Design and Remodification of Power Transmission system Of Cold Roll Forming Machine

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Abstract—
In Sheet Metal working industry a wide range of power and hand operated machines are being used. As the sheet metal industry is a large and growing industry different types of machines are used for different operations. Rolling is a fabricating process in which the metal, plastic, paper, glass, etc. is passed through a pair (or pairs) of rolls. There are two types of rolling process, flat and profile rolling. In flat rolling the final shape of the product is either classed as sheet (typically thickness less than 3 mm, also called "strip") or plate (typically thickness more than 3 mm). In profile rolling the final product may be a round rod or other shaped bar, such as a structural section (beam, channel, joist etc). In this study, different metals are been rolled by using three roller manually operated rolling machine and its process is being analyzed .

Keywords*-Roller operaion,Gears operation manually operated machine.*

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I. Introduction

Sheet Metal industry is a large and growing industry. There are many special purposes machines used in this industry to-day. The proper selection of the machines depends upon the type of the work under-taken by the particular industry. There are many examples of Sheet Metal work, which can be seen in our everyday lives. The metals generally used for Sheet Metal work include black iron sheet, copper sheet, tin plate, aluminum plate, stainless sheet and brass sheet.

In three roller sheet bending machine sheet is bend with the help of load acting on upper roller, which is movable. 3 roller sheet bending machine mainly consist of following parts: 3 rollers (upper roller and 2 bottom rollers), motors, gears, power screw, and frame. Bending operation is done by applying load (force) with the help of upper roller, which is movable. It can be moved by adjusting the power screw manually. Two bottom rollers are fixed which acts as a support for holding the metal sheet. When upper roller moves in a clockwise direction, bottom rollers simultaneously move in anticlockwise direction. Motor is used in sheet bending machine for providing power transmission. Gear drives are used for minimize the rpm transferred from motor to the assembly (machine). Spur gears are used in 3 roller sheet bending machine. Spur gears used are made up of cast iron. Square threaded power screw is used to change the position of upper roller. This operation is totally manual. Frame is a fixed rigid support used for supporting the assembly and also prevent machine from vibrations.

Three roller sheet metal rolling machine is a process of converting metal sheet of varying thickness into curve sheet at required circumference or into complete hollow cylinder at required radius. The factors on which the sheet metal rolling machine is designed includes maximum thickness of sheet to be used ,minimum and maximum diameter of hollow sheet cylinder which the company want from rolling machine,

The sheet metal rolling machine include several component:-

Base- The base on the sheet metal rolling machine is formed by used standard channel of 80X100 on which the entire weight of the metal rolling machine is acted.

Roller:-The metal rolling machine has two lower roller and one upper roller between which the sheet metal is feed. The material of the roller used in mild steel

Support end:-The rolling has two a support end on both side of the roller. One support has a single complete assembly and the other end can be split into two. The upper half support end can be removed completely so that the after the end of metal rolling process the hollow cylindrical sheet can be removed. The material of the support end is mild steel.

Manually operated handle:- The handle of the roller carries the upper roller such that its can be moved up and down normal to the roller so that sheet feeding between upper and lower roller can be done. V- threaded handle is used.

II. LITERATURE SURVEY

• M. Hua et al [1] developed, in the paper, an analytical model to study the mechanics of continuous plate edge bending mode of the four roll bending process, solving governing differential equation for the large deflection of an elasto plastic thin plate with an arbitrary strain hardening law for the material. The effect of material strain hardening on the mechanics is also studied and compared with those for a perfectly plastic material.

• M. Hua et al[2] discussed design consideration, working principle and bending mechanisms the four roller bending machine. Generalized procedure of four roller bending machine is also explained.

• Jong Gye Shin et. al [3] in the paper, 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 and 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 center roller displacement and residual curvature. With further development and refinement, the procedure proposed in this work has great promise for practical application, particularly for the automation of the process.

• Dr. C. C. Handa et. al [4] discussed about the productivity analysis of manually and power operated sheet bending machine considering time required to complete one pipe, total expenditure required to manufacture one pipe, number of operators and labors required during both operations, etc. Limitations of the manually operated sheet bending process over power operated sheet bending machine is also discussed.

