INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title:
BI-DIRECTIONAL BENDING FATIGUE AND STATIC TRANSMISSION CHARACTERISTICS OF POLYMER COMPOSITE GEARS

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SHORT ABSTRACT

Polymer and polymer composite gears nowadays substitute metal gears for medium load applications. In some applications such as actuators of satellite launcher, the gears experience bi-directional loads. In the present study, bi-directional (ratio of minimum to maximum stresses, stress ratio, $R = -1$) and uni-directional ($R = 0$) bending fatigue performance of injection molded unreinforced and carbon fiber reinforced polyamide 66 gears were evaluated using in-house developed gear test rig. Tests were carried out at different loads and frequencies. Carbon fiber reinforced gears exhibited lower temperature than that of unreinforced gears. Unreinforced gears exhibited both thermo mechanical and root crack failures. Mechanical fatigue failures of carbon reinforced gears exhibited tortuous crack path due to the existence of reinforced fibers. Carbon fiber reinforced gears exhibited superior bending performance compared to unreinforced gears. Significant fatigue life reduction was observed in bi-directional loading compared to uni-directional loading. Hysteresis loop area and surface temperature increase with increase in torque for unreinforced gears. At higher frequency, life decreases with increase in torque for both the bi-directional and uni-directional loads. Unreinforced gears exhibited both thermo mechanical and root crack failures in bi-directional loads and root crack failures at higher frequency. The straight root cracks with overlapping fractured surfaces both in bi-directional and uni-directional loads at higher frequency were observed.

In this work, numerical and experimental studies were carried out on steel-polyamide gear pair to evaluate the static transmission characteristics. Two-dimensional static finite element analysis using linear and nonlinear material models was carried out using commercial finite element analysis tool, ABAQUS®. Premature and extended contacts occurred in the mesh and were increasing with increase in load. The bending stress and static transmission error were also predicted through finite element analysis. Bending stress with nonlinear material models was lower compared to that of linear material models. The predicted static transmission error of gear pair was compared with the experimental data obtained using in-house developed gear test rig. The measured static transmission error was found to have good correlation with the static transmission error predicted with higher strain rate nonlinear material model.