



Structural Performance Tests of VHB™ Tapes in Architectural Metal Panels

Technical Bulletin

May, 2007

Introduction

3M™ VHB™ Tapes have been used worldwide in a variety of applications in the construction industry. To further support their consideration for such applications, performance tests were done at Construction Research Laboratory (Miami, FL) to evaluate 3M™ VHB™ Tapes under stresses and environmental conditions that architectural metal panels would typically experience either as exterior building cladding or in curtain walls.

Summary

Architectural metal panels assembled using three different 3M™ VHB™ Tapes underwent several sequences of construction tests to demonstrate their high performance in these applications. The tests included thermal cycling, air leakage, water penetration, wind load structural, wind load structural at non-ambient temperatures, hurricane impact, and hurricane pressure cycling.

The panels constructed with 3M™ VHB™ Tapes provided excellent performance overall. They passed wind load structural tests up to 120 psf, which corresponds to a sustained wind speed of 220 mph (350 kph); wind load structural tests at cold and hot temperatures up to 60 psf, corresponding to a wind speed of 155 mph (250 kph); and hurricane impact and pressure cycling tests with a building design pressure of up to 60 psf. They also demonstrated that no air or water leakage can be obtained with proper assembly methods.

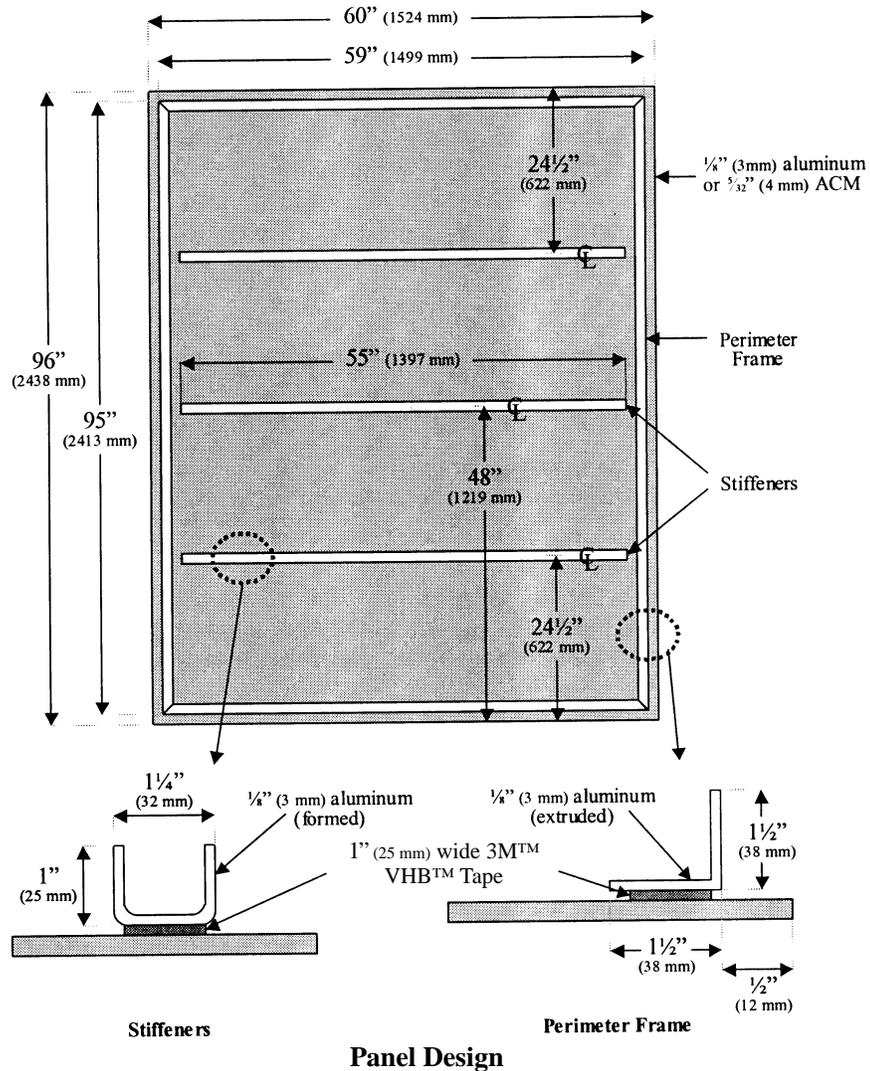
The following table briefly summarizes the results of the construction tests. See the descriptions of the three test sequences and the complete Construction Research Laboratory test report sections for more detailed information.

