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MODELING OF CRANKSHAFT ROLLER BURNISHING FOR THEIR HIGH-CYCLE FATIGUE DESIGN

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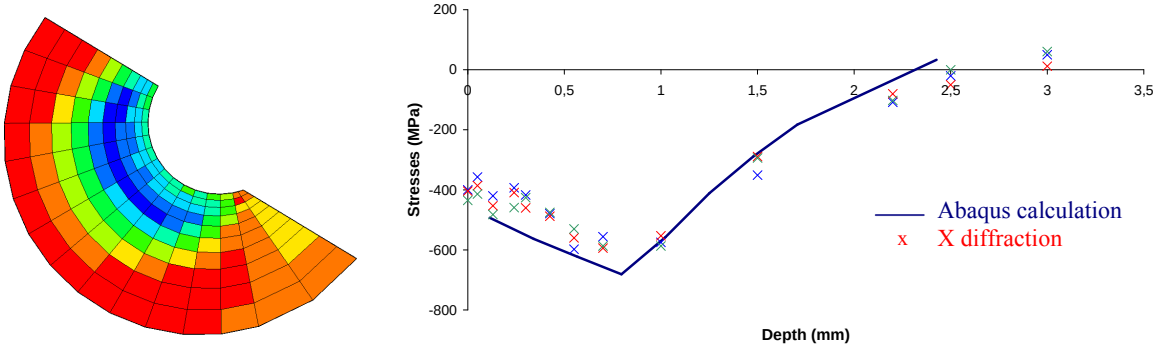
ABSTRACT

During their in-service usage, crankshafts are subjected to cyclic multi-axial loads that can induce fatigue cracks in the fillets. In order to increase their strength, they are submitted to a roller burnishing. This process generates compressive residual stresses which are beneficial to the fatigue strength of the crankshafts.

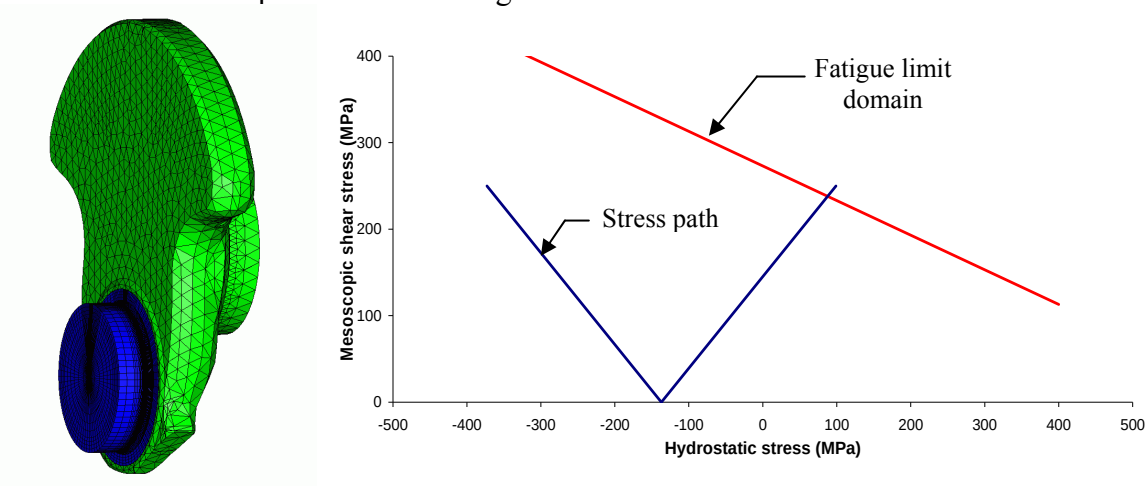
The objective of the present work is to develop a high cycle fatigue design methodology of crankshafts that takes into account the residual stresses generated by the roller burnishing. For this purpose, it is necessary to have a predictive multi-axial high-cycle fatigue criterion (we will use the Dang Van criterion) and to implement a numerical modeling that gives the stabilized mechanical response of the structure under a repeated load.

The first part of the method consists in calculating the values of the residual stresses reached after the roller burnishing. During this process, the crankshaft is submitted to a rotating load. The traditional numerical methods, in which the load movement is modeled with a space-incremental description, are time consuming. To save calculation time, we will use a particular method, called the stationary algorithm, proposed by Nguyen Q.S [1], Dang Van and Maitournam [2]. In order to avoid contact problems and save calculation time, the roller pressure will be modeled by a modified Hertz pressure.



Residual stresses in the fillet and correlation with X diffraction measurements

The second part of the method consists in calculating the stress relaxation that occurs during the first load cycles. This relaxation is slow and the stresses stabilize after about a hundred cycles. As the Finite Element models of crankshafts are usually big, the stress relaxation can not be incrementally calculated. A new calculation algorithm has been developed by PSA Peugeot Citroën and the Laboratory of Mechanical of the Ecole Polytechnique [3], which directly determines the stabilized response of a structure submitted to a cyclic loading. The Direct Cyclic Algorithm has been implemented in Abaqus. We will use it for the stress relaxation calculation of the crankshaft. The results obtained with this numerical method and the Dang Van criterion show a good estimation of the fatigue crack risk. The calculation time, which used to be prohibitive, is now more compatible with the engineers' time constraints.



Application of the Dang Van criterion to data taken from crankshaft fatigue crack tests

REFERENCES

[1] Nguyen Q.S., Rahimian, "Mouvement permanent d'une fissure en milieu élastoplastique", J. *de Mech. Appl., 5, pp.95-120*, 1981.

[2] Dang Van K., Maitournam M.H., "Steady-State Flow in classical elastoplasticity : Applications to repeated rolling and sliding contact", *J. Mech. Phys Solids, Vol.41, no11, pp.1691-1710*, 1993.

[3] Pommier B., "Détermination de la réponse asymptotique d'une structure anélastique soumise à une chargement thermomécanique cyclique", *PhD Thesis*, *Ecole Polytechnique*, 2001.