SIEMENS VAI's PORTFOLIO OF TECHNOLOGIES FOR CLOSE TOLERANCE ROLLING OF LONG PRODUCTS [1]

Luigi Giacomini [2]

Abstracts
In recent years, market drive toward better finished and closer tolerance rolling has become more important. An efficient answer to this demands are represented by the sizing technologies which have developed until becoming one of the key element of the rolling process. This paper outlines the most important features of the different SIEMENS VAI 's Sizing Technologies. More in detail about Multigroove 2-Hi Groups, this paper describes the benefits offered by this technology, including: range of application; dimensional tolerances; possibility of thermomechanical rolling; free sizing; single family rolling; flexibility; guide setup; The most recent results of Multigroove Group are illustrated.
Key words: Close tolerance; Long product rolling; Thermomechanical rolling.

PORTFOLIO DAS TECNOLOGIAS SIEMENS VAI PARA BAIXA TOLERÂNCIA NA LAMINAÇÃO DE PRODUTOS LONGOS

Resumo
Recentemente, a tendência do mercado de produtos bem acabados e com tolerâncias menores tornou-se muito importante. Uma resposta eficiente para essa demanda é representada por tecnologias de medição que se desenvolveram até tornarem-se elementos essenciais na laminação. Isso destaca as mais importantes qualidades dos diferentes Tecnologias de Medição SIEMENS VAI. Mais detalhadamente Multigroove 2-Hi Groups, este paper descreve os benefícios oferecidos por esta tecnologia incluindo: Aplicação; Tolerâncias dimensionais; Possibilidade de laminação termomecânica; Dimensionamento livre; Laminação de uma família única; Flexibilidade; Setup das guias. Os mais recentes resultados do Multigroove Group estão ilustrados.
Palavras-chave: Baixa tolerância; Laminação de produtos longos; Laminação termomecânica.

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INTRODUCTION TO SIEMENS VAI (LONG PRODUCTS)

SIEMENS VAI Rolling Mills for Longs provides technologies for all types of Long Products hot rolling, with core competences in :

- process & engineering
- manufacturing
- installation & service

It consolidates the know-how and technologies of former brands POMINI, ASHLOW, GFM and VAI.

ORIGIN OF CLOSE TOLERANCE ROLLING OF LONG PRODUCTS

Originated in the early 80ies, the issue of improving tolerances of hot rolled long products has since become more sensitive and better perceived by rollers and end-users, as well as by equipment manufacturers. However, only during recent years, namely during the last decade, the market pressure towards this goal has gained pressure and become more important.
The reasons behind this fact are both technical and economical. Technically, a better finished product provides designers and engineers with higher level components in the realization of machinery. Economically, improving the quality of hot rolling signifies a reduction (and in some case the elimination) of the post-rolling treatments required.

SPECIAL BAR QUALITY GRADES

One of the equipment developed which the most important suppliers have developed to this purpose is the sizing technology, which caters mainly to SBQ market.
SBQ (Special Bar Quality) requirements may be summarized in :

- good surface finishing
- close-tolerance dimensions
- improved metallurgical and mechanical properties

SBQ are typically required by :

- Bolt Steels
- Spring Steels
- Bearing Steels
- Stainless Steels
- Low Alloy Steels

SIZING TECHNOLOGIES FOR SBQ

Several sizing technologies are available on the market, divided in two main groups: with even number of rolls (2 or 4) and odd number of rolls (3).
Even-roll systems offer the widest range of applicability, including :

- Bars, not only rounds but also hexagons, squares, and flats
- Bars-in-Coil
- Wire Rod (entry stock or post-rolling)

SIEMENS VAI Sizing Technologies include 3 main types of equipment, all of them belonging to the even-roll group.

- Cantilever Sizing Stand

- 2-Roll Multi-Groove Sizing Group
- 4-Roll PRS Sizing Stand

which are applicable to all the above mentioned types of long products.

