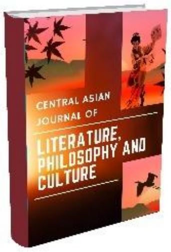

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DESIGN AND DEVELOPMENT OF A PROTO-TYPE CERAMIC MANUAL KICK-WHEEL FOR THE PRODUCTION OF CERAMIC WARES

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The design and development of a proto-type ceramic manual kick-wheel for the production of ceramic wares is the focus of this investigation. The problem of this study was how to improve on the manual kick-wheel usually characterized by wobbling as often prevalent among the locally produced ones. The general objective of this study was to develop a simple, easy to operate, maintain and above all cheaper to produce for cottage ceramic industries and for effective classroom teaching and learning where ceramics are being taught. To this effect, specific design standard, design considerations, design theories and calculations were generated and carried out. Initial design on paper was made as a working guide and was later developed using computer-Aided Design (CAD). The concern of the study was also to explore the possibility of using metal scraps from the junk yards for cost reduction and converting possible waste to wealth for the designing and fabricating a proto-type ceramic manual kick-wheel. For effective result achievement, material selections ranging from mild still, iron pipe, metal shaft, bearings, angle iron, cast aluminum disk, and so on were sourced for. Metal beneficiation was carried out for a rust free certification and spraying method was adopted using auto-car paint. The flywheel weight was a determinant factor for the high power rotation for effective clay centering and pulling resulting in less stress and convenience during operation. Raw materials such as Kaolin and Secondary Clays were also sourced for and beneficiated. Plywood was sourced for and used for the casting of moulds using Plaster of Paris (POP). The moulds were used for clay storage after its beneficiation and other treatments. From the result of the ceramic wares produced on the designed machine, it was established that the kick-wheel machine performed excellently well without wobbling, all the works thrown on the design machine were beautiful.

***Key Words**: Design, Fabrication, Ceramics wares, Teaching and Learning*

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INTRODUCTION

Pottery craft is significantly considered a part and parcel of human needs that requires constant innovation to meet with the dynamics of time (Ayodele, 2002). Attempts have been made so much as to improve on materials, tools machinery and equipment in most art studios and especially the ceramic studio of tertiary institutions of learning in Nigeria. These have yielded very positive results in the areas of modeling tools, kilns etc. A visit to some tertiary institutions in Nigeria shows that not much has been achieved in the area of some vital equipment. The recent emphasis on the development and fabrication of local machinery and equipment, coupled with the quest for self-reliance, has become necessary for researchers to finding solution to machinery acquisition for industries and manufacturing departments (Etuokwu, 2007). The utilization of industrial waste (metal scraps) for the production of useful product was also acknowledged by (Rania, et al 2021).

This study therefore, intends to design and develop manual kick-wheel using scrap metals found in some junk-yards in some cities in Nigeria to produce a wobble free ceramic manual kick-wheel for effective teaching and learning.

STATEMENT OF THE STUDY

This study is about the possibility of using metal scraps to design and fabricate proto-type ceramic kick-wheel free from wobbling.

AIMS AND OBJECTIVE OF THE STUDY

To develop a simple, yet effective proto-type ceramic manual kick-wheel using metal scraps.

JUSTIFICATION OF THE STUDY

If teaching and learning must be meaningful therefore, research into problems solving such as equipment fabrication must be a priority in various higher institution of learning for effective day to day classroom demonstration resulting to effective teaching and learning.

SIGNIFICANT OF THE STUDY

a. To convert waste to wealth

b. To make teaching and learning simple for both teachers and learners.

2. METHODOLOGY AND DESIGN

2.1 Research Design

Research design, according to Asika (2001) in Sulayman (2006), is a specific pattern of structuring investigation aimed at identifying variables and their relationships. This study therefore utilized experimental approach in a number of ways such as:

2.1.2 Product Design and Development

This study utilized experimental methodology through population of the study, material beneficiation, pilot study, welding of metal parts as well as clay preparation. The end result is expected to produce what is known in research circle as "research and development (R&D)" as suggested by Kurmi (2004). As well in line with the machine design considerations, theories and calculations.

