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Theme: Solidification / Casting

HIGHLIGHTS OF FLAT PRODUCT CASTER REFERENCES STARTING FROM NEW IMPLEMENTATIONS UP TO MODERNIZATIONS*

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Abstract

This paper presents the latest references of the Siemens VAI slab casting technology. Following the connect & cast philosophy Siemens VAI has developed technological packages suitable for installation in existing casters of any original supplier, as well as for complete new machines. A major demand on new machines is to adapt quickly to different market demands. This requirement for flexibility can be divided into two actual trends. Firstly into casting a broad range of steel grades, thicknesses and width on the same machine and secondly having installed slab, bloom and billet caster in one steel plant to deliver all different types of needs on the market. Depending on the condition of the existing machine the focus of modernization ranges from the substitution of single components featuring state-of-the-art technology to complete caster revamping projects. In this paper concepts and references for short machine outages and fast caster ramp-ups at moderate investment costs are presented.

Keywords: SIMETAL LevCon; Simetal Dynacs 3D; Simetal DynaPhase; Simetal DynaGap Soft Reduction® 3D.

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1 INTRODUCTION

Siemens VAI (SVAI) has been the innovative solution provider in the field of continuous casting technology since the late 1960's. For slab casters the SVAI design concept regarding straight mold design, continuous bending and straightening of the strand have become an industry standard and will be valid for the foreseeable future. Because of SVAI's comprehensive international experience in the engineering, supply, and installation of CC machines, along with the dedication to innovation, quality design and workmanship, the company has become the market leader in the field of continuous casting.
In addition to the supply of new machines, SVAI has considerable experience in the modernization of all types of CC machines. The modernization projects include revamp of own original installations along with upgrades of different suppliers. The proven Simetal Connect&Cast® concept results in quick and smooth installations of technological packages and fast ramp-ups of new or revamped machines.

2 SIEMENS VAI MODERNIZATION COMPETENCE AND SIMETAL CONNECT & CAST®

Short outages and fast ramp-ups after modernization are essential. With the application of technological packages and the Simetal Connect&Cast® approach SVAI can fulfill these special requirements. Figure 1 gives an overview about the historical trend of the introduction of technological packages.

2013	Hydraulically adjustable slab mold divider
2012	SIMETAL Opal, SIMETAL LevCon Actuator, DynaPhase
2011	SIMETAL DynaGap Soft Reduction 3D
2010	SIMETAL Dynacs 3D
2008	SIMETAL LiquiRob, SIMETAL EcoStar Roller
2007	SIMETAL LevCon 2.0, SIMETAL Mold Expert 2.0
2006	SIMETAL 3D Sprays dynamic spray width adjustment
2005	SIMETAL Smart Bender
2004	SIMETAL I-Star Revolver
2003	3D thermal tracking system SIMETAL DynaGap Soft Reduction® technology for blooms
2002	New segment design with 5 cylinders, SIMETAL DynaJet nozzle
2001	SIMETAL LevCon mold level control with smith predictior SIMETAL Smart DiaFace narrow face design
2000	SIMETAL DynaGap Soft Reduction® technology for slabs, SIMETAL DynaWidth hydraulic mold width adjustment
1999	SIMETAL Mold Expert System
1998	Patented Siemens VAI-Sollac Concept for Conversion from Curved to Straight Mold
1997	SIMETAL Smart Segment
1996	SIMETAL DynaFlex Hydraulic Mold Oscillator without Lifting Table
1995	Hydraulic Mold Oscillator
1995	SIMETAL Dynacs Cooling System Siemens VAI Discovery System
1993	SIMETAL Soft Reduction at SSAB Oxelösund
1992	SIMETAL I-Star Roller

Figure 1. Historical trend of the introduction of Technological Packages.

The modernization projects include SVAI original installations along with upgrades of machines of different suppliers. SVAI's primary goal is to assist clients in achieving their production and quality targets with a low investment and downtime of the casting machine.
In special cases workshop pre-assemblies and integration testing can be performed to ensure short installation duration and testing period on-site.
The SVAI's modular system architecture, fail-safe concept and exactly defined and standardized interfaces results in quick and smooth installation of technological packages with fast production ramp-ups.

