THE MODULAR STEC-ROLL® - A GOOD ALTERNATIVE TO EXISTING CASTER ROLLS*

Fabiano Soares[1]
Stephan Six[2]
Jochen Wans[3]
Oliver Hofmann[4]
Christian Geerkens[5]

Abstract

Strand guide rolls in continuous casters are crucial components for guaranteeing an optimum process for the production of high-quality steel grades. The properties of these rolls greatly influence the quality of the slab produced. The most commonly used designs so far have been the axle roll and the solid roll. A quite new roll concept is the STEC-Roll®. It combines the advantages of the axle roll with those of the solid roll. This paper explains the development of this roll type and shows the current design. The characteristics of the STEC-Roll® are presented in greater detail and are underlined by a number of simulation results. Beside the design itself, the benefits for casting and maintenance are explained, including for example the easy assembly and dismantling or the use of the roll for dry casting. A brief examination is made of the TCO for the STEC-Roll® and an estimation is provided of the exchangeability of this roll. To conclude, an overview on the current applications is presented.

Keywords: Caster rolls; STEC-Roll®; Revolver cooling; Dry casting.

1 *Dipl.-Ing., Technical Sales Special Technologies, SMS group, Vespasiano MG, Brazil.*
2 *Dipl.-Ing., Project Manager, Technical Sales Special Technologies / New Development, SMS group GmbH, Düsseldorf, Germany.*
3 *Dr.-Ing., General Manager, Technical Sales Special Technologies / New Development, SMS group GmbH, Düsseldorf, Germany.*
4 *Dr.-Ing., Manager, Technical Sales Special Technologies / New Development, SMS group GmbH, Düsseldorf, Germany.*
5 *Dipl.-Ing., Executive Vice President, Metallurgical Plants and Environment Technology Division, SMS group GmbH, Düsseldorf, Germany.*

1 INTRODUCTION

Strand guide rolls in continuous casters are crucial components for guaranteeing an optimum process for the production of high-quality steel grades. The properties of these rolls greatly influence the quality of the slab produced. [1] The most commonly used designs so far have been the axle roll and the solid roll.

Through an intensive exchange of experience with the owners of continuous casters from various suppliers, SMS group has succeeded in uncovering as yet untapped potential in the existing roll concepts.

Owners attach great importance especially to the dismantling and assembly of strand guide rolls during maintenance. [2] Furthermore, adequate internal roll cooling is obstructed above all by the designs of the axle roll and the roll with split bearings. This results in a high degree of wear.

The STEC-Roll®, see fig. 1, reduces maintenance costs and enables different types of cooling concepts in accordance with the steel grades produced. [3]

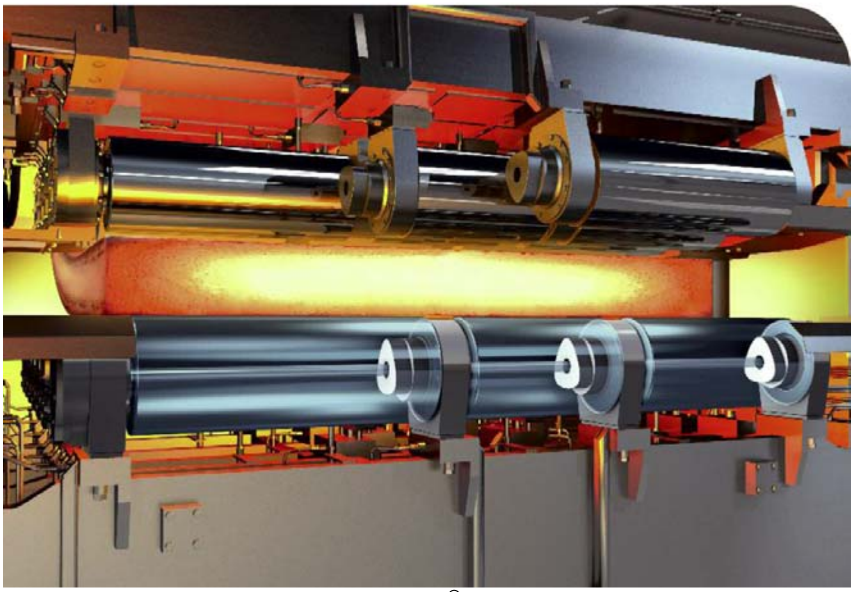
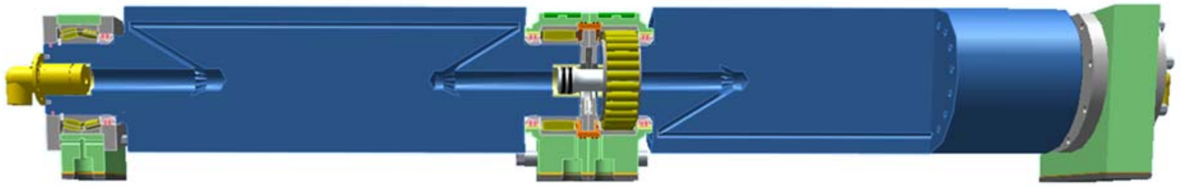


