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Combine Vertical Pipe Bending and Rolling Machine

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***Abstract*—The study represents combination of pipe bending- rolling machine assembled vertical and which works on less supply of the input power. The both operations can be done on the same machine. The defects occurred are tedious to eliminate. The main objective behind this machine was to lower the space utilized by the machine and initial cost of it too.**

***Index Terms*—** Forming, Bending- Rolling, Bending

I. INTRODUCTION

The term where we change the angle and permanently deform the pipe is said to be pipe bending. Bending and rolling is a process where curvature or radius is given to a material. Various circumstances are necessary to understand and do the operations with respect to many tools. This process gives us various curves, structural elements. It has two types a) form bound b) free bound.[1,2]. Free form bending processes are used for complex bending geometries. This geometrical process reduces the time required for runs and gives maximum flexibility in addition to reduce costs. In the type of three roll push bending 3 free form geometries are present [3]. In the process the work piece is clamped in pipe bender in two dies which are clamping block & forming die. Wiper die & pressure die also give support. Wiper die consists of softer alloy material, whereas other dies and tools are made of steel type hardened & tooled. Pressure and wiping die is of Al or alloy (bronze) to prevent changing shape of work piece. Mechanical force shapes the pipe. Though the machine is of any type like manual, hydraulic, electric, pneumatic the force required is mechanical force though the provider may be fluid or pressure air [4]. Many other methods like heating pipe to its plastic temperature and then working on it are introduced too. But it too has some of its disadvantages and arises problems too. Machines which bend the pipe have changed over time and also developed much. Here mechanical force is which depends upon energy, skill and work. But then too it fails in periods of accuracy and uniformity. Defects like wrinkling, uneven bends, scratches, cracking, bending and change in cross section get formed [5]. This need to use of automated machines which are bulky in structure require large power source and also are costly is formed. Wrinkling has main effect in thin- walled parts. Also it is responsible for aging of tools. Boundary conditions form a major part here. It is a challenge to state confirmatively this changing occurrences due to wrinkling [6]. It is not easy to fabricate curved tubes and it is needed to make running costs cheaper in proportion to work rated and reliability should be improved [7]. Increasing bent parts have attracted applications such as engineering, research, and aero plane industry, ship industry, and vehicle industry, hospital industry as they satisfy needs of products by their light weight, high strength and high performance in all aspects [8].

II. LITERATURE REVIEW

Prashant P. Khandare et al [1] stated the study in "Study of Portable 3 Roller Pipe Bending Machine" about the work of designing a machine to work & bend a pipe. A process of bending a metal which can be a sheet metal, tubes, square hollow, rod, and iron angle. Each different metal has its own thickness. To design the machine for bending designer will study many aspects and using them he can make the machine. The aspects can include roller sizes, drives, and dimensions etc. V. Senthil Raja et al [2] in "A New Model in Design and Manufacturing of Mobile Hydraulic Pipe Bending Machine in Industry" Described

