Criteria for Slab Cooling After Continuous Casting

Selecting the appropriate cooling method for slabs after continuous casting is crucial for both slab quality and processing time, which is important for meeting shipment deadlines. While intense cooling may reduce processing time, it can also affect the steel's microstructure and potentially lead to crack formation. In this study, criteria for determining the slab cooling method (e.g., forced cooling, common pile, sandwich pile, or hood cooling) was developed based on the steel grade composition, using a machine learning technique.

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Introduction

After exiting the continuous caster, slabs are stacked in the slab yard for cooling before further inspection, processing or shipment. Depending on the selected means of transport, the maximum allowed slab temperature for shipment ranges between 50 and 100°C. Slabs requiring scarfing for quality checks or surface defect removal before shipment must be cooled to around 250°C. Due to space limitations in the slab yard, the need to optimize production time and costs, as well as contractual deadlines, the cooling period is aimed to be as short as possible.

However, overly intensive cooling can create high temperature gradients inside the slab, leading to internal mechanical tensions. Depending on the steel grade, it may also alter the steel's microstructure during stack cooling. This can result in severe quality issues such as cracks, warping or even breakage of the slab, either in the slab yard or, even worse, further downstream in the production process in the reheating furnace or subsequent rolling process.

The slab exits the caster with a significant temperature gradient since the surface temperature is kept at around 800°C inside the caster by the secondary spray cooling system, while the strand core has solidified only meters before exiting the caster containment and is thus considerably hotter than the strand surface. After stacking the slabs, the temperature gradients decrease through thermal diffusion; however, the top and bottom slabs of the stack may experience higher temperature gradients due to the significant impact of the solid ground, free airflow or water contact on heat removal. Therefore, depending on the metallurgical and mechanical properties of the steel grade, the cooling process of the slabs in the slab yard needs to be controlled. Typical cooling methods, such as forced water cooling, conventional slab stacking and the utilization of a hood, are illustrated in Fig. 1.

The most intense cooling method is forced cooling of the slab stack using water, as shown in Fig. 1a. This method allows for cooling to 50°C in less than 24 hours but can only be applied to less demanding and soft steel grades not prone to cracking. Air cooling in a stack (see Fig. 1b) reduces the cooling intensity; however, the bottom and top slabs of the stack may be exposed to higher cooling intensities compared to the slabs inside the stack. For more sensitive steel grades, the heat removal of the ground and the stack's top surface must be limited by applying a "sandwich configuration," where the