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Kurzbeschrieb Projekte Bahninfrastrukturforschung

P-1110 Improved wear behaviour and friction control in the wheel/rail contact

Schwerpunkte Wirkungsziele	Verschleissoptimierter Bahnbetrieb Kostenoptimierung (Betrieb, Unterhalt oder Ausbau der Bahninfrastruktur)	**Geplante Projektdauer**	03/2018-03/2021
Projektträger/ Projektleitung	Swiss Federal Laboratories for Materials Science and Technology, (Empa) Rowena Crockett, rowena.crockett@empa.ch	**Budget total / Anteil BAV**	766'303 CHF 297'003 CHF

Zusammenfassung

In this project, we will determine how friction modifiers for the wheel/track contact work at the molecular level. Determining to what extent the components react at the surface and how the protective layer is formed will allow new, more robust materials to be designed. These new materials will be tested by the SBB in field tests following rigorous lab testing to demonstrate their suitability. The friction modifiers will reduce wear and fatigue while maintaining high safety standards and good environmental compatibility.

Problemstellung

Wear and friction at the wheel/rail interface are important in determining the durability of the materials as well as influencing aspects such as stopping distance and noise emission. The wheel/rail interface is a complex system, in which the friction is not simply required to be as high or as low as possible but should lie within a given range. The use of top-of-rail friction modifiers allows wear and fatigue to be reduced by limiting the metal-metal contact between wheel and rail. In the current technology, a layer is formed on the surface of the rail, generally described as a composite, which protects against wear. This layer also regulates the friction coefficient by providing a new shear plane within the composite layer

Ziele

The goal is to determine the mechanisms by which wear protection and friction control can be achieved at the wheel/rail interface. Design criteria will be developed for a more efficient friction modifier to address the specific problems of SBB. The requirements include environmental compatibility, a significant reduction in operating costs, increased capacity by reducing wear and fatigue, and a reduction in the noise emissions from the wheel/rail contact. The high safety standards of the SBB will be maintained.

Vorgehen / Module

The primary goal of this project is to gain a clearer understanding of the influence of a friction modifier on the wheel/rail contact. The first stages of the project will therefore be carried out in the lab. Equipment is available at the Empa and ETH Zurich that would allow the behavior of the friction modifiers to be assessed under different conditions and different types of contact. Both pure sliding and varying slide/roll ratios can be used. This variety is important as the behavior of both organic and inorganic materials can differ, depending on the conditions experienced by the material in the contact.

The whole range of modern surface-analytical techniques is available to examine the behavior of the friction modifier. If a simple composite is formed by pressing out the solvent, then important characteristics of this will include the adhesion to the substrate, the influence on roughness, and the elastic modulus. Given the severe conditions at the wheel/rail contact, it is plausible that reactions take place either within the adsorbed layer or between the friction modifier and the surface of the track. As the adhesion to the track has a critical influence on the durability of the layer, it would then be important to determine which components of the friction modifier react and what conditions they require to do that.

Kurzbeschrieb Projekte Bahninfrastrukturforschung

Polymers with improved mechanical properties are continually being synthesized. Thus there are a number of options to improve the organic component of the friction modifier. It is possible that sufficient improvements have been made in the field of polymer mechanics to allow the modifier to be entirely organic. Should the inorganic component still be required, there are a number of clays that are readily available. Sufficient mechanical strength of the composite should improve the durability, providing the adhesion to the track surface is sufficiently robust, thus underlining the importance of identifying the relevant adhesion phenomena. The friction as well as the mechanical and chemical properties of newly developed friction modifiers will be investigated in the laboratory.

The next stage will involve field tests, during which such parameters as the optimum application frequency and amount will be determined. The correlation with laboratory tests will be established by applying the friction modifier to the surface of a short length of track. The formation of a protective coating under operating conditions can thus be established and the physical and mechanical properties of the coating on the track will be compared to those of the coating produced in the laboratory. In addition, adhesion conditions for both braking as well as accelerating have to be tested in order to ensure both safe and reliable operation.

Erwartete Resultate

The protective layer not only reduces abrasive wear but also reduces fatigue, which has been shown to result in a large loss of material. Optimal friction coefficients can be achieved by means of friction modifiers. There is no evidence that the friction modifiers have a significant negative effect on contact impedance during rolling and thus do not represent a safety hazard. It is expected that there will be a significant drop in maintenance costs.