# NEW CONDITIONING TECHNOLOGIES TO MATCH PRODUCT QUALITY AND PROCESSING COST OPTIMIZATION [1]

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**Abstract**

The aim of our paper is explaining how is important to consider the conditioning as an integrated process that will help the steel producers to reach quality targets and processing-cost optimization. The new technologies in term of non destructive control testing joint with the new machines and fully automatic handling equipment designed by Danieli gives the opportunity to consider the conditioning as a complete automatic process with high productivity ratio and high quality control. The newest technology allows us to apply the automatic conditioning process on billets and slabs as well thanks to the worldwide experience we made on this field. The paper is complete with the latest technology plant description. It is divided in two main sections: Section 1 – Billets conditioning technology; Section 2 – Slabs conditioning technology.
**Key words:** Conditioning; Grinding; Scarfing; Quality control.

## NOVAS TECNOLOGIAS DE RECONDICIONAMENTO PARA ATENDER DEMANDAS DE QUALIDADE E OTIMIZAÇÃO DO CUSTO DE PROCESSAMENTO

**Resumo**

O Objetivo do nosso trabalho é explicar como é importante considerar o recondicionamento como um processo integrado que vai ajudar produtores de aço alcançar os objetivos de qualidade e a otimização dos custos de processo. As novas tecnologias, em termos de testes de controle não destrutivos, em conjunto com as novas máquinas de recondicionamento e equipamentos de manuseio completamente automáticos projetados pela Danieli, fornece a oportunidade de considerar o recondicionamento como um processo completamente automático com alta taxa de produtividade e alto controle de qualidade. A mais recente tecnologia permite aplicar o processo de recondicionamento automático em tarugos e também em placas devido a alta experiência mundial obtida pela Danieli neste campo. O trabalho está dividido em 2 seções principais: Seção 1 – Tecnologia de recondicionamento de tarugos; Seção 2 – Tecnologia de recondicionamento de placas.

**Palavras-chave:** Recondicionamento; Esmerilhamento; Escarfagem; Controle de qualidade.

[1] *Technical Contribution to the XXXIX$^{st}$ International Steelmaking Seminar of the ABM, May, 12-16$^{th}$ 2008, Curitiba – PR – Brazil.*

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## SECTION 1: BILLET ISPECTION AND CONDITIONING PLANT AT GERDAU AÇOMINAS, OURO BRANCO, BRAZIL

Back in 2001 Danieli Centro Maskin, among other competitors, was invited to visit Gerdau Açominas at the Ouro Branco facilities in relation to a project for a new billet inspection and conditioning plant. The carbon steel square billets processed in the line and produced with the existing hot rolling mill are in the range of 76 x 76 mm to 200 x 200 mm (3" to 8") and 6,000 mm to 16,000 mm (20' to 52'-6") lengths. Billet weights ranging from 200 to 5,000 Kg (or 440 to 11,000 lbs).
The billet grades are low, medium and high carbon steel, low alloy steel and forging quality steel. The billet grain size will be less than 40 microns as per ASTM 5 for UT inspection.
The plant capacity required by Açominas is 750,000 M.Tons/year of cleaned and NDT inspected material where 450,000 M. tpy will be conditioned in the new plant, while the remaining 300,000 M. tpy will be transferred to an adjacent bay and processed using existing grinding and conditioning facilities.
The plant is designed to carry out the following operations:
billet preparation, defect identification, billet conditioning of surface defects, billet conditioning of internal defects, billet re-marking station, automatic billet packaging, tying, weighing, tagging, billet unloading and collecting station.
The bidding process included several meetings and a few open-minded discussions with the client's engineering and plant personnel for the conceptual design and general features in order to fulfill customer requirements and the budget.
During this period we also organized some visits to Danieli Centro Maskin reference plants in both Europe and the Far East, and after having beaten some fierce competition Danieli Centro Maskin was selected to be the supplier of the plant.
Subsequently we continued to collaborate very closely with Gerdau Açominas' management, engineering and production personnel, through field work and working together with maintenance personnel, in order to supply a modern facility that can take into account all the customers' present needs while leaving the door open for future expansion.

## PLANT CHARACTERISTICS

The decision made in the early stages was that plant design and characteristics should generally be based on Danieli Centro Maskin's wide experience in the installation of 54 inspection and conditioning plants and the supply of over 1050 grinding machines to customers all around the world.
The final plant design will also satisfy all of Gerdau Açominas' consolidated methods of production scheduling, maintenance scheduling and production reporting so that the new production plant can blend into the existing system without disturbing it.
These needs further fuelled the idea in both Gerdau Açominas and Danieli Centro Maskin that right from the beginning an even closer collaboration was needed in order to achieve results while incorporating proven and vastly consolidated technological equipment and services, providing a tailor-made plant to fulfill customers' expectations.
The high capacity required for the billet inspection and conditioning plant, the wide billet range to be processed, the rather small defects to be located and identified in the product, the high work load required for conditioning a large portion of the inspected material, the constraints of installing the plant in an existing building,

blending into the existing inspection and conditioning facilities with little disturbance, the utilization of minimum manpower and so forth, right from the beginning suggested the guidelines for the making of the plant in order to render it highly practical and efficient (See Fig 1).

