Development of an Experimental Setup to Investigate the Premature Damage to Rear Wheel Hub Racers

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Introduction: Frequent exposure to harsh road conditions like potholes and road speed bumps, automotive wheel hub bearings often experience premature failure. Consequently, conventional test rigs are generally ineffective when it comes to replicating real-life harsh road scenarios. To mitigate this issue, the project proposes a unique experimental rig at laboratory scale that has the ability to replicate harsh road impacts and allow controlled study of bearing degradation.

Objectives: To implement a laboratory based dynamic testing system that mimics diverse pothole induced loads and vehicle impact scenarios to examine how dynamic loads contribute to failure modes in tapered roller bearings used in automotive wheel hub assembly.

Methodology: A setup features a mud tyre mounted off-center on a custom-machined steel plate that is driven by a rotating shaft. By altering the radial off-set of the mounted tyre, the platform can replicate pothole depths ranging from 12.7 mm to 130 mm. A 4kW, 3-phase AC motor coupled with a chain drive delivers Radial impact forces up to 7500 N. Vertical force data are acquired using a S-Type load cell and analyzed in MATLAB with use of (FFT, Envelope detection and Cepstrum analysis). The design is modeled using SoildWorks and structural validation was conducted using ANSYS Workbench to ensure safety and mechanical integrity.

Results & Discussion: The test rig effectively simulated consistent impact forces and produced premature failure modes including False Brinelling, Smearing and Pitting within 3 hours of testing. Throughout continuous testing, the system completed over 65,000 impact cycles, approximately +126 km of severe road condition, verifying its robustness in simulating harsh road impacts.

Conclusion: The developed test setup provides a practical and low-cost solution for conducting accelerated bearing failure studies. The test rig offers critical insights into bearing lifespan and contributes to the enhancement of component design. Its ability to deliver over 65,000 high impact loading cycles makes it an effective platform investigating endurance and fatigue behavior. Future enhancements include PLC automation, real-world driving cycles control via VFD, and multi-axis force sensing, enabling suspension testing and predictive maintenance applications.

Keywords: Bearing damage, Experimental simulation, Harsh road, Pothole impact, Wheel hub