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DEVELOPMENT OF MOBILE BLOCK MOLDING MACHINE TO AMELIORATE SHELTER CHALLENGES IN NIGERIA

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ABSTRACT

The desire to provide shelter is one of the most basic simple needs, of any man anywhere in the world. It is one of the highly significant difficulties that man has to face in his life. The difficulty of finding good accommodation differs from place to place. A good shelter provides safety and privacy. The advancement of a machine for making three hollow sandcrete blocks, by laying them 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 components, increasing the construction rate and minimizing damages incurred during transfer. The compacted block, measuring 460mm x 150mm x 230mm, was generated at a production rate of 33 blocks per hour with a cycle time of 5.25 minutes per batch. The total expense of the developed machine is ₦ 340,000, which is cost-effective compared to the locally accessible machine.

KEYWORDS: Blocks; Concrete; Hollow; Mobile; Molding; Vibrator

INTRODUCTION

The block molding business is one of Nigeria's most significant manufacturing sectors in the building industry. Before pursuing politics, art, or religion, man must first meet his basic necessities for food, clothing, and shelter (Frederick, 1983). Even with all of the groundbreaking discoveries, inventions, and advancements in engineering and other fields over the last 130 years, humanity continues to prioritize basic necessitates such as food, clothes, and shelter, and only then attention to individual wants, demands, and desires. Block production is undeniably profitable if correctly handled. In practice, a basic degree of technical knowledge, materials, equipment, machinery, and all necessary infrastructures are all that is required necessary to start generating blocks for personal or commercial use. Okoli et al., (2008) found that manufacturers and contractors only make blocks require for consumer use, a large number of contractors also create blocks for their own projects. Such contractors and customers hire stone molders and supply them with all the materials they desire to produce the blocks for their architecture or infrastructure projects, all with the goal (aim, purpose, and objective) of reducing construction costs (Ko, 2011; Ogunsakin et al., 2011; Oluremi, 1990). Clay bricks were the first man-made artificial building material. It has been adopted extensively at all times since

Assyrian and Babylonian times. Brick is essentially the oldest man-made building material, having been coined almost ten thousand decades ago. Its simplicity, strength and durability led to its widespread application and gave it a dominant place in history alongside stone. Hand-formed, sun-dried bricks, reinforced with materials as diverse as straw and manure, were so effective that fired bricks were not considered until the third millennium (Charles & Richard, 2001; Ejiko & Akinola, 2015). Natural sand, water and a binder are applied to make sandcrete block. According to Oyetola and Abdullahi (2006), cement as a binder is the costliest input in the production of sandcrete blocks. As a result, solid block manufacturers have been forced to expand blocks with minimal OPC content that are affordable for consumers of different income levels. Due to the high proportions of poverty in Nigeria, these blocks are generally adopted by residents to lessen construction costs. One of the oldest forms categories of human construction is the establishment of orders from separate parts. Since its invention, the hollow concrete block has enjoyed great reputation on architecture sites. Although mechanical engineering utilizing hollow concrete is little more expensive, builders and homeowners prefer it for its durability, strength, and heat retention (Don, 2014).

Blocks and Bricks Molding

Hollow concrete blocks are present in several countries around the world including Nigeria and have played a critical role in the construction industry (Al-Khalaf & Yousif, 1984; Anthony et al., 2015; Dashan & Kamang, 1999; Morenikeji et al., 2015). Sandcrete blocks and bricks are masonry units generated from a blend of cement, sand and water. They are frequently used as wall materials in housing and other infrastructure developments. According to Oyetola and Abdullahi (2006), sandcrete has been adopted as a common building material in West Africa for the production of building blocks and bricks for over 5 decades. It is generally used for load-bearing and non-load-bearing walls and foundations and is consequently suitable. The attributes of sandcrete blocks are determined by the material components, their mixture, the existence of admixtures and the manufacturing process. Concrete blocks make up over 95 percent of the wall materials in Nigerian buildings. According to Anwar et al., (2000) sandcrete walls provide sufficient strength and stability, are weather and soil moisture resistant, durable and easy to care for. They are also resistant to fire, heat, airborne noise and impact noise. As a wall material, sandcrete has a lower strength than fired clay bricks, but is significantly cheaper. According to Chandrasekhar et al., (2003) Concrete is the primary building material for constructing walls in most post-independence buildings in Nigeria. Sandcrete blocks, for example, are a significant expense of the very popular buildings in many parts sections of Nigeria. A vibratory machine is used (applied, employed, utilized) to improve pounding in block making (Cisse & Laguerbe, 2000; Falade, 1997). South Africa developed a modern method system of manufacturing sandcrete blocks (prevents) known as Hydra-Form technology, which is now extensively applied in various African countries, including Nigeria (Oyekan et al., 2001). Hydra-form blocks are often solid, and are a form of block that can be stacked together to build a wall without the application of cement. HYDRA derives from the word hydraulics, which refers to the hydraulic action in the production of blocks, and FORM is derived (drawn, obtained, extracted, taken) from the word formation, which refers to the creation of interlocking blocks.

