

Effect of Viscoelastic Materials on Laminated Composite Beams for Vibration-Sensitive Automotive Enclosures

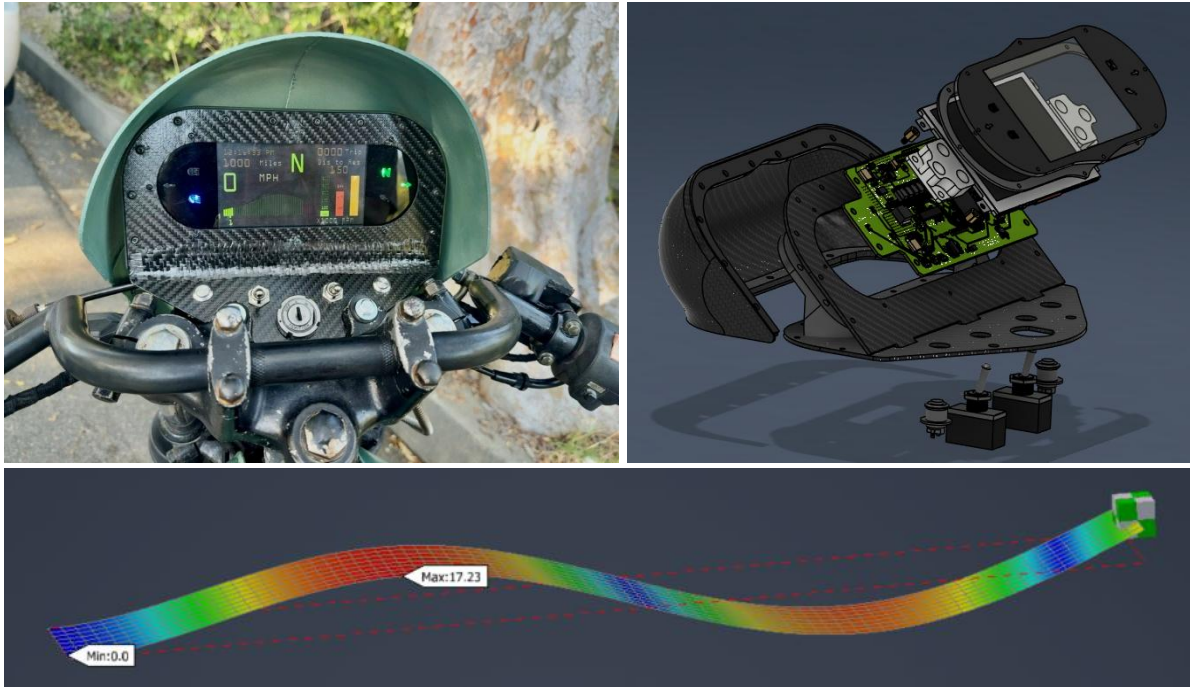
Master's Thesis Defense in Mechanical Engineering

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Date and Location: Thursday June 4, 2026, at 3:10 p.m. Building 13, Room 124B

Zoom ID: <https://calpoly.zoom.us/j/86332756708?from=addon> (863 3275 6708)



This study evaluates high-damping composite laminates for vibration-sensitive automotive components, with emphasis on motorcycle instrument clusters, the dashboard that houses the speedometer, indicator lights, and other rider information. Cantilever beam specimens were used as simplified test articles to compare analytical Euler-Bernoulli beam predictions, Autodesk Nastran finite element analysis, and sine-sweep experimental measurements. Metallic beams were first tested to validate modeling assumptions, FEA setup, and laboratory procedures. Analytical and FEA natural frequencies agreed within 0.6 % for ideal bonded metal beams, establishing a baseline for modal prediction. The method was then extended to carbon fiber, fiberglass, Kevlar, and hybrid laminates, with and without an embedded 3M viscoelastic damping layer. For composite laminates without the damping material, FEA predicted natural frequencies within approximately 1 to 5 % of measured values. Damped samples showed larger higher-mode prediction error because the 3M material response is nonlinear and not fully captured by a single isotropic material definition. Experimentally, the damping material reduced vibration amplitudes by up to 99%, lowered bending mode natural frequencies, and increased damping ratios by up to 180% depending on laminate configuration and vibration mode. Carbon-3M-carbon and carbon-3M-Kevlar laminates demonstrated the strongest overall vibration performance and are recommended for motorcycle dashboard and other vibration sensitive automotive applications.