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REVIEW ON COMPUTER AIDED ENGINEERING OF WORK ROLL CHOCK AND BACKUP ROLL CHOCK IN COLD ROLLING MILL

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ABSTRACT

The process of reduction of thickness of metal by passing it through the rolls called as the metal rolling. Rolling is widely used thickness reduction process, which can have high production figures and precise control of final product. Rolling is classified in two major types the cold rolling and hot rolling. Every part has its own theory, development of rolling process and consequently the designing of the cold rolling mill components, like rolls and rolling mill housing. The present paper studies to understand the various methodologies which are used to design the cold rolling mill. We have concentrated on the history of the rolling process; it is understand that the rolling process was adopted since year 1590. Though it was raw method but it initiated the slitting rolling mill and the actual experimentation were started from year 1670. In those days rolling was concerned with rolling of bars only after few years the rolling of bars were started In year 1783, after the entry of grooved rolls the rolling production increased up to 15 times and that was the start of modern rolling mill. We have studied the different parameters and factors that affect the roll design. While designing of rolling mill housing, we study the load that comes on the rolls during the rolling operations and how it affects the bearing life and chock life. The finite element analysis method is used for weight reduction of chock which is major part for failure.

Keywords:* *Cold Rolling, Plastic Deformation, Design Methodologies, Housing, Rolls, Split End, Central Burst

I. INTRODUCTION

Design of rolling mill is a hard-hitting process where the designer should have clear knowledge and understanding of the rolling process. There are various contradictory goals which need to satisfy, many investigations need to be done for the complete analysis [1] Chocks are almost invariably the highest stressed component in a manufactured item, and so are most susceptible to invariable the financial losses incurred as a result of chock failure will be far greater than the actual value of the chock instantiated delivery of chocks because of manufacturing presetting failure could stop a production failure at the assembly stage is almost certain to halt production if only one or two chocks out of a large batch tailback no manufacturer would willingly assemble goods that are suspecting failure in serviceable the most catastrophic consequences example failure of cold rolling mill chock is very likely to result in the complete destruction of the cold rolling mill. Failure of chocks in a cold rolling mill is basically because of higher stressed generated during start up and shut down condition of rolling mill so for a design of chocks for a cold rolling mill it is essential to know the maximum load acting on a chock to prevent from a failure fatigue failure beachwear of cyclic loading is also a criteria of chocks design. Second most important function of the work as an isolator case of cold rolling mill also it has to perform this function. So design chock hold has a required stiffness to transmit a vibration from a source to receiver. So while designing a chock for cold rolling mill two factors is very important i.e. strength of chock to sustain a maximum load and stiffness of a chock to transmit lesser vibration.

II. LITERATURE SURVEY

KatyalPuneet [1], in his thesis 'Stress analysis and optimization of rolling mill housing using CAE' studied the optimization of Rolling Mill Housings design for rigidity, to control the deflection of the housing for better gage control of the material being rolled. The Housing stress distribution has been analyzed using analysis software CATIA from which maximum static stress at critical areas have been calculated.

This study clearly concluded that, further work can be done so that housing experiences the same stresses at all sections which then be called a balanced housing. Further dimensions of the balanced housing can be proposed with respect of the components like chocks of respective positions so that the housing failure does not take place in under loading.So, we are focusing our project work to study the work roll & backup roll chocks for optimized design

2.1 History of Rolling Mills

The earliest rolling mills were slitting mills which were introduced from what is now Belgium to England in 1590. These passed flat bars between rolls to form a plate of iron, which was then passed between grooved rolls (slitters) to produce rods of iron. The first experiments at rolling iron for tinplate took place about 1670. These were followed by the erection by 1697 by Major John Han bury of a mill at Pont pool to roll 'Pont pool plates' -back plate. Later this began to be reenrolled and tinned to make tinplate. The earlier production of plate iron in Europe had been in forges, not rolling mills. The slitting mill was adapted to producing hoops (for barrels) and iron with a half-round or other sections by means that were the subjects of two patents of c. 1679.Some of the earliest literature on rolling mills can be traced back to Christopher Polhem in 1761 in Patriotism Testament, where he mentions rolling mills for both plate and bar iron. He also explains how rolling mills can save on time and labor because a rolling mill can produce 10 to 20 and still more bars at the same time which is wanted to tilt only one bar with a hammer. A patent was granted to Thomas Block leys of England in 1759 for the polishing and rolling of metals. Another patent was granted in 1766 to Richard Ford of England for the first Tandem Mill. A tandem mill is where the metal is rolled in successive stands; Ford's tandem mill was for hot rolling of wire rods. Rolling mills for lead seem to have exited by the late 17th century. Copper and brass were also rolled by the late 18th century.