The primary benefit of using Hydra-form spline blocks for a wall unit is that the spline blocks are dry poured which means that 70% of the construction does not require grout. The Hydra-Form locking block locks front and back, top and bottom, eliminating the need for mortar joints in superstructures (Nair et al., 2006). The male and female molds above and below are interlock. Hydra Shape Blocks are attached on all four sides: front and back; above and below; and front and back; above and below. The foundation is mortared as usual and the first layer of stones can be stacked dry. The top 3-4 layers below the roof truss must be mortared (ring beam). This will seal the wall and ensure each block is perfectly interlocked and in place. South Africa is the only original manufacturer of Original Hydra-Form machines in Africa (Abdullahi, 2005; Eze et al., 2005; Thwala et al., 2012). In many parts of Nigeria, sandcrete blocks are the primary cost component of most buildings, along with the materials needed for construction. The high and rising cost of materials for building sandcrete blocks has contributed to the failure to provide adequate housing for both urban and rural dwellers. Therefore, the availability of alternative building materials is particularly desirable in the short and long term as a stimulus for socio-economic growth. Materials that can temporarily replace cement or reduce cement consumption in the construction of sandcrete blocks make production more cost-effective. Oyekan, (2001) noted that the addition of mineral admixtures in building materials has been observed to significantly improve the strength, durability and workability of cemented products over the past decade. He also emphasizes that in flood-prone locations, the hydrothermal properties of the structure and building materials are critical. The building design and type of building affect the energy consumption of residential and commercial buildings. This is important to ensure a certain level of thermal comfort inside the building and throughout the annual climate cycle. The replacement of each of these mixtures aims to improve at least one of the properties of the block.

Light Manual Brick Press Known as Cinva Ram

The light manual brick press known as CINVA RAM, Montgomery's dynamic CEB production machine, Ajayi and Ejiko (2015) developed a hydraulic brick press, Akerele and Akhire (2012) developed a three-die hydraulic interlocking brick forming machine, etc. are all examples of these kinds of machines. Simpler and less expensive machines are being developed, but they all require a highly skillful operator and a high degree of commitment to produce decent and quality blocks. Additionally, owing to the laborious or inconvenient techniques involved in operating these simple machines, they are generally used to devise blocks or bricks by prospective homeowners. Cinva Ram is the most frequently used manually operated CEB lever press, as illuminated in plate 1. Depending on the quality of manufacture, it costs between ₦120,000.00 and ₦180,000.00. Although cheap, it has the following disadvantages: low capacity (often less than 1,000 bricks per day), dearth of quality control mechanisms and significant manual labor.

As a result, a machine is necessitated that is substantially less expensive, easier to maintain, use (adopt) or operate, and most importantly, has a solid quality govern system (e.g., pack pressure control). Secondly, the main idea of stone making, whether concrete or earth, is the same. To my knowledge there is no commercially accessible equipment that makes both concrete and earth bricks. Therefore, the objective of this study research, is to address the above issues.

MATERIALS AND METHOD

The mobile three-cavity prevent molding machine was designed utilizing various formulas present in technical textbooks, standards and trade journals. Materials were chosen based on their mechanical properties. Locally available mild steel was purchased from local markets. The materials were cut with a cutter, hacksaw, hand scissors and joined by welding. Another required module was the electric vibrator, the power of which relies on the compression ratio. The vibrations of the electric vibrator generate the vibration effects adopted to vibrate the mold and also make compaction for molding by the rammer. The machine designed is for molding three 6-inch hollow blocks per batch.

Production of Hollow Block Process

The present method of producing the hollow block is generated using a semi-mechanized stationary machine. The other production [construction] systems are a manual mold that necessitates hand tamping, a mobile semi-mechanized egg-laying machine, and a completely mechanized system method that combines pressing and manual pouring of concrete into the mold. The machine also compacts and consolidates the mix so that the blocks are uniform in size and attain the desired physical properties. The blocks are cured for at least 14 days before they are ready for use. On average, 600-800 blocks can be treated in 8 hours by 1 skilled worker and 6-8 semi-skilled workers. In this project, a high-quality machine is proposed, where the ongoing machine design is optimized according to the feedback and demands of the hollow block manufacturer.