| Test | Test Method | 3M™ VHB™ Tape Panel 4955 | 3M™ VHB™ Tape Panel 4956 | 3M™ VHB™ Tape Panel 5962 |
|--|---|-----------------------------|--------------------------|--------------------------|
| Thermal Cycling | 20 cycles -20°F to 180°F (-29°C to 82°C) | No loss of adhesion | | |
| Air Leakage | ASTM E283 | No leakage | | |
| Water Penetration | ASTM E331 | Small leak in one corner | No leakage through tape | No leakage through tape |
| Wind Load Structural at 90°F (32°C) | ASTM E330 (maximum pressure) | 90 psf (4.3 kPa) | > 120 psf (5.7 kPa) | 60 psf (2.9 kPa) |
| Wind Load Structural at -20°F, 90°F, 150°F (-29°C, 23°C, 66°C) | ASTM E330 (maximum pressure) | > 60 psf (2.9 kPa) | > 60 psf (2.9 kPa) | 40 psf (1.9 kPa) |
| Hurricane Impact | ASTM E1996 (Wind Zone 4) | Negligible loss of adhesion | | |
| Hurricane Pressure Cycling | ASTM E1886 + PA 203 (design pressure) | > 60 psf (2.9 kPa) | > 60 psf (2.9 kPa) | 40 psf (1.9 kPa) |

Structural Performance Tests of 3M™ VHB™ Tapes in Architectural Metal Panels

Panels

The panels submitted for the construction tests were built at a leading manufacturer of architectural metal wall panel systems using designs, assembly procedures, and factory conditions typical of the construction industry. The panels measured 5' x 8' (1524 mm x 2438 mm) and were made of either aluminum sheet or aluminum composite material (ACM). An extruded aluminum perimeter frame and three aluminum stiffeners were attached to the backside of each panel using only 3M™ VHB™ Tape. No mechanical fasteners, liquid adhesives, or any other bonding material were used in the assembly of these architectural panels.



Tapes

There are over 30 products in the entire 3M™ VHB™ Tape product family, each having specific features to meet the broad range of industrial requirements. The specific tapes used here were chosen to represent the three 3M™ VHB™ Tape series that have demonstrated themselves to be generally suitable for applications in the construction industry:

- 3M™ VHB™ Tape 4955 (4950 series)**
- 3M™ VHB™ Tape 4956 (4941 series)**
- 3M™ VHB™ Tape 5962 (5952 series)**

