



STRESS DURABILITY TEST FOR ADHESIVE LAP-SHEAR BONDS

Application

This method is used to evaluate the relative performance of adhesive bonding systems exposed to simultaneous tensile load and environment. It can be used to evaluate substrates, pre-treatments and adhesives for automotive body panel applications. The method includes how to create the test specimens as well as making fixtures for the test, equipment requirements and test procedure.

Apparatus

Stress Durability Fixtures

The Stress Durability fixtures (tubes) are not commercially available and should be constructed per the attached Figures 1-18. They must be made of stainless steel SS316 unless otherwise noted.

Springs: Part Number: 103-30-93-2
Associated Spring Raymond
370 W Dussel Drive
Maumee, OH 43537

Washers: 93493A234
Nuts: 94804A029
Bolts: 93190 A537
McMaster Carr
<https://www.mcmaster.com/>

Vise

A vise of sufficient size to hold the stress durability fixture and compress the spring, see Figures 19-24.

Tensile Testing Instrument

Tensile testing machine or equivalent (load cell) in tensile mode with an accuracy of 0.5% and in compression mode with an accuracy of 0.5% of the range used.

Environmental Chamber

An environmental chamber with temperature control of ± 2 °C up to 65 °C, relative humidity (%RH) control of ± 5 % up to 95% and forced air circulation of five air exchanges per minute. Test conditions are 50 °C ± 2 °C and 90 ± 5 %RH. The fluctuation, gradient and deviation within the chamber and while operating must not exceed these conditions.

The top of the environmental chamber should be constructed of material to maintain the operating conditions described above. The top should be modified to receive the stress durability fixtures with a washer to seal the fixture in to the chamber. See Figure 25.

Date	Action	Revisions	Rev. 03
2017 01 12	Revision	Complete revision	B. Witkowski, NA
2002 01 10	Revised	Editorial – no technical change	A. Cockman, NA
1994 10 12	Released		

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Documents

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**Tank**

Polyethylene tank with cover, of sufficient size and capacity to permit the stress durability fixtures to be immersed in the salt solution to a level covering the top test specimen yet making sure to keep the spring out of the salt solution.

Drying Rack

A rack for drying the stress durability fixtures such that the fixtures are maintained in a vertical position. A polyethylene cart can be modified to accommodate the fixtures. See Figures 26 and 27.

Materials Required**Test Coupons, Blanks and End Tabs** (See Figures 28-29)

- Test coupons shall be 25 x 56 mm x t where t is the thickness of the substrate to be tested.
- Blanks shall be of the same material as the substrate used unless otherwise specified and shall be 25 x 100 mm x t where t is the thickness of the substrate.
- End tabs are to be the same as the blanks except that the length is to be 52 mm instead of 100 mm.

Rubber Stoppers

Used to maintain the chamber conditions while the tubes are out for the daily cycle.

Substrates

Type, thickness, contamination, pre-treatment, and cleaning as required.

Adhesives

Material and manufacturing recommended cure conditions.

Pre-treatments

Material and manufacturing recommended application conditions.

Material to Maintain Bond Line Thickness

Example: Solid glass beads or other media to control bond line thickness of the adhesive can be used. A commonly employed glass bead diameter for metal to metal bonding is 0.25 +/- .01 mm. For composite to composite bonding 0.75 +/- .01 mm diameter glass beads are used.

Control Lap Shears

Known substrate, adhesive and/or pre-treatment test specimens may be required and will be specified by the Materials Engineer or other requester.

Sodium Chloride

Reagent grade

Distilled or Deionized Water

10 ppm maximum dissolved solids

Hydrochloric Acid

Reagent grade

Sodium Hydroxide

Reagent grade

Portable Temperature and Humidity Data Logger

Lascar EL-USB-2 or equivalent temperature humidity acquisition device



Procedure

Preparing the Lap-Shear Coupons

1. This test method requires six lap-shear test coupons for each load and environment combination. (Figures 28-30) The coupon overlap is 12.5 mm, the width is 25 mm and the bondline thickness is maintained with glass beads or other media.
2. Remove squeeze-out.
3. Cure assembled coupons per adhesive manufacturer's recommendations.
4. Punch 6 mm holes in ends of coupons except for coupons to be pulled for initial failure load.

Preparing the Stress Durability Fixtures

1. Fasten the six coupons together with the stainless steel bolts and glass fiber washers alternating the arrangement of each joint (Figure 2) as to keep the bondline aligned along the center of the fixture.
2. Fasten the end link to the end of the string of coupons.
3. Fasten the fixture into the vise (Figures 19-22) using specific loads for the testing as defined by the requestor.
4. Measure and record the compressed length (mm) between the end cap and the washer.
5. Screw down the hex nut on top of fixture (Figure 2).
NOTE: To avoid twisting of the test specimens, it is essential to compress the spring and tighten the hex nut with the stress fixture in the vise. **DO NOT TORQUE DOWN ON THE HEX NUT OUTSIDE OF THE VISE** (Figure 2).
6. Release vise. Measure and verify compression length (mm) and verify that it matches the length identified in Step 4.
7. Repeat compression steps until desired load (length), as defined by the requester, is obtained in the released position.