2.2Types of Roll Chocks

Roll Chocks are used in different applications and depending upon the nature of the application, the roll chocks are broadly categorized into 4 types. These types of roll chocks are:

- Work Roll Chocks
- Back-up Roll Chocks
- Upper Roll Chocks

- Bottom Roll Chocks

2.3 Back-up Roll Chock Liners

The roll chocks are protected from wearing by the backup roll that presents outside the chock liners. It also permits close clearance between the backup roll chocks and the mill housings. This clearance assists to maintain gaps and roll alignment. For both inside and outside backup roll chock liners, wear resistance lists, then parts having higher hardness will erode the part with lower hardness.

2.4 Bearing Housing

The most general Bearing Housing are constructed and designed as a single piece. Cast iron is used for casting these housings. After the casting is over, to provide a perfect flat mounting surface, the bases of the housings are machined. To provide the exact fit with the insert bearing, the inner diameters of the housings are also machined. The housing that is made of cast iron gets greater applicability and also get high rigidity. This housing is strong enough to suit for any type of application. For very heavy applications, other housing materials apart from the cast iron are also used for making housings. These housings are used for the special applications. Another one-piece designed housing is made of malleable cast iron. These housings are not very rigid and therefore, such housings are less susceptible to fracture than gray iron housings. Where the shock loads are present, in these applications malleable cast iron housings are applicable. Another type of housings is called Pressed Steel Housings, and these housings are stamped or pressed, of plain carbon steel. These housings are the least rigid then the other two type of housings, which have been mentioned above. In high duty applications, the presses Steel Housings are used. The Press Steel Housings are designed as tow- piece housings. Between the two sections, the insert bearing is cradled. The bolts that attached the housings to the applications help in holding the assembled units intact. Although, the bases of these housings are not machined, but these provide relatively strong and stable foundation for the insert bearing along with the most economical and lightest possible housing system. Sometimes, additional rubber tires or grommets are required in the applications of the Pressed Steel Housings around the insert bearing's O.D. This Grommet is used for reducing the noise. Cast Stainless Steel Housing is another kind of housing. The main purpose for making these housings is to prevent the corrosion against other contaminants and exposure to liquids. In food and beverage industries, these housings are mainly used. In these industries, the equipment have to keep hygienic, and therefore, these equipment’s are washed frequently.

2.5 Roll Chocks Maintaining: Features

The maintenance process of the Roll Chock is very important. The bearings and Roll Chock maintenance process is a comprehensive sub-system of the RMS providing maintenance scheduling and also recording for plain bearing, roll chocks, thrust bearings and roller bearings. The entire maintenance schedule is recorded through highly inherent data entry screens such as Roll Chock Maintenance Wizard. The features of this maintenance process are: Intuitive screens based on chock and bearing engineering diagrams. Detail recording of condition and dimensional checks. Recording of chock and bearing damage histories. Schedule component maintenance on basis of usage rather than time.Bearing performance analysis by type Significant. The hardness of the parts, which are being contacted by the backup roll chocks, is a very important material consideration for the backup chocks. This is because, if there is a difference between the hardness of two contacted par. Industrial Application: Steel Mills, Sugar Mills, Petroleum Industry, Cement Industry, etc.

2.6 Rolling Mill Housing

Housings are elements in a rolling mill that enclose and support the chock assemblies, the adjusting mechanism etc., and retain them in their proper positions. They set the rolls in correct vertical and horizontal position. An example of housing is shown in Figure 1 (a).

Fig. 2.1: Housing of rolling mill

III. EXISTING DESIGN OF CHOCK

3.1 Introduction

The housing of a work/backup roll bearing is called a chock. It is mounted on the window of the housing between the posts with a small clearness in open bearing the chock is usually a U-shaped frame of cast steel .in small mills when rolling is carried out with fixed pass setting the linings are usually mounted directly in the chock. In large mills where the roll is adjusted after each pass (blooming, primary, and plate mills), lining in boxes is mounted in the chocks. The lower roll chock is covered to prevent scale getting into the neck bearing, and to the lower part of the upper roll chock is fastened a support with an additional lining for holding up the top roll when the mill is idling. Housings are elements in a rolling mill that enclose and support the chock assemblies, the adjusting mechanism etc., and retain them in their proper positions. They set the rolls in correct vertical and horizontal position. Their construction and dimensions have to take into account the sizes of various other elements. The forces, which act on the rolls during rolling, are completely transferred on to the housing. So, the housing of rolling stand requires high rigidity, sufficient strength for taking the loads, simplicity of design and minimum cost of production.

