

# Multi-Objective Optimization and Experimental Investigation of Quarter Car Suspension System

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**Abstract:** The primary function of the suspension system is to improve ride comfort and vehicle control. However, typical passive suspension systems have to do this contradicting task. In order to do this task, one needs to tune/optimize the suspension parameters. This study presents a methodology for determining the optimal suspension settings for a quarter-car suspension system. Macpherson strut suspension is used to construct a test rig and simulate a quarter-car suspension system. For ride comfort and optimization purpose, a Macpherson strut model is implemented in Matlab/Simulink® environment. The suspension system is optimized for ride comfort and stability. Frequency weighted RMS acceleration, vibration dose value (VDV), Maximum transient vibration value (MTVV) objectives are used for ride comfort and for stability RMS suspension deflection and RMS tyre deflection are used as objective function during optimization study. As a result, the optimization problem becomes multi objective type, and the spring stiffness and suspension damping are optimized using the NSGA-II algorithm. Further, the optimized strut is installed and tested on quarter car test rig and further, on car to validate the results. The simulation results and test rig results are obtained and validated. From test rig and vehicle results, optimized strut improves ride comfort, by reducing RMS acceleration, VDV and MTVV and provides vehicle stability. The study of optimized strut on vehicle is conducted using four road surfaces and four different drivers. The findings are represented graphically in time as well as frequency domain and also in tabular form.

**Keywords:** Multi-Objective Optimization, NSGA-II, Ride Comfort, Quarter Car Test Rig, Macpherson Strut.

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## Author Contributions

**Mahesh Nagarkar, Yogesh Bhalerao:** Conceptualization, Methodology, Experimentation, Software, Writing-Original draft preparation **Dhiraj Bhaskar, Ajay Thakur, Vaibhav Hase, Rahul Zaware Ravindra Navthar, Jaydeep Ashtekar, Amol Wable and Nagorao Surner:** Experimentation, Resources, Draft Preparation, and Editing. All authors have read and agreed to the published version of the manuscript.

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