THE INTEGRATED RANGE OF SOLUTIONS FOR LONG ROLLING[1]

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Abstract
A little over one year ago, Morgan Construction Company was integrated in the Siemens Metals organization. Morgan and Siemens Metals Italy are the two centers of competence for the Long Rolling business segment. This paper outlines the key elements of the new Long Rolling organization and presence on the market, and gives an outlook about the integrated portfolio of technologies and services offered by Siemens to the market.
Key words: Long rolling; Bars; Wire rod.

PORTFÓLIO INTEGRADO DE SOLUÇÕES PARA LAMINAÇÃO DE LONGOS

Resumo
Há pouco mais de um ano, Morgan Construction Company foi integrada na unidade de negócio Metals da Siemens, Morgan e Siemens Metals Itália são os dois centros de competência do segmento de laminação de produtos longos. Este trabalho descreve os pontos salientes da nova organização Long Products e sua presência no mercado, apresentando o portfólio integrado de tecnologias e serviços que a Siemens disponibiliza ao mercado.
Palavras-chave: Laminação de longos; Barras; Fio-máquina.

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INTRODUCTION

The headquarters of the strengthened Long Rolling business segment of Siemens Metals are in Worcester, Massachusetts, USA. The new long rolling organization of Siemens includes Morgan Construction Company and Siemens Metals Italy (former VAI Pomini), both with significant long rolling experience. This paper outlines the key elements of Siemens Metals Long Rolling and its market presence. It also offers an outlook on the integrated portfolio of innovative technologies and services offered by Siemens Metals to long product producers.

The long rolling business segment is responsible for the design, manufacture and installation of equipment that produces both steel and non-ferrous rods, bars and sections. Siemens Metals Long Rolling holds an impressive record of thousands of installations worldwide. Together, these mills have set worldwide benchmarks for technological leadership, reliability and performance, and have captured the greatest market share in long rolling equipment.

Along with a wealth of technical expertise, Siemens improved its competitive position with new manufacturing facilities in Worcester, India and Shanghai, People's Republic of China. Keeping manufacturing in-house promises continued direct quality control, ensures that the company's innovative designs remain proprietary, and enables the testing and refinement of new processes across the entire Metals product portfolio.

Together with long rolling equipment manufacturing, the business segment includes a healthy spare parts and guides business, and specialized services for the metals industry. Thus, Siemens Metals Long Rolling portfolio includes the full spectrum of plant solutions, equipment and processes for all shapes and all grades of carbon, alloy and special steels and super alloys.

The expanded long rolling business segment also brings together two mechanical leaders to offer more cost-effective automation and mechanical combination packages, known as "mechatronic" options for both new mills and upgrades.

MATERIAL AND METHODS

An Integrated Portfolio of Innovative Technologies

With the basics of steel product manufacturing continuing to begin first processing in a rolling mill, the challenge is to perfectly coordinate and match a number of factors to ensure not just the quality of the steel, but an exceptional level of mill productivity in designing the optimal solutions for a mill.

Siemens Metals Long Rolling dates its experience in the field of rolling mills back to late 19th century when Pomini was established in Castellanza, Italy, in 1886, and when Morgan Construction began operations in Worcester, Massachusetts US, in 1888. It continues to innovate for competitive advantage, with the expertise required for all elements of plant construction: process, engineering, manufacturing, installation and commissioning, plus life-cycle management.

Process Optimization Yields Cost Savings

How much time is needed for each process step? What dimensional tolerance and temperature profiles are required? How can transfer areas be made more efficient?

Today's equipment can deliver very high precision with rolling stands designed to withstand high loads and changing temperature requirements. That same capability, coupled with sophisticated control technology, allows a wide range of process conditions for desired product qualities.
Cost optimization includes process-controlled yield maximization, downtime reduction and maintenance cost controls. A wide range of rolling mill components are available from Siemens, which are designed for maximum uptimes and, in many cases, extremely high loads and rolling rates.
A state-of-the-art rolling mill needs more than just first-class components. It takes analysis and in-depth understanding of all processes, and possibly their redesign, as part of an integral system layout, to create a customized solution that meets all of the production and quality needs.
Accurate planning that addresses everything from energy supply and raw materials logistics to throughput targets is a prerequisite for a successful plant start. All the up-front necessities ensure projects begin safely and end successfully.
An integrated automation solution from Siemens monitors and controls all rolling mill processes, which includes continually developed and partially self-learning process models for the reproducible manufacture of steel products of defined quality, an MES (Manufacturing Execution System) solution for optimized production planning and for minimizing rejects, and a Level 2 and mill management system for maximizing everyday performance and reliable product tracking through the mill.
Knowledge transfer by training experts, combined with a dependable supply of spare parts, ensures reliable operation. A full range of services from Siemens helps maintain high mill availability over the entire life-cycle, backed by carefully planned modernizations for cost-effective technical upgrades.

