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Design and Analysis of Brick Making Machine

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ABSTRACT:

The purpose of this paper is to develop localized machines for making quality bricks and also to domesticate the concept technology of automation of brickmaking. We designed a brick making machine that increases production output while decreasing the cost of operation. The development of this brick making machine is a step in the right direction to enable us as to produce bricks for building adequate housing and settlements for the growing population. Moreover, the machine produces bricks which have desirable advantages such as thermal comfort, fire resistance and superior moisture control. The infamous thermal comfort conditions attributed to houses made with bricks and the cost savings in terms of construction of shelters make bricks very functional in housing units. According to Baggs and Mortensen (2006), 2 thermal mass can be effectively employed in buildings to increase occupant comfort and bricks are known to have a high thermal mass. Appropriate use of thermal mass throughout your housing units can make a big difference to comfort as well as heating and cooling bills.

This brick machine will produce locally made, medium grade bricks which customers would purchase at a relatively fair cost price which would not factor in the country‘s unstable exchange rate and importation charges. In summary, this machine intends to provide a cheaper alternative to various brick machines in the market, which are quite expensive. The objectives of this work are as follows: To design and model a low cost, locally fabricated brick making machine relative to imported ones. To perform structural analysis on designed brick making machine mentioned above.

Keywords: Bricks, Manual, Full Automatic, Semi-Automatic

Introduction

In these 21st Century there has been drastically increased in the demand of new modern building material and ecofriendly material which leads to minimum or almost negligible harmful effects to the environment. In these order to match the supply we have to switch over to brand new and automation methods from traditional and conventional method of manufacturing bricks and other building materials of last century. With fast moving life cycle of cities the automatic and pollution free brick making machine is required and indeed to fulfill needs such as green and ecofriendly material, low cost of manufacturing for low and middle class, reduction in time for manufacturing, fast production, less and cheaper rate, excellent quality such factors have pushed the demand of modern days need of automatic and pollution less Fly ash Brick making machine. Thus, due to advancement in technology and automation there has been large scope of such fully automatic fly ash brick making machine. Brick making machine which are developed and currently available in market are mainly classified into two ways based on driving power:

Manually driven

Motor driven In electrical powered machine there is an either pneumatically or hydraulic operated method for power transmission similarly in these internal combustion engine powered also there is pneumatic or hydraulic power transmission, whereas in man powered machine there is mechanically operated method of power transmission by which force is applied by lever manually. Brick production machines are frequently used on big scale application firms on large merits. In this fact facility of bricks for manufacture production has been considered for an extensive time by big, hefty and costly machineries implication that brick making machineries have developed larger in magnitude as the demand for bricks enlarged.

Our concern in this project is to discover an inexpensive method compared to large rate expensive of growing high productivity of these small- scale 2 initiatives. We will make a fully automatic fly ash brick making machine with a more output than the ones present it could help very significantly to low entrepreneurs.

Current trends in brick making

According to the Brick Industry Association (BIA), over the past few years, brick manufacturers have added, and continued to add, new and more technological improvements to their product lines in response to or in many cases, anticipating of customer demand (Mason, 2003). As a result of this, various companies, organizations and countries have come up with their own set of technologies for brick making. Prior to the mid-1800s, people made bricks in small batches, relying on relatively inefficient firing methods. One of the most widely used was an open clamp, in which bricks were placed on a fire beneath a layer of dirt and the fire died down over the course of several weeks. Such methods gradually became obsolete after 1865, when the Hoffmann kiln was invented in Germany (Way back Machine, 2008). Better suited to the manufacture of large numbers of bricks, this kiln contained a series of compartments through which stacked bricks were transferred for pre-heating, burning, and cooling.

A Hoffmann kiln consists of a main fire passage surrounded on each side by several small rooms. Each room contains pallet of bricks.

In the main fire passage, there is a fire wagon that holds a fire that burns continuously. Each room is fired for a specific time, until the bricks are vitrified properly, and thereafter the fire wagon is rolled to the next room to be fired. Each room is connected to the next room by a passageway carrying hot gases from the fire. In this way, the hottest gases are directed into the room that is currently being fired. Then the gases pass into the adjacent room that is scheduled to be fired next. There the gases preheat the brick. As the gases pass through the kiln circuit, they gradually cool as they transfer heat to the brick. This is essentially a counter-current heat exchanger, which makes for a very efficient use of heat and fuel. This efficiency is a principal advantage of the Hoffmann kiln, and is one of the reasons for its original development and continued use throughout history (Way back Machine, 2008). Brickmaking improvements have continued into the twentieth century. Improvements include making brick shape absolutely uniform, reducing weight, and speeding up the firing process. For example, modern bricks are seldom solid. Some bricks are pressed into shape, which leaves a depression on their top surface. Others are extruded with holes that will later expedite the firing process by exposing a larger amount of surface area to heat. Both techniques lessen weight without reducing strength. However, while the production process has definitely improved, the market for brick has not.

Bricks do have the largest share of the opaque materials market for commercial building, and it continues to be used as a siding material in the housing industry In recent times in large industry brickworks, clay is taken from the quarry, and then carried by conveyor belt or truck/lorry to the main factory, although it may be stockpiled outside before being used. When the clay enters the preparation plant (Clay Prep) it is crushed, and mixed with water and other additives which may include very fine anthracite that aids firing. This process, which is also known as pug 4 Milling, improves the consistency, firing qualities, texture, and color of the brick. From here, the processed clay can be extruded into a continuous strip and cut with wires, or put into moulds or presses (also referred to as forming) to form the clay 5 Brickworks is a factory for manufacturing bricks into its final shape. After forming or cutting, the bricks must be dried, either in the open air, in drying sheds, or in special drying kilns. When the bricks have been dried, they must then be fired or 'burnt' in a kiln, to give them their final hardness and appearance (Bradley & Craven, 1963) Over time, brick making has undergone numerous processes to getting it to its current state. Various methods and techniques have been employed for brick making. Countries, industries, private bodies, individuals have all developed modern ways of making bricks in the most cost effective way. While there are various modern methods for making bricks, we only considered the very current methods which top organization use for their brick making.

Leading Industries in Brick Making

Industrialization and steam power brought huge changes to brickmaking. The fireclay (which is actually solid rock) was mined, by the stoop and room method. This involved digging a network of underground chambers, separated by stoops large pillars of rock left to support the roof.

The mined rock was then ground and water was added to create a clay-like substance. According to Wyomissing (2016), one of the largest manufacturers of brick is the Glen-Gerry Corporation. Glen- Gerry is the superior choice among architects, builders and homeowners who require high quality building products that meet both innovative design challenges and demanding construction specifications. Glen-Gerry is an industry leader for its diversified product line of more than 400 brick products, which are available in a wide- array of sizes and textures.

Below are some notable brickwork spread across the world:

- The London Brick Company.
- Glen-Gerry Corporation .
- Bursledon Brickworks .
- Brickworks limited – Australia Brick Manufacturer .
- Evergreen Brickworks.
- Indian Brick Machines.
- Eco Maquinas.

Overview of Brick Making Machines

Brick making machines are machine used for producing bricks of various types. They come in different shapes and sizes, and also have different modes of operations.

