

NEW DEVELOPMENT IN PLATE ROLLING AND PLATE PROCESSING ¹

Gerhard Horn ²
Peter Schmitz ³
Lothar Hanenberg ⁴

Abstract

Substantial developments have been made during the last decade to achieve production of top-quality plates. Four-high stands equipped with CVC/CVC[®] plus systems are state-of-the-art for strip production. SMS Siemag supplied the first CVC[®] plus application for plate rolling to SSAB Oxelösund, Sweden which has shown excellent performance since 1998. In the meantime SMS Siemag supplied additionally 11 Plate Mill Stands equipped with state-of-the-art CVC[®] plus Technology Packages. A further improved concept has been developed for accelerated cooling (ACC) and direct quenching (DQ) in conjunction with thermo mechanical rolling with enhanced possibilities. The new generation of rolling-cut type shears is designed to cut high-strength plates up to 50 mm plate thickness. The levelling strategy for hot and cold levellers for products with low levelling temperature in case of ACC and DQ and the highest flatness tolerances require high levelling forces and improved technology for plate levelling. All new Plate Mills supplied by SMS Siemag AG are outfitted with the most modern equipment and the most advanced and sophisticated technology.

Key words: SMS Siemag AG; Plate rolling; Plate processing.

NOVOS DESENVOLVIMENTOS EM PROCESSOS E LAMINAÇÃO DE CHAPAS GROSSAS

Resumo

Desenvolvimentos substanciais tenha sido feitas durante a última década para atingir produção de alta qualidade chapas. Cadeiras de 4 cilindros equipados com CVC/CVC[®] plus são sistemas estado-da-arte para a produção de tiras a quente. SMS Siemag forneceu o primeiro CVC[®] plus aplicado para laminação de chapas grossas para Oxelösund SSAB, Suécia, que tem demonstrado excelente desempenho desde 1998. Posteriormente, a SMS Siemag forneceu adicionalmente 11 Plate Mill stands equipados com estado-da-arte CVC[®] plus Technology Packages. Outro conceito de melhoria foi desenvolvido para resfriamento acelerado (ACC) e resfriamento direto (DQ), em conjunto com a laminação termomecânica com melhores possibilidades. A nova geração de tesouras de corte para laminação é projetado para corta chapas de alta resistência com até 50 milímetros de espessura. A estratégia de desempenamento a quente e frio para os produtos com baixa temperatura de desempenamento, no caso de ACC e DQ e as maiores tolerâncias de planicidade exigem altas forças de desempenamento e tecnologia para a melhoria da desempenamento de chapas grossas. Todos os novos Plate Mills oferecidos pela SMS Siemag AG são equipadas com os mais modernos equipamentos e a mais avançada e sofisticada tecnologia.

Palavras-chave: Desenvolvimento; Laminação de chapa grossa; Processo de laminação de chapa grossa.

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² *General Manager, Hot Rolling Mills Division, SMS Siemag AG, Germany*

³ *Senior Project Manager, Hot Rolling Mills Division, SMS Siemag AG, Germany*

⁴ *Project Manager, Hot Rolling Mills Division, SMS Siemag AG, Germany*

General

Driven by the high demand for heavy plate worldwide, capacities for plate production are currently greatly extended. Since 2000, new plants with an output of approx. 25 million tons have started operation, and by 2010/11 additionally 15 million tons will have been added to this capacity.

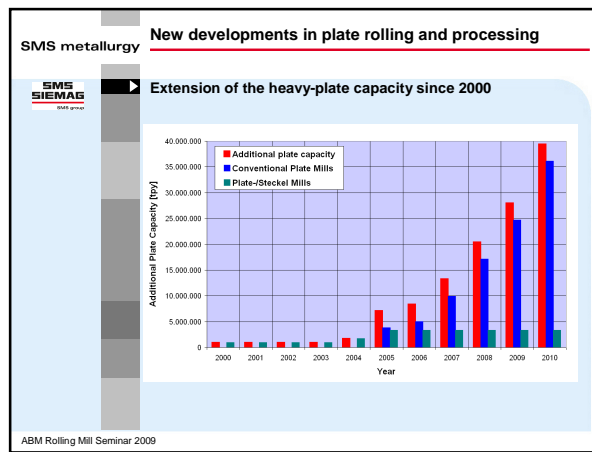


Figure 1: Extension of the heavy plate capacity since 2000.

