IDC, Interstand Dimension Control
Field experience at Shiu Wing Steel, Hong Kong
Field experience at Shiu Wing Steel, Hong Kong

Synopsis

Field experience is proving not only improved yield and product tolerances but also increased mill productivity. In a typical mill, the tolerances can be halved with IDC implemented compared to the normal performance.

In 2005 a MFC, mass flow control, was installed at ShiuWing Steel Limited, Hong Kong.

“The ABB, MFC and UGauge configuration is helping us to increase our yield and to reduce the rolling tolerances, when rolling single as well as welded billets. The system is also giving valuable online information to our operators”, says Erik Raftsjö, ShiuWing Steel.

The MFC control improves the tolerances from head to tail of rolled material, tighter tolerances results in more consistent bundle weights.

At ShiuWing Steel Limited, Hong Kong, achieved bundle weight tolerance in %, for 500 bundles of 40mm rebar, bundle weight 2000Kg.

<table>
<thead>
<tr>
<th>With MFC</th>
<th>µ = - 2,99</th>
<th>σ = 0,16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without MFC</td>
<td>µ = - 3,32</td>
<td>σ = 0,38</td>
</tr>
</tbody>
</table>

Each bundle consisted of the same number of reinforcing bars.

At Fundia Boxholm, Sweden final rounds in the range of 60 -70 mm have been rolled to a 1/8 DIN (1/4 ASTM) tolerance via two or three IDC controls in a 4-6 H/V mill stand configuration.

The same tolerances are achieved for 20 mm rounds rolled with three IDC controls.

Our SEAISI 2009 paper will give an overview to the IDC concept as well as results and experience from rolling mill installations.

Keywords: IDC, Interstand Dimension Control, MFC, Mass Flow Control, UGauge, Welded Billet, EBROS
IDC – Interstand Dimension Control
The IDC concept, Interstand Dimension Control, has been developed for rod and bar mills to achieve tighter tolerances head to tail, improve product quality, yield and availability, ensure fast product and dimension changes and obtain early indication of abnormal mill conditions, more consistent mill set-up and improved pass schedules.

The problem is that the set-up values from the last rolled billet may not be valid for the next billet, as the incoming billet can have changes in size as well as in temperature along the billet. In addition the mill changes slightly due to temperature and wear of the rolls.

The IDC system continuously measures and adjusts the dimensions of bars while they are being rolled. If/when dimensions are beginning to deviate, the system immediately adapts the speed of the rolling stands to compensate for this [1].

The IDC allows producers to roll closer to the specified tolerances, reducing the amount of material needed. Because bars are generally sold by length as opposed to weight, there is a lot to be gained by keeping as close to the specified dimensions as possible [2].

Experience shows payback time of an IDC system is less than one year.

The Interstand speed is controlled by the R-factor. If the width is too big the R-factor is increased and the speed of the upstream stand is decreased introducing a small tension that reduces the width. In the example below, [3], a R-factor change of 0.6 % affect the width by 0.7 mm, a traditional minimum tension control allows the R-factor to change 3 to 5 %.

![Figure 1, MFC, Mass Flow Control](image1)

![Figure 2, Tolerance distribution with and without IDC when rolling 11,5 mm round.](image2)

![Figure 3, IDC control, R-factor change of 0.6 % affect the width by 0.7 mm](image3)

![Figure 4, Width and Height of rolled material with and without MFC control.](image4)
**IDC Concept Components**

IDC is applicable to both old and new profile mills and it is easy to integrate into an existing automation system. Installation and commissioning can take place during normal production. The IDC system is available as Measuring system, Mass Flow Control systems and Integrated control system.

The concept is based on the latest developments in process control and wireless communication and consists of:

- IDC process control in AC800 RMC controller.
- TCP/IP gateway with web server and interface for external users.
- U Pads, Tablet PCs and touch Panels working with WLAN
- U Gauge tool, a PC based operator and maintenance interface.
- UGauge sensor for on-line measurements from head to tail.
- ADC, Automatic Dimension Control, on-line control of roll gap
- ADM, Adaptive Dimension Models used for optimization and simulation.

**UGauge – On-line measuring of dimensions**

The UGauge [6] is designed to make real-time, in-line measurements from head to tail end of key dimensions in wire rod and bar as it is rolled. The non-optical detection method is not affected by steam, dirt or scale, ensuring continuous performance under extreme conditions.

Pulsed Eddy Current Technology allows the UGauge to perform with exceptionally high accuracy to provide measurements under very difficult environmental conditions. Width, height and position of red hot billet at a temperature of 1000°C can be measured to an accuracy of about one-tenth of a millimeter (four thousands of an inch) in less than one millisecond.

![Figure 6, UGauge](image)
This type of measurement has been considered too difficult with other technologies. Water is continuously sprayed all around the billets, producing steam and consequently poor visibility. Mechanical challenges include heavy impacts and considerable wear.

The problem with optical technologies is that their use is more or less restricted to comparatively clean and mechanically undemanding environments. Obviously, rolling mills do not comply with this requirement. Also, light does not easily penetrate airborne dirt and steam, and is diffracted in water. Another factor is the actual optical components, such as lenses and lamps, which are mechanically sensitive and require regular cleaning.

Even systems employing radioactive and X-ray radiation – another commonly used measurement technology – are sensitive to environmental conditions, although not as much as optical systems. The hazardous nature of radioactive radiation is another aspect that makes this technology particularly difficult to envision as a general measurement solution in the long term.