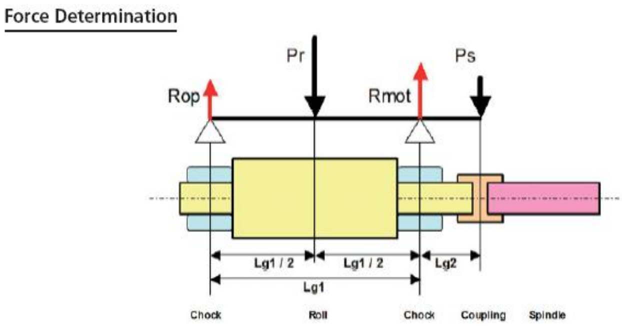

Fig. 3.1: Forces acting in rolling process

The chock strength can be ascertained approximately allowing for screw-down pressure and the tilting moment due to friction forces Q from the housing preventing the turning of the chock are

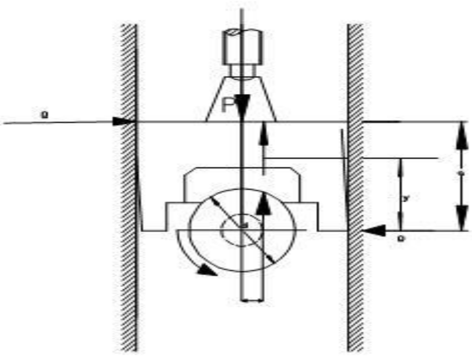

Fig. 3.2: Forces acting on top roll chock support

Q = (P/A)*l

Q= (P/A)* µ* d/2

Where

P = the pressure of the screw down, a = the arm of the couple Q , l = the radius of the circumference of friction µ = the coefficient of friction, d = the neck diameter,

The greatest bending moment will being the cross section I-I, where the bending stresses are defined by the formula

= Q y/w

Where,

y= Arm of the forces Q to neutral line of the section under consideration, w= opposing moment of the section I-I

The estimated stress on the surface of the chock allowing for the specific pressure p on the foot of the screw down is

Cal = ó +p

The top roll chock support is considered as a beam held at two points. The bending moment acting in the middle of the support

M=G/4*(l-b/2)

Where,

G = load on roll neck when it is idling, l = distance between the bolts, b = width of the lining ,Middle roll chocks in three high mills .with the exception of mills havingan adjustable middle roll and three high blooming mills, are calculated for bending using equations Except that in this case the value of G is equal to the pressure on the roll neck during rolling, and is equal to the t distance between the chock supports .in view of the limited size of the middle roll chocks and the large bending moment it is recommended that they should be made of forged steel with improved mechanical properties.

3.2 Material Used For Chocks

The original Roll Chocks are manufactured by fabricating from cast steel or gray cast iron. The cast iron from which such Roll Chocks are manufactured should contain carbon from 0.2% to 0.3%. In cast Iron Roll Chocks, minor welding repair is possible but major welding repair is not possible to these cast iron Roll Chocks because the major welding repair, large amount of welding material is required.

IV. MATHEMATICAL ANALYSIS OF CHOCK

4.1 Manufacturing Process of Roll Chocks

Roll Chocks can also be made of steel casting but in this manufacturing process a great diligence and utmost care are required. Especially, during the formation of precision holes of roller bearings and machining of diameters of these chocks, high degree of accuracy is needed. Surface accuracies of the holes those are present in these chocks is very essential.