Design Considerations and Calculations for Essential Machine Components

Design Considerations and Assumptions

The design consideration and hypothesis are; the size of the block/brick for this project is 460mm x 150mm x 230mm, the compaction/compression pressure of the machine was 10 MN/m^2 and it is assumed that the internal pressure/stress of the mold is evenly distributed. These were to establish the desire components specific parameters.

Design Requirement

The design computations for each element of the machine were established and based on the results, the materials were selected and the design carried out. The design specifications for the following elements were generated for: the mold, the rammer and the electric vibration motor.

Mould

The distributed stress intensity of the mold wall cross-sectional modulus (Z), the maximum bending moment (M max), and the maximum stress at the mold wall were all calculated. The maximum deflection was also calculated. The safety factor for the machine was also determined

Rammer and Ejector Struts

The sectional area moment, radius of gyration, slenderness radius and cripple load were all quantified based on the maximum bending moment and the sectional modulus.

Electric Vibrator Motor Selection

The electric motor is the normal component and its choice was generated after defining the followings:

i. Power requirement for the mould vibration.
ii. Torque precondition to vibrate the mould
iii. Weather and other environmental conditions of the site of utilization

The selection was performed in accordance with the National Electrical Manufacturers Association (NEMA) Standard Publication MG-1-2010.

Design Calculation

The machine has been designed and assessed using SolidWorks CAD 2020 version 2020 software, as explained in Fig. 1, and the working drawing is brought to the laboratory for the various [multiple] manufacturing operations to be carried out. Compressive force is necessary to compress/densify the sand mix in the mold box to set up this Equation 1 as listed by Khurmi & Gupta, (2005) and Ajayi & Ejiko, (2015).

$$F = mg \quad (1)$$

$$where\ m = mass\ of\ rammer\ assembly = 15kg$$

$$g = acceleration\ due\ to\ gravity = \frac{9.81m}{s^2} \quad (2)$$

$$F = 15\ X\ 9.81 = 147.5N$$

Force due to wet block

$$F = mg$$

$$F_b = mass\ of\ wet\ block\ \ X\ g$$

$$Mass\ of\ wet\ block = 27.5kg\ and\ g = \frac{9.81m}{s^2}$$

$$F_b = 27.5\ X\ 9.81$$

$$F_b = 269.78N$$

Mass Properties of Block Machine was obtained from the SolidWorks Cad Software

Mass = 252.0 kilograms

Total weld mass = 0.00 kilograms

Volume = 29307850.47 cubic millimeters

Surface area = 14644907.18 square millimeters

Center of mass: (millimeters)

X = -397.01

Y = 263.80

Z = -204.22

Principal axes of inertia and principal moments of inertia: (kg/mm^2)

Taken at the center of mass.

Ix = (0.04, 1.00, 0.08) Px = 41578066.87

Iy = (-0.97, 0.05, -0.23) Py = 42205385.65

Iz = (-0.23, -0.07, 0.97) Pz = 58456699.57

Moments of inertia: (kilograms* square millimeters)

Taken at the center of mass and aligned with the output coordinate system.

Lxx = 43077531.87 Lxy = -233578.01

Lxz = 3656694.71,

Lyx = -233578.01 Lyy = 41657481.30

Lyz = 1118815.19,

Lzx = 3656694.71 Lzy = 1118815.19

Lzz = 57505138.92

Moments of inertia: (kilograms* square millimeters)

Taken at the output coordinate system.

Ixx = 66160834.95 Ixy = -21955203.55

Ixz = 20472276.79,

Iyx = -21955203.55 Iyy = 82997326.05

Iyz = -10054692.06,

Izx = 20472276.79 Izy = -10054692.06

Izz = 104628565.99

Power Selection for Motor

The Mass Properties of the Design is calculated as follows: -

Mass = 252 kilograms

Volume = 7.69e + 007 mm^3

Surface area = 6.59e + 006 mm^2

Center of mass: (mm)

X = -17.6

Y = -3.86

Z = -114

In determining the expected force equation 1 as given was used.

Force (F) = m x g

252 x 9.81 = 2472N = 2.472KN

In determining the work done equation 3 as given by Khurmi (2005) and Ejiko et. al. (2021) was used.

