CST ARCELOR BRAZIL
Compact hot strip mill
Companhia Siderúrgica de Tubarão (CST) in Vitoria, Brazil, had chosen SMS Siemag to supply a complete 1,880-mm compact hot strip mill which went on stream in 2002. We implemented this turnkey project as the leader of an international consortium which comprised Toshiba Corporation, VAI-UK and SMS Siemag Ltda. In addition to the hot strip mill, the project also included a hot skin-pass mill and a shear line for hot-rolled strip. The first strip was rolled on August 31, 2002. Right from the start of production, the hot strip mill exceeded the contractually agreed capacity.

Until that time, Companhia Siderúrgica de Tubarão had operated a fully integrated steelworks with two continuous casting facilities. With the new hot strip complex, the Brazilian steelmaker has expanded its product range to include hot-rolled coils. We had already supplied several facilities to the Vitoria works:

- 1979  Slabbing mill
- 1995  Two-strand continuous slab caster No. 1
- 1997  Blast furnace No. 2 for maximum 4,000 t/day
- 1998  Two-strand continuous slab caster No. 2 for twin-casting
- 1999  RH plant
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Integration into the existing steelmaking plant</td>
<td>4</td>
</tr>
<tr>
<td>Product range</td>
<td>6</td>
</tr>
<tr>
<td>Furnace and roughing mill</td>
<td>8</td>
</tr>
<tr>
<td>Coilbox and crop shear</td>
<td>10</td>
</tr>
<tr>
<td>Finishing mill</td>
<td>12</td>
</tr>
<tr>
<td>Cooling system and coilers</td>
<td>14</td>
</tr>
<tr>
<td>Technology packages</td>
<td>16</td>
</tr>
</tbody>
</table>
INTEGRATION INTO THE EXISTING STEELMAKING PLANT

To ensure high cost-effectiveness of the production line, the new hot strip mill was arranged close to the existing continuous casting facilities.

Right after casting, roller tables convey the slabs from the two casters to the slab yard from where one of the five cranes carries them either to the specified storage location, or into one of the two heat-insulating pits for controlled cooling of special materials, or directly to the furnace approach roller table. Thanks to the short transport routes, a large share of the slabs can be hot-charged.

On their way from the slab yard to the hot strip mill, the slabs have to overcome a level difference of 6.0 m. Because of the nearby ocean, the rolling mill was erected on an elevated level to prevent problems with groundwater. Another advantage of this arrangement is that the utility supply systems (oil systems, pressure-water station, etc.) that are normally accommodated in the cellar are more easily accessible.
**TECHNICAL FEATURES AT A GLANCE**

<table>
<thead>
<tr>
<th>Mandrel-less coilbox</th>
<th>Roll-gap conditioning (roll cooling, roll-gap cooling, roll-gap lubrication)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogeneous transfer-bar temperature</td>
<td>Excellent strip surface</td>
</tr>
<tr>
<td>Small finished-strip thicknesses in case of harder materials</td>
<td>Longer roll service lives</td>
</tr>
</tbody>
</table>

**Hydraulic adjusting systems and loopers**
- Low friction
- Small moment of inertia
- Close thickness tolerances
- Stable strip flow
- Excellent strip surface
- Longer roll service lives
- Reduced rolling forces

**CVC technology**
- Flat and reproducible strip profiles
- Excellent strip flatness
- Flexible rolling program
- Longer rolling programs
So far a supplier of high-quality slabs, CST is now also producing premium-quality hot strip on the new rolling mill. The company soon managed to branch out into the market for vehicle external skin. In addition, the product spectrum includes hot strip for carbody elements, pipes for gas and oil pipelines, ship-building, household appliances and the construction industry.

The products feature close tolerances in geometrical dimensions and material properties as well as excellent surface quality. Our TGHR Thin-Gage Hot Rolling technology package enables the production of high-quality hot strip down to a minimum gage of 1.0 mm. The rolling mill is moreover able to roll stainless steels.

