SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

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Qualifying Aftermarket Two-Component Structural Foams

1. Scope

This recommended practice provides a guideline for qualifying automotive aftermarket, two-component structural foams, and defines a classification system for such foams.

1.1 Purpose

To establish a classification system for structural foams, and a method for testing them, thus allowing auto manufacturers and foam makers to specify the proper product for use in recommended repair procedures.

1.2 Background

The need for structural foams in the automotive collision repair market has grown as their use by the automotive OEMs in cars and trucks has grown. In recent years, structural foams have been used in new cars and trucks to help improve noise, vibration and harshness (NVH) characteristics, lower vehicle weight and improve structural integrity. The proper performance of structural foams is especially critical during a collision, as they play an important role in collision energy management. Many aftermarket two-component structural foams are not implemented in the same manner as at the OEM level, nor are they tested against rigorous OEM standards. This recommended practice provides OEMs with a method for specifying appropriate structural foams in their repair recommendations (see SAE J2376).

There are several types of structural foams available in the OEM market. They can be characterized several ways: the mode of cure, (i.e. heat cure or two-component ambient cure), by chemistry (epoxy or urethane) or by the strength of the final cured product.

The critical factor in choosing the appropriate structural foam for aftermarket replacement is to match the original foam strength and cavity fill as closely as possible to that applied at the OEM. Structural foams are tested against rigorous standards for strength, corrosion resistance, and most importantly, vehicle performance, during the initial design stages at the OEM.

OEM structural foams may be applied as a pumped-in mass that may be contained by baffles or blockers to maintain the foam in a specific configuration. Structural foams may also be supplied as drop-in parts that contain an engineered carrier (metal or plastic) to which the structural foam is applied. These parts are then placed in the vehicle and cured during the bake process in the OEM paint shop.

Repair of a body section in a manner that does not fill the cavity as specified by the OEM, or utilizes a structural foam that does not meet the original engineering requirements, can lead to a vehicle that no longer meets the original OEM performance objectives.

2. References

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein.

2.1.1 SAE PUBLICATIONS

Available from SAE, 400 Commonwealth Dr., Warrendale, PA 15096-0001. The latest issue of SAE publications shall apply.

SAE J369—Cured Flammability
SAE J1523—Cure Rate
SAE J1756—Fogging Test
SAE J2376—New-Vehicle Collision Repair Information

2.1.2 FORD MOTOR COMPANY SPECIFICATIONS

Available from Ford Motor Company, 20000 Rotunda, Dearborn, MI 48121.

Ford WSS–M99P35–A—Material Specification
Ford BV 11801—Sag Resistance
Ford BI 104-01—Water Immersion Test
Ford BQ 104-02—Humidity Resistance Testing

2.1.3 GENERAL MOTORS CORPORATION SPECIFICATIONS

Available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112

GM N8297—Structural Foam Performance Guidelines for Aftermarket Service Use

2.1.4 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATION

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ASTM B 117—Salt Spray Testing
ASTM D 1621—Compressive Strength
ASTM D 3574 (Test A)—Cured Density

3. Definitions

3.1 Acoustic Foams

Acoustic foams function either as a barrier to seal off a cavity to reduce wind noise, or as an absorption barrier for transmitted acoustical energy

3.2 Structural Foams

Structural foams are typically rigid and much harder than acoustic foams. Structural foams depend on their stiffness or hardness to perform their required function of providing structural enhancement to auto body sections.

3.3 Drop-In Parts

Drop-in parts are engineered parts in which a structural foam is applied to either a steel or plastic carrier, and then the carrier is inserted into the body cavity during the vehicle assembly process

3.4 Pumpable Structural Foams

Pumpable structural foams are typically applied by pumping wet material into body cavities and allowing the material to cure in place.

4. Structural Foam Characteristics

The following items should be included in the labeling of aftermarket structural foams.

4.1 Type Classification system

A classification system, based on compression strength modulus, is used to categorize structural foams (see Table 1). Both the OEM collision repair manual and the structural foam product label should state the type classification (see para. 7.1).

TABLE 1—STRUCTURAL FOAM TYPE CLASSIFICATION

Type	Modulus @ 25 °C
A	> 900 MPa
B	701 – 900 MPa
C	501 – 700 MPa
D	301 – 500 MPa
E	101 – 300 MPa

4.2 Bond Integrity

The product label should state that the cohesive failure exceeds 90% and the corrosion undercut is less than 12 mm when the product is applied to the listed substrates (see para. 7.2).

4.2.1 LISTED SUBSTRATES

The product label should list the substrates against which the bond integrity has been verified, such as hot-dipped galvanized steel, electro-galvanized steel, E-coated steel, and aluminum sheet of automotive quality.

4.3 Cure Rate (SAE J1523)

The product label should state the cure rate of the product. Most structural foams will set up within 30 min and be fully cured in 24 h.

4.4 Cured density (ASTM D 3574/ ISO 845)

The product label should state the interior density of the cured product as measured by Test A.

4.5 Volumetric Expansion

The label should state the percent of volumetric expansion that occurs as the product cures (see para. 5.1.1).

