Numerical study of the effects of the environmental and thermal factors on the damage of railway wheels produced using different materials

Nowadays, the railway is considered as a means of secure and fast transportation.

The constant development of this sector has led to the improvement of the performance of rail transport; nevertheless, this does not prevent the occurrence of conditions which still do not allow to achieve the maximum efficiency and performance. In this context, higher and higher speeds and heavy-haul require a major prevention.

The wheel-rail interface plays a fundamental role in the railway system reliability; indeed, it is here where the main damage mechanisms occur: rolling contact fatigue (RCF) and wear.

The presence of contaminants on the railway path may worsen the mechanical behavior of wheels and rails in terms of abrasion, sliding, crack initiation and consequent propagation. Among the main contaminants we find sand, ballast, debris due to wear, water, lubricants and so on.

Talking about damage mechanisms, the increasing temperature during braking should not be forgotten. Indeed, higher temperatures can cause changes in material microstructures and, therefore, a different mechanical response of the components.

The main **tasks** of this work can be summarized in the following points:

- Elaboration of finite element models to predict the behavior of the rail/wheel materials traded in Europe and America in clean conditions, in presence of contaminants and thermal factors;
- Elaboration of finite element models to predict the crack initiation and propagation in train wheels both in clean condition and in cracks filled with contaminants (in particular liquid one);
- Comparison between results obtained with FEM and empirical tests made by the mean of bi-disc testing machine in UNIBS RCF-lab;
- Comparison between results obtained with FEM and other numerical methods.

The research will be conducted mainly through the Finite Element Method with *Abaqus* software, with either Standard Implicit or Explicit solvers. Extended Finite Element Method (XFEM) and fracture mechanics theories will be adopted to study the crack propagation.

If it will be necessary, some empirical bi-disc tests might be done.

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Keywords

Rolling contact fatigue, wear, finite element analysis (FEM), wheel/rail contacts, wheel/rail materials, cyclic plasticity, fracture mechanics, solid contaminants, crack propagation, wet contact, frictional heat, thermal stress.

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