Structural Performance of 3M™ VHB™ Tapes Compared to Welding

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Introduction:
3M™ VHB™ Tapes have been used worldwide in a variety of structural applications for greater than 40 years. To further support 3M™ VHB™ Tape consideration in applications where well-known attachment options such as welding are commonly used, a variety of performance tests were run on aluminum panel assemblies at Intertek (Minneapolis, MN location), a trusted third-party test facility internationally known for its reliable testing capabilities.

Summary:
Three aluminum stiffeners were attached to 5' x 8' (1.5m x 2.4m) aluminum panels with different attachment methods – three panels with different VHB tapes and one with stitch welding. Figures 1-6 (pages 3-4) depict each specific attachment. Each panel was subjected to a sequence of rigorous test including thermal cycling, wind load structural, hurricane impact, and hurricane pressure cycling. Three different 3M™ VHB™ Tapes were tested:

Acrylic Foam Tape	Thickness	Description
3M™ VHB™ Tape 4956 or G16F	0.062" (1.6 mm)	Trusted bonding solution used in architectural panel bonding for many years
3M™ VHB™ Tape GPH-160GF	0.062" (1.6 mm)	Greatest temperature resistance (450°F or 230°C) in VHB portfolio and can withstand powder coating or liquid paint bake cycle processes
3M™ VHB™ Tape 4991B	0.090" (2.3 mm)	Thicker tape used on larger rigid panels like plate aluminum or stainless steel

All panels passed the rigorous testing sequence, showing that 3M™ VHB™ Tapes can provide excellent performance in stiffener attachment applications. The panels passed both positive and negative wind load structural tests up to 120 psf (5.7 kPa), which corresponds to a sustained wind speed of 220 mph (350 kph). For the hurricane impact tests, 96" (2.4 m) missiles were launched at panels between 15-16 m/s velocity and the stiffeners attached with 3M™ VHB™ Tape remained bonded. Hurricane pressure cycling tests at a design pressure up to 80 psf (3.8 kPa) were also passed.

Stiffeners are designed to add rigidity to panel constructions and limit panel deflection. Therefore, panel deflection distance was measured in two locations: the center of the middle stiffener and mid-panel between stiffeners. The construction industry typically looks for stiffeners to pass a "L/60" criterion – meaning that it is desirable for the deflection distance to be less than the long-edge length of the panel divided by 60. Table 1 below summarizes test results of each attachment method.

Test	Test Method	3M™ VHB™ Tape 4956 (G16F)	3M™ VHB™ Tape GPH-160GF	3M™ VHB™ Tape 4991B	Stitch Welding
Thermal Cycling	Fourteen 12-hour cycles: -33 °F to 180 °F (-36 °C to 82 °C)	No loss of adhesion			No weld failure
Wind Load Structural 21°C (70°F)	ASTM E330 (maximum pressure)	>120 psf (5.7 kPa)			
L/60 Deflection Criterion	Deflection <1.6" (maximum pressure)	80 psf (3.8 kPa)	80 psf (3.8 kPa)	40 psf (1.9 kPa)	40 psf (1.9 kPa)
Hurricane Impact	ASTM E1996-14a	Negligible loss of adhesion			No weld failure
Hurricane Pressure Cycling	ASTM E1886-13a (design pressure)	80 psf (3.8 kPa)			

Table 1: Third-party ASTM Results

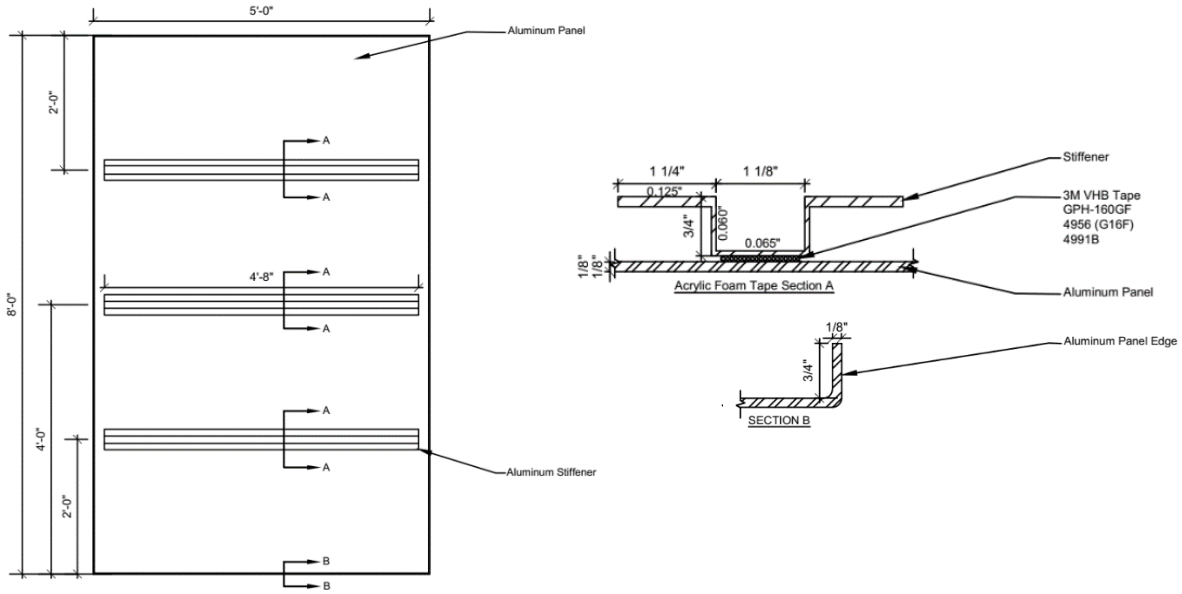
Conclusion:
After 4 different ASTM tests run sequentially, each set of panels and attachment likely saw greater stresses in a condensed time period than many real applications will see in their lifetime. None of the stiffeners failed when subjected to pressures equivalent of 220 mph (355 km/h) sustained wind speeds, and there was only one failure during missile impact testing. The entire application process, labor, cost and aesthetics should be assessed alongside the stiffener performance to determine an appropriate stiffener attachment method. Acrylic foam tapes offer the greatest process flexibility through ease of use and immediate handling strength and have the most aesthetically pleasing result, whereas welding has a more complicated or less efficient process but provides the greatest shear strength performance when needed for an application.