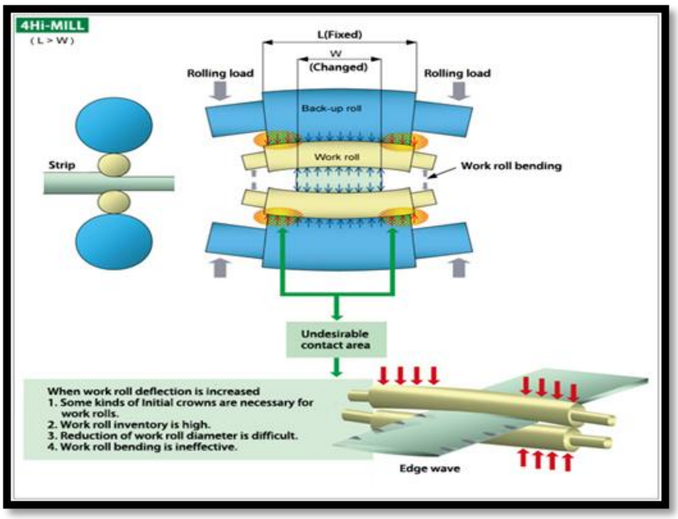

Fig. 4.1: Pressure diagram

4.2 Calculation of Roll Load

The force on the frame is the force applied by the rolls. It can be calculated by the most commonly used T-selikov theory. The forces on the roll neck and in the housing posts are identical. The strength of the neck (with a constant relation between its diameter and length) is approximately proportional to $\mathbf{d}^2$

Where **d**= diameter of roll neck bearing.

For various mills, roll load depends on the roll material.

The structural properties of mild steel material

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Properties	Values
Young's modulus	2 e11 N/m^2
Poisson ratio	0.266
Density	7860 kg/m^3
Yield strength	2.5e8 N/m^2

Table No-1: structural properties of mild steel material

Material	Roll Load, N
Iron rolls	(0.6-0.8)d^2
Carbon steel rolls	(0.8 to 1.0) d^2
Chromium steel rolls	(1.0 to 1.2) d^2

Table No-2: Roll load

4.2 Numerical calculations of forces of Chock

Working Pressure= 210 bar

= 21N/mm^2

Bore Dia. = 400mm

Rod Dia.= 350mm

Testing Pressure = 315 bar

Cylinder Force = P x A

= 21 x 0.785 x $(400)^2$

= 2.6376x10^6

= 2637.6KN

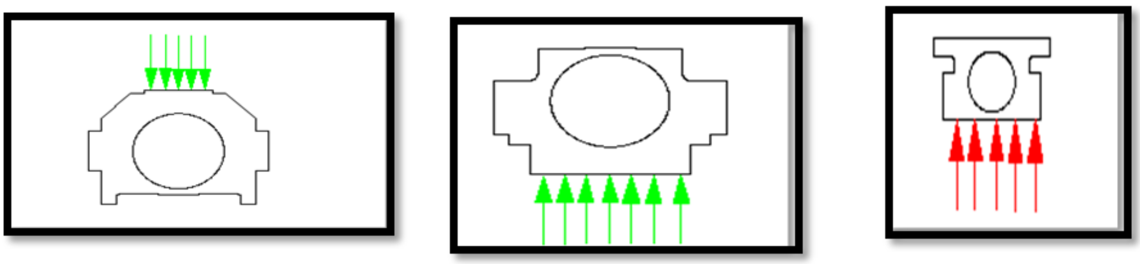

Fig. 4.2(a):Top Backup Chock **(b)Bottom Back up Chock** **(c) Top Work Roll Chock**

Pressure Acting on top backup chock

= Cylinder Force/Top Backup Chock Area

= 2637.6x10^3/ (450x300)

= 19.53N/mm^2

Pressure Acting on Bottom backup chock

= Cylinder Force/Bottom Backup Chock Area

= 2637.6x10^3/ (810*405)

= 8.04N/mm^2

Pressure Acting on Top Work roll Chock

= Cylinder Force/Top Work Roll Chock Area

= $2637.6x10^3$/ (550x350)

= $13.7N/mm^2$

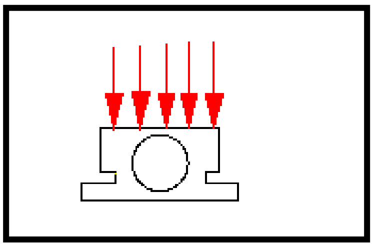

Fig. 4.3: Bottom Work Roll Chock

Pr

essure Acting on Bottom Work roll Chock

= Cylinder Force/Bottom Work Roll Chock Area

=$2637.6x10^3$/ (720x350)

=$10.4N/mm^2$

V. CONCLUSIONS

This paperreviewsthe earlier literature, which gives information about chock material and its operating conditions. The earlier literature only gives the idea about critical areas where the stresses can be induced at maximum level during the working conditions. From this literature we study that by using Finite Element Analysis the weight of chock can be reduce without affecting the life cycle of the rolling mill housing. The rolling chock can be design by applying Computer Aided Design and Engineering method for rolling housing mill and pressure generated on the surface of chock.

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