Structural Performance Tests of 3M™ VHB™ Tapes in Architectural Metal Panels

| | |
|-----------------------------|---|
| Testing | The panels were subjected to three different test sequences to evaluate their performance and summaries of the test methods, observations, and official results are provided on the following pages. While architectural metal panels can incorporate many different designs and materials, the testing of these “typical” panels should demonstrate the high performance level of 3M™ VHB™ Tapes in these demanding applications. The user should always conduct their own evaluation to determine if 3M™ VHB™ Tapes will meet all of the requirements of a given construction application. |
| Test Sequence 1 | This test sequence consisted of measuring the air leakage, water penetration, and wind load structural performance of a set of architectural panels built with 3M™ VHB™ Tapes that had experienced thermal cycling. |
| Thermal Aging | A set of three panels, with each panel assembled using a different 3M™ VHB™ Tape, was given 20 thermal cycles between -20°F and 180°F (-29°C and 82°C) actual panel temperature, with the temperature extremes held for a minimum of 15 minutes. The cycles subjected 3M™ VHB™ Tapes to thermal aging and stresses due to thermal expansion and contraction of the bonded parts and they retained complete contact throughout the thermal cycles, with no loss of adhesion. |
| Air Leakage | The air infiltration test was conducted in accordance with ASTM E283 “Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen” with a static pressure of 6.24 psf (0.3 kPa), corresponding to a 50 mph (80 kph) wind. There was no measurable air leakage through the 3M™ VHB™ Tapes bonding the frames around the perimeter of the panels. |
| Water Penetration | The water penetration test was performed in accordance with ASTM E331 “Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference” with a high pressure water spray under a static pressure of 15 psf (0.7 kPa) for 15 minutes. The panels assembled with 3M™ VHB™ Tapes 4956 and 5962 had no water leakage through the tape, while the panel built with 3M™ VHB™ Tape 4955 had only a small amount of leakage near the tape seam in one corner of the panel. 3M™ VHB™ Tapes, together with proper assembly procedures and perhaps a small amount of silicone sealant in the corner seams, should provide a seal against any water leakage in applications that require perfect sealing around the perimeter frame. |
| Wind Load Structural | The wind load structural test was performed in accordance with ASTM E330 “Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference”, with loads increasing incrementally up to a maximum of 120 psf (5.7 kPa). The panels were subjected to both positive wind loads (inward acting – the most severe direction for stiffener attachment) and negative wind loads (outward acting – the most severe direction for frame attachment). The panels were first subjected to loads of 10, 20, 40, and 60 psf (0.5, 1.0, 1.9 and 2.9 kPa) in each direction with the peak pressure held for 1 minute. The 60 psf (2.9 kPa) level represents the design pressure for a typical high-rise building or a sustained wind speed of 155 mph (250 kph). The panels were visually inspected after the loads, with the stiffeners and frames on all three panels still completely attached. The panels were then given loads of 90 and 120 psf (4.3 and 5.7 kPa) in each direction with the maximum pressure held for 10 seconds. The 120 psf (5.7 kPa) level is equal to a sustained wind speed of 220 mph (355 kph) or about twice the design pressure of a typical high-rise building. The panels were again inspected following the test. All stiffeners attached with 3M™ VHB™ Tapes 4955 and 4956 remained complete attached, and those bonded with 3M™ VHB™ Tape 5962 were still functioning with just a small amount of cohesive failure at the ends of the stiffeners. The frames attached with 3M™ VHB™ Tapes 4956 and 5962 were still entirely attached, while the panel bonded with 3M™ VHB™ Tape 4955 had a small separation of panel from frame only after experiencing the very high -120 psf (-5.7 kPa) pressure level for about 6 seconds. The 3M™ VHB™ Tapes showed excellent performance here, despite the panels and stiffeners themselves showing permanent deformation after being subjected to these simulated high winds. |

Structural Performance Tests of 3M™ VHB™ Tapes in Architectural Metal Panels

Test Sequence 2 This test sequence consisted of measuring the wind load structural performance of a set of architectural panels built with 3M™ VHB™ Tapes at ambient, cold, and hot test temperatures.

The wind load structural tests was performed in accordance with ASTM E330, with the panels subjected to loads of 20, 40, and 60 psf (1.0, 1.9, and 2.9 kPa) in both directions. This test was repeated three times with ambient (90°F, 32°C), cold (-20°F, -29°C), and hot (150°F, 66°C) outside air temperatures on the exterior faces of the panels. These were the most extreme temperatures achievable with the equipment in this test configuration. The panels were visually inspected after the loads were applied at all three temperatures. All stiffeners attached with 3M™ VHB™ Tapes 4955 and 4956 remained completely attached at the 60 psf level, corresponding to a wind speed of 155 mph (250 kph). The stiffeners bonded with 3M™ VHB™ Tape 5962 were also functioning after the 60 psf pressures, with just a small amount of cohesive failure at the ends of the stiffeners. Finally, all three 3M™ VHB™ Tapes maintained complete contact between the panel and perimeter frame throughout the entire test sequence. 3M™ VHB™ Tapes again provided excellent performance despite the panels and stiffeners undergoing high deflections during the test and exerting high stresses on the tapes at the cold, ambient, and hot test temperatures.

Test Sequence 3 This test sequence consisted of determining the ability of set of architectural panels built with 3M™ VHB™ Tapes to survive the pressure cycling and impact from flying debris that could occur during a hurricane or other high wind event.

Hurricane Impact The hurricane impact tests were conducted in accordance with ASTM E1996 “Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes”, using the most severe wind zone classification for non-essential buildings (Wind Zone 4). This category specifies two impact locations (center and one corner) per panel using a 9 lb (4.1 kg) lumber projectile with an impact speed of 50 ft/sec (15.2 m/sec). The impacts in the middle of the three panels all resulted in permanent damage to the panel and center stiffener. However, all three 3M™ VHB™ Tapes kept complete contact along the length of the stiffeners and had no loss of adhesion, with the foams expanding to take up the gaps caused by the dented panels and stiffeners. The impacts in the corner of the three panels all resulted in heavy damage to the architectural panels at those locations. Again, the 3M™ VHB™ Tapes kept the panels attached to the frame, with only acceptably small gaps appearing in the damaged corners.

