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Analysis of Roller for Hot Rolling Mill

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Abstract – *Temperature of the work piece influences spread appreciably. Breakages of work roll journals caused by bending or torque are mainly spontaneous ruptures due to high peak loads. This is also valid for barrel breakage of work rolls and in particular for 4-Hi work rolls. Journals breaking due to high torque on the drive end of work rolls have to be considered as predetermined breaking points in the case of mechanical overloads from setting the wrong roll gap, foreign bodies entering the roll gaped. This applies if there is no other protection equipment against torsion overloads or if this equipment is not working correctly.To development the model and analysis which facilitated research on surfaces. This research enabled the identification of mechanisms present during wear, at both the laboratory level and the industrial level.To develop a mathematical model for predicting the wear behaviour of bearing rolls that is used during hot rolling phase in production lines. Such a model would allow monitoring and prediction of roller wear to optimise the rotation, maintenance, and replacement of rollers, minimising corrective maintenance, downtime, and failures that could affect product quality.Most of the existing wear models use a series of analyzed variables and empirical coefficients.*

Keywords- ***Empirical Methods, Homogeneous Deformation Method, strain and temperature distribution, Slip Line Analysis.***

I- INTRODUCTION

Today, there are roll grades available which provide good performance down to discard size without abnormal stock loss for all established rolling operations if standard rolling conditions prevail. Of course, correct handling of the rolls is essential including campaign length and adequate dressing practice with appropriate non-destructive testing. In addition, measurement of additional features such as wear profile and work hardening can also be Beneficial. When specifying work roll grades for wide strip mills, roll manufacturers need to know the rolling conditions and in particular the Finishing Mill stand number in which the roll will be used, the specific rolling loads per unit of strip Width and the maximum rebinding applied through the journals. These facts will determine the selection of materials for the core and working layer on the barrel surface for compound rolls. Despite careful attention from the roll supplier and user, roll failures will happen in service which lead to partial or total loss of the rolls and may even cause subsequent damage to rolling equipment. These frustrating failures can have different kinds of origin related to either roll manufacture or the specific rolling conditions. The topography of the fracture indicates whether the breakage was matter of severe peak load or a fatigue fracture. Fatigue fractures start from primary cracks and grow progressively generating a classical fracture surface. These fractures are relatively smooth and exhibit arrest lines. Once the fatigue fracture achieves a critical size, a spontaneous rupture of the remaining section occurs. Typical examples of fatigue fractures include spalling of back up rolls and journal breakage of back up rolls or 2-Hi work rolls starting from the fillet area. (Stress corrosion may be involved). Breakages of work roll journals caused by bending or torque are mainly spontaneous ruptures due to high peak loads. This is also valid for barrel breakage of work rolls and in particular for 4-Hi work rolls. Journals breaking due to high torque on the drive end of work rolls have to be considered as predetermined breaking points in the case of mechanical overloads from setting the wrong roll gap, foreign bodies entering the roll gaped. This applies if there is no other protection equipment against torsion overloads or if this equipment is not working correctly.The roll journal failure prevents catastrophic damage of mill equipment such as spindles, gear boxes and drive motors. Failures resulting from torsional overloads show fracture planes at 45 degrees to the axis. To limit milldam age, a correct design of the weakest section of the drive end of the work roll related to the journal material and maximum design torque is recommended.

II - ANALYSIS

Slip-line field analysis allows the introduction of a more realistic model of metal flow. It utilizes a graphical approach, which presents the flow pattern in the deformed metal in a point by point basis. Alexander (1955) presented the first slip line field solution for hot rolling of wide sheets. He only offered a single and simple geometry of rolling. Crane and Alexander (1966) used new slip line fields for hot rolling to predict the deformation of the metal for a wide range of geometries. Dewhurst et al. (1973) presented a series of slip line field solutions for hot rolling of wide sttip, which was further discussed by Druyanov (1973). Slip line field solutions permit the determination of stress and velocity distributions in the plastic deformation zone. However, this method is only valid for assumed rigidperfectly plastic non-hardening materials (Shabaik 1968).

The basic assumption: is that strain is continuous and the volume of the material remains constant when its shape changes. The shape change must correspond to the flow velocity of the material. The method is more valuable in metalworking, where it is important to know the upper bound solution, to ensure the calculation of the load necessary to complete the forming operation. A detailed description of the technique would be lengthy. However, Figure 1. Illustrates a simple upper bound solution for plane strain extrusion. It has a reduction in area of 2: 1. Complex shape change will not usually be plane strain and hence the deformation will only be approximated by this calculation. The simple example demonstrates the principles.

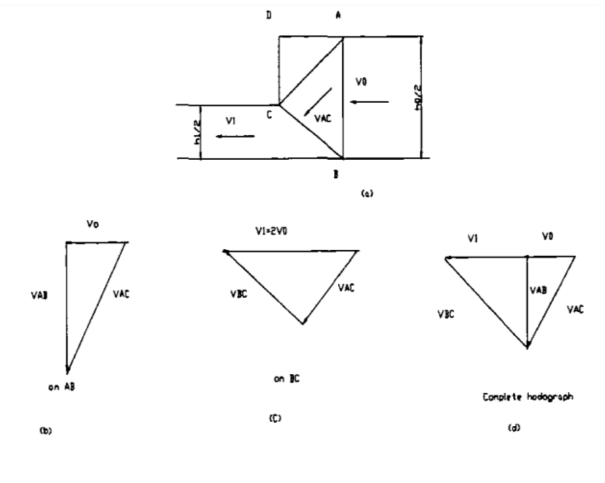

Figure 1. Upper bound solution for strain extrusion (Lyndon 1990)

The analysis of the Rolls and Billet is done in Ansys 15.0 and the analysis reports are as shown below. The geometry and the mesh model in Ansys are as shown in the Fig.2 below respectively.

