



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Influence of asymmetric tooth profile and manufacturing process on the bending strength of polymer spur gears**

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SHORT ABSTRACT

The usage of polymer gears has increased significantly due to the improvements in design practices, material properties and manufacturing accuracy. In polymer gear drives, asymmetric tooth profile and polymer mating gear exert significant influence on bending fatigue strength and stiffness behavior. Additive manufacturing of polymer gears such as by selective laser sintering process – advantageous for prototyping and low-volume manufacturing – confer properties that depend on the build configuration.

In this work, the bending fatigue behavior of injection-molded Nylon 66 symmetric ($20^\circ/20^\circ$) and asymmetric ($34^\circ/20^\circ$ and $20^\circ/34^\circ$) gears, and selective laser sintered Nylon 12 symmetric gears built in 'flat' and 'on-edge' configurations were evaluated. The effects of asymmetric tooth and polymer mating gear on the deflection and load sharing characteristics were investigated. The bending fatigue performance was evaluated experimentally through load-controlled, pulsator tests in a custom-built test rig. Experimental determination of mesh deflection was carried out using an in-house developed static tooth deflection test rig. Quasi-static numerical simulations were performed in ABAQUS[®] to predict root bending stress, load share ratio, and tooth and mesh deflections.

The bending fatigue performance of metal – polymer pairs was dominated by root bending stress, whereas operating temperature determined the performance of polymer – polymer pairs. The bending fatigue life of $34^\circ/20^\circ$ configuration was the highest among metal – polymer pairs, whereas in polymer – polymer pairs, the life of $20^\circ/34^\circ$ configuration was greater than other configurations. The form factor exerted a decisive influence on the magnitude of bending stress compared to the stress correction factor. The deflection-induced load sharing occurred in $20^\circ/20^\circ$ and $20^\circ/34^\circ$ configurations.

The peak mesh deflection and peak-to-valley amplitude in a cycle were lowest in the 20°/34° configuration. In the 34°/20° configuration, the increase in the single tooth contact period caused by a higher drive side pressure angle resulted in greater peak mesh deflection and peak-to-valley amplitude. The negligible tooth compliance of metal gear caused unsymmetrical load sharing in metal- polymer pairs' double tooth contact zones.

The bending fatigue strength of selective laser sintered Nylon 12 gears built in a 'flat' configuration was greater than that of injection-molded Nylon 66 gears. The layered structure of the selective laser sintered gears impeded the crack propagation, as the crack front extended across all the layers along the face width direction. The bending fatigue life of selective laser sintered 40° and 160° configurations were lower than injection-molded Nylon 66 gears. The cross-laminar mode of crack propagation in SLS 40° lead to greater fatigue life. However, the crack path in SLS 160° was along the interlayer region, which expedited the crack propagation.

