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MEASUREMENT AND ANALYSIS OF VIBRATIONS ON A COLD ROLLING MILL FOR STEEL STRIP

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ABSTRACT

In this paper the authors made measurements and registration of vibration by using accelerometers posted on the top backup rolls. This is a new way for predict the damage in the rolling mill equipment and the precision of laminated strip. Also is need this technology for monitoring the strip shape combined with a complex system of control for technological parameter of rolling mill process All these monitoring systems is necessary because the demands on the quality of rolled strip is happened in real time.

KEYWORDS: prediction, monitoring, strip shape, mill chattering

1. Introduction

The control of rolling mill process, consist in two ways. The first way is to analyze the rolling mill that deformed the material and second is to continuous recorded of drive and work parameters. It is the way to know where is the future damage that can to appear in the mill machine system and the possibility to prevent the malfunction and the default for the sheet dimension (rolled strip thickness differences).

Dynamic analysis of plate and strip mills is in the idea of reducing the weight of these assemblies, the failure to avoid excessive size and time required for certain parts dynamic. This analysis is done by comparing the initial vibration signal (at the commissioning of the mill) with the vibration signal measured after a certain time of operation.

Monitoring of parameters is practically the feedback from those who participate in the iterative process of optimizing the operation of the mill process. The measurement and calculation procedures described below apply known.

The innovations elements are accessibility, flexibility, speed and power. Necessary hardware features dynamic measurements can be grouped as follows: size mechanical transducers (strain gauge, force cells, displacement transducers, accelerometers, etc.).

The whole transfer function or functions derived from measurements of time recorded even if they were obtained by simultaneous acquisition can be used for graphical representation of distortions.

In case of transfer functions can be simulated deformations that occur under the action of forces other than those actually used for measurement. For example, disposing of transfer functions measured with the excitation pulse can simulate and plot the likely deformations under the action of a certain frequency sinusoidal forces. They can also be identified frequencies at which parts deformation is at maximum. Of all the research results made the current problem is to analyze the conditions for scientific working of rolling mills, the identification and quantification disturbing factors and finally, modern design, for increasing resistance, reliability, reduce consumption, ensure continuity processes and product quality finished [1]. All this led to the development of a general concept for the establishment of dynamic influences on complex machinery and quantification of the dynamic forces. The modern analysis of the tensions leads to the design with a minimum of approximation and uncertainty of sub-assemblies of equipment [2].

One of the main measures in the design and optimization systems for machinery important action is to determine the size of dynamic moments that may occur during operations.

2. Experimental procedure

2.1. Measurement of vibrations on the cold rolling mill machine

The equipment for measurement of vibration is described, with the main orientation for viewing and analysis of three-dimensional deformations of complex structures subjected to vibration stresses. The measurements were made with transducers placed upright, horizontal and axial position-on cylinders support in the operator side.

We have not registered print and sudden wave variations in the thickness of rolling strip. During the measurement we are recording signals during normal operation of the vibration sources in rolling mill machine work.

The conditioning has functions to convert the transducer output voltage in the standard signal (the voltage is between ± 1V and ± 10V with low impedance) to conduct or offsetting characteristics transducer linearity and limit the frequency of the field required. For acquisition board we use A / D conversion (National Instruments AT-MIO-16E2), computer (PC compatible). The last three components are part of the experiment, using Lab VIEW application. Without going into details of the transducers may be worth noting that virtually no restrictions on the type of sensors used or the manufacturer.

Minimum necessary to perform the full range of dynamic measurements is two channels of input and output channel.

Analog output channel can be used to generate the excitation signal and the two signal input channels to measure real and that the excitatory response [4]. By using multiple input channels and therefore more transducers, the exact same results are obtained but in a shorter time (shorter working time is not proportional to the increasing number of channels). Excitation signal generated by computer can be designed to cover a whole range of frequency and type can be selected by scanning sinusoidal noise type with limited bandwidth or pulse.

Vibrations of the functional parts of the mill frame are investigated by simultaneous recording of signals with two transducers (Fig.1). One of them is mounted on the backup roll (drive side) and the other is mounted on the other backup roll (operator size).

The vibration parameters (displacement, frequency and acceleration) are done automatically, without supervision. Partial results are saved periodically. If processing speed is very low we can eliminate disturbances that exceed the useful signal amplitude. The results are stored as average power spectra. Obtaining power spectra may take a while the order of minutes or hours.

