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THE MONITORING OF CHATTERING IN COLD ROLLING MILL SYSTEM WITH FIVE STANDS FOR THIN STRIP

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ABSTRACT

Each system (stand – driving) and the continuous rolling line to which it belongs have its own functional and energetically parameters. To reduce any faults of the strip surface it is also necessary to check (eventually having a control line) the roll surface quality, the work roll eccentricity, and depending on the disposal by compensation, of eccentric lobes. The appearance of the specific faults on the rolled strip-during the experiments carried out is duet o the vibrations covered by the range of 100-300 Hz. This many-sided theme needs mathematical patterns to correlate the factors and the dimensions (strip types, technological flow, driving) which should be able to basically support the monitoring system. Taking into account the aspects regarding the quality of the surfaces, the geometry of strips and the costs, it necessary to do a monitoring

KEYWORDS: chatter, monitoring, stand, work parameters, accelerometer

1. Introduction

In this paper is show the most important dynamics' loads and there influence on the cold rolling mill process.

The most rolling mills equipments work in very hard dynamics conditions and loads [4].

A lot of equipments (machines, components etc.) are singulars and have greatest influence on the price and productivity.

In work, is very important to reduce the dynamics load [5], to choose the optimal parameters, to foresee the adequate dumping device and moderns systems to deaden the stresses and tensions in equipments of rolling mill.

Greatest dimensions for strip have an important influence on the mills equipments.

In the fig. 1 is show the schedule of rolling mill machine with five stands and the position of the accelerometers (on the chocks of the work and backup rolls).

It is important to diminish the dynamics loads from the beginning of work program for obtain an optimal cinematic scheme for all components of mill.

The High-Tech Rolling Mill is distinguished by the use the integrated adjusting mechanism and control systems foe quality assurance in the final product.

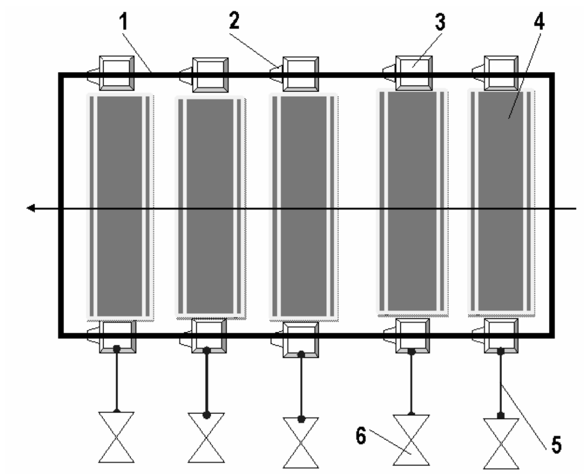

***Fig. 1.** Measurement vibration system on the mill stand: 1. Rolling mill frame; 2.Accelerometer; 3.Backup roll; 4. Mill roll; 5.Coupling bar; 6.Engine.*

Using the rapidly reacting work roll bending facility for roll gap correction is made an outstandingly dynamic adjusting system [2].

The work bending system installed at the five stand of the mill machine carry out the adjustment commands transmitted from the flatness control system.

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Hydraulic screw down is an operationally reliable and dynamic adjustment mechanism for controlling the strip thickness. Expansion of strip products and different size and strip thickness determine the construction of universally coilers for complete the all range of cold strip thickness and width. The sturdy wrapper roll system guides the strip head to the start of the coiling operation around the mandrel. As the wound material passes over the strip head position the wrapper rolls must be able to very quickly deflect otherwise the large moment of inertia of the system would cause damage to the strip. It is not possible to achieve this objective deflection of the roll with conventional method operated coilers.

2. Studies of vibrations on the cold rolling mill

In previous study of hot cold strip mill vibration we established a relations ship between mill chatter, mill speed and the phasing and number of teeth in the mill spindles.

The specific problem studied was chatter occurring at finishing stand of strip mill, when is produced an accelerated roll wear on the bottom work roll and is observe a strip marching.

The strip and roll marking (like a pattern) is visible occurred, when the chatter was present. The vibration has been exists on the cold rolling mil machine for a considerable time and, for unknown reasons, the frequency and intensity of occurrence varied in time [1].