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The main benefits of SVAI's Simetal Connect&Cast® philosophy are full functionality of L2 and technological packages at first heat, the immediate production of quality products, an increased yield by utilization of L2 models, the increased flexibility in planning by use of all technological packages and the quicker return of investment.

3 SIEMENS VAI TECHNOLOGICAL PACKAGE FOR THE TUNDISH FLOW CONTROL

3.1 Simetal LevCon

Simetal LevCon applies an advanced control algorithm that takes into account delayed system reaction, clogging, surface waves in the mold, and mechanical wear of the tundish stopper or slide gate through improved dynamic behavior. Automatic starting and resumption of the casting process are available for single, twin, triple and multi-strand casting. The newly included bulging compensation feature allows to reliably counteract unsteady bulging effects by precisely modeling the mold level behavior and applying a compensating signal thus ensuring stable mold level conditions. Thanks to the modular concept, all common types of mold level measurements, flow control mechanics, and actuators can be used.
The main benefits of SVAI's Simetal LevCon system are the unsteady bulging compensation, the automatic smooth start of casting process as well as the compact electromechanical actuator.

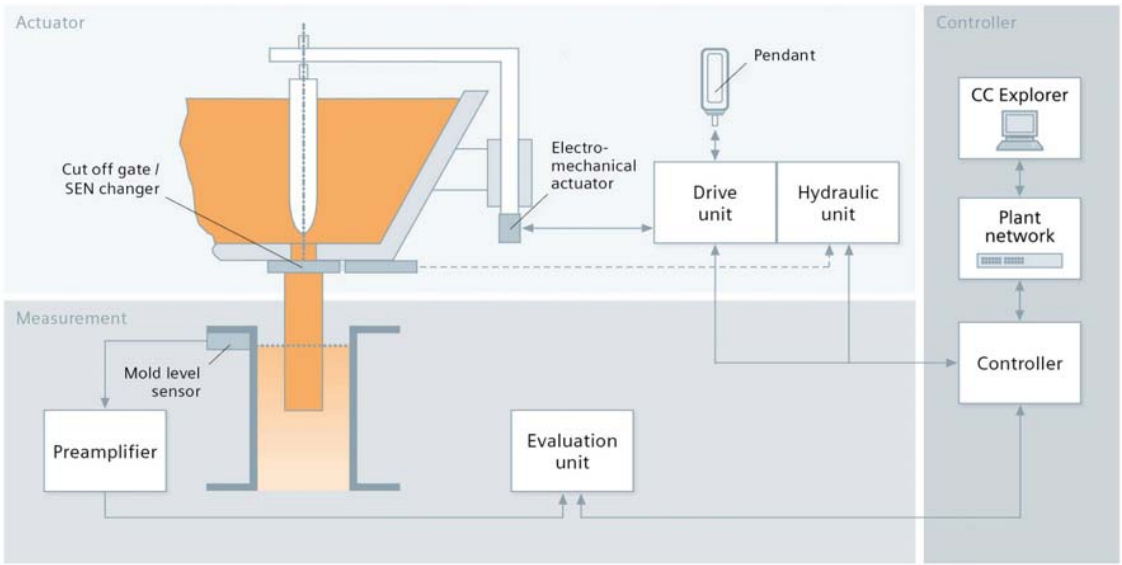

Figure 2. SIMETAL LevCon – Schematic diagram.

4 SIEMENS VAI TECHNOLOGICAL PACKAGE FOR THE MACHINE HEAD

4.1 Simetal DynaWidth

Simetal DynaWidth is the SVAI solution for fast remote width adjustment of slab caster molds. Width adjustment is done by means of 2 hydraulic drives per narrow side, which are directly linked to the narrow faces of the mold (Figure 3). This technical solution can be realized even in case of very limited space availability (e.g. revamps).