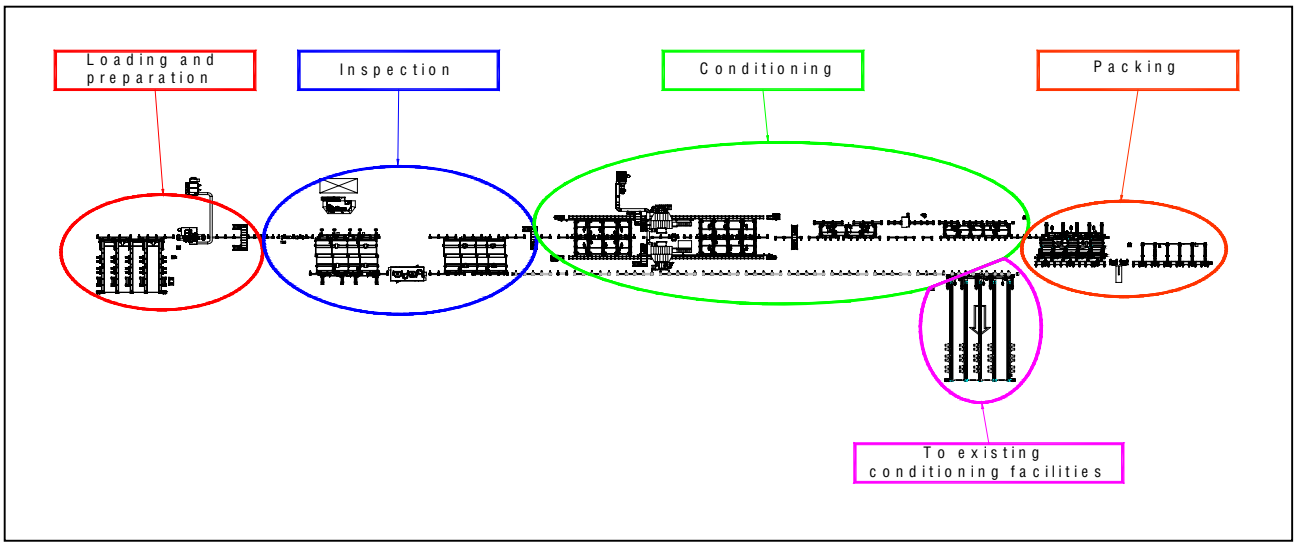


**Figure 1**. Plant Layout

General plant design guidelines:

- Provide a high capacity billet loading system at entry side of the line to guarantee a large quantity of billets in the line and minimize crane work.
- For optimum cleaning and descaling of the billets being processed, utilize a high performance billet shot blasting unit. Shot blaster designed to process billets at operating speeds of up to 30 mpm (approx. 100 fpm).
- For inspection of internal defects install an Ultrasonic Inspection System (UT) produced by Krautkramer. The UT system is designed to process billets at operating speeds of up to 60 mpm (approx. 200 fpm).
- After the UT system install a totally enclosed paint type defect marking station.
- For surface defect inspection it was decided to include two Magnetization and Spraying (MT) stations made by CGM. The surface inspection system is designed to process billets at operating speeds of up to 15 mpm (approx.50 fpm).
- For surface conditioning, considering the high capacity required, provide two high power, totally enclosed, static type Danieli Centro Maskin grinding machines, model “CM 16000 41 N” designed for high removal rates.
- After the cutoff unit include a billet re-marking station.
- Inspected and conditioned billets bundled with an automatic stacking, weighing and tying station.
- Provide a high capacity transfer receiving station for finished bundles to minimize crane use.
- Provide a second billet outlet to convey a portion of inspected material to the adjacent building for conditioning purposes with the existing billet grinding and cutoff facilities.

## LAYOUT DESCRIPTION AND PLANT PRODUCTION FLOW

### Billet loading and billet surface preparation:

Billets are loaded in 3 layers onto 3 fixed loading racks and a chain transfer designed to hold up to 100 billets for a total holding capacity of 190 M. tons (approx. 210 tons).
The first set of racks is equipped with a billet lining-up mechanism to simplify billet conveying to the downstream facilities.
The billet surface is prepared with a billet shot blaster having 4 powerful turbines, each one equipped with a 55-KW motor, blasting shots at high speed from 4 different points to perfectly clean the entire billet surface. The unit includes a totally enclosed dust recovery and filtering system composed of an air suction and air duct conveying system with a maximum guaranteed dust emission of 10 mg/Nm². The shot basting station has a production capacity of up to 150 M. tph (approx. 165 tph) for the medium and larger sizes. (See fig.2)

**Figure 2**. Shot blasting, cleaning unit

**Figure 3**. UT inspection station

### Billet defect identification

The Ultrasonic Inspection Station (UT) (see Fig 3) is made up of one set of “V” type probes. The system includes 18 probes (9 per billet side) installed on a lifting holder. Between the probes and the billet surface is a water film sprayed onto the billet. The water is then collected in a stainless steel tank where it is filtered and pumped back into the cycle.
Parts of billets showing internal defects are cut off to eliminate the faulty portion, by means of a cut-off machine mounted downstream.
The system detects internal flaws of 1.5-2 mm by 20-25 mm in length (1/16”- 5/64” by ¾”-1” length) at operating speeds of up to 60 mpm (approx. 200 fpm) and production rates exceeding 200 Mtph (approx. 220 tph) for medium and larger billet sizes.
Following the UT is an automatic spray marking station with 4 spraying nozzles designed to mark the area where internal defects are present. The marking station is enclosed in order to prevent paint dispersion and environmental contamination.
After the UT control station rejected billets are collected in a set of billet reject cradles.
After UT inspection billets are transferred to the billet Surface Inspection Station composed of two manual Magnetic and Spraying units run by two operators.