Work done (W) = F x Distance (3)

2472 x 50 = 123,600J

$$\text{Power (P)} = \frac{\text{Workdone (W)}}{\text{Time (T)}}$$

$\frac{123,600}{60}$ =2060 w

1hp = 746w = k

x = 2060 w

x = $\frac{2060}{746}$ = 2.76 ≈ 3hp

3Hp Vibrator Motor is required to vibrate the mold sufficiently as required for sandcrete block compacting. The motor chosen were 2hp and 1hp to be mounted on the mould and the rammer, due to the length of the mould, during molding there's need for a rammer also to vibrate to create a compacting pressure on the block and also helps to eject the block out from the mould.

Component and Part of the Machine

The concrete prevents making machine consists of welded structural frame, mold, rammer, mold lifter, tamper lifter, drag cone, mold box, sand collector, motor vibrator and rubber impeller. Fig. 1 Show the part multitude of the three concrete block generating machines and the quantity amount of the different modules shown in the drawing.

Frame

Figure 3 illustrates the frame, which is constructed mainly of Square Pipe mild steel. The mild steel is applied to make the frame rigid. This will hold the block mold firmly in place on all sides on which the mold, tamper and motor will be placed.

Mould

This part was constructed from 3mm thick mild steel sheet which is bent and folded to 921mm x 460mm lengths to generate six blocks out of six as shown demonstrated in Fig.1. 3.4. The block mold rests in the ground when the machine is in operation

Rammer

This part consists of a 10 mm thick plate, a 20 mm diameter iron rod and an angle iron to enhance the compaction of the block so that the moisture content dries marginally when it is cut, as, explained in fig. 5. The block mold is designed (engineered, made) to move up the inside of the frame to enable ejection of the formed block. A lever or arm is attached to eject the formed blocks.

Vibrating Mechanism

A 2hp, 240volt electric motor vibrator as demonstrated in Fig 3.2 was fitted by attaching it to the length of the mold casing to amplify the vibration of the mold and rammer.

Rubber Caster Wheel

A 100 mm diameter rubber tire as shown in Fig. 2 assists in moving the machine from one location to another.

Materials Consumption

i. ***Mild Steel plate*****: -**The steel plate was used with a plate thickness of 3 mm thick and a purchase dimension of 8 ft by 4 ft of 1 piece.

ii. ***Round Pipe*****: -**The round tube used, 1\" x 1\" in size and thickness, has an extra tick and a standard length of 2.5 pieces

iii ***Square Pipe*****: -**The whistle is 2\" x 2\" tick quality and has a purchase length of 2 standard lengths

iv ***Bolt and nut*****: -**To connect the cut out details to each other, choose bolts and nuts with a thread diameter of 10 mm.

v. ***Cutting disc and grinding disc*****: -**These are attached to the angle grinder to provide energy for its operation. When the cut-off wheel is attached, it is used to cut the sheet metal to the desired shape and orientation, while the grinding wheel is also used to smooth out the roughness of the cut detail.

vi ***Welding electrode*****: -** A standard specification welding electrode was used. Parts that need to be held together permanently were joined by welding processes.

vii. ***Non-polar solvent*****: -** This is selected based on market availability. The purpose of the solvent is to wash and clean the metal parts packed with dust and dirt. The choice of solvent was one of the petroleum hydrocarbon products, e.g., gasoline, kerosene.

viii ***Iron Wire brush***: - It would be used to brush down the corroded surfaces. This would prepare the surface for painting.

ix ***Paint*: -** Silver colored paint would be used to coat, protect and add shine to the extractor.

x ***Painting brush*:** - This is used in paint application to the machine surfaces.

RESULTS AND DISCUSSION

Cement, sharp sand and water as binding material were adopted to test the machine, a shovel and wheeled cart were adopted to mix and transport the sand to the manufactured machine for production, a stop watch was applied to measure the intervals at which the blocks were located to ascertain the machine capacity. The mixing proportion was three sand head pans to one cement head pan. The mixed sand was packed into the mold cavity while the vibrator was turned on under the mold after the machine was positioned on a leveled platform to enable movement of the machine when laying the block during molding. After filling the mold with sand, the rammer was released for ramming, while the rammer also vibrated the mold, compacting the sand and facilitating in ejecting the block. Once a batch was completed, the machine was permitted to proceed moving forward, with the mold and tamper dangling at one point on the frame, before the mold was placed on a flat platform for the next batch. Preliminary tests were carried out step by step on the machine, with the first block serving as samples A and B. The primary ultimate test was performed on the blocks produced as Samples C and D. The arrangement alignment of the blocks on the platform is shown illustrated in Table 2. For each specimen, the timer is started at the origin and stopped at the collapse of the process. When reading the process, the computations to verify the machine capacity are generated and are given in Table 1.