The case study consisted of the following phases:

-Finite element modeling to determine natural (frequencies and vibration mode shapes of mill stand [3];

-Analysis of load cell signals with strip recorder and spectrum analysis;

-Drive train analysis to establish forcing function;

-Tests in which spindle teeth phase angles were adjusted to minimize chatter.

A correlation between chatter and spindles has been established. A better understanding of this problem will permit a further reduction in chatter and increased roll life. In our analysis, the inclusion of spindles in the model has provided additional information on the important subject of low frequency mill stand vibration [6]. The transition from the operator side elevation shows us the deflection of mill stand at a particular frequency. The chatter are measured (between 110-320 Hz.) and identified with accelerometer fixed on the backup roll chock. The measured system has a filter, signal amplifier, a process interface, a computer and a printer (fig. 2).

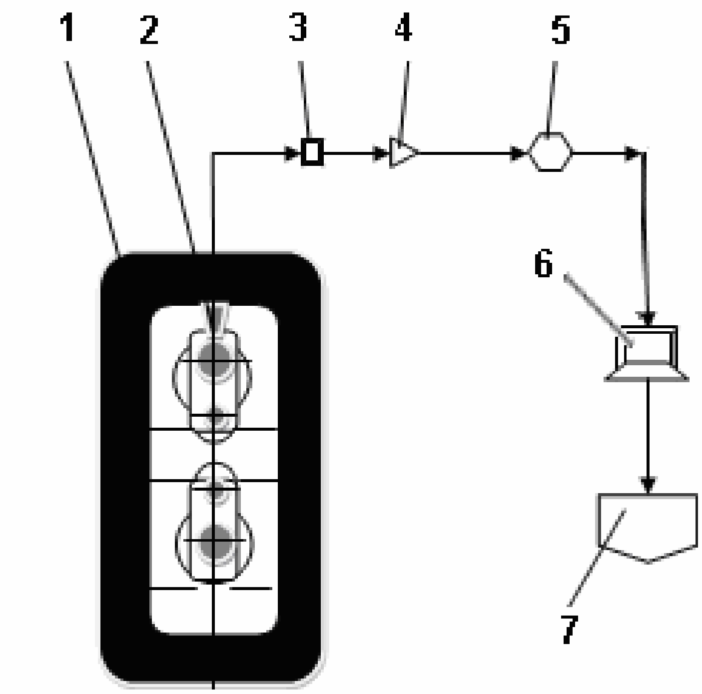

Fig. 2. *Measurement vibration system on the mill stand: 1. Rolling mill frame; 2.Accelerometer; 3.Filter 4. Signal amplifier; 5. System interface; 6.Process computer; 7. Printer.*

Finite element analysis models, confirmed by mill tests, indicate that spindles and their subsequent effect on work roll neck deflection are a potential source of mill chatter.

During a production run (identical coils), vibrations were measured with an accelerometer.

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During a production run (identical coils), vibrations were measured with an accelerometer.

At the last the finite model was in agreement with the vibration measured on the work roll necks.

If vibration propagation started at the drive, the chatter marks on the bottom roll land strip should be intense on the drive and of the work roll land strip.

The stress is still less than the yield strength, which implies that there might be a fatigue failure problem but the housing of mill will not fail duet o yield under the normal operating force. If the housing has the possibility of fatigue failure what is the life expectancy based on current and projected future production. For the growth of the housing mill life we must to found a new type of design for that. The variations of the strip thickness during acceleration and deceleration are caused by fluctuation of the friction coefficient between the rolls and strip the inter stand tension and roll force at each stand [6].

When the roll gap is constant, the relationship between the change of roll force (ΔF_1)and the change of strip thickness (Δh) is:

$$\Delta h = \frac{\Delta F_1}{M}$$

where: M is the equivalent mill rigidity modules.

Equation is applied at each stand in tandem cold rolling mill and the inter stand tension connects all stands simultaneously.

During acceleration and deceleration, rolling condition change and simulation is affective to study total characteristics during non steady state rolling.

