THE ANNALS OF “DUNAREA DE JOS” UNIVERSITY OF GALATI.
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N^0. 2 – 2009, ISSN 1453 – 083X

MONITORING OF THE ROLLING MILL VIBRATION

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ABSTRACT

These researches show the influence of mill vibration on the thickness profile of the stainless steel sheet. The alloy elements like Ni and Cr inside the stainless steel could amplify the rolling mill vibration and determine severe damages for rolling sheet. These damages consist in variation of thickness on the length of strip. We made recordings of vibrations during the rolling process and we propose an integrate system for vibration monitoring.

KEYWORDS: mill vibration, sheet thickness, monitoring, sheet damage

1. Introduction Vibration monitoring in rolling mills

During the rolling process, the oscillation of mill stands installation is produced for reasons of construction (coupling, gear box, gap into the back up rolls and coupled bars).

The process parameters (sheet tension, mill speed, deformation force and thickness percentage of reduce in every cage), can determine a major influence on the vibrations.

The bearings lubrication or hydraulic cylinders for damping the oscillations of mill machine cannot decrease to a sufficient degree the rolling mill vibration.

We must ensure that the rolling mill machine operates with roll speeds at which the oscillation level will not determine severe diminution of the product quality.

This can be achieved by using an integrate system online vibration monitoring.

The aims of online vibration monitoring systems in rolling mills are quality control and a predictive maintenance for equipment functionability.

We used acceleration sensors seated on the rolls backup. The signals of the acceleration sensors are amplified, passed through low-pass filter, transformed in a digital signal and transmitted to a computer.

The result of the quality diagnosis is displayed online in the control unit. Figure 1 shows schematically the construction of the integrate vibration measuring system.

The online and offline-display of all the recorded data in different display modes, allows the performance of standard signal processing, the comparing with the` standard mill signal and a simultaneous analysis.

2. Measurement of vibration in a rolling mill stand

Figure 2 presents the results of gage chatter on a 4th stand cold rolling mill in terms of roll stand vibrations. We see an intense increase of oscillations in the 4 stand and after the decrease trend.

The results of the analysis showed that stand number four initially caused the gage chatter. The stand vibrations are transmitted in the strip beginning from the stand three.

The vibration showed a level of frequency of about 125 Hz. The change of the level of upper screw down, determines a reduction of the vibrations.

The record, what we made, shows the necessity to install a permanent vibration monitoring system at the rolling mill.

During the experiments we could analyze how mill stand resonance is exited by speed in correlation with the tension strip.

The speed, correlated with tension strip excitations is generally due to mechanical defects within the rolling mill, bearing and gear box. A very important problem is represented by work roll shape which depends on rolls wear.

This wear appears in time and determines a particular pattern on the surface of work rolls which is printed on the strip surface.

The level of vibrations can alarm us when damage is produced inside of mill machine. Mechanical damages causes can represent interne excitations whose effects depend on many strip parameters (material, width, thickness etc.), and thus do not appear during each pass in our research.

The cumulative frequency-speed has been developed to simplify the evaluation of vibration spectrum.

This cumulative frequency-speed has the greater time basis and can equilibrate the distribution in the cinematic of rolling mill.