The typical heavy plate mill remains the prevailing type of plant as it combines high productivity with an excellent product quality and a large range of steel grades and dimensions.

With a market share of more than 50 %, SMS Siemag is definitely the leader of the market in the heavy plate sector. Since as recently as 2009, ten heavy-plate mills supplied by us have been commissioned, and another six are under construction and will start production by 2010/11.

SMS metallurgy New developments in plate rolling and processing					
Most recent plant references					
Customer	Width [mm]	Production [mio t/a]	Commissioning First Plate	Plant configuration	Remark
Maghreb, Morocco	2,800	0,5	2010	1 Stand Mill	Complete Automation System
Tangshan, China	5,000	2,0	2010	2 Stand Mill	
Posco, Korea	5,500	2,0	2010	2 Stand Mill	Widest Plate Mill
Vyksa, Russia	5,000	1,2	2010	1 Stand Mill	Complete Electrica and Automation System
Hyundai, Korea	5,000	1,5	2009	1 Stand Mill	Complete Automation System
Yingkou, China	5,000	2,0	2009	2 Stand Mill	Complete Automation System
Magnitogorsk, Russia	5,000	1,5	2009-06-27	1 Stand Mill	Complete Electrica and Automation System
Pudong, China	4,300	1,5	2008-02-27	2 Stand Mill	
Anshan, China	5,500/5,000	1,8	2008-08-30	2 Stand Mill	Widest Plate Mill
Ural Steel, Russia	2,800	1,15	2008-03-14	2 Stand Mill	
Baotou, China	3,800	1,4	2007-10-27	2 Stand Mill	
Shougang, China	4,300	1,2	2006-10-18	1 Stand Mill	2nd Stand Phase 2
Xiangtan, China	3,800	1,4	2005-09-30	2 Stand Mill	Complete Electrica and Automation System
Abu Zaabal, Egypt	3,800	0,12	2005-09-12	1 Stand Mill	Major Automation System
Xinyu, China	3,800	0,8	2005-04-10	1 Stand Mill	
Baosteel, China	5,000	1,4	2005-03-01	2 Stand Mill	First 5 m Plate Mill in China
		1,8	2008-12-18 RM		

Figure 2: Most recent plant references


The users of all new mills have awarded contracts to us for the supply of the entire process line from the mills stands to the plate finishing section. The scope of supply of

some contracts also included the furnaces, equipment for heat treatment and roll shop. An increasing number of the contracts equally include the electrical equipment and all automation systems like for the already completed plant at Xiangtan (China) and the most recent contracts for MMK and OMK Vyksa in Russia as well as Yingkou in China and Hyundai in South Korea.

SMS metallurgy **New developments in plate rolling and processing**

SMS SIEMAG

Benefits from a common source of mechanics and E&A



- The SMS Siemag Automation solution is perfectly matched to the SMS Siemag mill design and technology, same models used for technological and mechanical design (off-line) and for on-line process control
 - Exploit the full potential of SMS Siemag technology and mechanics with an exactly matched E&A solution
 - The Customer will share SMS Siemag's latest technological experiences
- One single partner: clear responsibilities, e.g.
 - SMS Siemag is responsible for the performance guarantees as a whole
 - SMS Siemag is responsible for all work progress within the mechanical and E&A scope
- The execution of the project is fully under SMS Siemag's project management

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Figure 3: Benefit from a common source of mechanics and electrics/automation

Layout

For the development of the optimum plant layout, vast experience and close cooperation with the customer are of vital importance. The layout mainly depends on the production specifications of the customer and the site premises which is why the arrangement of the various plant sections rather often differs greatly.

