 15. Oil filter 16. Hydraulic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

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 wereselected.Fromtheselectedconceptthedesignwasdevelopedinaccordancewithtechnical 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.

DESIGNSIMULATIONANDANALYSISOFMANUALBLOCKMAKING 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.

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, bylayingthe acrossa platformandmovingon to layanotherset of blocks in batches. Themachineisengineeredtosolve the glitchesencountered intheexistingsandcrete hollow block making machine by optimizing the formulation of basic component increasing the construction rate andminimizing 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.

DEVELOPMENTAND EVALUATIONOFA DUAL-BLOCK MACHINE

Oladimeji S.T et al., work on this research focused on construction and testing of a dual-block mouldmachine that produces high qualityblockforlow costhousing. The construction of atwinblock makingmachinewascarriedoutasanimprovementofthemanualproduction 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. Theaverage bulk densityforwet blockwasobtained tobe1927 (+47.37)kglm^3 whilethe dry blocks gave 1838(+40.35) kglm^3.

CHAPTER THREE

MATERIAL AND METHOD

Materialselection

Sandcreteblocks,a common building material,require careful material selection to ensurestrength, 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 desiredcompressive strength and other properties. Here's a breakdown of the material selection criteria:

1. Cement:

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.

Quality

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

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.

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:Thesandparticlesshouldbeproperlysizedtoprovideadenseandstrongmatrix when combined with cement.

Quantity:The sandcontent isdeterminedbythe desiredmixratiowithcement.

Water

Quality:Clean,potablewaterisnecessary.

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

SupplementaryMaterials

Micronizedlaterite:Somestudiesexplorereplacingcementwithmicronizedlateritetoreduce costs.

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

MixProportions

Cement-to-sandratio:

Theratioaffectstheblock'sstrengthandworkability.Commonratiosare1:6and1:8,but some research suggests leaner mixes are adequate.

Water-cementratio:

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

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).

Density

Thedensityoftheblockaffectsitsstrength, thermalinsulation,and durability.

Water Absorption:

Excessivewaterabsorptioncanweakentheblockandaffectitsperformanceinwet conditions.

Dimensions

Standarddimensionsforsandcreteblocksare450mmx225mmx225mmand450mmx 150mm x 225mm. (Dieter, G.E., & Schmidt, L.C., 2016)

1. Mildsteel plate
2. angleiron
3. channel iron
4. Hollowmetalpipe
6. springs
7. bearing
8. Welding electrodes
9. fasteners(nuts,bolts, washers)

MATERIALSELECTION FORTHEMACHINE

MATERIAL

Component(s)

JustificationforSelection

MildSteelPlate

Frame,moldbox, leverarms,compression plate

Hightensilestrength,excellentweldability,cost-effective,widelyavailabledimension 2440 x 1220 x 1.5 (2440 x 1220 x 3mm)

AngleIron

Framestructure,verticalandhorizontalsupports

Providesrigidity, easeofassembly,suitableforstructuralframingdimension

(50.4x50.4 x5mm)

ChannelIron

Baseframe,moldtrack guides

Highbendingresistance,suitableforload-bearingapplicationsdimension (100 x 50 x 6mm)

HollowSteelPipe

Handles,guideshafts

Lightweight andstrong,idealformovingorrotating parts

HighCarbonSteel

Compressionsprings

High elasticityandfatigueresistance,returnsmoldtooriginalposition

SANDCRETEBLOCKTESTINGPROCEDURE

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.

CompressiveStrength Test

Apparatus

Compressionmachine,steelplates,weighingbalance,andthesandcreteblocksamples. Procedure:

- Weigh theblockandrecorditsweight.
- Place the block on the compression machine with steel plates on top and bottom to distribute the load evenly.
- Applyloadgraduallyandcontinuouslyuntiltheblockfails.
- Recordthemaximumloadthe blockcanwithstand before failure.

WaterAbsorptionTest

Procedure:

Weighthedryblock.

Immersetheblockincleanwateratroomtemperaturefor24hours.

