“PERFECT CIRCLE”
THE NEW SMALL DIAMETER SBQ FINISHING LINE AT “THE TIMKEN CO.”, CANTON, OH, USA [1]

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Abstract
The Timken Co. installed a new small-diameter finishing line for SBQ bar at their Harrison Steel Plant in Canton, Ohio. The line features the innovative hydraulic 3-roll precision sizing mill by SMS. A cooling bed and cold saw finishing line complete the supply. The paper gives an overview of the motives for the revamping thru the final commissioning with first quality figures during the run up phase.
Key words: PSM; SBQ; Precision sizing; Three roll technology.

[1] *Technical contribution to the 46th Rolling Seminar – Processes, Rolled and Coated Products, October, 27th-30th, 2009, Santos, SP, Brazil.*
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INTRODUCTION

The new SBQ small bar finishing line at the Harrison Steel Plant will allow the Timken Company to produce SBQ rounds of the highest quality and precision in the range from 1" to 6"-⅝. The core of the new line is the innovative SMS Meer Precision Sizing Mill (PSM®) with hydraulic gap adjustment.
This paper reviews this important project from the beginning to the successful start-up and initial commercial production.

PROJECT GENESIS

The Timken Company, a primary engineered steel producer and bearing manufacturer, operates several steel making and processing facilities in the Canton area. Their product range was however limited to medium and large rounds, primarily from their Harrison and Faircrest Steel Plants. The Harrison Steel Plant has a meltshop, caster and rolling mill, made of a reversible breakdown mill and ten continuous finishing stands and had the capability of rolling down to a minimum 1-⅞" inches in diameter.
Timken decided to extend and complete their product range down to 1" and do so by using the three-roll rolling method. This technology allowed several goals:
- Precision rolling
- Free-size rolling
- Rapid size change and turn-around

The line would be completed by a cooling bed designed for the smaller sizes and dedicated cut-to-length and product delivery lines.
After a detailed selection process, in February 2007 Timken placed an order with SMS Meer for the supply of the mechanical equipment, electrical equipment and automation.

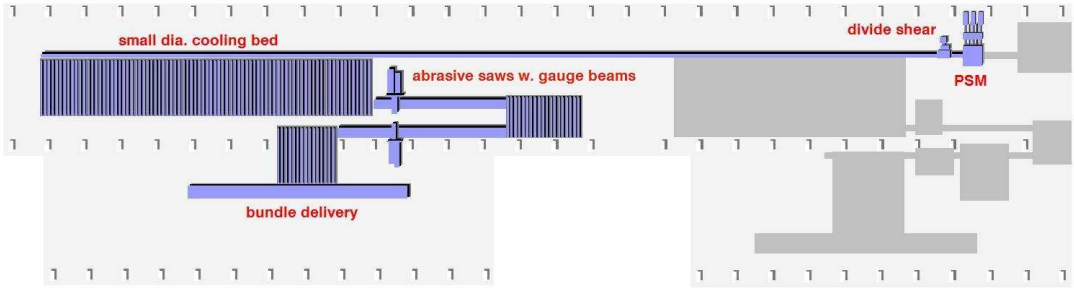


Figure 1. Lay-out with the old large diameter line (gray) and the new equipment.

UPSTREAM PRODUCTION AND FEEDING SIZES

Blooms of 11"x 14"-⅜ and 12"-¾ x 14"-⅜ are first reduced to billet sizes in a reversible breakdown mill. The square billets are of three sizes: 5-½", 7-½" and 8" and are fed to the ten stand continuous mill. There are six feed sizes to the new PSM®.

