GUIDE SERIES – INTELLIGENT ONLINE-ROLLING *

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Abstract

The new product, a force controlled roller guide was patented in December 2014 by DANIELI Morgårdshammar. The development started in April 2015 and April 2016, 1 year later, the first product was sold. During that year, a prototype was designed, tested in real-life production, and redesigned to become the first zero production series of guides. This presentation is about the new guide and what benefits it can bring in a rolling mill and how rolling mills for long products can become ready for Industry 4.0. It will also set a completely new safety standard in the mills.

Keywords: Industry 4.0, Long Rolling Mill, Guide System, Roller Guides, Safety and lower Overall Equipment Efficiency (OEE).

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1 INTRODUCTION

Gaining OEE with new guide technology
Demands on shorter lead times and smaller order quantities leave many hot rolling mills struggling to find an economic balance between making to stock and producing merely to order. Smaller batch sizes means more setup time and lower Overall Equipment Efficiency (OEE). The philosophy of planning in a mill is often determined either by temperature or dimension, Figure 1. Traditionally dimension is major determining factor even though there are mill with extremely long temperature setup times that already today organize their campaigns by rolling temperature. This order prevails when temperature differences are big.

2 DEVELOPMENT

The prototype was first tested in Ovako Hällefors, Sweden. It was mounted on stand 8 (figure 5).

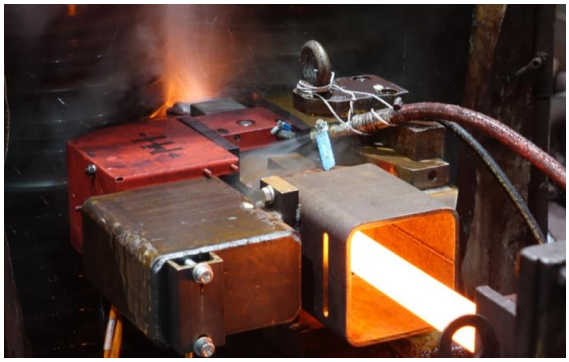

Figure 5
The finishing bar size in this mill ranges from 25 to 40 millimeters. The guide was designed for the same size range. The roller lengths range between 55 and 80 millimeters with diameters between 50 and 70 millimeters. The rollers are 64 millimeters high; the total width of the guide amounts to 155 millimeters. This design is slimmer than that of the old 800 series. Thus, the new guide fits wherever a guide of the old series fitted. The maximum holding force of the guide in the trial was 10 kN. This figure was based on the apparent bearing size in the existing guide and deflection calculations on the structure of guides known at that time. These two input values were the starting basis for the layout of the holding force. The mill stand had a 400 millimeter roll. The oval was 28 by 63 millimeters and the speed 1.85 meters per second. During that test, about 200 tons were produced. A reference guide - a D0960 double roller guide normally used on stand 8 - was equipped with force calibrated strain gauges (figure 6).