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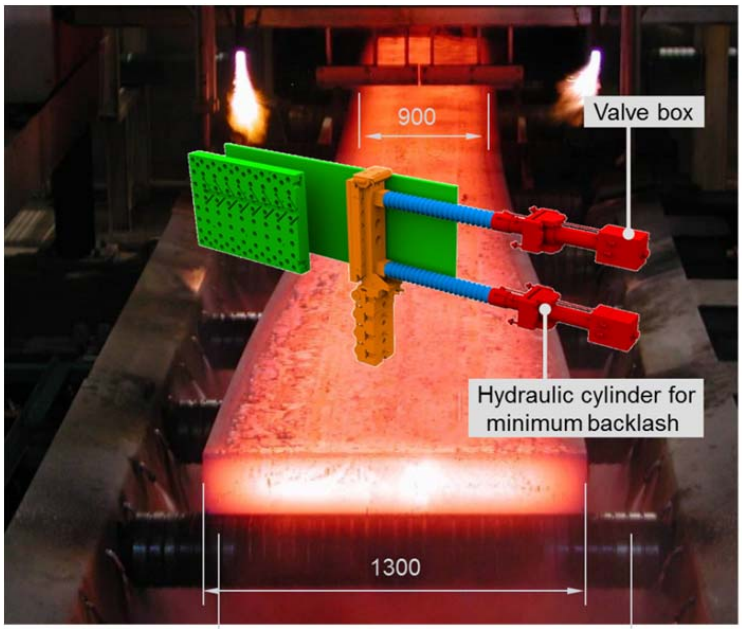

Figure 3. Simetal DynaWidth – Features and benefits.

Conventional mold width adjustment systems often require a cast speed reduction and therefore reduce the caster throughput. The Siemtal DynaWidth width adjustable mold provides online mold-width adjustments at any casting speed without any limitation for flexible, fast and secure slab-width changes at full casting speed. Thus the throughput of a caster can be increased by several percent depending on production factors like speed reduction during adjustment (before revamp), adjustments/day and tapered length. Moreover it guarantees minimal mechanical backlashes and high guiding accuracy. The position feedback of individual hydraulic cylinders is measured via ultrasonic linear position transducers integrated into the cylinder. The hydraulic drives consist of standard components typically used in steel plants. Therefore, existing hydraulic systems can be used in most cases as power source for the Simetal DynaWidth system [1].

4.2 Simetal DynaFlex

The oscillation systems of older casters are mostly either of lever type or 4-eccentric type. Major disadvantages of these older designs are the inexact guiding system, leading to an increased breakout rate at higher casting speeds, non-linear consumption of casting powder, leading to poor or non-uniform surface quality, and higher wear of the mechanical elements of the system. The SVAI Simetal DynaFlex hydraulic mold oscillation system (Figure 4) has the following advantages: highest guiding accuracy with a wear-free leaf-spring guiding system, low oscillating masses for resonance-free operation and the advantage of individual adjustment of frequency, stroke and waveform to suit the casting conditions. Thus, the oscillation mark depth is kept low and mold powder consumption is enhanced. A stiff and rigid frame design prevents harmonics and resonances over the entire oscillator operating range. The individual oscillation units are quickly changeable and simple to operate using intelligent software for so called “inverse oscillation“.

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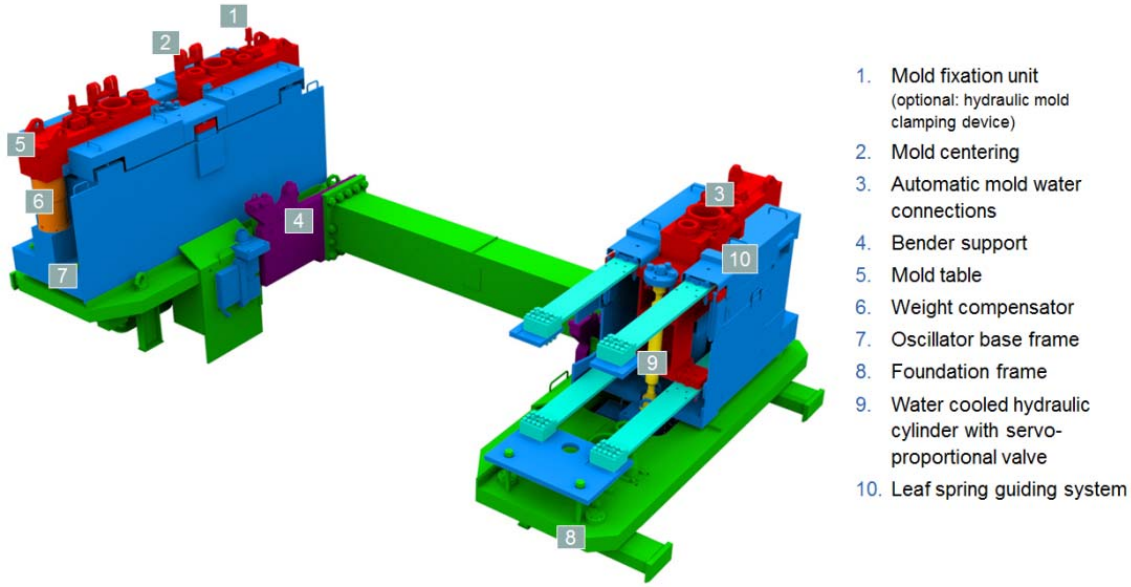

