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Finite element simulation of high cycle fretting wear using an implicit integration scheme and an adaptive cycle jump

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Keywords

Fretting – Wear – Finite element – Implicit scheme – Cycle jump

Abstract

Among the various mechanical and chemical processes that can generate wear, fretting refers to small amplitude cyclic tangential motion between two contacting solids. Wear under fretting motion happens in different industrial contexts and can significantly reduce the lifetime of components. For example, such damage mode could occur in pressurized water nuclear reactors between guide cards and control rods. Due to the diversity of mechanisms at stake, modeling wear is complex, and predicting fretting wear by numerical approaches raises some issues, especially due to non-linearities and the need to compute a very large number of time steps. This explains why investigations still mainly rely on experimental approaches. In the present study, a finite element model and a simulation strategy aiming at predicting fretting wear are presented. The model represents a stainless steels cylinder/plane cyclic contact and the numerical results obtained are compared with experimental data from the literature. The proposed simulation process is particularly suitable for computing a high number of fretting cycles. To this end, a cycle jump technique is used in association with different integration schemes. Results show that instabilities may arise on the computed pressure when an explicit scheme is used, which limits the cycle jump. On the other hand, an implicit scheme ensures stable computations but involves a trade-off between the possibility of considering a higher cycle jump and the number of iterations required for convergence. Results show that the more cycles we perform, the faster the implicit scheme converges. Therefore, the implicit scheme is especially appropriate for high-cycle computations. In addition, an adaptive cycle jump is used with the implicit scheme, enabling to accelerate the computations with a high number of cycles. The adaptive acceleration factor is obtained from an estimate of the wear profile enlargement rate.

[292/300 words]