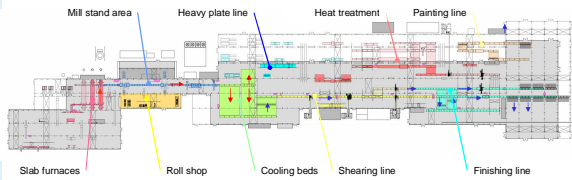
Two examples ... Yingkou/China Two-stand Plate Mill
 MMK/Russia Single-stand Plate Mill

SMS metallurgy **New developments in plate rolling and processing**

SMS SIEMAG

Two-stand heavy plate mill
 Minmetals Yingkou Medium Plate Co., Ltd./China

Production capacity	2 million t/year
Commissioning	2009
Slab/Ingot weight, max.	80 t
Plate length, max.	56 m
Total plant length	1,600 m



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Figure 4: Two-stand plate mill.

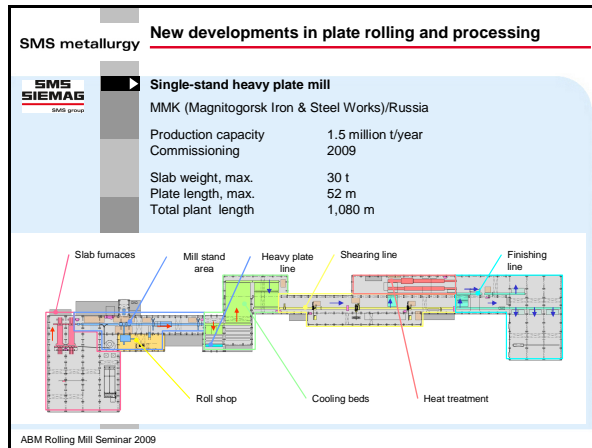


Figure 5: Single-stand plate mill.

To enable the demanded large range of products with a great proportion of high-strength plates to be produced, new plate mills are designed for a great variety of production technologies. In addition to this, unrestricted compilation of the rolling campaigns is called for with great variations in terms of thickness, width and steel grade from one plate to the next without negative effects on the productivity (schedule free rolling). Prime quality in terms of thickness, width, profile, flatness, rectangularity and a homogeneous microstructure are likewise expected with all steel grades and even extreme dimensions.

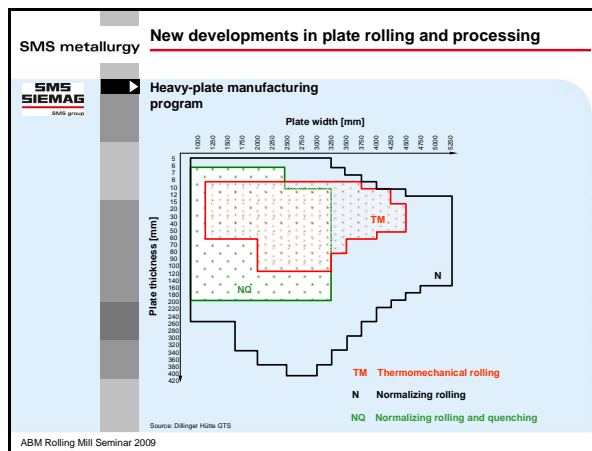


Figure 6: Plate manufacturing program.

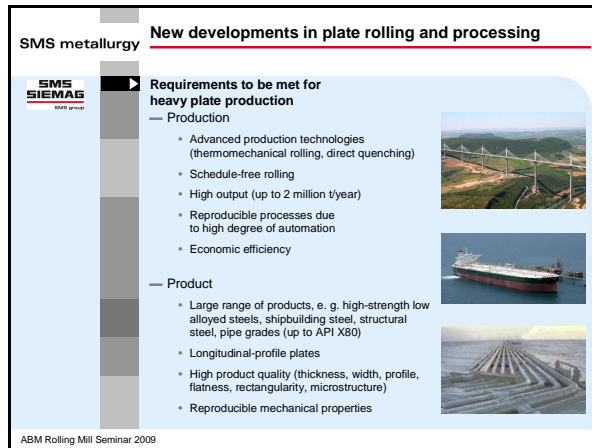


Figure 7: Requirement for production units.