RESULTS

Mill Automation and Process Control

From mill management, supervisory and control systems all the way down to motors, drives and individual component and sensor control, Siemens offers a complete solution to rolling mill automation needs. With a full array of mechatronical packages for equipment units throughout the process, a totally integrated automation solution is available to cover from the factory floor to upper management.
In addition to the extensive selection of motors and drives for every part of the rolling mill, Siemens offers systems for controlling, automating and managing the whole operation – thus offering a total solution for every rolling mill need.
In electrical, it defines project scope and requirements from Level 0 to Level 2, including AC and/or DC drives, full voltage devices and various controls; provides full technical documentation and integrated system testing.
For automation, Siemens engineers newly-developed equipment, fully integrated mill control systems and stand-alone systems, including supervisory control, maintenance scheduling, process monitoring, product handling and alarming systems.
At commissioning, Siemens supervises installation and start-up of electrical and automation systems to ensure the shortest possible time to reach full production and consistent operation, with experienced automation and electrical engineers knowledgeable in long products.

Mechatronics in Long Rolling

Mechatronics merges mechanical, electrical, control systems and software as an intelligent approach to the design of electromechanical systems. Siemens has advanced the design process for these systems by integrating the best available technologies into streamlined systems that offer functionality, flexibility and ease of use.

Standard mechatronical packages include shears, high speed finishing blocks, Reducing/Sizing Mills, pinch rolls, laying heads, Stelmor conveyors, coil reform area, coil handling, compactors, cooling bed entry systems, bar counting, stackers and tiers and bundlers.

For long rolling, mechatronics provides fully automated control of stand change and roll parting in a bar Reducing/Sizing Mill, fully automated control of drive system clutches, automated setup, with mechanical expertise incorporated in gear change strategy, direct interface to the mill control system, integrated tension control, easy-to-navigate HMI interface for the pulpit operators, and full local and remote control options.

Fluids Systems

The Siemens fluids group provides advanced circuit design, systems analysis and equipment component selection services. With expertise in lubrication, air-oil, water, pneumatic and grease systems, as well as in descalers and temperature control, it offers a wide range of systems for all applications within the long products mill.

Lubrication systems provide temperature control and oil cleanliness that operates under a wide range of ambient conditions and can incorporate vacuum dehydration. Water systems are designed specifically for in-line water boxes for product cooling, and incorporate specially designed water valves for high speed operation.

XpertManager: More Than a Manufacturing Execution System

From the initial Manufacturing Resource Planning stages to the actual production process, the customized mill design provides seamless integration of process data in real time. By applying proprietary algorithms to the collected data, XpertManager generates comprehensive reports of current production performance, trends and history. With the Level II capabilities, the production plan, the process and the finished product are all integrated in a seamless system of mill automation.

Bar Rolling

The Red Ring stand design has been a popular solution for many roughing and intermediate mill applications. With the quick disconnect capability of the spindles and fluid utilities, the stands can be interchanged very quickly.

Different versions of these stands are in operation, including vertical, horizontal and convertible, which allows for rapid adaptation to a variety of rolled products needed to fulfill stringent market demands.

Typical features of roughing 3-high stands, reversing 2-high stands and compact roughers include high rigidity, reduced stress path, fully automatic operation, axial roll adjustment, automatic screw-down system, with adjustment under load available.

Modern 2-high sliding stands are reversible and fully automated on a simple foundation. They represent an innovative solution for roughing and intermediate mills, with a fixed rolling line with sliding stands to match the exact groove in the pass design, reduced roller table width, advanced billet manipulation system, and automatic roll gap adjustment.
Convertible stands provide an unlimited selection of products from a single mill layout, changing from one product to an unrelated one by a simple push-button operation, without the lengthy procedures needed for an old-style mill changeover. Convertible stands allow either horizontal or vertical positioning and are mainly used in the intermediate and finishing trains, in accordance with production requirements.
The compact and rigid cassette design is suited to many special bar mill rolling requirements that demand flexible and efficient production.