CANTILEVER SIZING STAND

It is a simple, quick, economical project and installation. It improves cross dimension tolerance at 90° with last finishing rolling stand. It is relocated and always positioned close to last finishing rolling stand, in order to avoid bar rotation. The Cantilever Sizing was installed in several plants originally designed for Rebar and Merchant Bar Quality, and later upgraded to SBQ

The main advantages of Cantilever Sizing are :

- small dimensions and weight for easy relocation with overhead crane
- traditional roll material or tungsten carbide rings

2 ROLL MULTI-GROOVE SIZING GROUP

This type of equipment is positioned before hot dividing shear to allow a reduced finishing temperature.

With its features and capabilities of optimizing the technological process, it is one of the most sophisticated sizing technologies for SBQ application. In fact, it has been selected by a great number of SBQ producers.

It evolved from 3-pass sequence Oval-Round-Round to a 4-pass sequence Oval-Round-Round-Round, for an even better finishing operation.

Its concept stems from the design of RedRing® rolling stand, which is the most imitated design with over 4,000 installed units, of which it shares its features of

- rigidity
- sturdiness
- durability

FEATURES OF 2-ROLL MULTI-GROOVE SIZING

The 2-Roll Multigroove Sizing Group provides several features, which may be summarized in:

- Very close tolerances *(Figure1)*
    - guaranteed values are smaller than 1/4 DIN (even better for larger sizes)
    - finished bar quality is improved
    - surface defects are minimized

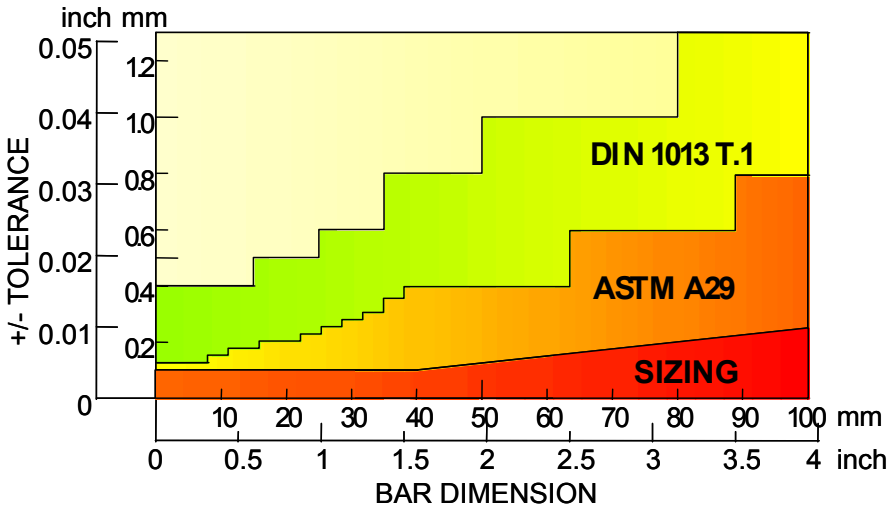

Figure.1. Tolerance Chart

- High load capacity, necessary for rolling high equivalent carbon, and for low temperature rolling, which may be requested in order to provide:
  - controlled grain size
  - improved mechanical properties (YTS, UTS, E%)
  - reduction of conventional post-rolling heat treatments
- The greatest operation flexibility among available sizing technologies. In fact, it may also be used for:
  - rebars and normal rounds
  - flats, hexagons, squares
- Smaller capital cost for group and spare stands
- Possibility of using both conventional rolls and carbide rings
- Reduced operation downtime because of less changes
- Short operation downtimes for stand change
- Short times for roll redressing and offline stand setting
- No special turning lathe required for rolls
- Free Sizing is possible, for small lots of production
  - Rolling a continuous range of bar sizes, contiguous (plus/minus) to a nominal value
  - Reduced, but still acceptable tolerances
  - Particularly beneficial in case of small lots of production
- Single Family Rolling SFR is possible
  - changes are concentrated in pre-finishing and sizing train
  - fewer and shorter downtimes, hence better plant utilization
- Automatic Gap Control is possible, which allows :
  - quicker start of rolling campaign
  - automatic roll wear compensation
- Change times are reduced to a minimum
  - Automatic in-line stand change by means of transfer cars, which minimizes stand change time *(Figure 2)*
  - Automatic offiline roll change by means of a dedicated “robot”, which minimizes roll change time (*Figure 3)*

