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STRUCTURAL SHAPE ROLLING

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ABSTRACT :

The objective of this work was to experimentally determine the inner deformation and the surface deformation of a bar during wire-rod rolling and compare the results with simulations using FEM. This information could help in the work towards the reduction or elimination of the amount of surface defects on the finished wire and provide better knowledge on the inner deformation behaviour of a bar during shape rolling. The aim of the project is the importance of Structural shape rolling in current metal forming process without loss of material. Structural shape rolling is a metal forming process in which metal stock is passed through a pair 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, also called “strip” (thickness less than 3 mm,) or plate (thickness more than 3 mm). In profile rolling, the final product is either a round rod or other cross sections shaped products such as structural sections (beam, channel, joist, rails, etc.). The initial breakdown of ingots into blooms and billets is done by hot-rolling. The process involves plastically deforming a metal work piece by passing it between rolls. Rolling is the most widely used method of forming / shaping metals, which provides high production, higher productivity and close control of final product than other forming processes. This is particularly important in the manufacture of aluminium and copper for use in construction and other industries. Aluminium has lighter weight and bent easily to any complex shape and form sheet by using structural shape rolling.

Key Words:
Structural Shape Rolling, ingots, Deformation, FEM, billets, Aluminium.

I.INTRODUCTION:

Structural Shape rolling is a manufacturing process used to produce wire and bars, and can also be used to manufacture products with a more complicated cross section. The process normally starts with heating of the billet, followed by rolling in a roughing mill, which is commonly reversible, rolling in an intermediate mill and in a finishing mill, possible followed by some kind of heat treatment. For aluminium qualities that can be deformed at higher speeds without problems, some of the last passes can be performed in a wire block. The difference between shape rolling and hot strip rolling is that instead of flat rolls, the rolls have grooves of different shapes.Rolling the billet in these grooves provide deformation around the entire cross section which gives a more complicated stress-state. The billet is rotated between each pass to enable deformation around the perimeter of the billet.

The grooves can have several different geometries, like square, diamond, round, oval, box etc. Roll-pass design, which decides the shape, size and combination of the grooves, is a complex work. However, using an optimal roll-pass design will result in defect free products with correct dimension. In the work of improving the roll-pass design finite element simulations are a useful tool. Using FEM can provide a picture of the deformation of the billet and risks for defects could possibly be detected. A drawback of FE is, however, that the simulations generally are quite time consuming. Rolling is a metal forming process in which metal stock is passed through one or more pairs of rolls to reduce the thickness and to make the thickness uniform. The concept is similar to the rolling of dough. Rolling is classified according to the temperature of the metal rolled.

If the temperature of the metal is above its recrystallization temperature, then the process is known as hot rolling. If the temperature of the metal is below its recrystallization temperature, the process is known as cold rolling. Rolling begins with preheated sheet ingots that can weigh more than 20 tons. As the size of rolling mills has increased, so has the size of these ingots, but a typical ingot is approximately 6 feet wide, 20 feet long and more than 2 feet thick.

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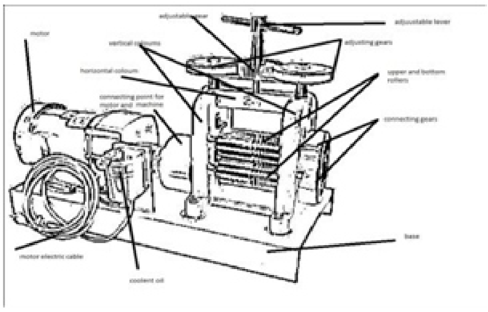

