



Metal Bonding Structural Adhesive Performance Requirements

1 Scope

1.1 Material Description. This standard is intended to cover the performance requirements of structural adhesive candidates that are used to bond metallic automotive substrates.

It is anticipated that assemblies bonded with these types of adhesives will incorporate a mechanical means of attachment (hems, fasteners, and/or welds) to facilitate fixturing prior to cure of the adhesive – generally, in the heat of the paint bake ovens.

It is further anticipated that this specification shall cover "true" structural bonding applications – antifriction adhesive bonding (semi-structural) shall be addressed in a separate performance specification.

For specific material specifications that meet the classifications described herein, see 3.3.5 (Table 2).

1.2 Symbols. Not applicable.

1.3 Applicability.

1.3.1 Body Structure. Augmenting welds used in the attachment of body panels, reinforcements, frame members, floor pans, etc., where strength is required either to increase assembly, or vehicle, durability or stiffness.

1.3.2 Closure Assemblies. Bonding of hem flanges and/or inner panel reinforcements to provide integrity and "lock-up" of the hem seam or durability and stiffness of the reinforcement to the inner panel.

1.4 Remarks. The use of a structural adhesive in an application does not automatically constitute "sealing" of that application. Each "bond" application, requiring "seal" shall be evaluated on a "case by case" basis, by representatives of both disciplines.

2 References

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

2.1 External Standards/Specifications.

ASTM D638	ASTM D1876	ASTM E831	ISO 11343
ASTM D792	ASTM D5026-06	ISO 4587	

2.2 GM Standards/Specifications.

9982259	GMW8	GMW14729	L 000 0365
9982281	GMW11	GMW15416	L 000 0728
9982285	GMW3008	GMW15477	L 000 0729
9985800	GMW3011	GMW15481	L 000 0735
9985872	GMW3025	GMW15634	L 000 0740
9986265	GMW3059	GMW15635	L 000 0749
9986321	GMW3205	GMW15735	L 000 0752
EDS-M-8610	GMW3221	GMW16269	L 000 0757
EDS-M-8626	GMW3286	GMW16700	
EMS 9309579	GMW14124	GMW16853	
GMW2	GMW14270	L 000 0131	

2.3 Additional References.

GWS-5K Standard Test Procedures - Welding Performance of Weld-Through Sealer & Adhesive – Steel available from GM Supply Power at Uniform Resource Locator (URL): [https://gmsupplypower.covisint.com/web/portal/home: Document Library \(tab\): Manufacturing, Standards Mach & Equip Facilities, Global ME Body \(folders\).](https://gmsupplypower.covisint.com/web/portal/home: Document Library (tab): Manufacturing, Standards Mach & Equip Facilities, Global ME Body (folders).)

3 Requirements

3.1 Requirements on Test Specimens. Reference GMW3221.

3.2 Substrates. Testing shall be completed with the substrates in Table 1. Steel grade to be used is cold roll 3/4 with a thickness of 0.8 mm to 1.0 mm. For oily metal, use one challenging approved lubricant as specified by the approving material engineer. Degreasing and oiling according to GMW15477. Oil coating weight shall be 3 g/m² – 0.25 g/m² for corrosion protection oils/lubricants and 1.25 g/m² – 0.25 g/m² for drylubes. Oils shall not exceed a storage time of 1 year and shall be stored in opaque and inert bins.

Table 1: Substrates

Substrate Description ^{Note 1}
Oily Cold Rolled Steel (CRS): GMW2 ^{Note 2}
Oily Hot Dipped Galvanized Steel (HDG): GMW8, 60 g/m ² galvanized coating weight
Oily Electrogalvanized Steel (EG): GMW11, 60 g/m ² galvanized coating weight
Other substrates identified and required by the regional material engineering group or the regional material specification

Note 1: After application of the adhesive the oily metal panels shall be processed through pretreatment and Electrodeposition Primer (ELPO) prior to baking and exposure according to 3.5.4 and 3.6.4. Use any GM approved pretreatment (GMW3011) and ELPO (GMW3008) at target film thickness, as specified by the approving material engineer.