Classification of brick making machines

Brick making machines can be classified into the following categories:

- Manually Operated Brick Making Machines
- Semi-Automated Brick Making Machines
- Fully Automated Brick Making Machines

Manually operated brick making machines

These are brick machines that are manually operated. They do not use any form of hydraulic system to achieve the brick formation. These types of machines are advantageous, in the sense that, they require no electricity to operate. All operations are done by hand, the maintenance cost is significantly low and little or no skill is required to operate the machine. Also, manually operated brick machines are cheaper to procure as compared to the other categories of brick making machines.

Some setbacks to the use of this type of machine are the facts that, the production rate is slower than more automated systems, the operator become fatigued quickly from the continuous operation as the system requires a lot of physical manpower and due to the lack of a control system, and the bricks produced are not completely uniform. Various examples of these types of machines include;

QM2-40 Manual brick making machine

FL1 40 Manual Interlocking brick making machine (Eco-Maquinas)
QMR2-40 Manual Interlocking brick making machineQMR2-40 Manual

Interlocking brick making machine

Fig.1 Manual Brick Making Machine

Semi-automated brick making machines

These types of brick machines make use of hydraulic systems to compress the brick. It is categorized as a semi-automated system because it still requires a human operator to perform operations on the system. But unlike the manually operated brick making machines, these systems do not require the operator to exert as much human effort in the brick making process. They produce more bricks than the manual type, and the sizes of bricks produced are relatively uniform. These systems provide better efficiency. The demerits of a semi-automated system are; the cost of purchasing a single unit is quite expensive. Cost of purchasing such a machine is of the range \$15000 - \$21000. Also, it cost more to maintain such a machine, it requires a skilled labour to operate. Nonetheless, the overall efficiency of the semi-automated brick making machine still makes it better preferred to the manually operated type.

Fig.2 Semi Automated Brick Making Machine

Fully automated brick making machines

These are the type of brick making machines in which were all operations carried out on the machine are completely automated. These type of machines do not require any form of human input to operate. They are simply feed with appropriate specifications and left alone to carry out their task of producingbricks. Fully automated brick making machines are ideal for large industrial use, were a large number of bricks are scheduled to be produced in a large amount.

These machines are more efficient than the other categories of brick making machines. They produce large quantity of bricks within short periods of operation as compared to other types of brick making machines, they produce uniformly shaped bricks, and they are more efficient and save time during production hours. Though fully automated brick making machines are very effective, they are very expensive to purchase and maintain. Highly skilled labour is required to run routine checks on the 14 System as it operates and to monitor its daily or weekly operations.

Fig.3 Fully Automated Brick Making Machine

Semi-Automated Systems for Brick Making Machines

What largely distinguishes the semi-automated brick making machines from fully automated brick making machines is the extent of the material handling concepts employed. According to Vincent (1996), material handling adds expense, but not value, it should be reduced as much as possible with respect to time, distance, frequency and overall cost. Material handling relates to feeding of raw clay mix, conveyor moving and handling as well as robot manipulation in stacking of produced bricks. All these classes of material handling are reduced to the barest minimum as in the case of semi- automatic brick making machines. The Semi Automated Brick machines require more operating personnel for the loading, carrying, excavating of raw materials also stacking of produced bricks are done manually. The sole function of the semi-automated brick machine is to compress the raw clay mix using compress force imposed mostly by hydraulic powered units. This is done manually in its counterparts (manual brick making machine). Among the common semi automated brick machines are the Hydra- form, the Eco Brava and Eco Premium. Both the Eco Brava and Eco Premium are machines produced.

These machines are solely for producing 9ecological bricks (also referred to as compressed earth bricks). Most other brick making machines falling into the category of semi-automated machines are spin-offs of the Eco Maquinas machine designs and the Hydra-form. Hydraulic machines utilize fluid power to do work. During operation, high pressure hydraulic fluid is transmitted throughout the machine to various hydraulic motors and hydraulic cylinders. Control valves are used to control the flow of fluid directly or automatically so as to distribute it through necessary hoses and tubes. As fluid gets pressurized within its distributary channels and hoses, it impacts forces on the movable components of the machine so as to do 9 Ecological Bricks- is produced using only soil, cement and moisture useful work. The popularity of hydraulic machinery is due to the very large amount of power that can be transferred through small tubes and flexible hoses, and the high power density and wide

Literature Survey

[1]V.S.R. Pavan Kumar Rayaprolu et. al.(1) Presented result on study of cow dung ash (CDA) as supplementary cementing material in mortar and concrete. They highlighted the significance and necessity of consumption of these waste materials for the manufacturing of sustainable concrete for construction of green buildings in future.

[2]T. Omoniyi, S. Duna, et al.(2). They studied on the topic Compressive Strength Characteristic of ash blended cement Concrete. These reports on an investigation into the use of cow dung ash as Supplementary Cementations Material in concrete. Cement was replaced with cow dung ash up to 30% at 5% interval. Setting times and slump test were carried out on the fresh cement/CDA blended paste and concrete respectively.

[3] Peter Paa-Kofi Yalley, he studied and research on the topic based on Strength and Durability Properties of Cow Dung Stabilized Earth Brick. This research, reports on the investigation into the strength and the durability properties of earth brick stabilized with Cow dung. A local earth was stabilized chemically by Cow dung. A best compressive strength at the dry state and after 15 minutes of immersion in water was obtained with cow dung stabilization at content of 20% by weight of earth. Bricks stabilized with 20% Cow dung contents by weight of earth have a dry and wet compressive strength of 6.64 and 2.27MPA respectively.

[4] S.K. Kolwale et al [2013], they designed and fabricated clay moulding machine which was producing four bricks at a time. They used clay with water for making a paste for filling clay mould boxes. Also they were tested this machine for one hour and they found that an average of 40 bricks were manufactured. Mamta B. Rajgor et al [2013] developed a comparative study for governing the rate of bricks .Their study has included development of automated and rabotized construction. For that they developed fully automated bricks machine.

[5] Gumaste et al. (2007) studied the compressive strength and elasticity properties of wire-cut and table moulded bricks of India with different mortar grades. Different combinations of masonry prisms and wallets such as soft brick-strong mortar and strong brick-soft mortar were used for experimental study. Similarly, to study the size effect, different sizes of prisms and wallets with different bonding arrangement were tested. An empirical relationship for masonry prism compressive strength as a function of brick and mortar strength was derived for Indian context.

[6] Kaushik et al. (2007) developed a uniaxial compressive stress-strain model for clay brick masonry. The compressive strength and elastic modulus of prisms was determined experimentally.

[7] McNary and Abrams (1985) evaluated the strength and deformation of clay brick masonry under uniaxial compressive force. The constitutive relations of bricks and mortar were established by performing biaxial tension-compression tests on brick units and triaxial compression tests on mortar. The force-displacement relation for stack-bonded prisms was derived from a numerical model. The results were then compared with experimental values and a relation was established.

Theoretical Analysis

For this project, the brick making machine was designed as a semi-automatic type. This implies that the compression of brick is done by the action of a hydraulic ram with an operator manning the controls.

