



Knuckle Steering Arm Fatigue

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this standard is to determine the fatigue life characteristics of front suspension knuckles when subjected to repeated turning loads through the knuckle steering arm.

1.2 Applicability. This test procedure applies to passenger vehicles and light duty trucks.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- Component Technical Specification (CTS)
- Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities. Bedplate approximately 3.1 m × 3.1 m (10 ft × 10 ft) with hydraulic capability.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Hydraulic actuator capable of required test forces and frequencies.

3.2.2 Load cell.

3.2.3 Angle stand for mounting knuckle with Gen3 bearing, or wheel hub with Gen0 or Gen1 bearing to the bedplate.

3.2.4 Simulated brake caliper to lock out the knuckle to the wheel hub to prevent the knuckle from rotating about the spindle (only required for Gen0 and Gen1 style bearings).

3.2.5 Production tie rod ends.

3.2.6 Adapter to attach the tie rod ends to the load cell.

3.2.6.1 An alternate, though less preferred, method of attaching the actuator to the knuckle. Drill out the tapered tie rod hole in the steering arm to accept an 18 mm to 20 mm socket head shoulder screw. Attach the hydraulic actuator to the screw through a spherical bearing and appropriate rod end. (This obviously will not test the tie rod stud to steer arm attachment interface, but will expedite structural fatigue testing of the steer arm without incurring tie rod joint issues.)

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3.2.7 Spacers fabricated as required to properly position the axis of the load application between the load point of the tie rod stud and the surface of the steering arm stud boss, if using the device in 3.2.6.1.

3.2.8 Single channel strip chart recorder or a digital data display unit.

Note: All instrumentation is to be calibrated as required. Record instrumentation details and date of calibration unless the information is otherwise preserved in the laboratory records.

3.3 Test Vehicle/Test Piece.

3.3.1 Front knuckles, minimum of six (6) samples (three (3) left-hand and three (3) right-hand).

3.3.2 Wheel hub, complete with wheel studs and inner and outer wheel bearings (Gen0 and Gen1 bearings only).

3.3.3 Spindle, spindle nut, and washer (for Gen0 or Gen1 bearings only).

3.4 Test Time.

Calendar time: 21 days (24 h/day)

Test time: 500 hours

Coordination time: 36 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. The test technician should be familiar with the test machine and the instrumentation required to obtain test data.

4 Procedure

4.1 Preparation.

4.1.1 Submit all samples for magnetic particle inspection (iron or steel knuckle) or dye penetrant inspection (aluminum) prior to testing.

4.1.2 For knuckles incorporating an integral spindle (Gen0 wheel bearing), install hub and wheel bolt assembly with bearings. Pack inner and outer bearings with wheel bearing grease. Tighten the spindle nut to minimum specified torque.

4.1.3 For knuckles incorporating a Gen1 wheel bearing, install the spindle assembly with appropriate bearing and spacing components. Tighten the spindle nut to the minimum specified torque.

4.1.4 For knuckles using a Gen3 wheel bearing, mount the knuckle to an angle stand using the bearing bolts.

4.1.5 Attach the hydraulic actuator and load cell to the steering arm through the device specified in 3.2.6 or 3.2.6.1.

4.1.6 Determine test loads from the formula:

$$\text{Test load (Newtons)} = \text{Turning torque per wheel (Newton·meters)} / \text{Steering arm length (meters)}$$

Where:

Turning torque per wheel = $0.613 \times \text{Front Gross Axle Weight Rating (GAWR)}$

Steering arm length is calculated by taking a line perpendicular to the kingpin axis and passing through the outer tie rod ball center, and projecting it onto the datum A (bearing mounting face) or wheel center plane.

4.1.7 If the knuckle uses a pinch joint at any interface, install the appropriate stud in each joint and tighten the pinch bolt to the maximum torque specification.

4.1.8 Reference Appendix A, Figure A1 for a typical test setup.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

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