The billet surface inspection system is made up of two water showers spraying the magnetic fluid, one set of magnetization heads, one set of power coils, AC Electromagnetic Generators to feed the magnetization heads, one set of monitoring circuits with min.-max- current threshold, magnetization safety circuits and a Siemens S-7 PLC.
The reading of the surface defects is done using 4 UV lights (one on each side of the billet) and two mirrors mounted on pre-adjusted supports to simplify operator inspection.
Before entering the inspection area billets are pre-washed in a stainless steel tunnel equipped with 4 sets of water nozzles.
The system includes an air drying unit and a soundproof enclosure made of insulated plates complete with access doors, interior lighting and air conditioning system for the operators.
The system detects both longitudinal and transversal surface defects of 0.1 mm in width, 0.3 mm in depth and 5 mm in length (0.004" width, 0.012" depth and approx. 13/64"length), at operating speeds of up to 15 mpm (approx.50 fpm) and production rates of 160 Mtph (176 tph) for medium and larger billets. (See Fig. 4).

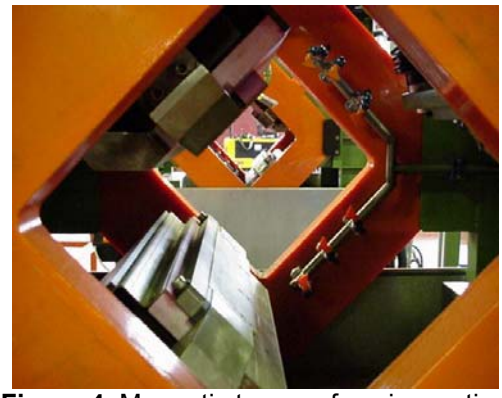

**Figure 4**. Magnetic type surface inspection

After the inspection stations, billets with surface defects are transferred with chain transferring tables and roller conveyors to the two billet surface conditioning stations (See Fig. 5).
Billets without surface defects are directly conveyed to the billet cutoff station to eliminate internal defects or directly to the stacking station for finished products (See Fig. 6).

**Billet conditioning**
Billet surface conditioning is done with two totally enclosed high power grinding stations. The 2 grinding stations include "CM 16000 41 N" static type grinding machines with high power grinding spindles driven by 200 KW (approx. 272 hp), vvvf-controlled AC motors. The grinding machines mount 610-mm (24") and 76-mm (3") diameter thickness grinding wheels.

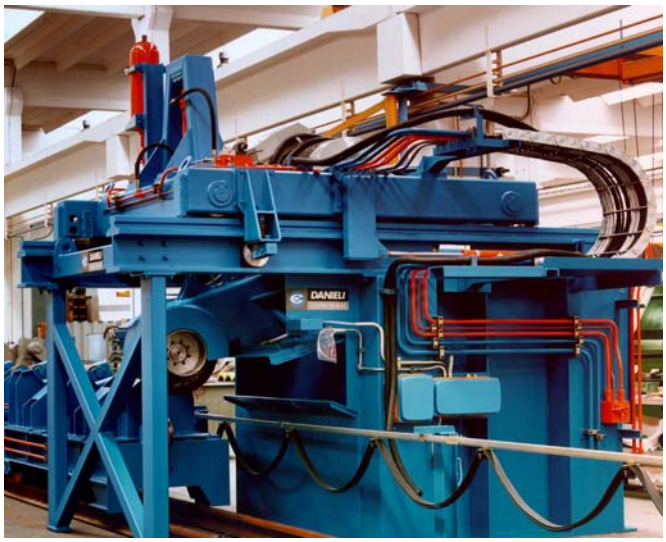

**Figure 5**. Billet Grinding Machine assembly

The machine grinding spindle is mounted on a pivoted hydraulically activated pendulum where a high pressure cylinder provides the grinding force in modulated mode with the proprietary Danieli Automation Hi-Grind control system, to optimize motor power and obtain smooth cutting and the highest removal rates.
Each grinding station includes a movable grinding table designed to automatically load and turn the billets so that both sides and corners can be worked. The grinding table driving system is suitable for 60 mpm (approx. 200 fpm) grinding speeds.
Both grinding stations are complete with a wheel changing device, noise and chip protection system, a set of heavy chip collecting bins, an air suction system for dust and smoke capture and filtering, designed for maximum dust emission through the chimney of 10 mg/Nm², with a noise proof air-conditioned operator's cabin.