Figure 4. Simetal DynaFlex oscillator with foundation frame.

4.3 Simetal Mold Expert

Simetal Mold Expert combines state-of-the-art sticker detection algorithms with friction and heat-flux derived analysis tools. It features the Level Expert package, which permits the operator not only to "see" into the mold but also to look further down the strand by detecting the effects of strand and roller-related defects. Sticker detection algorithms are continuously improved in order to reduce sticker breakouts and false alarms to an absolute minimum. The ease of Simetal Mold Expert's integration into existing environments has been demonstrated on several occasions.
The following features integrated into the SVAI Simetal Mold Expert:
The Breakout Expert combines the functions of a breakout prediction system for sticker detection with thermal mapping displays, as shown in Figure 5.

- HeatFlux Expert: The heat removal associated with the primary cooling water system provides key information about the process condition in the mold. Online calculation of heat removal for all copper plates shows important information relating to the solidification process inside the mold, immediately indicates cooling problems and compares heat fluxes between different mold faces.
- Friction Expert: The evaluation of friction helps to provide insight into the effectiveness of casting powders as well as indication for breakout likeliness due to loss of lubrication.

The Level Expert implements the features roll impact detection, dynamic bulging detection, stopper / flow supervision as well as statistical evaluation of mold level performance.

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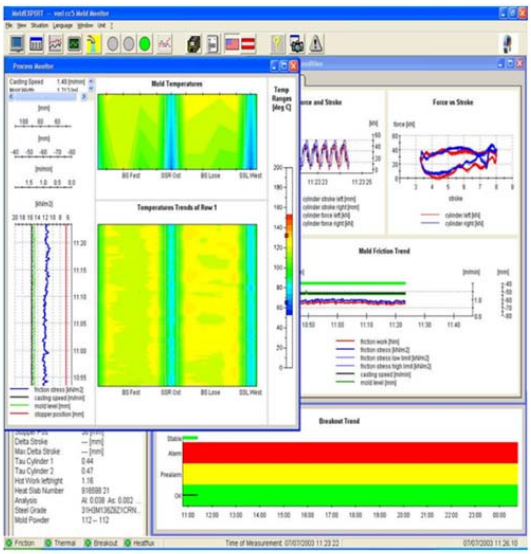

The look into the mold enables

- Process visualization
- Metallurgical assistance
- Know-how generation

Benefits

- Process stability
  - increase production time
  - decrease costly repairs
- Product quality

Figure 5. SIMETAL Mold Expert – Breakout Expert HMI Interface.

4.4 Reference Examples of Modernization Projects

In 2011 SVAI was awarded a contract from Eregli Demir, Turkey, to replace the existing 4-eccenter oscillators of the continuous casting machines #3 and #4 with new frame type hydraulic oscillators (Figure 6). During this revamp the mold narrow side drive systems SimetalL DynaWidth were also installed. The revamp was successfully performed in 2012 and a revamp of casting machines #1 and #2 may follow due to the achieved improvements in operation stability and product quality.

Figure 6. Replacement of oscillator.