The production of high-strength plates has implications for all sections of a heavy plate rolling mill. Mill stands and plate cooling systems as well as all downstream mill sections have to be designed such that high-strength plates can be produced and processed to obtain top-quality final products. This is why SMS Siemag has improved rolling, cooling, levelling and shear technologies with a view to achieving highest quality standards.

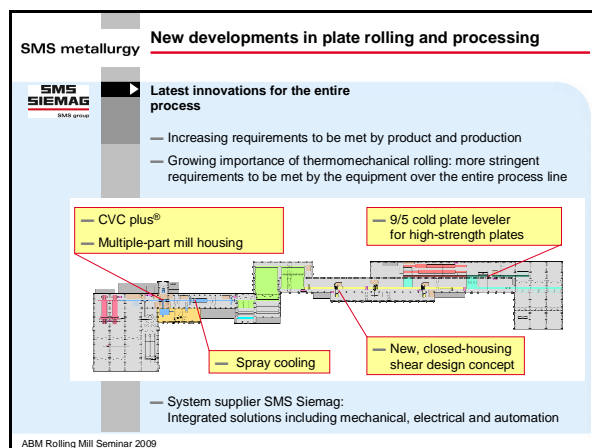


Figure 8: Latest process innovations.

The basis for reproducible production processes and a high production rate is a high degree of automation. SMS Siemag as system supplier provides integrated solutions including mechanical, electrical and automation equipment and hence the conditions for optimum process control.

CVC® plus

In the mill stand sector, the use of the CVC® plus technology is certainly the most important development. CVC® plus is an integrated system and based on the combination of work roll bending, axial shifting of the work roll with the special CVC contour as well as technological process model for profile and flatness control. For each pass, bending and shifting position are set under consideration of the roll force such that profile and flatness can exactly be trimmed. CVC® plus allows higher drafts during the

last passes which altogether implies that a smaller number of passes is required and therefore productivity is higher. In addition, CVC[®] plus makes flexible production possible due to free compilation of a rolling campaign.

The advantages of the CVC[®] plus technology can also be applied for mill stands with a large roll gap. Mill stands with CVC[®] plus and a roll gap up to 550 mm have already been built several times. For even larger roll gaps, a CVC[®] plus system has been developed with vertical movement of the shifting system together with the work roll.

