MODELLING OF CYCLIC AND VISCOUS BEHAVIOUR OF PEARLITIC STEELS-APPLICATION TO TREAD BRAKED RAILWAY WHEELS

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ABSTRACT

The tread material, in the block (tread) braked wheels, is subjected to high multiaxial contact stresses induced by rolling and sliding of the wheel and also elevated temperatures due to frictional heat generation (between brake block–wheel and wheel–rail)[1]. The rolling contact loading is applied very fast while at the same time, the thermal loading results in high temperatures and thermal stresses which cause slow time dependent processes such as creep, relaxation and static recovery of the wheel material.

The focus of this work is on material modeling of pearlitic ER7 wheel steel for a wide range of loading rates at elevated temperatures. The wheel steel shows a time/rate dependent behaviour also at the rates of the rolling contact loading especially for elevated temperatures. The starting point is a viscoplastic model including nonlinear isotropic and kinematic hardening. Two overstress functions, Norton and Delobelle, are employed and their capability to capture strain rate dependent response are evaluated. The model also includes static recovery of the hardening to capture slower viscous (diffusion dominated) behaviour of the material. Moreover, the hardening is further extended by including the Burlet–Cailletaud model for multiaxial ratchetting to study the influence of multiaxial loading.

Experiments for the pearlitic steel ER7 in terms of cyclic strain-controlled uniaxial tests with hold-time at different temperatures are used to calibrate the material model. Also, experimental results for the wheel steel at a wide range of strain rates at different temperatures have been used to calibrate the high strain rate response of the model with the purpose to investigate the importance of including such behaviour in the modelling of block braked railway wheel. Finally, the identification of the multiaxial ratchetting parameters contained in the material model, is carried out against the cyclic biaxial test data for the wheel steel at room temperature. The study is concluded with a numerical example[2] of a block braked wheel where the importance of the viscoplastic and multiaxial modelling is highlighted.

REFERENCES

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