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THERMAL AND CONTACT FE ANALYSIS OF A RAILWAY WHEEL IN SLIDING-ROLLING MOTION

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In case of a railway wheels we can distinguish several types of failures [1]. During our work we focused on two types of them which were the micro thermal cracks and the sub-surface fatigue cracks (Fig.1.). Our investigations aimed to map the generation of these failures with coupled transient thermal and elastic-plastic contact FE simulations.


(a)

(b)

Fig. 1. Thermal micro-cracking (a) and sub-surface fatigue cracks (propagated to surface)(b) on a railway wheel [1]

In the course of the intensive braking process of railway vehicles equipped with disc brakes, the tread of the wheel can slide considerably along the surface of the rail in inappropriate conditions of adhesion. Although macroscopic sliding is restricted, it is not eliminated deliberately by the Wheel Slide Protection system (WSP). As a result of macroscopic sliding, considerable heat is generated instantaneously between the two components in contact at their area of contact, which may lead to the appearance of micro cracks along the tread of the wheel [2, 3].

During our simulation we aimed to model the surface and subsurface thermal stress development (caused by heat generation during braking) and the contact stress distribution between wheel and rail, by a coupled transient thermal and elastic-plastic contact FE simulation using temperature dependent material properties. The FE model was produced by the ANSYS Workbench V14.5 software.

Our investigations resulted in the fact that thermal expansion caused by heat generation and heat conduction induced considerable local stress peaks along the thread of the wheel approx. ~0.1-0.2 mm underneath the surface [4,5] meanwhile the contact condition induces considerable local stress peaks along the thread of the wheel approx. ~1-4 mm underneath the surface (Fig. 2.).

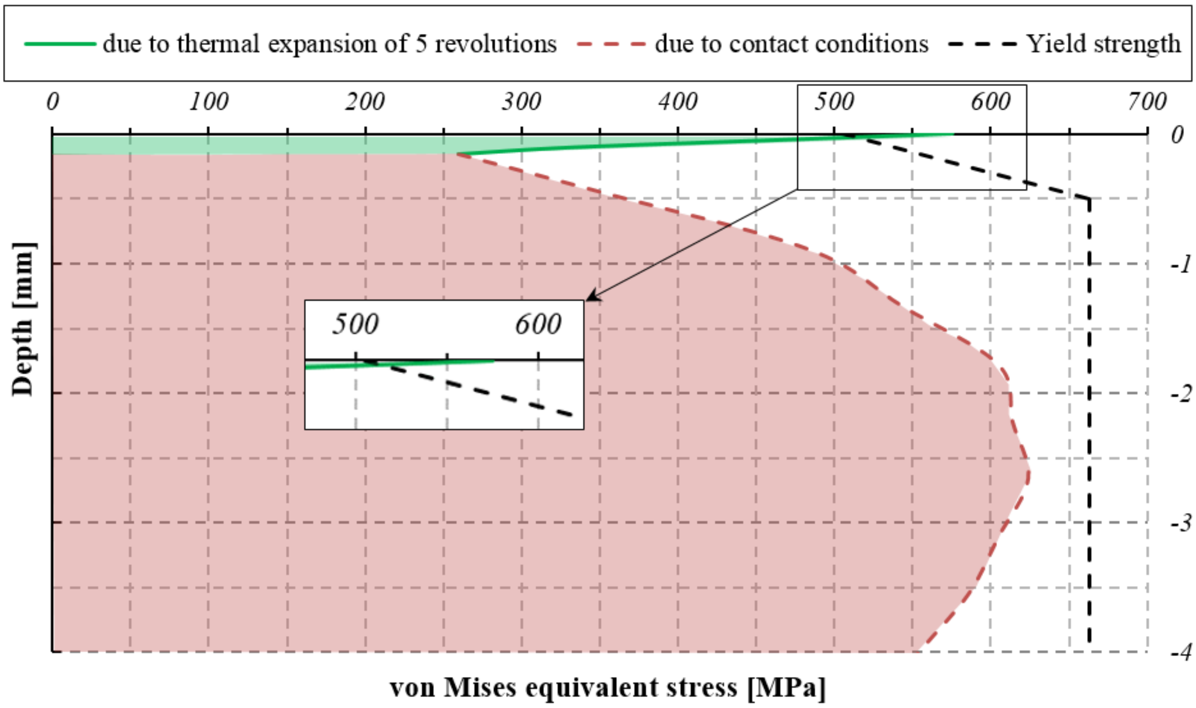

Fig. 2. The equivalent stress distribution under the wheel thread with the two stress peaks under contact conditions with 15% slip.

As it can be seen in the figure, the two peaks can be squarely separable which means we have to pay attention to the sliding conditions under heavy breaking in the "surface-near" region. If the WSP systems allows high rates of sliding it may causes micro thermal cracks on the surface of the railway wheel.

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