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ON THE PREDICTION OF THE STRIP SHAPE IN A COLD ROLLING MILL (1700 mm)

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ABSTRACT

In this paper is shown a new way for predicting the precision of laminated strip in a cold rolling mill (1700 mm). The increasing demands on the quality of rolled strip; need new technology for monitoring the strip shape, by using complex system control for technological parameter of the rolling mill process. It is very important to reduce the dynamic load, to choose the optimal functionary parameters and modern systems to control the stress, tensions, lamination force and speed in cold rolling mill machine.

KEYWORDS: shape, prediction, dynamic load, monitoring, roll bending

1. Introduction

The shape control determines the deviation of the measured strip tension stress distribution from the selected set point curve. It uses a special procedure to convert the control deviation into a polynomial whose coefficients can be individually assigned to the available execution elements.

These can be: tilt; roll bending; variable crown roll shifting; roll force; strip speed.

Each execution element takes over a component of the control difference according to its "execution element efficiency". The analysis is based on the control deviations, a least square analysis and on the self-adapted execution element efficiencies. In order to coordinate the operation of execution elements which have similar effects, the control system uses a priority principle.

This ensures that the faster execution elements react for the first, the slower execution elements being brought in later so as to achieve the best possible operating point for the faster execution elements. The flatness control procedure then combines the execution element setting so as to ensure, even during the alteration, a coordinated interaction between the execution elements. In this way undesirable tension distribution during the execution element setting is avoided.

The variable combination of the execution element movements, together with the self-learning function for the estimation of the execution element efficiencies allow the application of the control principle for any execution element or stand type.

The control system adapts itself automatically to achieve the best performance for any combination of the available execution elements.

2. Experiments and results

The efficiencies of the mechanical execution elements which are required for the set point calculation and shape control are determined by an "on-line self-learning process" (patent learning).

An accurate knowledge of the execution element efficiencies is a prerequisite for the calculation of the execution element set points and a successful compensation of shape errors. The execution element efficiencies are automatically determined on-line during rolling, using measured data from the rolling mill. The self-adaptive estimation of the plant behavior is based on the execution element control actual values and the associated changes in shape values. The self-learning of the execution element efficiencies takes place in two stages. In the first stage the efficiencies are determined based on the strip width. In the second stage, the efficiencies are determined by functionary of the strip width, the roll force and roll diameters by means of neural networks.

This two stage operation has the advantage that, even after a short time, that is after the first stage, relatively accurate execution element efficiencies are available to the shape control and that no separate.

These accurate execution element efficiencies are also made available to the computer process (setup) for the improvement of the calculated preset execution element position (fig.1).

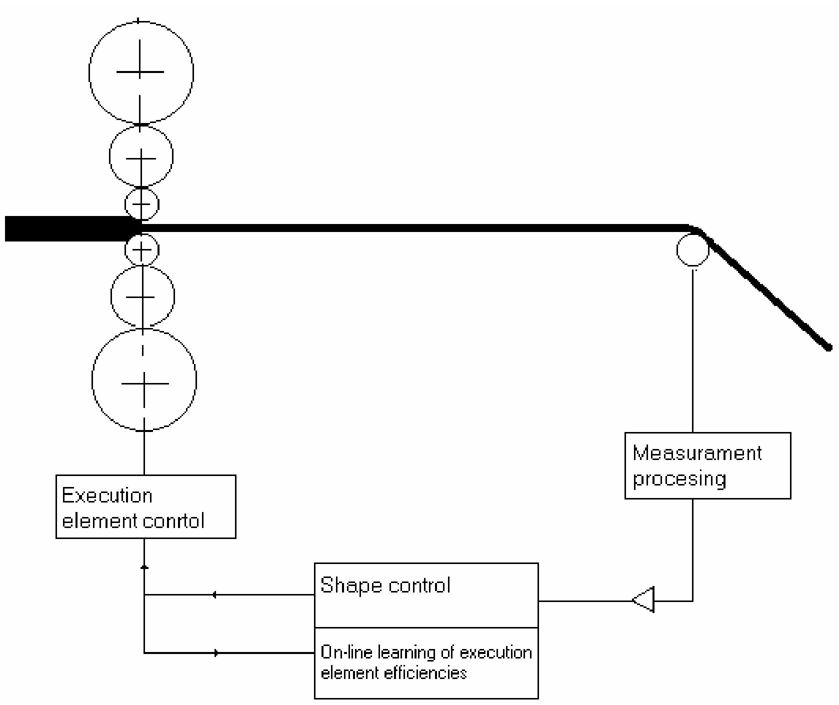

Fig.1. *On – line monitoring system.*

The execution element efficiencies are extremely difficult to determine mathematically being heavily dependent on various operating point parameters, such as for example strip width, roll load, roll diameter and roll shape.

The strip thickness is not only one of the most important quality factors of rolled strip, it is also of vital importance to the rolling process since shape errors lead to non-uniform distribution of tension stresses across the strip width. As this can cause the breaks of the strip in many cases, a reliable measurement of the strip tension distribution or shape is necessary. A measure of the shape of a cold-rolled strip is the strip tension stress distribution, recorded across the strip during rolling.

Unflatness or waviness for a strip is caused by length differences between neighboring segments across the strip. Provided that the material remains completely stressed and within its elastic range, these length differences are converted proportionally into strip tension stresses.

The tension stress distribution across the strip is recorded by the shape measurement roll consisting of a solid body which is divided into individual measuring zone. Each measuring zone contains a sensor which records the pressure resulting from the strip tension. The sensors are inserted in such a way to prevent the transmission of any forces from the roll body, thus torque and force errors caused by roll bending are not transferred to the sensors.