the complete forecast and essential control of many lack of success and unreliability in bend of pipe material. Peter H. Vatter et al [3] stated in "Process model for the design of bent 3-dimensional free-form geometries for the three-roll-push-bending process" that complex shaped tubes are required in various fields of application as in the automotive industry or in modern architecture and design. For the transport of media or as structural components these parts can be used. The use of Free-form geometries give a good freedom in the construction and also help to reduce cycle run of production. Akbar H. Khan et al [4] described in "Design Development and Experimental Study of Pipe Bending Machine" about the design of the machine for the bending purpose which is man-operated with use of dies, gears and support frame. The main aim to achieve here was to boost up accuracy thereby also lower the cost of production. This machine is capable bend about 01-10 mm thick pipes and also simple kinematic system is implemented rather than complicated design. Here, we also studied this machine experimentally present in different workshops. Readings were also taken at different degrees of bending. This also gives golden chance of reduction of capital investment on machine and reduce human efforts. Basil E. Okafor et al [5] in "Development of a Motorized Pipe Bending Machine" told us about the machine used by workers at small construction sites which is man-power operated and is also progressed. Smooth operations are ensured for the bend processes where the cross-section of the pipe is bent to the required angler. The drive of 2 Horse Power motor is given attached to gearbox for speed reduction & the force required to bend is provided Nan Liu et al. [6] wrote in "Modeling of wrinkling in NC bending of thin-walled tubes with large diameters under multi-die constraints using hybrid method" different varieties of imperfections are stated in shape. By giving a geometrical imperfection for the tube mesh, a various finite element models for the basis of numerical controls rotary-draw bending are being initiated. Different modes of bifurcation also carry out the studies numerically. Y. Zhang et al [7] in "Shell element simulation of the push method of tube bending" described the advanced push type bending process for the formation of bent curve shaped tubular structures obtained by using the FEA. Demonstration here says that the results we get when we use shell elements are matched with those obtained earlier using three-dimensional elements. Effect of changes in geometry and on results can be indicated by a research which is carried here. YANG He et al [8] wrote in "Advances and Trends on Tube Bending Forming Technologies" that by analyzing the characteristics of bending and various flaws, the new advances on analyze the normal problems in the bent tubular structures saying wrinkling phenomena at the wall thinning. spring back phenomena optimization. He also gone through some newly originated techniques of bending irrespective of their profits and losses. Zhgniew Pater et al [9] at "FEM Simulation Of The Tube Rolling process in Diescher's mill" described the matter of the numerical modeling of the process of piercing in a two rolled sketch rolling mill, comprising of assembled devices called guides of Diescher's type. Then after a little statement of geometry model developed of the processes was discussed, where kinematics of tool moments and thermal phenomena present in metal during forming was observed. Also to result of calculation were presented in the field of strength, damage criteria and temperature. Distributions of force parameters acting on particular tools during the processes of bush rolling were also described.

III. EXPERIMENTAL SETUP

The structure of the entire machine is built on the mild steel square bars of dimension 1*1. It has rigid structure and capability to hold the weight of the entire housing which is approximately up to 25-30kgs of entire setup. The length of the machine is 2 feet. Its height is 2 feet and the breadth is of 1.5 feet. The motor is assembled at a height of 1.5 feet from the bottom structure of the machine. This is done too balance the entire weight and also reduce the chain length and give efficient transmission. The bottom fixed rollers are prepared on the CNC machine for greater

accuracy whereas the above movable roller is prepared on Lathe machine. The entire machine has simple design, is cost effective and does not require any skilled laborers. The structure is also rigid in nature. The maintenance cost is also low. Frequent maintenance consists of motor. Time to time maintenance comprises of oiling regularly to chain drive and lead screw. Cleaning of machine. Cooling of rollers and cleaning them properly. Proper maintenance of battery is also the essential factor here. Checking the battery fluid and replacing it if necessary forms a part of the battery maintenance.

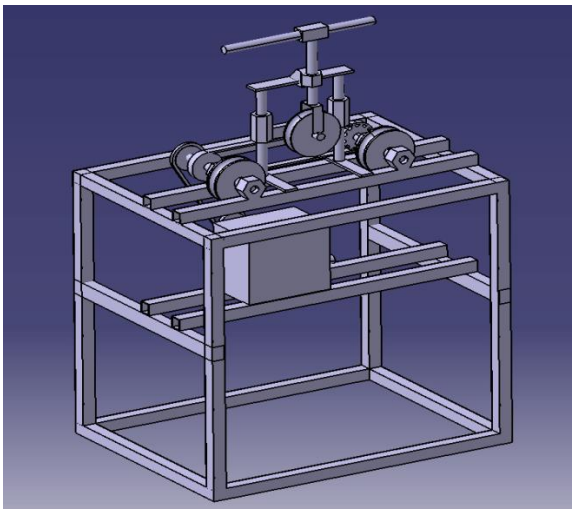

Figure 1: Fabricated structure CAD Model of the Machine

IV. Finite Element Analysis

There are three steps included in finite element analysis of any of the material in ANSYS. These steps remain common in any of the present FEA software. They can be classified in three steps:-

1. Problem definition by Finite element model
2. Solving it and finding its Solution
3. And Interpretation of results

The first step also known as pre-processing includes formation of the model which is to be solved using FEM. It is a physical problem too. It includes various steps like designing the model, meshing or discretization, Element selection, Geometrical characteristics, Material selection, constrains, loads and analysis types.