Figure 1. STEC-Roll® in the segment.

The STEC-Roll® focuses mainly on roll diameters larger than 150 mm, due to some technical issues explained later on. Special designs of rolls are also feasible but have not as yet been analyzed and need to be evaluated in detail. These diameters make the STEC-Roll® most suitable for the bow area and the horizontal part of the caster. This roll is mainly a combination of two already existing roll types. It combines the advantages of the conventional strand guide roll and the axle roll.

The conventional strand guide roll, shown in the upper part of Fig. 2, is a solid construction. This solid type allows all kinds of cooling that are available on the market: Single-center cooling as well as revolver cooling and even spiral cooling are possible. It is easy to assemble and disassemble without any special equipment but it has quite a large bearing window due to the fact that two bearings are used and, in the case of a driven roll, that a coupling is additionally needed.

Conventional strand guide roll



Axle roll with rotating axle

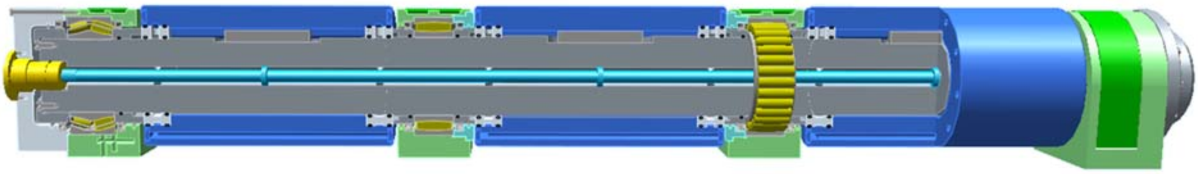


Figure 2. Overview of strand guide roll types – conventional (above) and axle (below).

The axle roll in the lower part of Fig. 2 avoids these disadvantages. The bearing window is small because there is only one bearing per window. The roll bodies are mechanically coupled by one through-going axis. The barrels themselves are shrunk on to this axis and are additionally secured with a feather key. These advantages are offset by the inability to use different types of cooling. Only center cooling types are possible and the heat has to be transferred through the discrete layer between roll and axle.
The STEC-Roll® was developed from the attempt to combine the advantages of these two roll types. [4]

2 DESIGN OF THE STEC-Roll®

The design of the STEC-Roll® is shown in Fig. 3. The design is the same for both the driven and the non-driven roll. There is no difference as regards the roll itself or the strand support. Only some additional parts like flange and rotary joints have to be adapted. As mentioned before, the minimum diameter of the STEC-Roll® type is 150 mm. For lower diameters it is difficult to transfer the necessary moments via the STEC connection. The minimum diameter for a STEC-Roll® with revolver cooling is about 230 mm. Otherwise there is too little space for the revolver holes. Each roll line consists of coupled single rolls. It has two or more roll bodies, bearing housings and standard components e.g. self-aligning roller bearings. [5]