The sensors operate according to the piezzo-electric principle and the recorded signals are processed in charge-coupled amplifiers built into the shape roll. The output of each charge-coupled amplifier is digitized and transmitted over an optical decoupler to the processing electronics.

The processing electronics allocate the signals to the measuring zones, evaluate them and pass them to the monitor for display. Measurement errors are avoided by monitoring the channels continuously and calibrating them automatically. An optimum signal level is ensured by means of automatic amplification switching in the charge-coupled amplifier (Fig. 2.).

The research effectuated on the strip shape concerning the thickness, the length, the width, have the purpose to increase a new quality for laminated sheet. It must control and monitor all the rolling mill parameters (force, tension, mill speed, rolls bending) and also the drive parameters which can be the attribute of a good work for mill. On the monitoring display of the mill stand it can be seen the gauge of strip shape, determined by work roll bending.

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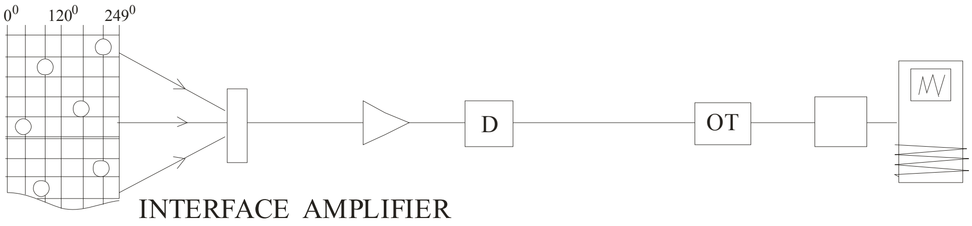

Fig.2. *Shape Measurement, Transmission and Processing*

This tension distribution is recorded and displayed by the shape measurement system (Fig.3.). The shape control has the task of setting the required strip tension stress distribution whereby the roll gap is matched to the strip shape as far as possible. Various execution elements are available to the shape control for this purpose. Any roll force change causes a corresponding alteration of the roll gap profile leading to shape errors which must be corrected by the shape control. This delayed correction is avoided by the implementation of a feed forward control which simultaneously alters the other roll gap execution elements (roll bending) is such a way as to compensate the expected effect of a roll gap change.

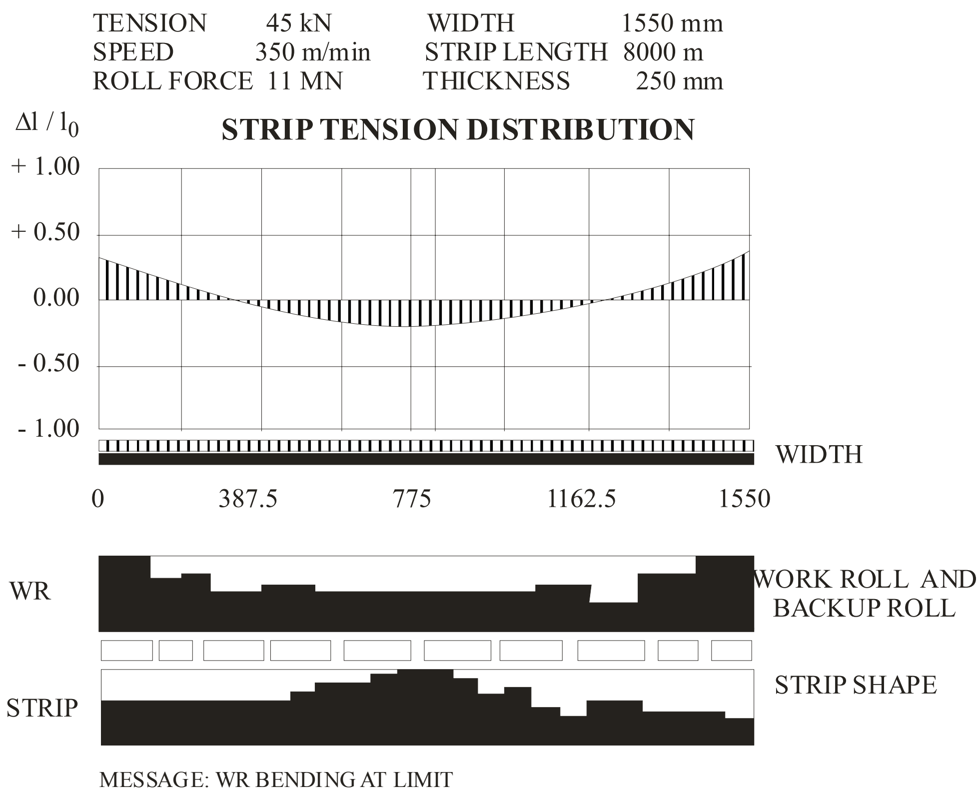

Fig.3. *Shape Display Screen.*

The relationship between roll force changes and changes of the other execution element positions is given by a factor, which is determined by the on-line self-learning function.

A feed forward correction is only executed if it supports the shape control in reducing the shape errors.

3. Conclusions

The strip is subject to additional influences which either cannot be measured or can distort the measurement.

These are mainly:

-temperature variations over the strip width, so far that they cannot be compensated:

-errors resulting from the geometric changes of the measuring path.

-plastic deformation during the winding of the strip on the rewired.

These effects mean that the wound strip will display, after cooling, a different shape characteristic the one measured. These factors can be taken into account by adjusting the shape of the set point curve over the following parameters: edge drop; set point curve from and amplitude; coil shape curve from and amplitude. In addition the operator can undertake an on-line set point curve correction during rolling which has an immediate effect on the tilt, bending or edge drop of components of the shape curve.

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