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Laboratory Corrosion/Fatigue Testing of Vehicle Suspension Coil Springs

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RATIONALE

Not applicable.

FOREWORD

This laboratory test for combined corrosion and fatigue testing of vehicle suspension coil springs is based on the work of the SAE Corrosion/Fatigue Test Task Force. Results from this test will provide an assessment of the performance of coil springs in the cyclic corrosion environment defined by SAE J2334 in combination with mechanical durability testing.

1. SCOPE

This lab test procedure should be used when evaluating the combined corrosion and fatigue performance for a particular coating system, substrate, process and design. The test is intended to provide an A to B comparison of a proposed coil spring design versus an existing field validated coil spring when subjected to the combined effects of corrosion and fatigue. The corrosion mechanisms covered by this test include general, cosmetic and pitting corrosion. Fatigue testing covers the maximum design stress and/or stress range of the coil spring design (typically defined as excursion from jounce to rebound positions in a vehicle). The effects of gravel and heat are simulated by pre-conditioning the springs prior to fatigue testing. Time dependant corrosion mechanisms such as stress corrosion cracking are not addressed with this test.

2. REFERENCES

2.1 Applicable Publications

The following specifications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J400 Test for Chip Resistance of Surface Coatings

SAE J2334 Laboratory Cyclic Corrosion Testing

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2.1.2 ASTM Publication

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM G 46 Standard Guide for Examination and Evaluation of Pitting Corrosion

3. DEFINITIONS

3.1 Fatigue

Cyclic loading of the part under conditions of maximum and minimum defined stress or strain.

3.2 Cosmetic Corrosion

Corrosion that occurs as a result of the breakdown or damage to a coating system. Typically, this type of corrosion does not impact function but does compromise appearance. (SAE J2334)

3.3 General Corrosion

Corrosion of a component that is typically bare (no organic coating). Corrosive attack is uniform in nature and distributed over "large" areas. (SAE J2334)

3.4 Pitting Corrosion

Pitting corrosion is a highly localized attack of the metal surface due to the loss of the protective coating or a localized discontinuity in the coating. (ASTM G 46)

4. EQUIPMENT AND TEST MATERIALS

4.1 Corrosion Test Cabinets

Test cabinets will meet the requirements of SAE J2334

4.2 Salt Solution Application

Salt solution application shall meet the requirements of SAE J2334 (application to be specified by the customer)

4.3 Abrasive Solution

The abrasive slurry shall consist of the following; 2.8 kg of 24 mesh (coarse) brown aluminum oxide, and 0.3 kg of Kaolin (white clay) powder added to 1 liter of water.

4.4 Fatigue Test Equipment

The fatigue test equipment shall be capable of cycling the spring from maximum to minimum stress at 1 to 4 cycles per second.

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4.5 Gravelometer

4.5.1 Rotational Test Equipment

A standard gravelometer and process, as depicted in SAE J400, shall be either modified or a suitable alternative manufactured so that either the spring mounting fixture or the gravelometer nozzle shall be adjustable and a coil can be rotated at a constant rate during the graveling process. A typical test unit is depicted in Figure 1. The spring holding fixture shall trap the suspension spring between two seats that apply enough pressure to keep the spring from moving during gravel application. A shaft no greater than 25.4 mm (1 inch), in-line with the axis of rotation and the centerline path of the nozzle, can pass through the center of the seats and spring. The equipment shall be set-up so that the mid-point of the first bottom full active coil, in the vehicle at curb height, shall be 350 mm (13.75 inches) from and in-line with the centerline of the face of the nozzle. The spring will be graveled in its free height condition (uncompressed). The nozzle pressure will be adjusted to 480 ± 20 Kpa (70 ± 3 PSI) and the spring rotation will be no faster than 12 revolutions per minute.