Removetheblockfromthewaterandallowittodrainforaminute. Weigh the wet block.

Calculatethewaterabsorptionpercentageusingtheformula:(Wetweight-Dryweight)/Dry weight * 100.

Other Tests

DimensionMeasurement:Measurethelength,width,andheightoftheblock.

Density: Determinethemassandvolumeoftheblocktocalculateitsdensity.

Important Considerations:

Curing

Sandcreteblocksshouldbeproperlycured(typicallybysprayingwithwaterforaspecific duration) to ensure adequate strength development.

MixRatio

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

StandardCompliance

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

Quality Control

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

SANDCRETEBLOCKTESTINGCRITERIA

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'sa breakdownofthe keytestingcriteria:

CompressiveStrength:

Thistestmeasurestheblock'sabilitytowithstandcompressiveforces,acrucialfactorfor load-bearing walls.

The Nigerian Industrial Standard (NIS) 87:2000 specifies a minimum compressive strengthof 2.5 N/mm² for non-load-bearing walls and 3.45 N/mm² for load-bearing walls.

Blocksare typicallytested at28daysafterproduction.

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

Thecompressive strengthisthencalculatedbasedontheblock'scross-sectional area.

Water Absorption

Thistestevaluatestheblock'sabilitytoresistwaterpenetration,whichisimportantfor durability and preventing structural damage.

Thetestinvolvesmeasuringtheamountofwaterabsorbedbytheblockafteraspecific immersion period.

TheASTM C140standard recommendsamaximumwaterabsorptioncapacityof240 kg/m³.

DimensionalAccuracy

Thisinvolvesverifyingthattheblock'sdimensions(length,width,andheight)conformto specified standards.

Sandcreteblocksareproducedinstandardsizes,suchas450mmx225mmx225mmand 450mm x 225mm x 150mm.

Deviationsfromthesedimensionscanaffecttheoverallstructuralintegrityandaesthetic appearance of the building.

OtherTests(Optional)

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

VisualInspection:Avisualcheckforcracks,defects,andpropershape.

SoundTest(RingTest):Acoustic assessmentbyknockingtwoblocks together.

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

ImportanceofTesting

EnsuringStructuralIntegrity:

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

Compliancewith Standards

Adheringtostandardsensuresthatbuildingsaresafeandmeetregulatory requirements.

PreventingFailures

Testinghelpsidentifyandpreventtheuseofsubstandardblocks,reducingtheriskof construction defects and failures.

Quality Control

Testingprovidesameansofqualitycontrolthroughouttheproductionprocess,ensuring consistent and reliable block production.

Byadheringtothese testingcriteria, sandcrete blockmanufacturerscanensure theproduction of high-quality blocks that meet the demands of the construction industry.

METHOD

DESIGN CONSIDERATION

DesignConsiderationsforSandcreteBlockMoulding 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.

MaterialSelectionand 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).

StructuralDesignandVibrationResistance

The machine's structural design must withstand continuous vibrations and dynamic loads. FiniteElementAnalysis(FEA)canbeemployedtooptimizetheframedesign,ensuringstress 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)

CompactionMechanism

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)

MouldDesign

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)

ErgonomicsandSafety

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 withoccupational health and safety standards. (Sanders, M.S., 1999).

DESIGN SPECIFICATION

DesignSpecificationofSandcreteBlockMouldingMachine.

The design specification for a sandcrete block moulding machine encompasses variouscriticalparametersthatensurethemachine'sefficiency,effectiveness,andsafetyinproducing quality sandcrete blocks. The specifications can be categorized into mechanical, electrical, and operational requirements.

MechanicalSpecifications

- Frame Material: Structural steel (e.g., ASTM A36) with a minimum thickness of 5 mm toensure 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 systemwith a frequency rangeof50-60 Hz and adjustable amplitude for optimal compaction.

- ProductionCapacity:Capableofproducing200-300blocksperhour,dependingonthe block size and mix design.