• P.G. Mehar [5] in his M. Tech Thesis studied the manually operated and power operated sheet bending machine. Experimentations were conducted on sheet in order to measure actual no. of passes, time required to complete bending process etc. Also, productivity of sheet bending process is analyzed in depth. Design of various components of power operated sheet bending machine considering various theories of failure in elastic region and values for bending force, power required, spring back radius etc. for different diameters, thicknesses and width of sheet metal has been determined.

III. PROCESS DESCRIPTION

FORMING PROCESS Forming processes are those in which the shape of a metal piece is changed by plastic deformation .Forming processes are commonly classified into hot-working and cold-working operations. Typical forming processes are:

- Rolling
- Extrusion
- Forging
- Drawing

ROLLING

Rolling is a process of reduction of the cross-sectional area or shaping a metal piece through the deformation caused by a pair of rotating in opposite directions metal rolls. Rolling is the plastic deformation of materials caused by compressive force applied through a set of rolls. The cross section of the work piece is reduced by the process. The material gets squeezed between a pair of rolls, as a result of which the thickness gets reduced and the length gets increased. A machine used for rolling metal is called rolling mill. A typical rolling mill consists of a pair of rolls driven by an electric motor transmitting a torque through a gear and pair of cardans. The rolls are equipped with bearings and mounted in a stand with a screw-down mechanism.

BASIC ROLLING PROCESS

• Heated metal is passed between two rolls that rotate in opposite directions

• Gap between rolls is less than thickness of entering metal

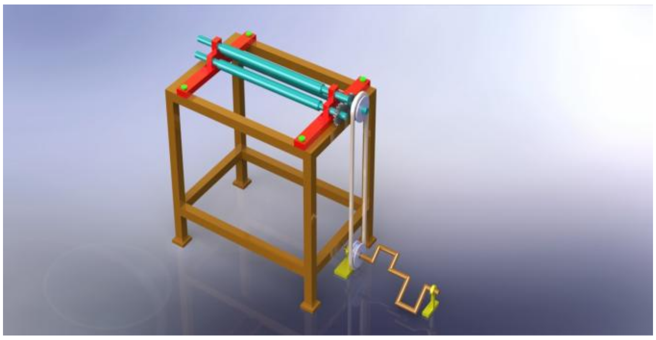
Rolls rotate with surface velocity that exceeds speed of incoming metal, friction along the contact interface acts to propel the metal forward.
• Metal is squeezed and elongates result in decrease of the cross-sectional area.
• Amount of deformation in a single pass depends on the friction conditions along the interface.
• If too much material flow is demanded, rolls cannot advance the material and simply skid over its surface.
Too little deformation per pass results in excessive production cost.

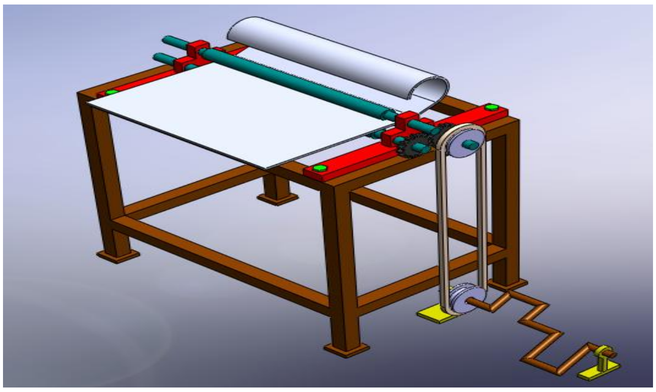
IV. WORKING PRINCIPLE

The Sheet Metal, which is to be formed in flat plate shape, is present at the edge by hammering. In rolling flat plate shape is to be put in the metal rather than sharp bends. Now the sheet metal is introduced between the top and the bottom roll, the gap between the top and bottom roll are adjusted as per the required diameter by regulating the screw rods. When the hand wheel is rotated, the worm which is keyed to the shaft transmits power to the worm wheel, and the worm wheel rotates. The stud gear which is fixed to the worm wheel also rotates and so that the two spur gear which is keyed to the bottom roll. Both rollers rotate in the same direction. Now the sheet metal is bent, the top roller presses the sheet and gives it to the curvature; the cylindrical shape is formed by rotating the hand wheel. The formed material can be slipped off by removing the top roll.

