International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 01 | Jan-2018 www.irjet.net p-ISSN: 2395-0072

Development of Single Hydraulic Cylinder Operated sheet metal Bending Machine

Gebremichael Tasew[1], Ajay Jaswal[2]

[1]*Student m. tech (Machine Design Engineering), Parul University, Vadodara, Gujarat, India*
[2]*Assistant Professor, Mechanical Engineering, Parul University, Vadodara, Gujarat, India*

Abstract - *Hydraulic bending machine is a common tool in the machine shop that is used to bend a piece of plate. Bending machines in different type found in a small and large scale industries which have limitation on utilizing cylinder force, all those machine lost cylinder force without any function. The main objective of this project to develop one hydraulic cylinder driven 5mm thickness stainless steel plate bending machine with low cost and light weight. For reducing the weight and the cost of the machine use only one hydraulic cylinder and maximize the hydraulic cylinder bending load by the help of right angle lever. In this paper generate an innovative idea for handling loss of cylinder force. As a result the machine become low in cost and light in weight simple operation and high competitive marketable machine. The main components of the machine is lever, lower die, punch, frame, table and double acting hydraulic cylinder.*

Key Words: ***lever, cylinder force, innovative mechanism,bending load, low cost, markeatable machine***

1. INTRODUCTION

In Hydraulic bending machine bending of sheet metal through an angle is usually done on a machine by the help of hydraulic cylinder known as hydraulic bending machine. This is a common operation in a sheet metal forming widely used in manufacturing of U-shape, V-shape, etc. and done by applying uniform pressure all throughout the bending axis from hydraulic means.

In all hydraulic bending machine hydraulic cylinder generate input force for driving the mechanism and bending the work piece. In this paper the proposed single hydraulic bending machine which uses only one hydraulic cylinder for driving the whole operation of the machine. The hydraulic cylinder is a device which used to convert fluid power to mechanical power by Pascal principle. The Pascal principle states that pressure exerted anywhere in a compressible fluid is transmitted equally in all direction through the fluid. In hydraulic cylinder a confined incompressible fluid pressure exert on three surfaces (1) cylinder wall (2) cylinder base plate (3) piston head. The piston head surface area and cylinder base plate surface area and the pressure exerted on it are equal, therefore the developed pressure force on piston head and cylinder base plate are equal in magnitude but opposite in direction.

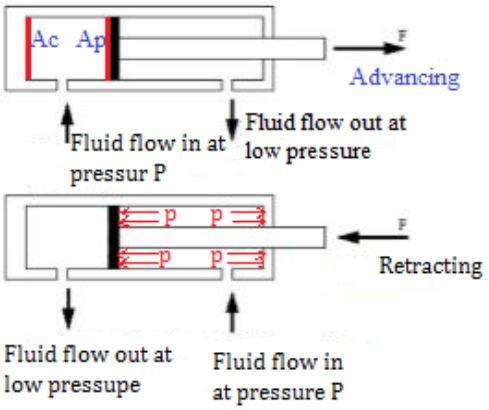


Figure -1: Fluid flow direction in cylinder

The hydraulic cylinder have to forces which are the piston force in the forward direction and the cylinder force in the back direction. Those forces are equal in magnitude, but opposite in direction and collinear to each other. The piston force is used for the purpose of bending while the cylinder force is exerted on the cylinder support that have no function simply lost without any function but it cause failure on cylinder support.

In this paper developed a simple mechanism that handle and maximize the hydraulic cylinder and piston force for the purpose of bending as a result the machine become light in weight and low in cost.

1.1 Components of single hydraulic cylinder driven bending machine

Figure 1 shows single hydraulic cylinder driven plate bending machine consists the following components (1) frame, which used to support the whole components of the machine. (2) Lever, which used to maximize the piston force and change its direction from horizontal to vertically downward force. (3) Pin, which used for join to components of the machine that have relative motion at a common point. (4) Die holder, which used to carry the punch and also connect the ling and the punch. (5) Punch, which used to press the work piece for getting the final bend product. (6) Lower Die, which is either v- shape or u- shape which used to give shapes for bend product. (7) Double acting hydraulic cylinder, which used to convert fluid power into linear mechanical power. (8) Table which used to support the lower die.