The Performance Evaluation

The performance of the machine is important in determining how well it does the job it was proposed to do and whether it is affordable, easy to finance, easy to set up and operate, and will deliver high quality in a short size of time, whatever that is will aid in reducing the difficulty of collapsed buildings. Part of estimating a machine's performance is determining its capacity. The term capacity refers to the quantity of work that can be done in a given size of time. According to the quantified values in Table 1, the capability of the machine was quantified and presented.

Table 2 gives the construction data, while Figure 6 shows the production rate of different batches, it was found that the total time required for the ingot mold serving as samples A, B, C and D indicates that the required time of the four sandcrete blocks took 21 minutes for production. In determining the average time taken to produce a batch of block: -

$$\text{The Average Time Taken} = \frac{Total\ Time\ Taken}{Number\ of\ Specimen}$$

$$= \frac{21}{4} = 5.25 mins$$

Each batch of block production receives 3 block pieces, which means that 3 block blocks were generated in a 5.25 minute interval. This means that in one hour the machine would have treated about 11 batches, which equals about 33 block pieces. This outcome in the overall number of blocks that are generated in an 8-hour working day = 264 blocks per day. The specifications of the machine are captured in Table 3.

CONCLUSIONS AND RECOMMENDATIONS

The machine for generating three hollow blocks were designed, manufactured and tested for block making at the Faculty of Mechanical Engineering of Federal Polytechnic in Ado-Ekiti State. The sandcrete block making machine was designed to produce three blocks per batch. In addition to the compaction vibrating system, the weight of the machine in relation to the personnel to move the machine and operating comfort are also taken into consideration in the design. The machine is suitable for the production creation of three hollow blocks indoors or outdoors, it only necessitates a smooth and level concrete floor. The result effect of the growth of the mobile concrete block-making machine report serves as a useful origin of information and reference for others who desire to improve on this project.

In mandate to craft Hollow Wall Blocks, the mould must be converted to a movable mould that can hold a pallet. The machine could be controlled automatically, notably in the loading and unloading mechanism. This improves performance and operator safety. This machine can be modified to have a larger shape and a likelihood, of feeding and compacting the mixture in elevators, preferably automatically. This should be easy and not expensive. In addition, the materials adopted to craft the Stone Making Machine should be stronger. The project is also suggested to save costs for small-scale industries in rural and urban areas because it is efficient, durable and relatively inexpensive.

REFERENCES

Abdullahi, M. (2005). Compressive strength of sandcrete blocks in Bosso and Shiroro Area of Minna, Nigeria. *Assumption University Journal of Technology*, *9*(2), 126 – 131.

Abdullahi, M. (2006). Properties of some fine aggregates in Minna, Nigeria and environs. *Leonardo Journal of Sciences*, *8*, 1-6.

Acisse, I. K., & Laquerbe, M. (2000). Mechanical characterization of filler sandcretes with rice husk ash additions: Study applied to Senegal. *Cement and Concrete Research,30*(1), 13 - 18

Afolayan, J. O., Arum, C., & Daramola, C. M. (2008). Characterization of the compressive strength of sandcrete blocks in Ondo state, Nigeria. *Journal of Civil Engineering Research and Practice*, *5*(1), 15-28.

Ajayi, B. A. & Ejiko, S. O. (2015). Development of bricks making machine for production of refractory bricks. *Journal of Engineering & Earth Sciences*, *9*(1), 55- 63.

Akelere, F., & Akhire, N. (2013) Design and construction of a three- mould hydraulic interlocking brick moulding machine. *Journal of Emerging Trends in Engineering and Applied Sciences*, *4*(3), 527-532

Al-Khalaf, M. N., & Yousif, H. A. (1984). Use of rice husk ash in concrete, *The International Journal of Cement Composites and Lightweight Concrete, 6*(4), 241-248.

Anthony, B. S., Adewuyi P. A., Olabosipo, I. F., & Musibau, A. A. (2015). Sandcrete block and brick production in Nigeria – Prospects and challenges. *International Journal of Environmental Research, 1*(4), 1 – 17.

Anwar, M. N., Miyagawa, T., & Gaweesh, M. (2000). Using rice husk ash as a cement replacement material in concrete. *Waste Management Series, 1*, 671 – 684.

Anosike, B., & Oyebade, H. (2012). Sandcrete blocks and quality management in Nigeria building industry. *Journal of Engineering, Project, and Production Management, 2*(1), 37-46.

Chandrasekhar, S., Satyanarayana, K.G., Pramada, P.N., Raghavan, P., & Gupta T. N. (2003). Processing, properties and applications of reactive silica from rice husk – An overview. *Material Science, 38*(15), 3159-3168.