Design Consideration

For this design the following design factors were taken into consideration.They are:

a. Cost

b. Production Efficiency

c. Rigidity of the System

d. Strength of Materials

e. Ease of Handling

f. Safety

Design Concept

The underlining conceptual design for our semi-automated machine bothers downward orientation of the Hydraulic Press based on the design considerations. The compression of the clay mix in the mould is a result of the compressive effect which the hydraulic ram has on the clay mix during operation. Downward orientation of the Hydraulic Press: This particular system has some advantages and disadvantages which were considered during selection. Here, the downward movement of the ram compresses the clay mix and the retraction of the ram with an attached mechanism lifts or ejects the brick out of the BCC (mould). This particular design concept is advantageous as gravity aids the movement during compression as the hydraulic ram does work on the clay mix in the mould. Therefore, the resultant brick produced are quite strong as the earth's gravitational force aids the compressive action of the ram. The disadvantages of this concept bothers on its complexity and the use of metallic material to design and fabricate needed mechanisms to implement the ejection of the brick from the mould as the hydraulic ram retracts after compression. The design operates on two degrees of freedom. The first degree of freedom along the X- axis allows for the to and fro movement of the feeding box to fill clay mix into the molding box. The second degree of freedom along the Y- axis allows for the up and down movement of the pressing box and the ejecting box. Notice the keys showing that the hopper, moulding box, ram cylinder are in a fixed frame while the feeding box, ram plunger and pressing box, ejecting box are in the movable frame of the machine structure.

Design Calculations

Design calculations were carried out on the following key components of the machine, they are

- The moulding chamber
- The pump
- The hopper and the feeder 21
- The support frame of the machine the guide rods

Moulding chamber design

The moulding chamber (MC) was designed in such a way as to accommodate the changing of the mould plates which give the bricks different shapes, that is, the MC can produce bricks with grooves and bricks without grooves depending on the manufacture choice.

Determining Yield Stress (MPa) Knowing that:

Maximum allowable stress=yield stress point (MPA)/Factor of safety

Maximum Allowable Stress acting on mould walls = 10MPATaking the factor safety = 5

Yield Stress Point = Maximum Allowable Stress x Factor of safety = 50MPAKnowing that the yield strength

for Structural steel = 250MPA

Determining Mould Deflections and allowable thickness to determine the mould deflections, thefollowing design parameters were considered;

- Distributed load intensity (ω) (N/mm)
- Length of applied loading (L) (mm)
- Moment of Inertia (I) (kg/m^2)
- Young Modulus of Elasticity.

Maximum deflection is determined by:

Y max = wl4/384EI

From the results of the calculation above, the allowable mould thickness = 18mm

Mould Dimensions

The mould size was determined based on the size of the brick to be produced and the amount of claymix needed to produce such a brick. Factors considered;

Brick Dimensions (L x W x H) = 300mm x 150mm x 150mmThickness of the

Stamping Plate = 20mm

Thickness of the side grooves = 10mm

Tolerance = 20mm Thus, the mould dimension Width = width of brick = 150mmLength = length of brick +

thickness of side grooves = 300 + (2 x 10) = 320mm

Height = height of brick + 60% of height of brick + added tolerance + thickness of two stamping plate

= 150 + 90 + 20 + 40 = 300mm Therefore, dimension of mould (L x W x H) = 320mm x 150mm x300mm.

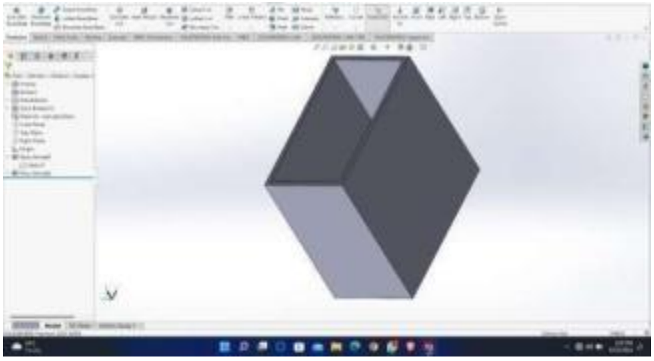


fig 4 mould chamber

Feeder and hopper design Feeder Design:

The following were determined for the Feeder: Volume of the Feeder

The feeder is designed to accommodate the entire volume of mix needed to produce a brick at each compression. Since the feeder function is to take mix from the hopper and deposit to the mould, a thickness of 3mm mild steel will be used.

Volume of mould (L x W x H) = 320mm x 150mm x 300mm,

Since Volume of the feeder must be at least equal the Volume of mould,Factors considered include:

Thickness of the mould = 10mm

Length of the mould = 320 The side stamping plates which are of 10mm thickness on both sides of themould Thus, the Feeder dimensions are;

Width of the feeder = width of the rectangular base of the hopper = 190mmLength of the feeder =

320mm + 10mm + 10mm = 340mm

Height of the feeder = height of brick + 60% of height of brick + added 24 tolerance =150 + 90 +20mm = 260mm

Fig 5. feeder drawing

Therefore, Dimension of feeder (L x W x H) = 340mm x 190mm x 260m

Hopper Design:

The Hooper will be designed to accommodate the volume of mix required to make at least 80 bricksat a run. The hopper will have a shape of a truncated right angle Pyramid as the large container supplying the feeder needed volume of mix for each brick production operation.

Therefore, the Dimension of the rectangular base section of the hopper;Width = 190mm

Length = 340mm

Also, the Dimension of the rectangular top section of the hopperWidth = 190mm;

Length = 340mm

Height of the truncated Pyramid Hooper= 575mmWeight of hopper

with clay mix

This will be determined using the weight density relation below;

Weight Density of the mix (N/m3) = weight of mix in the hopper /volume of mix in the hopper (m ^3)Volume = [H/3] / [(X2Y-x2y)/(X-x)]

X= length of upper rectangle Y= width

of upper rectangle x= length of lower

rectangley= width of lower rectangle

V = [570/3] [(1300X2X735) - (340X2X272) / (1300-340)]V=0.341612m^3

Density = Mass/Volume

Density of MIX is D= 1800N/M^31800Kg/m=

m /0.34161m^3

Mass = 630kgW =

M X G

W= 630 X 9.8m/s^2F =

6180N/ S^2

Force acting on Hooper is 6180/s^2

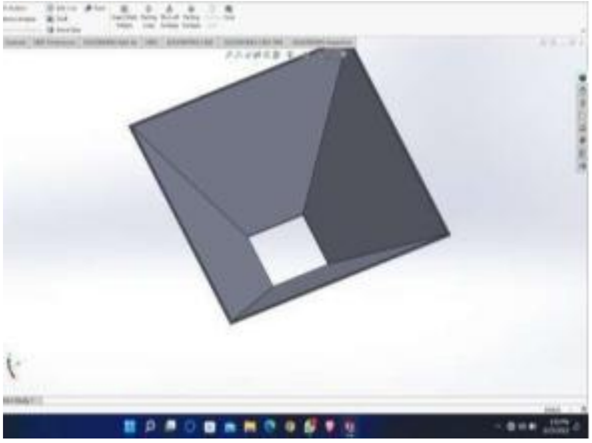


Fig 6 Hooper drawing

For Solid Shaft;

Allowable Stress due Axial Load (σa) = 4F/D^2

Where, d ---the diameter of the guide rods,

F --- The axial force imposed on the shaft during compression by the hydraulic ram, using 10bolted joints as tension joint such that the stud end of the shaft and clamped components of the joint are designed to transfer 29 an applied tension load through the joint by the design. The joint is so designed so the clamp load is never overcome by external tension forces due to the reaction from the double acting cylinders. To derive the bolted joint characteristics when the line of action of load on the shaft is parallel to axis of bolt (Stud); that is, thread characteristic especially nominal diameter, core diameter the thread.