Preparing the 5% Sodium Chloride Solution

1. Dissolve 53 +/- 0.5 g of sodium chloride per liter of distilled or deionized water. Prepare a sufficient amount to allow for complete immersion of test coupons contained in the stress durability fixtures.
2. Adjust the solution pH to 6.0 - 8.0 by the addition of sodium hydroxide or hydrochloric acid.
3. Replace salt solution and clean out tank when appreciable residue accumulates in the bath or when the pH is outside the 6.0 - 8.0 range (do not readjust the pH) or every 3 months. **NOTE:** Do not dispose of the salt solution if the pH is below 5.5 or above 11. Contact the Facilities Manager for proper disposal.

Mapping the Chamber

NOTE: The mapping of the chamber should be performed initially and then once a year (for reference only) This data must be provided to Ford Motor Company upon request.

1. Place a lascar (temperature and humidity data acquisition device) in each access port halfway down the stress durability fixture.
2. Run the chamber at a constant 50 °C and 90+/-5% relative humidity for 24 hours without opening the chamber to acquire the temperature humidity data.
3. Compare this data to the controller readout on the front of the chamber to verify the temperature and humidity are within 50 +/- 2 °C and 90 +/- 5% relative humidity.



Exposing the Stress Durability Fixtures

1. Begin the first test cycle on a Monday morning. Immerse the samples in the 5% sodium chloride solution in the tank at ambient conditions for 15 +/- 1 minutes. Care should be taken not to get salt solution on the springs.
2. Remove fixtures from salt solution, drip dry vertically at ambient conditions for 105 +/- 5 minutes in the cart or equivalent drying apparatus.
3. Place stress durability fixtures vertically in the environmental chamber at 50 +/- 2 °C and 90 +/- 5 % relative humidity for 22 h. Keep the springs out of the cabinet while allowing the samples to be exposed to the environment using the specially designed lid.
4. On a daily basis check for failure of the coupons. Failure of the coupons is defined as a breaking of the bond (ex.) cohesive with adhesive, interfacial between adhesive and substrate, substrate failure, or other.
5. When failure occurs record the number of cycles to failure and take out the failed coupon, replace with a blank, and reload the fixture to the previously determined compressed length.
6. Check the displacement of each of the springs daily for when they exceed the specified length for the first 10 cycles and thereafter check every 5 cycles. If the measured length is exceeded by + 2 mm re-adjust the spring to the original length (See Preparing the Stress Durability Fixtures steps 4-7).
Note: One test cycle is completed after performing steps 1 through 6.
Note: Cover the access ports with a rubber stopper or similar stopper to maintain chamber environment when the tubes out of the chamber for daily cycle.
7. Repeat steps 1 through 6 every 24 hours, Monday through Friday randomizing the stress durability fixtures location in the environmental chamber for the number of cycles stated on the lab request. During weekends and holidays leave the fixtures in the environmental chamber at 50 +/- 2 °C and 90 +/- 5 % relative humidity.

Report

1. Substrate identification including: Manufacturer, code number, type, thickness, treatment, contamination, cleaning
2. Adhesive identification including: Manufacturer, code number, type, date manufactured
3. Pre-treatment identification: Manufacturer, code number, type, date manufactured
4. Bond measurement including: Bondline thickness, overlap length, bond width.
5. Conditioning prior to testing.
6. Compression length (mm)
7. Specimen location in fixture (specimen 1 at the top through specimen 6 at bottom).
8. Cycles to failure for each specimen. Include the number of unfailed specimens and total number of cycles.
9. Report the failure including but not limited to, cohesive with adhesive, interfacial between adhesive and substrate, substrate failure, or other.

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Summary of Revisions

2017 01 07 Complete re-write of the method.