Most metal rolling operations are similar in that the work material is plastically deformed by compressive forces between two constantly spinning rolls. These forces act to reduce the thickness of the metal and affect its grain structure. The reduction in thickness can be measured by the difference in thickness before and after the reduction, this value is called the draft. In addition to reducing the thickness of the work, the rolls also act to feed the material as they spin in opposite directions to each other. Friction is therefore a necessary part of the rolling operation, but too much friction can be detrimental for a variety of reasons. It is essential that in a metal rolling process the level of friction between the rolls and work material is controlled, lubricants can help with this. A basic flat rolling operation is shown in figure; this manufacturing process is being used to reduce the thickness of a work piece. During a metal rolling operation, the geometric shape of the work is changed but its volume remains essentially the same. The roll zone is the area over which the rolls act on the material; it is here that plastic deformation of

the work occurs. An important factor in metal rolling is that due to the conservation of the volume of the material with the reduction in thickness, the metal exiting the roll zone will be moving faster than the metal entering the roll zone. The rolls themselves rotate at a constant speed, hence at some point in the roll zone the surface velocity of the rolls and that of the





4.1 Orthographic Projection of 3 roller bending machine

V. DESIGN CALCULATIONS

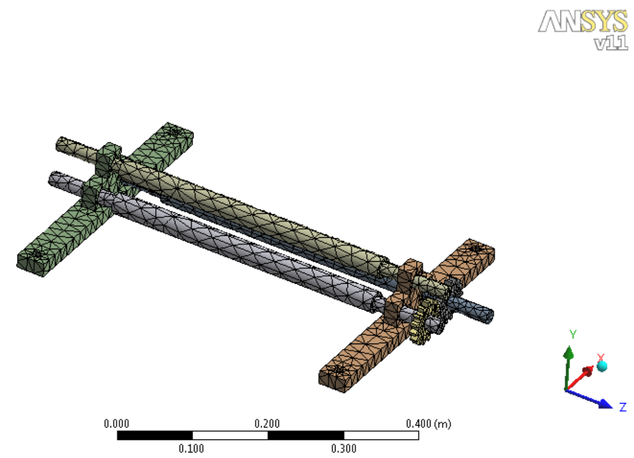
Modal & Static Structural Analysis on Roller & Gear Assembly

Modal Analysis:

A modal analysis determines the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component. The natural frequencies and mode shapes are important parameters in the design of a structure for dynamic loading conditions.

Static Structural Analysis

A static structural analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time.



Applied Boundary Conditions :

- Material – Grey Cast Iron for gears & other parts
  - Teak Wood for rollers (Properties as shown in image)
- Fixed support at lower bottom surface
- Remote displacement applied for all moving parts. (Rollers & Gears)

Results :

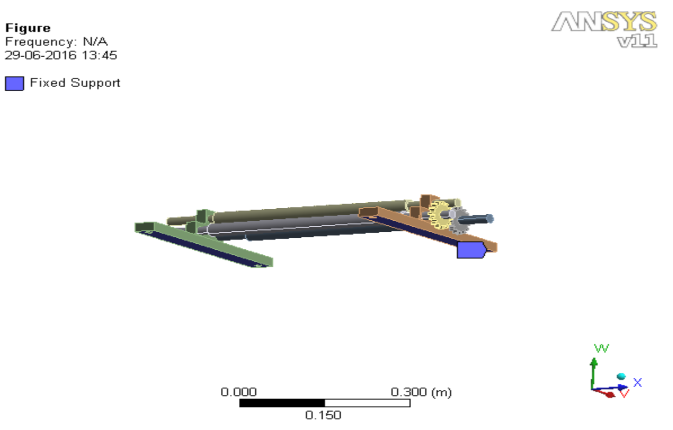
- Frequencies at various modes
- Total deformation
  Directional deformation