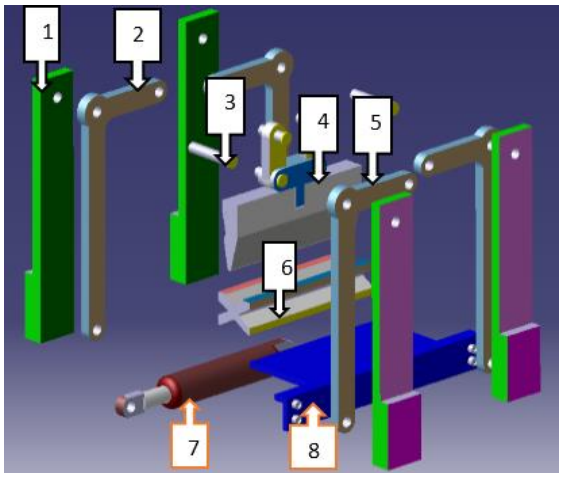


Figure -2: Detail components

1.2 Hydraulic circuit of the system

Figure 2: hydraulic circuit which consists components: (1) Tank, which containing oil that supplied to the system. (2) Pump, which supplied the oil to the component. (3) Hydraulic cylinder, which use to convert fluid energy to liner energy to move the lever. (4) Direction control valve control direction of oil. The double acting hydraulic cylinder circuit diagram is shown in the bellow figure.

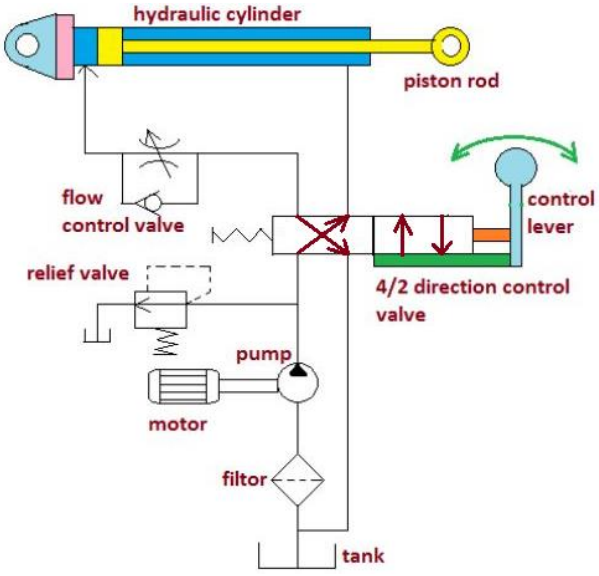


Figure -3: Double acting cylinder Circuit

2. OBJECTIVE

The aim of our project is to get effective hydraulic bending machine by using only one hydraulic cylinder as a result the machine become light in weight and low in cost.

The main objective of this project is to design a new bending machine with new feature and simplified operation by handling the hydraulic cylinder reaction force for the purpose of bending.

- To maximize the hydraulic action and reaction force by the help of right angle lever.
- To get a multipurpose machine that is sheet bending, pipe bending and press by changing die.
- To get light weight and low cost machine.
- High competitive marketable machine.

3. LITERATURE SURVEY

Dr. P. G. Halakatti (2015) [1] have investigate on the simulation of the hydraulic operated press brake that subjected to a load. The analysis is done by advanced FEM tool that is called ANSYS. Whereas the structural analysis is done by static as well as dynamic analysis. The author have to been use a number of optimization techniques mostly use Taguchi method. For manufacturing the hydraulic press brake the authors use a material that is mild steel which contains 0.4 carbon and have a density of 780Kg/m3. stress analysis of the 30 ton hydraulic press by ANSYS 14 work bench and static structural analysis for components hydraulic operated press brake would be successfully designed and meet the requirements because the induced stress on hydraulic operated press brake is 133.3Mpa which is less than allowable stress of the given material.

Work carried out by Manar Abd Elhakim Eltantawie (2013) [14] shows that, hydraulic press V-bending operation designed, manufactured and modelled with 2 tone maximum press load and the hydraulic circuit are simulated by in mat lab library. The proposed punch and die design consider to reduce the spring back as well as spring forward. The bending press is tested by using a low carbon steel sheet metal with 3mm thicknesjy6u. The result shows that, there is little amount degree in the spring back and there is no defects on the work piece surface.