The current nominal capacity of the hot rolling mill amounts to 2.0 million t/year, a value that has already been exceeded by nearly 20% in 2005. The rolling mill was designed so that capacity can be boosted in steps to 3.4 million t/year, and then to 4.2 million t/year.

Continual increase of production (First strip: August 31, 2002).
Fields of application of CST’s hot strip in 2006.

**SLAB DATA**

- **Steel grades**
  - Structural steels
  - ULC steels
  - IF steels
  - High-carbon steels
  - High-strength, low-alloyed steels
- **Slab thickness**: 200 to 250 mm
- **Slab width**: 750 to 1,955 mm
- **Slab length**: 4,500 to 11,500 mm
- **Slab weight**: max. 40 t

**STRIP / COIL DATA**

- **Strip thickness**: (1.0) 1.2 to 16.0 mm
- **Strip width**: 700 to 1,880 mm
- **Coil inside diameter**: 762 mm
- **Coil outside diameter**: 2,100 mm
- **Specific coil weight**: max. 22.5 kg/mm
- **Total weight**: max. 40 t
As soon as the bay crane has placed the slab on the furnace approach roller table, it is weighed on the slab weighing roller table and then carried to the slab charging machine. Inside the 400-t/h walking-beam furnace, the slab is heated from charging temperature to approx. 1,250 °C. To maximize furnace utilization, especially when handling short slabs, the furnace is equipped with two separately driven walking-beam sections. Following discharging, the heated slab is placed on the hot-side furnace roller table. For emergency situations, an extension roller table is available to return the slab to the slab yard.

During passage through the hydraulic high-pressure descaling system (primary descaler and spraying headers for descaling in the roughing stand), furnace scale is removed from the slab surface. Five to seven passes are run in the four-high reversing stand to roll the slab down to the desired transfer-bar thickness. The edger attached on the entry side serves to set the transfer-bar width. The maximum net width reduction is 75 mm. Space has already been reserved for installation of a second roughing stand.
**TECHNICAL DATA**

**Walking-beam furnace**
Digital burner technology (for optimal combustion and reduced gas consumption)
Production capacity (per furnace) 400 t/h
Maximum slab length
- single-row operation up to 11,500 mm
- two-row operation up to 5,500 mm

**Edger**
Roll diameter 1,200 to 1,100 mm
Maximum edging force 7,000 kN
Maximum width reduction 85 mm per pass
Gap 700 to 2,050 mm
Main drive 2 x 1,500 kW
Rated torque at the rolls 2 x 463 kNm

**Roughing stand**
Work roll diameter 1,250/1,150 mm
Backup roll diameter 1,530/1,350 mm
Barrel length 2,050 mm
Rolling force 40,000 kN
Main drive motors
- Nominal rating 2 x 7,500 kW
- Rated torque 1,433 kNm
COILBOX AND CROP SHEAR

During the final pass, the roughing stand and the coilbox, which serves as heat accumulator, operate in tandem mode. Due to temperature equalization, the head and tail of the transfer bar feature an identical temperature level as they run into the finishing mill. This results in constant rolling-force and speed levels in the finishing mill, which in turn assists rolling of ultra-thin strip (down to 1.0 mm) with high coil weights.

Transfer from the coiling station to the uncoiling station is accomplished without mandrel, thus avoiding local temperature differences on the inner windings. In addition, this smooth process prevents surface damage.

The coilbox attains high coiling speeds. To implement very short cycle times, one transfer bar can be coiled while another transfer bar is running from the uncoiling station into the finishing mill.

The drum-type shear crops the transfer-bar head and tail, with an automatic crop-length optimization system ensuring minimum crop ends. To optimize the contour of the crop cut, the drum-type shear is equipped with one knife each for head and tail cropping.

