Dynamic behaviour of epicyclic gears and planets support conditions

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The introduction of planetary gears in turbofans has recently emerged as a promising technological solution to reduce fan rotational speeds in the next generation of aircraft engines. In view of the rotational speeds and loads, journal bearings appear as interesting since, beyond their load carrying capacity at high speeds, they bring significant damping in mechanical systems.

The present work aims at understanding the static and dynamic couplings between journal bearings and gear meshes in epicyclic gears. Lumped parameters models of the sun-gear, planets and ring-gear are coupled with a condensed finite elements model of the carrier using the planets bearings as interface elements. The journal bearing reactions are linearized around the quasi-static equilibrium of the system in order to use classical algorithms for the time-step integration. The gear teeth elasticity at the mesh interfaces are modelled using a thin-slices approach with an elemental stiffness attached to each discrete cell on the line of contacts. Sets of normal deviations are added to these discrete cells to account for the effect of manufacturing and assembly errors, as well as tooth modifications.

A number of comparisons with results from the literature validate the precision of the model, especially regarding the frequency contents of the output signals of the simulation.

This work focuses on two main aspects: a) the effect of tooth lead modifications on the static and dynamics of a planetary gear set and, b) the influence of journal bearings as planet supports compared with rolling elements bearings. Particular emphasis is placed on the stiffness and damping properties brought by journal bearings.