Mr. Harshad Khairkar1, Mr. Dhananjay Kopre2, Mr. Saurabh Kalkar3, Ms. Dipali Kambe4 (2017) [4] have investigated on to fabricate a hydraulic operated jack for the purpose of pipe bending and bend removing machine. The authors proposed to remove the bends from pipe or rod to be supported between the die holders and jack is actuated on pipe. It exerts force on the pipe and the bends to a suitable angle depending on the dies used. The application this bending machine is used in workshop, in small scale industries and automobile industry. This hydraulic pipe bending machine is used for bending and also bend is removed. This machine have the application to use in workshop, small scale industries and automobile industries.

work carried out by Ankit Vyas1, Chandra Kant Tiwari2, Arnav Tulsian3, Ankit Patel4, Kiran Wangikar5, Prashant Anerao6 (2016) [9] shows that the designed a hydraulic pipe bending machine which used at construction sites as well as

small scale industries with less cost compared to the existing bending machine. In this project the authors focused on the concept of press bending is used to perform the operation in the required pressing force is applied with the help of single acting hydraulic jack. The bender can bend a round pipe of outer diameter range of ½ inch to 3 inches, with maximum thickness 3mm and radius of curvature up to 325mm it have 900 maximum bend angle. The reduction in weight of frame for topological optimization due to various technics developed for analysis and optimization. The proposed design process successfully integrates machining cost into a structural shape.

Gaurav Suresh Kanhe1 Dr. C. N. Sakhale2(2017) [2] have investigate bending machine which is capable of bending 5mm thick stainless steel sheets of 8 ft. wide and 4 ft. length in size. The CAD model of the machine is develop and optimization of the machine is done using FEM. In this paper the authors focused to reduce weight and manufacturing cost of the machine.

Akbar H Khan1, Pravin K Ghule2, Ranjit P Shingare3 (2017) [3] conducted study on the design and development of manually operated pipe bending machine which is useful to bend a pipes of different thickness in workshops as well as in engineering works. The capacity of the machine can bend 1-10 mm thickness of pipes and operated by one operator and portable.

Deepak Annasaheb More1 N.k. Chhapkhane2, Ravindra Kolhe3 (2015) [10] conducted study on press frame, cylinder and press frame, cylinder and press table are designed and analyzed to improve their performance and quality for press working operation. As a result the hydraulic press components can affect reduction in the cost by optimizing the weight of material utilized for building the structure. This paper the authors consider an industrial application project consisting of mass minimization of H frame type hydraulic press. In this project FEM is used for analysis and optimization of hydraulic press. The model analysis is done at a minimum cost of material and analysis time.

Work carried out by Parthinban1, P.Eazhumali2, S.Karthi3, P.Kalimuthu3 (2014) [9] the frame and cylinder are modeled by using modeling software CATIA. Structural analysis is done on C frame hydraulic press by ANSYS software. According to the structural values the dimension of the frame and cylinder are modified to perform the functions. As a result the size and of the machine is reduced.

Ankit H Parmar1, Kinnarraj P Zala2, Ankit R Patel3 (2014) [12] conducted a study on Structural optimization have gained the importance for industrial applications. The result of innovative designs, reduced weight and cost effective products. The model is built by CREO and analysis is done by ANSYS. The analysis and design is done on top plate, movable plate and column. After optimization the weight of the machine is reduce that 2263 KG to 1303 KG as a result the cost of the machine also reduced.

3.1 Identified the gap in the literature

- In All hydraulic machine the hydraulic piston reaction force is lost to the ground without any function.
- The support frame of hydraulic cylinder is designed for the purpose of resisting and loosing hydraulic reaction force. The size and weight of support increase the cost and weight of the machine.
- The hydraulic action and reaction force are not maximized for increasing bending load.
- For bending plate requires two and more than two hydraulic cylinder to handle the whole operation it increases the cost of the machine it makes the hydraulic bending machine have high unit weight that increases the cost of the machine.
- In this project by developing innovative mechanism to solving those big problems. As a result the cost, weight, operation and maintenance time of the machine is reduced. Then the machine become light weight low cost multi-operation and high competitive marketable machine.

4. METHODOLOGY

This innovative project is smart after completed the design and fabrication of the machine, but now it is very challenge full because it needs gather information from internet, manufacturing sectors and bending machine users. The methodology flow diagram of this research project is shown below.