Dashan, I. I. & Kamang E. E. I. (1999). Some characteristics of RHA/OPC Concretes: A preliminary assessment. *Nigeria Journal of Construction Technology and Management, 2*(1), 22-28

Don, V. (2014). Concrete Building Blocks, Home:Tips. https://www.hometips.com/buyingguides/concrete-cinder-blocks-construction.html retrieved 14th June, 2014

Ejiko, S. O. & Akinola, J. O. (2018). Development of hydraulic molding machine for interlocking bricks. *Journal of Engineering & Earth Sciences, 11*(1), 8 – 15.

Ejiko, S. O., Omojogberun, Y.V. & Aluko, A. O. (2021). Development of a pedal powered water ump (PPWP). *Journal of Engineering & Earth Sciences, 14*(1), 85 - 89

Eze, J. I., Obiegbu, M. E., & Jude-Eze, E. N. (2005). *Statistics and quantitative methods for construction and business managers*. Lagos, Nigeria: NIOB Publishers.

Falade, O. (1997). The use of ground broken bottles as partial replacement of cement in concrete. *Proceeding of Fourth International conference on Structural Engineering Analysis and Modeling, Ghana,473 - 486.*

Frederick, E. (1883). *Dialectics of Nature*. Retrieved from https://www.marxists.org/archive/marx/works/1883/don/ch01.htm retrieved (June11, 2016)

Khurmi, R. S., & Gupta, J. K. (2005). *A textbook of machine design* (14th ed.). New Delhi, India: Eurasia Publishing House (PVT) Ltd.

Ko, C. H. (2011). Integration of engineering projects and production management. *Journal of Engineering, Projects and Production Management, 1*(1), 1-2

Okoli, O. G., Owoyale, O. S., & Yusuf, M. I. (2008). Assessment of early compressive strength development of concrete with selected ordinary Portland cement. *Nigerian Journal of Construction Technology and Management*, *9*(1), 18-24.

Morenikeji, G., Umaru, E. T., Liman, S. H., & Ajagbe, M. A. (2015). Application of remote sensing and geographic information system in monitoring the dynamics of land use in Minna, Niger state, Nigeria. *International Journal of Academic Research in Business and Social Sciences,5*(6), 320-337.

Oluremi, A. A. (1990). Input of local materials in buildings as a means of reducing cost of construction. *A Journal of the Nigerian Institute of Quantity Surveyors*, 12-14.

Oyekan, G. l. (2001). Effect of granite fines in the compressive strength of sandcrete blocks. *Proceedings of Conference on Construction Technology, Sabah, Malaysia*, 14 -17.

Umaru, T. E., Aiyejina, T. W. &Ajagbe, M. A. (2012). The impact of non-residential tertiary institutions on housing in Nigeria. *An International Journal of Engineering, Science and Technology, 2*(4), 592 – 598.

Thwala, D. W., Ajagbe, A. M., Enegbuma, W. I., Bilau, A. A., & Long, C. S. (2012). Sudanese small and medium sized construction firms: an empirical survey of job turnover. *Journal of Basic, Applied Scientific Research, 2*(8), 7414- 7420.

Ukoba, O. K., Olusunle, S. O., Oyelami, A. T., Adejugbe, I. T., & Idowu, A. S. (2014). Development of double mould vibration- compactor block moulding machine for developing countries. *Physical Science International Journal of Basic,4*(10), 1358 - 1369.

Rufus, O.C., Okpala, D. C., & Kamiyo, O. M. (2016). Design modelling and simulation of block moulding machine: management approach. *Journal of Engineering and Applied Sciences, 3*(9), 735-741.

Yemane, Z. (2009). Design, analysis and development of improved hollow concrete block making machine. *International Journal of Engineering Research & Technology, 9*(3), 298 – 302.

Table 1:Time Interval for Producing a Batch of Block

Specimen	Time /Batch in Mins.	Quantity Produced
A	8	3
B	5	3
C	4	3
D	4	3
Total	21	12

Table 2: Time Interval versus the Quantity of Block Produced.

