Three Roller Rolling Machine

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Abstract— My project is to design and fabrication of three roller rolling machine. This machine is converted the straight sheetmetal convert into curvature just like cylindrical and conical shape. The size of three roller rolling machine is more convenient. Rolling machine is fully fabricated by steel. For designing a three roller bending machine, it is required to calculate the exact force for bending. Based on this force, the machine parameters and motor power are decided. Various factors that should be considered while calculating this force are material properties, width, and thickness, number of passes, bending radius, force developing mechanism and link.
Key words: Bending Machine, Working Principle and Process, Stress, Force

I. Introduction

Roller rolling process can be used to deform a sheet or plate to hollow shapes of constant (i.e. cylindrical, elliptical) or varying cross sections like cone frustum. Cylindrical and conical shells are the basic components used for the various engineering applications like cylindrical tanks, boiler chambers, heat exchanger shells, pressure vessels, tunnels, etc.

II. General design principal

Following basic shearing operation on a sheet metal, components can be rolled to give it a definite shape. Bending of parts depends upon material properties at the location of the bend. To achieve bending, the work material must be subjected to two major forces; frictional force which causes a no- slip action when metal and roller came in contact and a bending force acting against the forward speed and the torque applied to move the material.

A. *Features:*

- Low initial cost
- Low tooling cost
- Easy & Quick setting
- repetition & bending
- User friendly
- Easy maintenance

B. *Objectives of the work:*

The following are the objectives of the work:
- To make a bending machine to bend metal sheets up to 10-12 mm.
- To make on simple working principle.
- To reduce the time for operation.
- To make in minimum cost.
- Easily operating

C. *Applications:*

- Fabricating/Rolling
- Boilers, Pressure Vessels
- Storage Tanks, Silos

III. Literature review

A. *Himanshu:*

Himanshu has done bendability analysis for bending of steel plates on heavy duty 3-roller bending-chine. In this experiment they found out the equivalent thickness, equivalent width and maximum width analytically &based on power law material model.

B. *Ahmed Ktari:*

Have done Modeling and computation of the three-roller bending process of steel sheets. This experiment consists of two-dimensional finite element model of this process was built under the Abaqus /Explicit environment based on the solution of several key techniques, such as contact boundary condition treatment, material property definition, meshing technique, and so on.

C. *Jong GyeShin:*

Has done the experiment on Mechanics-Based Determination of the Center Roller Displacement in Three-Roll Bending for Smoothly Curved Rectangular Plates. The objective of this paper is to develop a logical procedure to determine the center roller displacement, in the three-roll bending process, which is required in the fabrication of curved rectangular plates with a desired curvature.

D. *M K Chudasama:*

Have done the experiment on Analytical Model for Prediction of Force during 3-Roller Multi-pass Conical Bending. In this paper, the total deflection of the top roller required is divided in steps to get the multi pass bending.

M. B. Bassett and W. Johnson: The bending of plate using a three roll pyramid type plate bending machine, J. strain Analysis Process manual, maintenance manual, machine capacity chart and technical specification of rolling-machine.

IV. METHODOLOGY

A. *Machine specification:-*

1) Total Machine Length – 6000 mm.
2) Roller Length – 3750 mm.
3) Sheet Bending capacity – 2 mm to 10 mm.
4) Machine Structure Height – 382mm.
5) Machine Width Top & Bottom – 1030 & 1670 mm.
6) Pedestal Size – S 517.
7) Gear Motor rating – 5 HP, 50 Hz, 230 VAC.
8) Gear Size -40/1

B. *Parts of Bending / Rolling Machine:-*

1) Available item: -

Different size Gear(Fabricated gear), Speed Reduction Gear Box, Electric Motor, Coupling, power pack, Hydraulic cylinder

2) Fabricated item: -

Mild Steel I Beam, Pedestal Bearing, Roller

C. *Rolling Sequence Process:-*

A rolling sequence involves rolling material backwards and forwards to achieve a desired shape.