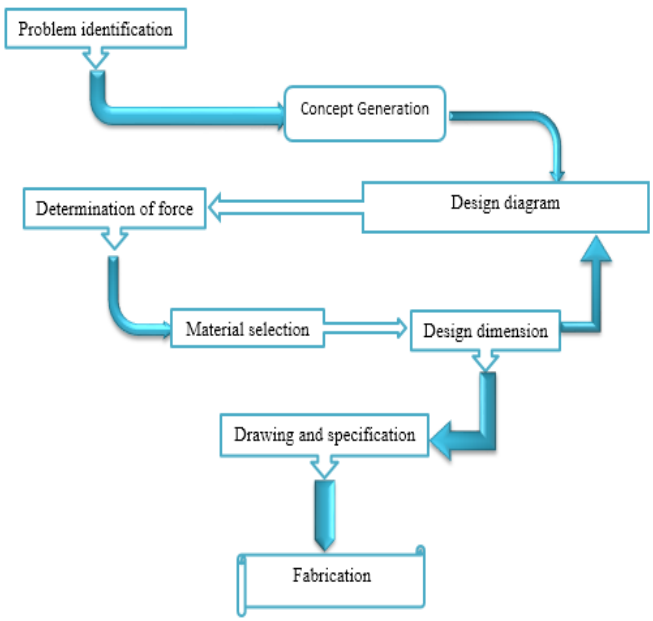


Figure -4: Methodology flow diagram

4.1 Problem Identification

The main problem identified in this project is loss of cylinder force and failure of cylinder support due to cylinder force.

4.2 Concept of the work

The core concept of this project is focus on hydraulic cylinder and piston forces due to fluid pressure by Appling the Pascal principle that states in closed system the oil pressure is the same in all direction therefore the pressure on the cylinder base plate and on piston head are equal because the area of piston head and cylinder base plate are equal. As we know the force is the product of pressure and area covered by pressure, the direction of force develop on the cylinder base plate is in reverse and the force developed on the piston head is in forward direction. The force piston exert on the right side lever and the cylinder force is exerted on the left side lever.

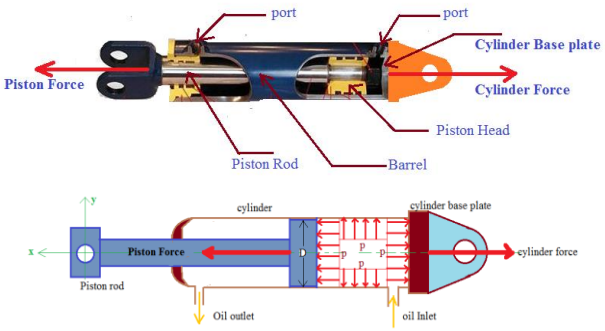


Figure -5: Cylinder Free Body Diagram

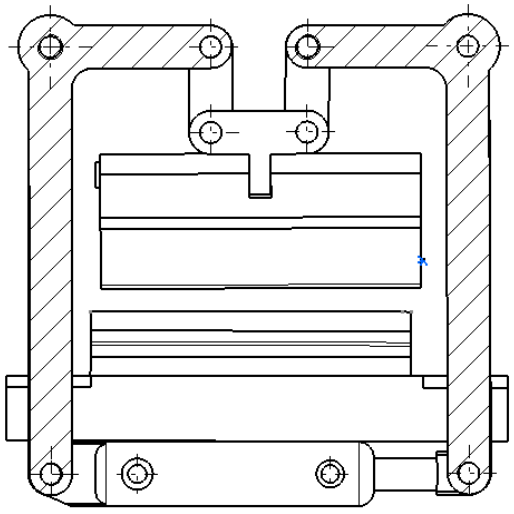


Figure -6: Layout of the Mechanism of the Machine

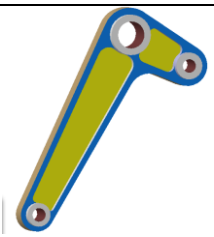
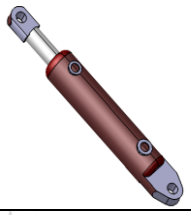
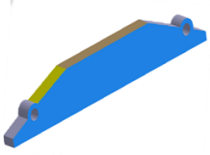
As shown in the above figure equal amount of load is developed in cylinder end and piston end but, opposite in direction. Those equal and opposite forces are handled by means of lever by its nature it have mechanical advantage. It depends on effort arm and load arm ratio it can multiply the load. In addition to this it can convert the direction of force from horizontal to vertical down ward force because it is right angle lever.