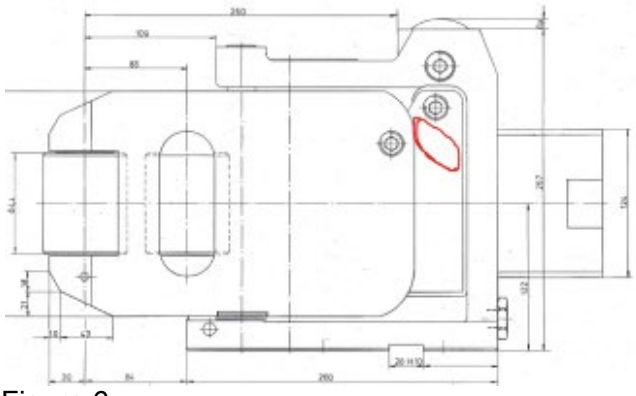

Figure 6

By that means the impact of the rolling stock head was measured. In the graph, this is a negative value. The continuous holding force while the stock was running through the guide was rather constant with a small peak at the end. The highest initial impact measured was 47 kN; the typical value was 24 kN. The holding force that had been set by the operator based on his experience had been about 10.5 kN. These values are 80-100 % higher than previously measured in 1975 on a guide of a similar size.
The same test was run with the new RX 35 guide. Strain gauges were attached to the roller holders. The force readings in that case turned out to be lower for both the initial impact and the continuous measurement. The highest impact force measured was 10 kN; the typical value was 6 kN. The holding force needed was only about 2 kN. This value was approximated based on the operators' experience. The stock coming out of the stand was checked for marks from the roller guide. The initial value set at 4.5 kN was decreased down to the value of 2 kN. About 200 tons of rolling stock ran through the guide set this way. The conclusion from the tests was that only 20-25% of the usual force - both impact and holding force - is needed. Of course, lower forces allow the bearing sizes to be reduced as well as the overall size of the guide. Figure 7 shows a schematic comparison of the forces in the D0960 versus the RX 35 guide. In principle, the force has been reduced to 25%, in case of both the peak and the constant force. An interesting observation is that there is a small increase in force at the rolling stock tail in case of the D0960 guide. The RX production planning concept The following paragraphs explain how the above described technology can be applied most efficiently in the RX production planning concept. The benefit of this concept is that the waiting times can be reduced due to fewer temperature changes.

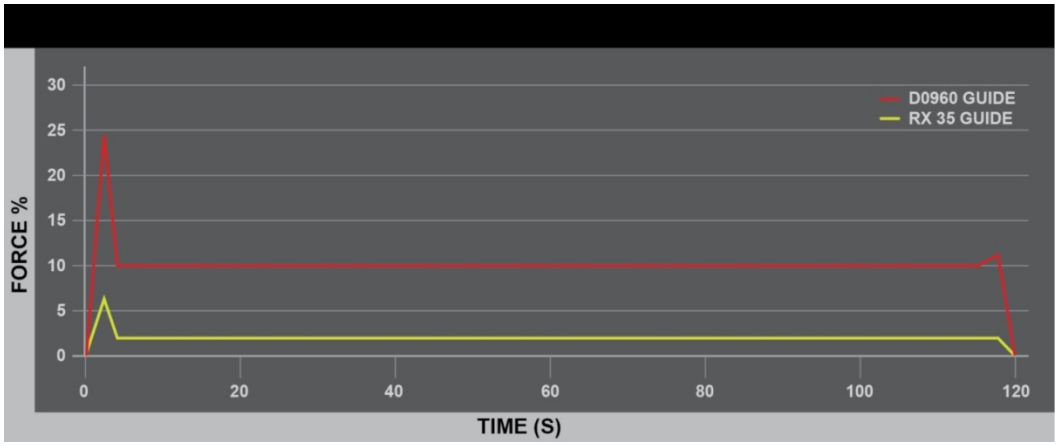

Figure 7

If guide settings can be changed really quickly and the guide is located at a fixed position in the mill, the stands can be side-shifted to another groove in the rolling stand and the rolling mill is quickly ready to roll a new dimension. In that case, it would be possible to finish roll every sizes in one stand with just one guide setting – every sizes from 22 to 26 millimeters (figure 8)

Figure 8

Previously the entry guide halves had to be changed when there were big changes in dimension. With the new RX concept this
is no longer necessary. A special feature of the new roller guide is that the mechanical set-up covers several dimensions. The centerpiece of the guide are the split entry guide halves. There is a pre-entry guide half and a secondary entry guide half. While the pre-entry guide half does not move, the secondary entry guide half - mounted on the roller arm - follows the rollers. Figure 9 shows a set-up for 28 millimeters.

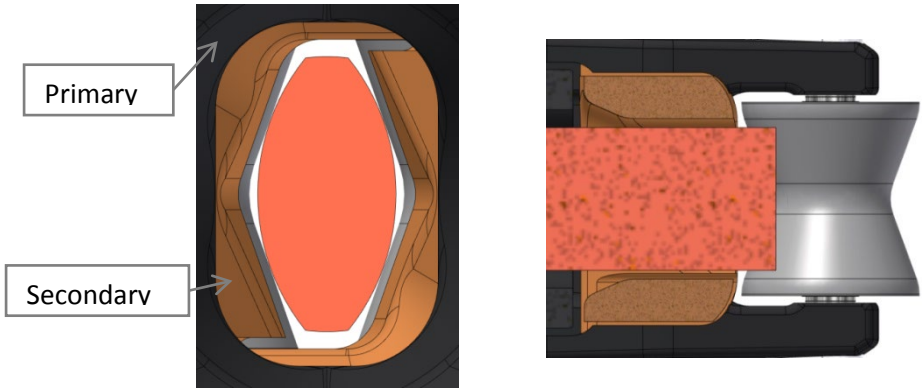

Figure 9

The set-up for 22 millimeters is shown in figure 10.