2.1.3 Pilot Study

A local manual kick-wheel was studied, and improved upon for a prototype and for easier fabrication. At this stage preliminary drawing of the entire machine was done using Computer Aided-Design (CAD). The drawings were equally broken into various component parts to ease fabrication.

2.1.4 Product Design

The initial free hand drawing design on paper was made as a working guide, and was later developed using Computer Aided Design (CAD) See fig.1

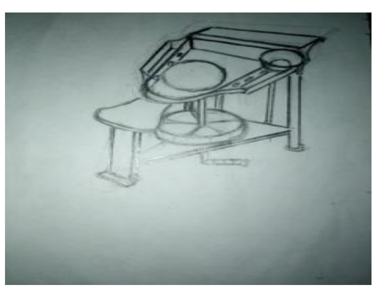

Fig. 1. A Free Hand Drawing Design Concept
Source: Original Research Sketch (Ayodele 2023)

The Fig. 1; above was later re-modified using Computer Aided Design (CAD) as seen in Fig.2.

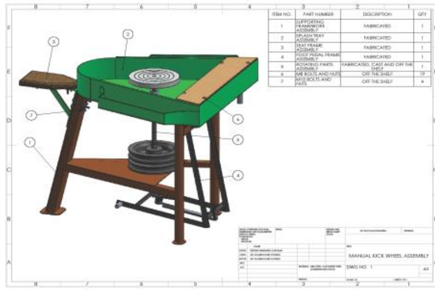

Fig. 2 The free hand drawing re-modified using Computer Aided Design (CAD)
Source: Original Research (CAD) (Ayodele 2023)

2.1.5. Materials Selection

The researchers made several visits to some scraps markets within the state of domicile and neighboring states should a particular material not found or not even good enough for use. In developing this research, the followings equipment/tools/materials were employed: They are: angle iron, shaft, cast aluminum plate, metal sheet, electrodes, bearing, grinding machine, cutting blades, grinding blades, grease, cylindrical pipe, colours (auto-car paints), bolt and nuts. Others are hack saw, cutting machine, bending machine, Plaster of Paris (POP), Secondary clay, Primary clay (Kaolin) etc. were also required.

2.1.6. Beneficiation of Metals/Clay

Metals piled up for several years under the rain are bound to corrode, hence the need for their beneficiations. Furthermore, other items such as nuts and bolts, bearings, metal off-cuts that were bought were also subjected to beneficiation using hydraulic oil or thinner where necessary with the aid of metal brushes.

The sourced secondary clay was soaked together with kaolin in a big metal drum, allowed to dissolve stirred rigorously (levigated), sieved and allowed to settle overnight. Excess water was drained off and finally scooped into the waiting plaster of Paris mould cast. The clay was used for the throwing test run using the fabricated machine.

2.2 ALUMINUM WHEEL HEAD CASTING

A wheel head is required for any designed kick-wheel. Fabricating a proto-type manual kick-wheel therefore requires a good wheel-head. Hence the need to go for cast aluminum that was further worked on (machining) into the required diameter and thickness rather than cutting any flat plate that might possibly warp due to improper welding of treaded nut to the flat metal plate usually characterized by such welding approach.

This research used purely cast aluminum for the wheel head and this was made in the local casting aluminum shed workshop in Katsina State, Nigeria. Plate 1 shows a successfully cast aluminum head which was later machined to the size required.