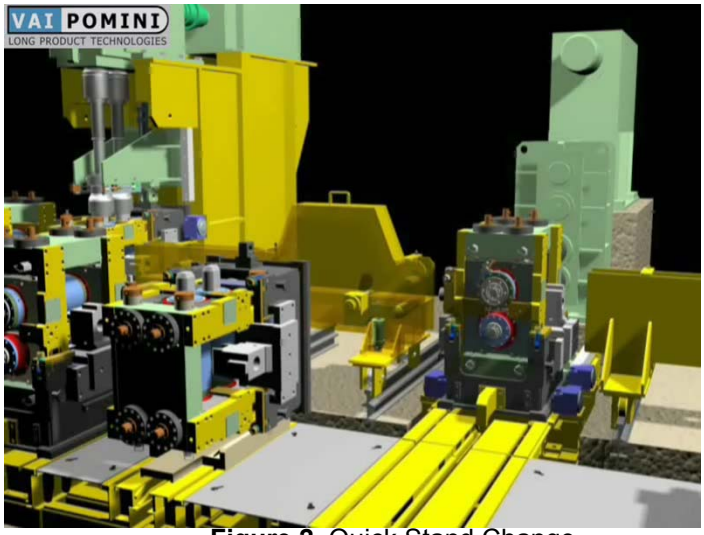

Figure 2. Quick Stand Change

Figure 3. Quick Roll Change

- Guides / rolls positioning times are minimized with the Easy Setting system (*Figures 4,5)*
  - 4-finger probe system offer a great accuracy of rolls and guide setting
  - user-friendly operation

Figure 4. Easy Setting system

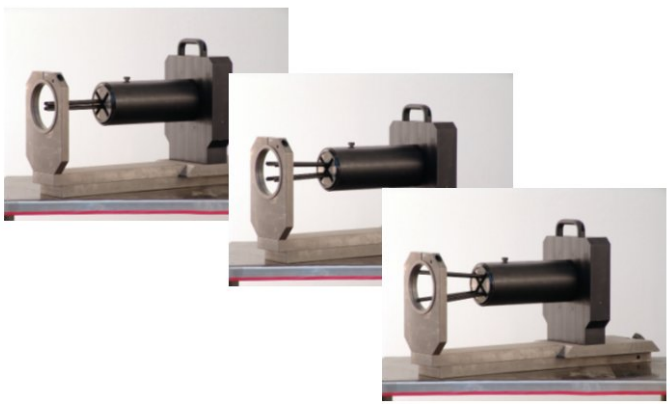

Figure 5. Four Finger Probe

APPLICATION EXAMPLE OF 2-ROLL MULTI-GROOVE SIZING

(ORI MARTIN, Italy - 2003)
ORI MARTIN is a leading SBQ producer located in Italy, and rolls steel grades from low alloy for automotive applications, to welding and tool steels.
The rolling mill has a rated yearly capacity of 500,000 mtons, with an 85mtph reheating furnace which processes square billets 140mm x 12m long.
The finished rolled products include :

- Straight Bars : Ø14÷50mm, with a maximum finishing speed of 13m/s
- Wire Rod : Ø5.5÷16.5mm, with a maximum finishing speed of 90m/s
- Bars-in Coil : Ø17÷42mm, with a maximum finishing speed of 13m/s

The sizing project set the following goals to be reached :

- improve the finishing quality, to both narrow the dimensional tolerances and minimize the surface defects
- improve the metallurgical and mechanical features

The sizing line supplied by SIEMENS VAI comprises :

- qty. 2 pre-finishing stands dia. 430mm
- qty. 3 multi-groove sizing stands dia. 320mm with quick stand change
- controlled cooling zones
- accessory equipment (pinch roll, flying shear, looper, guides, etc.)