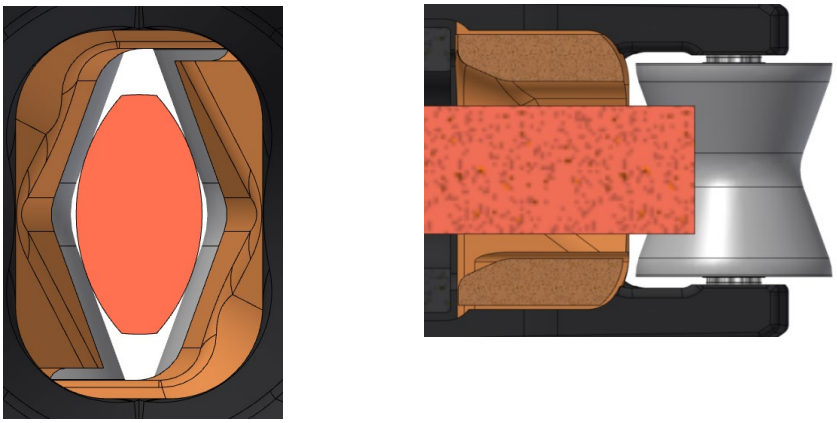

Figure 10

In both cases, safe guiding is achieved with the same mechanical parts. This is a key element of the concept. What benefits can be derived from this? If you have a traditional rolling schedule, for each dimension heating is done in several steps (figure 11).

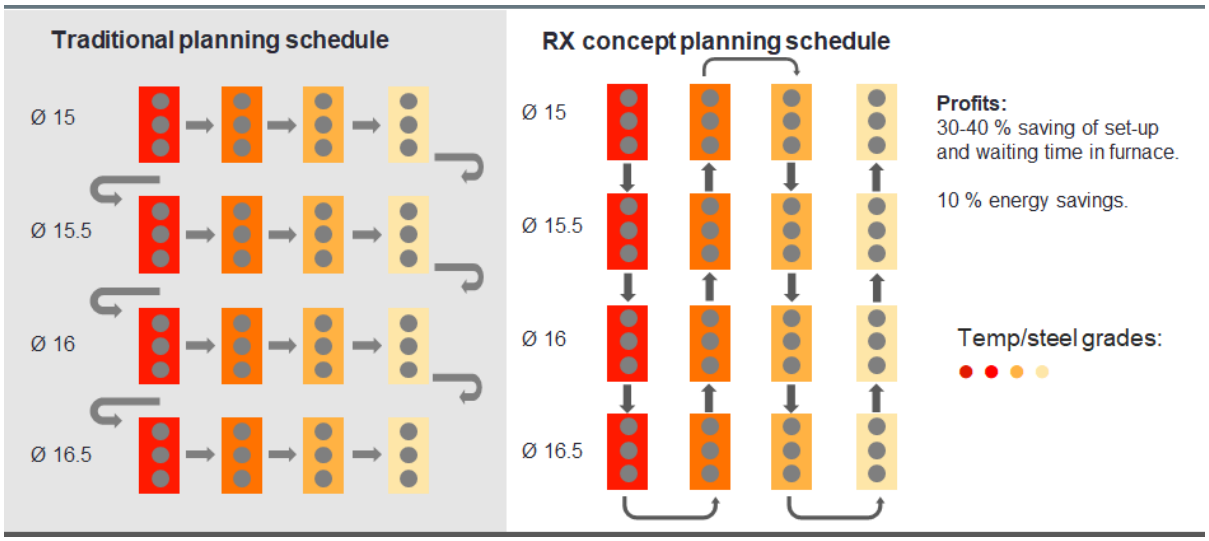

Figure 11

Changing the furnace temperature multiple times for each dimension results in considerable waiting times. With the RX planning concept it is possible to load the furnace with multiple dimensions that require the same temperature. This saves much of the set-up time otherwise necessary for the frequent temperature changes. Also energy is saved as the total time needed for production will be reduced. The most important benefit is that waiting time will be saved as a result of the fact that the furnace has to be heated less frequently to the corresponding temperatures. Another objective of the project was to reduce the total number of guide sizes and, hence, the number of spare and wear parts. Fewer guide sizes mean fewer things to keep track of and more flexibility. Figure 12 summarizes the technical data of the new roller guide series.