Plate 1: Showing a Successfully Cast Aluminum Plate Being Lifted out of the Mould by the Craft Man and the Researcher Respectively Using Pincer to lift it up.
Source: Original Research Photo (Ayodele 2023)

2.3. FABRICATION PROCEDURE

2.3.1 Supporting Framework:

The supporting framework comprises of two vertical cylindrical pipes of 42mm diameter that were bought from the metal shop and cut using hack saw to a length of 700mm and a slanting rectangular pipe of 76mm by 36mm that was cut to a length 690mm. At the base of the two pipes, a 5mm thick plate of 65mm by 55mm were cut using cutting disc and welded to each of the pipes using arc welding machine. Similarly, a 5mm thick plate was purchased from the metal shop and a dimension of 107mm by 100mm was cut and welded to the base of the rectangular pipe and a 5mm thick plate of 700mm by 76mm was cut using cutting disc and welded to the back of the slanting rectangular pipe for additional strength. **See drawing No.1**

Three angle iron of 38mm by 38mm were purchase from the shop and cut to lengths of 510mm, 630mm and 630mm using hack saw and welded to the top of the three pipes (two cylindrical and one rectangular pipes) in the shape of a triangle. **See drawing No.1**

Similarly, two angle irons were cut to lengths 670mm and 670mm to form a base support for the flywheel and welded at a distance of 405mm from the top of the supporting frame using arc welding machine. **See Plate 2 and drawing No.1**

Two flat bars of 40mm by 5mm thick metal were purchased from the metal shop and cut to lengths of 340mm and 280mm using cutting disc and welded using arc welding machine to the top triangular angle iron at a distance of 20mm apart and 165mm from the front angle iron. A cylindrical casing to house a bearing was fabricated using a cylindrical pipe. This case was then welded using arc welding machine in between the flat bars. **See drawing No.1**

A 5mm thick metal plate was bought from the metal shop and cut to the dimension of 425mm by 530mm by 90mm by 530mm using cutting disc and welded to the lower triangular angle iron. A hole of 20mm diameter was drilled using table drilling machine at a distance of 70mm from the front (side with 425mm length) of the metal plate. Also, a bearing case was fabricated and welded at the bottom of the metal plate concentric to this hole that was drilled.

See drawing No.1


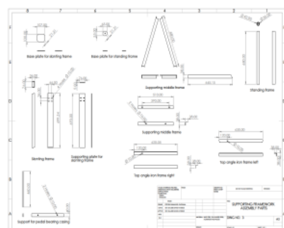

Plate 2: Supporting frame work
Source: Ayodele 2023
Drawing 1

2.3.2. Splash Tray

The splash tray was made from a 2mm sheet metal that was bought from the metal shop and cut using cutting disc to the shape of a triangle with one vertex curved instead of the regular sharp vertex. The measurement of the cut sheet metal was 615mm by 770mm by 615mm by 175mm radius. A hole of 22mm diameter was drilled at a distance of 370mm from the edge of the curved edge using the table drilling machine and a fabricated bearing case was welded to the bottom of the drilled hole at concentric position. Another hole of 26mm diameter was drilled using the table drilling machine at a distance of 80mm and 60mm away from the left-front corner of the cut sheet metal. A galvanized steel pipe of 26mm diameter was bought from the market, cut to a length of 105mm and was welded to the 28mm hole for the flow of water from the splash tray. See plate 3a. This forms the base of the splash basin. See drawing No.2. It is important to note that body filler was purchased and applied on welded areas in order to block possible areas that water may eventually leak out in the process of throwing.

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A 2mm sheet metal of 2,490mm by 115mm was cut using the cutting disc and welded to the edges of the splash tray's base. This forms side wall of the splash tray. Three holes of 4 mm diameter were drilled at a distance of 6 mm from the base of the wall and at 150 mm a parts (centre to centre). The top of the side walls was folded using the bending machine to add more firmness and strength to the side walls. Two flat bars of 24mm by 5mm thickness were cut using the hack saw to the length of 765mm and 688mm and welded using the arc welding machine at the top edge of the front of the splash tray and a distance of 85mm apart. Two holes of 8mm were drilled at a distance of 92mm from both ends of the flat bars for screwing wood on it. A 5 mm thick plank was cut to a shape of an isosceles trapezoid using hack saw to the length of 670 mm (short base length) 765 mm (long base length) and 150 mm height and bolted to the flat bars using M8 bolt and nut. **See drawing No. 2**

