INVESTIGATION OF INFLUENCES OF OPERATIONAL PARAMETERS ON CHATTER VIBRATION OF COLD ROLLING MACHINES USING FINITE ELEMENT METHOD

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ABSTRACT

Chatter is a particular case of self-excited vibrations which arise in rolling operations as a consequence of interactions between the structural dynamics of the mill stand and the rolling process. Dynamic forces generated in the rolling process deflect the structure of the mill, leading to variations at the roll gap and the roll speed. In such a condition part of the energy of the mill's drives is transformed into vibratory energy of the structure. In this paper, the chatter vibration of cold rolling machines is analysed using the finite element method (FEM). The model presented here contains two sub models; one for the structure of the mill and the other for the rolling process. The structure of the mill stand is modelled as a system of linear springs and lumped masses. An implicit FE model is used for the rolling process. The whole model is then utilized to detect the chatter vibration of a cold rolling machine. The influence of rolling parameters such as the rolling speed, reduction and friction coefficient on chatter vibration is also investigated.

Keywords: Chatter, Rolling, Self-excited vibration

1. INTRODUCTION

During the skin pass rolling, the operation is often accompanied by undesirable mechanical vibrations originating chatter mark on thin strip. Chatter could lead to unacceptable gauge fluctuations, sheet corrugations, surface imperfections, damage to mills and undesirable noise in the work environment.

Three different chatter regimes are reported; (i) Torsional chatter, (ii) third-octave-mode chatter, and (iii) fifth-octave-mode chatter. The first is related to the torsional vibration of the rolls while the other two are related to the vertical vibrations of them. These are distinguishable primarily with respect to their frequencies. The torsional mode is within the range of 5-15 Hz. This type of mill chatter has been investigated by Moller and Hoggart [1] and also by Monaco [2]. The frequency of vibration, in the third-octave mode, is in the range of 125-240 Hz. This type of chatter is often referred to the gage chatter, which may occur in one or more stands of high-speed tandem mills, generally exhibits a frequency about 200 Hz. For the fifth-octave mode, the frequency of vibration is between 550 to 650 Hz. The fifth-octave mode has been observed on tandem and temper mills. Fifth octave mode chatter is generally accompanied with the creation of chatter marks on the rolled strips as well as the rolls which, in turn, may become the sources of more detrimental forms of rolling chatter, e.g. third octave mode chatter. Fifth octave mode chatter is unique in the sense that it tends to develop gradually, and it is usually not as difficult to suppress as the third octave mode chatter [3]. The major reasons that, the fifth octave mode chatter needs to be understood and controlled are related to strip and rolls. On the strip, it produces subtle, transverse striations across the surface but no corresponding thickness changes of significant magnitude. The marks manifest themselves as discontinuous dark and light regions, on the top and