



HiPerStrut Yokes under Braking Loads

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 test is to determine the fatigue life characteristics of HiPerStrut Yokes for passenger cars front suspension for forward and reverse braking loads. This procedure may be used for development and validation.

1.2 Applicability. This test procedure applies to passenger cars.

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

3 Resources

3.1 Facilities.

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 Bedplate approximately 3.0 m × 3.0 m with hydraulic capacity.

3.2.2 One (1) actuator capable of applying the required force for vertical loading.

3.2.3 One (1) actuator capable of applying the required force for before/after brake loading.

3.2.4 Two (2) load cells.

3.2.5 Two (2) channel load readout devices.

3.3 Test Vehicle/Test Piece. Multiple samples are tested to multiple lives of simulated severe customer usage to demonstrate customer reliability. The defined number of test pieces will be determined by responsible system validation engineer.

3.4 Test Time. One (1) test cycle representing one (1) life is 210 000 braking events. With a maximum repetition of four (4) times per second, this will take approximately 15 h.

3.5 Test Required Information. Determine load vehicle parameters provided per vehicle program under test.

3.5.1 Setup.

3.5.1.1 All joints are attached with the production released fasteners to the yoke.

3.5.1.2 A simulated knuckle is attached with production released upper and lower ball joint. It includes the load arm to simulate the rolling radius of the largest wheel and tire assembly released for the vehicle being tested.

The load arm is constructed such that the braking force is applied at the tire patch and the vertical load is applied along the wheel centerline. See Appendix A, Figures A1 and A2.

3.5.1.3 The control arm is attached with production released yoke bushings to the yoke, and mounted with the production released bushings to the bedplate.

3.5.1.4 A control arm dummy can also be used to simulate the control arm. The control arm dummy is dimensioned as shown in Appendix A, Figure A6 and mounted with joints to the bedplate. The yoke bushing centerline is parallel to the control arm pivot axis.

3.5.1.5 To avoid rotation of the simulated knuckle, the tie rod is attached to the bed plate (see Appendix A, Figure A1).

3.5.1.6 Simulate strut with hollow rod fixed with a ball joint to bedplate. The orientation from the strut, relative to the brake force actuator, is corresponding to the real vehicle orientation of the strut in rear and side view (see Appendix A, Figures A4 and A5).

3.6 Personnel/Skills. Experienced testing technician for hardware tests.

4 Procedure

4.1 Preparation. Load calculations for front suspension HiPerStrut Yoke.

Note: The vertical load is applied upward relative to the vehicle.

4.1.1 Setup. A test setup with vehicle mounting orientation is desirable (see Appendix A, Figures A1 through A6).

4.1.2 Assemble yoke with yoke bushings; upper and lower joints. Use production released fasteners to tighten to the minimum specified torque.

4.1.3 Attach simulated knuckle with load arm to the yoke.

4.1.4 Attach strut/strut dummy with vertical load force actuator to yoke.

4.1.5 Attach control arm to yoke.

4.1.6 Attach tie rod to simulated knuckle.

4.1.7 Attach vertical load force actuator.

4.1.8 Position the braking load force actuator and load cell at a right angle to the loading arm and secure the actuator to the bedplate.

4.1.9 Test – Operating. Instructions for HiPerStrut Yoke braking test.

4.1.9.1 Calculate the vertical load (V_f) for a 0.8G forward brake stop using the formula in 4.2.2.1 (reference Appendix A, Figure A7).

4.1.9.2 Calculate the forward braking load (F_f) for a 0.8G forward brake stop using formula in 4.2.2.2 (reference Appendix A, Figure A7).

4.1.9.3 Calculate the reverse braking load. The reverse braking load is equal in magnitude to the forward braking load as calculated in 4.1.9.2 (reference Appendix A, Figure A7).

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.

4.2.2.1 Static Vertical Load for one (1) front wheel:

$$V_f = \frac{\text{FrontGAWR}}{2} + \frac{\text{GVW} \times A \times H}{2 \times L}$$

Where:

GAWR = Gross Axle Weight Rating

GVW = Gross Vehicle Weight

H = Height of the center of gravity of the vehicle above the ground

a = Deceleration rate

A = Deceleration ratio (a/G)

L = Vehicle Wheelbase

4.2.2.2 Forward Braking Load for one (1) front wheel:

$$F_f = V_f \times A$$

The forward braking load, F_f is a function of μ , the coefficient of friction between the tread and road and the dynamic normal force on the tread V_f :

For a 0.8G forward braking condition:

$$F_f = 0.8 V_f$$

4.3 Instructions.

4.3.1 With the vertical load force actuator, apply the vertical load calculated in 4.1.9.1.

4.3.2 With the braking load force actuator, apply 20 forward braking loads, as calculated in 4.1.9.2, in the forward direction followed by one (1) reverse braking load, as calculated in 4.1.9.3, in the reverse direction. Repeat this cycle 10 000 times until a total of 210 000 counts are achieved (see Table 1). Applying 200 000 forward braking loads followed by 10 000 reverse brake loads is not permitted, as this will result in an inaccurate outcome.

Table 1: Yoke Loading Test Recipe

Test Block ^{Note 3}	Cycle Count ^{Note 4}	Loading	Load type ^{Note 2}	Force ^{Note 1}	Maximum Frequency (Hz)
1	20	Forward Braking force	Sinusoidal	$0.8 \times V_f$	5
2	1	Reverse Braking force	Sinusoidal	$-0.8 \times V_f$	5
Total	21				

Note 1: Vertical force is applied constant during testing V_f

Note 2: F_f is sinusoidal.

Note 3: Repeat Test Blocks 1 and 2 10 000 times for 1 life.

Note 4: Total Count = 20 (Test Block 1) + 1 (Test Block 2) = 21

5 Data

5.1 Calculations. Supply the reliability group to the requirement R99C50.

5.2 Interpretation of Results.

5.2.1 All samples shall be magnetic particle (or equivalent for non-ferrous knuckles) inspected following test, whether or not cracks are apparent.

5.2.2 Mark all cracks found during inspection and photograph one (1) or more representative samples.

5.2.3 The part fails the test if a crack occurs during the test, or a crack is found after test, during inspection.

5.3 Test Documentation.

5.3.1 Any issues which occur outside of the validation requirements shall be documented in a test report.

5.3.2 The following information shall be included in the final evaluation report:

- Sample model year/model/system.
- Load derivation and calculated loads.
- Test methodology.
- Any deviations from procedure.