Note 2: Cyclic corrosion testing according to 3.5.4 and 3.6.4 is not required with oily CRS.

3.3 Bond Strength and Adhesion. Metal bonding structural adhesive candidates shall be evaluated for strength and separation mode. Samples testing shall be done in sample "sets". Five (5) samples shall constitute a "set".

3.3.1 Lap Shear (ISO 4587). All Structural Adhesive candidates shall be evaluated using the "lap shear" configuration.

Lap shear testing shall be done to establish tensile shear strength. The preferred separation mode of the adhesive shall be "cohesive" within the adhesive layer. However, due to the high yield strengths of adhesives, and "necking" or "stretching" of the lap shears bond area, the appearance of "bare" metal on the bond areas of the lap shears after tensile testing is not necessarily representative of unsatisfactory performance of the adhesive system.

In any case, the minimum required lap shear strength must be maintained, both initially, and after environmental exposure, and there may not be any evidence of "undercutting" corrosion of the bond site after environmental exposure. After environmental exposure a minimum of 80% cohesive separation within the adhesive is acceptable.

"Adhesive" separation of any "layer", e.g., metal coating, adhesion promoter, etc. in the test samples other than the adhesive/test substrate interface, shall be deemed a "non-test" of the adhesive and therefore, unacceptable for adhesive evaluation in regards to this specification.

Individual sample pieces shall measure 20 mm x 100 mm, with a bond flat of 20 mm x 10 mm.

Lap shear bond gap shall be 0.2 mm ± 0.05 mm, unless otherwise stated in this specification.

Lap shears shall be tensile tested (pulled) at a rate of 10 mm/minute.

3.3.2 T-Peel (ASTM D1876). All Structural Adhesive candidates shall be evaluated using the "T-peel" configuration.

T-peel testing shall be done to establish tensile peel strength and separation mode of the adhesive. The acceptable separation mode of the adhesive shall be "cohesive" within the adhesive layer when evaluated initially (3.5.1). T-peel samples exposed to corrosion tests (3.5.4) and pull tested, shall exhibit 80% minimum cohesive separation within the adhesive layer and shall maintain the minimum load required by the specification. Furthermore, there shall be no evidence of "undercutting" corrosion of the bond site after environmental exposure.

"Adhesive" separation of any "layer", e.g., metal coating, adhesion promoter, etc. in the test samples other than the adhesive/test substrate interface, shall be deemed a "non-test" of the adhesive and therefore, unacceptable for adhesive evaluation in regards to this specification.

Individual sample pieces shall measure 30 mm x 200 mm, with a bond flat of 30 mm x 100 mm.

The bond gap shall be 0.2 mm $\pm$ 0.05 mm.

T-peel samples shall be tensile tested (pulled) at a rate of 50 mm/minute.

3.3.3 Wedge Impact Peel (ISO 11343). Structural adhesive systems that are classified as, or intended to be used as, "impact resistant" or "fracture toughened" shall be evaluated by means of the ISO 11343 test method.

Test samples shall be of the "symmetric wedge" configuration.

Individual sample pieces shall measure 20 mm x 90 mm, with a bond flat of 20 mm x 30 mm.

The separation mode of the adhesive to the test substrate shall be "cohesive" within the adhesive layer.

"Adhesive" separation of any "layer", e.g., metal coating, adhesion promoter, etc., in the test samples other than the adhesive/test substrate interface shall be deemed a "non-test" of the adhesive and therefore, unacceptable for adhesive evaluation in regards to this specification.

Test sample bond gap shall be 0.2 mm $\pm$ 0.05 mm.

Wedge Impact Peel samples shall be tested at a rate of 2 m/s for steel substrates and 3 m/s for aluminum substrates.

3.3.4 Classification of Strengths Performance. Adhesive systems shall be classified as described in Table 2.

3.3.5 Material Specifications. Table 3 contains identification of the material specifications that meet the respective performance classifications.