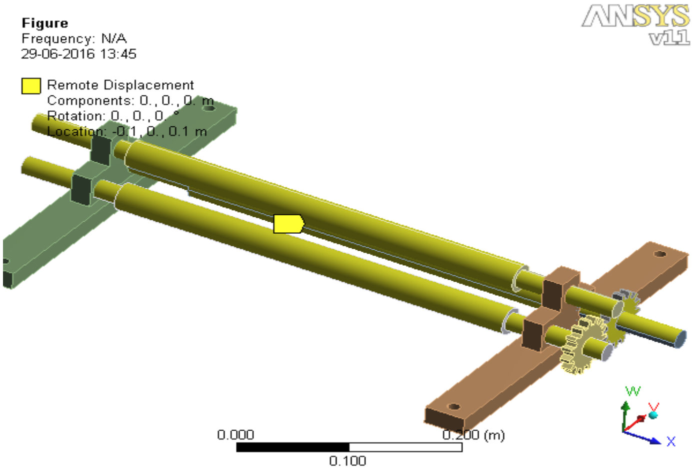
Gray Cast Iron

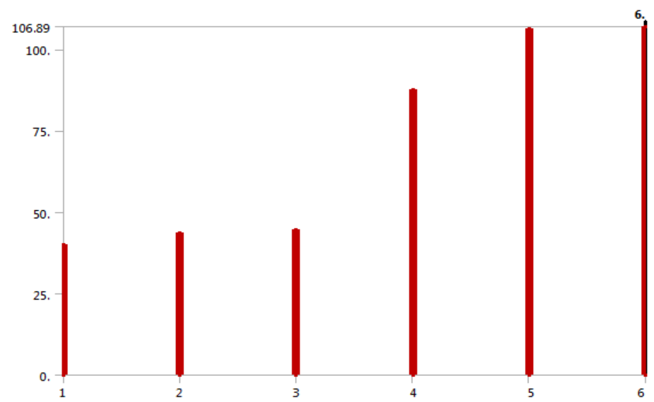
Structural	Add/Remove Properties
Young's Modulus	1.1e+011 Pa
Poisson's Ratio	0.28
Density	7200. kg/m³

Teak wood

Structural	Add/Remove Properties
Young's Modulus	8100. Pa
Poisson's Ratio	0.4
Density	0.9 kg/m³



