Finishing/sizing group with agc system

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The uses of long quality products (SBQ) increasingly require high metallurgical properties and excellent tolerances. Their rolling is therefore a fast process that requires high speed control and communication capabilities, with fast response electromechanical-hydraulic control systems. To offer high process stability, POMINI Long Rolling Mills has developed a finishing/sizing unit equipped with an AGC (Automatic Gap Control) system for the automatic control of the gap between the rolls, able to dynamically maintain the required dimensional tolerances. The finishing/sizing unit is placed at the end of the continuous train and consists of two vertical and horizontal two-roll stands. To control the size of the bar, the AGC system manages the dynamic positioning of the rolls, whose light variation is applied by means of synchronous screws operated by a hydraulic servomotor with proportional valve. With the finishing/sizing unit enslaved to the AGC system, a minimum tolerance of 1/5 DIN for round bars can be obtained. The same system is applicable, with the applicable changes in the product characterization, even with flat bars, for which a minimum tolerance of 1/4 DIN can be obtained.

KE OiD : HYDRAULIC POSITION CONTROL, AUTOMATIC GAP CONTROL, FINISHING SIZING STAND GROUP, AGC CONTROL

INTRODUCTION

In the steel industry, the production of a SBQ rolling mill, for smooth bar and flat profile, calls for high accuracy in the product specification and high stability of the process. The bar rolling is a fast process which requires high-speed control and communication capabilities, thus the control objects are electromechanical and hydraulic systems with fast response. With the technological and industrial development, the requirements for high-quality profiles in terms of tight tolerances and metallurgical properties are becoming critical. A finishing sizing group composed by 2-rolls finishing stands (Vertical + Horizontal) is considered.

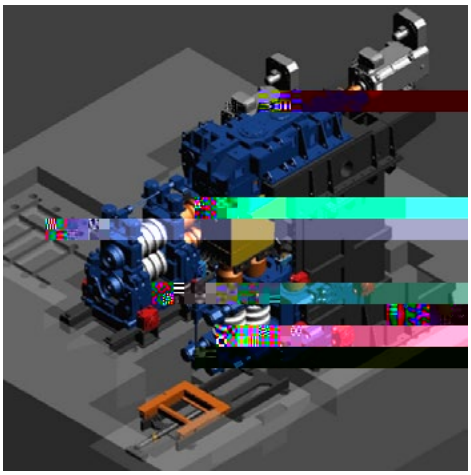

Fig.1 - Arrangement of sizing mill.

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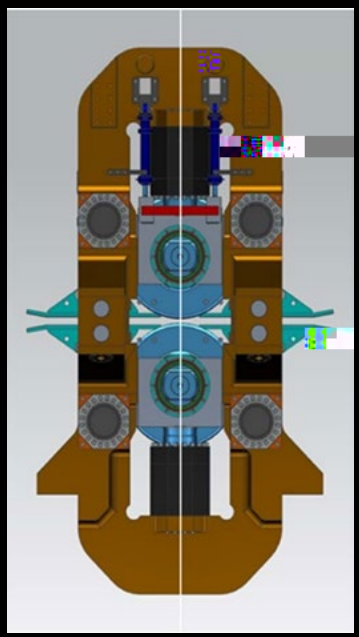