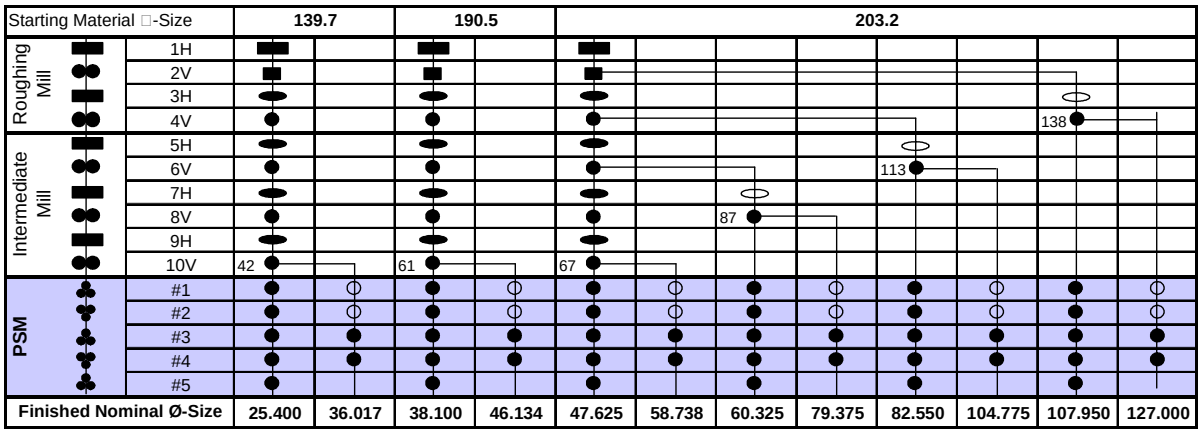


Figure 2. Pass design

PRECISION SIZING MILL PSM®

The core of the new line is the new three-roll Precision Sizing Mill by SMS Meer. The PSM® is installed immediately following the 10 stand continuous mill and before the large round existing cooling bed. The PSM will run all sizes between 1” and 5” and will be by-passed for the remaining bigger sizes.
The three-roll technology is well known in the industry. SMS Meer was a pioneer in using this system in the seamless pipe industry, where it had the market leadership. In 2005, based on this vast knowledge, SMS Meer developed the three roll system for the bar and rod industry with, first of its kind, an under load hydraulic gap adjustment. These kind of controls have been used since many years in flat mills, structural mills as well as pipe mills manufactured by the SMS group and thus it was a natural step to apply this modern technology to bar sizing.

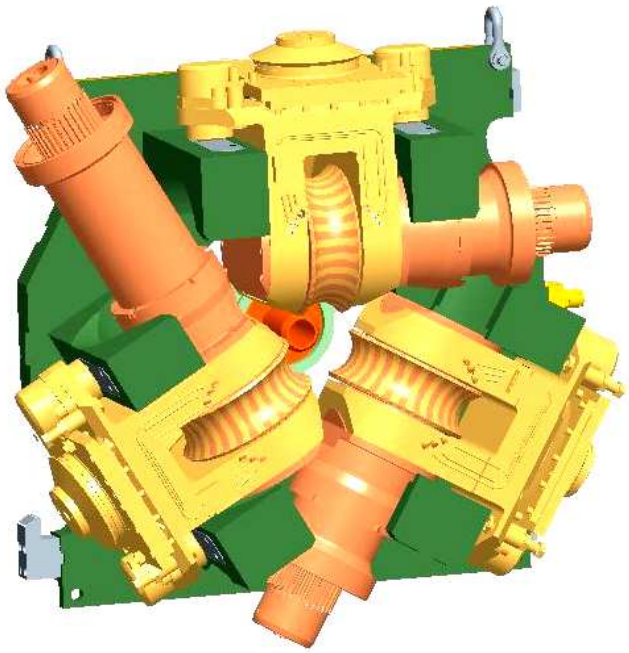


Figure 3. 3D Section view of the exchangeable three-roll cassette.

Figure 4. The PSM in operation at Timken.

The advantages of the hydraulic controls can be easily summarized:
- True under-load real time gap adjustments with extreme precision
- Pressure detection feedback allows continuous monitoring of the stock characteristics (roll force measurement)
- Cobble detection through pressure feedback and automatic stand opening
- Overload protection

The key feature of the hydraulic controls is the continuous monitoring of the rolling and the under-load gap adjustment. The rolling load is continuously monitored through pressure gauges on the hydraulic capsules and their position is also registered by a precise position control mounted on them. When a pressure increase is detected, for example resulting from a colder bar being rolled, the system will react in real time with the necessary corrections of the roll positions so that ultimate cold bar dimensions are maintained. This allows for close tolerances on the whole length of the bar, even in the presence of head to tail temperature differentials.

The hydraulic controls result in these advantages:
- Capability for precision size rolling up to and beyond ¼ ASTM tolerance on the whole bar length
- Free-size rolling up to and beyond ½ ASTM tolerance on the whole bar length
- Capability for no trial bars (first bar in tolerance).
- The compensation of different rolling conditions or temperature gradients
- Front and tail end temperature differences compensation
- Compensation of the nearly symmetrical mill modulus and variations of entry side
- Automatic gap control and monitor control for a downstream bar gauge

Another big advantage of the system is the automatic gap set-up. The hydraulic capsules position is initially zeroed and then automatically moved into the rolling position. This “virtual roll kissing” procedure allows extremely fast mill set-up and reduces off-line operations, since the only data required is the correct roll diameter information.

