PROJECT ABSTRACT

Quarter Car Suspension Test Rig

A single-corner vehicle suspension rig with coil spring, damper, wheel and displacement gauge for hands-on ride-dynamics experiments.

Project type: Hardware

Availability: Built to order

Suitable branches: Mechanical

Technologies: Welded frame fabrication, Coil spring unit, Hydraulic damper, Displacement gauge, Swing-arm mechanism, Mass set testing, Fabrication drawings, Suspension test worksheets

Price: Request a quotation

Prepared by Projectech · projectech.in — for academic project reference.

1. Introduction / Background

Vehicle dynamics is taught through the quarter-car model — a sprung mass, a spring and a damper drawn on paper — but students rarely get to push down on a real one and watch it bounce. Full vehicle rigs are far beyond student budgets, yet the quarter-car rig captures the essential physics in a single corner: the unsprung wheel, the spring carrying the body mass, and the damper controlling the motion.

This project fabricates that rig as a welded steel frame holding a real wheel-and-tyre, a coil spring and a hydraulic damper, with a dial displacement gauge reading the body motion. The student measures spring stiffness in a static test, runs drop tests from a fixed height, and compares the settling behaviour with the damper connected and bypassed — the paper model, made physical, with every number measured by the student's own hand.

2. Problem Statement

Suspension theory — natural frequency, damping, transmissibility — is derived mathematically and seldom felt physically. Without a rig, students cannot observe how a damper kills oscillation, cannot measure a real spring stiffness, and cannot connect the natural-frequency formula to a bounce they have watched.

A single-corner suspension rig with real wheel, spring, damper and instrumentation brings the quarter-car model into the laboratory at student-project cost. The problem this project solves is the absence of an affordable, hands-on ride-dynamics rig for undergraduate mechanical laboratories.

3. Objectives

- Fabricate a quarter-car rig: welded frame, swing arm, real wheel-and-tyre, coil spring and hydraulic damper.
- Instrument the rig with a dial displacement gauge reading sprung-mass motion.
- Provide a damper bypass so every test runs in damped and undamped configurations.
- Establish static-test and drop-test procedures with worksheets for stiffness and natural-frequency work.
- Produce fabrication drawings, a project report, presentation and viva preparation material.

4. Proposed Methodology

- Design the welded steel frame with a pivoted swing arm that constrains the wheel carrier to vertical motion.
- Mount the real wheel-and-tyre as the unsprung mass with the coil spring and hydraulic damper in parallel above it.
- Fit the dial displacement gauge (0.01 mm least count) on the frame to read sprung-platform motion.
- Arrange the damper bypass so the damper can be connected or isolated without dismantling.
- Prepare the known-mass set (5–25 kg total) for the static deflection test and mark the fixed drop height (approximately 50 mm).
- Validate with trial static loadings and drop releases, checking gauge repeatability and clean release.
- Run the experiment programme: static stiffness measurement, damped and undamped drop tests, and natural-frequency check.
- Document fabrication, procedures, results and comparison in the report.

5. System Architecture / Working

The rig has five functional assemblies. The **frame** is the welded steel structure carrying everything. The **swing arm** pivots the wheel carrier for consistent vertical motion. The **unsprung mass** is the real wheel-and-tyre. The **suspension units** — coil spring and hydraulic damper in parallel — connect the carrier to the sprung platform. The **instrumentation** is the dial displacement gauge plus the known-mass set and the marked drop height.

In the static test, known masses are added to the sprung platform in steps and the gauge deflection recorded; the student plots load against deflection and takes the spring stiffness from the slope. In the drop test the platform is lifted to the marked height and released cleanly while the student observes and notes the settling bounces. Running the drop with the damper bypassed shows prolonged oscillation; connected, it settles quickly — the direct, visible function of the damper. The measured stiffness and known masses then feed the natural-frequency worksheet, checked against the observed bounce rhythm.

6. Hardware / Software Requirements

- Welded steel frame with pivoted swing arm
- Wheel and tyre assembly (unsprung mass)
- Coil spring suspension unit
- Hydraulic damper with bypass arrangement
- Dial displacement gauge, 0.01 mm least count, with mounting
- Known-mass set, 5–25 kg total
- Fixed drop-height release provision (approximately 50 mm)
- Dimensioned fabrication drawings; experiment worksheets (no software required)

7. Expected Outcomes

- A working quarter-car suspension rig with smooth vertical wheel motion and repeatable drop release.
- A student-measured spring stiffness from the static load–deflection plot.
- Documented damped-versus-undamped drop-test behaviour with gauge readings and settling observations.
- A natural-frequency value computed by the student from measured stiffness and mass, checked against observation.
- A complete project report with fabrication drawings, procedures, plots and analysis, plus presentation and viva kit.

8. Applications

- Undergraduate vehicle-dynamics and vibrations laboratory experiments.
- Hands-on demonstration of spring stiffness, natural frequency and damping.
- Classroom visualisation of why a damper matters — felt, not just derived.
- Mini-project platform for studying mass and stiffness changes on ride response.
- Exhibition piece for automotive and mechanical open days.

9. Future Scope

- Electronic displacement transducer with data logging for recorded bounce traces.
- Adjustable damper unit for studying damping-ratio variation.
- Interchangeable springs for stiffness-sensitivity studies.
- Eccentric-mass road-profile simulator for forced-vibration experiments.
- Half-car extension with a second corner and anti-roll comparison.