The second step also known as processing can be characterized into two general direct types viz.

- Force method
- Displacement method

The third step post processing evaluates the results of the solution. They also do sorting, printing & plotting of the results. They also include various operations for interpretation of results.

FEA is done to predict the way of any designed product how will it react to various factors including heat, vibration, physics, stresses and loads.

The finite element analysis has been carried out to find out the stresses and deformation acting on frame of the machine and its rollers.

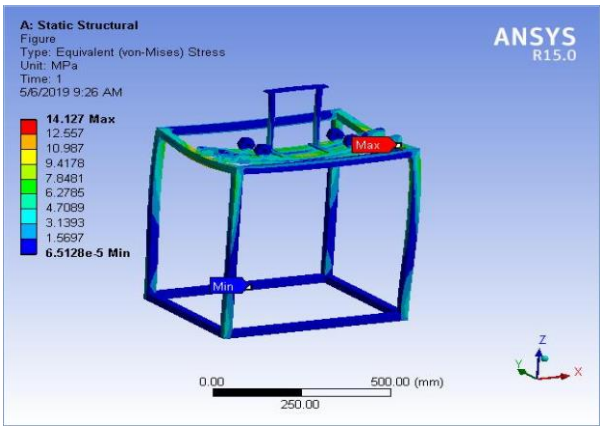

Figure 2: Equivalent stresses acting on frame

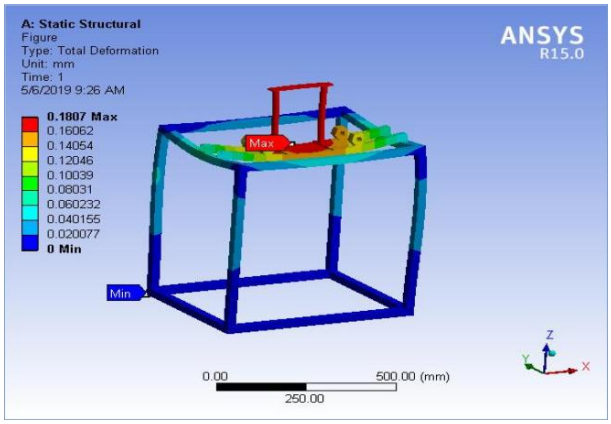

Figure 3: Total deformation in frame

TABLE 1

STRESS AND DEFORMATION ON FRAME

Range	Equivalent Stress	Total Deformation
Minimum	6.5128e-005 MPa	0. mm
Maximum	14.127 MPa	0.1807 mm