**Figure 6**. Billet surface conditioning plant

**Figure 7**. Billet machine control pulpit

In each grinding station, the operator can observe and control the entire grinding process through two side windows facing the loading and unloading areas and through a front window facing the grinding wheel. The front window is made with three layers of transparent material and is bullet-proof to protect the operator, who can comfortably monitor the grinding operation (see Fig. 7).
After the operator has entered all the grinding parameters, i.e. grinding table speed, grinding wheel crossfeed and grinding depth, etc., according to the recipe system, the machine automatically starts to measure billet length to precisely determine the table inversion points. It also performs skin grinding in automatic mode. Spot grinding

is done in manual mode by means of the joystick installed on the operator's control desk.
The two billet surface conditioning stations for the standard defect pattern as defined by Gerdau Açominas, are designed to reach production rates from 120 M. tph to 180 M tph (approx. 132 tph to 200 tph) for medium and larger cross-sections and lengths over 12,000 mm (approx. 40').
Internal defect conditioning is done using a billet cutoff machine supplied directly by Gerdau Acominas. The resulting billet lengths of 4,500 mm (approx. 14'-8") and higher are sent to the stacking station while shorter lengths are collected in a billet collecting table as scrap and/or second quality material.
Installed after the billet cutoff unit is a billet re-marking station to mark the cut billets for identification and tracking purposes.
Billets for re-inspection are segregated and collected in a hydraulically operated pusher type 25-ton capacity unloading station and transferred with the overhead crane.

**Billet packaging**
The billet packaging station is composed of an entry roller conveyor designed to receive one billet at a time. Billets are hydraulically pushed while a set of movable fingers transfers the layer of billets to the billet stacking cradles.
When the stack is completed the stacking cradle lowers to its bottom position and transfers the stack onto a movable roller table. At this point the stacking cradles are free to return to their original position where they are ready for the next stack.
The stack is then transferred downstream for tying; weighing and tagging operations (See Fig. 8).

**Figure 8**. Stacking station and bundles chain transfer

The billet stacking station is designed to stack billets ranging from 76 to 200 mm (approx. 3" to 8") and up to 16,000 mm in length (approx. 52'-6") at production rates exceeding 200 M tph (220 tph) for the medium and larger billet sizes.
Finished stacks using a stop-and-go sequence are tied with an automatic strapping machine provided by Sund Bistra. The number of straps applied in a single stack depends on stack length and can vary from 3 to 6 straps or as required. The strapping station has a production capacity exceeding 160 M tph (approx. 176 tph).

Finished stacks are weighed on the conveying roller table and sent to a chain transferring table, where they are removed by the bay overhead crane.

**Billet conveying system to the existing conditioning facilities**

The plant includes a line for transferring a portion of inspected billets to the existing billet conditioning facilities. It consists of a line comprising a roller table, a chain transferring table and a set of billet collecting racks designed to transfer up to 300,000 M tpy (approx. 330,000 tpy) of material.

**Electrical and Automation System**

The electrical and automation system was supplied by Danieli Automation. The concept applied in the design of the electrical and automation system was to minimize maintenance of the electrical hardware and machine components and, given the variety of products and high production rates, to be user-friendly and highly dependable. These requirements were achieved by using AC motors throughout the line while the drives, hardware and PLC's selected are first-rate.

The highly sophisticated user-friendly material tracking system, as well as the entire automation system in general, requires minimum production personnel placed in strategic locations for plant supervisory purposes. It guarantees high productivity, close monitoring and quality reporting at all times (see Fig. 9).

The fully integrated automation system supplied provides the following characteristics:

- High flexibility to cover the wide range of products
- Consistency in the various phases of material tracking and processing
- Centralized data storage
- Early and consistent quality control
- Quality-oriented and comprehensive production reporting.
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**Figure 9**. Main control Pulpit

The supplied automation is also based on the Gerdau Açominas server architecture and highly specialized automation units, where the server is dedicated to database management and the single "client units" allow the operators to directly make use of the various production management functions.

**Plant results**

The production results of this plant fulfill the customer's requirements, making it possible to set production and technological targets. The plant is able to provide fully

inspected and conditioned (I/C) prime product for the downstream operations within the scheduled time period.
After approx. 5 years in production the plant is providing the material quality originally required by Gerdau Açominas while the plant is presently producing at rates higher than its design capacity, providing an additional plant capacity of approx. 50,000 M tpy (55,000 tpy).
In fact, considering the time required for the plant learning curve, personnel training for the multiple working shifts and production variables, the plant is presently producing at rates close to 800,000 M. tpy (approx. 880,000 tpy) for inspected material and 500,000 M. tpy (approx. 550,000tpy) for conditioned and packaged material.

## SECTION 2: GRINDING PLANTS FOR CONDITIONING QUALITY STAINLESS AND CARBON STEEL SLABS.
## DEVELOPMENT OF DANIELI CENTRO MASKIN SUPER GRINDERS

The market requirements for modern steel making plants producing quality products for the engineering, automotive and avionic industries, is the ability to provide total quality at high production rates. For this purpose Danieli Centro Maskin is introducing the high capacity grinding plants presently in operation and the new developed Super Grinders.
The Super Grinders are very high power machines with the capacity to dramatically increase, with the same number of machines, the production capabilities of the new grinding plants.
These machines constitutes also an interesting option for substituting the existing grinding machines in order to increment the production capabilities of the grinding plants presently in operation.
These machines can be used for both Cold and Hot grinding in order to achieve high productivity, lower investment, minimum manpower requirements and environmentally friendly operation.

