Meshless Simulation of the Hot Rolling with Non-Symmetric Grooves

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ABSTRACT

In this study, a rolling simulation system is presented, based on a novel meshless Local Radial Basis Function Collocation Method. The simulation relies on discrete 2D slices, which are aligned with the rolling direction and become computational domains for the coupled thermo-mechanical solution procedure at a certain position and time. An initial slice with uniformly distributed collocation nodes is created for the initial cross sectional size of the bloom. Local solution is then achieved by considering overlapping local influence domains containing either 5 or 7 nodes. Thermal and mechanical models are simultaneously solved through discretized temperature and displacement fields with Radial Basis Functions. The solution procedure is repeated until the slice reaches the final rolling position. Strong form equations are used for both the thermal and the mechanical models. A plastic stiffness matrix is used by considering effective stress-effective strain relation of the material and consequent non-linear system of equations are solved by direct iteration. To increase the stability of the numerical solution, collocation nodes might be redistributed over a slice based on elliptic node generation algorithm when necessary. The method has been successfully applied to solve temperature field [1], thermo-mechanics [2] and hot-rolling [3], which are considered in this simulation.

Specific for the present simulation, complex groove geometries are integrated in such a way that they are compatible with the slice model. Groove surface lines are created with imaginary groove surface points for each slice position and checked if there exists a contact with the slice or not. Coulomb model of friction is considered at the contact boundaries. In addition, the numerical model is capable of using non-symmetric grooves, which might contact the slice at multiple sections with different deformation rates and boundary conditions. The simulation results are shown in terms of temperature, displacement, strain and stress fields as well as roll forces and torques. A user friendly computer application is created for industrial use based on C# and .NET.

REFERENCES

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