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Finite Element Thermo-Mechanical Modeling of Continuous Casting: Simultaneous In-Mould Solidification and Mould Condition Analysis for High-Speed Billet Casting with Danieli's Power Mould™

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The design of billet moulds fulfills multiple, conflicting, objectives. High productivity at minimal cost remains the primary goal of steelmakers, requiring elevated casting speeds while ensuring optimal surface quality.
The copper mould plays a critical role in the continuous casting process, with its design centered around three key parameters: mould taper, cooling system efficiency, and geometric dimensions. These parameters are inherently interdependent, as the thermal conditions of the mould directly influence strain distribution, actual taper, and mechanical stress states during casting, ultimately affecting mould lifespan, as demonstrated by extensive research ongoing in the past five decades.
Since the 1970s, with the advent of computational modeling, numerical simulation has become an indispensable tool for continuous casting mould design. Computational Fluid Dynamics (CFD) analyses are applied to optimize tundish and submerged entry nozzle (SEN) designs, while thermal and thermo-mechanical FEM simulations are essential tools for mould design and process optimization. As computational power has increased, FEM-based models have evolved to capture the multi-physics complexity of continuous casting, integrating heat transfer, mechanical deformation, and stress analysis with greater accuracy (see VALCRA Seminar, 2020).
Danieli and Transvalor conducted a systematic comparative analysis of two different simulation approaches for mould design. The investigation focused on Danieli's Power Mould™, an advanced mould configuration optimized for high casting speeds. Danieli's methodology is based on the well-established numerical model developed by Prof. Brian Thomas, implemented within a general-purpose commercial FEM software. Transvalor' s approach utilizes THERCAST®, a proprietary FEM software designed explicitly for solidification and casting, integrating advanced thermal, mechanical, and metallurgical modeling. By systematically evaluating predictive capabilities, computational methodologies, and practical applicability of each approach, the study provides insights into the accuracy, efficiency, and suitability of these tools for mould design.

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