## ADVANTAGES AND FEATURES OF SLABS, BLOOMS, INGOTS CONDITIONING WITH THE GRINDING METHOD

Grinding can be regarded as the optimum method for conditioning practically all type of steels produced to eliminate cracks, seams, casting powder inclusions, scale and any kind of surface defects. It consists of a dry method where the material is conditioned (ground) using high pressure grinding machines mounting grinding wheels with different grit size, to achieve high production rates and guarantee the precise roughness required for each particular production process. The man power requirement is minimum as several grinding machines can be automatically controlled, while the complete grinding plant can be supervised by one operator located in a single grinding plant control pulpit. The Grinding process is achieved by using an all surface skin and corner grinding and also a pattern grinding concept already pre set on recipes loaded in the machine control system. Grinding defects can be seen by the operator using high resolution CCD cameras, and be able to change on-line the grinding pattern for adapting the automatic grinding program to the actual needs of the material surface being conditioned. (See Fig. 10 and Fig. 11 )
Heavy chips produced with the grinding process are collected in sealed bins to be removed by crane and sent to the melt shop for being recovered, while the fine dust

and smoke are sucked with a high power fan and ducked to the bags filtering unit located outside of the grinding plant building, to be also partially recovered in a fine dust bin.
Approx 90% of the grinded material can be recovered with the grinding process and being this a dry system, there is no need of water which would generate mud to be further processed and disposed as it is required with the scarfing process.

**Figure 10**. In line CASTTGRIND® plant for stainless steel slabs at Outokumpu, Tornio, Finland

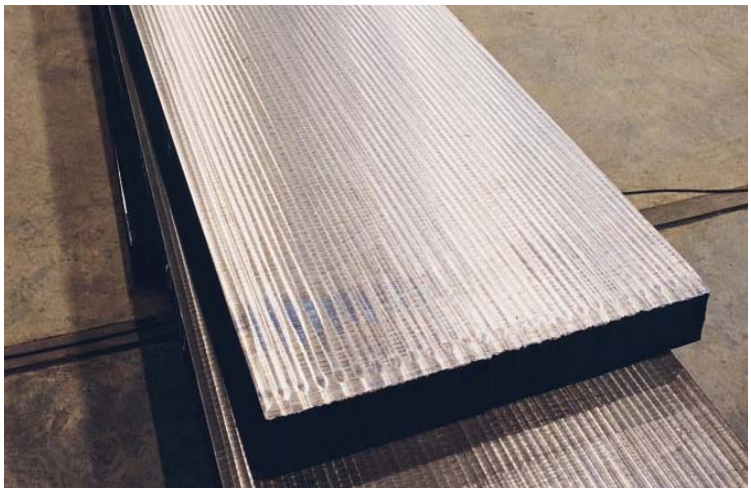

**Figure 11**. High quality grinded surface of stainless steel slab

## GRINDING PROCESS AND GRINDING WHEELS CHARACTERISTICS

Grinding wheels used for steel conditioning in high pressure machines are the HOT PRESSED WHEELS. Such grinding wheels are composed of abrasive grits and resin bonds of various characteristics according to the application and grades of materials been conditioned. They are provided with strong reinforcement at both sides of the wheel for cold-worm grinding concept (below 500 C°) and with additional internal fiber glass strong reinforcements buried inside the wheel body, designed to better hold together the wheel components for hot- grinding (from 500 C° and over 900 C°). The abrasives mostly used are Aluminum Oxide and Zirconium-Aluminum Oxide, Rod in various combinations according to the needs.

The grit size is measured in “Mesh” standardized by FEPA, which means the size of the grit passing through a one square/inch mesh, i.e.: a 16 grit size equal to the largest grit passing through a 1 inch x 1 inch mesh. A higher grit size number wheel provides a finer material cut and a better finish: i.e.: small roughness (or R max) measured in micron/meter, but on the contrary the wheel has a lower metal removal rate (MRR) and a higher consumption, therefore a suitable combination of these two parameters are necessary to get the best results of the grinding process.
Extreme demanding applications for special Stainless Steel grade slabs require roughness values of R max ≤ 60 micron/meter which has been achieved in normal production, with the Danieli Centro Maskin grinders as in Outokumpu, Avesta plant in Sweeden, but still obtaining a good wheel consumption rate. Standard roughness values are however on the range of R max = 120 to 200 micron/meter for stainless steel slabs and up to 300 micron/meter for carbon steels. For long products such as bloom, billets and ingots the roughness required is normally higher.
Standard grinding wheels used for such applications are diameters: 610 mm, (760 mm) and 914 mm, and thickness 76 mm, 102 mm, 125 mm and 150 mm.
The grinding process consists in pressing the grinding wheel with A high but modulated force on the surface of the material to be conditioned and moving it along the surface where defects are present for been eliminated.
The wheel however shall follow the material surface in order to equally grind the same and not remove a higher amount of material than necessary, to properly condition the product and avoid any unnecessary waste. Usually the grinding is done with the wheel positioned at 90° or at 45° angle with respect to the surface being worked, but it can be positioned also with any angle as needed in order to optimize the grinding process.(See Fig. 13)