At SSAB Tunnplåt Luleå, Sweden, a different approach was chosen: In 2000 the old oscillator was replaced by the new Simetal DynaFlex oscillator system, which features two individual oscillation units located on a common foundation frame, see Figure 7a. The advantage of this solution is the excellent accessibility to the units, and the possibility of exchanging the units individually and rather quickly for maintenance purposes. During this upgrade the Simetal DynaWidth system was installed for the first time ever, since then it has become the standard mold width adjustment system for all new SVAI slab casters, Figure 7b.

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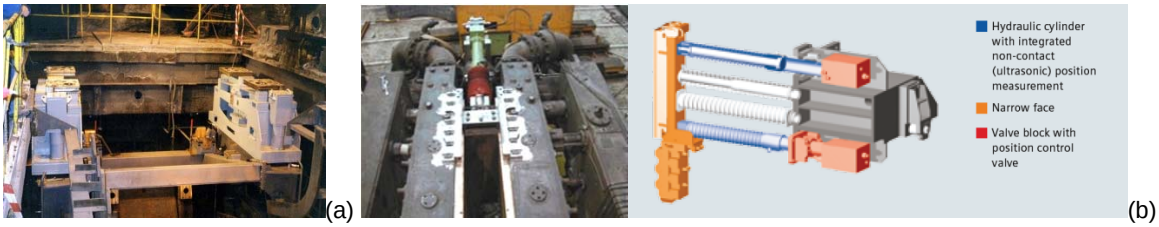

(a) (b)

Figure 7. (a) DynaFlex oscillator for SSAB; (b) First installation of DynaWidth.

Further oscillator upgrade projects were performed at SSAB Oxelösund, Sweden, Outokumpu Avesta, Sweden, Acciai Speciali Terni, Italy and NLMK, Russia.
SVAI has installed a complete new SMART machine head (Figure 8) at Caster #1 at Outokumpu Tornio, Finland in 2004, including a cassette type mold with Simetal DynaWidth hydraulic width adjustment, Simetal MoldExpert breakout pre-detection system, a new mold level control system and a Simetal DynaFlex hydraulic oscillator. The driving force for this upgrade was the good experience of the client with the machine head features of the new CC2.
At Outokumpu Avesta, Sweden, a similar upgrade was performed in 2007 as the last step of a complete machine revamp procedure. During this machine head upgrade, a Simetal Smart Bender for inline thickness change was also introduced [2].

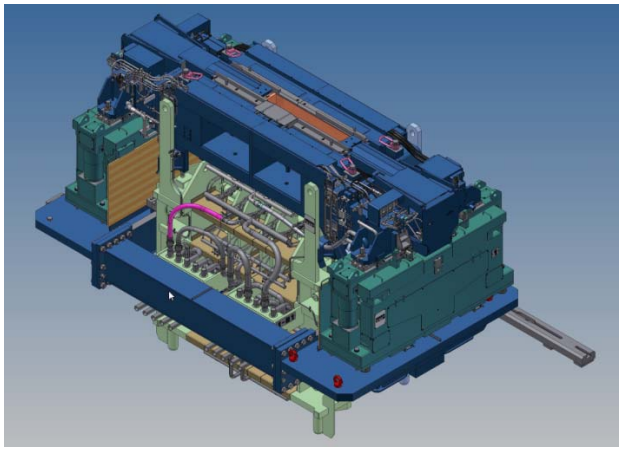

Figure 8. New machine head.

Currently SVAI is working on a project for ArcelorMittal Bremen, Germany, where the machine head of the existing two-strand slab caster will be replaced in September 2013.

5 SIEMENS VAI TECHNOLOGICAL PACKAGE FOR THE STRAND GUIDANCE

5.1 Simetal Dynacs 3D

The new advanced secondary cooling model Simetal Dynacs 3D derives suitable water flow rates even in transient casting situations such as steel grade changes, casting speed variations, different tundish temperatures, tundish exchanges, and at the beginning and end of a casting sequence. The water flow rate for each cooling zone is calculated to maintain a defined surface temperature throughout the entire casting sequence (Figure 9). Simetal Dynacs 3D gives metallurgists the opportunity to even control individual cooling nozzles. This is facilitated by an explicit finite volume approximation that solves the heat transfer equation and takes into

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consideration temperature-dependent material properties, e.g. density as well as the position-specific product cross section. The maintenance system allows the metallurgist to easily change cooling practices and introduce customer specific cooling expertise. The offline simulation system is used to test the effect of the new settings in various casting situations before utilization in the production process [3].