Cutting Equipment

Siemens designs flying- and static-type cold shears, with clutch and brake or direct drive, to produce precise end products. Whether pendulum, rotary, crank, or convertible, they can crop, divide, emergency chop and sample.
When end deformation is critical, for example quality steel bars, sections, rails, abrasive and metallic disc saws are available, equipped with automated dust removal systems.

Rod Rolling

Vee No-Twist Mills
Siemens finishing blocks have been installed in scores of rolling mills throughout the world, having set the standard for successful mill operations. Available in a variety of stand combinations, they can satisfy virtually any need on the finishing end. Rolling load capacity and pass design are tailored to the product requirements, while the Vee No-Twist Mill can roll grades ranging from carbon steels to tough-to-roll, heat-resistant alloys. All housings have provisions for remote adjustments under load. Moreover, they can be equipped with monitoring facilities for bearing condition.
In this newly patented design, all stands are driven by a common drive. Each pair of rolling stands can be removed, or engaged into the assembly for quick size changes. Rolling stands are the same and can be used in any location from the pre-finishing mill in the intermediate mill to the last stand of the Modular NTM.
Offline spares can be held for quick repair in case of unplanned maintenance, allowing the mill to continue production or limit down time.

Vee Mini-Blocks
The Vee Mini-Block is an innovative two- or four-stand mill expandable up to an eight-stand unit, with a host of benefits for rod and bar producers. In numerous existing installations around the world, mini-block mills have increased productivity by as much as 50%, permitting the rolling of various diameter rod and bars, and achieving thermomechanical rolling properties.

Bar Sizing Technology
High precision rolling coupled with process flexibility and equipment durability describe the Siemens bar sizing blocks. Bar sizing technologies include various solutions to meet every need, offering the benefits of good surface finishing, close-tolerance, improved metallurgical and mechanical properties, high-load capacity for

thermomechanical rolling, and flexibility of operation. Single family rolling permits to minimize roll and guide changes, and maximize the cost-efficiency of operation of the whole mill. For rolling small lots of contiguous bar sizes, free sizing is especially beneficial. A fully-featured mechatronics package is provided for complete and effective control of the process.

Rod sizing technology

With more than a decade of operational knowhow on more than 50 installed strands, the Rod Reducing/Sizing Mill is now the most versatile, sought-after rolling technology available.

The advantages of the Rod Reducing/Sizing Mill are nearly unlimited. It can be integrated after a conventional finishing block, boosting the mill productivity on small sizes by up to 60%. Its extreme precision has been proven in many practical applications.

The patented pass design enables true single family rolling from the first stand after the reheat furnace to the last stand of the block ahead of the Rod Reducing/Sizing Mill. Added after a conventional rod finishing block, the RSM can significantly increase finishing speeds on smaller sizes.

The combination of advanced technologies allows very low-temperature rolling. This results in a more refined microstructure that can eliminate additional processes.

Rod Equipment

High Speed Laying Heads and Pinch Rolls

The laying head and pinch roll system plays a crucial role in the success of a high speed rod mill. It must be capable of the high speeds with smooth operation, which providing well-shaped rings correctly positioned on the conveyor. This calls for a precise mechanical system, accurate control and continuous monitoring.

Siemens pinch rolls and laying heads are proven for sustained operation at high speeds and for flexibility with a large range of product sizes.

The Morgan Laying Head design with tail end control helps improve the ring pattern on the conveyor for both small products at speeds up to 150 m/s and large products at lower speeds. It allows operators to increase production, improve yield, and ensure consistent product quality.

Mechatronical solutions

A key element to the success of these laying heads and pinch rolls is the mechatronics system, which provides for repeatable front end positioning of each coil, speeds coordinated with pinch rolls to ensure smooth, error-free operation on tail ends, and fine adjustment to allow coil diameter control.

A good coil package delivered from the laying head to the Stelmor conveyor is important for achieving uniform metallurgical properties during the controlled cooling process as well as for getting a well-formed coil for shipping.

Another improvement in long rolling technology is the high speed shear, which eliminates oversized front and tail ends, reduces wear and impact stress on downstream equipment, and automatically trims uncooled product. A high speed shear can increase product yield by eliminating manual cutting errors and interface with new or existing control systems.

Stelmor Controlled Cooling Conveyor

The more than 350 Stelmor lines installed at mills throughout the world have established the reputation of this system being the best for product quality, processing versatility and equipment performance.

The Stelmor Controlled Cooling Conveyor System enables processing in a wide range of conditions, including both fast and slow cooling modes in a single system. Forced air cooling with high capacity fans gives accelerated cooling rates. The traditional Optiflex system or the new Optimesh system achieve excellent cooling uniformity in fast cooling mode. This capability enables mills to produce a wide spectrum of plain carbon and alloy steels, as well as stainless steels and other specialty grades. The results are improved as-rolled rod properties.