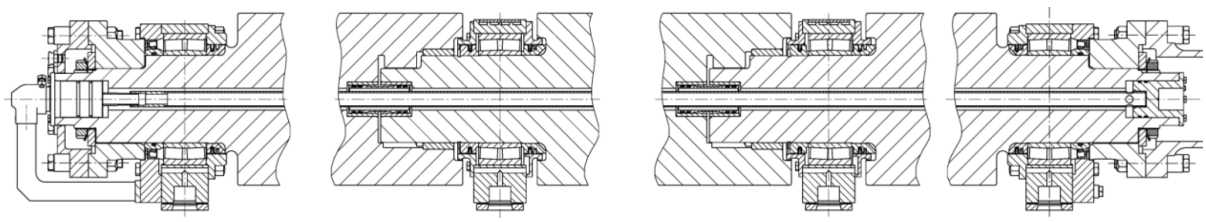


Figure 3. Design drawing of a driven STEC roll®.

The advantage of the axle roll with the small bearing window can be found here also. Only one bearing is used at each bearing window, which means that the window itself can be of quite small construction. The single roll bodies are simply pushed together. Both the load forces and the torsion are transferred via this connection. The water link between the roll bodies is provided by a bush, installed during assembly.

ISSN 1982-9345

The bearings used are standard components, which can be procured quite easily and cost-effectively. This also provides advantages concerning delivery times and maintenance costs. If, for reasons of safety or customer wishes, special bearings are needed with, for example, higher load capacities, the use of these is also possible.[6]

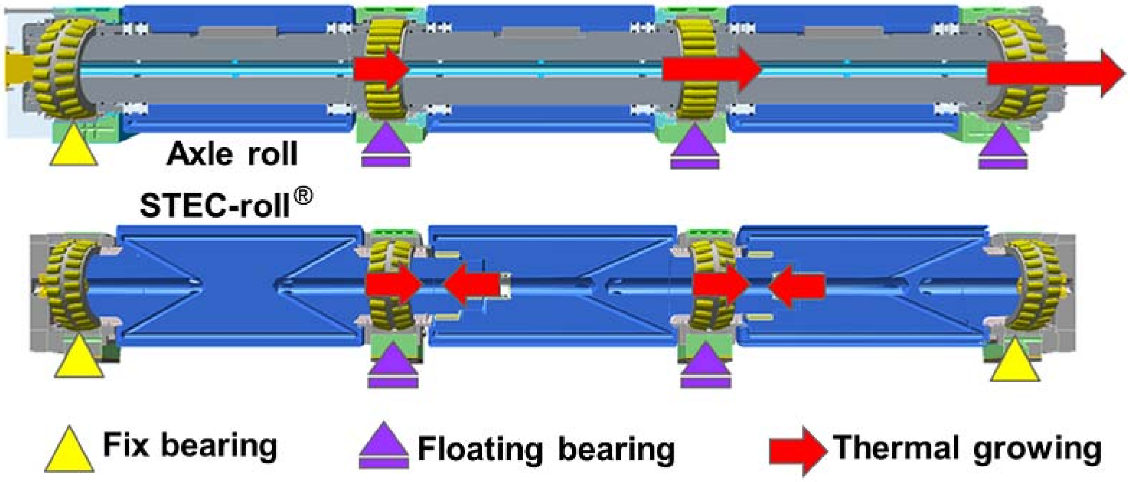


Figure 4. Compensation of the thermal growth.

Another effect is the thermal growth. An axle roll is fixed on one side and the axle grows in one direction. This means that the movement becomes increasingly larger towards the loose side, as can be seen in the upper part of Fig. 4. The STEC Roll® has fixed bearings on both sides and the thermal growth is compensated in the STEC connection. As mentioned, all the bodies have only been put together and they can still move against each other. This kind of compensation has great advantages for the bearings. Only the thermal growth of one roll barrel has to be compensated by the bearing. This means that the reduction of load capacity due to movement in the bearing is much lower.