Guides	For finishing round min/max ø [mm]	Roller height [mm]	Roller min/max ø [mm]
RX 15	6 / 20	30	40 / 55
RX 25	8 / 30	45	45 / 65
RX 35	25 / 40	65	50 / 70
RX 60	35 / 65	110	60 / 100
RX 85	55 / 90	150	80 / 130
RX 125	85 / 140	200	120 / 180
RX 185	120 / 200	250	150 / 230
RX 240	180 / 260	300	200 / 280

Figure 12

3 CONCLUSION

The RX technology will make rolling of long products safer in the future. Set-ups can be made at a safe location via the HMI. Through the continuous force control, the stock is safely held throughout the rolling process. This leads to less roller wear, longer bearing lifetime, reduced maintenance and longer service intervals in the mill. Moreover, there is a continuous feedback on dimension consistency based on the detected groove wear and tension during rolling. Automatic guide setting allows a set-up to be changed in a matter of seconds. This significantly improves the overall equipment efficiency (OEE) and is operator-independent. The RX planning concept provides much greater flexibility in rolling smaller series and changing the set-ups more often. The risk of cobbles is minimized as the risk to set the guide incorrectly is also minimal. By reducing the number of wear parts, the maintenance costs of the wear parts are also reduced. Outlook As a next step, it is planned to fully integrate the mill control system, the Wicon software and the RX guide with the Internet (figure 13).

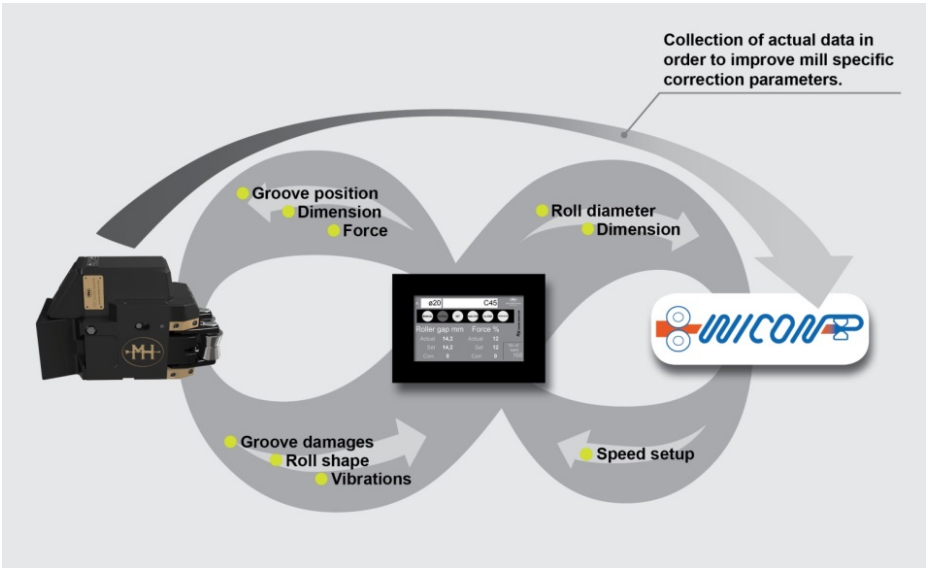

Figure 13

It will thus become possible to collect actual production data, such as the composition of the input and roll material, rolling speeds and temperatures, which are different from rolling mill to rolling mill. Already today, rolling processes can be successfully simulated by means of the Wicon software. Adding big data and actual production data will make it possible to further improve the settings in Wicon and optimize the operation of the rolling mill.

REFERENCES

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4 Insert the references according to the guide for authors' instructions (Vancouver style).