In addition to these advantages specific to the unique SMS Meer hydraulic controls, the three-roll system allows for quick change of the mill stands in as little as 5 minutes, including set-up times. This is achieved by the change car positioned in front of the mill and able to change all five stands at once. All operations are automatic and only require minimal supervision.

Figure 4. The PSM during stand change. In foreground the changing car, on the right the new mill set-up ready to be transferred on-line.

CONTROL SYSTEM

The automation is based on the SMS Meer proprietary CARTA® process model for bar mills and consists of the following two main components:

• Process technology system

The process technology system comprises extensive functionalities for planning and calculating the rolling process. The objective here is to optimize mill utilization and product quality on the basis of an accurate and reproducible rolling technology.

The process technology system includes the following main functions:

- Calculation of the basic settings of the rolling mill, in particular of roll-pass geometries, speeds and roll adjustment positions, material grade and shrinking factors
- Automatic data transfer to the basic automation system, metrology and HCCS
- Archiving and visualization of rolling data
- Tools management

• Hydraulic Capsule Control System (HCCS)

The Hydraulic Capsule Control System performs an exact position control of the hydraulic adjustment mechanisms at real-time conditions. Special position and pressure sensors supply the necessary feedback signals for roll forces and roll positions. The algorithms stored in the control system are based on practice-proven know-how gained in the application of hydraulic adjusting mechanisms in rolling mills.

The Hydraulic Capsule Control System (HCCS) performs the following tasks:
- Capsules position control
- Calculation of rolling forces
- Synchronized position control
- Automatic pass diameter control during rolling, considering impact settling, heavy head and tail bar ends, force/temperature variation on bar length
- Actual diameter measure feedback loop
- Motor speed corrections
- Servo-valve drift adjustment
- Servo-valve flow gain compensation
- Automatic capsule position transducer zeroing
- Alarm procedures
- Link to basic automation system, metrology, process technology system

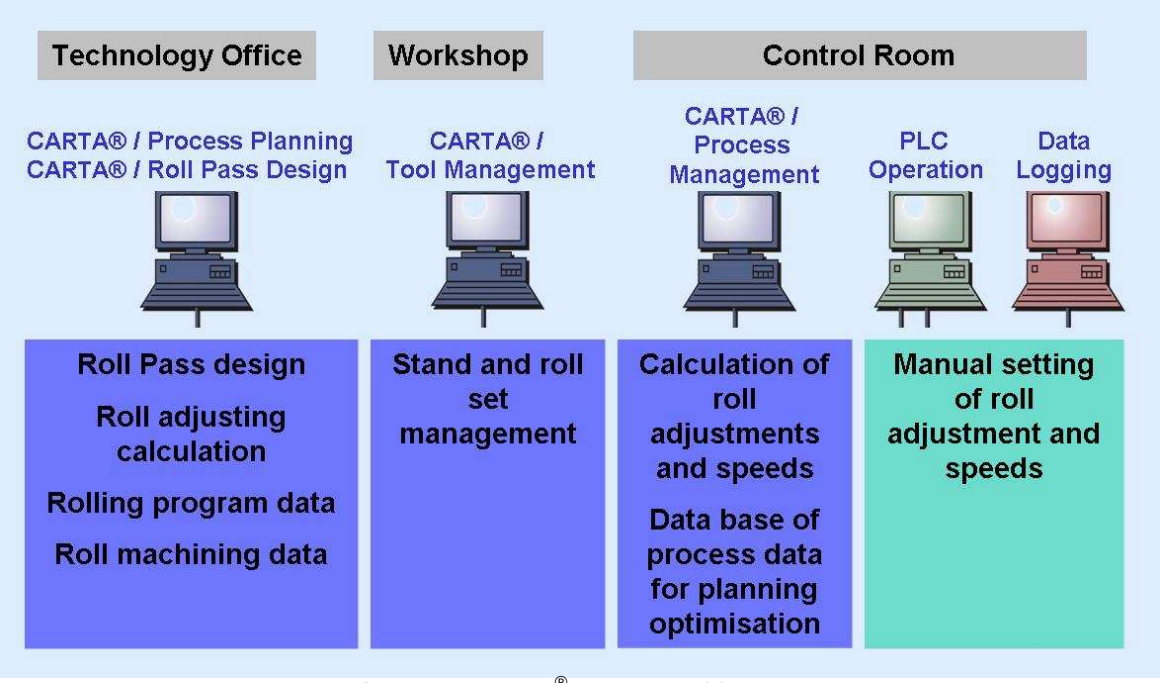


Figure 5. CARTA® system architecture.