Fig.1 Rolling mill

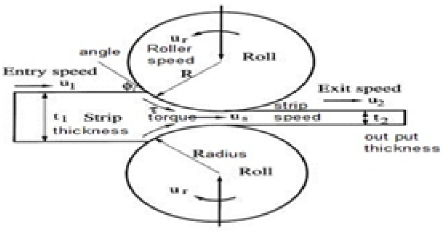

Fig.3 ROLLING

A cylinder that rotates about a central axis and is used in various machines and devices to move, flatten, or spread something. The sheets moved through rollers and down the folding machine a long swelling wave that appears to roll steadily towards the shore. Both rolls are equal diameter Only the upper roller can move up and down for required distance between two rollers Bottom roller doesn't move up and down and moves in radially.[1]

II.TYPES OF INPUTS:

Manufacturing companies producing metals supply metals in form of ingots which are obtained by casting liquid metal into a square cross section.

» Ingot (approx. 6 feet wide and 20 feet long)
» Slab (500-1800 mm wide and 50-300 mm thick)
» Billets (40 to 150 sq mm)
» Blooms (150 to 400 sq mm)

•Sometimes continuous casting methods are also used to cast the liquid metal into slabs, billets or blooms.
•These shapes are further processed through hot rolling, forging or extrusion, to produce materials in standard form such as plates, sheets, rods, tubes and structural sections.[2]

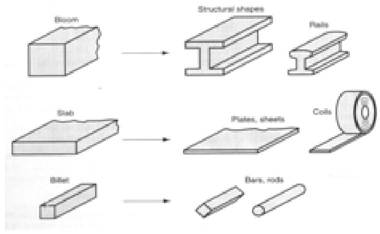

Fig.2 Types of Inputs

III.LITERATURE SURVEY:

In particular, a wide web cannot be guided by means of flange and pulley because of undesirable distortion or damage of the edge. Markey (1957) researched the edge position control of webs in the steel industries. Freytag (1967) studied steering and displacement type web guides in the rolling process. Shelton (1968) first order model presents the dynamics of a moving web that includes the relation of the lateral velocity to the longitudinal velocity and the input error. Shelton and Reid (1971) had derived the first order and second order model through geometrical by taking the elasticity of webs into account, and represented dynamic behavior by regarding web as Euler beam.Using modified initial conditions, Young and Reid (1993) represented transfer function based on the second order model. Brandenburg (1977) studied the longitudinal dynamics of a moving web, but did not consider the changes, and register errors are described. Reid and Lin (1993) proposed the fixed again and variable-gain control of web tension in the winding section.

For variable gain, the control parameters are continuously updated based on the diameter of the roller, which is a major contributor to the system dynamics and uses pole placement techniques. Shelton (1991) had derived the first order and second order conditions, Young and Reid (1993) represented transfer function based on the second order model. In Postlethwaite and John Geddes (1994) presented a paper which considers the application of robust multivariable control based on 31" design produced significantly less undershoot in response to skid chill. Zoon Cho et al (1997). The accurate prediction of roll force is essential for product quality. Mathematical model. Both networks were shown to improve the accuracy by 30–50%. One difficulty was when promoting the use of the neural network the inability to estimate the A new variable structure control based on a co-ordination optimization algorithm (Ringwood 2000).

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Simulation results verify the effectiveness of the proposed. Recently, some methods have been used to solve such paradoxical problem. Han and Jingling Han (1994) developed a new methodology for web tension regulation based upon a unique Active Disturbance Rejection Control concept. In this approach the disturbances It is designed without an explicit mathematical model of the plant. Lin and Land (1993) derived a mathematical model for a typical single-stand rolling mill and design Proportional.

IV.STRUCTURAL SHAPE ROLLING:

Structural shape rolling, also known as shape rolling and profile rolling, is the rolling and rolls forming of structural shapes by passing them through a rolling mill to bend or deform the work piece to a desired shape while maintaining a constant cross-section. Structural shapes that can be made with this metal forming process include: I-beams, H-beams, T-beams, U-beams, angle iron, channels, bar stock, and railroad rails. The most commonly rolled material is structural steel; however other includes metals, plastic, paper, and glass. Common applications include: railroads, bridges, roller coasters, art, and architectural applications.Structural shape rolling is a cost-effective way of bending this kind of material because the process requires less set-up time and uses pre-made dies that are changed out according to the shape and dimension of the work piece. Structural shape process can roll work pieces into full circles.