D. *Steps*

Note: The pressure is increased in the top roll.

1) Pre-set the ends to the desired radius. This can be done by pressing, shaping, crimping or using initial pinch rolls.

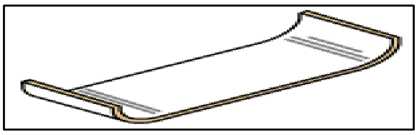

Fig. 3.17: pre-set of sheet

2) Apply slight pressure so that the rollers grip the plate. Align the plate square to the rolls at 90 degrees using a plate square.

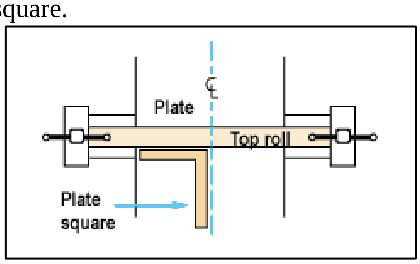

Fig.3.18 Arrangement of sheet into the rolling

3) Apply slightly more pressure by adjusting the rolls.

Roll the plate through to the preset end.

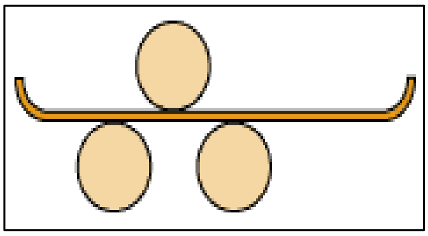

Fig. 3.19: Movement of sheet into the rolling

4) Increase tension as you complete each roll.
5) Continually check that:

– the rolls remain parallel
– the plate is (and remains) square in the rolls
– The curvature and circularity are constant.

Repeat sequence until desired curvature is reached. Using a standard pyramid roll

V. CALCULATION & RESULTS DISCUSSIONS

Calculations of Gear Drive Power Transmission System for rolling machine

FOR DRIVE 1 :-

A. *Pd1 = Pr x K1*

Power supply P=746 w
there are 5% power losses
HP(Horse Power)= 5HP
N(RPM of electric motor)= 960RPM
Pd = Design power
(Pd)Power input=746x5x0.95=3543.5w

Where,

Pr = Rated power
[load factor K1 = 1.25for medium shocks]
=3543.5x1.25
Pd1 = 4429.3 W

B. *Torque of moter*

P= 2x3.14xNT /60
= (4429.3x60)/(2x3.14x960)
= 44.059KNM
= 44059.9 NM

C. *Power transmitted from electric motor pully to reduction gear box pully*

D1/D2 = N2/N1

D1= Dia. of electric motor pully =150mm
D2 = Dia. of reduction gear box pulley=225mm
N1= RPM of electric motor pulley =960RPM
N2= RPM of reduction gear box pulley =
(150/225)= (N2/960)
N2= 640RPM

Inlet rpm into reduction gear box(U400) or gear ratio are 40:1

So inlet rpm is 640rpm and outlet rpm with (40:1) gear ratio

40:1= 640:N3

N3= 16RPM
T3/T4 = N4/N3
Where T3= 20 (No. of teeth)
T4 =57 (No. of teeth)
N4 = ?
N3 = 16 RPM

N4= 5.6 RPM =6 RPM
And so on N5= 16 RPM T5 = 20 (No. of teeth)
N6 = 6 RPM T6 = 57 (No. of teeth)
N7 = 16 RPM T7 = 20 (No. of teeth)

D. Force calculation:-

Pitch circle dia.= 168mm or 478mm pitch circle radius= 84mm or 239mm = .084m or .239m
Motor force= torque / pitch circle radius (Distance)
so torque on teeth no. 57 then rev. 6 RPM =70123.5N
Torque on teeth no. 20 then rev. 16 RPM
Fm1 = 44059.9 / .084
Fm1 = 524522.6 N
Fm2 = 44059.9 / .239
Fm2 = 184351N