Two pockets like-shape were fabricated using the 2mm sheet metal and welded on each side of the splash tray. The base of the pocket slanted to allow the flow of water which may pour from the bowl in the pocket to the splash basin through some tiny holes created. The dimensions of the sheet metal that was cut to fabricate the pockets are: 750mm by 75mm for the pocket walls and 610mm by 135mm pocket base with curved sides. See plate 3b and drawing No. 2. Also an adjustable flat bar was constructed into a ring, with projected hooks that would rest on the pocket wall of the splash tray to house the water container in the process of throwing. This design can be moved to either side of the pocket wall depending on the user (lefty or right hander). This design however is optional in use; that is, the user can decide to place the plastic water bowl on the side pocket walls. **See Plate 3b.**

Two fabricated bearing casing was constructed using a 65mm diameter pipe with 2mm thickness that was cut to a length of 22mm. One of these bearing casing was welded to the bottom of the splash tray base and the other was welded to the bottom of the fly wheel sheet metal support. **See drawing No. 2**

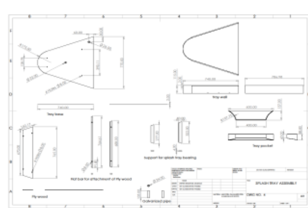

Plate 3a: welding a galvanized pipe for water passage
Drawing 2
Source Ayodele (2023)

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Plate 3b: Welding of flat bars to the top edge of the tray for the attachment of wood and an adjustable ring using flat bar constructed for the side placement for water container.
Source: Ayodele (2023)

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2.3.3. Seat Frame

The seat frame was made from a 5mm thick metal plate that was cut using the cutting disc to a dimension of 470mm by 75mm and bent at an angle of 78^0. A 5mm thick metal plate was cut to a length of 215mm using a cutting disc and welded to the bent sit frame to form a flange support to the frame. Two slots of 13mm diameter were cut to a length of 165mm using a milling machine on the slanting side of the frame. These slots are for adjustment of the sit higher or

lower. Three holes of 10mm diameter were drilled on the top side of the sit frame using the drilling machine. These holes are for the screwing of the wooden sit platform. See drawing No. 3 and plate 4

 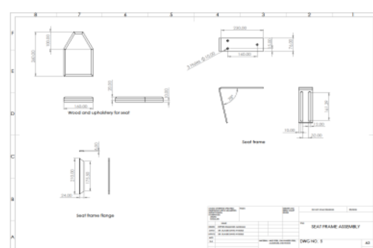

Plate 4. Bent and adjustable metal plate for the seat frame
Drawing 3
Source: Ayodele (2023)

2.3.4 Foot Pedal Frame

The foot pedal frame was fabricated from two arms of flat bars and a crank arm link mechanism to transmit the linear motion of the pedaling to rotational motion to the wheel head. Two 24mm by 5mm thick flat bar of lengths 445mm and 580mm were cut using cutting disc and welded at an angle of $70^0$to form an "L" shaped frame. Two of these arms were fabricated and were separated/linked by a similar flat bar at a distance of 245mm apart. A hole of 8mm were drilled using the table drilling machine on each of the open end of the horizontal bar to allow for the screwing of the left or right foot pedal arm. Two 5mm thick plate were cut with the dimension of 50mm by 30mm and welded to the upper end of the flat bars using arc welding machine. A hole of 16mm diameter was drilled on each of the plate to allow for the passage of the shaft for swinging of the pedal frame. A shaft of 16mm diameter was purchased from the metal shop and cut using a cutting disc to a length of 295mm. **See drawing No.4**

A flat bar of 40mm by 5mm thick was cut to a length of 455mm using cutting disc and welded to the two-supporting frame at a distance of 65mm from the top angle iron frame. **See drawing No.4**

Two flat bars (24mm by 5mm thick) of length 90mm were cut using cutting disc and two holes of 10mm diameter were drilled at 8 mm from both ends of each of these flat bars. This was for the screwing of bolts and nuts to hold the bearing case for the pedal frame. **See drawing No.4**