Hurricane Pressure Cycling The hurricane pressure cycling tests were conducted in accordance with ASTM E1886 “Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials”. The same set of panels that had undergone the impact testing was first subjected to the pressure cycling sequence given in Dade County Specification PA-203 using a typical low-rise building design pressure of 40 psf (1.9 kPa), which results in a total of 1,342 pressure cycles on the panels. The panels were visually inspected upon completion of the pressure cycles, which indicated that all stiffeners still had full contact with no separation or loss of performance. The pressure cycling sequence was then repeated on the same set of panels, except using a typical high-rise building design pressure of 60 psf (2.9 kPa), which resulted in another 1,342 pressure cycles on the panels. Inspection after completion of the second cycling sequence indicated that the panels made using 3M™ VHB™ Tapes 4955 and 4956 were still complete attached. The 3M™ VHB™ Tapes demonstrated excellent performance throughout these demanding hurricane-related tests.

Construction Research Laboratory Report Refer to the following pages.

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7600 N. W. 79th AVENUE • MIAMI, FLORIDA • 33166
September 22, 2003

(305) 592-9222 • FAX (305) 594-9148

Dates Tested: July 23 through August 12, 2003

Test No. 6902 - 3M^(TM) VHB^(TM) Acrylic Foam Tape Tests

Client: 3M

Description of Test Specimens

Panel Types

Panel 4955

Tape: 80 mil thick VHB Tape 4955
Panel: 1/8" thick aluminum sheet
Surface prep: Light abrade + IPA/water wipe (all substrates)

Panel 4956

Tape: 62 mil thick VHB Tape 4956
Panel: 4 mm thick aluminum composite panel (ACM) Reynobond
Surface prep: Light abrade + IPA/water wipe (all substrates)

Panel 5962

Tape: 62 mil thick VHB Tape 5962
Panel: 4 mm thick aluminum composite panel (ACM) Reynobond
Surface prep: IPA/water wipe (all substrates)

Panel Construction

All panels were made using the same dimensions:

Panel size: 60" x 96" (5' x 8')
Frame size: 59" x 95"
Frame: 1 1/2" x 1 1/2" L-shaped 1/8" thick extruded aluminum
Stiffeners: 1 1/4" wide x 1" high U-shaped 1/8" thick bent/formed aluminum

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Witnessed by: Messrs. Tony Kremer - 3M
(for all or
partial testing)

A. A. Sakhnovsky) - Construction Research
Richard Sembello) Laboratory
John Ely)
Robert Vilan)

Manner of Testing

The specimen (consisting of one each of the three different panel types) was installed in a strong test chamber with anchorage designed to simulate job conditions. The specimen was tested for static pressure air and water infiltration, and static pressure structural performance in substantial accordance with the test procedures described in the referenced ASTM standards. The specimen was also subjected to thermal cycling where noted.

All observations are referenced to viewing the specimen from the exterior. Where elements are identified by number, they have been numbered from left to right starting with the bottom left element as 1.

In the structural deflection data, the second number of the data pair is the dial indicator reading taken after removal of the test load. The dial indicators were set to zero before each test load.

Neither tape nor film were used to seal against air leakage during structural testing.

The order of testing was as follows:

Test Conditions and Results

Three sets of three panels each were subjected to the tests as follows:

TEST SEQUENCE NO. 1

Thermal cycling

Static pressure air infiltration (ASTM E283)

Static pressure water infiltration (ASTM E331)

Static pressure structural loads (ASTM E330)

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Test I-Thermal Cycling

Manner of Testing

The specimen was installed in one side of an enclosed test chamber. The interior of the specimen faced to the interior of the chamber. The exterior of the specimen was encased by a separate, insulated test chamber containing 250-watt infra-red heat lamps located 24" OC horizontally and vertically in a grid pattern for heating and mechanical refrigeration plus direct liquid nitrogen evaporation for cooling. The exterior of the specimen was subjected to twenty temperature cycles with each cycle consisting of:

Nominal -20°F panel surface temperature for 15 minutes

Nominal 180°F panel surface temperature for 15 minutes

Test II-Air Infiltration by Static Pressure (ASTM E283)

The total air infiltration through the specimen at a static pressure of 6.24 psf (equal to a 50 MPH wind) was as follows:

Results: No measurable air infiltration occurred.

Extraneous leakage was determined by covering the specimen in accordance with ASTM E283.

Test III-Water Infiltration by Static Pressure (ASTM E331)

The specimen was subjected to water spray at the rate of five gallons per hour per square foot and static pressure as follows:

15 psf for 15 minutes

Results:

Panel 4955

Water leakage occurred at a sill frame corner at the top.