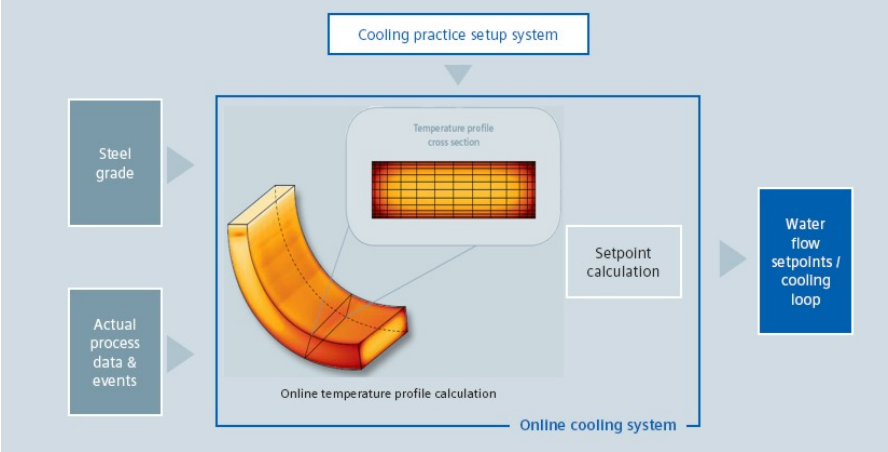

Figure 9. SIMETAL Dynacs 3D – Online cooling system.

5.2 Simetal DynaPhase

The SVAI thermodynamic package Simetal DynaPhase (Figure 10) is an add-on module for Simetal Dynacs 3D which calculates the material properties and solidification parameters required for Simetal Dynacs 3D according to the specified steel grade chemical composition.. Simetal DynaPhase accounts for precipitation from the liquid phase.

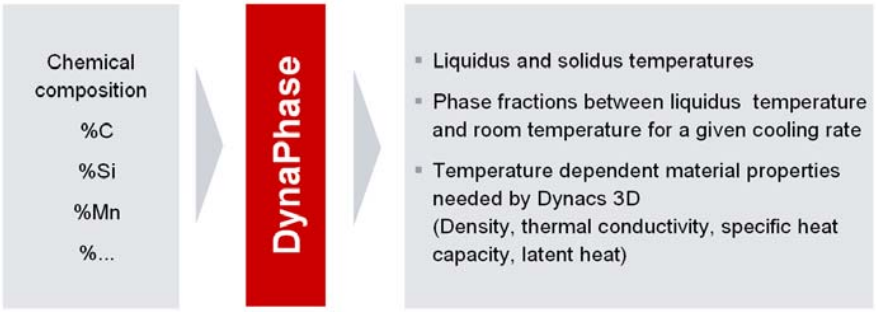

Figure 10. SIMETAL DynaPhase.

5.3 Simetal DynaGap Soft Reduction® 3D – The new dimension in soft reduction

The rapid, easy and remote adjustment of the roll gap significantly reduces preparation time. Optimized product quality based on automatic strand taper/thickness control is obtained combining technological packages and the Simetal DynaGap Soft Reduction® technology with the results of the thermal tracking system. Simetal DynaGap Soft Reduction® reduces center segregation by compensating for the thermal shrinkage of the strand by intentional thickness reduction near the point of final solidification. Figure 11 shows the Simetal DynaGap Soft Reduction® 3D control concept.