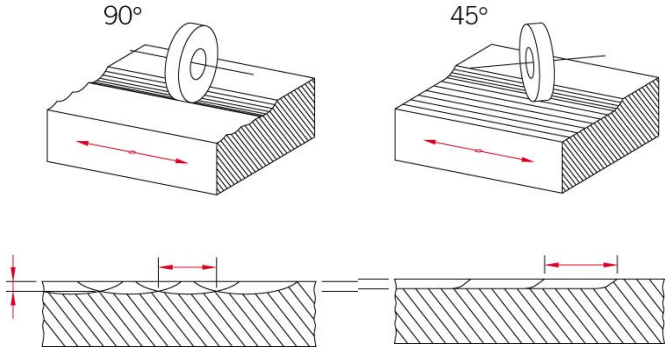


**Figure 13**. Usual grinding wheel orientations during the grinding process

## GRINDING MACHINES CHARACTERISTICS

The grinding machine shall guarantee high productivity, precise removal of defected material, high surface finished and suitable to the down stream production process, long lasting components, optimized manpower, effective human machine interfacing and environmentally friendly operation. All above shall also be obtained with a low investment for a quick payback.
Danieli Centro Maskin Grinders incorporates a grinding control system based on the effective power consumption of the motor to regulate the pressure applied on the grinding wheel and to the grinded surface. The system permits to obtain the highest efficiency of the grinding operation at all times and still provide the surface finish needed for each particular process. This is done with the HIGHGRIND control,

developed by Danieli. The latest is a PLC based control system and presently in operation in several modern plants.
The grinding spindles holding the grinding wheel is of a well engineered and sturdy design, mounting high precision bearings properly assembled and set in order to obtain longer spindle life. Danieli Centro Maskin grinding spindles are of two mayor models: a belt driven grease lubricated type and gear driven, air-oil lubricated type. The belt driven grease lubricated is used for lower power demand and cold to worm grinding operations, i.e.: material temperature form 0 C° to 400-450 C°, while the gear type air-oil lubricated is used for high power requirements and for the hot grinding operations, i.e.: material temperature from 450-500 C° to over 900 C°. In this latter case grinding spindles are effectively shielded with water cooled panels and incorporates heat protected hoses to obtain high spindle life and trouble free operation.
Danieli Centro Maskin grinding spindles records a standard life of approx. 8.000 operating hours, however over 13.000 hours and up to 15.000 hours has been recorded in several production plants.
The grinding spindle together with the motor and driving system are mounted on a pendulum where the hydraulic cylinder providing the grinding pressure for the grinding operation is installed.
The grinding pendulum and spindle assembly are mounted on a cross car hydraulically operated, placed perpendicularly to the material in process. This car provides the cross feed forward stroke of the grinding wheel, to cover the required material surface. The cross feed car is mounted on a heavy duty supporting structure which supports also the heavy chips conveying system, the chips water cooling panel for cooling the grinded chips and conveying them to the underneath collecting bins, the air suction system for conveying the fume and fine dust produced with the grinding process to the bag type filtering and dust recovery system. The complete machine is enclosed in a dust and noise suppression cabin for safety, noise abatement and environmental control of the grinding operation. (See. Fig. 14).

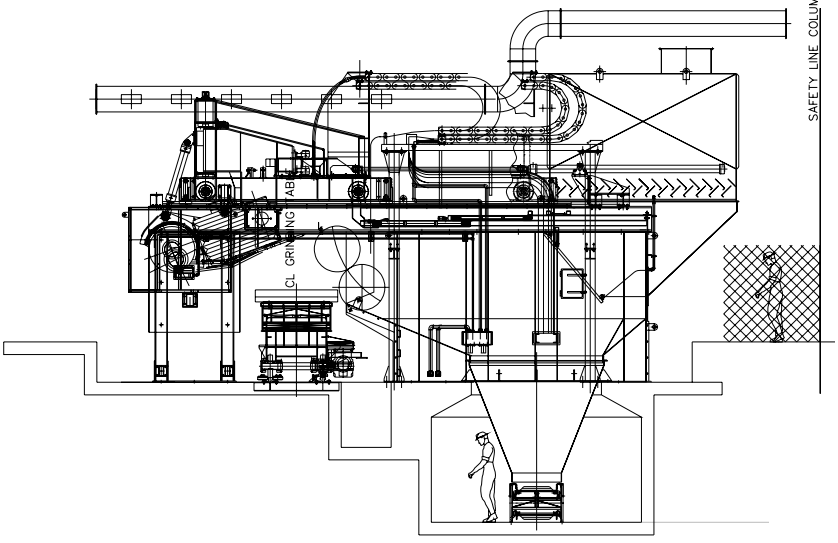


**Figure 14**. Machine enclosure for dust and noise suppression

## PRODUCTION CAPABILITIES OF DANIELI CENTRO MASKIN PLANTS

The grinding capacity of a plant is directly related to the Material Removal Rate (MRR) and is measured in Kg of steel removed per kWh of the grinding motor