Table 2: Classifications

IR-FS (Impact Resistance, Full Temperature Spectrum, -40 °C to +80 °C)	Initial impact strengths shall be $\geq$ 25 N/mm when tested at +23 °C, and $\geq$ 15 N/mm after any environmental exposure 3.6.2 Cold, 3.6.3 Heat, and 3.6.4 Cyclic Corrosion Youngs Modulus: Initial, tested at +23 °C $\geq$ 1400 MPa Glass Transition Temperature (T_g): $\geq$ +90 °C Note: GMW8 "Galvaneal" and GMW11 "Zinc/Nickel" substrates are not acceptable for "impact resistant" applications and therefore, shall not be subjected to this performance test T-peel testing after 3.5.2 Cold and 3.5.3 Hot are not required Color (globally agreed): purple
IR (Impact Resistance, Room Temperature to +80 °C)	Exhibiting initial impact strengths shall be $\geq$ 25 N/mm, when tested at +23 °C, and $\geq$ 15 N/mm after any environmental exposure 3.6.3 Heat, and 3.6.4 Cyclic Corrosion Youngs Modulus: Initial, tested at +23 °C $\geq$ 1400 MPa Glass Transition Temperature (T_g): $\geq$ +90 °C Note: GMW8 "Galvaneal" and GMW11 "Zinc/Nickel" substrates are not acceptable for "impact resistant" applications and therefore, shall not be subjected to this performance test T-peel testing after 3.5.3 Hot is not required

HS (High Strength)	Lap Shear Strength: Initial lap shear strengths shall be > 16.0 MPa, and lap shear strengths > 12 MPa when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Cyclic Corrosion, and 3.5.5 Water T-Peel Strength: T-peel strengths > 4 N/mm and T-peel strengths > 3 N/mm when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Cyclic Corrosion and 3.5.5 Water Youngs Modulus: Initial, tested at +23 °C ≥ 1400 MPa Glass Transition Temperature (T_g): ≥ +90 °C
MS (Medium Strength)	Lap Shear Strength: Exhibiting initial lap shear strengths > 10.0 MPa, and lap shear strengths > 7.5 MPa when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Corrosion and 3.5.5 Water T-Peel Strength: T-peel strengths > 2 N/mm, and T-peel strengths > 1.5 N/mm when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Corrosion and 3.5.5 Water
LS (Low Strength)	Lap Shear Strength: Exhibiting initial lap shear strengths > 5.0 MPa and lap shear strengths > 3.8 MPa when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Corrosion and 3.5.5 Water T-Peel Strength: T-peel strengths > 0.5 N/mm, and T-peel strengths > 0.4 N/mm when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Corrosion and 3.5.5 Water
LS-GB (Low Strength with Glass Beads)	Lap Shear Strength: Exhibiting initial lap shear strengths ≥ 6.0 MPa to 9.0 MPa and lap shear strengths > 5.0 MPa when tested after any environmental exposure 3.5.2 Cold, 3.5.4 Corrosion and 3.5.5 Water. Lap shear strengths > 2.5 MPa when tested after 3.5.3 Hot T-Peel Strength: T-peel strengths > 3.0 N/mm to 5.0 N/mm, and T-peel strengths > 2.5 N/mm when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Corrosion and 3.5.5 Water Elongation at brake: 20% to 30% and 20% when tested after environmental exposure 3.5.2 Cold, 3.5.3 Hot, 3.5.4 Corrosion and 3.5.5 Water Note: Other substrates as listed in Table 1 may provide different strength levels, e.g., press hardened steel, aluminum Expansion: > 5% to 30% GB (Glass Beads): Contains solid glass beads, maximum 5%, maximum diameter 0.3 mm
GB (Glass Beads)	Contains solid glass beads: Maximum 5%, maximum diameter 0.3 mm

Table 3: Material Identification

General Motors Worldwide (GMW)	General Motors North America (GMNA)	General Motors Europe (GME)	General Motors Brazil (GMB)	General Motors Holden	General Motors Korea (GMK)	Pan Asia Technical Automotive Center (PATAC)	Preferred Application
GMW15200-HS-IR-FS	9982285 Note 1	L 000 0740/ 9273202 Note 1	9982285 Note 1	9982285 Note 1	9982285 Note 1	9982285 Note 1	All crash relevant body joints