The tensile strength on each joint can be determined using the equation below: Tensile Strength on each stud

(Wt) = ���/ 4 *���c ^2 * σt

Where, σt = Tensile Stress

dc = core or root diameter of the thread on the shaft.

Pump design

Knowing the compressive pressure required to form the block, we narrowed our pump selection to three different classes .The specification of the three various types of pumps. Our pump design considers three major parameters;

Pump Displacement Pump

Power

Drive Power

Determination of Pump Displacement The pump displacement can be calculated using the following equation:

The pump displacement can be calculated using the following equation: Vp =

(Qm*1000)/np*nvol.p

Where:

Vp = Pump displacement (cm^3/rev)

Qm = Flow rate required by pump (lit/min)np = pump shaft

speed (rpm) Determination of Pump Power

The power rating of the pump is given by the following equation:Pout =

p*(VP*nP)/600000

Where:

p=pressure (bar)

Pout=power (kW)

Vp= pump displacement (cm^3/rev)nP = pump

shaft speed (rpm) Determination of Drive Power

The drive power of the pump is calculated by using the equation below;

Pin = p*(Vp*nP)/600000*.pWhere:

Vp= pump displacement (cm3 /rev)nP= pump

shaft speed (rpm)

Pin= power (kW)p =

pressure

Material Selection

The factors considered during the material selection are;

- Mechanical properties
- Machinability
- Mechanical performance
- Availability of material
- Chemical performance

The most important factors considered are mechanical properties (Ashby et al, 2004). Here, importance has also been given to the local conditions i.e. Availability of material and financial capacity of the entrepreneur.

Analysis of Moulding Box Assembly

The moulding box assembly consists of two sides, the longitudinal sides and the lateral sides. These sides form the rectangular box which makes up the whole mould assembly. Both sides are made of structural steel, which has yield strength of 250MPa and an ultimate tensile strength of 460Mpa. The maximum, imposed by the hydraulic cylinder, within the moulding box is 2.1MPa, thus the force acting on the walls on the members varies based on the surface area in contact with the compressed brick.

Analysis of the longitudinal sides

Surface Area of longitudinal side = L x B = 350mm x 300mm = 105000mm^2 = 0.105m^2

Force acting on surface area = P (MN/m^2) x A (m^2)

Table 4.1.1.a: Ansys analysis result on longitudinal side of mould box

	Maximum Value	**Minimum Value**
Equivalent Stress (MPa)	1025.3	0.910
Total Displacement (mm)	4.926	0
Maximum Principal Stress (MPa)	1397.1	-584.14
Maximum Principal Strain (MPa)	0.00526	0.000000211

Based on the Ansys simulations Result shown in Table, we see that we have an equivalent stress (von- Misses stress) of 1025.3MPa and a total deflection of 4.92mm. From the results gotten, it’s clear that the vonMisses stress is greater than the yield strength of the material at certain stress points. Noting this, we modified our design to address this issue. Our modifications and simulation results are shown in the sections below.

Modifications on longitudinal sides

To solve the problem of the equivalent stress been greater than the yield stress, we added reinforcements to the longitudinal sides then carried out an Ansys stress analysis simulation to checkif the part would fail when subject to the allowable stress of 2.1MPa. Table shows the results generated from the Ansys simulation software. From our Ansys simulations results shown in Table. It was observed that the maximum (von-Misses stress) obtained was 849.55MPa and the total deflection gives 1.75mm. The results obtained shows that the von-Misses stress obtained is greater than the yieldstrength of the material at certain stress points. With this data, we knew that the part can fail at those regions of high stress build up. To address this issue, we made modifications to the initial design to ensure that the part performs as expected without failure during operation.