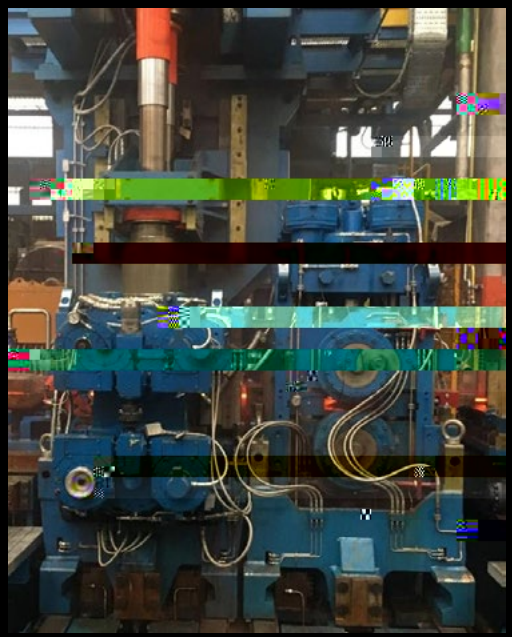

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ARCHITECTURE OF AUTOMATIC GAP CONTROL SYSTEM

The sizing stands group is also composed with the presence of two profile measurement gauges. One of these devices, located at the exit of the final stand, accurately measures the size dimension in a distance from the mill and therefore gives a delayed measurement of the bar sizes.

Feedforward AGC is provided to help compensation for known incoming product variations. To upgrade the feedforward AGC functionality, another measurement device is being added in the entry position of sizing group in order to correlate the final exit dimension to the entry feedstock. The measurement gauges assist the AGC algorithm as it, cannot completely correct gauge due to factors such as different material spread due to different rolling temperature and tension control along bar.

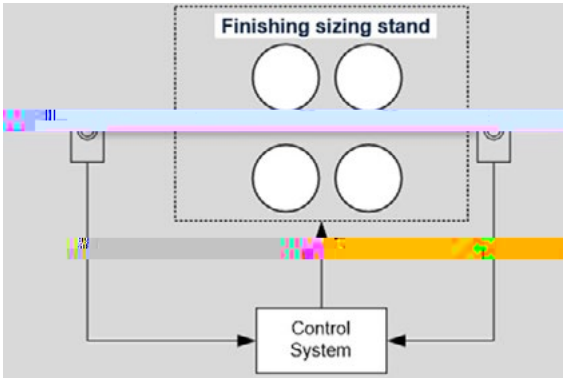

Fig.3 -Concept control of measurement gauge.

THE MEASUREMENT TECHNIQUE

The moving bar passes through the gauge head. Four independent optical modules allow for a continuous line of laser light to be projected around the section being measured. The camera, mounted at an oblique angle to the laser constantly see the complete profile illuminated by the laser line, enabling full dimensioning of the product. The system is based on optical triangulation principle and structured light.

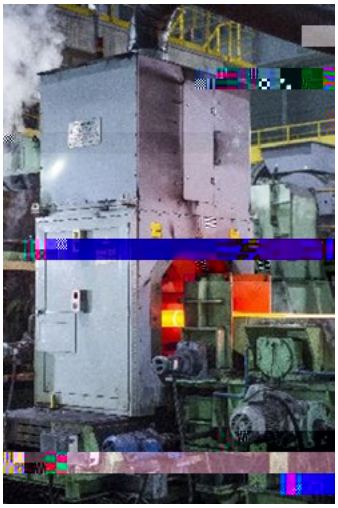

Fig.4 - Measurement gauge.

The gauge head is the working heart of the system. It is a unique combination of state-of-the-art precision opto-electronics and rugged engineering. This measurement data is transferred from the optical assemblies by a fiber optic link and fed into the operator workstation by a dedicated network. The product temperature is measured by an infrared scanning pyrometer, and the system processor computes the cold size. To protect the opto-

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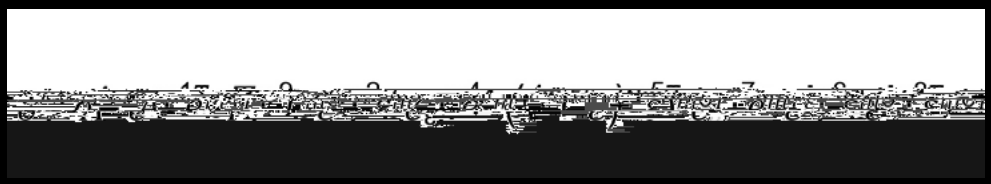


The amount that the mill stretches is not actually linear as suggested in the above gaugemeter equation. The amount of stretch is a combination of stretch in the mill housing and deflection in the roll barrel. The mill housing stretch is typically non-linear at low forces and becomes nearly linear with force at high forces. Roll deflection is typically linear with force but varies significantly as the bar section changes.