Panel 4956

No water leakage occurred.

Panel 5962

Water leakage occurred at a frame corner intersection.

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Test IV-Structural Performance by Static Pressure (ASTM E330)

The specimen was subjected to the following structural loads each held for one minute or as noted:

- 10 psf
- + 10 psf
- 20 psf
- + 20 psf
- 40 psf
- + 40 psf
- 60 psf
- + 60 psf
- 90 psf - 10 seconds.
- + 90 psf - 10 seconds.
- 120 psf - 10 seconds.
- +120 psf - 10 seconds.

No damage nor failures were evident.

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Deflections, in inches, were as follows:

| Member | Deflection Measured | | | | | | | | | | | |
|-------------------------------|-----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-------|--|
| | -10 psf | +10 psf | -20 psf | +20 psf | -40 psf | +40 psf | -60 psf | +60 psf | -90 psf | +90 psf | | |
| Panel relative to structure @ | | | | | | | | | | | | |
| 1 | near left edge | .045 | .045 | .085 | .080 | .150 | .140 | .220 | .180 | .285 | .240 | |
| | | 0 | 0 | .005 | .005 | .010 | .010 | .015 | .010 | .030 | .030 | |
| 1A | near left end of stiffener | .095 | .100 | .160 | .195 | .290 | .390 | .400 | .530 | .500 | .760 | |
| | | 0 | 0 | 0 | .005 | .010 | .010 | .030 | .030 | .050 | .060 | |
| 2 | midspan of stiffener | .465 | .495 | .845 | .890 | - | 1.570 | - | 2.080 | - | 2.680 | |
| | | 0 | .005 | 0 | .020 | - | .120 | - | .285 | - | .530 | |
| 3 | midspan above stiffener | .465 | .500 | .840 | .885 | - | 1.580 | - | 2.090 | - | 2.740 | |
| | | 0 | .005 | .015 | .010 | - | .120 | - | .280 | - | .565 | |
| 4 | near right edge | .045 | .035 | .080 | .075 | .145 | .135 | .210 | .180 | .255 | .230 | |
| | | 0 | .010 | 0 | 0 | .010 | .010 | .015 | .015 | .020 | .025 | |
| 4A | near right end of stiffener | .090 | .095 | .170 | .190 | .290 | .380 | .400 | .520 | .550 | .730 | |
| | | 0 | 0 | .005 | .010 | .015 | .020 | .030 | .035 | .060 | .060 | |
| 5 | near left edge | .045 | .055 | .080 | .095 | .155 | .160 | .220 | .200 | .280 | .250 | |
| | | 0 | 0 | 0 | 0 | .005 | .005 | .010 | .010 | .020 | .020 | |
| 5A | near left end of stiffener | .095 | .110 | .170 | .215 | .290 | .420 | .395 | .510 | .490 | .705 | |
| | | 0 | 0 | .010 | .005 | .010 | .010 | .020 | .005 | .040 | .040 | |
| 6 | midspan of stiffener | .500 | .520 | .890 | .875 | - | 1.610 | - | 2.030 | - | 2.700 | |
| | | .005 | .005 | .020 | -.005 | - | .130 | - | .280 | - | .535 | |
| 7 | midspan above stiffener | .490 | .515 | .895 | .910 | - | 1.605 | - | 2.020 | - | 2.690 | |
| | | 0 | .010 | .025 | .020 | - | .120 | - | .280 | - | .540 | |