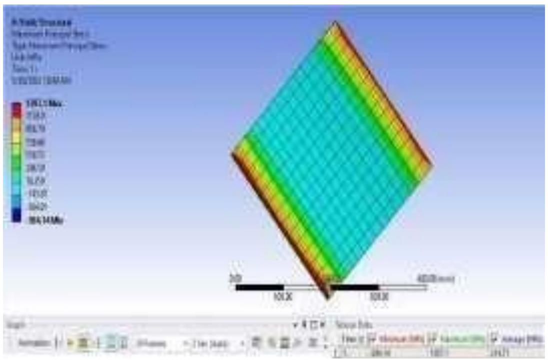


fig 7

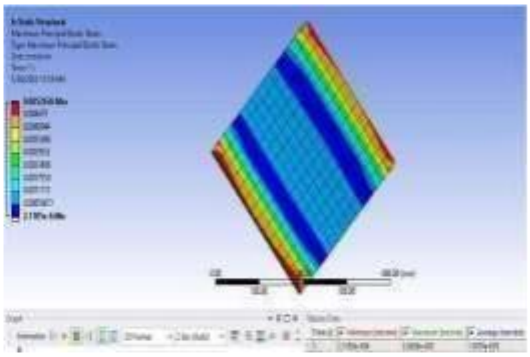


fig 8

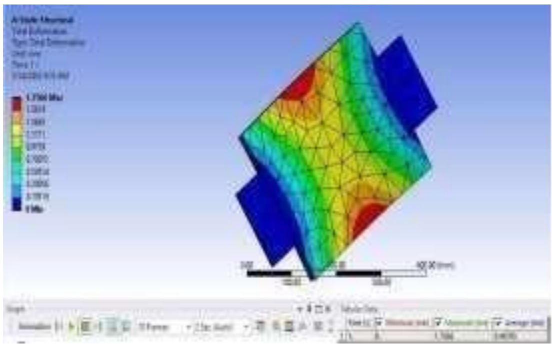


Fig 9

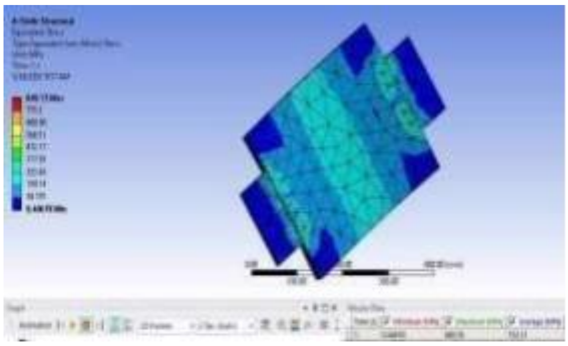


Fig 10

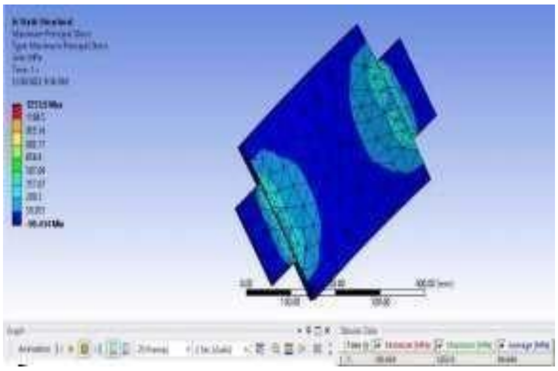


Fig 11

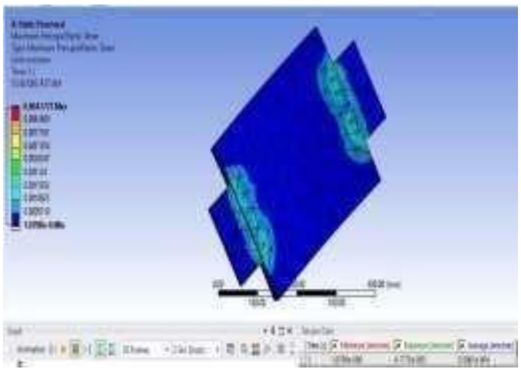


Fig 12

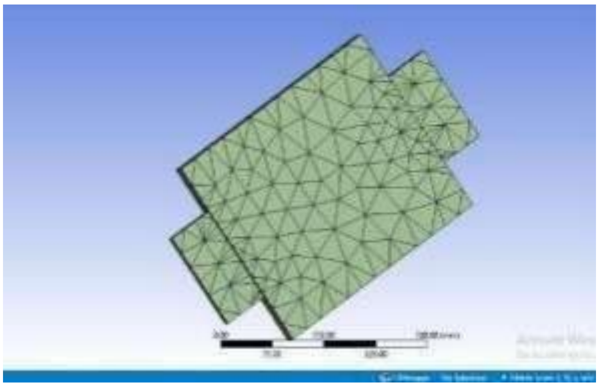


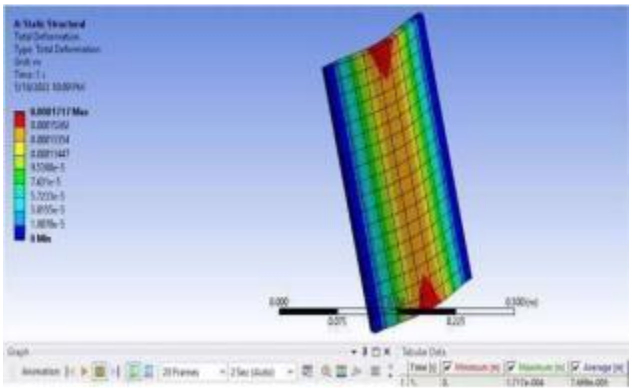
Fig 13

Table.4.1.1 b: Ansys Result of Modified longitudinal side of moulding box.

	Maximum Value	**Minimum Value**
Equivalent Stress (MPa)	176.76	6.0689
Total Displacement (mm)	0.77884	0
Maximum Principal Stress (MPa)	198.05	-64.618
Maximum Principal Strain (MPa)	0.0008142	-2.747x10−6

Analysis of Lateral Side of Moulding Box

Surface Area of longitudinal side = L x B = 300mm x 150mm = 45000mm^2 = 0.045m^2Force acting on surface area = P (MN/m^2) x A (m^2) = 2.1x106 x 0.045m^2 = 94500N



Once the force acting on the surface area of the lateral side was determine, we imported the CADmodel to Ansys for stress analysis to be carried out.

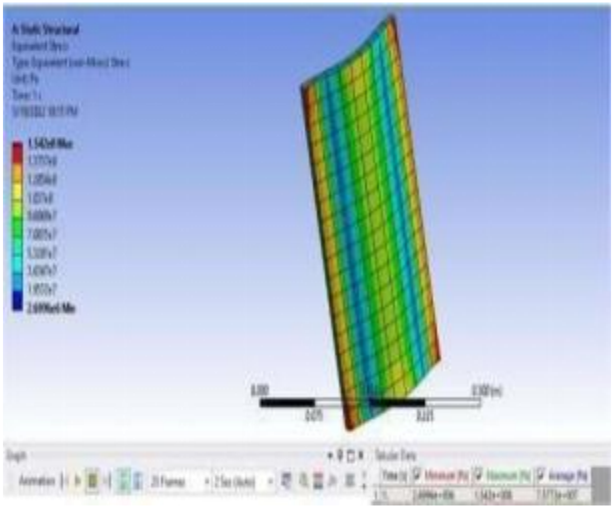


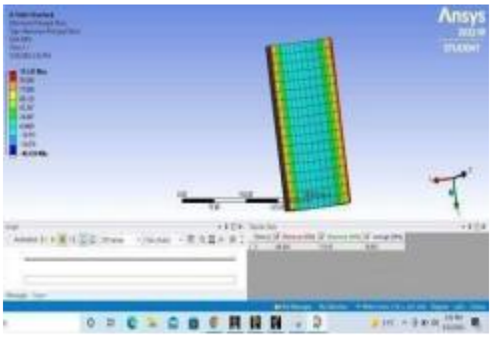
Fig 4.1.2.b stress

Table.4.1.2a: Analysis on lateral side of mould

	Maximum Value	**Minimum Value**
Equivalent Stress (MPa)	154.2	2.69
Total Displacement (mm)	0.1717	0
Maximum Principal Stress (MPa)	251	-102.44
Maximum Principal Strain (MPa)	9.590	7.91

Modifications on lateral sides.

By adding an extra 6mm structural steel plate within the mould box, also taking into account the10mm insets that we use to chamfer the edges of the brick produced, both structures make up a reinforcement of 16mm in thickness. This helps to reduce the stress generated at various stress points within the part. We import the modified CAD geometry into Ansys simulation software to perform a structural stress analysis to determine how the model would behave when reinforcements have been added. Table 4.2 and Figure show the results generated from the Ansys simulation software. From Table, after modifications were carried out on the model, the effective stress became 76.12MPa and the total deformation was 0.69mm. These values are well within the allowable stress ensuring that thatpart would not fail during operation.



