THE ANALYSIS OF ACTUAL SURFACE AREAS IN ROLLING-SLIDING CONTACT FOR REAL OPERATIONAL CONDITIONS BY MEANS OF FEM AND PROFILOGRAFOMETRIC TESTS

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1. Introduction

In real working conditions of the wheel-rail system, there are stresses and slips affecting the processes occurring in this important areas in the place of contact. The contact surface is permanently changed depending on many factors, both construction and operation. As a result of the overlap of these factors, the problem of durability of the surface layer, especially the running surface of railway rails, remains unsolved. Currently, the biggest problem is the balance between abrasive wear (vertical and lateral wear - present in railway rails) and fatigue wear, which occurs in the form of contact-fatigue damages leading to cracks on the surface and even crosswise cracks. In addition, tribological processes, occurring on the surface and just below it, in the rail are very similar to those that are formed in the railway wheel.

The phenomenon of wear occurring in a rolling-sliding contact always has the form of flaky wear products, the size and shape of which is determined by variable operating factors, type of treatment (thermal or plastic) and condition and properties of the surface layer of the material. However, in order to fully correlate the relationship between wear and durability, all the different types of stresses that occur in the rail under the influence of variable interactions should be considered [1].

2. Test procedure

Nowadays, FEM is the basic method of carrying out computer aided engineering calculations (CAE). The manufacturing process can also be made much simpler while designing and servicing the combustion engines. The reason of damages found in the selected subassemblies may be justified more easily by constructing the model of the analyzed object and performing the calculations by the Finite Elements Method. In order to reconstruct the real object and its real operational conditions as well as properly interpret the obtained calculation results it is necessary to apply the knowledge of mechanics, physics, machine and device operation and finally tribology.

Complementing the metallographic and simulation studies are geometric structure tests of the surface made on the TalySurf Series 2 profilographometer by Taylor Hobson. The calculations of stereometric parameters and isometric images of the surface in a photographic (3D) approach were developed using the TalyMap Universal program. This allowed to confirm the obtained results from simulation tests, which testifying to the type of wear process [2].

3. Numerical simulation

Appropriate models of the analyzed machine parts have to be built if FEM is to be effectively applied. Therefore the user should undertake the following activities:

- define the model of construction geometry,
- chose the type of element,
- build the finite elements mesh,
- define the material properties,
- define the elements properties,
- verify the quality of finite elements mesh,
- introduce load and boundary conditions,
- specify the type of required analysis,
- define the requirements regarding the number and kind of results,
- interpret the obtained results.

The above stages of preparation of the 3D model of the friction surface were preceded by the determination of the real friction surface on the nanotomograph - Nanotome S (Fig. 1).

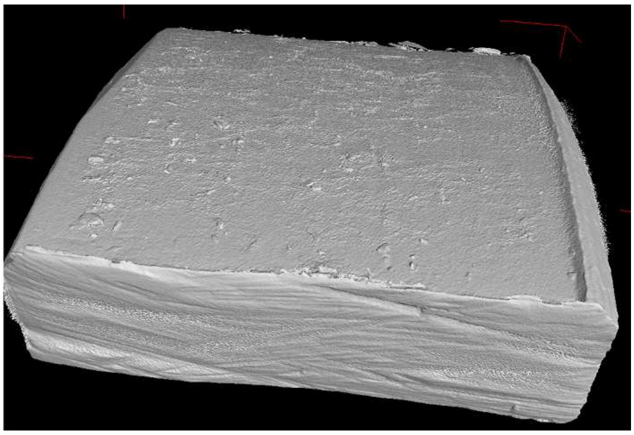

Fig 1. The real surface layer obtain in laboratory test by Computed Tomography (Nanotom S)

The subject of simulation tests is determination of stresses and deformations in the wheel-rail system for the redl contact surface in the following test sets:

a) analysis of friction surface after cooperation (both worn surfaces),
b) analysis of the friction surface after cooperation and the ideal surface (deformable),
c) analysis of the friction surface after cooperation and the ideal surface (rigid).

4. Conclusions

Numerical analysis allow to determine local stress values which are essential for understanding the wear mechanisms of the analyzed contact. The obtained results of operational investigations prove that cracks and spallings of the micro and macro scale appear in areas with maximum stress and deformation. On the basis of the conducted simulation tests, FEM was found to be the right tool used to identify the areas of special wear hazard. The method also helps to explain the wear mechanisms. FEM analysis helped to recognize and explain the wear mechanisms in depend of the selected operational conditions. The determination strains of the local stresses value of allowed the prediction of wear initiating places.
The main objective of the research was to determine the actual contact area and the relationship between the analyzed friction surface and its susceptibility to mechanical damage. This is of particular importance as the analyzed wear processes form differently on the actual contact surface than is the case for analyzes of ideal surfaces with isotropic material properties. An important part of the research is the attempt to locate the most vulnerable places depending on various operating conditions and to identify the basic mechanisms of wear.

References

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