INVESTIGATION INTO SOURCES OF CHATTER AND VIBRATIONS IN COLD ROLLING MILLS

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ABSTRACT

Dynamic phenomena in rolling mills, generally known as chatter, not only overloads the mechanical components of the rolling mill structure but also give rise to variations in gauge or to shape defects in the rolled strip. A complete study on chatter analysis in cold rolling mills was carried out in the current work. It considers an innovative idea of taking into account the forcing load functions, which are rising through the interdependence between the rolling mill structure and the phenomena in the roll-gap during the plastic deformation of the metal. In this paper, initially two mathematical models have been proposed to represent the rolling process and rolling structure. Then, by combining these models, a complete expression of mill behavior under dynamic conditions was obtained. Subsequently, mill behavior is investigated as a function of a number of mill operational parameters, using established linear system analysis methods. Such parameters as friction coefficient, strip entry velocity, strip width, and thickness, forward and backward tensions and reductions ratio are considered. Finally, the validity of the model was verified by comparing the results from the model with those obtained from experiment on a specific cold roll mill machine.

Keywords: Chatter, Rolling, Vibration

1. INTRODUCTION

As technology has continuously provided better solutions for rolling flat strip at high speed, one problem generally referred to as chatter, has remained persistent and prevalent in rolling mills throughout the world. This kind of undesirable mechanical vibration or oscillation has been investigated by industrial and academic researchers in the mid 70's; since then, many different models and solutions have been proposed in the attempt to understand and eliminate chatter in strip rolling and provide satisfactory explanation for rolling instability. Moller and Hoggart [1] and Monaco [2] are the first who investigated torsional chatter occurred in a very low frequency range of 5 to 20 Hz. This kind of chatter has little influence on strip quality. Roberts [3] investigated second and third type of chatter. He called these types of chatter as a third and fifth octave mode chatter because the frequency of these kinds of vibrations is in coincidence with third and fifth musical octave. Third octave mode chatter is also called gauge chatter. It usually happens in a frequency between 125 to 240 Hz and it is the most serious kind of chatter that is characterized by a very sudden occurrence. The vibration usually reaches its maximum amplitude within few seconds and resulting severe and unacceptable gauge variation on the rolled strip and very pronounced tension fluctuation between stands, often resulting in strip breakage.

Fifth octave mode chatter that is also designated as the roll chatter, occurring in the range of approximately 500 to 700 Hz. This chatter is generally accompanied with the creation of chatter marks on the rolled strips and on the rolls. It, in turn, may become the source of more detrimental forms of rolling chatter, e.g. third octave mode chatter. The striations may become very distinct on the products, in which a light paint coating or electrodeposited paints are applied (critical for automobiles, appliances, etc.) [4].