1) Compressive force

Fm1 = 524522.6 N Fm2 =184351N
Pressure angle= 20’ Pressure angle= 20’
Fc1 = Fm1xsin20’ Fc2 = Fm2xsin20’
Fc1 = 524522.6xsin20’ Fc2 = 184351xsin20’
= 179397.2N = 63051.7N

2) Tangential force

Fm1 = 524522.6 N Fm2 =184351N
Pressure angle= 20’ Pressure angle= 20’
Ft1 = Fm1xcos20’ Ft2 = Fm2xcos20’
Ft1 = 524522.6xcos20’ Ft2 = 184351xcos20’
= 492890.0N = 173233.2N.

VI. Design for 3 Roller Sheet Bending Machine

Calculation of load & stress acting on the sheet

W = 4EI/ RL

Where, E = Modulus of elasticity of compression
I = Moment of inertia of sheet.
R = Radius of curvature
L = Length of sheet
FOR MILD STEEL

A. t1=5mm

b =1000 mm
L =6300mm

1) W1 = 4EI / RL

E= 196x10^3 MPa or N/mm^2
I = BH^3/12
R = Radius of curvature =120mm
L = Length of sheet.n

$$W1 = \frac{4x196x1000x1000x5x5x5}{120x6300x12}$$

W1 = 10802.46N

2) Bending stress.

$$\sigma b1 = \frac{MY}{I}$$

M = Bending moment
Y = Perpendicular distance of the neutral cassis

$$\sigma b1 = \frac{10802.46X500X2.5X12}{1000X5X5X5}$$

σb1 = 1296.29 N/mm2

B. for t2 = 10mm

b =1000 mm
L=6300mm

1) W2 = 4EI / RL

E=196x10^3 MPa or Nmm^2
I= BH^3/12
R = Radius of curvature =120mm
L = Length of sheet.n

$$W2 = \frac{4X196X1000X1000X10x10x10}{120X6300X12}$$

W2 = 86419.75 N

2) Bending shress.

$$\sigma b2 = \frac{MY}{I}$$

$$\sigma b2 = \frac{86419.75X500X5X12}{1000X10x10x10}$$

σb2 = 2592.59 N/mm2

Thickness of sheet used practically varies from 5mm or 10 mm. The experimental performed on sheet having dimensions (1000 x 6300) mm. The power gained by upper roller through different gear drive system and this load is applied on the sheet. A sheet passes through between the upper and lower roller the sheet goes bend. This process is continuing till the required result is obtained. The stress induced on the sheet is calculated by the analytically as well as virtually using analysis software.

VII. Conclusion

As compare to the manually operated sheet bending machine the power operated sheet bending machine is better. The productivity of power operated sheet bending machine is higher. The part of machine is able to handle the heavy load on machine. The time required to complete bending operation is less and the requirement of extra worker’s reduced. Power operated sheet bending is less time consuming process with high productivity.

After performing actual experiment force calculation and fem analysis on metal sheet at different materials, we conclude that the force which required for bending the sheet is found by virtually it is tested in terms of factor of safety as well as material safety while bending operation. On the basis of the results and its analysis, following conclusion can be drawn. From the result’s analysis for constant radius of curvature (R) ,constant dimensions by changing the material, load(W) increases as the value of modulus of elasticity(E) increases ie Load is directly proportional to the modulus of elasticity. From the result’s analysis and calculations we can conclude that for same material keeping dimensions constant change in radius of curvature(R) changes the value of load(W) .As radius of curvature(R) increases the load(W) value also increases. From the result’s analysis and calculations , for same radius of curvature (R) and material if thickness varies from 5 mm to 25 mm ,it directly affects the value of load(W) i.e. Load increases as the thickness changes in increasing order. Required surface finish of cylinder or any circular product is directly affected by skilled labour as they lowered the top roller with the help of power screw in some extent.

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