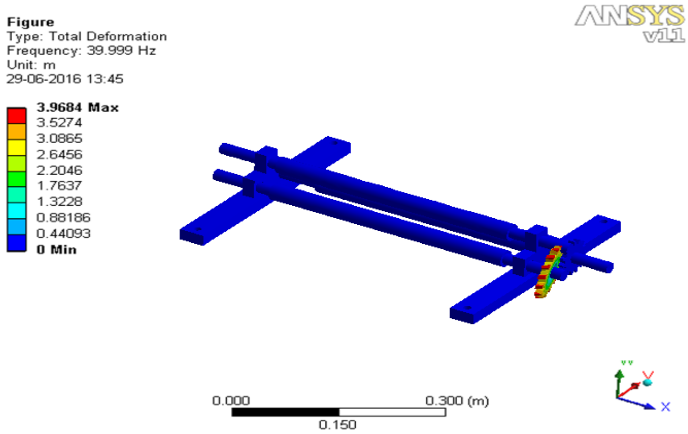


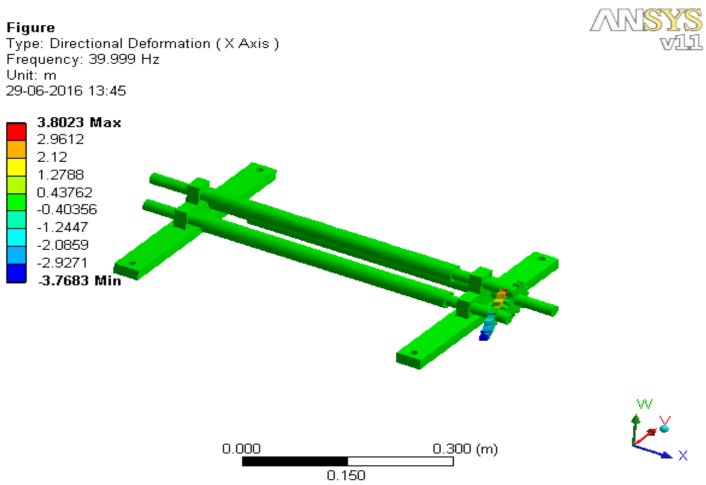


Maximum modes applied for analysis = 6

	Mode	Frequency [Hz]
1	1.	39.999
2	2.	43.753
3	3.	44.602
4	4.	87.401
5	5.	106.27
6	6.	106.89

Frequency values after modal analysis are as shown in image above





Applied Boundary Conditions :
Material – Grey Cast Iron for gears & other parts
- Teak Wood for rollers (Properties as shown in image)

Fixed support at lower bottom surface
Frictionless supports over rollers contact points with frame
12 Nm Torques applied to gears
Results :
Equivalent (Von misses) stresses