The sizing may be used to size the finished products of straight bar and bars-in-coil lines, and the feeders to the wire rod line i.e. Ø13.5÷19.23mm
The project had to comply with the existing space restrictions. *(Figure 6)*

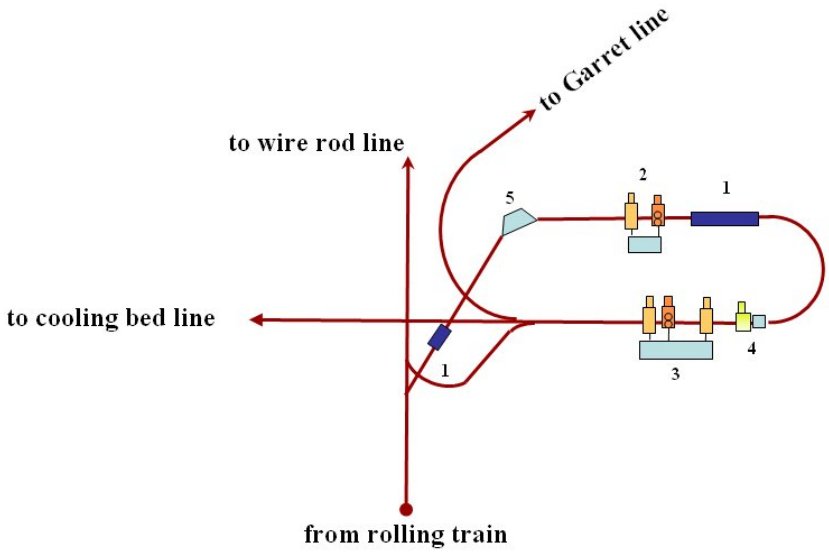

Figure 6. Ori Martin Layout

The sizing line allows ORI MARTIN to produce all range of dimensions with a tolerance consistently better than 1/4 DIN (*Figure 7)*

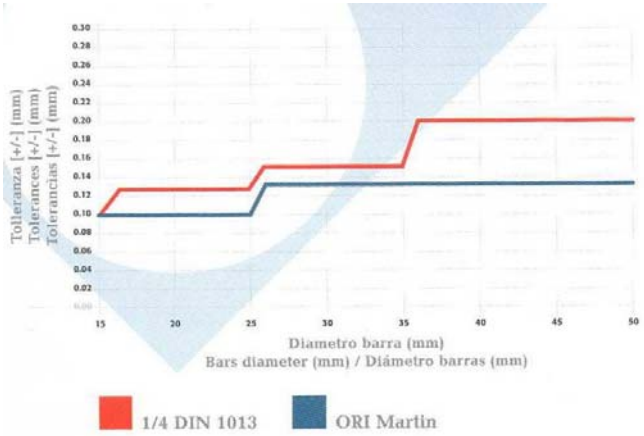

Figure 7. Ori Martin Tolerances

During tests done with round 45mm, the following results were achieved *(Figure 8)*:
Average MAX Dimension = 44.99 mm
Range MAX Dimension 45.07÷44.92
Average MIN Dimension = 44.86 mm
Range MIN Dimension 44.92÷44.80
giving an ovality of 0.13mm, which corresponds to 1/12 DIN. *(Figure 9)*