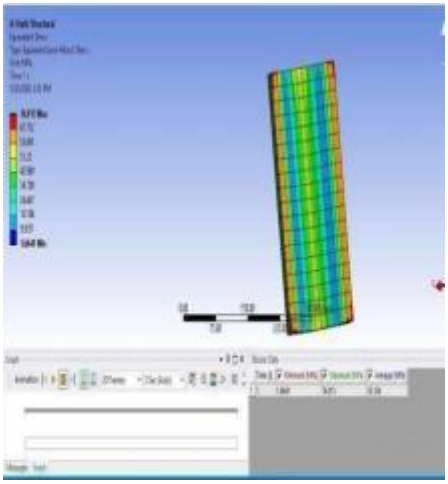


fig 4.1.2.e Principal Stress

	Maximum Value	**Minimum Value**
Equivalent Stress (MPa)	176.76	6.0689
Total Displacement (mm)	0.77884	0
Maximum Principal Stress (MPa)	198.05	-64.618
Maximum Principal Strain (MPa)	0.0008142	-2.747x10−6

Analysis of Guide Shafts (Columns)

The guide shaft assembly, also called the column assembly, consist of two units; The Long Shaft (Long Column) ii. The Short Shaft (Short Colum) .The guide shafts are made of stainless steel which has an ultimate tensile strength of 505MPa and yield strength of 215MPa. The long shaft is serves as a guide and a linear constrain to the pressing box assemble also, the short shaft serves as a guide and a linear constrain to the ejecting box. Together they constitute the guide shaft assembly. For calculations on the shaft design, has done above. Tensile forces act on the guide shafts due to reactions imposed on the cross members which act as a result of the force 45 generated by the hydraulic cylinder. A tensile force of 34.65 KN acts through the long shaft all through to the short shafts, which are position just below the long shafts. As a result of these tensile forces, the shafts would want to undergo necking at their centerlines which could cause them to fail under loading conditions. From our design calculations, we determined that the minimum allowable diameter for which the shafts would not neck is 32mm, hence, choosing a suitable factor of safety and checking through standard shaft design catalogue we determined that the shaft diameter be 50mm to prevent necking from occurring on either shafts. To further confirm that the shafts would not fail when imposed by the generated tensile forces, we carried out an Ansys Stress Analysis Simulation on both shafts. Table and Figure show the results gotten from our Ansys simulation.

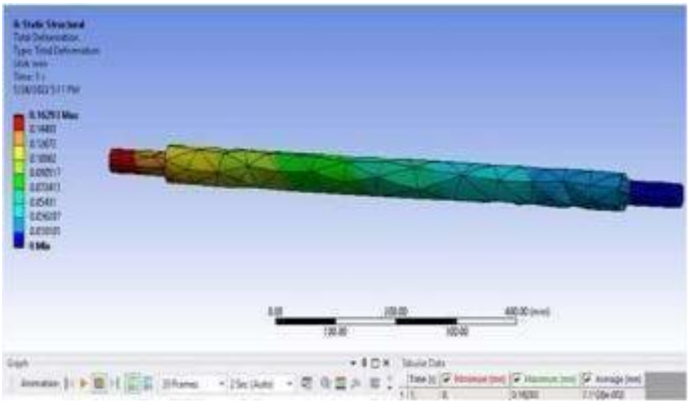


Fig. Total Deformation

Long shaft Analysis

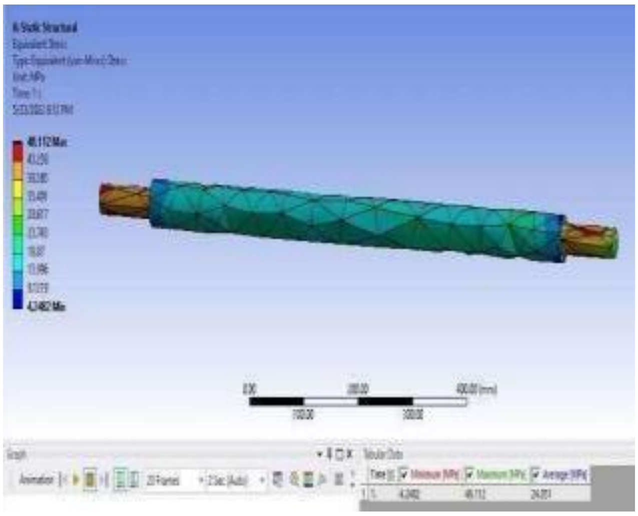


Fig.Principal Stress

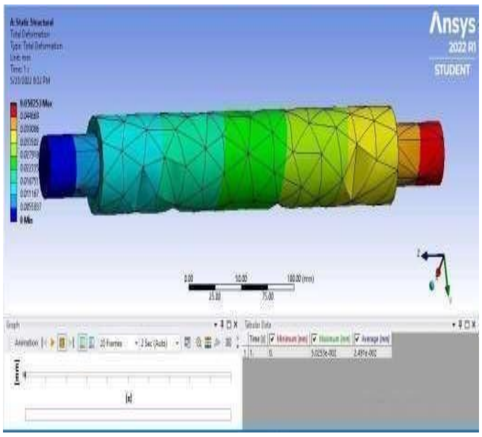


Fig. small shaft analysis

Table 4.2.2: Analysis on shaft

	Maximum Value (Long Shaft)	**Minimum Value (Long Shaft)**	**Maximum Value (Small Shaft)**	**Minimum Value (Small Shaft)**
Equivalent Stress (MPa)	48.112	4.248		
Total Displacement (mm)	0.162	0	0.0502	0
Maximum PrincipalStress (MPa)	56.121	0.233	48.22	-1.39
Maximum Principal Strain (MPa)	0.000237	0.0000098		

Hopper Analysis

The amount of fly ash mix which can poured into the Hooper is dependent on the volume of HooperThus, volume of Hooper is:

Volume = [H/3] /[(X2Y-x2y)/(X-x)]X= length of

upper rectangle

Y= width of upper rectangle x= length

of lower rectangle y= width of lower

rectangle

V = [570/3] [(1300X2X735) - (340X2X272) / (1300-340)]V=0.341612m^3

Density = Mass/Volume

Density of MIX is D= 1800N/M^31800Kg/m=

m /0.34161m^3

W = M X G

W= 630 X 9.8m/s^2F =

6180N/ S^2

Force acting on Hooper is 6180/s^2

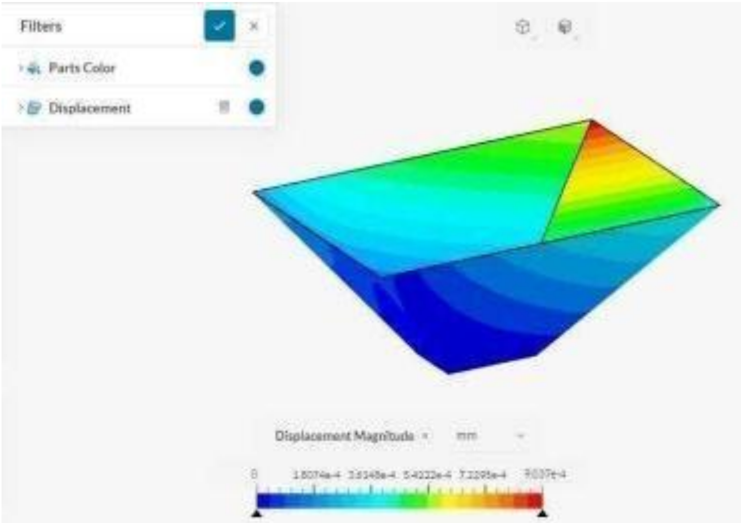


Fig 4.3.b

A Hooper is a large, pyramidal or cone shaped container used in Brick making machine to hold flow- able gravel. The Hooper is made up of Galvanized steel plate, its ultimate tensile strength is 400MPa and yield strength is 300Mpa. From the analysis we got the Von-Misses stress is 0.120MPa and total deformation is 0.0009mm.Thus Hooper will sustain to the load applied on it with fail.