Top backup roll and bottom backup roll, generated occurrence and oscillatory vibration. That is not influenced by the structural resonance's of the mill, is caused by roll eccentricities. Most modern cold mills are equipped with x – ray or beta – ray gage measurement equipment that can detect fluctuation in the gage of the rolled product at frequencies up to 25 Hz.

The frequency spectrum of the gage deviation can be seeing in fig. 3.

In the case of unstable vibration due to feedback mechanism, the vibration amplitude (fig. 4) will continue to grow in amplitude at an exponential rate until the forcing function is reduced enough to counteract the effect of instability.

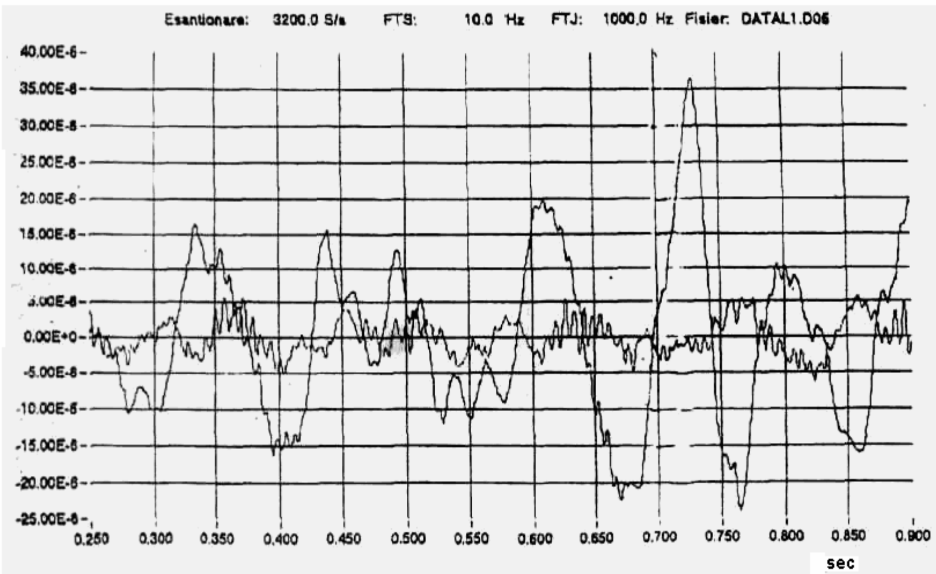

Fig. 3 *Displacement frequency spectrum.*

Some problems types that occur frequently in cold rolling mills are:

Sources of excitation are: excessive reduction; fluctuation of tension between entry and exit side; backup rolls wear pattern; the work roll bearing is defect; entry tension is excessive; oil temperature bearing is increase; uncontrolled quantity of lubricant on the strip.

In the normal operation speed of the mill, the cause of the third octave chatter is the strip surface.

For the fifth octave chatter (520-710 Hz.) the most important sources of excitation are: defective work roll bearing; strip with chatter marks; a wear pattern on the backup roll, the work roll bearing is defect; the surface of work roll has some undulation.

In most cases the vibration signal received by the housing is much smaller than that of the roll chocks.