A flat bar of 40 mm by 460 mm was cut using cutting disc and two holes of 8 mm were drilled at a distance of 280 mm apart. This was then welded to the front of the cylindrical supporting frame at a distance of 73 mm from the top. **See drawing No.4**

The fabricated bearing case (44mm diameter by 20mm height) was welded to the two flat bars. See appendix drawing attached. **See drawing No.4**

A 5mm thick metal plate was cut to the dimension of 96mm by 27mm using cutting disc. Five (5) holes of 12mm diameter were drilled at 23mm centre to centre distances. A 27mm diameter cylindrical pipe of length 50mm was cut and welded to the plate. This forms the crank arm of the pedal frame. A hole of 8mm diameter was drilled at a distance of 25mm from the top of the cylindrical pipe to allow for the bolt and nut (M8) which connects the lower shaft (from the flywheel) and the crank arm. A ball socket joint was purchased from the vehicle spare parts market and was screwed to one of the holes (middle hole) on the crank arm. This screw on the ball socket joint could be screwed to any of the five holes to vary the desired speed as the potter desires see plate 5. Two 5mm thick flat bars were cut to a length of 260mm and welded together. Also, two similar flat bars were cut to a length of 55mm and welded together to form an “L” shaped link and a hole of 8 mm was drilled. A bolt and nut of M8 was used to hold together this link to the pedal frame. The other shaft on the ball socket joint was welded to this link. **See drawing No.4.**

A rod of 20 mm diameter was cut to a length of 65 mm using cutting disc and stepped by one end to a 10 mm diameter using a lathe machine. This is the pedal rod which could be removed from the right side of the pedal frame to that of the left if the left leg would be used for the pedaling of the kick wheel. See drawing No.4


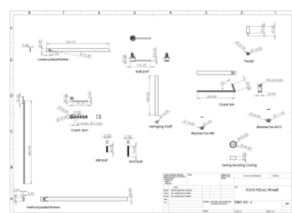

Plate 5: Foot pedal frame, the crank arm link of the pedal frame

Drawing 4

Source: Ayodele 2023

2. 4. ROTATING PARTS

The rotating parts comprises of the wheel head, shafts, bearing, bearing casing and flywheel. The wheel head was cast using aluminum metal in the local casting aluminum shed workshop. See plate 1 above. The diameter of the centre of the wheel head was 238mm and the thickness was 26mm. A hole of 19mm was drilled at the centre of the wheel head. This is to allow the passage of the 19mm shaft diameter. See drawing **No.5 and plate 6.**

A shaft of 19mm was bought from the metal shop and cut to two lengths of 380mm and 180mm using cutting disc. The 380mm length shaft (upper shaft) connects the wheel head to the flywheel while the other shaft (lower shaft) connects the flywheel to the pedal crank arm. A hole of 8mm was drilled at a distance of 15mm from top and bottom end of the top shaft using table drilling machine. Similarly, the same holes were drilled on the lower shaft. **See drawing No.5**

Two bearings of 52mm outside diameter and 19mm inside diameter were bought from the market and attached at the various fabricated bearing casing.


Plate 6: Already machined wheel head, treaded at the top, drilled and bolted to the shaft head.
Source: Ayodele 2023.

The flywheel of 240mm outside diameter and 28mm diameter shaft hole was purchased for the scrap market. See plate 7. Fabrication using cylindrical pipes which was welded using arc welding machine to reduce the shaft hole to 19mm diameter was carried out. **See drawing No.5**

After the whole process of purchasing (metals, bolts and nuts, bearings, flywheel, body filler, electrodes, cutting disc, grinding disc, paints, etc.), cutting, welding, grinding of rough edges and welded parts, application of body filler to the splash tray and painting of the parts, the parts were assembled together to form the manual kick wheel. **See drawing No.5**



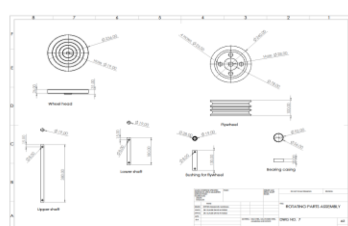

Plate 7: Measuring of flywheel using weighing scale
Drawing 5

Source: Ayodele 2023.