- Weight:Totalmachineweightshouldnotexceed500kgforportabilitywhileensuring stability during operation.

ElectricalSpecifications

- Power Supply: Three-phase electric motor witha power ratingof 5-7.5 kW for the vibration mechanism.

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

- SafetyFeatures:Emergencystopbutton,overloadprotection,andsafetyguardsaround moving parts to ensure operator safety.

OperationalSpecifications

- UserInterface:Intuitivecontrolpanelwithdigitaldisplaysformonitoringoperational parameters such as vibration frequency and production count.

- MaintenanceRequirements:Designedforeasyaccesstoallcomponentsforroutine maintenance, including lubrication points and electrical connections.

- NoiseLevel:Operatingnoiseshouldnotexceed85dB(A)tocomplywithoccupational health standards.

DESIGN CALCULATION

Rammingforce =Mg

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

M=ρx v...(3.14.1)

ρsteel=1875kg/m³ V
= L x b x t

508 x508x10=0.01

=0.00258064m³

FortheMassofRamBase Plate

MBp=(Lxb+t)(p)……………………………………………(3.14.2)

=Vp

=0.00258064(1875)

$=4.8387kg$

$Wbp=MBpxg$ .... (3.14.3)

$=4.8387x9.81$

$=47.4676N$

For Ram Sleeper Rod

$11^{11}x25.4=279.4mm$

$=0.2794m$

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= accelerationduetogravity= $9.81m/s^2$

$WRss=p(\pi r^2h)(g)$…………………………………………..(3.14.6)

$=1875(3.142(0.01)^2(0.279)x9.81$

WRss = 1.61N

PowerRequirement

T = Torque

F=Rammingload T

= 60/2πN

T=P/w…………………………………………………….. (3.14.7)

FR=P/w…………………………………………………….(3.14.8) F

= Total Ramming load.

R=Deptof Ramming (max)

$=2^{11}x25.4=50.8mm$

=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=MaxRammingDept=0.0508m π =

3.142

N = rpmofVibrator

=800rpm

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

=386.43w

Since 1hp=74.5w

-Approximately½Hpselected.

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:

Mixing

Sand and cement arecombined ina specific ratio, typically1:6 or1:8 (cement to sand),along with water.

Molding

Themixtureisplacedintomolds,oftenusingahydraulicpressmachine,toachievethe desired block shape and size.

Compaction

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

Curing

Themoldedblocksarecured,typicallybysprinklingwithwater,toallowthecementto hydrate and the blocks to gain strength.

MixRatio

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

Water-Cement Ratio

Theappropriateamountof waterisalsoimportantfor proper hydrationof the cement.

Compaction

Propercompactionensuresadense andstrong block.

Curing

Adequatecuringis essentialfortheblockstoachievetheirfull strength.

StandardSizes

Commonsizes for hollow sandcreteblocksinclude450mmx225mmx 225mm,450mmx 150mm x 225mm, and 450mm x 125mm x 225mm.

Strength

Sandcreteblockshaverelativelylowcompressivestrengthcomparedtoconcreteandare susceptible to seismic activity.

EnvironmentalConcerns

Theuseofdredgedsandforsandcreteproductioncanhavenegativeenvironmentalimpacts.

BILLOFENGINEERINGMEASUREMENTANDEVALUATION(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, andquality control, as well as labor and equipment requirements.

KeyComponentsofa BEMEfor Sandcrete Block Production:

SitePreparation:

Clearingthesiteofvegetation,debris,andtopsoil.

Excavation and leveling of the ground.

Compactingthebaseforblockproduction. Materials:

Sand:Specifythetype(riversand,pitsand),quantity,andquality(e.g.,particlesize distribution).

Cement:Specifythetype(OPC,PPC),quantity,andgrade. Water:

Specify the quantity and quality (potable water).

Admixtures:Ifused,specifythetypeandquantity.

Mixing:

Proportionsofsand,cement,water,andadmixtures(e.g.,1:6cement-sandratio). Method of mixing (manual or machine).