Figure 6 show the relationships between gap position, mill stretch and section sizes considering both the variation due to bearings settlement and the stand spring load.
To also validate the behavior of each side if single stand is installed an electric transducer to check the real correlation between encoder gap for screw and capsule position.

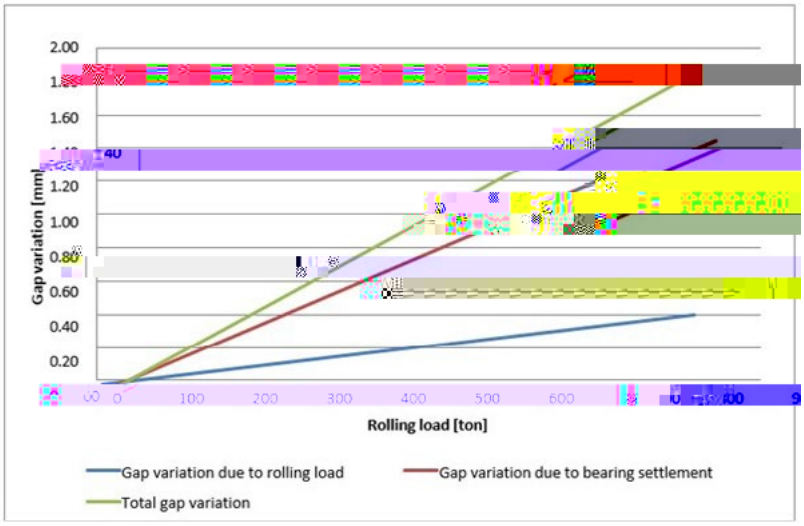


Fig.6 - Gap variation vs rolling load and bearing settlement.