The robust design includes durable drives for reliable high speed operation and high quality components for reduced maintenance downtime and cost.

The Ring Distributor

The patented Ring Distributor collects rings high in the reform tub using a rotating blade for optimal placement. This system enables the coil package to be shorter, therefore helping with shipping and storing space, therefore reducing costs. Improved collection also results in better-shaped coils for fewer tangles and snags at payoff.

Coil Handling and Compactors

From complete handling systems to system upgrades, Siemens has many solutions to every coil handling need. Both the vertical stem pallet and horizontal hook carrier systems are of modular design, providing for unique configurations with standard components. Individually driven and controlled modularized conveyor system offers quiet yet high productivity and system movements provide scratch-free handling of the coils.

Mechatronical solution

For maximum benefits in the coil handling system, a mechatronical system provides for fully-automated coil transport system, minimized installation and start up times, individual AC drive motors, customized coil distribution and storage, and automatic “pushing” and “pulling” strategies which maximize cooling time and product throughput.

Both the horizontal compactor and the vertical compactor systems provide a wide range of capabilities for all coiled products, with either wire binding or steel strapping for Low operating and maintenance costs. Standard compactor design allows for easy retrofit from wire to strap, or vice versa. A unique wire binding unit design offers quick-replace wear cassettes.

Bar-in-Coil Outlets

The Siemens pouring reels, or Garrett coilers, enable the production of bar products in coiled form, typically for bar sizes from approximately 10mm to 60mm. Designed for minimum foundation depth, these feature interchangeable entry spouts to accommodate a wide product size range, and multiple pinch rolls to assist the bar into the tub and control tail ends. Pinch rolls are all traversable to allow for quick groove change between sizes. Wear strips prevent damage to coil. In addition, they use no direct water cooling to help reduce maintenance.

A pivoting mast supports a boom assembly for transporting the coil from the elevated coil plate to a pallet or coil conveyor. Depending on the configuration when using a pallet system, elevators transfer the pallets between levels in the mill.
The coiling line can be provided with a new coil handling system or interfaced with an existing vertical pallet or horizontal hook system. In addition to the forming of a well-shaped coil with excellent surface quality, the Bar-In-Coil system is designed for optimal metallurgical and scale characteristics, with blowing stations available for accelerated cooling and insulated tunnels available for slow cooling of critical grades.

Bar Cooling

High speed entry systems to bar cooling bed

The recent trend in bar mills has been for modern mills to roll small-size rebars at high rolling rates and process in straight lengths. This requires consistent rolling at high speeds from the mill stands as well as on to the cooling bed. High capacity bar mills now have a No-Twist Mill block and high speed cooling bed entry equipment known as the Rotary Entry System (RES).
The Rotary Entry System comprises a pair of rotating drums, for each strand, with a guide pipe in each quadrant of a drum that indexes the bar after it is braked by the high speed pinch rolls located before the cooling bed.

Cooling beds

Siemens cooling beds use standard elements that can be combined in accordance with plant product mix requirements and production capacity. Full mechanical component standardization assures constant equipment quality, as well as high performance levels. For special applications, the cooling beds are provided with slow cooling by insulated covers and forced cooling by water spray systems or water tanks.

Bar finishing components

In addition to the wide array of rolling stands and finishing blocks for every bar product, Siemens has an extensive portfolio of equipment to cover the complete range of final processing needs. From cutting to length, counting, and bundling, everything can be arranged for a smooth final production process.
Fully-automated counting of bars moving from the cooling bed to the bundling station assure accurate and complete order fulfillment. The system is capable of high production rates and is accurate for all types and sizes of bars.

Technologies for sections and rails

Universal / Horizontal rolling stands

A new generation of universal stands uses the Red Ring design for the rolling of structural shapes and can be easily converted to conventional horizontal rolling, according to production requirements, thus avoiding the need for additional horizontal stands. The Red Ring concept assures extra rigidity for minimum strains, as well as long life of components.

Straighteners
Multistrand inline bar straighteners with independently adjustable rollers and quick cassette change, assure close straightness tolerances. A fully automated operation provides a precise guiding of the product.

Stackers
Stackers suited to handling straight and reverse layers are available for all types of sections. Handling of the straight and reverse layer can be mechanical or magnetic with high stacking cycle performance. All stackers have a built-in bundling function. The packing form can be round, square, rectangular and hexagonal. Automatic binding of the packages and bundles is available with wire or strapping.