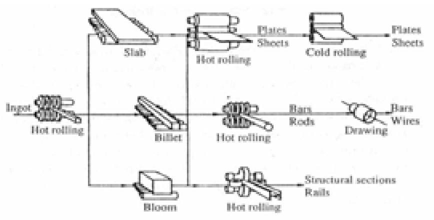

Fig.4 Sequence of operations for obtaining different shapes

• In sheet rolling we are only attempting to reduce the cross section thickness of a material. If instead we selectively reduced the thickness we could form complex section easily. This technique is called shape rolling.

• In practice we can make complex cross sections by rolling materials in multiple passes. We can't do this in one pass because we would overwork the material, and it would crack.

ELONGATION:

Elongation in stock length is associated with reduction in area, as volume of metal leaves the rolls as enters them is equal. Elongation factor, i.e., the ratio of the final length to the initial length is always greater than unity.[3]

V.TYPES OF ROLLING HOTROLLING:

Rolling is classified according to the temperature of work piece rolled. If the temperature of the metal is above its recrystallization temperature, then the process is termed as hot rolling.

•These mills are normally two-high reversing mills with 0.6 -1.4 metres diameter rolls (designated by size).

•The objective is to breakdown the cast ingot into blooms or slabs for subsequent finishing into bars, plate or a number of rolled sections.

•The blooms/slabs are heated initially at 1100ºC -1300ºC. In hot-rolling of steel, the temperature in the ultimate finishing stand varies from 850ºC – 900ºC, and is always above the upper critical temperature of steel.

COLD ROLLING:

One of the perquisites of the hot rolling practice is heating the input bloom/billet/slab from the room temperature to the reliable temperature. At that higher temperature the steel is transformed in to a single austenite phase from the dual phases of perlite and cementite at room temperature. Such phase change temperature for 0.68 % carbon steel is 738º C. At lower or higher carbon percentage, this phase change temperature increases and therefore, the temperature to which the steel is heated for hot rolling is increased accordingly. However, in practice steel is actually heated to a temperature of about 50º C to 100º C above the phase change temperature. This increase in temperature is because steel besides having varying percentage of carbon and iron also contain other alloying elements which affect the Phase changing temperature. Hot rolling takes place in a number of steps and drafting / reduction is given in every stage. The ultimate draft is at a temperature above the recrystallization or phase change temperature. Accordingly the cold stock is heated to a much higher temperature than the recrystallization temperature.

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RECRYSTALLIZATION:

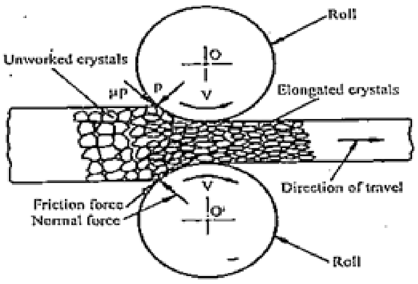

Fig.5 Recrystallization

•The distinction between hot and cold rolling depends on the processing temperature with respect to the recrystallization temperature of material.
•Rolling is classified according to the temperature of the metal rolled. If the temperature of the metal stock is above its recrystallization temperature then the process is termed as hot rolling, whereas if the temperature of stock is below its recrystallization temperature the process is known as cold rolling.
•The most important industrial uses are the softening of metals previously hardened by cold work, which have lost their ductility, and the control of the grain structure in the final product.[4][5]

VI.ROLLING DEFECTS AND REMEDIES:

The main problem during rolling process is the calibration of rollers. This calibration faults may occur in case of used bearings and may affect the thickness of parts. A simple classification is as here below:

WAVY EDGES AND ZIPPER CRACKS:

These defects are caused due to bending of rolls under the rolling pressure. A roll can be considered as beam supported in its stands. Under rolling pressure, the rolls deflect in the manner. Consequently the work material becomes thinner at the two edges and thicker in the central portion. In other words, it means that material becomes longer as measured along the edges than in centre. These causes tensile stress in the centre and compressive stress in the edges. The former causes zipper cracks in the centre and causes the latter causes wavy edges.Remedy for zipper cracks and wavy edges lies in provide a “camber” to the rolls. They are made slightly convex in the central portion to offset the effect of deflection under rolling loads.