installed (Kg/kWh). The standard Material Removal Rate (MRR) for Cold to Worm (up to 500 C°) are: for the Stainless Steels grades 2.5 - 3 Kg/kWh; and for the Carbon Steel grades 3-4 kg/kWh; while for Hot Grinding or from 600 C° to above 900 C° it is as high as 6.5 - 7 Kg/kWh for both Stainless Steel and Carbon Steel grades.
High production plants installed by Danieli Centro Maskin incorporate gear type spindles with a motor power of 315 KW. It assembles two 914 mm diameter wheels having each from 100 mm to 125 mm thickness. Grinding wheels are mounted side by side and are locked in a hub and flange assembly which can be changed in automatic or semi automatic mode.
Considering the above Material Removal Rates, the grinding capacity for each machine ranges from 800 to 1100 Kg/hr for cold grinding operations and close to 2.000 Kg/hr for hot grinding operations.
High production Hot Grinding plants for slabs presently in operation supplied by Danieli Centro Maskin are composed of two (2) main grinding machines placed one after the other in a continuous mode.
The first machine grinds the top face of the slab and eventually one narrow side of the same by using a smaller grinder for edge grinding. The slab is then conveyed to an automatic slabs turning manipulator and to the second grinding machine which grinds the second face and if required, the opposite narrow side of the slab with a second edge grinder.
A plant of this nature considering skin grinding Stainless Steel hot slabs with an average weight of 30 tons and 1.6 meters wide, removing approx. 2% of material (2,5 mm per side, one 45° rough and one 90° finish pass), has a production capacity of approx. 50 TPH.
Should we consider to grind hot slabs of carbon steel grades, and a combination of skin grinding (60%) and spot or pattern grinding (40%), the same plant has a production capacity of approx.120 TPH. (See Fig. 15).

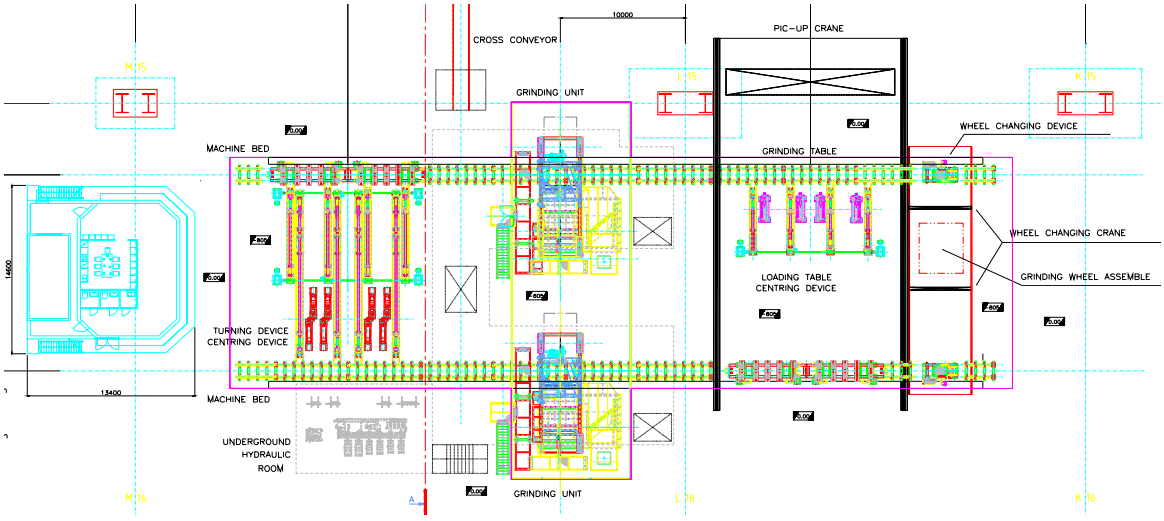


**Figure 15**. Grinding area layout

However should a plant require higher production rates obliges to double up the number of grinding machines installed in the plant which calls for the need of larger space, higher investment costs, more extensive slabs handling, higher manpower, more machines to be maintained and serviced, etc.

## DEVELOPMENT OF DANIELI CENTRO MASKIN SUPER GRINDERS

The steel producers to be competitive and to remain competitive also in the future, shall guarantee a total quality, fully inspected and conditioned product. They shall be able to process it efficiently and in the fastest way possible.

For both Stainless Steel and Carbon Steel producers there is the need of higher production plants with just two (2) machines only: the first for the top face and the second after turning the slab, for the bottom face of the slab, thus limiting the space and equipment requirements. (See Fig. 15)

Specially in the carbon steel sector a grinding plant in-line with a modern slab grinding machine shall be able to grind at very high production rates to condition in continuous the “as cast” hot slabs, with only two (2) machines and therefore with a lower investment and transformation cost.

Based on Danieli Centro Maskin experience with the installation of 1060 grinding machines since 1953 for slabs, blooms, billets and ingots as well as the development of commercial plants for IN –LINE hot grinding of slabs coming directly from the continuous casting machine, the CASTTGRIND® system developed since 1995, we have consolidated an internal research for developing the SUPER GRINDERS, a new set of grinding machines which incorporates a high capacity grinding spindle driven with a motor having double power than the standard 315 KW motor.