S/N	Time Interval	Quantity Produced
1	5.25	3
2	15.75	9
3	26.25	15
4	36.75	21
5	47.25	27
6	57.75	33

Table 3: Specifications of the Three Hollow Block Molding Machine

CONTROL	MANUAL
Block Size	460mm x 150mm x 230mm
Maximum block height	230mm
Frame dimension	1100×1000 × 1500mm
The Machine Height	1856mm
Vibrator	2.2 kw
Capacity	3 pcs / cycle
Condition	Mobile (On site)

Plate 1. Locally Hand Operated Solid Block Machine Cinva Ram

Plate 2. Arrangement of the blocks in the platform

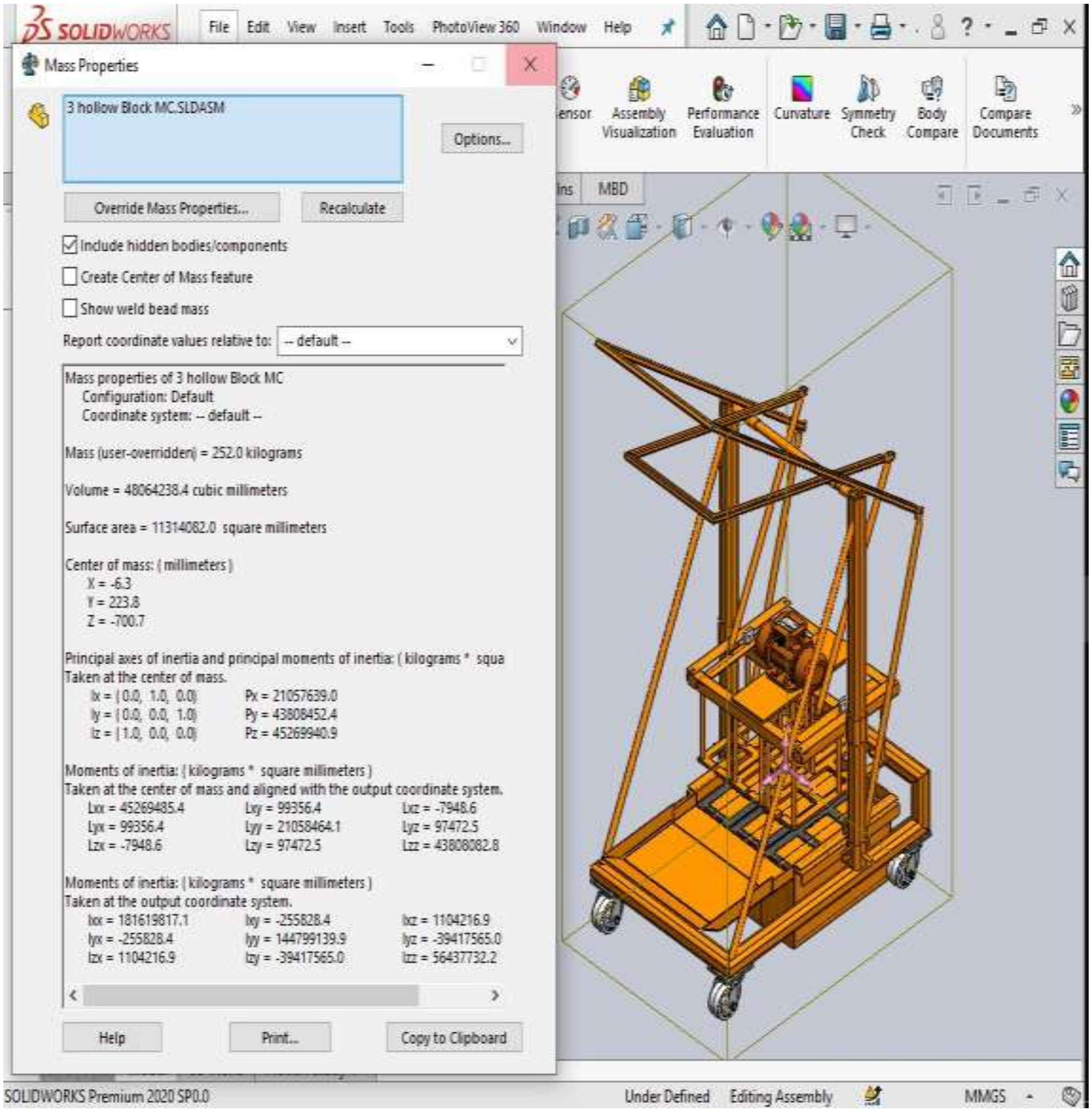
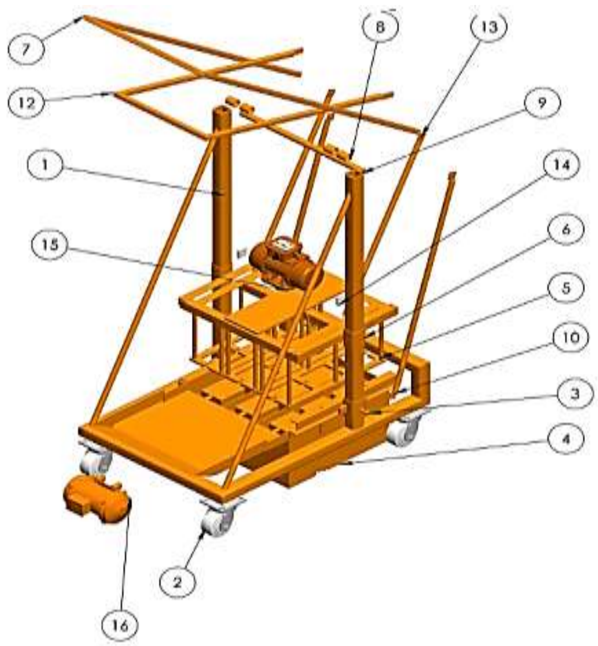