Rail Pre-cambering
Pre-cambering devices are specifically designed for rails at the entrance of the cooling bank. Pre-camber geometries are calculated in function of various rail parameters and cooling models.

FRB Flat Rolling Block
The flat rolling block permits flexible rolling of medium/large flats, with simple adjustment of roll gaps and grooveless rolling of a continuous range. It also allows size change within seconds and produces sharp edges and tight tolerances.

Thermo-processing

Temperature controlled rolling
The Siemens proven water cooling systems can make a significant difference in the operation of a bar or rod rolling mill, from improved utilization to better product quality. Available cooling elements include conventional solid injector and cooling pipe to the more up-to-date split nozzle design. The high cooling efficiency in these sturdy water box systems results in reduction in water usage, which therefore increases the life of pumps, valves and other critical components while reducing water consumption costs. Less water in contact with the product also reduces the tendency for cobbles, enabling higher rolling speeds.
Water quenching systems with stationary, lift-out or traversable water boxes, provide efficient cooling of ribbed products in straight lengths to a cooling bed or in coil form to meet virtually any worldwide specification for quenched and tempered rebar. They increase yield strength and can eliminate expensive post-rolling treatment, such as cold drawing and stretching.

Mechatronical solution
The Morgan Enhanced Temperature Control System (METCS) provides monitoring and control of stock temperature to insure that the correct mechanical and metallurgical properties are obtained accurately and consistently throughout the process. By monitoring product speed and temperature, along with cooling water pressures and temperatures, the system can provide real-time feedback for closed-loop control of cooling zones, from the furnace exit to the laying head or cooling bed.

Thermomechanical Rolling
Thermomechanical Rolling (TMR) requires a combination of proper arrangement of rolling and cooling equipment, adequate load capacity in the rolling stands and

intelligent rolling and cooling practices. The result is a refined microstructure in the product that has superior as-rolled mechanical and metallurgical properties, which can eliminate or significantly reduce subsequent downstream processes, mostly done in-house by the major steel producers, thus lowering the conversion cost.

TMR in a Reducing/Sizing Mill

Although high productivity and efficiency remain the main attraction of the Reducing/Sizing Mill to most plain-carbon unalloyed steel producers, metallurgical processing flexibility is becoming an equally important benefit to the specialty steel and cold heading quality producers. Through an engineered combination of high load design and proper mill layout, thermomechanical rolling at low temperatures becomes a practical production process. A successful combination of equipment design and process design has been developed, evidence of which is provided by more than 30 installed and operating MFB/RSM blocks in a variety of mill configurations, from existing two-strand rod mills to new high speed, high production rate single strand rod mills.

Maximizing Mill Utilization with spares, guides and services

Intense demands on equipment call for a well-designed service concept, up to and including around-the-clock monitoring of the plant. Clearly defined processes, uniform manuals, assured parts availability and a globally available team of specialists ensure minimized shutdown times and high performance throughout the life-cycle of the plant.

A rolling mill is a long-term investment with a long service life. As newly developed technologies, components and materials are introduced, a comprehensive life-cycle approach ensures a mill receives the benefits of these innovations.

Long Rolling Services comprises the bundled experience of Morgan, Ashlow and Pomini to delivers that support for mills. Examples range from the best possible spare parts to the most recent equipment designs for maximum performance, as well as updated mill supporting elements, including lubrication, hydraulics and water systems.

Dedicated experts respond quickly and follow up until problems are resolved. A worldwide network of warehouses and sales facilities provide access to the most critical spare parts, typically within a day. All spares come with a full warranty.

The combination of Ashlow and Morgan as guides suppliers is a formidable team. Their track record in slit rolling and numerous bar, rod, section and special steel installations ensure competitive solutions for any guiding requirements.

Long rolling services experts offer complete solutions, including “peace of mind” maintenance programs, mechanical and lube system audits, training, upgrades and reconditioning, all backed by Siemens worldwide resources.

CONCLUSION

There are many good reasons to consider Siemens rolling mill solutions, including reliability that draws on more than 120 years of experience, thousands of roll stands commissioned and more than 500 rolling mills installed or upgraded on six continents. The integrated portfolio provides verifiable expertise for all elements of plant design and construction, supported by the global presence and economic strength of Siemens.

Every rolling mill train is different, varying in design according to the customer's required products, qualities and volume. From high-speed production or the fastest product changeover time to precise microstructure qualities, Siemens offers the right solution to meet every requirement.