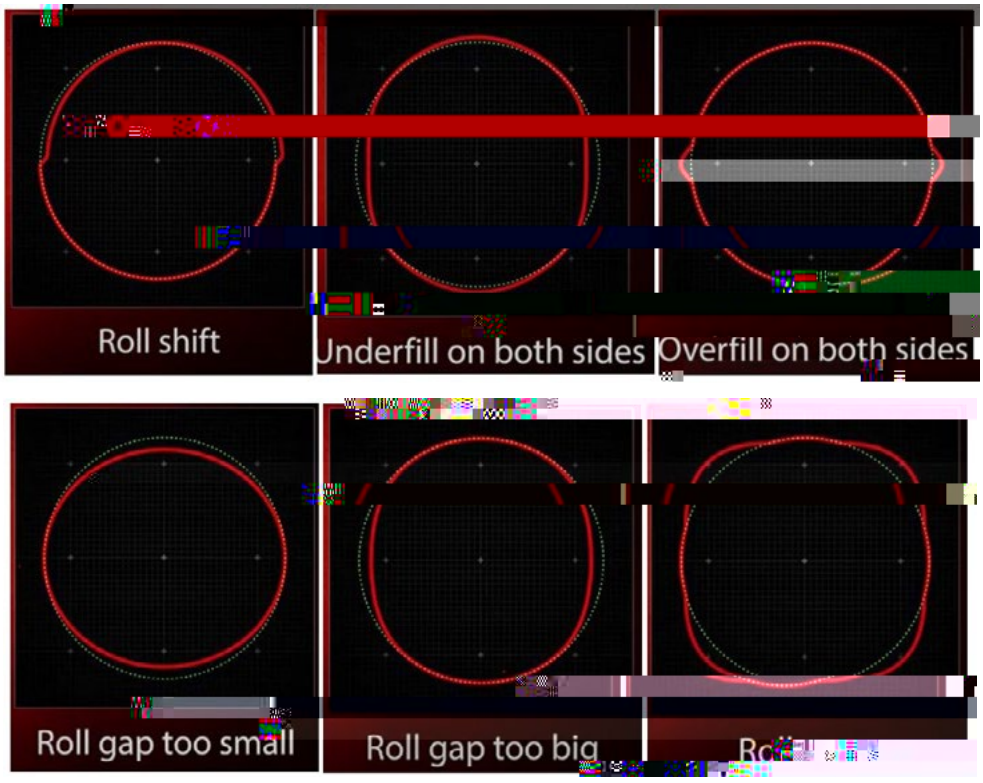


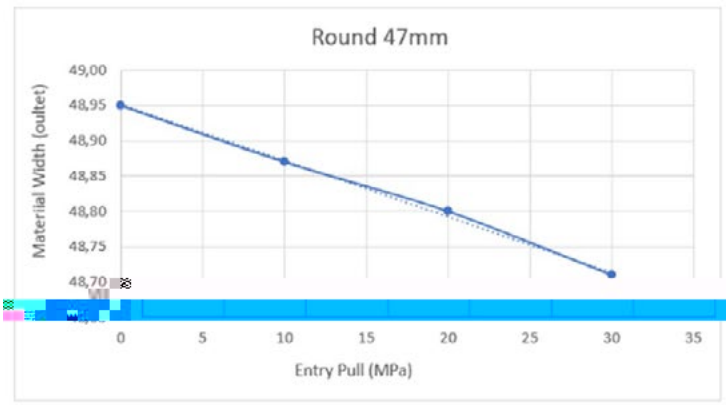
Fig.7 - Shape defects.

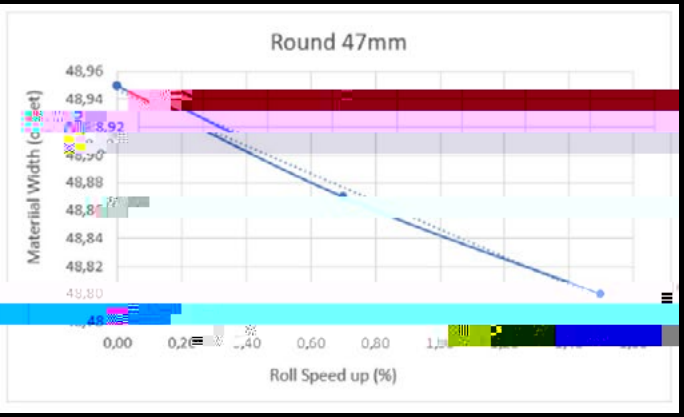
1st sizing stand - spring steel	
characteristic dimensions	
40 < b < 60	
60 < b < 90	
90 < b < 125	
125 < b < 160	
160 < b < 200	

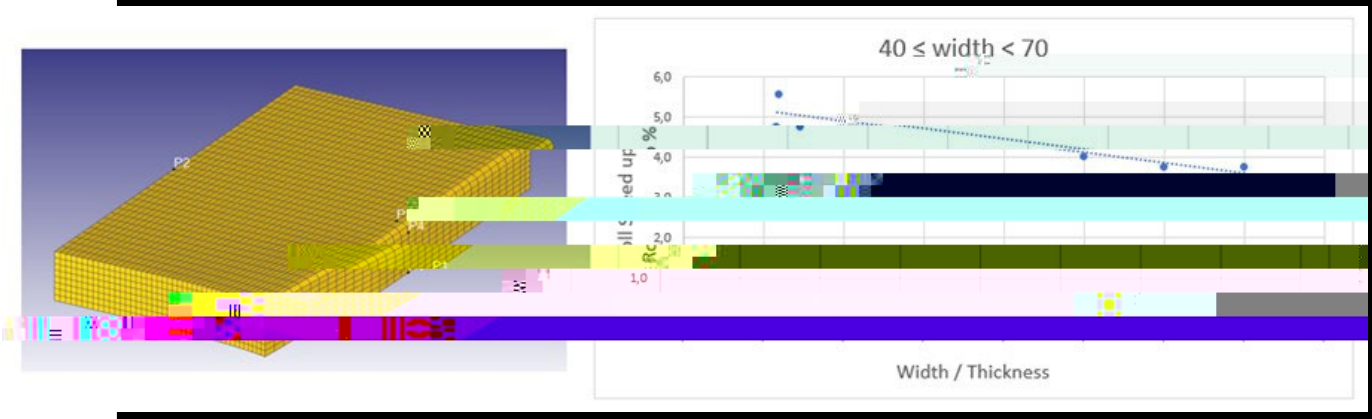
2and sizing stand - spring steel	
Thickness [mm]	Width [mm]
7 < h < 15	50 < b < 70
	70 < b < 120
	120 < b < 200
15 < h < 35	40 < b < 80
	80 < b < 130
	130 < b < 170
40 < h < 70	50 < b < 100
	100 < b < 130
	130 < b < 200
70 < h < 80	100 < b < 130