Moulding:

Specifythetypeanddimensionsofthesandcrete blocks.

Numberof blockstobe produced.

Methodofmoulding(manualormachine). Curing:

Specifythemethodofcuring(wetcuring,etc.).

Duration of curing.

Quality Control:

Specifythetestingprocedures(e.g.,compressivestrengthtesting). Acceptance

criteria for blocks.

Labor:

Numberandtypesofworkersrequired(e.g.,mixer, moulder,carrier,etc.).

Labor rates.

Equipment:

Specifythetypeandquantityofequipmentneeded(e.g.,mixers,wheelbarrows,moulds, etc.).

Equipmentrentalratesorownershipcosts.

Transportation:

Costoftransportingmaterialstothesite.

Cost of transporting blocks.

OtherCosts:

Contingencyforunforeseenissues.

Profit margin.

IMPORTANCE OF A BEME

CostEstimation:Providesadetailedbreakdownforaccuratecostestimationfortheproject.

Tendering: Used by contractors to prepare bids and tenders.

Progress Measurement:Usedtomeasureandvalueworkdoneforpaymentpurposes.

ContractualAgreement:Providesaclearbasisforthecontractualagreementbetweenthe client and the contractor.

VariationandExtraWork:Helpsinnegotiatingandvaluingvariationsandextrawork. Dispute Resolution: Provides a documented basis for resolving disputes.

LABTEST

PHYSICAL PROPERTIESOFSANDCRETEBLOCKS

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.

COMPRESSIVESTRENGTH

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 amountof sand in a mix aggregate because of increased water requirement and then effect on the water-cement ratio.

DENSITY

Orchard(1996)said themaximum densityis obtained when the mix usedis of adequatework ability.Nasa (1980),saidthereisaclosecorrelationbetweenthestrengthatagivenage(fora 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, butBSEN771-3:2006, specifiesthattheblockdensityoftypeAblockwhether 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.

DRYSHRINKAGEANDMOISTURE 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.

FIRERESISTANCE

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 thicknesscanprovideanadequateresistancetofireforuptotwohoursifload –bearingorup to four hours if non-load bearing

THERMAL CONDUCTIVITY

The thermal conductivity of a concrete block is largely dependent on its density. It isobserved 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).

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

TEST RESULTSANDDISCUSSION

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 compressivestrength, waterabsorption, density, anddimensionalaccuracy.Thediscussionof results should focus on comparing these properties against established standards and benchmarks for sandcrete blocks, highlighting any deviations and potential causes.

1. CompressiveStrength:

Test:

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

Example:

Ifthemachineproducesblockswithanaveragecompressivestrengthof3.0MPa,andthe required strength for the application is 2.5 MPa, the machine passes this test.

2. Water Absorption:

Test:

Blocksareweigheddry,thenimmersedinwaterforasetperiod(e.g.,24hours),andre- weighed. The difference in weight, relative to the volume, indicates water absorption.

Example:

Iftheblocksabsorbmorethan10%oftheirweightinwater,thiscouldbeaconcernfor durability in wet climates.

3. Density:

Test:

Thedensityoftheblocksisdeterminedbymeasuringtheirmassandvolume. Example:

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

4. Dimensional Accuracy:

Test:

Thelength,width,andheightoftheblocksaremeasuredtoensuretheymeetspecified dimensions.

Example:

Iftheblocksaresupposedtobe400mmlongandtheyareconsistently measuring405mm, 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.

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 industrystandards, 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 beingproduced.

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

CONCLUTION AND RECOMMENDATION

CONCLUSION

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

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:Makesurethe machinecompactsthe mixevenlyandthoroughly.
* Curing:Properlycuretheblocksbykeepingthemmoistforatleast7daystogain strength.

* Quality Control: Regularly check the dimensions, strength, and density of the blocks tomeet standards.

* Training:Properlytrainmachineoperatorstofollowbestpracticesandspotpotential issues.

