

Experimental investigations into surface crack formation under continuous casting conditions

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Most former experimental investigations into the formation of surface cracks in continuous casting involved conventional hot tensile tests. In these investigations either reheated samples (i.e. heating to a solution temperature of 1200 – 1350°C to generate coarse austenite grain size and to re-dissolve microalloying elements) or as-cast samples (melting of test sample in-situ prior to testing) are cooled to the test temperature. The cooling rates are adjusted to the continuous casting process. Hence, valuable results have been generated and the influences of austenite grains size, strain rate, cooling rate, precipitation state and formation of grain boundaries on the sensitivity to cracking have been successfully analyzed. However, most hot tensile test arrangements do not precisely simulate the stress/strain situation in the solidifying strand shell. A major divergence is the degree of straining which is well below 2% in the cc process, whereas in the hot tensile test, the strain to fracture is in the range of 5 – 100%. This makes a case for the development of a process-oriented laboratory experiment, enabling

- (1) the deformation of in-situ solidified samples (cooling rate, micro/macrostructure similar to cc) and
- (2) controlled deformation without rupturing the as-cast samples (deformation limits in the order of magnitude of the CC process) and thus,
- (3) the determination of a critical strain to prevent surface cracking.

The present study describes the principles and further development of the In-situ Material Characterization (IMC) test. This laboratory experiment represents a hot tensile test (IMC-T) or bending test (IMC-B) on samples after solidification and controlled cooling. Solidification, microstructure formation, grain growth, precipitation and deformation of the samples are simulated by means of numerical models.

Extensive metallographic work on deformed samples proves the congruency of the fracture appearance with transversal cracks on slab surfaces.

Results of experiments on high-strength low-alloy steel grades are finally compared with the results of conventional hot tensile tests. The results indicate the reproducibility of a critical strain minimum within the second ductility trough. The present paper will be concluded with an outlook on future developments.