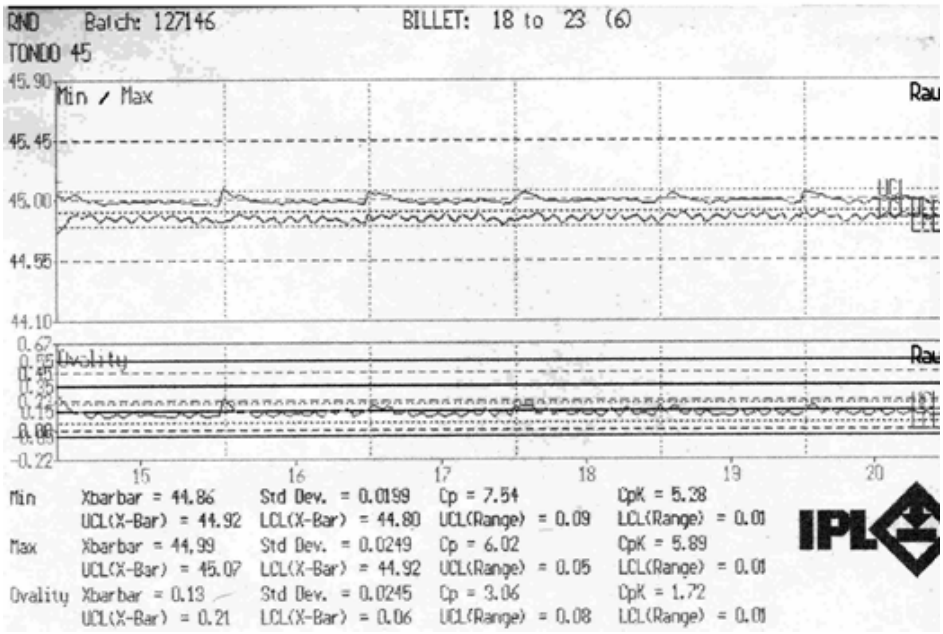

Figure 8. Ori Martin Round dia.45 Measurement Recording

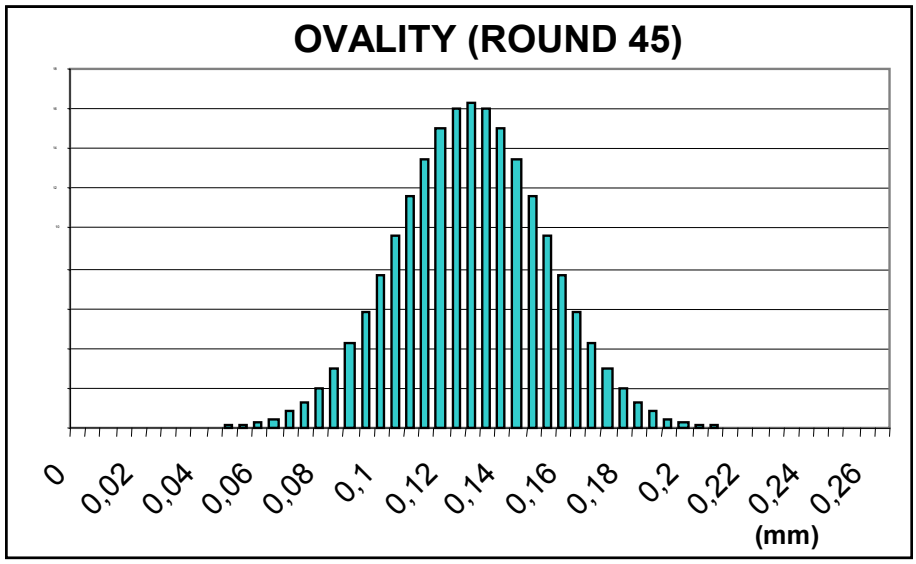

Figure 9. Ori Martin Round dia.45 Ovality Gaussian Distribution

MOST RECENT RESULTS OF 2-ROLL MULTI-GROOVE SIZING

(SHIJIAZHUANG, People Republic of China - 2006)

In January 2006, the Shijiazhuang installationed was commissioned in PROC (People Republic of China)

(Figure10)

Shijiazhuang is one of the most important chinese SBQ producer, and rolls steel grades from carbon to low alloy (automotive applications), to spring and cold heading quality.