Due to the modularity and compatibility of National Instruments products, system acquisition can be completed with programmable filters, galvanic isolators, analog multiplexers, bridges and other load cells.

Acquired signals are standard signals in the ± 10V voltage, single or differential, which enables connection to most types of existing sensors and signal conditioner. Acquisition system may include, besides the signal generator and digital PID controllers, DSP processors, in a series of products the company National Instruments Motion Control for controlling the operation of sources of vibration, hydraulic or electro [5].

For the first date the experiments were made on a laboratory cold rolling mill for steel strip in two phases, from February to October 2012 - with performance equipment and up-to-date acquisition equipment like: line of data acquisition: transducers, preamplifiers, filters, analog-digital converter; modal analyzer, with data acquisition in Lab VIEW programming environment. It was realized 115 different charts [5], have been made by this equipment. To make the measurements of: displacement, accelerations and frequency, transducers were fixed upper and lower cylinders support of considered rolling mills by the vertical and horizontal direction. (Fig. 1).

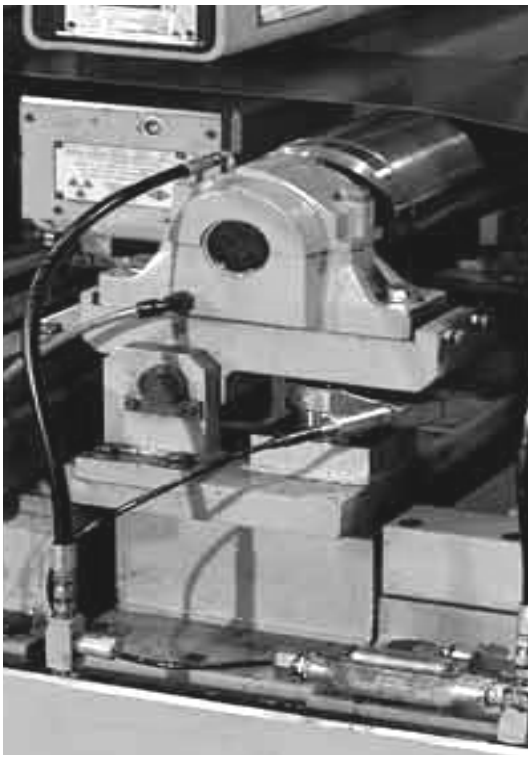

Fig. 1. *Accelerometers mounted on back-up of the cold rolling mill, (in the equipment laboratory), for vibration measurement*

The experiment that we made, lead to particular trends of mechanical properties and may be utilized for optimization of work parameters steel in a cold strip rolling mill, reflecting the specific requirements for a relation between strength and plastic properties of laminated carbon steel.

Other experiments were performed on the cold rolling mill machine for steel strip (LBR1-Arcelor Mittal S.A). It observe that in the last cages of the milling tandem respectively four and five, there are the recorded the lowest values for displacements, acceleration and frequency vibrations. These values represent the latest stage in the achievement of the finished milling product [5].

The measurements were performed on 28 cold rolled carbon steel strips, after which the change was made on the working cylinders. The frequency of vibrations are influenced by the speed of rotation of the cylinders, rolling force, the tension between frames, emulsion used - the characteristics of vibrations and they were recorded during mentioned periods of time - On the surface of the last 5 rolls rolled- before the change of working cylinders, we see traces and printings were noticed belonging to these cylinders.

3.3. Results and discussions

The measurements that are made on the laboratory equipment and in parallel on a real cold milling machine, showing the amplitude, accelerations and frequency spectrum of vibrations that occurred in the rolling mill process. The accelerometers are mounted on the lower and upper cylinders support, on the operator and the drive side.

Vibration measurement in cold rolling mill has been carried out with accelerometers being mounted on the work and bottom roll chocks. Strip thin was 0.4mm. Such result is obtained if we suppose that upper housing do not represent symmetrical stack part. Thick strip stable rolling was available at the high speed without chatter.

Rolling mill machine had the same technical condition and almost the same rolling parameters (steel type, work rolls, loads, speed between entering and exit from mill machine).

