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STRUCTURAL SHAPE ROLLING

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ABSTRACT :

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 as well as the copper material also have greater tendency to draw wire and sheet by using structural shape rolling.

Introduction:

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.

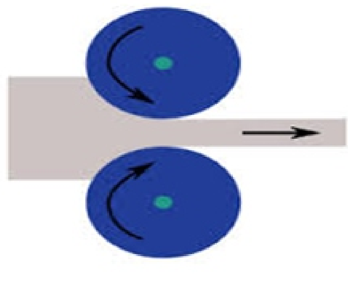
•Manufacturing companies producing metals supply metals in form of ingots which are obtained by casting liquid metal into a square cross section.

» Slab (500-1800 mm wide and 50-300 mm thick)
» Billets (40 to 150 sq mm)
» Blooms (150 to 400 sq mm)

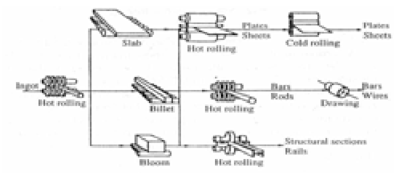
•Sometimes continuous casting methods are also used to cast the liquid metal into slabs, billets or blooms.

•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.

ROLLING:



Sequence of operations for obtaining different shapes



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.

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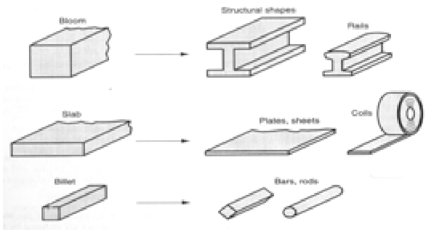
Structural shapes that can be made with this metal forming process include: I-beams, H-beams, T-beams, U-beams, angle iron, channels, bar stock, and railroad rails. The most commonly rolled material is structural steel; however other includes metals, plastic, paper, and glass. Common applications include: 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.



• 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" 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.

HOT ROLLING :

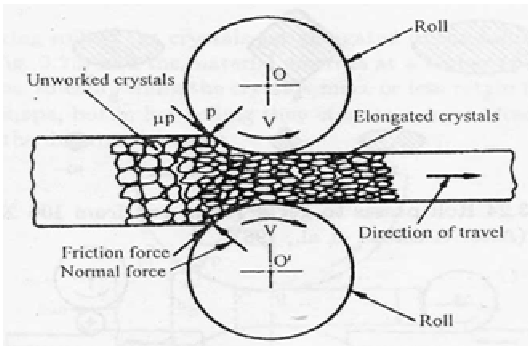
Rolling is classified according to the temperature of work piece rolled. If the temperature of the metal is above its recrystallization temperature, then the process is termed as hot rolling.

•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 11000 C -13000 C. In hot-rolling of steel, the temperature in the ultimate finishing stand varies from 8500 C – 9000 C, and is always above the upper critical temperature of steel.

COLD ROLLING:

One of the perquisites of the hot rolling practice isheating 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 7380 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 500 C to 1000 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.

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.

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ROLLING & its PARAMETERS:

•When a piece of metal is rolled between two rolls, the metal piece experiences both vertical and horizontal stresses caused by the compressive load from the rolls and the restrains by the portions of the metal piece before andafter the material in contact with the roll respectively.

•As the rolls exert a vertical stress on the metal piece, thelatter exerts the same amount of stress back onto the rolls itself. As such the rolls are subjected to elastic deformation due to this stress induced by the work piece.

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 inthe manner. Consequently thework 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.

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.

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.

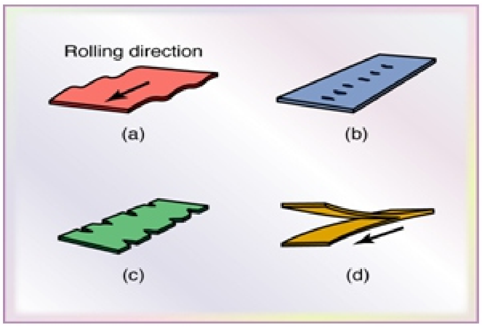

Figure Schematic illustration of typical defects in flat rolling: (a) wavy edges; (b) zipper cracks in the center of the strip; (c) edge cracks; and (d) alligatoring.

ADVANTAGES 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 premade 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.

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Applications of structural shape rolling:

•construction materials,
•partition beam
•ceiling panel
•Roofing panels.
•steel pipe
•automotive parts
•household appliances
•metal furniture,
•door and window frames
•other metal products

PRATICAL CALICULATIONS:

Original Dimensions of Aluminium Plate 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:

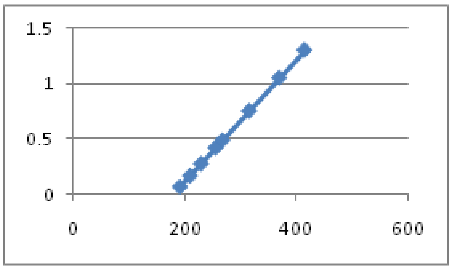
PASS	1	2	3	4
PASS 1	2	192	25	0.067
PASS 2	1.7	210	25.5	0.167
PASS 3	1.5	230	25.8	0.278
PASS 4	1.4	256	25.8	0.422
PASS 4	1.3	268	26	0.489
PASS 5	1	316	26.2	0.756
PASS 6	0.9	370	26.6	1.056
PASS 7	0.6	415	28	1.306

In table 1&2&3&4 are
1: thickness; 2: length; 3: width; 4: strain

GRAPH: 1:

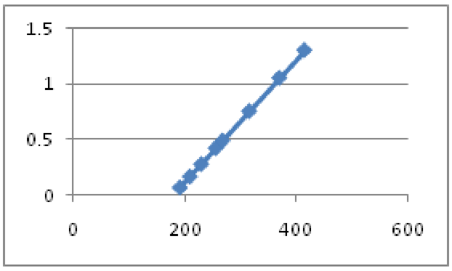
From graph 1, the length of material increases the strain values also increases gradually. Aluminium metal passing through the rollers the length of the metal increases here some structural changes takes place.

LENGTH VS STRAIN:



X-AXIS: LENGTH
Y-AXIS: STRAIN
GRAPH: 2

WIDTH VS THICKNESS



X-AXIS: WIDTH
Y-AXIS: THICKNESS

From graph 2, here the thickness of aluminium metal decreases then the width of the metal increases.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.

FEATURES SCOPE:

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.

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!

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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.

CONCLUSION:

By using structural shape rolling mill, we 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.

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