Table.4.3 analysis of hopper

	MaximumValue	**Minimum Value**
Equivalent Stress (MPa)	0.1209	0.000181
Total Displacement (mm)	0.0009037	0
Maximum Principal Stress (MPa)	0.000172	0.000148

Analysis on Frame

The Frame gives the support to the Hooper and the feeder and all other parts of the machine. But this analysis is done on a single part of the frame where the frame part is subjected to the Hooper and feeder load, which acts on the frame.

The load acting is the weight of fly ash mix +Weight of Hooper + weight of feeder.F= 6180N + 200N + 250N = 6630N

Table 4.4: Analysis on Frame

	MaximumValue	**Minimum Value**
Equivalent Stress (MPa)	104.6	0
Total Displacement (mm)	2.79	0
Maximum Principal Strain(m/m)	1.732	0

The Frame is made up of Mild steel it has ultimate tensile strength is 440MPa and yield strength is 370MPa .By analysis we got the

Equivalent stress as 104MPa and total deformation is 2.7mm. The values are within the allowable stress, So the frame will not fail.

Result Discussion

Analysis Result of longitudinal side of mould box

	Maximum Value	Minimum Value
Equivalent Stress (MPa)	1025.3	0.910
Total Displacement (mm)	4.926	0
Maximum Principal Stress (MPa)	1397.1	-584.14
Maximum Principal Strain (MPa)	0.00526	0.000000211

Analysis Result of Modified longitudinal side of mould box

	Maximum Value	Minimum Value
Equivalent Stress (MPa)	176.76	6.0689
Total Displacement (mm)	0.77884	0
Maximum Principal Stress (MPa)	198.05	-64.618
Maximum Principal Strain (MPa)	0.0008142	-2.747x −6

Analysis Result of lateral side of the mould

	Maximum Value	Minimum Value
Equivalent Stress (MPa)	154.2	2.69
Total Displacement (mm)	0.1717	0
Maximum Principal Stress (MPa)	251	-102.44
Maximum Principal Strain (MPa)	9.590	7.91

Analysis Result of modified lateral side of mould

	Maximum Value	Minimum Value
Equivalent Stress (MPa)	76.12	1.66
Total Displacement (mm)	0.69	0
Maximum Principal Stress (MPa)	113.4	-46.43
Maximum Principal Strain (MPa)	4.41	3.98

Analysis Result of small shaft and long shaft

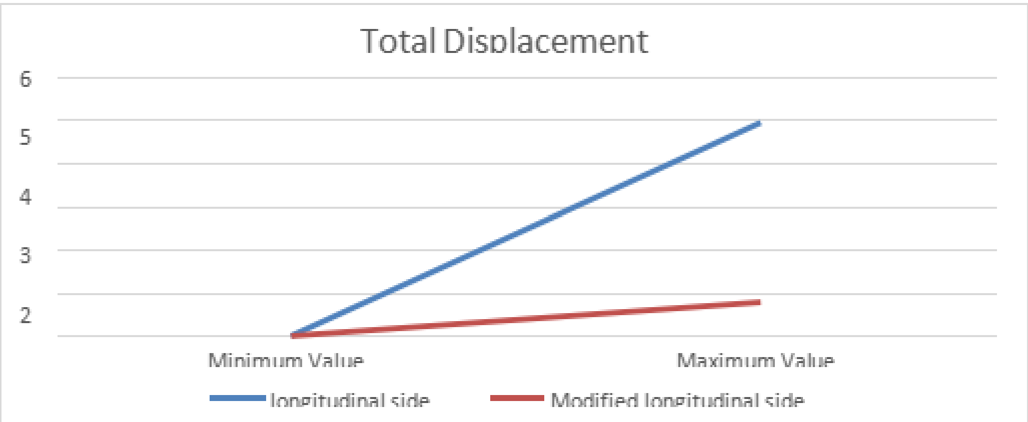
	Maximumvalue (Long Shaft)	Minimumvalue (Long Shaft)	Maximumvalue (Small Shaft)	Minimum value (Small Shaft)
Equivalent Stress (MPa)	48.112	4.248		
Total Displacement (mm)	0.162	0	0.0502	0
Maximum Principal Stress(MPa)	56.121	0.233	48.22	-1.39
Maximum Principal Strain(MPa)	0.000237	0.0000098		

Analysis Result of Hopper

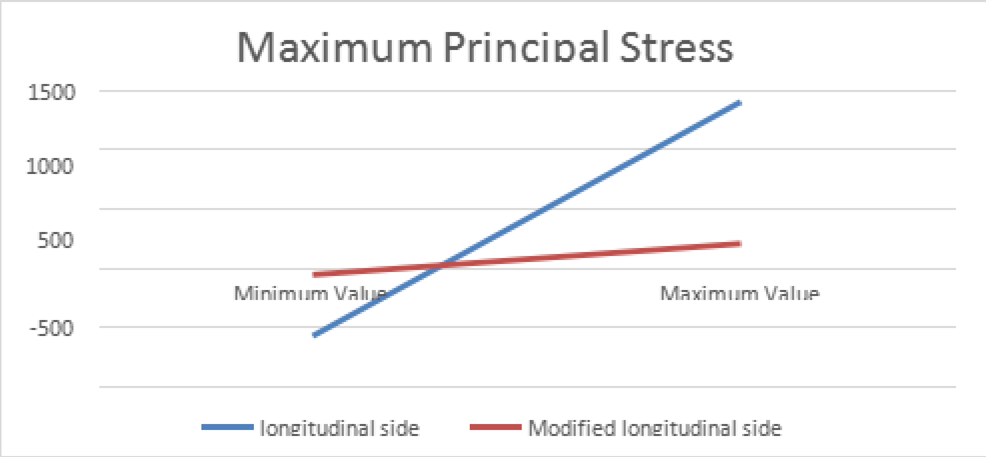
	Maximum Value	Minimum Value
Equivalent Stress (MPa)	0.1209	0.000181
Total Displacement (mm)	0.0009037	0
Maximum Principal Stress (MPa)	0.000172	0.000148

Analysis Result of Frame

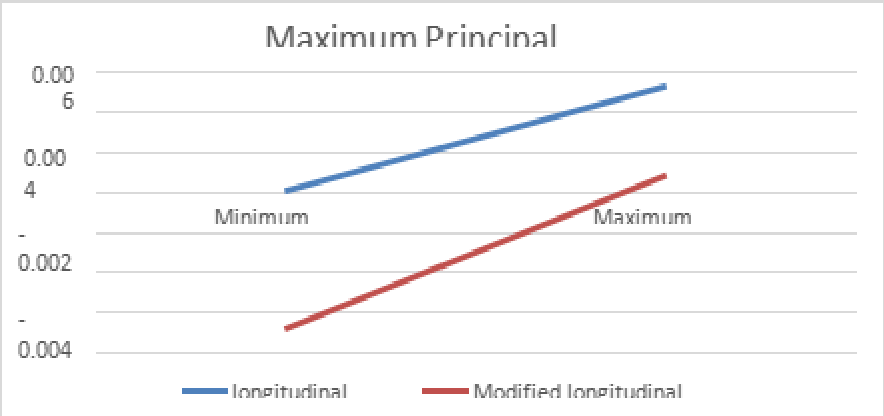
	Maximum Value	Minimum Value
Equivalent Stress (MPa)	104.6	0
Total Displacement (mm)	2.79	0
Maximum Principal Strain(m/m)	1.732	0