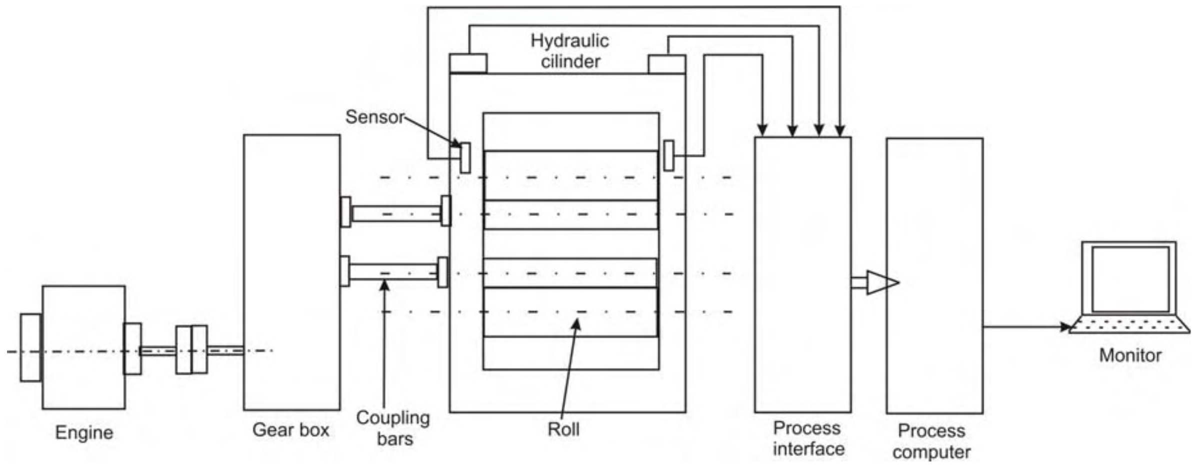

Fig.1. *The integrated on line for rolling mill monitoring system.*

3. Measurement of coupling torque

The measurement of coupling torque is necessary because a lot of dynamics effects are transmitted from the propulsion system. This dynamics effects are transmitted like oscillations from engine, through coupling, gear box, coupling bars, to work rolls to backup rolls inside the milling stand.

The torque monitoring systems for rolling mills can create predictive maintenance strategies and optimize the rolling process.

The measurement was made in three round and the results are shown in table no.1.

Table 1

Mill vibr. / No. of frame	Vibration amplitude			Vibration frequency engine zone			Vibration frequency operator zone		
	[mm]			[Hz]					
	I	II	III	I	II	III	I	II	III
3	0.128	0.120	0.119	127.9	128.1	128.4	126.3	125.6	127.2
4	0.198	0.193	0.211	127.4	127.9	126.8	125.8	124.9	126.8
5	0.118	0.115	0.113	127.8	127.3	127.6	123.7	125.1	124.7

A torque monitoring system has a torque sensor, mounted on the shafts of the main drive (engine zone) of the rolling mill an interface for data acquisition and a process computer. The system has the possibility to record, display and storage the data about the level of torque online and offline display of time signal. The two systems (vibration monitoring and torque monitoring) can give the level and limit for rolling mill normal functionary.

The torque sensors used in rolling mills must be very robust due to the rough ambient conditions. A strain gauge was used for torque measuring and a system protects the strain gauge and the electronics parts on the shaft against industrial fluids or mechanical damage.

Torque sensors are sensitive and must be protected on during operation.

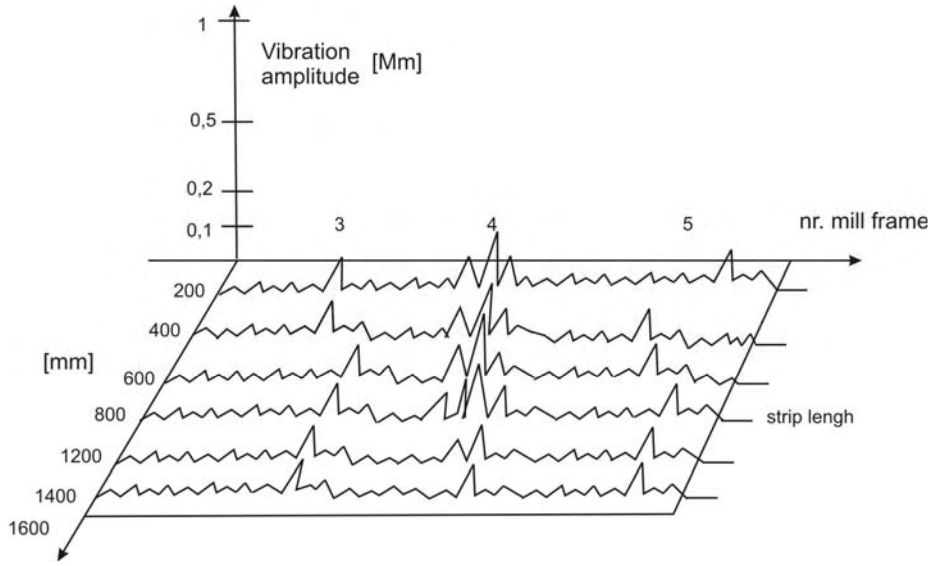

Fig. 2. *The spectrum of frequency-speed-cumulative of the vibrations measured at the last rolling on the three, four and five stands. The vibrations was measured during the rolling of 10 coils.*