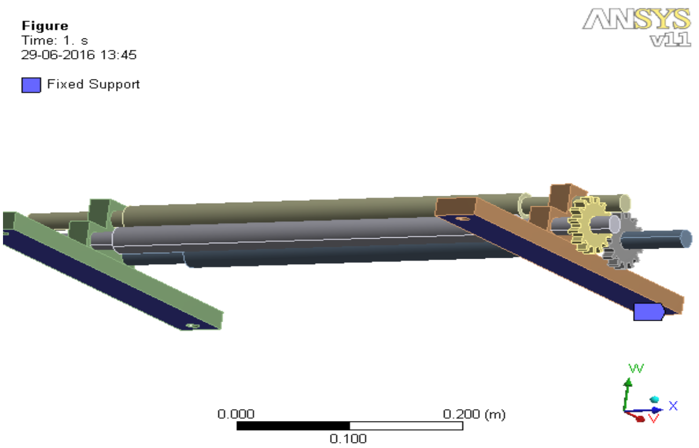
Equivalent (Von misses) strain

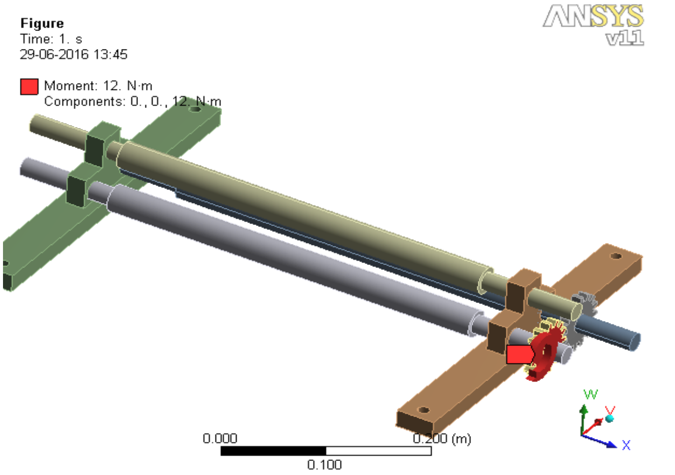
Gray Cast Iron

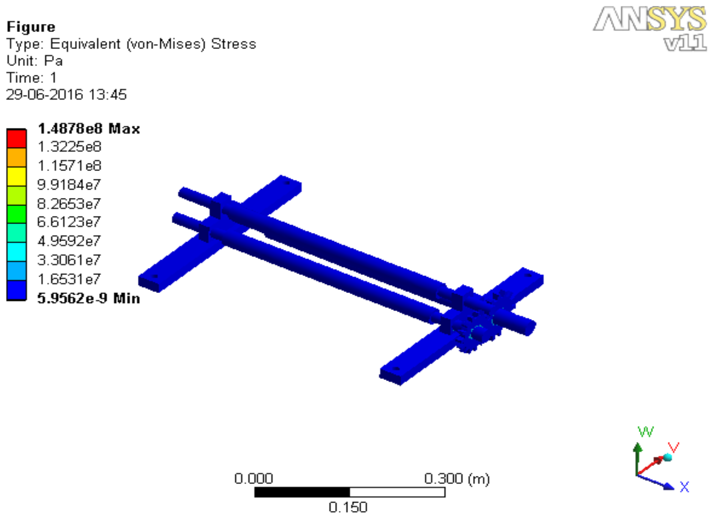
Structural	Add/Remove Properties
Young's Modulus	1.1e+011 Pa
Poisson's Ratio	0.28
Density	7200. kg/m³

Teak wood

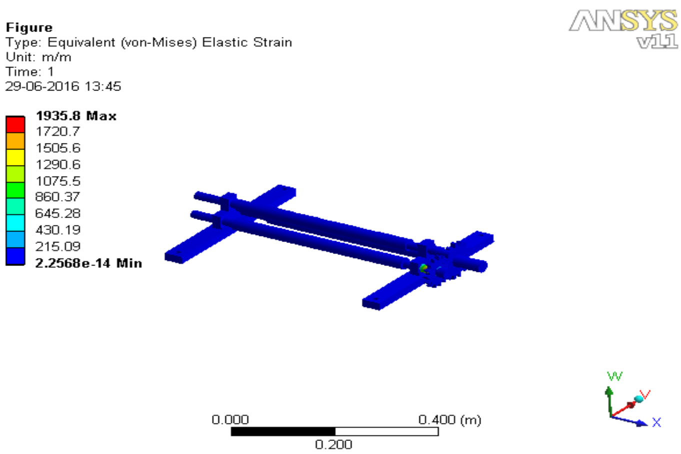
Structural	Add/Remove Properties
Young's Modulus	8100. Pa
Poisson's Ratio	0.4
Density	0.9 kg/m³







The equivalent (von misses) stresses results shows that there will be max stresses at red portion and minimum at blue portion



The equivalent (von misses) strains results shows that there will be max strain at red portion and minimum at blue portion

VI. APPLICATIONS

- Heated Roll Rolling, and the suitability of this technique for magnesium sheet production.
- Asymmetric Cryo rolling, which has potential for large-scale industrial production of nano structural materials
- Variable-Gauge Rolling, used for production of flat products with variable thicknesses
- Through-width Vibration Rolling, used for fabrication of ultra fine material sheets done

VI. CONCLUSION

Study of manually operated sheet bending machine and power operated sheet bending machine has been From the results, it is cleared that, productivity of power operated sheet bending machine is higher. Based on the results, following graphs can be drawn. All graphs showing below are drawn by comparative study of various parameters required for manufacturing of one pipe using manually operated and power operated sheet bending machines.

VII. REFERANCES

[1] Y. H. Lin, M. Hua, "Mechanical analysis of edge bending mode for four-roll plate bending process", Computational Mechanics, Springer-Verlag 1999, pp 396-407

[2] P. S. Thakare1 , P. G. Mehar ,"PRODUCTIVITY ANALYSIS OF MANUALLY OPERATED AND POWER OPERATED
SHEET BENDING MACHINE : A COMPARATIVE STUDY"

[3] K. L. Elkins, R. H. Sturges, " Spring back analysis in Air bending", Tran, ASME, J. Manufacturing science and engineering,

[4] C. C. Weng And R. N. White, " Residual stresses in cold-Bent thick steel plates", Journal of structural Engineering, 116 (1990), no.1, PP. 24-39

[5] L. P. Pomrehn, P. Y. Papalambros, "optimal design with application to gear design," Tran, ASME, J. Mechanical design, 117, sept. 1995, PP. 419-424

[6] J. Shigley, " Design of machine elements", Tata mc-Graw Hill Publication

[7] R. L. Mitchell "Introduction to work study", Universal book corporation, third revised edition.

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