**Shiu Wing Steel, Hong Kong**

Shiu Wing Steel is the only steel rolling mill in Hong Kong and has been the leading manufacturer and retailer of reinforcing bars for over 45 years. Over the past five decades, Shiu Wing has contributed to the Hong Kong economy by supplying quality Made-in-Hong-Kong products at competitive prices to the market, with guaranteed on-time delivery. Shiu Wing combines tradition with creativity, innovation, and advanced technology and is committed to the long term development of steel products in Hong Kong and mainland China.

The mill is capable of producing annually over 750,000 MT of round and reinforced bars with diameters from 10 to 50 mm and is equipped with EBROS, Endless Bar Rollin System.

Shiu Wing decided in 2005 to invest in the ABB Mass Flow Control system to further increase yield and to reduce the rolling tolerances, when rolling single as well as welded billets.

One UGauge was installed after stand V9 together with a mass flow control, [7].

The MFC controls the width coming out of stand V9 by controlling the speed of stand H8.

Achieved bundle weight tolerance in %, for 500 bundles of 40mm rebar with a bundle weight of 2000Kg are shown in figures [8] and [9].

With MFC: \( \mu = -2.99 \), \( \sigma = 0.16 \)

Without MFC: \( \mu = -3.32 \), \( \sigma = 0.38 \)

Each bundle consisted of the same number of reinforcing bars and the achieved result with the mass flow control was more consistent bundle weights due to more even material dimension.

---

**Figure 7, Shiu Wing mill configuration**

**Figure 8, Shiu Wing bundle weight tolerance with and without MFC**

**Figure 9, Shiu Wing bundle weight distribution with and without MFC**
Fundia, Boxholm Fine Section Mill
Fundia, Boxholm Fine Section Mill, one of Europe’s leading manufacturers of long steel products, is not only a successful supplier of a portfolio of more than 2,000 products in different steel grades, but also a world-class supplier of close-tolerance round products.

In order to maintain market leadership with regard to tolerances, yield and availability, Fundia decided to invest in ABB’s Interstand Dimension Control, IDC.

The tolerance demands for the rolled round products, in total ~ 84 different dimension in the range Φ39 - 14 mm were < ¼ DIN.

The project was divided into two stages

Stage 1  Φ39 - 30 mm, σ ± 0.150 mm
Stage 2  Φ30 - 20 mm, σ ± 0.100 mm
          Φ20 - 14 mm, σ ± 0.075 mm

By measuring the width, height and position of the rolled material after each stand in the mill the IDC identified problems related to mechanical adjustments, pass design, and temperature. After mechanical modifications and pass design changes the final IDC control configuration was optimized to a few strategic positions in the mill, [10].

The IDC system has exceeded Fundia’s expectations regarding the tolerance specifications for round products. With the help of the IDC system tolerance of ±0.04 mm for Φ20 mm bars, [12], was achieved. This is less than half that normally obtained with sizing mills.

The successful results are not only attributable to IDC but also to the Fundia crew’s competence, their process know-how and dedication to the rolling of world-class products.

ADC – Automatic dimension Control
The ADC system from ABB is a dynamic control method that compensates for temperature variations along the billet, skid marks, welded joints, and uneven roll wear al to maintain profile accuracy. The idea behind Automation Dimension Control is simple – measure the bar leaving a mill stand and use this information to calculate optimized setpoints for roll gap. For stands in the mill an UGauge is used and for last working stand a profile meter.
The ADC position control makes the roll gap servo drives accurately follow the calculated correction along the rolling of a billet. The roll gap position is measured via pulse transducers mounted on the servo drive.

**ADM - Adaptive Dimension Models**

The ADM is an expert system based on consistent rolling models used for optimization and simulation of multi stand rolling in rod and bar mills [13].

Mill availability, yield, and production cost can improve when production speed and energy requirements can be simulated and optimized, and when bar dimension, roll load sharing and groove utilization can be controlled.

The ADM tool gives the mill floor worker the parameter settings to reach these optimal conditions in an easy-to-use graphical interface.

Corner stones are state-of-the-art optimization and on-line model learning techniques along with unique simplified mechanical and physical models.

- **Optimization**: Minimization or maximization of various rolling quantities such as Production rate, Energy consumption, Load sharing, Groove utilization, etc.
- **Simulation**: Setup data related to billet, rolls, and drives are used by the simulation to determine speed, tension, area, width (spread), height, motor power and torque.
- **Sensitivities**: In sensitivity analysis small changes are applied to roll gaps or roll speeds in one mill stand and its effect to speed, tension, area, width (spread), height, motor power and torque in other mill stands are calculated and displayed.
- **Monte Carlo**: A statistical evaluation of the effects of model and parameter uncertainty. Results are presented as confidence bounds.

- **Model Adaptation**: On-line readings or manual measurements can be used to further improve the accuracy of the ADM models. Model parameters are adjusted in a way that the model deviates as little as possible from the actual measurements.
- **Thermal Calculation**: Bar temperatures are computed from centre to surface along the entire bar. Radiation to air, bar cooling, roll cooling, bar heating due to the plastic work are included in the models

**Process Benefits - Summary**

**Yield and availability**

- With continuous dimension control, we know exactly what comes out of the stands and can act on it. Rolls and guides can be set more tight.
- With the ADM model the production can be optimized and the mill can be setup faster and more accurate, less test billets.
- Reduced need for test billets
- Reduced cobbler rate
- Reduced number of downgrades
- Reduced wear of guides
- More time for rolling

Figure 14, Process benefits.

Figure 13, ADM process interaction
ABB Ltd
Affolternstrasse 44
CH-8050 Zurich, Switzerland
www.abb.com