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Thermomechanical capacity of wheel treads at stop braking: A parametric study

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ABSTRACT

During tread braking, the treads of railway wheels are subjected to a complex loading due to combined rolling contact and thermally induced stresses. In revenue traffic the running mode of the train varies and the operational parameters will influence the life of the wheels. To prevent excessive damage, it is therefore important to understand at which operational conditions wheel damage becomes unacceptable. The current study aims to find limits for tread braking with respect to the influence of thermal stresses on rolling contact fatigue (RCF) of the wheel tread when subjected to repeated stop braking. A parametric study, using 3D FE simulations and involving operational parameters such as axle load, maximum vehicle speed, deceleration, brake block material and initial wheel temperature, is carried out for a new wheel with an S-shaped web. Additional analyses investigate impact from wheel geometry by studying a wheel with a straight web and a wheel with a thin (worn) rim. The effects of simultaneous thermal loading from wheel–block frictional contact during braking and mechanical loading, due to the traversing wheel–rail rolling contact, are studied in an uncoupled thermomechanical analysis. In the wheel–rail contact simulations, frictional rolling contact stress distributions induced by braking are accounted for. Interfacial shear stresses and partial slip are also included in the model. A temperature-dependent elastoplastic model is utilised to characterise changes in material behaviour during braking. In the vicinity of the wheel tread, damage evolutions for the studied brake load cases are evaluated. The results show that high tread temperatures, in particular temperatures above 450 °C, have a strong detrimental influence on the