Fig.6 WAVY EDGES

Fig.7 ZIPPER CRACKS IN THE CENTRE OF THE STRIP

EDGE CRACKS AND CENTRE SPILT:

These defects are caused due to non-homogeneous plastic deformation of metal across the width. As the work piece passes through the rolls, under the rolling pressure its height decrease while its length increases. Some lateral spread i.e., increase in width also takes place. However the lateral spread is more towards the edges than in the centre as there is little resistance to lateral spread towards the edges. In the centre lateral spread is resisted by friction and the adjacent layer of material. Hence decrease in lateral spread in the central portion of work material results in greater increase in length in this region as compared to the edges. It can be realised that under such non homogeneous deformation of work material,the edges experience a tension (as the central portion tries to pull it due to continuity of material) and the central portion experience a compressive stress. Such a distribution of stress may result in edge crack or in severe cases,it mat even lead to asplit along the central portion.

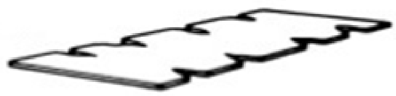

Fig.8 EDGE CRACKS

ALLIGATORING:

Rolling entails a reduction in the height with consequent increase in length. But due to friction present at the interface of the rolls and upper and lower surfaces of the work material, the elongation on the top and bottom surfaces is less than the material located at the centre of thickness of the work piece. If conditions become severe, it may cause a defect called “alligatoring” i.e., rupture of material along the length into an upper half and a lower half resembling the open mouth of an alligator.[6]

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Fig.9 ALLIGATORING

VII.ADVANTAGES & APPLICATONS OF STRUCTURAL SHAPE ROLLING:

•It is a cost-effective way of bending this kind of material because the process requires less set-up time and uses pre-made dies that are changed out according to the shape and dimension of the work piece.
•In this process there is no material wastage.
•Required complex shapes can be easily done.

APPLICATIONS:

•Construction materials,

•Partition beam

•Ceiling panel

•Roofing panels.

•Steel pipe

•Automotive parts

•Household appliances

•Metal furniture

•Door and window frames[7]

VIII.PRATICAL CALICULATIONS:

Original Dimensions of Aluminium Sheet In "millimetre (mm)"
Length = 180 mm
Width = 25mm
Thickness = 2mm
One Pass (360˚) = 0.5mm

*STRAIN = CHANGE IN LENGTH / ORGINAL LENGTH

*THICKNESS ά 1/ WIDTH

OBSERVATION TABLE:

No of PASS	LENGTH (mm)	STRAIN	WIDTH (mm)	STRAIN	THICKNESS (mm)	STRAIN
0	180	0	25	0	2	0
1	192	0.067	25.2	0.008	1.9	0.050
2	210	0.167	25.4	0.016	1.7	0.150
3	230	0.278	25.6	0.024	1.5	0.250
4	256	0.422	25.8	0.032	1.4	0.300
5	268	0.489	26	0.040	1.3	0.350
6	316	0.756	26.2	0.048	1	0.500
7	370	1.056	26.6	0.064	0.9	0.550
8	415	1.306	28	0.080	0.6	0.700

Fig.10 Observation Table

IX.GRAPHS:
GRAPH 1 LENGTH VS STRAIN

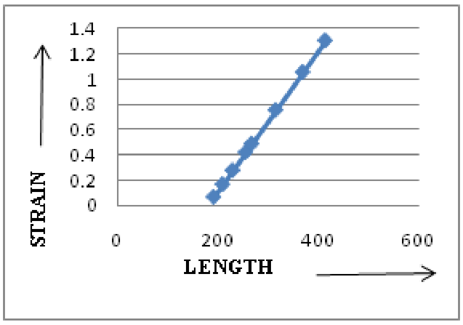

Fig.11 Length VS Strain

From Fig.11, the length of aluminium sheet increases the strain values of aluminium sheet also increases gradually.

