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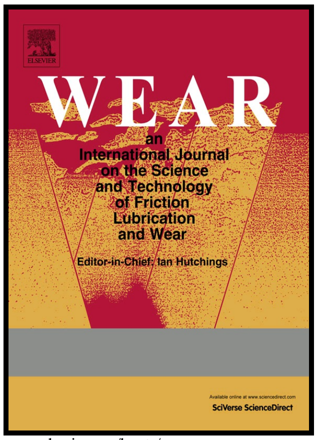

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Katsuyoshi Ikeuchi, Kazuyuki Handa, Roger Lundén, Tore Vernersson

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Wheel Tread Profile Evolution for Combined Block Braking and Wheel–Rail Contact: Results from Dynamometer Experiments

Katsuyoshi Ikeuchi*, Kazuyuki Handa*, Roger Lundén#, Tore Vernersson#$

* Railway Technical Research Institute, Tokyo, Japan
#CHARMEC / Department of Applied Mechanics, Chalmers University of Technology, Gothenburg, Sweden
$also ÅF Industry, Gothenburg, Sweden

* ikeuchi.katsuyoshi.95@rtri.or.jp

ABSTRACT

Wheel treads are subject to different types of damage such as wear, rolling contact fatigue (RCF), thermal cracks, plastic deformation and flats caused by wheel sliding. These types of damage cause changes in the tread profile of the wheel, which necessitates frequent wheel reprofiling in order to maintain the ride comfort of the vehicle.

In this study, a series of full-scale tread braking experiments, including wheel–rail rolling contact, were conducted to clarify the factors influencing the wheel tread profile evolution. The experiments focused on plastic deformation and the wear caused by the rolling contact and tread braking.

The results showed that the maximum tread indentation was 0.20 mm at the rolling contact center when the stop braking action was repeated 40 times. This was caused by the plastic deformation of the wheel tread, which, in turn, was the result of high contact pressure and material softening from high temperatures caused by tread braking. The results were supported by the observed tread protrusions near the rolling contact area and also by the difference in the rolling contact area hardness and that of the other wheel tread areas.

1. BACKGROUND

Wheel treads are subject to different types of damages such as wear, rolling contact fatigue (RCF), thermal cracks, plastic deformation, and flats caused by wheel sliding. [1] These types of damage result in a change in the tread profile, which aggravates wheel–rail contact forces, both vertical by the wheel out-of roundness and lateral by the impaired vehicle dynamics. It is possible that the forces are increasing or the ride comfort is compromised by changes of the tread profile. This might also accelerate deterioration of track and vehicle components and cause vibration [2]. An understanding of the tread damage mechanisms is essential to reduce the costs of wheel repair and maintenance. Several factors such as speed, axle load, wheel–rail adhesion, wheel material, and braking conditions affect the wheel tread damage [3]-[7].

This study is focused on the evolution of the wheel tread profiles subject to block braking and wheel-rail contact. The conditions of conventional block-braked trains were investigated. Full-scale dynamometer experiments [1] were conducted with tread braking to reproduce the wheel tread wear. These experiments involved using sintered brake blocks and the wheel–rail contact, which was accomplished by a rail–wheel. Stop braking was performed repeatedly. The profile and hardness of the tread were measured and evaluated, and the temperatures and crack development of the tread were monitored. The wheel wearing mechanisms were clarified. Thus, an understanding of the mechanisms directly affects the selection of the materials for wheel and brake blocks. In addition, it enables the development of a more efficient wheel maintenance procedure.

This study is focused on an experimental approach for observing wheel wear. In a parallel paper [8], thermally induced wheel tread cracking at the brake test stand was studied quantitatively.