Figure 1. Mass properties of three hollow block moulding machine (SolidWorks 2020).



ITEM NO.	PART NUMBER	QTY.
1	Frame	1
2	Caster Wheel	4
3	Mold Cone	2
4	Mold Assembly	1
5	Rammer Assembly	1
6	Rammer Cone	2
7	Mold Lifting Pipe	1
8	Lifting Cone	4
9	Frame Rod	1
10	Mold Lift Rod	2
11	Part5^3 hollow Block MC	1
12	Rammer lifting Pipe	1
13	Rammer Lifting Rod	2
14	Rammer draw hole	2
15	1 hp Vibrator Motor	1
16	motor_vep3_12200	1

Figure 2. Component and Part of the Machine

Figure 3. Machine Frame

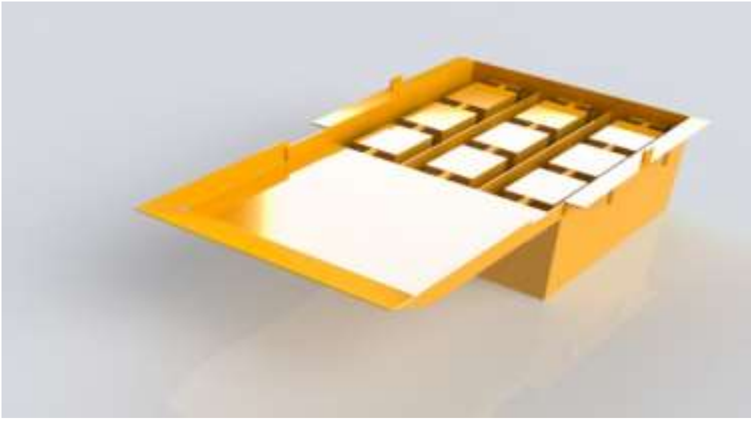


Figure 4. Mould

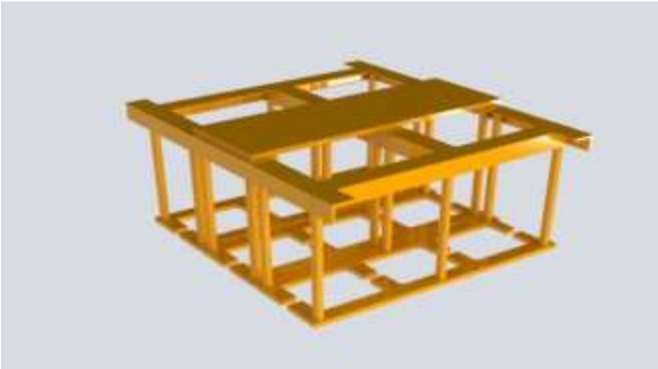


Figure 5.Rammer

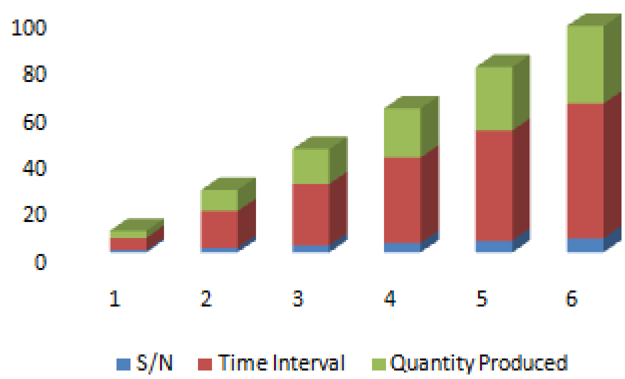


Figure 6. Time interval versus the quantity of block produced