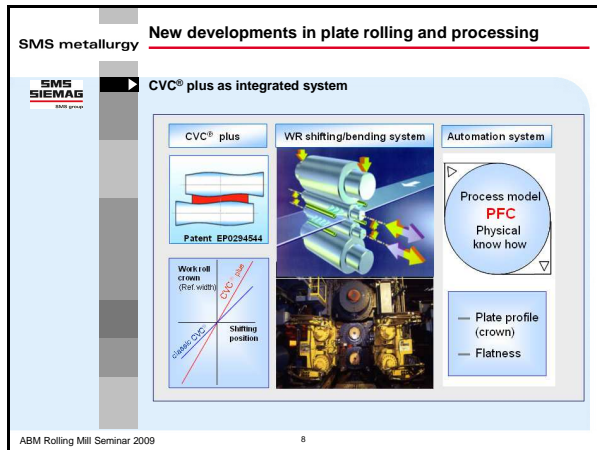


Figure 9: CVC[®] plus as integrated system

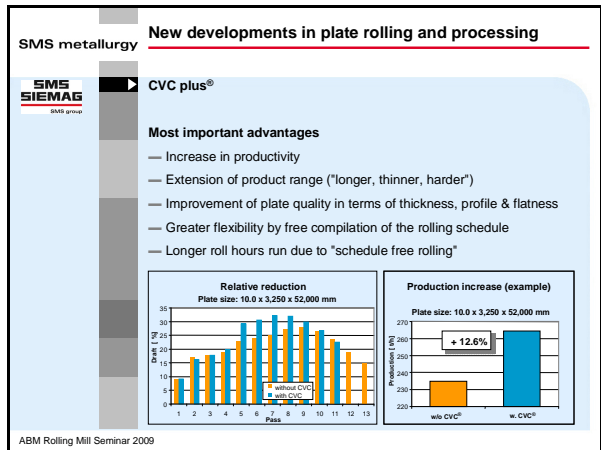


Figure 10: Advantages of CVC[®] plus

Mill housings in multi-part and bolted design

For construction of a new heavy plate mill, procurement of the mill housings may be a bottleneck given the currently extremely heavy work loads of foundries respectively the limitation of the max. casting weight. This is why SMS Siemag offers multiple-part mill housings in addition to well proven single-part mill housings and the multiple-part welded design concept. Only on site are the finish-machined mill housings yokes and posts connected by strong tension rods. This approach simplifies casting of the mill housing, reduces the manufacturing risk, cuts delivery times and makes shipment to the site easier. At the same time, controlled preloading of the tension rods ensures minor deformation of the mill housing under load such as necking and hence very good plate travel and excellent plate geometry.

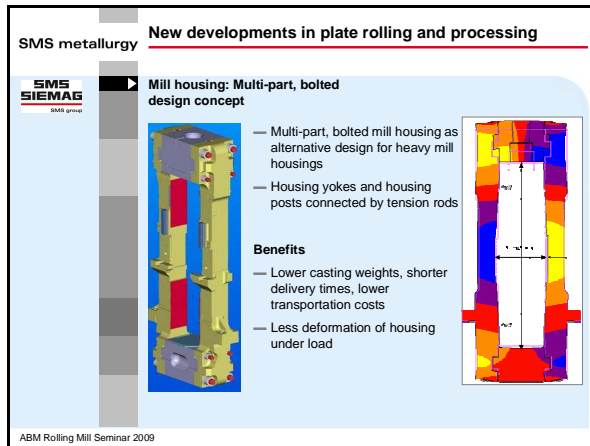


Figure 11: Multi-part mill housing

Cooling system

Further development of the material properties of high-strength plates is one of the major trends in the heavy-plate market. Energy producers demand ever higher strength and toughness for pipe grades in order to make the transport of energy over very long distances profitable. By combining newly developed spray cooling with the proved laminar cooling in a cooling system, SMS Siemag has developed a crucial metallurgical “tool”. In the spray cooling section upstream of the conventional cooling section, a high-performance high water pressure station together with special cooling ramps enable very high cooling rates to be reached. This allows accelerated cooling and direct quenching for wide, thick and thin plates. With a view to achieving good flatness despite the high-rate cooling, the rolling stock is guided between pinch rolls in the spray cooling section. The cooling model is based on the mapping of physical processes and controls the cooling process such that the metallurgical properties are precisely obtained.