Figure 1: Stress Durability Fixture Assembly with Blanks

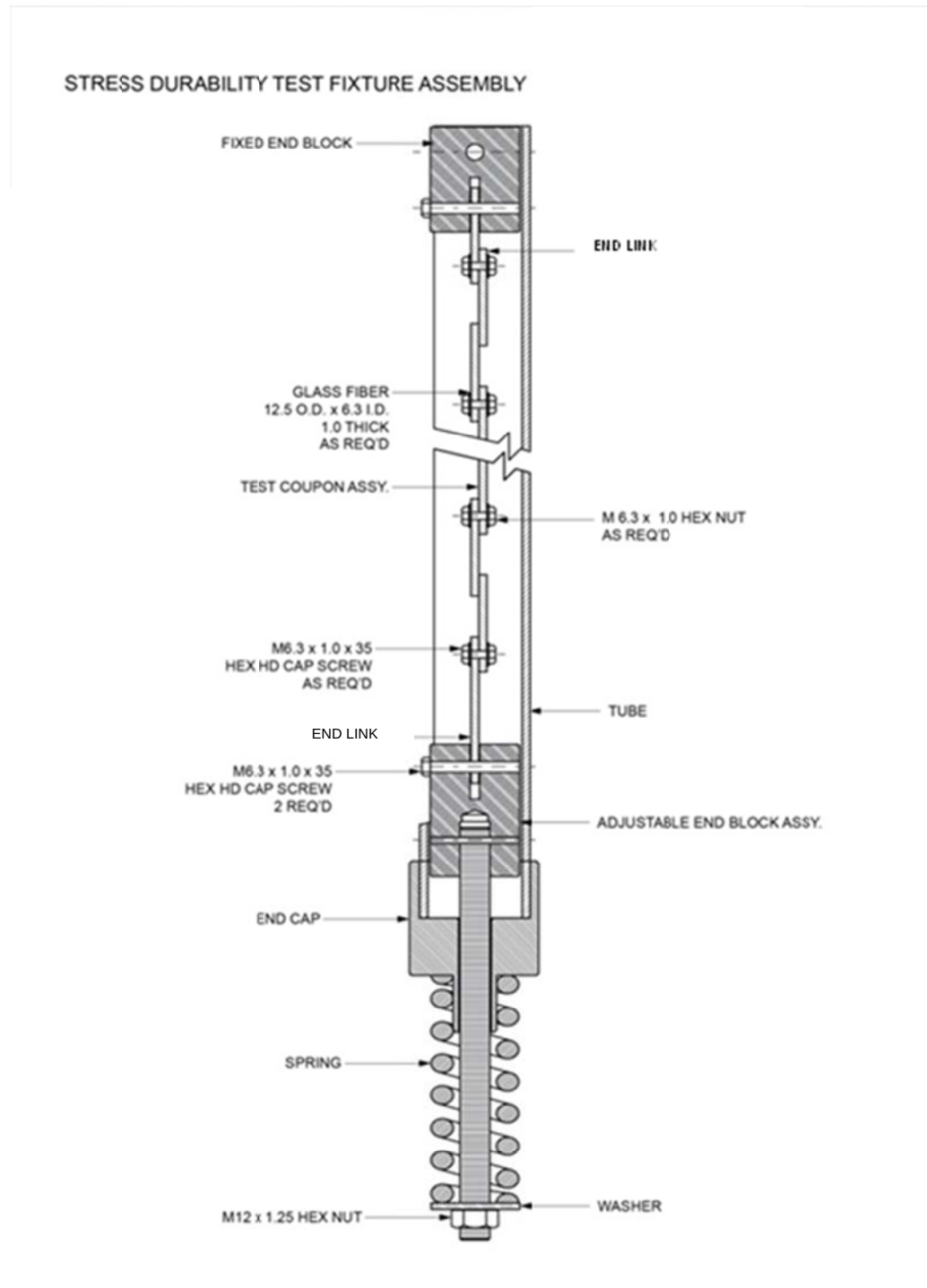


Figure 2: Schematic of Stress Durability Fixture



Figure 3: Washer

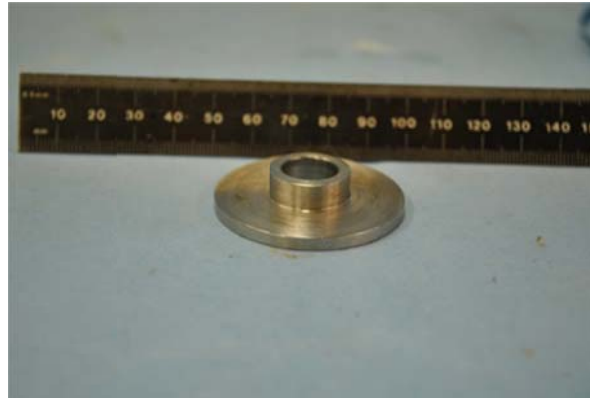


Figure 4: Washer (side view)

WASHER
MATERIAL: GRADE 316SS
Units: mm

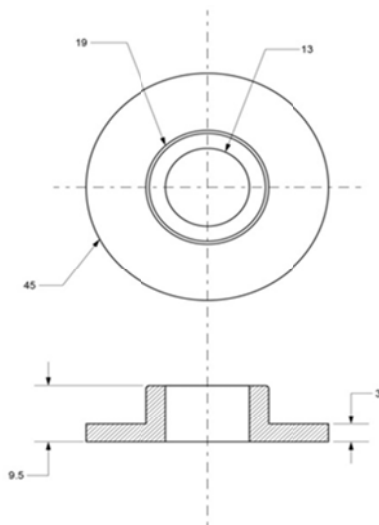


Figure 5: Schematic of Washer