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Alternating torsion and bending moment testing of a vehicle rim

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Abstract

The automotive wheel is a fundamental vehicle component connecting the chassis to the road. Understanding the loading mechanism which leads to fatigue failure of a wheel is necessary to design light, safe wheels. This work characterised the strain along the length of spoke for various orientations with respect to the loading direction. Three wheel designs were tested according to the bending moment (cornering) and alternating torsion fatigue test specifications of the TÜV and SAE. The results showed that the bending moment fatigue test (which reproduces the loading when cornering) is more critical than the alternating torsion fatigue test (which reproduces the loading when accelerating and decelerating). The bending moment load case produced strains that were on average 32 % higher than the torsion load case. The experimental results were compared to a finite element analysis (FEA) using commercial software (Ansys) and an analysis of the wheel which used Euler-Bernoulli beams and torsional elements to model the spokes of the wheel. The FEA underestimated the peak strains by 20 %, while the simplified model underestimated the peak strains by 30 %. Both the FEA and simplified model followed the same trend seen in the experimental results. The simplified model was further used to investigate the effect of spoke arrangement on the wheel's efficiency (i.e. the safety factor of the wheel normalised by the mass of the wheel). The model showed that increasing the number of spokes as well as increasing the angle of spoke to the radial increases the factor of safety (even after normalised with respect to mass).