GRAPH 2 WIDTH VS STRAIN

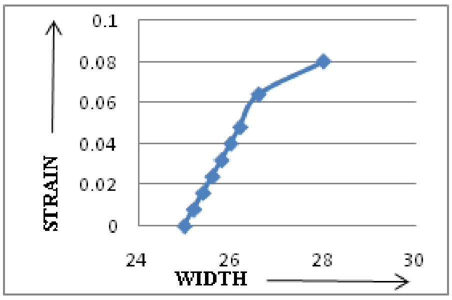

Fig.12 Width VS Strain

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From Fig.12, the width of aluminium sheet increases the strain values of aluminium sheet also increases gradually.

GRAPH 3 THICKNESS VS STRAIN

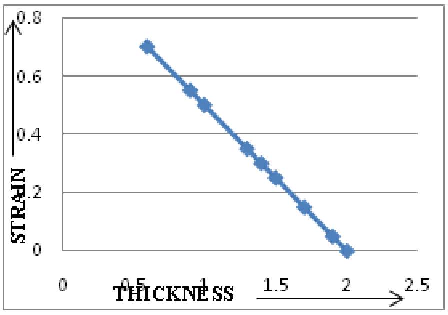

Fig.13 Thickness VS Strain

From Fig.13, the thickness of aluminium sheet decreases the strain values aluminium sheet also increases gradually.

GRAPH 4 WIDTH VS THICKNESS

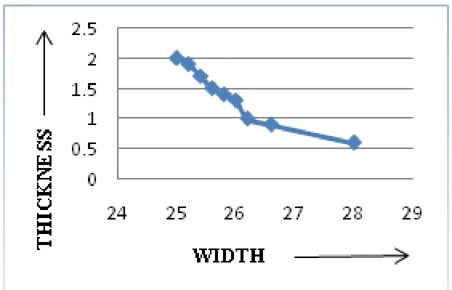

Fig.14 Width VS Thickness

From Fig.14, Here the thickness of aluminium metal decreases then the width of the metal increases.

GRAPH 5 PASSES VS LENGTH STRAIN

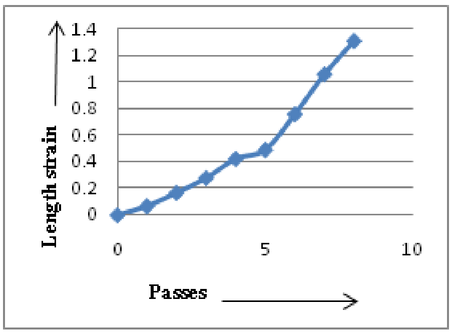

Fig.15 Passes VS Length Strain

From Fig.15, the number of passes increases then the length strain of aluminium sheet also increases gradually.

GRAPH 6 PASSES VS WIDTH STRAIN

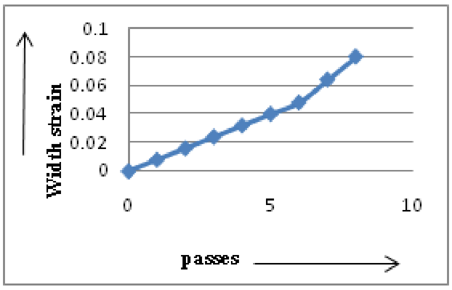

Fig.16 Passes VS Width Strain

From Fig.16, the number of passes increases then the width strain of aluminium sheet also increases gradually.

