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DESIGN METHOD FOR WEAR IN TRANSMISSION SYSTEMS

***D. Herisson[1, 2, 3], B. Delattre[2], G. Jamart[2], T.M.L. Nguyen[2], R.M. Pradeilles-Duval[1], H. Maïtournam[1], S. Fourvy[3]**

[1] LMS
École Polytechnique,
91128 Palaiseau Cedex,
France
herisson@lms.polytechnique.fr

[2] PSA Peugeot Citroën
Route de Gisy,
78943 Vélizy-Villacoublay
Cedex, France
damien.herisson@mpsa.com

[3] LTDS
École Centrale de Lyon,
36 Avenue Guy de Collonges
69134 Ecully Cedex, France

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In the automotive industry, the transmission systems (gearbox) transmit the engine torque to the wheels. The spline couplings are mainly used to link two revolution parts in case of mean torque. The aim of the study is to model wear occurring in spline couplings. The target application is the junction between the electric engine and the gearbox in the hybrid car.

The spline couplings undergo two types of damage. The first one is the fatigue which can occur at the tooth root. The latter one is the fretting wear. Robust methods are already used to compute the fatigue design. On the other hand, there are no available tools for the assessment of wear.
The objective is to develop a design method for wear combining an experimental approach and a numerical one.
From an experimental point of view, spline coupling damages have been studied by many researchers like Ratsimba and co-workers [1]. The experimental part of our work is the subject of another paper presented in April 2008 during the DGM "Friction, Wear and Wear Protection" congress (Abstract submitted).
Here, the presentation will focus on the numerical part of our work.

The objective is to develop a computational method which uses macroscopic variables and leads to a global-local transition.
The first step is to use a beam modelling of the gearbox which enables us to estimate the admissible global variables space in terms of normalised position defaults. Second step, a 3-D modelling of the spline coupling gives us the local scale variables which control the wear induced by global position defaults.

From the study of the global and local behaviour, we can distinguish three loading cases and the last one is the worst as regards wear.
A second result shows that, under a constant contact surface, a stabilisation of the sliding loops occurs during the first cycles.

Third step, an analysis of the first cycles of revolution determines the wear cases. Wear is computed in stabilized wear process cases.

Since few years, a technique consisting in remeshing the finite element model is often used. This technique is CPU time expensive. An extension of this technique is the jump cycle algorithms which assume that the behaviour of the structure will not change drastically from cycle to cycle. And so, the computation can be accelerated taking a discrete evolution. For these techniques, the work of Öqvist [2] can be mentioned.
Another approach is inspired by the direct methods much used in computational fatigue.
Our work consists in the development of a direct method for the fretting wear application. In that sense, we will use the work of Peigney [3] whose aim is to develop a direct method for fatigue and wear using an optimal control approach.
A comparison with the jump cycle remeshing technique will be done on a simple finite element model.

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