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DESIGN & ANALYSIS OF MOTOR OPERATED SECTION ROLLINGMACHINE

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Abstract – *metal forming is manufacturing process in which a raw material is convert into a product by applying tension, compression & shear stresses. Roller bending is a continuous bending operation in which a long strip of metal is passed through rollers till the desired radius of curvature is achieved. Roller bending process used for producing larger parts of cylindrical or conical shapes in large amount. Roller bending still depends upon the experience & skills. Trial & Error is a common method in industry. Rolling process always starts with critical operation of pre bending both ends of material. Process eliminates flat spot while rolling a full cylindrical cross section & gives better closure.*

1. INTRODUCTION

Roller bending process can be used to deform a channel angles, sections, flat plates, cylindrical, elliptical or cone frustum. Cylindrical & conical shells are commonly used in different engineering applications for example boiler chambers, cylindrical tanks, pressure vessels, tunnels. The materials used are alloys of steels, Aluminum & titanium, carbon. Rolling machines are available with three & four rollers for production of cylinders with various radius of curvatures. Generally rolling process is done by using 'pyramid type' rollers i.e. three rollers. 1.Positioning the blank section.2. Lower the center roller. 3. Feed the section. 1st step – a straight section is fed between rollers until section is properly positioned. 2nd step – centre roller moves downward with particular load causes bending of section. 3rd step – two side rollers starts rotating so, that section bents continuously. The rolling process always starts with critical pre bending both ends of the sections. Flat dpots get eliminated when rolling. Roller bending process depends on the experience & skill of operator.

1.1 Literature Survey:

- M. Hua et al [2] discussed design consideration, working principle & bending mechanisms the four-roller bending machine. Generally used procedure of four roller bending machine is also explained.

- Jong Gye Shin et. al [3] developed 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. To this end, the mechanics of the process was analyzed by both analytical & finite element approaches. Comparisons of the results reveal that a simple analytical procedure, based on the beam theory, yields a reasonably accurate relationship between the centre roller displacement & residual curvature. With further development & refinement, the procedure proposed in this work has great promise for practical application, particularly for the automation of the process.

- P.G. Maher [4] in his M. Tech Thesis studied the manually operated & power operated section bending machine. Experimentations were conducted on section in order to measure actual no. of passes, time required to complete bending process etc. Also, productivity of section bending process is analyzed in depth.

- **Problem Identification:**

Manufacturing converts raw material into useful product. This is power operated machine which requires motor, gear box & gearing arrangement. Power from motor supplied to the gear box. This power gets transmitted to gears & then to the roller. In the process the section is insert in between the lower rollers & upper roller than with the help of leadscrew. when screw moves downward then roller is also moves downward. Now much distance the upper roller should came or the setting of roller is depending upon the thickness & diameter of section which is to be bend in the machine. Once the setting of screw is over, operator start the machine, the section passes towards the other side of the machine. After one pass screw setting is required & next pass is again start. The main causes get a desired curve on a 3-roller section bending machine, force is applied by using a leadscrew which is approximate & depends on experimentation so that it is a trial & error method carried out.

- **Study Objective of Research:**

This research pertains literature review reveals that trial-&-error experience of operator is still a common practice in the industry. Stepwise bending on a roller bending machine is widely used but requires very high amount of manpower, inspecting the sections after each bend. An operator should have knowledge of different machine parameters to obtain cylinders with desired radius of curvature. Overall objective ofthe research work is, 1. Modelling & Simulation of section bending machine. 2. Force Analysis of sections with Different thicknesses & materials.

- **Research Methodology:**

The study of 3 roller section bending machine. Where first identify the mechanical Element &dimension of the machine component. 1. Productivity analysis of power operated section bending machine 2. Modelling of section bending machine. 3. Simulation of section bending machine with different materials. 4. Force analysis of metal section by analytical method. 5. Analysis of sections during bending with help of software.

2. Design & Analysis:

For, Radius of Curvature: 500 mm
Diameter of Roller: 250 mm
Maximum thickness of plate: 16 mm
Centre Distance (AB): 600 mm
Moment of Inertia (I): $238.93*10^3$ mm^4

Camber: -Standard bends, where a member is bent about a principal or geometric axis to form a single-radius curve. The member can be bent about the weak axis, known as bending the easy way, or bent about the strong axis, known as bending the hard way. Hard & easy ways of bending arecalled as camber.
For Plate, By flexural formula, $M / I = \sigma / y = E / R$
Radius @ yield point = 4540.54mm
Deflection in beam, x= 60.01mm
Using deflection of beam with x= 60.01mm
$\therefore$ $x = (WL^3 / 48EI)$, we get
load,W =1.28 MN
Maximum allowance of shaft be
0.1mmNow, Simply Supported Beam
with UDL
$\therefore$ Deflection = $(5/384) * (WL^3 / EI)$
$\therefore$ d= 272.88
mmFrictional
Force,
$F_f = \mu.R_N$, F_f = 0.565 MN
To overcome this frictional force,
a. Power = 6 KW
b. N = 0.694 rev/ min
Flexural Formula, $M / I= \sigma/ y$ M = 450 MN-
mmD = 258.94mm ≈ 260 mm
For Maximum Transverse Loading Condition to resist bending failure of shaft.
Transmission
CalculationsStage 01 •
Power – 6 KW

