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Development of Chamfered Mold Technology for Slab Continuous Caster in CSC

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To reduce the transversal cracks in continuous cast slabs, advanced chamfered mold casting technology has been developed in CSC, including mold repair technology and integrated production plan. The experiment shows that the temperature of the slab corner was increased by about 60℃, and the rate of transversal cracks decreased by about 33%. Which incentivizes the Steelmaking Plant to implement and extend the chamfered mold technology.

Keywords: Chamfered mold, Transversal crack, Continuous casting

1. INTRODUCTION

Transversal cracks are one of the most significant defects in a continuous casting slab. The cause factors include volume shrinkage associated with the peritectic effect, abnormal strain source from poor strand alignment, strain concentration effect associated under the oscillation mark, low slab corner hot ductility which comes from 2-Dimentional cooling[1].

One trend of research is to improve and modify the second cooling stage[2]. The effect is limited by the casting equipment's capabilities and the more complex steel grade designs. From practical experience, maintenance of alignment between mold and strand roller[2], oscillation pattern and phase difference are workable, however, it is not easy to maintain long term stability, especially mechanical hot deformation being hard to control when producing.

Over the past three decades, an idea referring to the slab corner 2-dimention cooling phenomena and strain concentration effect can be subverted via chamfering the slab corner[3, 4]. Nowadays, there is more and more research support and development of chamfered mold technology.

Research shows the benefits of a chamfered mold includes decreasing transversal cracks, lower down edge seam problems of hot rolling, and the enhancing effect of heavy reduction[4, 5]. But the bottleneck of a chamfered mold is angle cooling and a deforming problem which may cause slab breakout, the limitation of mold width change and casting speed, and the short age of the mold, impact the producing capability heavily[6].

Under the ambition to provide a good quality slab, China Steel develops chamfered mold technology and gains a significant breakthrough.

2. STRATEGY

Focus on peritectic carbon steel transversal cracks as the main target, the mold design takes the concept of large chamfered faces to increase slab corner temperature[4, 5]. At the same time, a multi-face mold, supporting foot roller, and increased water spray cooling is applied to prevent embryo breaking out. To lower the mold manufacturing complexity, mold design subjected on a vertical-bending type caster, but no need to consider the mold bending arc.

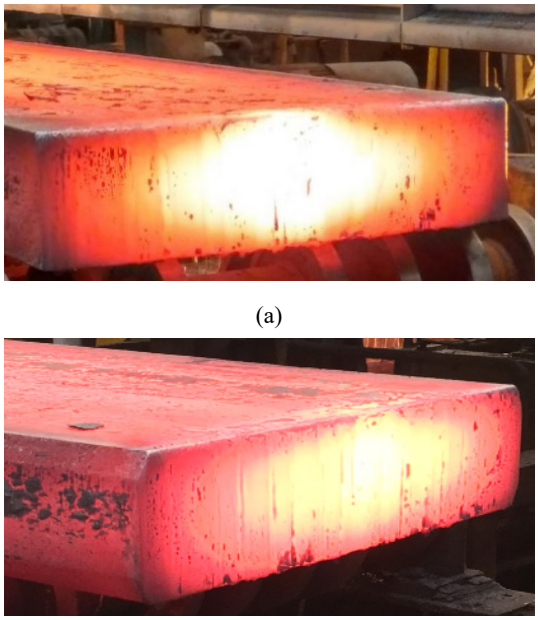
Consider the age of the mold, a new coating material was developed, which uses a Nickle & Cobalt-base to replace the Nickle-base coating, to enhance wearing ability, so that multi-face mold's steel flux won't be sharply lower than the conventional mold of 225,000 tons.[6]

Other related optimizations include: the number and shape of Dummy bar head spacers, mold width setting, taper gauge, casting parameters, mold repair technology, bridge crane signal, and integrated production plan, etc.

3. RESULTS AND DISCUSSION

No.5 caster in Steelmaking Plant II is the first one taking chamfered mold technology. Figure 1 shows the

contour of slab produced via (a) conventional mold and (b) chamfered mold. Measuring the temperature of the slab corner, the conventional slab measured 785°C, where the chamfered slab measured 818°C. Which means the temperature and the slab hot ductility will be better when unbending.



(a)

(b)

Fig.1. Slab contour produced via (a) conventional mold (b) chamfered mold[4]

Figure 2 shows the transversal crack index of the conventional slab as 0.51%, and the chamfered slab as 0.34%.

The quality improves significantly by 33%. Which fulfills the main target of this technology. The result incentivizes Steelmaking Plant II to change the producing plan via integrating the width and grade of orders to extend the chamfered mold producing cycle.