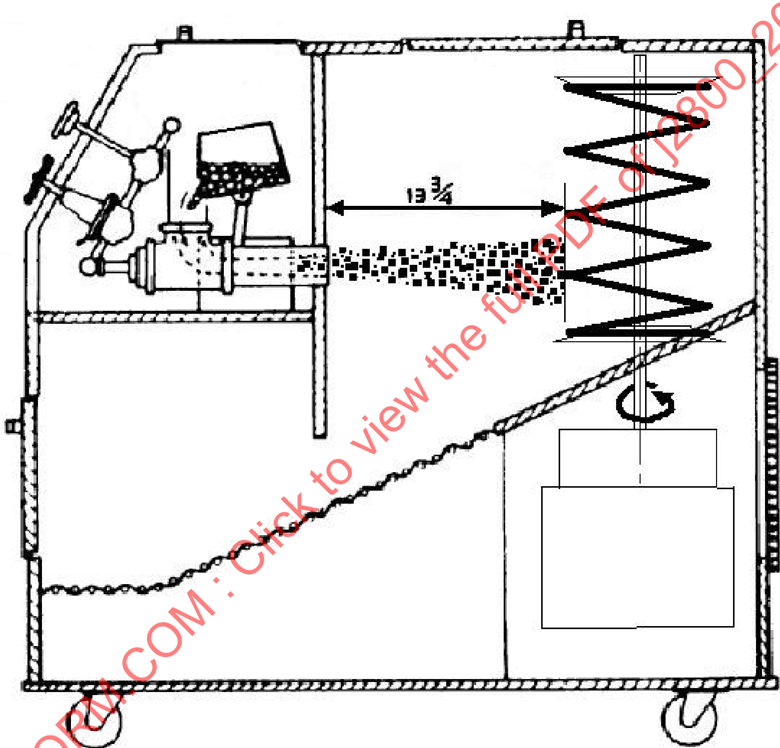

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FIGURE 1 - TYPICAL ROTATIONAL GRAVELOMETER TEST EQUIPMENT

4.6 Oven

Oven or environmental chamber capable of maintaining 80 ± 2 °C.

4.7 Cold Box

A cold box capable of maintaining –36 ± 2 °C shall be available to condition the spring prior to gravelometer exposure. As an option, the chamber can be sized to accommodate the gravelometer tester.

5. TEST PROCEDURE

The coil springs shall be preconditioned and then subjected to combined corrosion/fatigue testing as described below. A recommended sample size of 10 {minimum of six (6)} springs shall be tested for each combination of coating system, substrate, process and design.

5.1 Preconditioning

5.1.1 Heat Resistance

Place springs in an 80 ± 2 °C chamber for five days and remove. Note any changes to the coating such as cracking or loss of adhesion. Cycle the springs 200 times from maximum to minimum stress at room temperature.

5.1.2 Chip resistance

Place the gravelometer and springs in a chamber held at –30 ± 2 °C for 4 hours or until the springs reach equilibrium. Alternatively, it is acceptable to under cool the springs to –36 ± 2 °C in a separate cooling chamber. Remove the cooled springs one at a time from the chamber and immediately place in the gravelometer. Place the springs in the rotating fixture so that the bottom portion (in-car position) of the of the spring will be graveled first. The spring shall then be graveled with 1 pint of gravel at a uniform rate so that the rocks have been exhausted as close to either one or two full revolutions of the spring. The spring will then be flipped over and the top portion will be graveled in the same manner. If the top and bottom of the spring can not be graveled within 2 minutes, the spring shall be placed back in the freezer for an additional hour before repeating the graveling procedure on the top portion. The fixture does not need to be repositioned for the top portion of the spring, even if center of the first active coil is not the same distance from the end as the bottom portion.

5.1.3 Low Temperature Flexibility

Cycle springs 200 times from maximum to minimum stress at –30 ± 2 °C. Cycle frequency should be between 1 and 4 cycles per second. Alternatively, under cool the springs to –36 ± 2 °C and place into a room temperature fatigue tester. Immediately cycle the undercooled springs 200 times from maximum to minimum stress. Note any changes such as cracking or loss of adhesion in the coating.

5.1.4 Abrasive Slurry Exposure

Apply the abrasive slurry described in 4.3 to the spring by dipping the bottom and top coils into a container containing the mixture. Up through the first active coil and any sleeves should be completely covered. Rotate the spring two times clockwise and counterclockwise to thoroughly coat the surface. Allow excess slurry to drip off.

Place the spring in the fatigue machine with production level spring seats and isolators. Vehicle geometry is preferred over parallel plate for the fatigue cycling.

Cycle spring 15 000 times from maximum to minimum stress at up to 2 cycles per second.

Note condition of any wear surface, especially locations of exposed metal substrate.

5.2 Corrosion Fatigue Testing

5.2.1 Option 1 – Corrosion Followed by Fatigue Testing

5.2.1.1 Corrosion Cycle

Expose the preconditioned springs to 30 cycles of cyclic corrosion testing per SAE J2334. Manual or Automatic operation is acceptable. Do not scribe springs. The test may be monitored by the coupon method. The dip method is preferred for the salt solution application. The salt solution should be agitated or stirred for at least 30 minutes prior to submersion and must be replaced every 7 days.

Photograph typical gravel impact, seat wear and coil contact areas after 5 cycles and estimate the gravel damage per SAE J400.

Photograph the typical surface condition of the springs after 30 cycles.

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