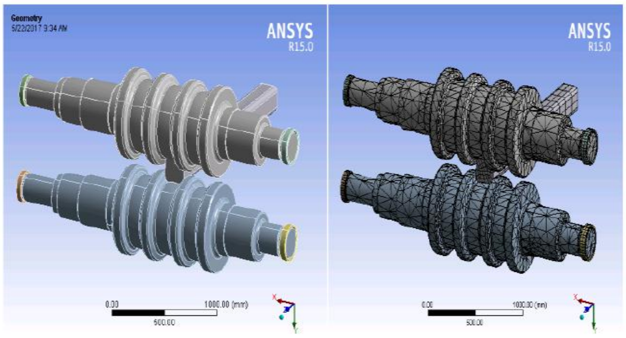

Fig.2 Geometry of the Rolls and Billet

III - FUTURE SCOPE

Hot wear rate is directly proportional to the normal pressure on roll surface. Average rolling pressures can be considered to be in range 100 - 300 MPa. The corresponding cyclic stresses, amplified by thermal cycles, in roll surfaces are estimated to amount to ±500 MPa. Cyclic loads result in material fatigue and other forms of surface deterioration. Besides the well-known mechanisms of cyclic softening and corrosion fatigue, there is growing evidence of the damaging influence of tensile stress during the contact fatigue, leading to cracking and pitting . In addition, it has been found that cyclic pre-stressing has a significant influence on the material removal process in sliding wear . A related question is the actual distribution patterns of the rolling loads and stresses. The observed non-uniform wear, particularly the unsymmetrical wear of the symmetrical calibres, illustrates the significance of the irregular pressure distribution. The appreciation of these contrasts in stresses has led to the introduction of different materials for top rolls and bottom rolls in the practice of section rolling. If metal flow is not appropriately allowed for in roll pass design, metal is unnecessarily forced to exert additional localised pressure and wear on the groove walls. There are in fact basic principles for roll pass design in existence, where roll wear is among the main criteria. Higher loads and draft non-uniformity should be applied in the initial passes and they ideally should diminish in the finishing passes. Rolling loads and stress distributions should be designed to ensure stable and uniform wear of finishing calibres. Corrosion fatigue can be suppressed by proper design considerations aimed at reducing stress. The tensile component of stress causes stress corrosion. Residual compressive stresses, deliberately introduced through an adequate heat treatment, will suppress crack initiation and growth, as well as stress corrosion and fatigue. Geometrical aspects (eg roll diameter) have considerable effect on tool life via associated stress and heat concentration. Considering the feasibility of influencing stresses and loads as process variables that can be controlled by roll pass design, this established correlation between stresses and surface deterioration must be an important aspect of research into roll wear.

IV - CONCLISION

The combination of both Finite element method and Matrix-based hot roll design provides a hot roll design methodology with a systematic approach. It includes the existing formulae, empirical data, experimental graphics, and technical methods for hot roll pass design. This study has included a lot of existing empirical knowledge of experts as well as the results of research into new approaches. For specific hot rolled products, by comparing the different formulae conditions of application, graphics data and computer simulation results, the optimum formulae and data can be chosen after discussion between the designers using the matrix. The optimum manufacturability of the rolled product is thus ensured from the optimum design, as early as possible in the design stage. Further; the matrix also provides a systematic viewpoint and facilitates the consideration of hot roll design, not only based on the traditional methods, but also from the more modern techniques such as: Concurrent Engineering (CE), the planning of manufacturing, Computer-aided Design (CAD), Finite Element Method (FEM) and other methods.Steel rolling is recognised as one of the most important industrial processes. Rolling using grooved rolls (as a category different from groove-less rolling) is the most common practice in production of steel sections. Key tools in this process are the rolls that contribute up to 15 % of production costs. A main cause of roll consumption is due to continuous wear, complex process where mechanical and thermal fatigue combines with impact, abrasion, and corrosion. The necessity to compensate for the non-uniform wear during machining is an additional aspect of roll consumption. An area of specific interest is concerned with abrasive wear within the environment of rolling in grooves, where the nature of the deformation zone can accelerate roll surface deterioration.The published research into roll wear is mainly concerned with the effects of roll material, oxide scales, temperature, normal force and sliding velocity. Though a selective application of numerous roll materials is decisive for roll consumption, there is no general index for determining their resistance to wear. Several authors have examined how temperature has affected the wear of various roll materials via corrosion, formation of oxide films and fatigue. Detrimental influences of the rolling load and relative slip on hot wear are clearly proven. On the other hand, the published works give very little, if any, information on the possible ranking and interactions of wear factors. In addition, there is a lack of knowledge about the influence of bulk stress in roll material on abrasion.

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