The solid design of the STEC technology allows all kinds of cooling concepts. Shown on the left side in Fig. 5 is the concept of center bore cooling. There is only one hole in the center of the roll and the heat is dissipated there. This means that all the heat from the strand has to be transported through the roll body. To achieve longer roll life, and especially longer life of the cladding layer, additional cooling with secondary cooling water is essential.

Another applicable concept is that of revolver cooling. There is still the drilled hole in the center but, additionally, holes near the surface and connection holes are also drilled. This can only be done with a solid roll type. By introducing water through the holes, the heat is already withdrawn on the outside diameter of the roll body. This keeps the entire roll body cooler and ensures longer lifetimes for the roll and the cladding. This enables casting to be performed with minimized secondary cooling water.

The simulations in Fig. 5 demonstrate these effects. The four simulation results on the left side show the center-type cooling, the four on the right side the revolver-type cooling. Simulated are cases of normal casting and cases with no rotation at all, e.g. due to some caster defect. These two cases are then examined under the aspect of casting with and without secondary cooling. Nearly all caster experts would expect the strand to be on the upper side of the roll, but because a simulation specialist carried out this analysis the strand is located on the right side.

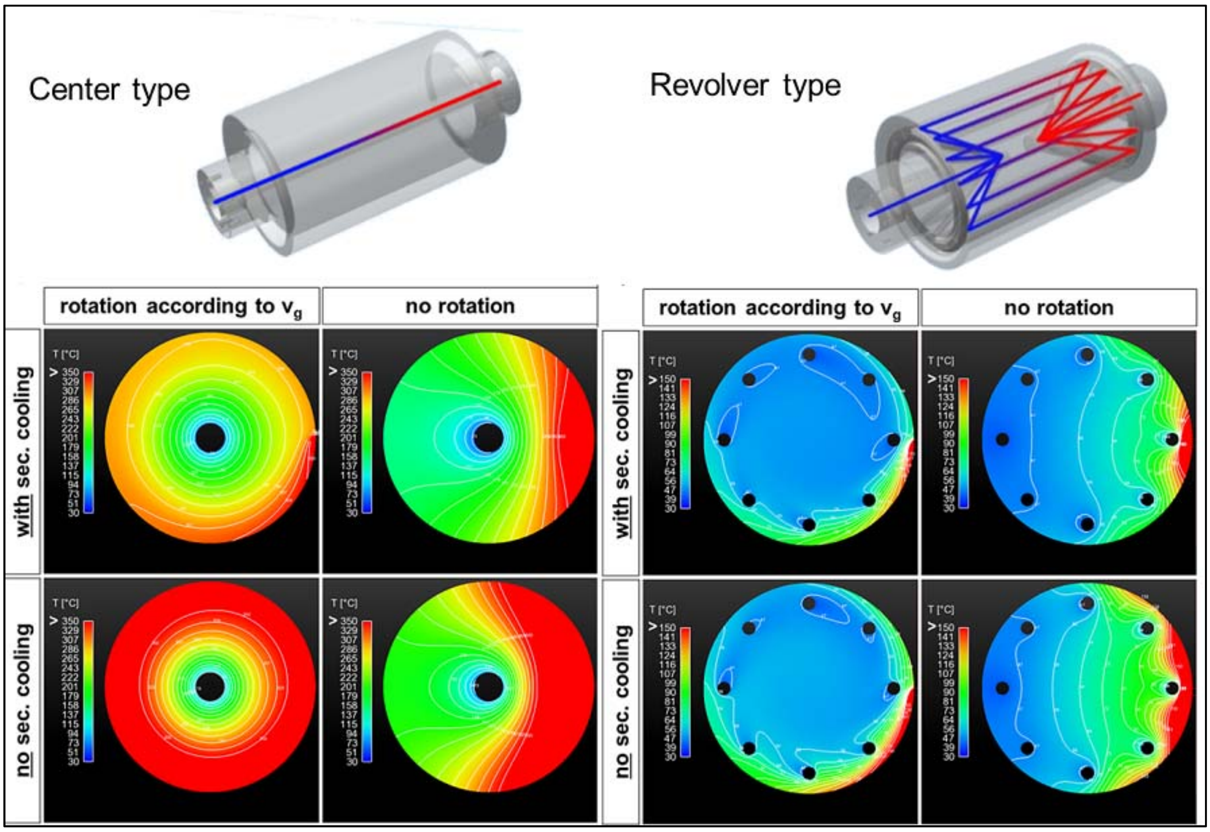


Figure 5. Simulation of different cooling types.