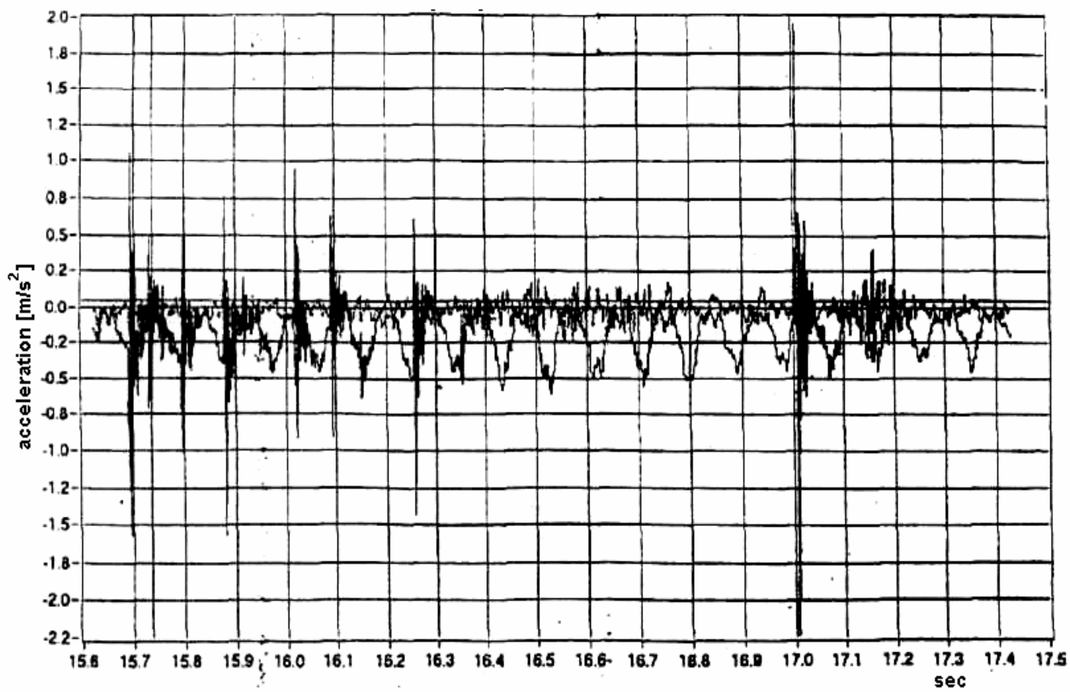

Fig. 4. *Acceleration spectrum for mill plate.*

The vibration of mill is influenced by one on more resonant frequencies of the system. Vibration becomes unstable duet o the influence of some force feedback mechanism which is direct result of the initial vibration caused by variation of technologically parameters, like: strip speed (acceleration, deceleration, displacement, fig. 3, 4), tension and roll force at each stand, strip thickness etc.

3. Conclusions

The study revealed that the maximum vibration occurs at the work roll. For vibration monitoring the best location for an accelerometer would be the roll chocks. A force spectrum, including instantaneous force changes can be established by combining the average in coil force variation and coil to coil force variation. The former is usually obtained directly from force and strain gage measurement. The amplitude stress can be computed for the amplitude to mean ratio. Further mathematical derivation and assumptions lead to the upper and lower bound estimate can eliminate the measurement of in coil force variation which is costly. The average amplitude force can be roughly estimated by observing the rolling force in work of mill. A detailed finite element analysis on the mill housing is necessary to convert the force into stress using the proportion rule. At the end we see the correlation between the measurement signals, load and vibration and characteristics defects of installation. A complete system of chatters monitoring, could advertising at time the moment when something is wrong – a malfunction – with the rolling mill. By using a combination test and analytical methods to initially diagnose problems, combined with continuous and automated monitoring for rolling mill to detect further occurrences defects in function.

References

[1]. Keller, N. et al., 2005, *Vibration analysis of Stand F2 in Cold Strip Mill*. AISE Year Book, pp. 205-210.

[2]. Lin, Y. J., Suh, C. S., Langari, R., Noah, S. T., 2003, *On the Characteristics and Mechanism of Rolling Instability and Chatter*, Journal of Manufacturing Science and Engineering, Vol. 125(4), pp. 778-786.

[3]. Poplawski, J.V., and Seccombe, D.A., 1980, *Mathematical Modeling of Cold Rolling in Tandem Mills*, Iron and Steel Engineer, Vol. 58, pp 47- 59.

[4]. Rusinski, E., Moczko, P., Przybyłek, G., 2005, *Degradation of roller mills load carrying structure -experimental and numerical identification and investigation of reasons*, http://cdm.unipr.it/das2005/papers/88.pdf, accesat 05.2007.

[5]. Voinea, R., Voiculescu D., 1989, *Introducere în mecanica solidului cu aplicaţii în inginerie*, Editura Academiei.

[6]. Yarita I., Furukawa K. et al., 2004, *An Analysis of Chattering in Cold Rolling for vibration gage strip steel.* Transaction of the Iron Steel Institute of Japan, 19, nr. 1, pp. 1-10.