- Input RPM – 1400 & Output RPM – 175
- Planetary Gear Box with Ring gear fixed
- Gear Ratio – 8 = 1+(ZR/ZS)
- [(SH)p = FOS = 1.535]2 < [(SF)b = 8.394]

Stage 02

- Input RPM – 175
- Output RPM – 21.875≈ 22
- Planetary Gear Box with Ring gear fixed
- Gear Ratio – 8 = 1+(ZR/ZS)

Stage 03

- Input RPM – 22
- Output RPM – 0.687
- Worm & worm gear
- Gear Ratio – 33
- (WT)bend = 3548.37lbf & (WT)wear = 2228.85lbf

- **Bearing:**

For the bending stress material chosen will be ASTM as 36 ductile iron Grade 100-70-03 quenched & tempered.

A] Bearings are parts that assist object rotation. Bearings support the rotating shafts & allowing them to rotate more smoothly. Various types of load are applied to bearings, load magnitude, types (radial or axial) & direction of application must be considered in order to select the proper set of bearings.

B] In this case, high amount of Radial Load as is present. Cylindrical roller bearings have high radial load carrying capacity as the rollers & raceway are in linear contact, according to load acting on particular shaft, selected bearing having internal diameter as 340mm load capacity of 3.25 MN for upper roller. On basis of load transformation, we choose bearing having internal diameter as 280mm having load capacity of 2MN

- **Modelling:**

The importance of modelling & simulation in manufacturing technology is increasing due to the need for continuous reduction of development times. This shows necessity of the optimization processes, this results in increment in quality of product & cost reduction.

The application of numerical modelling is especially resorted to in the development of new production methods & in the use of new materials.

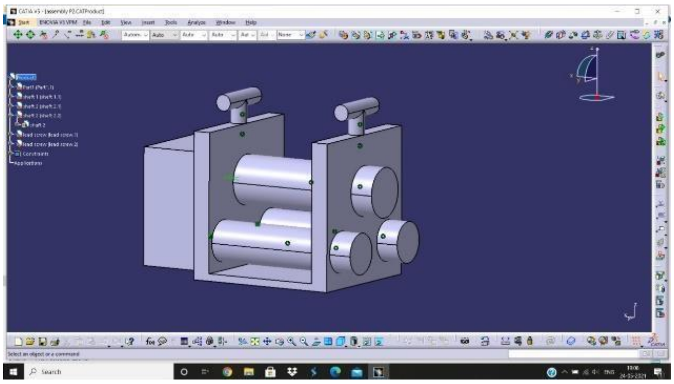


Fig -1: Isometric View of Machine

3. Analysis

Linear static analysis using Hyper works software.

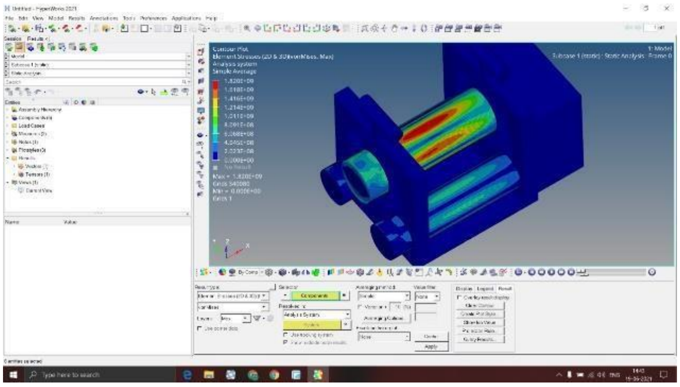
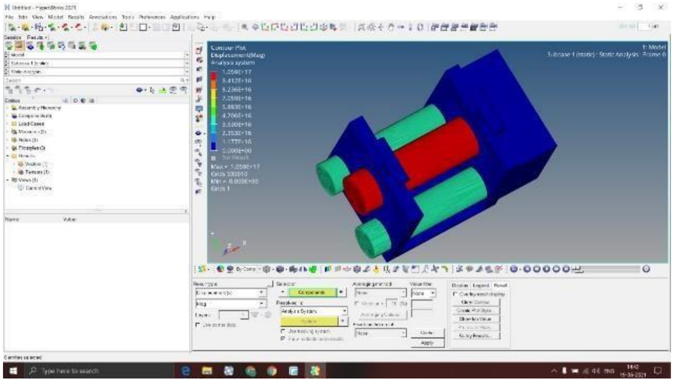


Fig -2: Element Stress (Stress Analysis)



1.For bending of section of thickness 16 mm into the 500 mm radius of curvature the required load is 1.28 MN distributeduniformly over the length of shaft without failing in bending. Similarly, for bending of C-Section into 4000 mm radius of curvature 9.27 MN load is required at shaft diameter 340 mm.
2. For the Rolling & Bending of components 0.69 rpm is required at shaft output of gearbox.
3. For rolling 7.5 HP motor of 1400 rpm is required with 3 stage gearboxes.

5. Future scope of Project:

Industrial buildings & non- building structures are usually designed for functionality rather than aesthetics. curved members are more efficient than straight members. Example: C- clamps, crane rod. Convention centers, cement silos.

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