If the center-bored roll is turning normally, the heat is brought into the contact area between strand and roll and then transported to the center bore. The maximum temperature of the roll body in this case is 350°C. If the secondary cooling is switched off, the maximum temperature is similar, but the entire roll becomes hotter. The same effect can be seen if the roll body is not turning. The maximum temperature stays in the same range but the entire area becomes warmer. Compared to the revolver-cooled type, the bodies are much hotter. Revolver cooling removes the heat already at the outside and, finally, the maximum temperature is only 150°C. Also in the non-rotating cases the entire roll stays cooler.
The highly effective roll cooling allows almost dry casting even of challenging steel grades such as API and micro-alloyed grades. Casting of these steel grades requires that the straightening temperature of the slab does not drop below 920°C. If the STEC-Roll® is operated with a suitable cooling concept, this target temperature may also be attained in the crack-susceptible edge zone.
The amount of water used with revolver cooling is higher, but at least for test cases such as one or two roll lines or even on a complete segment, nothing needs to be changed. If the entire strand guide rolls are changed to the revolver-cooling type, the water distribution will have to be examined.

3 BENEFITS FOR CASTING AND MAINTENANCE

As shown in Chapter 2, there are quite a lot of design improvements and advantages. But what are the benefits for the casting process and the maintenance? The roll provides the best possible strand support at this time, e.g. with small bearing windows.

3.1 Maintenance of the STEC-Roll®

The use of standard components, e.g. self-aligning roll bearings, allows easy and cost-efficient exchange without having to make great efforts to obtain the components. This is one reason why the STEC-Roll® is maintenance-friendly. But the main advantage is the modular design that enables easy assembly and disassembly. [7]
This modular design of the STEC-Roll® makes it easy to install, and no special tools or presses are needed. Easy dismantling and assembly as well as the reusability of the rolls will sustainably reduce maintenance costs.

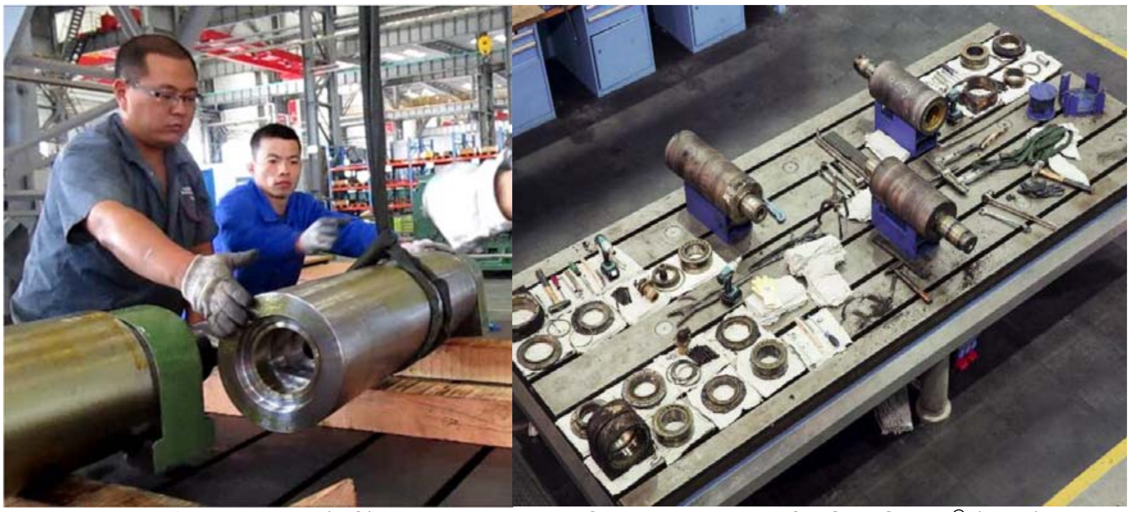


Figure 6. Assembly (left) and workbench after dismantling of a STEC-Roll® (right).