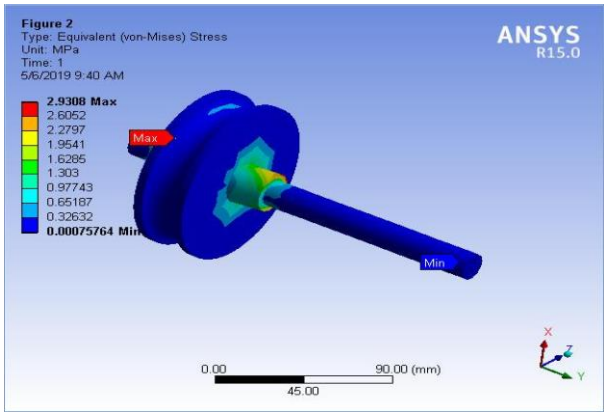

Figure 4: Equivalent stresses acting in rollers

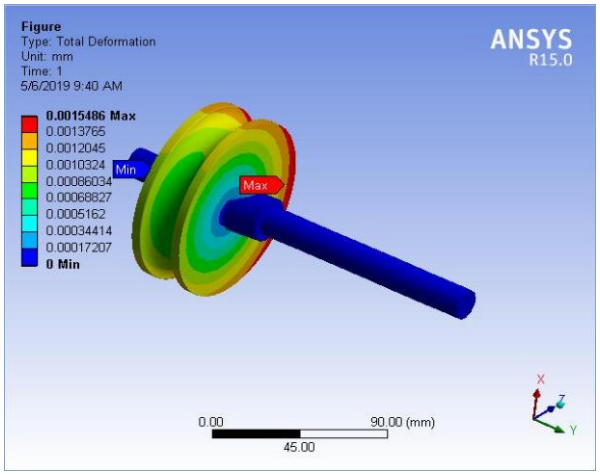

Figure 5: Total Deformation in rollers

TABLE 2

STRESS AND DEFORMATION ON ROLLER

Range	Equivalent Stress	Total Deformation
Minimum	7.5764e-004 MPa	0. mm
Maximum	2.9308 MPa	1.5486e-003 mm

IV. COMPONENT DESIGN

A. *Selection of Pipe*

In industry 1/2", 3/4" and 1" pipes are commonly used. For our project we selected 19mm (3/4") diameter pipe as it would be economical.

Pipe specifications:-

O.D (Dp) = 19mm I.D (dp) = 17mm

Pipe material

Cold rolled M.S. Sut = 350 Mpa, Syt = 195Mpa

B. *Design of rollers*

Material = HS

Roller diameter = 95mm

C. *Bending force and torque*

Stress required to bend pipe (σb) = Syt = 195Mpa

Force required to bend = 5667 N

Torque to bend = 296.1657 Nm

D. *Motor specifications*

Motor type = Wiper Motor

Make = Lucas TVS

Specifications = 14W – 12V

Part number = 26071126

Supply = Battery operated

E. *Power Supply*

Rechargeable battery supply

Specifications:- 12V 7.5 Ah

Make:- FUZION

Supply:- Single phase current supply

F. *Design of chain drive*

Motor speed shaft (N') = 30 rpm

Output shaft speed (N)= 12 rpm

Chain type = Industrial – Heavy duty – Medium size chain.

G. *Design of Gearbox*

Type = Worm drive

Make = Greaves Cotton

Dimensions = d1 = 33 mm

da1 = 39mm

γ = 10.30°

df1 = 26.1 mm

Pitch = 9.424 mm

Dimensions of worm wheel d2= 93mm

Da2 = 98.8 mm

Df2 = 85.81 mm

H. *Design of lead screw*

Material = Grey C.I (FG200)

F.O.S = 3

Nominal diameter (d1) = 20mm

Pitch (p) = 3mm
O.D of collar (Do) = 40mm
I.D of collar (Di) = 20mm
Coefficient of friction (μ) = 0.15
Load (W) = 5667 N
Mean diameter (dm) = 18.5 mm
Core diameter (dc) = 17.0 mm
Pitch angle (Φ) = 8.53°
Helix angle (α) = 2.955 °
σc=66.67 N/mm2
T =33.33 Nmm

I. Design of bearing

Bearing number = 6603
Housing diameter (Db) = 35mm
Internal diameter (db) = 17mm
Width of bearing (wb) = 10mm

J. Machine dimensions

Length = 61cm = 2 feet
Height = 61 cm = 2 feet
Width = 48 cm = 1.5 feet

V. RESULTS

1. The objective of performing bending and rolling operations on same machine is achieved effectively.
2. The cost of the machine and space is also reduced which was the main aim after design of the machine
3. Use of skilled laborers is also eliminated as the operation is easy and can be done by any of workmen.
4. Safety is also not compromised in view of above aspects.
5. The experimental run carried out on machine showed that all the factors which were needed were achieved and met. Accuracies and approximations were also judged and met.

VI. FUTURE SCOPE

Future scope is to make this machine automatic using micro controller or arduino circuit. Hydraulic advancing mechanism employment to make easy operation can also be done. Using different diameter dies we can bend different diameter pipes. Using limit switch system we can preset bending angles.

VII. CONCLUSION

The project thereby was completed successfully. After experimentation and running trials on the machine we can conclude the fabricated machine can perform both operations depending upon need one by one. Machine uses battery operated power source which can be charged by single power source which hence reduced the cost of the machine. The machine is designed to work on the pipe of 19mm diameter. The pipe we worked on was of Mild Steel material. Thereby we can also say that the machine is capable to work on materials softer than Mild Steel too.

VIII. REFERENCE

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