4.3 Design diagram of machine components

After the concept generation diagram, shape and nature of element is shown in simplified form. The force applied on the each element is assumed to be either distributed or concentrated according to fundamental law. the critical components of this machine is one double acting hydraulic cylinder, four right angle lever, two links upper beam, lower beam, bed, frame, punch and die.

the critical components of this machine is lever, link, upper beam, lower beam, bed and frame all those components are determined their nature shape function type of load they carry are specified and determined in bellow table.

Table -1: critical components of the machine

Sr. No	Item Name	Model	Function
1	lever		convert horizontal direction force into vertical down force and used to maximize the input force
2	link		Used to connect the liver load arm point and upper beam.
3	cylinder		Hydraulic cylinder gives input horizontal force for deriving the whole operation of the machine
4	upper beam		The upper beam have a trapezoidal shape it carry's uniformly distributed bending force

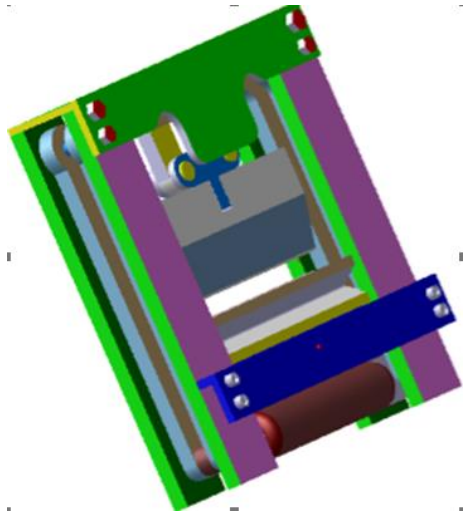


Figure -7: premilary model of machine assembly

4.4 Force Determination

The amount of force acting on the element is determined this helping in recognizing the element. Force analysis is done considering by statistical equilibrium. For determining the force exerted on each element first determine the maximum bending force the following equation [20].

$$F = \frac{K_{bf} * UTS * L * t^2}{W} \quad (1)$$

Where

F = bending force (N)
UTS = ultimate tensile strength of sheet (Mpa)
L = part length in the direction of bend axis (mm)
t = stock thickness (mm)
W = die opening dimension
K_{bf} = bending factor,
K_{bf} = 1.33 for V – bending,
K_{bf} = 0.33 for edge bending

4.5 Material Selection

In this phase appropriate material is selected for recognized element and either factor of safety or allowable stress. Material selection is the heart of this project consider the following criteria for selecting proper material.

- Material property ductile, brittle tough etc.
- manufacturability of material
- Environmental effect corrosion, temperature etc.
- material cost
- weight of material

4.6 Dimension analysis

In this phase by using relevant formula of strength of materials the dimension of the recognized element are determined. In this phase the dimension of element is determined by static analysis and by FEM analysis using ANSYS software.

4.7 Drawing and specification

The manufacturing drawing of machine element is prepared, showing its dimensions and manufacturing specification, such as accuracy, surface finish and other conditions relating to its manufacture by CATIA V5 Software.

5. CONCLUSION

In this machine the whole operation is controlled by single hydraulic cylinder then the machine become simple in feature and operation as well as low in cost and light in weight machine. Hydraulic cylinder backward force is handled for the purpose of bending. The piston forward and cylinder backward force are multiplied by the mechanical advantage of right angle lever.

ACKNOWLEDGEMENT

I would like to thank my thesis advisor Assistant professor Ajay Jaswal for him helpful suggestion, words of encouragement and understand though out my research.

REFERENCES

[1] BLDEA'S Dr. P. G., "Design and Analysis of Hydraulic Operated Press Brake", Journal of Mechanical and Mechanics Engineering, Volume 1, Issue 2, Publications 2015

[2] Gaurav Suresh Kanhe[1], Dr. C. N. Sakhale[2] "Design and analysis of sheet bending machine" IJSRD – International Journal for scientific Research and development - Issue 02, 2017

[3] Akbar H Khan[1], Pravin K Ghule[2], Ranjit P Shingare[3], "Design and development and experimental study of pipe bending machine", Journal of Industrial Engineering and its Application, volume 2, Issue 1, Publications 2017

[4] Mr. Harshad Khairkar[1], Mr. Dhananjay Kopre[2], Mr. Saurabh Kalkar[3], Ms. Dipali Kambe[4], Prof. Sarang Gulhane[5], "Fabrication of automatic hydraulic bending and bend removing machine", International Research Journal of Engineering and Technology, issue 02/ Feb/ 2017