The assembly of a STEC-Roll® with three roll bodies is done in five simple steps. The first step is the preassembly of the bearings and bearing housings. In the second step the necessary parts for the roll bodies are assembled, such as support rings, bushes and the bearing housings. In each case, two housings are taken for the barrel with the fixed bearing and one for the other barrels. The next two steps involve putting the roll bodies together. Barrel one with barrel two for step three, and the third body for step four. Step three can be seen in Fig. 6 and needs only some wood and a crane. The final step comprises the assembly of the water pipe and the rotary joint. The roll line is then completely assembled and can be put into operation.
These simple steps are also used for the disassembly. The roll bodies can be pulled apart just with the aid of a crane. Then, the bearing housings are taken off with only a pry bar and even the bearings slip off quite easily. Fig. 6 shows the disassembled parts, including all equipment needed for the disassembly process.
To prove this easy dismantling of the STEC-Roll® a test was carried out. After their first campaign, the test rolls from a trial installation were brought to our apprentices' workshop. They completely dismantled an entire used roll line within 19 minutes, including the dismantling of the bearings. The three roll bodies, all housings, rings, screws, etc. were removed during this time. This was done even without intensive training or practice and can be seen in [8].
The rolls had been in operation for about 17 months when the dismantling was performed. A first remachining was then carried out. This included a 2 mm skin cut on the roll and the changing of bearings, screws and rings. Then the STEC-Roll® went back into operation for another 15 months. After this second campaign the entire roll body can be reworked, including new cladding. Then the roll will be ready for further

operation. This complete reworking has not been done as yet, but tests have been carried out with single roll bodies to demonstrate the feasibility of this.

3.2 TCO for STEC-Roll® lines

The STEC-Roll® has a high grade of reusability, which serves to keep the TCO low. Fig. 7 shows the investment comparison between the STEC-Roll® and other rolls.

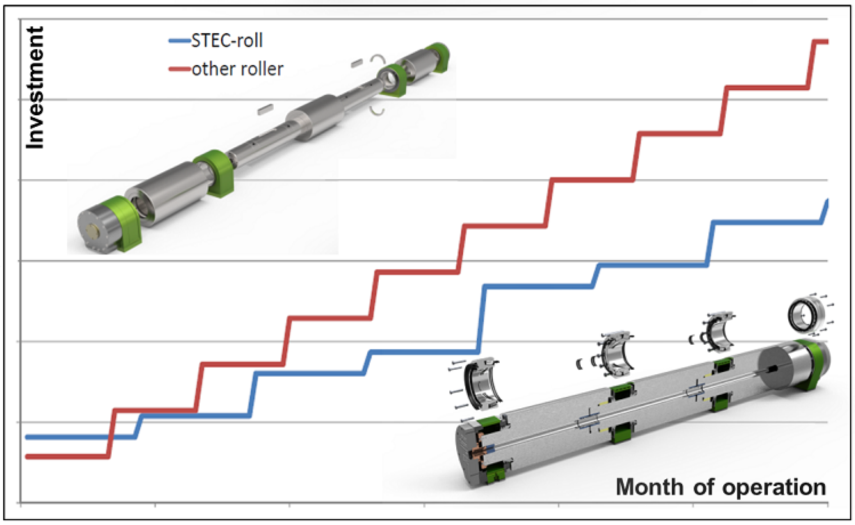


Figure 7. Comparison of investment costs for rolls.