Before the material runs into the finishing mill, it is freed from fresh scale by means of the finishing mill’s descaler.
TECHNICAL DATA

Mandrel-less coilbox
Transfer-bar thickness 20 to 40 mm
Transfer-bar width 700 to 1,880 mm
Entry speed max. 3.0 m/s
Coiling speed max. 4.5 m/s
Uncoiling speed max. 2.0 m/s

Drum-type crop shear
Design rotating drum
Maximum strip cross-section 40 x 1,880 mm
Maximum shear force 12,000 kN
Transfer-bar speed during cutting 0.4 to 1.5 m/s
Number of shear knives per drum 2/180° offset
To attain maximum product quality, the six-stand finishing mill incorporates a whole range of high-tech control and actuating elements. All of the stands are equipped with fully hydraulic AGC cylinders (Automatic Gage Control) for roll-gap setting and thickness control, as well as CVC systems (Continuously Variable Crown) for profile, contour and flatness control. The roll conditioning system, which comprises the roll and interstand cooling systems, the anti-peeling device and the roll-gap lubrication system, safeguards top strip surface quality along with extended work-roll service lives.

Another feature of the new rolling mill is our technology package for thin-strip rolling (TGHR – Thin-Gage Hot Rolling). High-speed AGC systems, combined with low-inertia hydraulic loopers for stands F1 to F3 and segmented tensiometer loopers for stands F4 and F5, permit cost-effective production of thin strip with gages so far attained only through cold rolling.

The step-wedge system in the last finishing stand keeps the passline constant despite different work roll diameters. Thanks to a high-speed roll changing device, the work rolls can be changed automatically in just a few minutes. Locomotives transport the work rolls from the rolling bay straight to the roll shop and back.
**TECHNICAL DATA**

Finishing mill

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Total rolling force</td>
<td>40,000 kN</td>
</tr>
<tr>
<td>Work rolls:</td>
<td></td>
</tr>
<tr>
<td>Diameters F1 to F3</td>
<td>820/720 mm</td>
</tr>
<tr>
<td>Diameters F4 to F6</td>
<td>700/620 mm</td>
</tr>
<tr>
<td>Barrel length</td>
<td>2,350 mm</td>
</tr>
<tr>
<td>Backup rolls:</td>
<td></td>
</tr>
<tr>
<td>Diameters F1 to F6</td>
<td>1,530/1,350 mm</td>
</tr>
<tr>
<td>Barrel length</td>
<td>2,050 mm</td>
</tr>
<tr>
<td>Bearings</td>
<td>Morgoil® bearings</td>
</tr>
<tr>
<td>Main drive motors:</td>
<td></td>
</tr>
<tr>
<td>- Nominal rating</td>
<td>6 x 8,000 kW</td>
</tr>
</tbody>
</table>

Fully-automatic roll change.
COOLING SYSTEM AND COILERS

LAMINAR-FLOW COOLING LINE

After leaving the finishing mill, the strip runs through the laminar-flow cooling line which comprises 13 groups with micro-zones and two groups with trimming zones to set the desired coiling temperature. The X-Pact® cooling model serves to select the cooling rates and coiling temperatures so that the specified material properties will be attained within close tolerances.

COILERS

At the end of the hot strip mill, two coilers with associated hydraulic sideguides and pinch roll units coil the rolled strip at very short strip cycle times. All adjusting functions are implemented in servo-hydraulic mode. The Step Control system for the wrapper rolls ensures that strip tension is built up very quickly and in a manner protecting both the mechanical equipment and the material to be coiled. In addition, marks on the inner windings are prevented.
<table>
<thead>
<tr>
<th>TECHNICAL DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laminar-flow cooling system</strong></td>
</tr>
<tr>
<td>Total flow volume</td>
</tr>
<tr>
<td>Cooling groups</td>
</tr>
<tr>
<td>- with microzones</td>
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<tr>
<td>- with trimming zones</td>
</tr>
<tr>
<td><strong>Coilers</strong></td>
</tr>
<tr>
<td>Thickness range</td>
</tr>
<tr>
<td>Maximum coil weight</td>
</tr>
<tr>
<td>Maximum outside diameter</td>
</tr>
<tr>
<td>Mandrel diameter (spread)</td>
</tr>
<tr>
<td>Mandrel drive</td>
</tr>
<tr>
<td>- Motor rating</td>
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<tr>
<td>- Nominal torque</td>
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</tbody>
</table>
TECHNOLOGY PACKAGES