4.6 Mix Ratio

The product label should clearly state the appropriate mix ratio of the components.

4.7 Sag Resistance (Ford BV 11801)

Structural foams should have sufficient sag resistance to prevent excessive leakage and flow during application.

4.8 Preconditioning Requirements

The product label should state any preconditioning requirements, such as warming, to increase flow and reactivity.

4.9 Surface Preparation

The label should describe any required preparation of the surfaces to which the product will be applied.

4.10 Cleanup Instructions

The label should describe a method of cleaning the product from adjacent surfaces, within 10 min of application, using a common cleaning solvent (such as naphtha), leaving no permanent stains.

4.11 Safety and Personal Protection

Product labels should include warning statements regarding flammability (sparks and flames) and handling precautions (skin and eye protection).

5. Sample Preparation and Initial Measurements

5.1 Compression Test Sample Sets

Five sets of five cylindrical samples shall be prepared. Each sample is made by pouring 500 cc of two-component structural foam into a vertical cardboard cylinder (75 mm inside diameter x 200 mm length). Immediately mark the height of the foam on the outside of the cylinder. Repeat until 25 cylinders have been filled and marked. Allow the samples to fully cure, following the manufacturer's instructions.

5.1.1 VOLUMETRIC EXPANSION

Measure the height of the cured samples and calculate the percentage change in volume for each sample. Record the average percentage change in volume for the 25 samples. Remove and discard the cardboard cylinders from the samples, and cut the samples to a length of 150 mm ± 0.1 mm.

5.1.2 PAINT BAKE SIMULATION

To simulate a typical paint bake that would follow the repair of a vehicle, all test samples shall be baked for 30 min at 60 °C.

5.1.3 INITIAL TEST TEMPERATURES

One set of five samples shall be tested immediately following a five-hour soak at –30 °C. Two of the remaining sets shall be similarly tested following soaks at 25 °C and 80 °C respectively (see para. 5.1.4). The remaining two sets shall be held in reserve for environmental exposure (para. 6) and later tests (para. 7.).

5.1.4 COMPRESSION STRENGTH MODULUS (ASTM D 1621–COMPRESSIVE STRENGTH TESTING)

Test three sets of samples at 10 mm/min compression rate on an Instron or similar type of testing equipment to determine the initial strength modulus. Record the initial strength of the five samples in each temperature set. Disregard the highest and lowest readings in each set, and calculate the average of the middle three readings. Record the average compression modulus for each temperature set, and select the lowest average modulus as the base for comparing the results of the measurements in para. 7.1.

5.2 Adhesion Test Sample Sets

Two sets of five samples shall be prepared for testing the structural foam bond integrity. The samples are made by forming 75 mm x 75 mm x 100 mm, open-top, rectangular adhesion cans. The walls and bottom of the cans are made of the substrates to be specified on the product label (see para. 4.2.1), and bonded together on the outside with heat-resistant aluminum tape. Pour 500 cc of two-component structural foam into each can and allow it to fully cure, following the manufacturer's instructions. Subject both sets to the paint bake simulation in para. 5.1.2. Peel the cans from one set of the foam blocks and examine them for cohesive failure. All five of the adhesion cans should exhibit more than 90% cohesive failure. Record the percentage of cohesive failure for each sample in the set. Reserve the remaining sample set for environmental exposure (para. 6) and later tests (para. 7.2).

6. Environmental Exposure Requirement

Environmental exposure should be conducted on two sets of bare, cut compression cylinders and one set of adhesion cans, after the structural foam is cured and initial measurements have been taken (see para. 5.1.4 and 5.2).

6.1 Salt spray (ASTM B 117)

1000 hours

6.2 Humidity (Ford BQ 104-02)

30 days, 95% ± 5% Relative Humidity at 38 °C.

6.3 Water soak (Ford BI 104-01)

Five days immersion in tap water at 25 °C.

7. Test Requirements

After the environmental exposure of para. 6, all samples should be tested at 25 °C.

7.1 Compression Strength Modulus

Following the environmental exposures in para. 6, perform the compression test of para. 5.1.4 on one sample set. The structural foam must maintain more than 80% of its initial strength modulus, based on the average of the middle three readings, as recorded in para. 5.1.4. Record the average of the middle three readings, and use this average modulus to assign a type classification (see Table 1). Reserve the remaining sample set for testing in para. 7.3, 7.4 and 7.5.

7.2 Adhesion Test

Following the environmental exposures in para. 6, the cans are peeled from the foam blocks and examined for percentage of cohesive failure. All of the adhesion cans should exhibit more than 90% cohesive failure, and no more than 12 mm corrosion undercutting at the material edge. Record the percentage of cohesive failure for each sample in the set.

7.3 Dimensional Stability

Measure and record the length of a compression test cylinder to ± 0.1 mm, and compare it to the original length (150 mm) measured in para. 5.1.1. Record the percentage change in length. The maximum acceptable dimensional change is 5%.

7.4 Fogging (SAE J1756)

Three hours at 100 °C, 21 °C cooling plate, posttest conditioning: 1 hour & 16 hours. The minimum acceptable fog number is 70. Formation of a clear film, droplets or crystals is cause for rejection.