Fig.9 - Characteristic dimensions setting, example for Flat range family.

Another action to get the correct exit dimension is the tension control between the two sizing stands: usually, in a continuous mill the rolling material must be flow among







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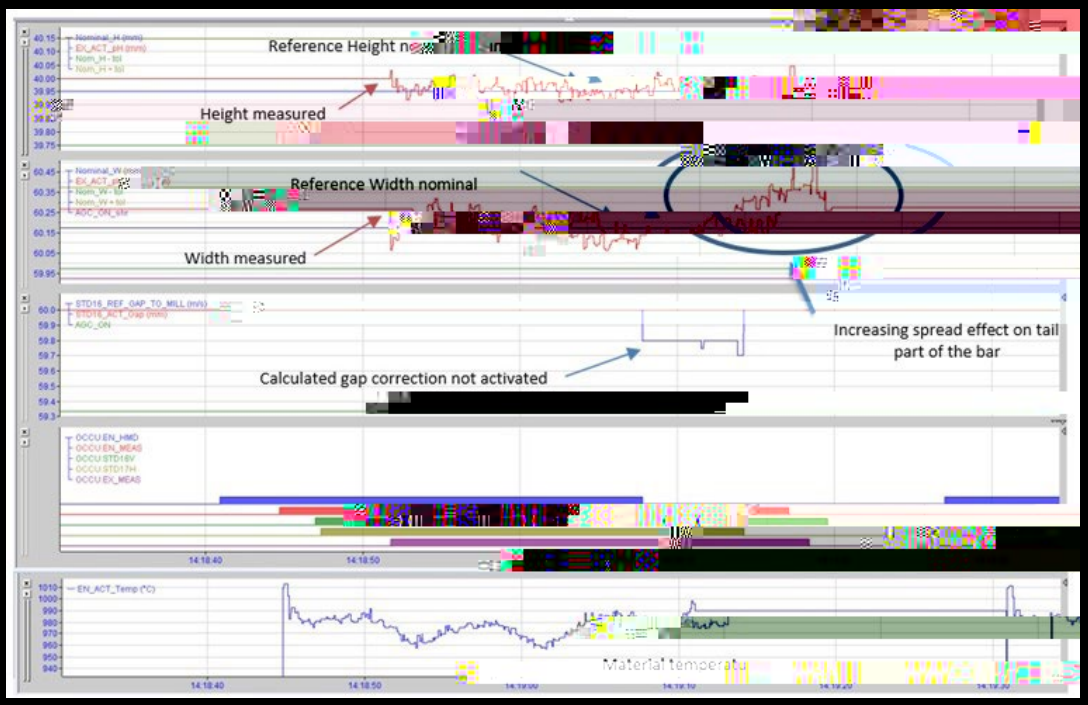