The figure shows the months of operation in x-direction and the amount of money invested on the vertical axis. As can be seen, the roll price for the STEC-Roll® is slightly higher. One definite factor here is the revolver drilling. However, the other rolls have to be replaced earlier. The first remachining of the STEC-Roll® is done as described above and is therefore not as cost-intensive as is buying new rolls. Thus, in this case, the STEC-Roll® costs less already after the first exchange. This adds up over time, as can be seen in the diagram.
And these are only the investment costs. For a TCO calculation the maintenance costs have to be considered as well. As every company has its own rules, regulations and mode of operation, it is not possible to determine the precise savings. However, on considering the advantages mentioned regarding spare parts and taking into account the simple assembly and disassembly as described, the savings seem to be quite evident.

3.3 Exchanging of roll lines

All segment connections will be kept the same. This allows, for example, an axle roll to be exchanged for a STEC-Roll® without segment modification. One roll line can be replaced in nearly every case without changes to the segment.
All other connections of the STEC-Roll®, e.g. the water and grease supply systems, are made in a similar way to those present in the caster. This allows an easy exchange of the roll type by simply changing the roll for example during normal maintenance. And it would also make it possible to go back to the old design if still so wished after testing the rolls.
Nearly 95% of all casters with one bearing per window can be changed to STEC-Roll®. A bearing calculation is carried out to check the safety factors and to verify the

forces in accordance with today's needs. Rolls with two bearings have to be examined because of the normally lower load capacity of only one bearing. In cases where the safety is not sufficient, the STEC-Roll® can be used too, but this would necessitate changes to the bearing positions and involve changes to the segment.
The STEC-Roll® is already being implemented in several locations in Europe and North America as a replacement roll for axle rolls. In the USA they are also used as exchange parts for split bearing rolls [9]. And a complete new caster has been equipped with STEC rolls in Asia.

4 CONCLUSION

The STEC-Roll® is quite a new roll concept for use in strand guiding. It combines the advantages of the conventional solid roll and the axle roll because there are narrow bearing windows, mechanically linked roll bodies, and cooling concepts for minimum spay water or for dry casting. This ensures a longer lifetime for the roll itself, the cladding and the components, such as bearings. Besides these design improvements and advantages, the STEC-Roll® allows efficient handling. Assembly and disassembly can be done without any special tools in an effective and fast manner. This package not only reduces the investment costs but also the entire TCO significantly. The change to STEC-Roll® normally needs no adaptations of the segment or the surrounding area. Only the rolls will be exchanged. This has already been done in some cases worldwide and is at least worth considering.

REFERENCES

1 Schulz, O., Engel, K., Haslinger, M., Derflinger, F.: Slab Caster Revamping – The Approach to Excel in the Market. AISTech 2010 Proceedings, 2010, pp. 23-33
2 Piemonte, C., Lester, J., Kozak, B.: Technological Upgrade of Slab Casting Plants. The Danieli Davy Distington Experience for Plant Renovations and Performance Improvements. AISTech 2010 Proceedings, 2010, pp. 11-22
3 Geerkens, C., Fischer, L., Hofmann, O.: High Speed Casting – Further steps to increase flat production. China Steel Conference 2013
4 X-Cast® - STEC-Roll®. Available from: http://www.sms-group.com/press-media/video-gallery/, 08.04.2016
5 Hofmann, O.: Continuous casting, Lecture MISIS National University of Science and Technology, Moscow, Russia, 2013, pp. 79-81
6 Los, N., Rhodes, J., Daberger, G.: The Timken ADAPT Bearing for Slab Support Rolls in Continuous Casters. IRON & STEEL REVIEW. 2012. pp. 160-168
7 Müller, J., Geerkens, C., Emling, W.: CSP® Casting Technology – 25 Years of Success, AISTech 2015 Proceedings, 2015, pp. 2380-2388
8 STEC-Roll® - Convincing performance after 17 months of operation. Available from: http://www.sms-group.com/press-media/video-gallery/, 11.04.2016
9 STEC-Roll optimiert den Gießprozess bei SSAB Iowa, USA, Stahlmarkt 2016, https://www.stahleisen.de/Content/News/AktuelleNews/Newsentry/tabid/360/sni[847]/17371/language/de-DE/Default.aspx, 23.04.2014.