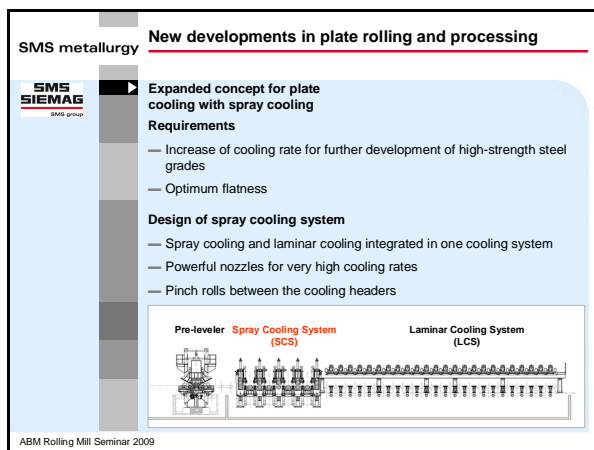


Figure 12: Spray cooling system

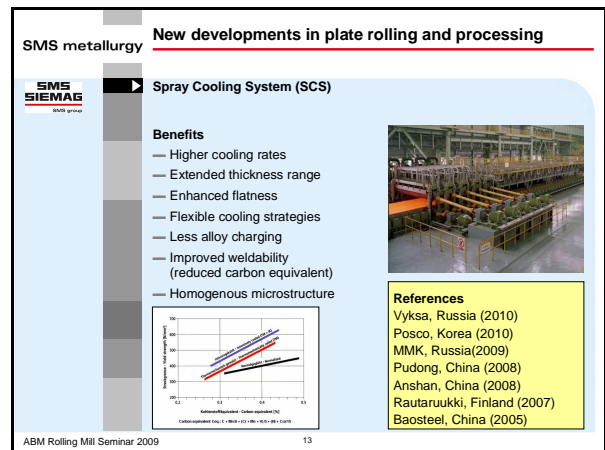


Figure 13: Benefits of spray cooling system

Levelling Systems

Regarding plate quality, the issue flatness with minimized residual stress has become of increased importance for further manufacture of the plates. Levelling of plates becomes more demanding due to the trend of higher strength and thicker plates. The SMS Siemag leveller concepts are the result of consistent improvement of heavy plate levellers so far built and long-year intense studies of the roller levelling theory.

Both the design detail solutions and the concept of the machine i.e. diameter, spacing and number of levelling rolls as well as the adopted adjusting, control, operating and drive systems permit, by integrated use, operator independent levelling in practically one pass levelling featuring max. yield strength.

In general three possibilities within a plate mill for levelling are considered.

The Pre-Leveller arranged in front of the cooling system to improve the ingoing flatness of the plate before cooling and therefore optimizes the cooling results.

The Hot Plate Leveller arranged after the cooling system especially designed for levelling heavy gauge plate.

The Cold Plate Leveller arranged within the finishing line to cover plates coming as rolled as well as plates from the heat treat lines.

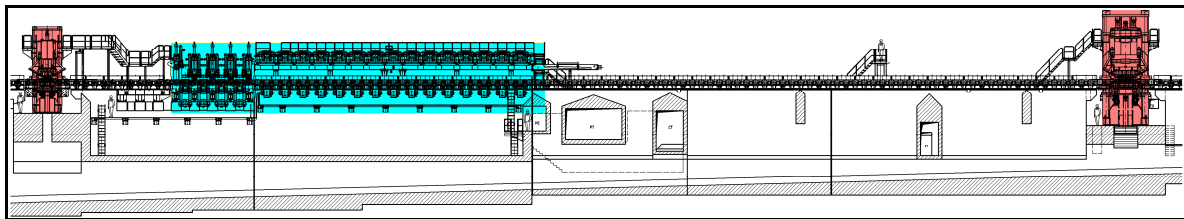


Figure 14: Integrated cooling and leveller system

Especially for cold levelling, the combination of a mechanical solution with an efficient levelling model has resulted in substantial improvement. Each levelling roll of the patented 9/5 cold plate leveller has a separate hydraulic adjusting system and individual drive apart from the hydraulic main adjusting system. In conjunction with the latest-state levelling models, it is possible to set the ideal curving for each plate and to thus reduce unflatness and residual stress. Individual adjustment of the levelling rolls allows to operate the cold plate leveller in the 9-roll and 5-roll mode. The levelling range is thus extended up to maximum plate thickness of 50 mm and the leveller has practically the capacity of two conventional plate levellers.