4. Conclusions and results

The results of some examinations on different types of rolling mills illustrate the benefits of monitoring systems in rolling mills. The first example shows a machine-related pass schedule optimization.

This leads to longer lifetime expectations for the high loaded components of the main drive. The loss of production time is insignificant, but the lifetime expectation of the spindles increases dramatically. The use of integrate monitoring system means a constantly high level of product quality.

The heavy torsion chatter which occurs in the middle of the pass marks the surface of the block and causes severe damage to the drive.

A process optimization may be carried out if such events are recorded and analyzed. In this case, the lubrication system was improved in the last three years.

During the first pass the entering torque impact is very high. During the reversing pass a similar, but inverted characteristic was observed.

This research was developing in two directions: the first we analyze mill stand components during mill vibrations and the second, the actionnary system (engine, coupling, gear box, coupling bars).

This all, was doing to obtain a quality strip and a good maintenance for rolling mills systems. We analyze the vibration monitoring system to reduce the risk of gage or roll vibrations and than we measuring the torque inside of monitoring system, for process optimization and condition-based maintenance.

The diagram and the schedule presented here confirm the efficiency of the two systems to obtain a quality product.

References

[1]. Asch, A., Hohn, W. - *Monitoring System for Roll Stand Drives using Strain Gage Technology*. In: Proceedings of the 9th IF AC Symposium on Automation in Mining, Minaral and Metal Processing, S. 175 - 180, IF AC International Federation of Automatic Control, 1998

[2]. Farkas, T. - *Entwickung eines Verfahrens zur Identifikation von drehzahlpropor-tionalen und nicht-drehzahlproportionalen Storschwingungen an Walzanlagen*. Diplomarbeit an der RWTH-Aachen, 1999.

[3]. Hani, K. - *Untersuchung hochfrequenter Storschwingungen an schnell laufenden Kaltwalzanlagen.* Dissertation, RWTH Aachen, Umformtechnische Schriften Band 28, Verlag Stahleisen, 1991

[4]. Donkle HI, L. - *Fifth octave chatter problem solved using vibration analysis*. In: AISE Steel Technology, Volume 76 No. 11, 1999

[5]. Mackel, A., Cerv, H., KeBler, H.-W., Luckmann, F. - *Mill Diagnostic System (Mi-DaS) - a monitoring system with quality- and maintenance-related diagnostic functions.* In: Aluminium, Volume 74 (1998).

[6]. Mackel, J., Asch, A., Seeliger, A. - *Brummerschwingungen an Walzgeriisten vol-lkontinuierlicher Kaltwalzanlagen*: Detektierung, Verifikation, Vermeidung. VDI-Berichte Nummer 1220, 1995.

[7]. Mackel, J., Seeliger, A. - *Qualitatssicherung an schnell laufenden Walzanlagen.* In: Alma Mater Aquensis RWTH-Aachen (1995/96).

[8]. Mackel, J., Seeliger, A., Georges, D. - *Measurment and Diagnosis of Process-Disturbing Oscillations on Plants for Machine Condition Monitoring and Quality Control.* In: Proceedings of the XIV Imeko World Congress (1997).

[9]. Mackel, J. - *Maintenance and Quality Related Condition Monitoring in Rolling Mills.* Presented at the AISE Annual Convention in Chicago (2000).

[10]. Markworth, M. - *Querwellen auf kaltgewalztem Band*. In: Stahl und Eisen 114, Nr. 11(1994).