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Influence of Simulated Flash Butt Welding Thermal Cycles on Microstructure and Mechanical Performance of Rail Steel HAZ

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Introdroduction



Fig. 1: Welded long rails

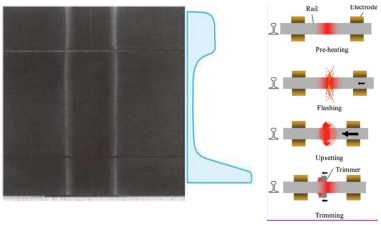


Fig. 2: Current profile: Vignole

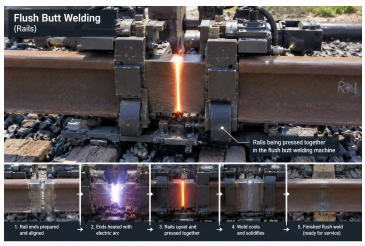


Fig. 3: The Process (FBW)

Objective

Objective: to correlate thermal cycle, phase transformation, microstructure and final properties in the HAZ of DHH370 rail steel during flash butt welding.

Methodology



Fig. 4:Schematic illustrations of the (a) dilatometric test showing only four cooling rates and (b) physical simulation of heat-affected zone thermal cycles.

Results

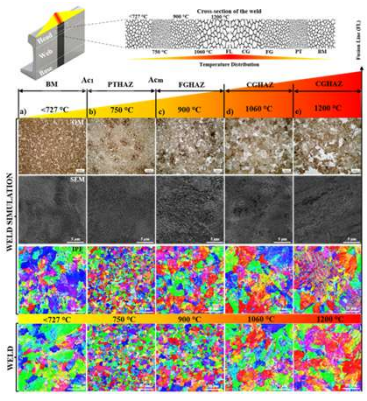


Fig. 5:Optical micrographs (OM), scanning electron microscopy (SEM) images, and inverse pole figure (IPF) maps obtained after thermal cycle simulations at peak temperatures and the weld region by the FBW process

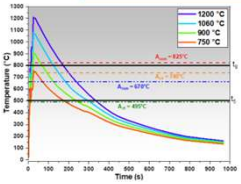


Fig. 6: Simulated thermal cycles of the HAZ regions at varying distances from the weld centerline

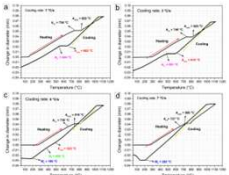


Fig. 7: The phase transformations at cooling rates of (a) 1 °C/s, (b) 3 °C/s, (c) 5 °C/s, and (d) 7 °C/s.

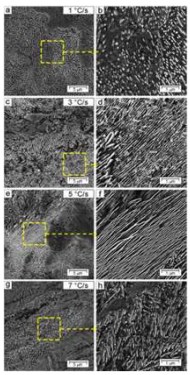


Fig. 8: SEM-SE micrographs: from spheroidized cementite to heterogeneous hard constituents.

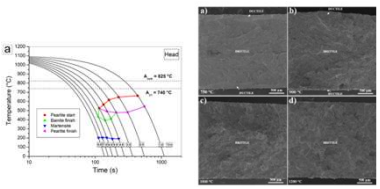


Fig. 9: CCT diagrams of the (a) head end SEM fractographs of the central region of the fracture surfaces of Charpy.

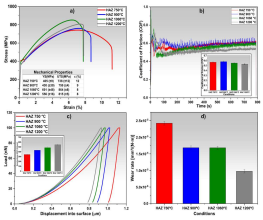


Fig. 10: Mechanical and tribological properties of the simulated HAZ regions of the premium rail steel after thermal cycles at different peak temperatures

Conclusions

The results demonstrate that the microstructural integrity of welded rails is strongly governed by the cooling conditions experienced within the HAZ. These findings provide valuable guidelines for optimizing FBW parameters and improving the in-service performance of welded railway rails.

References

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