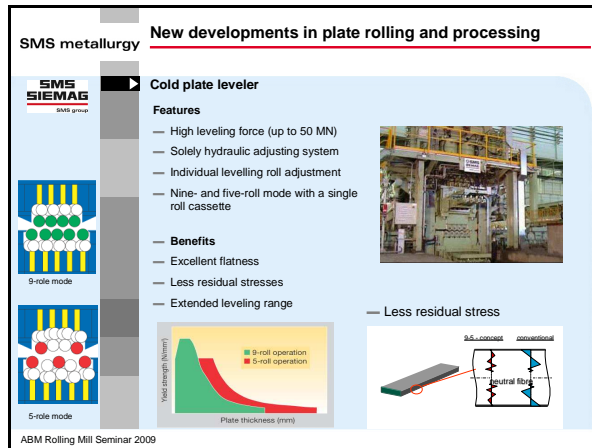


Figure 15: 9/5 Cold Plate Leveler

Shear technology

The shear line consists of Crop Shear, Double Side Trimming Shear, Slitting Shear and Dividing Shear. All shears are designed according to the rolling cut principle. Accurate cutting of a plate to the required dimensions is a key quality feature for the final customer. SMS Siemag has improved the shear technology in such a way that even high-strength plates of a thickness up to 50 mm can be accurately cut. Crop and dividing shears are of the closed-housing design type. Due to the high rigidity of the structure, the cutting accuracy and edge quality have been improved. This design concept and its combination with the rolling cut principle applied by all SMS Siemag heavy-plate shears make it possible to cut the plates accurately and with straight edges.

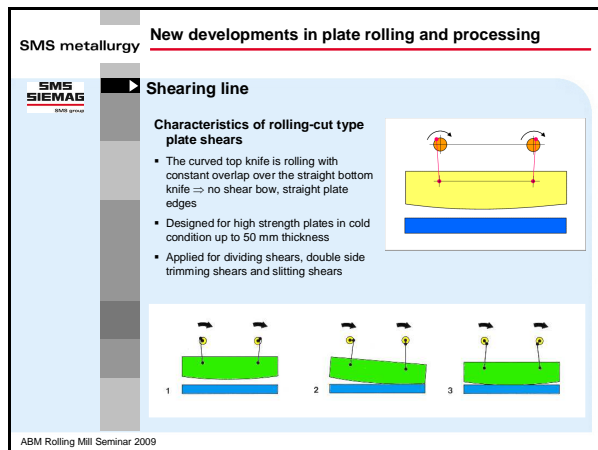


Figure 16: Rolling-cut principle

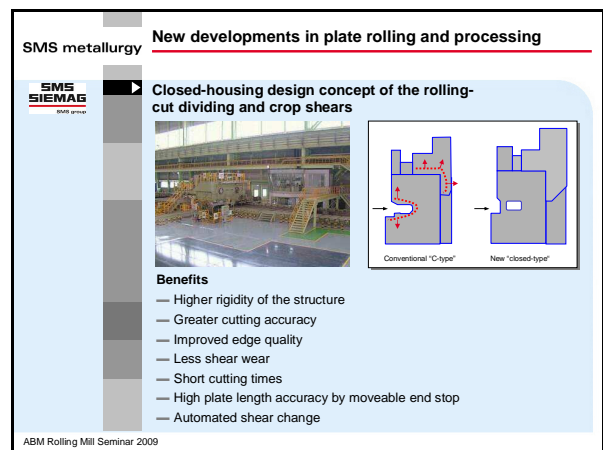


Figure 17: Closed housing for Shears

Summary

The presented further and new developments are the result of close cooperation between SMS Siemag and the rolling mill operators, aiming to increase the heavy plate quality and achieve a high capacity utilization of the installations. The CVC[®] plus technology, multiple-part and bolted mill housings, combined spray and laminar cooling as well as the innovations in the shear and levelling technology make SMS Siemag the forerunner in the development of heavy-plate rolling. These innovations improve the entire production process from rolling to plate finishing and have allowed to further develop the material properties and enhance the plate quality

- Ongoing further developments of SMS Siemag improve the process and allow high productivity and first-grade product quality:
 - Four-high stands with CVC[®] plus and work roll bending (also with greater roll gap)
 - Multiple-part bolted mill housing with controlled preloading
 - Combination of spray and laminar cooling for an extended cooling technology
 - Closed and optimized housing design of rolling cut type crop and dividing shears for optimum cutting quality
 - Cold plate leveller with 9/5 mode and individual adjustment of all levelling rolls for high-strength plates with stringent flatness requirements
- SMS Siemag as system supplier offers optimized packages including mechanical, electrical and automation equipment.