Development and validation of a wear model by means of innovative measuring instruments

E. Butini[1] , L. Marini[1], E. Meli[1], A. Rindi[1], S. Logozzo[2], M.C. Valigi[2]

[1]*Department of Industrial Engineering, Università di Firenze,*
{elisa.butini,lorenzo.marini,enrico.meli,andrea.rindi}@unifi.it
[2]*Department of Industrial Engineering, Università di Perugia, {mariacristina.valigi,silvia.logozzo}@unipg.it*

The wear at the wheel–rail interface is a crucial aspect in railway field. Wear causes a change in wheel and rail profile with a deep effect on vehicle dynamics and on its running stability, leading to a performance variations. Therefore, the original profiles have to be periodically re-established by means of turning in order to continue to guarantee the running in safety condition with a consequent increasing in maintenance costs. Because of all these reasons, the development of a model for wear prediction represents a powerful tool useful both in vehicle design phase and in maintenance planning. Since the importance of rail and wheel quality conditions, their health status are constantly monitored by means different measuring instruments which range from visual inspection and 2D contact profilometer to the most recent and innovative 2D/3D optical scanner. At present, 2D wear measurements are the most used to check wheel and rail wear condition. They use a mechanical sensing element or a laser beam to detect a set of reference parameters representative of the wear status or wheel and rail profiles geometry. However, most of them do not ensure a sufficient accuracy necessary both in vehicle dynamic simulations and if a detailed wheel and rail wear assessment is required. Moreover, using 2D measuring instruments, it is not easy detect and study particular phenomena as corrugation, cracks or plastic deformations. The most recent devices use a laser beam to detect wheel and rail profiles in terms of Cartesian coordinates and thanks to the continuous improvement in laser scanner technology, a higher degree of accuracy and effectiveness can be reached especially with 3D optical scanner, which permit a more complete analysis of the wear condition over the whole component surfaces.

The aim of this research activity is the validation of an innovative wear model, developped by the Authors in the previous year [2][3], using experimental data about tracks wear acquired using a non-contact portable metrological 3D laser scanner on a straight and curved section of the Florence tramway line.

Fig. 1 Example of 2D and 3D measuring instruments and profiles acquired

The wear model (see Fig. 2) is capable to evaluate wear evolution, simultaneously, both on the wheel and on the rail. It is made up of two separate blocks that mutually interact: the dynamics block where the dynamical analysis is carried out and the wear model block for the wear evaluation. The first one consists of two parts that interact online during the dynamic simulations creating a loop: a 3D multibody model, implemented in Simpack environment, of the tramway vehicle that interacts online, creating a loop, with the global contact model. The latter is based on an efficient algorithm developed by University of Florence [1] in the previous years for the contact points detection while the contact forces (normal and tangential) and the global creepages on the contact patch are calculated through Hertz's and Kalker's global theories. The wear model, entirely implemented in MATLAB and based on a local contact model (in this case the Kalker's FASTSIM algorithm) starts from the outputs of the dynamic simulations and calculates the material removed by wear through an experimental law between the friction power produced by the tangential contact pressures and the material removed by wear. Finally, the worn profiles of wheel and rail are obtained subtracting the worn material from the wheel and rail old profiles. An appropriate profile update strategy, based on the distance travelled by the vehicle and the tonnage burden on the track has been developed taking into account the different time scale in wear evolution of the wheel and the rail. The new profiles are reintroduced into dynamics block as input of the vehicle model and the whole iterative process can proceed forward with the next discrete step. In fact, the whole model is based on a discrete process: in each discrete step one profile update by means of the wear model are done while, within the discrete step, the profiles are supposed to be constant. Consequently, the evolution of the wheel and rail geometry is described through several intermediate profiles.

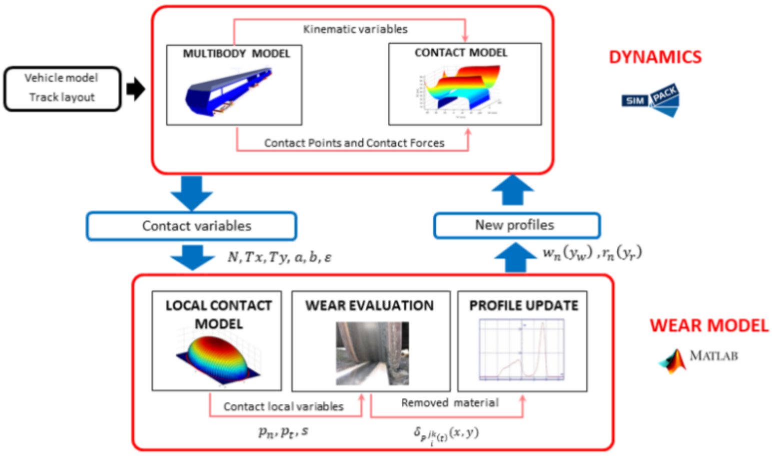

Fig. 2 Wear model general layout

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