A WINNING COMBINATION OF PROVEN TECHNOLOGY AND NOVEL SYSTEMS

Stable production of the high share of ultra-thin strip is ensured by the segmented tensiometer loopers that are installed downstream of stands F4 and F5 of the finishing mill. These systems detect and measure the strip tension distribution across the strip width, and this data serves as input information for strip flow control as well as profile, contour and flatness control.

With the aid of proven control elements, high-speed hydraulic adjusting systems and low-friction loopers, the strip flow control system safeguards stable strip flow also when handling ultra-thin strip, and minimizes strip tail-end crashes.

Profile, contour and flatness control is implemented through the proven CVC technology (work-roll shifting and bending). CVC plus technology systems offer a wider profile control range, and can be retrofitted with but minimal work or effort. The desired strip profile is attained by selecting the adequate CVC shifting position. Strip flatness is measured by means of the tensiometer loopers downstream of F4 and F5 and the flatness measuring system on the exit side of F6, and controlled via the work-roll bending systems.
Finishing stand with hydraulic adjusting, CVC shifting and work-roll bending systems.

Screenshot of the finishing mill process.
Stands F1 to F3 and F4 to F6 each require rolls with just one contour which reduces the amount of work in the roll shop and the number of required roll sets as compared to conventionally ground rolls.

The process model for profile, contour and flatness control cyclically calculates the elastic deformation, the thermal crown and the amount of wear of the roll sets, and ascertains the resultant contour of the strip cross-section.

Knowing exactly what the strip contour is like makes it possible to minimize profile anomalies by means of contour-optimized shifting strategies. This allows greater flexibility in program planning with a large variety of finished-strip dimensions and material strengths within one rolling program, or the successive rolling of a larger number of strips with the same width.

These technological functions for ensuring stable production of hot strip within close tolerances in terms of geometrical dimensions and material properties were implemented in combination with SMS Siemag’s X-Pact® automation systems.
X-PACT® AUTOMATION COMPONENTS IN THE CST HOT STRIP MILL

Strip-thickness and mass-flow control
- Roll gap control under load (AGC) with dynamic correction of disturbing variables
- Thickness control via thickness-gage monitor
- Automatic leveling by means of the Roll Alignment Control for stable strip flow
- Highly dynamic loop- and strip-tension control for constant strip tension from the head to the tail
- “Flying” gage changes for thin strip of less than 1.2 mm

Strip profile, contour and flatness control
- Process model for profile, contour and flatness control (PCFC)
- More flexibility in planning the rolling program through contour-optimized work-roll shifting strategies
- Control of CVC shifting positions
- Control of work-roll bending forces
- Flatness control through tensiometer loopers at back of F4 and F5, and the flatness measuring system downline of F6

Control of coiling temperature
- Process model to pre-calculate and control the cooling rates and the coiling temperature to achieve the desired material properties

Coiler controls for uniform and straight-edged coils
- Control of hydraulic sideguides
- Control of pinch roll gaps
- Control of wrapper rolls including Automatic Step Control

Checking the proper functioning without extra measuring instruments.
The information provided in this brochure contains a general description of the performance characteristics of the products concerned. The actual products may not always have these characteristics as described and, in particular, these may change as a result of further developments of the products. The provision of this information is not intended to have and will not have legal effect. An obligation to deliver products having particular characteristics shall only exist if expressly agreed in the terms of the contract.