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Semi-Analytical Modelling of Non-Conformal Fretting Contacts Using an Elastic Half-Plane Approach

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Friction-based joints are widely employed in mechanical systems and may experience fretting damage when subjected to dynamic loading conditions. Fretting occurs when two contacting bodies undergo oscillatory relative motion with an amplitude small compared to the contact size along the sliding direction. Depending on the contact conditions, fretting damage may evolve in partial-slip or gross-slip regimes, typically associated with different dominant damage mechanisms, such as fretting fatigue, wear, and oxidation. The severity of the damage is governed by process parameters, including displacement amplitude, normal load, and temperature, whose combined effects are commonly correlated with the energy dissipated during the loading cycle.

This work presents a semi-analytical elastic half-plane model for the analysis of non-conformal contacts under combined normal and tangential loading. Both contacting bodies are locally modeled as isotropic linear-elastic half-planes, while the coupling between the normal and tangential problems is described through Coulomb friction. The proposed approach enables the computation of normal pressures, tangential tractions, and fretting hysteresis loops associated with partial-slip and gross-slip conditions.

Compared to fully numerical approaches, the semi-analytical formulation provides an efficient framework for the simulation of fretting contact problems, representing a suitable basis for the development of more comprehensive fretting damage models, including wear, fretting fatigue, and oxidation phenomena. In the reference sphere-on-plane configuration, the predicted contact stresses and hysteresis cycles are compared with the classical Hertz and Mindlin–Deresiewicz analytical solutions. The comparison demonstrates that the proposed model accurately reproduces the analytical distributions of normal pressure, tangential traction, and hysteresis response, confirming its effectiveness for the simulation of fretting contact problems.

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Keywords 2: Semi-analytical model
Keywords 3: Elastic half-plane
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