2.5. WORKING PRINCIPLES OF THE KICK WHEEL

The kick wheel was designed for manual operation approach. The operator (Potter) sits conveniently for his operation. This design also considers human factor of being a lefty or righty of both arms and foot. In that the pedal points are adjustable to either right or left side for the conveniences of such operator. The wheel head is turned to rotate anti clock wise after a ball of clay is placed on it and subsequently pedaled at the frequency desired.

3.1 ERGONOMICS

This has to do with the science of designing the job, equipment, and work place to fit the worker/handler. It is also a way of designing any machine, with the aim of maximizing the safety or comfort and the efficiency of the users. Person of normal height and above can conveniently use the machine. The relationship of components with the body was convenient and comfortable with the environment it has been used. On safety, sharp injurious edges were thoroughly chamfered and dulled. It has an adjustable seat for the convenience of the users.

3.2 COLOUR APPLICATION

According to Microsoft Corporation (2003), the durability of any product is further enhanced by coating the surface with an impermissible layer such as paint. The fabrication of the prototype manual kick-wheel was sprayed using auto base car paint to further enhance its look for better appreciation. Dark green colour was adopted for the top frame and brown colour for the base frame using spraying machine.

4.0 RESULTS AND CALCULATION

4.1 Design Theory

Power transmitted by shaft is given by:

$P = \frac{2\pi NT}{60}$ - - - - - - - - - (equ. 1)

Therefore, $N = \frac{60P}{2\pi T}$

Where $T = F_f \, x \, r$ - - - - - - - - (equ. 2)

Kinetic Energy stored in the flywheel is given by:

$K.E. = \frac{1}{2} \, x \, I \, x \, \omega^2$ - - - - - - - - (equ. 3)

Where;

$I = mk^2$ - - - - - - - - - (equ. 4)

And $\omega = \frac{2\pi N}{60}$ - - - - - - - - (equ. 5)

The twisting moment or torque acting upon the shaft is given by:

$T = \frac{\pi}{16} \, x \, \tau \, x \, d^3$ - - - - - - - - (equ. 6)

The bending moment on the shaft is given by:

$M = \frac{\pi}{32}\ x\ \sigma_b\ x\ d^3$ - - - - - - - - (equ. 7)

Where;

$\sigma_b = \frac{F}{A}$ - - - - - - - - - (equ. 8)

At the joint between the hub and shaft, the pin (bolt and nut) is under double shear and is given by:

$T = \tau_p\left(2\frac{\pi}{4}d_p^2\right)\ x\ \frac{d}{2}$ - - - - - - - - (equ. 9)

Therefore, shear stress on the screw pins is:

$$\tau_p = \frac{4\ x\ T}{\pi\ x\ d\ x\ d_p^2}$$

4.2 DESIGN CALCULATIONS

Input	Calculation	Result
$\pi = 3.142$ r = 0.043m F_f = 1,000N P = 75W	Power transmitted by shaft is given by equ. 1: $P = \frac{2\pi NT}{60}$ Therefore, $N = \frac{60P}{2\pi T}$ From equ. 2, $T = F_f\ x\ r$ $T = F_f\ x\ r = 1{,}000\ x\ 0.043 =$ 43N-m $N = \frac{60P}{2\pi T} = \frac{60\ x\ 75}{2\ x\ 3.142\ x\ 43} = 16.66\ rpm$	T = 43N-m N = 16.66 rpm
m = 11 kg k = 0.12 m	Kinetic Energy stored in the flywheel is given by equ. 3: $K.E. = \frac{1}{2}\ x\ I\ x\ \omega^2$ From equ. 4, $I = mk^2$) And from equ. 5, $\omega = \frac{2\pi N}{60}$ $\omega = \frac{2\pi N}{60} = \frac{2\ x\ 3.142\ x\ 16.66}{60} = 1.74\ rad/s$ $I = mk^2 = 11\ x\ 0.12^2 = 0.16\ kg - m^2$ $K.E. = \frac{1}{2}\ x\ I\ x\ \omega^2 \frac{1}{2}\ x\ 0.16\ x\ 1.74^2 = 0.24\ Joules$	ω = 1.74 rad/s K.E. = 0.24Joules
d = 0.019 m	The twisting moment or torque acting upon the shaft is given by equ. 6: $T = \frac{\pi}{16}\ x\ \tau\ x\ d^3$	$\tau = 31.93\ MN - m^2$