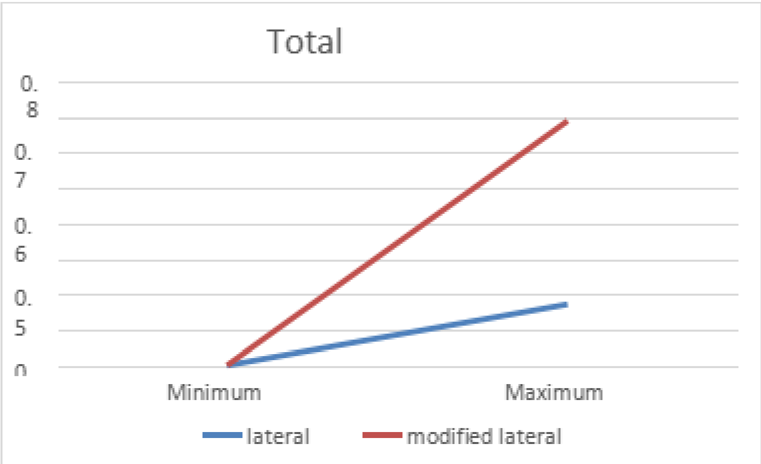
Graph1. Total displacement deformation of longitudinal and modified longitudinal mould box.

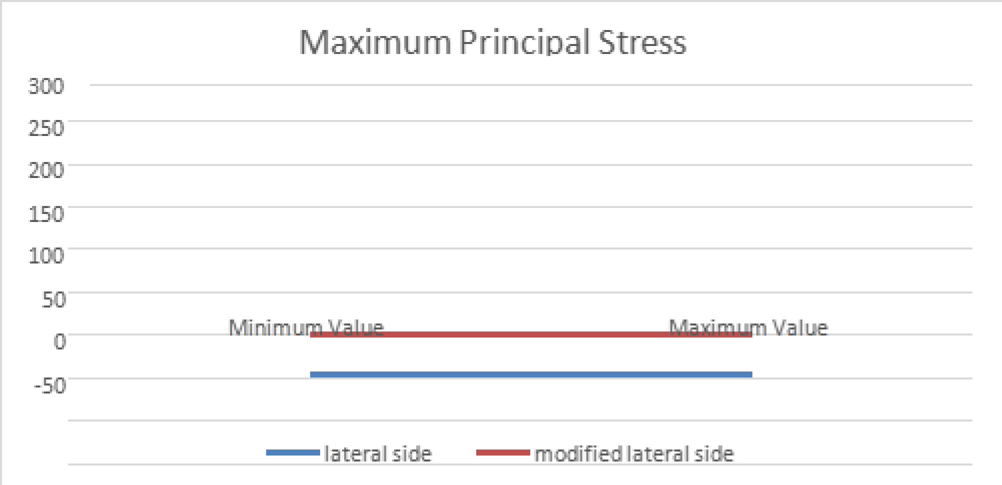


Graph2. Max Principal stresses of longitudinal and modified longitudinal mould box.

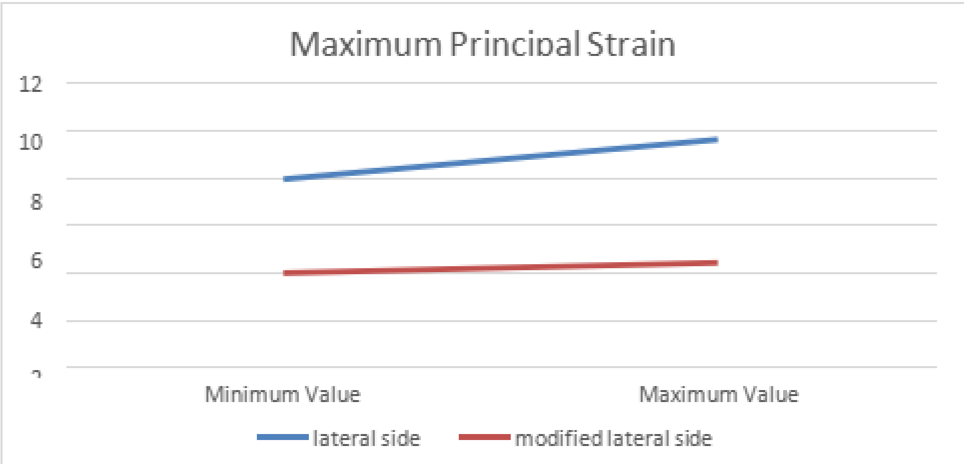


Graph3. Max principal strain of longitudinal and modified longitudinal mould box.





Graph4. Total displacement of lateral and modified lateral mould box.



Graph6. Max principal strain of lateral and modified lateral mould box.

From our analysis, using the Ansys simulations software and solid works software, we were able to confirm that the assemblies would not fail when loaded to their maximum values. This gives us the confidence that the parts modeled are conform to standards and are unlikely to fail due to the permissible maximum loading been imposed on system as a result of our designed parameters put in place.

Conclusion

Based on Ansys simulation result we got maximum equivalent stress of: 176.76mPa and total deflection of 0.778 mm for the longitudinal side of moulding box. Thus, it is under the yield strength of the material (Mild Steel) which is used for making the mould, so that it can withstand the applied force. The maximum equivalent stress on the lateral side of the mould box is 76.12 MPA and total displacement is 0.69 mm which falls under the allowable stress ensuring that the part wouldn’t fail during the operation. The Structural analysis on long and small shaft is of diameter 50mm and length 600mm and 400mm respectively. The values we got for the long shaft’s maximum equivalent stress is 48.12 MPA and total displacement of 0.12 mm. For the small shaft’s maximum principal stress, we got the value as 4.24 MPA and total displacement of 0.05 mm. Thus, these values are less than the ultimate tensile strength of stainless steel which is 505 MPA and yield strength of 215 MPA and therefore it can withstand the tensile load applied on it. From the analysis of hopper, we got the values of maximum principal stress of 0.000172 MPA and 0.1209 MPA for the maximum equivalent stress. The total deformation is 0.000903 mm which is allying under the yield strength (300 MPA) and ultimate tensile strength (400 MPA) of hopper which is made of galvanized steel. Thus, it can sustain the load applied on without fail. From the

Structural analysis of the frame, we got the values of maximum equivalent stress as 104 MPA and total deformation of 2.7mm. This smart and integrated brick making machine is designed to give a reasonable production rate with an affordable investment. The machine is designed to perform the task within a short period. It achieves mass production, which increases the efficiency of the plant that reduces the workload and also reduces the production cost.

Future Scope of the Project

Our Project is about the semi-automatic brick making machine where we automated the pressing box and the ejection of the brick from the mould by using the hydraulic cylinder. But in this machine the feeding of the mixture is manual which can be automated in the future. Also, the operation of the machine is manual where we can use the IOT application to automate the machine in the future. The automation process helps in reducing the man power and increase the production of the bricks.

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