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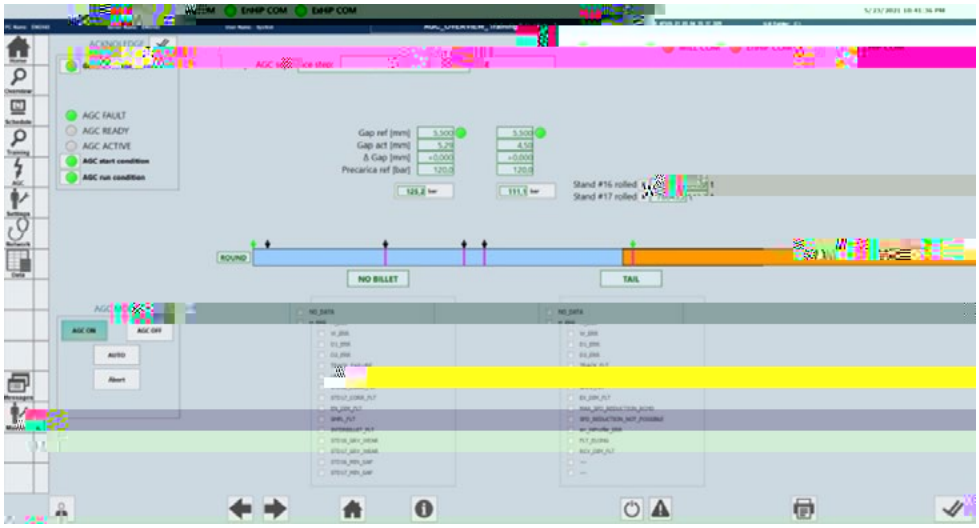

Fig.14 - Main HMI overview.

Operators can open the dedicated HMI window to check the status of AGC sequence as it follows:

INIT	Initial phase: AGC is not working because is switched off
WAIT	AGC is waiting for the first billet (rolled in the upstream stands)
FIRST PHASE	Sizing group is rolling: AGC starts to fit the matrix of parameters get while the first bar is passing through (no adaptation during the rolling)
SECOND BILLET	Since the entry/ exit conditions and the stands setup are known by measuring systems and Level2, AGC checks if the Algorithm can be validated or a further modification of parameters is needed (if the system is confident of algorithm evaluation, automatically dummies this additional control)
FIRST AGC	The system is ready to start the correction on the incoming bar
AGC	System continuous running with AGC active

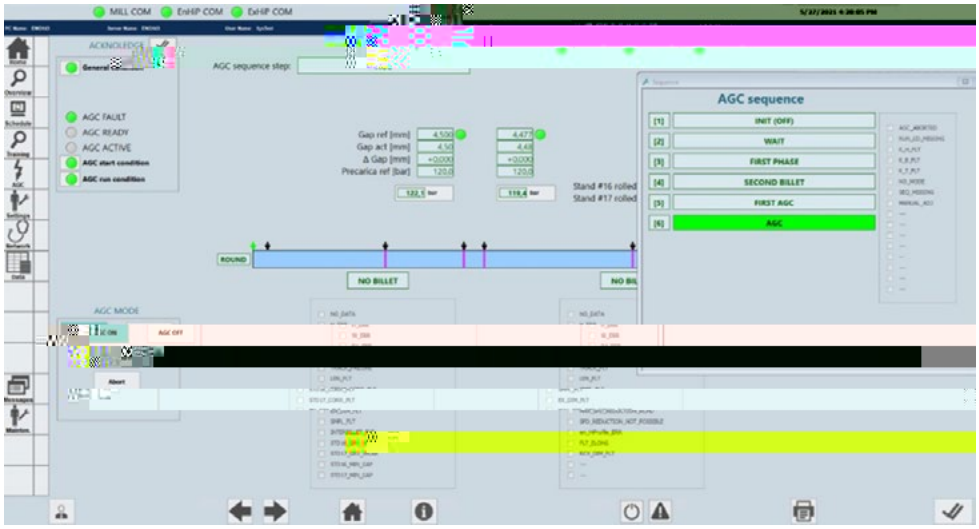

Fig.15 - AGC sequence detail.