Even with a little output thickness deviations (aprox. 0.1mm) strip mechanical properties are preserving. It influences on damping properties of steel strip in the roll bite. Harder strip corresponds to less damping. Work rolls bending influence only high frequency to 980Hz [6]. Strip variable stiffness in the roll bite may be considered like an excitation parameter in the mill machine. Experiments with the mill drives rotation under the working loads and speed without strip between the works rolls shown that vibration signals is in another patterns It will be noticed by comparing these data that the highest value of movements was on cylinder upper support (Action part). This is due because of the existence of some vibrations coming from the chain of cinematic shareholders.

The acceleration measured and recorded maximum (shareholders) was about 4.4m/s^2 and from the operator side was about 3.8m/s^2 [5].

After measured and recorded of accelerations we can say:

- the highest amplitude of vibrations has been emphasized in area of drive mechanism.

- the vibrations caused the appearance of some wavy parts on the surface band (exemplified for a sheet with thickness output of 0.3mm and width of 1660mm (in the Arcelor Mittal milling area-LBR1) with up to about 20-40mm distances between pikes of waves. At mill speeds between 600-1150m/min, the vibration frequencies measured not exceeding 460Hz.

Vibrations in the range of frequencies 5-90Hz corresponding couplings, gearing, box gears, flaws in the camps.

Vibrations in the range of 125-300Hz frequencies corresponding to common problems like games in interspaces positioning system, wear in the camps, lubricant used.

Frequency in range of 100-300Hz is characteristic for positioning system and those interspaces, for the quality of surface of working cylinders. It is noticed a growth of vibrations amplitude of cold rolling mill machine in this range of frequencies.

Frequency in range of 500-900 Hz, show a wear stressed of decks of cylinders support, of their camps (with games in the interspaces), determined the marks in the wave shape due the printing that existing on the surface of rolled strips.

This can lead to the interpretation of surface defects that occurred due to some reasons presented to a point but correlated with the state of wear rolling mill in general, the working cylinders support, the lubricant used.

Experiments in tandem operation revealed: the tendency of growth of vibrations amplitude at high speeds lamination where arise as to increase the speed of rolling with about 50% per rolling mills, registered a magnitude vibrations Growth of around 35% per frame [7].

On the other hand, the band widths with narrow and heavy manifest the same tendency of increasing amplitude vibrations, unlike bands with great width and thickness, where the effect of damping vibrations is considerably higher.

Measures to reduce the load in stage design are:

-choice of cinematic scheme rationale without links liabilities;

-the establishment of real physical processes that occur in equipment with consideration and the

mass distribution, game engine and electric characteristics;

-use computer modeling to determine the parameters of simulation-optimal, cinematic and dynamic;

-rational location of the drive mechanisms;

-use of transmission without long or complicated parts;

-design adequate for action and work parts of rolling mill machine.

4. Conclusions

As a major conclusion of the investigation on the basis of which have some researches contracts concluded with ARCELOR MITTAL S.A. and completed - is a pressing need reduction and possible elimination vibrations in order to increase reliability of all the rolling and the production of endless bands in accordance with standards International.

In conditions which do not take into account the effect of varying tasks, and in particular of the dynamic errors appear to dimensioning of machinery components, with repercussions all over the reliability and quality production.

In the researcher made was the following:

1. Under the action tasks variables (interior and exterior system), the chain of cinematic equipment to distort, charging the forces and resistance of the materials from which they are made the components, by installing the phenomenon of fatigue. This is the most frequent cause of the deterioration of equipment subassemblies.

2. Main sources demands are dynamic forces of inertia period starting and braking; games in components from inside the spaces of the cinematic chain entrapment - working; wear subassemblies; faulty execution and assembly, fault of positioning system; the usage of the decks cylinders; hardening band;

4. We can appreciate that the most important dynamic effect, in the cold rolling mill, is mainly due to the positioning system, with take in consideration the kinematic chain, which will transmit the necessary torque and rotational speed of the engine through the gearbox and coupling rods from working cylinders. The experiment should be supplemented by additional vibration analyses explaining other types of damage that can appear in work for rolling mill machine.

5. Work rolls surface temperature is an essentially parameter vibration existence

Vibration frequency harmonics may be used for diagnostic of friction forces. Stands synchronization control is a real method to control the vibration parameters in cold rolling mill machine in work.

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