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APPENDIX

POWERREQUIREMENT

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. ControlSystemandAuxiliary 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. TotalPower Requirement:

* Small-Scale Machines: Total power might range from10 HP to 25 HP (7.5 kW to 18.5kW).

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

* Large-ScaleMachines: Totalpowermightexceed40HP(30kW).

5. Voltageand 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. PowerFactor Correction:

* Toimproveenergyefficiency,powerfactorcorrection(PFC)maybeemployed.This involves using capacitors to reduce reactive power and improve the power factor closer to 1.

Keepinmindthattheseаregeneralranges,andthespecificpowerrequirementscanvary based on the machine's design, capacity, and features.

MOULDINGFORCE REQUIRED

1. Hydraulic Pressure:

* Typicalhydraulic pressure insandcrete blockmachinesrangesfrom1500PSIto3000PSI (10 MPa to 20 MPa). The exact pressure depends on the block size, density, and machine design.

2. Cylinder Specifications:

* CylinderDiameter: Thediameter ofthehydrauliccylinder(s)directly affectstheforce applied. Common cylinder diameters range from 4 inches to 8 inches (100 mm to 200 mm).

* Number of Cylinders: Some machines use multiple cylindersto distribute force evenlyacross the mould.

3. ForceCalculation:

* Theforceexertedbya hydrauliccylinder iscalculatedusingthe formula:

* \(F=P \timesA \)

* Where:

* \(F \) istheforce inpounds ornewtons.

* \(P \)isthe pressurein PSI or Pascals.

* \(A\)isthearea of thecylinderpistoninsquare inchesorsquare meters.

4. ExampleCalculation:

* 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\(A =\pir^2=\pi \times(3 \text{inches})^2\approx 28.27\text{squareinches}\)

* Force\(F=2000\text{PSI}\times28.27\text{squareinches}\approx56,540\text{ pounds} \)

* So,a singlecylindercanexert approximately56,540poundsof force.

5. TotalMouldingForce:

* 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-ScaleMachines:Totalmouldingforcemightexceed100,000lbs(440 kN).

6. VibrationForce:

* 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. VibratorMotorSpecifications:

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

* Amplitude:Vibrationamplitude is usuallybetween0.5mmto2mm.

* Force: The dynamic forceexertedbyeachvibratormotorcanrangefrom1kNto5kN.

8. Combined Effect:

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

MOULDBULGINGPROCESS

1. ExcessiveMixWater:Toomuchwaterintheconcretemixincreasesthehydrostatic 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, andthe material exerts more outward force.

4. WornorWeakMoulds:Overtime,mouldscanweakenduetorepeateduseandstress, making them more susceptible to bulging.

5. Overfilling: Puttingtoo muchconcretemixintothemouldatoncecanoverloadit.

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

7. InadequateCuring:Impropercuringcanweakentheblocks,butit'smoreofaconsequence than a direct cause of bulging during moulding.

To preventmouldbulging:

* Usethe correctwater-cement ratio.
* Ensurepropermixproportions.
* Maintainthe mouldingmachineandmouldsingoodcondition.
* Avoidoverfillingthemoulds.
* Ensureeffective compactionduringthemouldingprocess.

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. FrameStructure:

Theframeistypicallymadeofsteel,oftenQ345steel,knownforitsstrengthanddurability. 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 duringoperation.

2. VibrationSystem:

Blockmachinesusevibrationtocompacttheconcrete mixwithinthemold.

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. MoldDesign:

Moldsaredesignedtocreatespecificblockshapesandsizes,suchashollowblocks,solid blocks, or paving stones.

Themoldmaterialisoftensteel,anditmayundergoheattreatment(likecarburizing)to enhance its wear resistance and lifespan.

Moldsaredesignedtobeeasilyremovableandreplaceable,allowingforproductionof different block types.

4. MaterialFeeding System:

A hopperisusedtostorethe concretemix,whichisthenfedintothe mold.

Thefeedingsystemcanbemanualorautomated,dependingonthemachine'sdesign. 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.

Fullautomationcansignificantlyimproveproductionefficiencyandreducemanual 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.