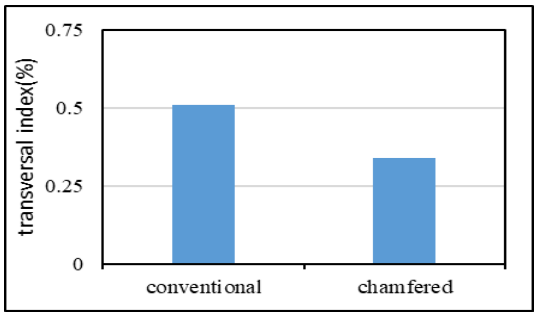
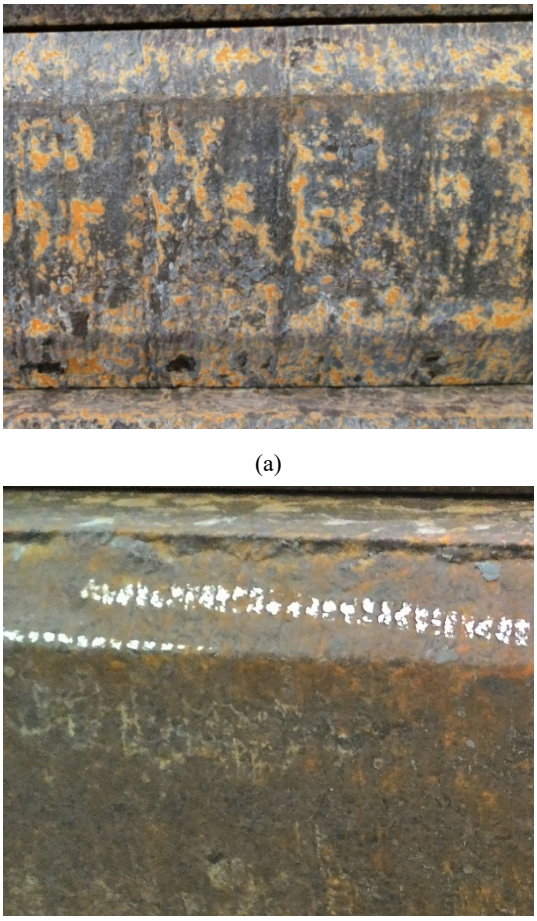


Fig.2. Transversal crack index between slabs produced via conventional mold and chamfered mold.

Besides, regarding of other slab quality, Figure 3(a), the slab corner is normal, which means the alignment of the chamfered mold and foot roller is proper, the shape of the mold is not damaged, the seam of the narrow and broad mold plate is also fine. Figure 3(b) shows the abnormal corner with bleeding defect. Possibly caused by deformed or misalignment of the mold angle or foot roller, deformed seam between narrow mold plate and broad mold plate, slag entrapment in the seam, or poor powder lubrication in this area. These observations reflect that chamfered mold technology heavily depends on the process of slag cleaning, more precise alignment and bespoke repair technique than that of conventional mold.



(a)

(b)

Fig 3. Chamfered slab corner (a) normal and (b) abnormal corner[4]

Comparing the steel flux, Figure 4 shows the chamfered mold (Nickle-base coating) is not higher than 121,000 tons, the coating is easily damaged at the angle area. The chamfered mold (Nickle & Cobalt –base coat-

ing) is 192,500 tons, more stable than Nickle-base coating, and similar to the conventional mold, which ensures the producing capability won't be impacted severely with the coating material.

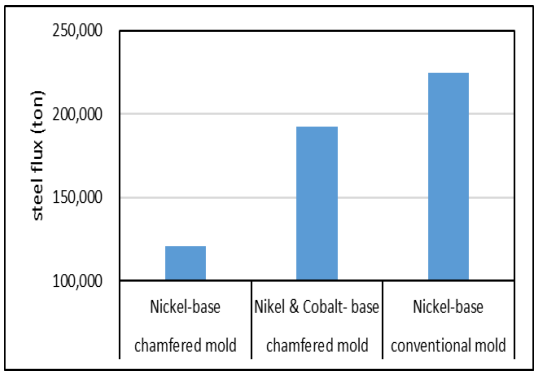


Fig.4. Steel flux between different coating material and different mold.

4. CONCLUSION

The first chamfered mold technology is realized at no.5 caster in Steelmaking Plant II. To increase the peritectic carbon steel quality, the mold design concept includes a large chamfered face, multi-face, support foot roller and increased water spray. The transversal crack is reduced by 33%, incentivizes the producing plant to implement the chamfered mold and extend to other caster(s). Besides, a new coating of Nickle & Cobalt base material was successful developed to replace the traditional Nickle-base coating on the chamfered mold, which ensures the steel producing capability won't be impacted severely.

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