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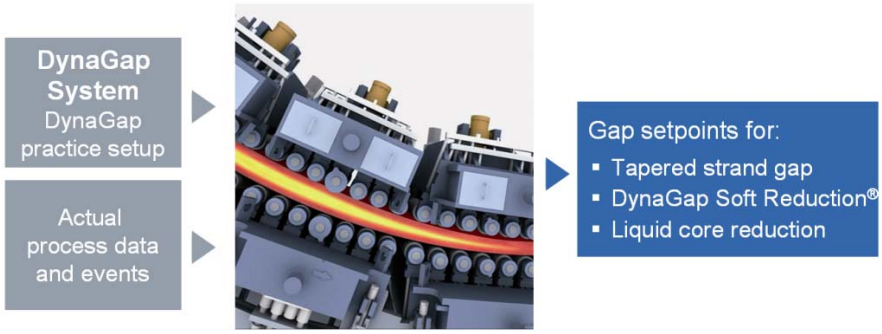

Figure 11. SIMETAL DynaGap Soft Reduction® 3D – Control concept.

Supervision of the roll positioning, depending on the state of solidification (liquid, mushy or solid) and the calculated strand-thickness profile, is a decisive factor for precise roll adjustments and thus improved product quality. An optimized roll positioning also reduces excessive forces on the strand and decreases roller wear.
An upgrade of a slab caster was performed recently at Sidenor Stomana, Bulgaria, where the lower part of the strand guidance was replaced with Simetal Smart Segments (Figure 12). The introduction of split rollers with smaller diameter, a continuous straightening curve, Simetal Dynacs 3D and Simetal DynaGap Soft Reduction® 3D led to a significant improvement of the product inner quality [4].

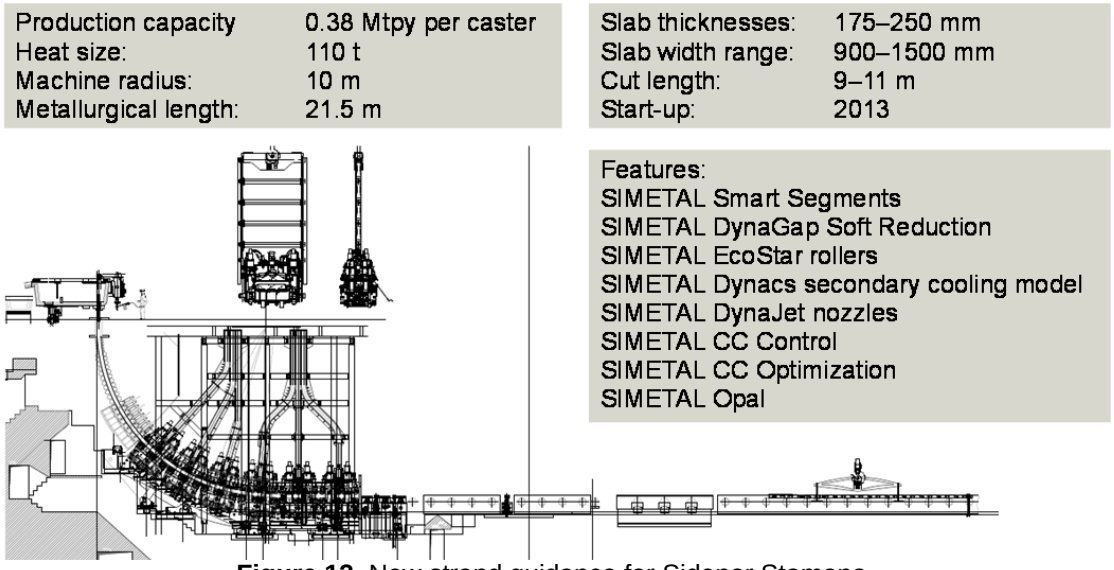

Figure 12. New strand guidance for Sidenor Stomana.

6 CONCLUSION

Since the late 1960's SVAI has been providing innovative solutions for continuous casting machines to customers all over the world. The introduction of technological packages following the proven Connect&Cast® philosophy was done in the mid 1990´s. Since then continuous innovations have resulted in customer benefits including full functionality of all automation systems at first heat, immediate production of quality products, increased yield, increased flexibility in planning and quicker return on investment. This paper presents the advantages of SVAI casting technology like Simetal DynaWidth, Simetal DynaFlex, Simetal Mold Expert, Simetal 3D Sprays, Simetal Dynacs 3D, Simetal DynaPhase and Simetal DynaGap Soft Reduction® 3D as installed at state of the art reference slab casters.

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