F = 120 N Dp = 0.001	$\tau = \frac{16\ x\ T}{\pi\ x\ d^3} = \frac{16\ x\ 43}{3.142\ x\ 0.019^3} = 31.93\ x\ 10^6\ N - m^2$ The bending moment on the shaft is given byequ. 7: $M = \frac{\pi}{32}\ x\ \sigma_b\ x\ d^3$ From equ. 8, $\sigma_b = \frac{F}{A}$ $\sigma_b = \frac{F}{A} = \frac{120}{3.142\ x\ 0.0095^2} = 4.23\ x\ 10^5\ N - m^2$ $M = \frac{\pi}{32}\ x\ \sigma_b\ x\ d^3 = \frac{3.142}{32}\ x\ 4.23\ x\ 10^5\ x\ 0.019^3$ $= 0.28\ N - m$ At the joint between the hub and shaft, the pin (bolt and nut) is under double shear and is given by equ. 9: $T = \tau_p \left(2\frac{\pi}{4}d_p^2\right)\ x\ \frac{d}{2}$ Therefore, shear stress on the screw pins is: $\tau_p = \frac{4\ x\ T}{\pi\ x\ d\ x\ d_p^2}$ $\tau_p = \frac{4\ x\ T}{\pi\ x\ d\ x\ d_p^2} = \frac{4\ x\ 43}{3.142\ x\ 0.019\ x\ 0.008^2}$ $= 4.50\ x\ 10^7\ N - m^2$	$\sigma_b = 423\ \text{kN} - \text{m}^2$ M = 0.28 N-m $\tau_p = 45.0\ \text{MN} - \text{m}^2$

Source: Ayodele 2023

4.3 RESULTS AND DISCUSSIONS

The various results and discussions based on the research work in relation to the objectives are hereby evaluated to the extent of their realization or failure if any for better understanding. Other results aside the ones below were highly successful.

4.3.1 Results of Some Parts Fabricated

Outcome of some of the various components and processes are given below.

4.3.2 Supporting Frame

The frame skeleton as seeing in Plate 2 above is the pivot of the design machine carrying the entire load. It was highly effective in its require functions.

4.3.3 Flash Tray

A flash tray was designed to have beveled attachments at both sides and with perforations that would not allow for water logging in those sides attachments. These were done for the comfort of the users especially for working tools. It was highly effective in its requiring functions as in Plate 3 above.

4.3.4 Adjustable and detachable stand

Also an adjustable and detachable stand was constructed and directly placed on the beveled attachment that would house a plastic bowl water container. It was highly effective in its require functions. **See Plate 3 above.**

The adjustable seat frame constructed and fielded into bending machine for bending to the right angle required was highly successful. **See Plate 4 above**. The fabrication of foot pedal plate 5, the crank link and the arm of foot pedal frame also in **plate 5** were very successful.

4.3.4 The Complete Assemblage

Plate 8: Complete Assembled Kick-Wheel Design.
Source: Ayodele (2023).

4.3.5 Samples of Ceramic Vases Produced.

Plate 9: Test running the Design Machine in the Workshop and Vases Produced before Painting
Source: Ayodele (2023)

CONCLUSION

The purpose of this research is to produce a prototype ceramic kick-wheel machine using locally available scrap metals from the metal junk yards. The fabrication of the ceramic kick-wheel is highly required for effective teaching and learning in higher institution of learning where theory is much dwelled on than practical due to lack of such equipment.

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