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Poster

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A Mathematical Model for Predicting the Thermal and Thermo - Elastic Behavior of a Hot Roll - Steel Work

In this paper we develop the mathematical models of stress, strain and thermal dilatation of a hot roll-steel work through an analytic mathematical solution. This allows us to have a simulator sensitive to changes on operational parameters and thermal properties of materials. Taking as a basis the thermal profile model in the stable-dynamic state which is present on the production line after having rolled out a certain number of pieces which contemplates the profile of variable temperature on the deforming piece.
The simulation on the already mentioned models, based on the periodicity of heat transfer towards the roll under operation conditions allow us to obtain the cyclic stress-strain response by means of hysteresis which is present on the roll, and the energy dissipated per rolling cycle. In the same way, the dilatation experienced by the roll leads to obtain the resulting thermal crown.
The work roll experimental information of the industry located at the rolling mill was taken as a data base.
The model for the roll's thermal behavior allowed to obtain theoretical data to carry out our investigation and compare it to experimental data in similar conditions to ours; and to predict the roll's useful lifetime by means of studying the statistical fatigue properties, strain-life and mean stress and strain effects, as well as damage modes for the roll's material under thermal fatigue. The models can be used to avoid service related fails and to allow selective maintenance of the roll as an approximation at the end of its useful life.
The result of this research will be presented in the classroom to students who attend the matter of Analytical Methods in Conduction Heat Transfer in the Centro de Investigación en Materiales Avanzados, S. C., CIMAV during the semester 2/2002. This with the objective of teach them modeling of thermal profile of a material, thermal stress, strain and expansion, and representation of schematic diagrams showing waveforms of temperature, strain, and stress in thermal fatigue tests, cyclic stress-strain response and hysteresis energy to a material which is subject to operation conditions in the industry. After this, the students will learn to analyze the thermal response through strain-life approach and mean stress effects, damage modes in materials, fundamental statistical characteristics of fatigue failure, which have resulted in the development of various statistical approaches to laboratory fatigue testing.