The rolling mill has a rated yearly capacity of 900,000 mtons, with a 150mtph reheating furnace which processes square billets 150mm x 12m long.

The finished rolled products include :

- Rebars : Ø10÷50mm
- Rounds: Ø14÷50mm
- Flats: 45 to 100mm

The maximum finishing speed is 18m/s

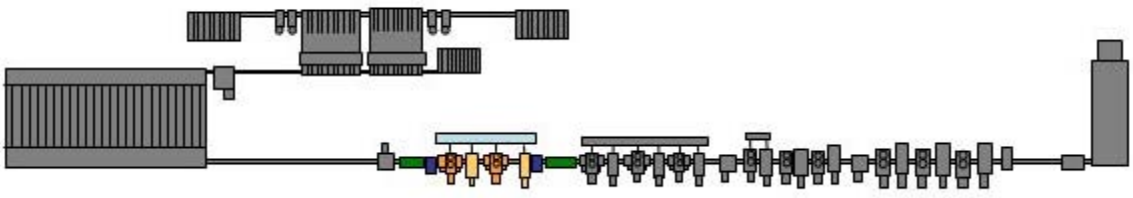

Figure 10. Shijiazhuang Layout

It should be emphasized that the 2-Roll Multi-Groove Sizing allows also the processing of rebars and flats, differently sizing systems with odd number of rolls. The sizing line supplied by SIEMENS VAI comprises qty. 4 multi-groove sizing stands dia. 320mm with quick stand change, new measuring gages and controlled cooling zones. The remaining equipment had been installed in a previous SIEMENS VAI project.

Since commissioning early stages, the ovality smaller than 0.1mm has been reached with the smallest diameter (14mm) rolling at maximum speed of 18m/s, which corresponds to a tolerance better than 1/8 DIN. This values is consistently reached from head to tail of bar. (*Figure11)*

Figure 11. Shijiazhuang Round dia. 14 mm Screenshot of In-line Gaging

REFERENCES OF 2-ROLL MULTI-GROOVE SIZING

Some among the most important and modern SBQ producers of th world have installed or will soon be installing a 2-Roll Multi-Groove Sizing Group, including :

- Europe
  - Ori Martin
  - Acciaierie Venete
  - Leali Sisma
  - Acciai Speciali Cogne
  - Huta Warsaw
- China & Far East
  - Yieh Hsing
  - Daye
  - Shijiazhuang No.3
  - Shijiazhuang No.4
  - Hang Zhou
  - Quzhou
  - Benxi
  - Pangang Changcheng
  - Shan Xi

OUTLOOK FOR SIZING TECHNOLOGIES

The latest generation of multigroove sizing units are capable to reach tolerances better that 0.1mm. This level represents a dramatic improvement over the level which used to be obtained only a few years ago.
It may be hard to further improve this value, due to limitations of precision in roll machining as well in stand machining.

On the other hand, the product rollers (=product suppliers) regard the closer tolerance / better quality as an opportunity to enter market share which reward them with a higher added value. For this reason, it should be carefully assessed how much dimensional precision the final product customers really require, in order for the product suppliers to appreciate how much the tolerance envelope still needs to be pushed, while at the same time finding a sound economical justification of the additional investment and operation costs.
The automatic adjustment of roll gap (closed loop) is already available on latest generation sizing equipment. However, the controlling algorithms and mathematical models required to effectively control the operation still need to be refined and improved, since the adjustment operation may affect several stands.
In case of normal rolling operation, the closed loop adjustment may prove not really necessary, since modern control systems may easily store a full database containing all recipees for each combination of grade/size/required properties, which may be quickly and simply pulled up every time the same product rolling campaign is repeated. However, the closed loop adjustment may prove useful in case there are unpredictable variations of operation conditions (e.g. bar temperature). In order to provide an efficient automatic control, the actual level of precision of in-line gaging systems need also to be assessed and possibily improved, similarly to what occurred in the field of flat products.

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