From a panel deflection viewpoint, the two thinnest acrylic foam tapes (3M™ VHB™ Tape G16F and 3M™ VHB™ Tape GPH-160GF) outperformed all the other attachment methods by passing the L/60 criterion up to 80 psf (3.8 kPa) while the welding only passed up to 40 psf (1.9 kPa).

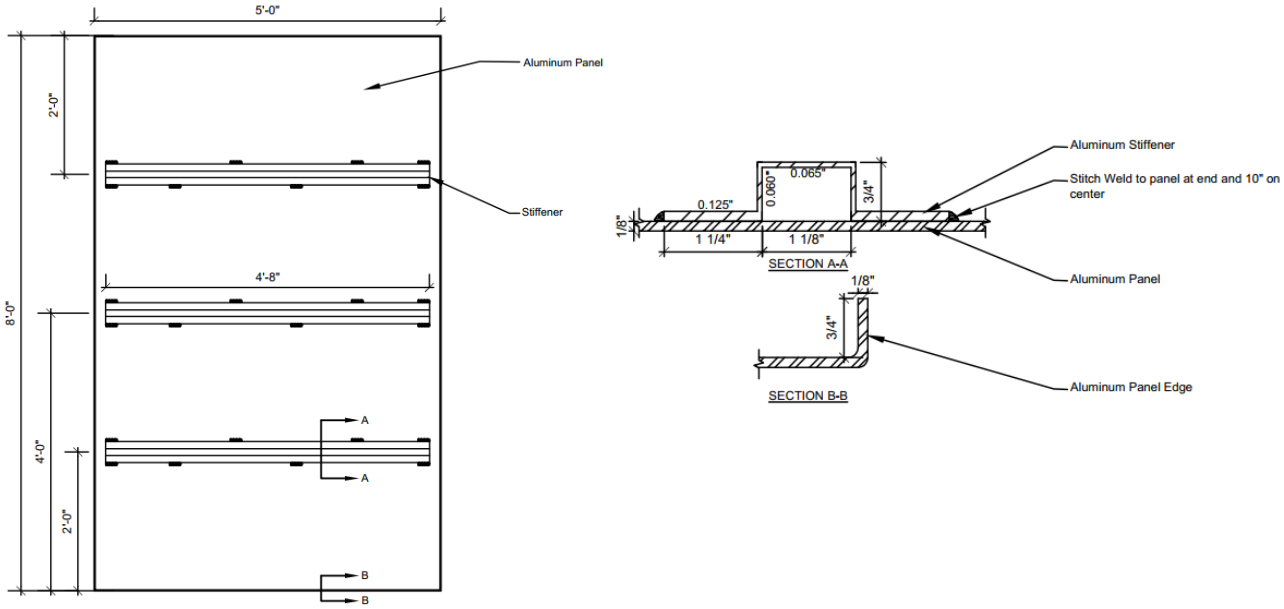
Table 2 offers a simplified summaries of the testing and process information.

Attachment Method	Load	Impact	Process	Shear Strength	Aesthetics
Stitch Welding	Passed all tests. Passed L/60 deflection criterion at 40 loading	Passed missile impact test. No failures	Minimal surface preparation. Requires skilled labor to apply.	1000+ psi when correctly applied	Least Attractive, requires refinishing for smooth appearance
Acrylic Foam Tape	Passed all tests. 1/16" (1.6 mm) calipers passed L/60 deflection criterion up to 80 psf loading. 0.090" (2.3 mm) caliper passed up to 40 psf.	Passed missile impact test. Minimal cohesive failure at bottom stiffener ends closest to corner impact.	Medium surface preparation. Easy, fast application. Immediate handling strength	65+ psi ultimate dynamic strength.	Smoothest look

Table 2: Results Comparison Table



Figures 1-6: Bonded Panel Dimensions and Stiffener Attachment Methods



Figures 6-8: Welded Panel Dimensions and Stiffener Attachment Method

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