Simulation of crack growth during heating processes.

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ABSTRACT

Before forming operations, steel billets undergo heating from ambient temperature to temperatures between 1200°C and 1300°C to provide them hot forming ability. On the basis of investigations on produced continuous casting billets, some specific defects have been highlighted as being impacted by the heating conditions. This study concerns the heating step during which the temperature gradient is considered as responsible of the evolution of the initial defects [1, 2]. In order to have a better understanding of the associated phenomena and to provide a heating process management, 3D simulation has been performed.

This simulation has been developed in three steps. Firstly the thermal field, considering the heat transfer by radiation among others, was modeled using in-situ measurements and the finite element method. Constitutive laws, identified by Gleeble tests performed in the authors' laboratory, were then added to identify critical loading state during heating. Finally, from the previous thermal fields calculated by the finite element model and by identifying a single failure criterion at different temperatures, the propagation of defects has been simulated according to different process configurations using the enriched finite element method [3].

In parallel, tests at different temperatures on Compact Tension specimens [4] have been performed to identify the above mentioned criterion based on the maximum principal stress. This criterion will be able to highlight the influence of the thermal gradient on the propagation of the defects. The developed 3D Simulation will further become a tool for fast and robust production management.

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