## CHARACTERISTICS OF DANIELI CENTRO MASKIN SUPER GRINDERS

The Danieli Centro Maskin SUPER GRINDERS are high power grinding machines incorporating a gear type grinding spindle air-oil lubricated, driven by an AC motor having 630 KW power, v.v.v.f. controlled.

The grinding machine supporting structure has been redesigned and made heavier in order to keep under control the heavy forces involved to avoid abnormal vibrations which could have a negative affect on the of the surface of the product being conditioned.

The grinding spindle has been redesigned with the installation of larger bearings and an improved air-oil lubrication system. The spindle is mounted on a heavy duty pendulum, housing the spindle with its gear driving assembly, coupling and motor. The pendulum is pivoted at one side while at the other side it is connected to the hydraulic cylinder that provides the grinding pressure required for the grinding process.

For the hot grinding operations as applied on the CASTTGRIND®, the pendulum and spindle assembly are shielded with a set of heavy duty water cooled panels and provided with high temperature water cooled hoses to withstand the severe working conditions and obtain a long life of the spindle and of the machine components.

The grinding spindle houses 2 grinding wheels having a diameter of 914 mm and 150 mm thickness each, mounted side by side.

Both grinding wheels are mounted on the standard Danieli Centro Maskin hub and flange arrangement designed for a semi-automatic or an automatic grinding wheels changing method (specially used in case of IN-LINE hot grinding conditions).

The grinding plant handling system is the same as the one used in the Danieli Centro Maskin standard grinding plant, which has proven to be highly reliable, works in fully automatic mode, it is made of heavy duty and long life components and requires very little maintenance.

Such characteristics represents the main parameters to be taken in chief consideration for high efficiency grinding plants used also for the continuous, in-line operations as in the CASTTGRIND® system.

## PRODUCTION CAPACITY OF DANIELI CENTRO MASKIN SUPER GRINDERS

**Table 1**. Slab Grinding Productivity Chart

| **PRODUCTIVITY OF GRINDING PLANTS FOR CONDITIONING OF SLABS**<br>1 - Slab characteristics:<br>Dimensions: 1600 mm x 250 mm x 10 meters<br>Weight: 30 metric tons<br>2 – Total Material Removal: 2%<br>3 – Plant grinding time: 7600 hrs./year<br>4 – Number of Grinding Machines in Plant: 2 | **STANDARD GRINDERS PRODUCTIVITY METRIC TONNS/YEAR** | **SUPER GRINDERS PRODUCTIVITY METRIC TONNS/YEAR** |
|---|---|---|
| **COLD GRINDING OF STAINLESS STEEL**<br>(Skin Grinding) | **320.000** | **405.000 (+27%)** |
| **HOT GRINDING OF STAINLESS STEEL**<br>(Skin Grinding) | **400.000** | **460.000 (+15%)** |
| **HOT GRINDING OF STAINLESS STEEL**<br>(60% Skin grinding - 40% pattern grinding) | **600.000** | **660.000 (+10%)** |
| **COLD GRINDING OF CARBON STEEL**<br>(60% Skin grinding - 40% pattern grinding) | **670.000** | **950.000 (+41%)** |
| **HOT GRINDING OF CARBON STEEL**<br>(60% Skin grinding - 40% pattern grinding) | **920.000** | **1.250.000 (+36%)** |

As before explained the grinding capacity of a plant is directly related to the Material Removal Rate (MRR), measured in Kg/kWh.
Considering the previously mentioned Material Removal Rates, the grinding capacity for each machine ranges from 1600 to 2100 Kg/hr for cold grinding operations and approx. 3750 Kg/hr for hot grinding operations.
A plant of this nature considering skin grinding of stainless steel hot slabs with an average weight of 30 tons and 1,6 meters wide, removing approx. 2% of material (2,5 mm per side, one 45° rough and one 90° finish pass), it has a grinding capacity of approx. 60 TPH.
Should we consider to grind hot slabs of carbon steel grades, and a combination of skin grinding (60%) and pattern grinding (40%), the same plant have a capacity of approx. 165 TPH.(See Table 1)

## CONCLUSIONS

Quality stainless and carbon steel products for the engineering, chemical, automotive and avionic industry requires total quality products, surface conditioned and free of any defect. They shall be produced efficiently, with the lowest investment and at high production rates.
Grinding as a process competing with the cold or hot scarfing operations, presents several advantages.
Danieli Centro Maskin grinding machines and integrated grinding plants presently installed are high performance plants, which provides In-Line hot grinding operations as with the CASTTGRIND® system, which allows to grind hot slabs at casting temperatures over 900 C°.

For higher production requirements it is necessary to duplicate the number of grinding machines and grinding plants.
In order to fulfill such needs, Danieli Centro Maskin have developed the SUPER GRINDERS which houses a double power motor to provide the extra grinding capacity, without incrementing the number of grinding machines, therefore keeping to the minimum the size of the grinding plant and the investment required.
The SUPER GRINDERS are designed for high capacity conditioning of slabs, blooms, billets and ingots in automatic or semi-automatic mode. By using 2 SUPER GRINDERS in a CASTTGRIND® plant incorporating the In-Line hot grinding method, it is possible to handle in continuous the total capacity of a modern carbon steel slab casting machine with production rates exceeding 1.2 Mil/Tons/Year.