[5] Bhutan V.Golechha[1], P.S. Kulkarni[2], "Design, analysis and optimization of 10 ton pneumatic press machine", International Journal of Advanced Research in science, Engineering and Technology Vol. 4, Issue 3, March 2017

[6] R. Sanjay[1], S. Sreyas Anand[2], Tamilselvan Senthilkumar[3], G. Vignesh[4] M. Sathish Kumar[5], "Design and fabrication of hydraulic pipe bending machine", International conference on recent advancements in mechanical Engineering, Issue March 2017

[7] Vaibhav Bankar[1], Akash Gurve[2], "Design, analysis and optimization of plate bending machine", International Journal for Scientific Research and Development, Issue 05, 2016

[8] Akash Gurve[1], Vaibhav Bankar[2], "A review on design, analysis and optimization of plate bending machine", International Journal of Engineering Research and General Science Issue 2, March- April, 2016

[9] Ankit Vyas[1], Chandra Kant Tiwari[2], Arnav Tulsian[3], Ankit Patel4, Kiran Wangikar5, Prashant Anerao6, "Design and development of hydraulic pipe bending machine", International journal of Research in Advent Technology Issue, 19 March 2016

[10] Deepak Annasaheb More[1] N.k. Chhapkhane[2], Ravindra Kolhe[3], "Design development and optimization of hydraulic press", International journal for Research in APPLIED Science and Engineering Technology, Issue vol., June 2015

[11] Parthinban[1], P.Eazhumali[2], S.Karthi[3], P.Kalimuthu[4], "Design and analysis of C type hydraulic press structure and cylinder", International journal of Research in Aeronautical and Mechanical Engineering, Issue, March 2014

[12] Ankit H Parmar[1], Kinnarraj P Zala[2], Ankit R Patel[3], "Design and modification of foremost element of hydraulic press machine" International Journal of Advanced Scientific and Technical Research, Issue 4 Volume 3, May/June 2014

[13] Sana Khana[1], K. I. Ahmad[2], "A Review of literature on design of horizontal press machine", International journal for scientific research and development, vol. 4, Issue 09, 2016

[14] Manar Abd Eltantawie[1]*, "Design, Manufacturing and Simulate a hydraulic bending press", International Journal of Mechanical Engineering and Robotics Research, vol. 2, No. 1, January 2013.

[15] Gwangwava N[1]*, Mugwagwa L[1] and Ngoma S[1], "Design of a dual Operating Mode Sheet Folding Machine", International Journal of Mechanical Engineering and Robotics Research, vol. 2, No. 4, October 20

[16] Pedro G. Coelho, Luis O. Faria, Joao B. Cardoso, "Structural Analysis and Optimization of Press Brake", science direct, publication 2005.

[17] Mr. M.M. Dange, Prof. R. Zaveri, Prof. S.D. Khamanrar, "Stress Analysis of Bell Crank Lever", International Journal on Recent Innovation Trends and Communication, p Xiobing Dangand Ruxu Du Hai He and Wedli. "A New Method for Incremental Sheet Metal Bending Based on Minimum Energy Principle" IEEE, publication2016ublication 2014

[18] Xiobing Dangand Ruxu Du Hai He and Wedli. "A New Method for Incremental Sheet Metal Bending Based on Minimum Energy Principle" IEEE, publication2016

[19] Yang sia, qiu lii Jun, "Hydraulic Sheet Metal Bending Machine Hydraulic Servo Valve Synchronization System", science direct, publication 2011

[20] Usual Alua, Satyyandra K. Gupta, "automated design of sheet metal punches for bending multiple parts in a single setup" science direct publication 2001

[21] J.R. Duflou. R.Aeres, "Force Reduction in Bending of Thick Steel Plates by Localized Preheating", science direct publication 2006.

[22] Gwangwava N, Mppofo K. Tlale N. And Yu Oy, "Concept Development for Reconfigurable Bending Press Tools" science direct publication 2013

[23] Mechanics of material by Ferdinand P. Beer, E. Russel- Johnston.Jr, John T. Dewolf, David F. Mazurek

[24] Shigley's mechanical engineering design by Richard G. Budynas And J. Nieth Nisbelt

BIOGRAPHY:

Gebremichael Tasew earned his BSc. degree in 2015 at Aksum University, Ethiopia in Mechanical Engineering Department currently he attending his master's degree in Machine Design Engineering at Parul University, India and his main field of interest are machine development.