DOWNSTREAM EQUIPMENT

A combination rotary/crank shear is installed immediately after the PSM® with capabilities to cut up to 4" diameter. A roller table will convey the stock to the building extension housing the cooling bed and cut-to-length saws.
The rake type cooling bed is fed by a drop-wall roller table. Cooling bed dimensions are 255' long by 38' wide. The movement of the bed is electromechanical with worm screw gearbox and AC motors. The bed is equipped with a bar aligning system. Layer is transferred to the cut-to-length line via a chain transfer device and trolleys. The layers are then fed to two abrasive saws, the first will perform the double cut and the second will perform the final cut. The saws are positioned in front of each other and thus a transfer table will convey the layer between the two.

Fig. 6: The divide shear.

Fig. 7: Bars on the cooling bed during hot commissioning.

The bars will then reach a bundler where a marking machine will identify all bars. The machine is served by a mechanism to correctly position and hold the bars in front of the marking head. Finally, bars are discharged into cradles via a lever system to avoid excessive vertical drops and surface damages.

Figure 8: Cooling bed exit with cut-to-length saws

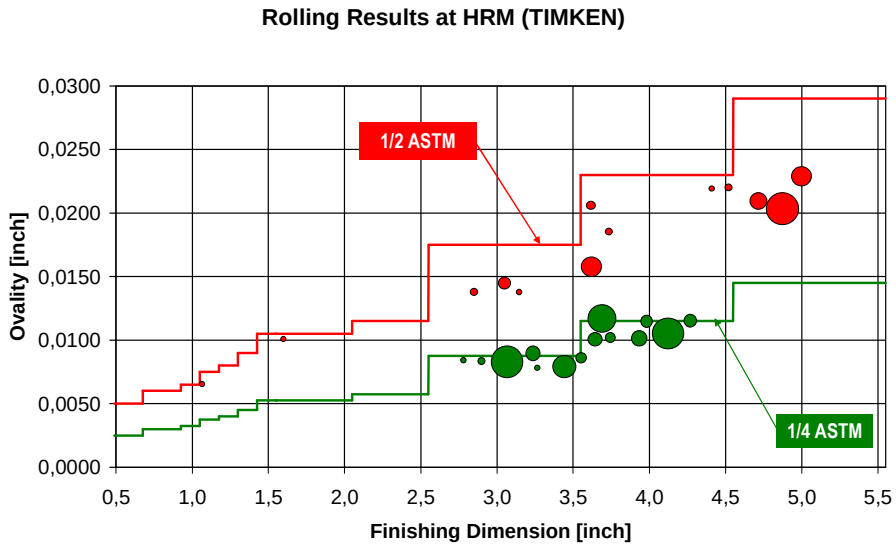
PROJECT SCHEDULE AND START-UP

The Timken Company placed equipment orders in February 2007. Equipment was delivered on-site in Canton, OH in June 2008 and started up in September 2008, just a little over 16 months from the order date.
Production ramped up in the last few months of 2008 while new bar sizes were commissioned. Tolerances on bar sizes were immediately achieved even if most advanced features were not yet operative.

Figure 9: a special oversized truck delivers the PSM to The Timken Company

RESULTS OF THE FIRST MONTHS OF OPERATION

Since the start of hot commissioning, at the end of September 2009, a production of roughly 10.500 metric tons via the PSM® has been achieved in the two first months.
In addition, different sizes with a variety of steel grades have been tested and were produced as sellable bars in between the tolerance range of ½ to ¼ ASTM and better.
Fig. 10 shows a detailed qualitative analysis of this production for the several sizes tested. The different dot sizes show the production quantities in relation to the total PSM® production.
After fine tuning, even better tolerances may be achieved.



CONCLUSIONS

The new small diameter finishing line at Timken represents the state-of-the-art for precision sizing mills: a leap forward from the mechanical design is the SMS Meer hydraulic control system. At the time of this writing, the PSM® installed at Timken is currently operating without having its most sophisticated features operative. The Timken highly qualified and dedicated workforce, in cooperation with the SMS Meer technology and process support, will make sure that this installation will become the benchmark for precision size rolling.