GRAPH : 7 PASSES VS THICKNESS STRAIN

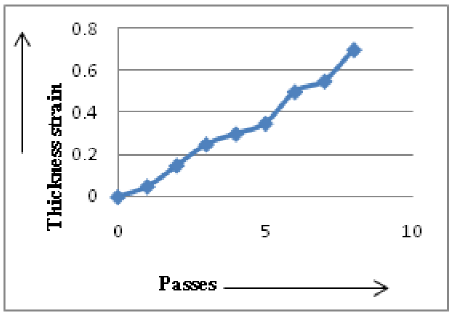

Fig.17 Passes VS Thickness Strain

From Fig.17, the number of passes increases then the thickness strain of aluminium sheet also increases gradually.In the structural shape rolling, place rollers which are contain profile shape which the final shape required. In this we give the metal feeding with a constant rate and the speed of rollers also be maintain same through operation.

X.FEATURESCOPE:

Rolling process is a major metal forming process, in which large quantity of production can be achieved. As Compared with extrusion, cold rolling and drawing production rate of hot rolling is higher. The highest accuracy levels are imported from Germany. Identical Roll units on both sides, enables operators to keep a min. stock of spare Roll units. These roll units are the most expensive spares of a Wire rod Block. [8]

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XI.TECHNOLOGICAL ADVANCES USING AL IN ROLLING:

Aluminium (Al) rolling has gained steadily in both quality and efficiency through advances in its own specific technology as well as improvements applied to metal rolling in general.The maximum speed of the first U.S. cold "strip" mill was reported to be only about 200 feet per minute (60 m/min.); modern cold mills operate about 35 times faster!In recent years, aluminium rolling mills have been introducing computerized process control, quality control and inventory tracking, and advanced gauge and shape controls, to achieve even higher product quality and consistency. Computerization, in turn, is pointing the way to such further developments as Computer Integrated Manufacturing (CIM), Statistical Process Control (SPC), and Just-In-Time (JIT) production schedules. These recent advances are designed to increase product quality and delivery reliability and to reduce production costs. [9]

XIII.CONCLUSION :

By using structural shape rolling mill, the insertion of a metal grid in a bar as presented in the present work is a good method to determine the deformation of the cross-section of a bar. To better predict crack reduction, cracks must be modelled in the FE simulations rather than monitoring the location of a subsurface node in a solid bar. By this fabricated the complex shapes without loss a material. It is a cost-effective way of bending this kind of material because the process requires less set-up time and uses pre-made dies that are changed out according to the shape and dimension of the work piece. This process can roll work pieces into full circles.

XIII.REFERENCES:

1.Shey, John A., Introduction to Manufacturing Processes, 2nd Edition, McGraw-Hill Book Company, New York, 1987.

2.Groover M.P., Fundamentals of Modern Manufacturing, John-Wiley and Sons, New York, 1999.

3.https://en.wikipedia.org/wiki/Structural_shape_rolling

4.Athans, M. and P.L.Falb"Optimal control an introduction to the theory and its applications", Chap. 9.1996.

5.Rolling Process, http://www.cemr.wvu.edu.

6.S. Tomita: Research and Development for Rolling and Production Process, CAMP-ISIJ Vol.17 No.2 (2004.3) pp. 258

7.Dieter, G.E., Mechanical Metallurgy, SI Metric Edition, McGraw-Hill Book Company, London, 1988.

8.S. Takatani et al.: Control System Development on Plate Rolling with Back-up Roll Bending Device, the 110th ISIJ Rolling Theory Committee NO 11 in the 110th ISIJ Rolling Theory Committee (1999.7).

9.M. Kuchi et al.: Recent Aluminium Rolling Mill Design, Ishikawajima-Harima Engineering Review Vol.43 No.4 (2003.11) pp. 129-133