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| Member | Deflection Measured | | | | | | | | | | | |
|--------|---------------------------------------|--------------|------------|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|--|
| | -10 psf | +10 psf | -20 psf | +20 psf | -40 psf | +40 psf | -60 psf | +60 psf | -90 psf | +90 psf | | |
| 8 | near right edge | .045 0 | .060 0 | .080 0 | .100 0 | .145 0 | .170 -.010 | .200 0 | .190 -.005 | .250 .005 | .250 .005 | |
| 8A | near right end of stiffener | .125 .005 | .130 0 | .210 .005 | .270 .010 | .370 .015 | .530 .005 | .480 .020 | .550 .020 | .605 .040 | .875 .035 | |
| 9 | near left edge | .030 0 | .040 0 | .060 0 | .070 0 | .120 0 | .120 -.010 | .160 -.010 | .135 -.015 | .215 .005 | .185 -.005 | |
| 9A | near left end of stiffener | .060 0 | .060 0 | .115 0 | .120 0 | .210 0 | .240 -.005 | .280 -.010 | .275 -.005 | .380 0 | .410 -.005 | |
| 10 | midspan of stiffener | .350 0 | .365 0 | .630 0 | .620 0 | - - | 1.080 .030 | - - | 1.325 .045 | - - | 1.750 .140 | |
| 11 | midspan above stiffener | .360 0 | .380 0 | .650 0 | .625 0 | - - | 1.070 .010 | - - | 1.340 .060 | - - | 1.750 .130 | |
| 12 | near right edge | .035 0 | .035 0 | .070 0 | .065 0 | .130 0 | .100 0 | .170 0 | .160 .005 | .240 .005 | .200 0 | |
| 12A | near right end of stiffener | .070 0 | .080 0 | .130 0 | .150 0 | .220 0 | .300 .005 | .305 0 | .430 .010 | .400 .020 | .600 .005 | |
| 1X | Center of panel relative to structure | .470 0 | - - | .865 .020 | .875 .020 | 1.450 .090 | - - | 1.900 .215 | - - | 2.535 .440 | - - | |
| 2X | Center of panel relative to structure | .515 .010 | - - | .910 0 | .900 .030 | 1.540 .090 | - - | 1.960 .250 | - - | 2.630 .460 | - - | |
| 3X | Center of panel relative to structure | .370 0 | - - | .670 0 | .620 .015 | 1.160 .035 | - - | 1.450 .080 | - - | 1.980 .150 | - - | |

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After the +90 psf load, the specimen was inspected and a slight permanent deformation occurred at the center stiffeners and tape separation of 1 1/2" occurred at both ends of the center stiffener of Panel 5962.

After six seconds during the -120 psf load, a 6" long permanent panel deformation occurred at the midheight of the right jamb of Panel 4955.

Due to the opening described above, only +115 psf was attained for ten seconds with no other failure.

After the -120 psf and +120 psf load, the specimen was inspected and a 3" long tape separation was measured at each end of the center stiffener of Panel 5962.

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TEST SEQUENCE NO. 2

Static pressure air infiltration (ASTM E283)

Static pressure structural loads (ASTM E330)

Non-ambient temperature structural loads (ASTM E330)

Test I-Air Infiltration by Static Pressure (ASTM E283)

The air infiltration through the specimen at a static pressure of 6.24 psf (equal to a 50 MPH wind) was as follows:

No measurable air infiltration occurred.

Extraneous leakage was determined by covering the specimen in accordance with ASTM E283.

Test II-Structural Performance by Static Pressure (ASTM E330)

The specimen was subjected to the following structural loads each held for one minute:

- + 20 psf
- + 40 psf
- + 60 psf
- 20 psf
- 40 psf
- 60 psf

No damage nor failures were evident.

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Criteria and deflections, in inches, were as follows:

| | <u>Member</u> | <u>Deflection</u> | | | | | |
|-----|---------------------------------------|-------------------|--------------|--------------|--------------|--------------|--------------|
| | | <u>Measured</u> | | | | | |
| | | <u>+20</u> | <u>+40</u> | <u>+60</u> | <u>-20</u> | <u>-40</u> | <u>-60</u> |
| | | <u>psf</u> | <u>psf</u> | <u>psf</u> | <u>psf</u> | <u>psf</u> | <u>psf</u> |
| | Panel relative to structure @ | | | | | | |
| 1 | near left edge | <u>.120</u> | <u>.210</u> | <u>.255</u> | <u>.130</u> | <u>.210</u> | <u>.270</u> |
| | | .010 | .010 | .010 | .010 | .020 | .020 |
| 2 | midspan of stiffener | <u>.920</u> | <u>1.480</u> | <u>1.865</u> | - | - | - |
| | | .025 | .040 | .045 | | | |
| 3 | midspan above stiffener | <u>.915</u> | <u>1.490</u> | <u>1.880</u> | | | |
| | | .030 | .045 | .060 | | | |
| 4 | near right edge | <u>.090</u> | <u>.155</u> | <u>.175</u> | <u>.095</u> | <u>.180</u> | <u>.255</u> |
| | | 0 | 0 | .005 | .010 | .010 | .020 |
| 5 | near left edge | <u>.095</u> | <u>.150</u> | <u>.190</u> | <u>.100</u> | <u>.170</u> | <u>.215</u> |
| | | 0 | .010 | .005 | .015 | .020 | .015 |
| 6 | midspan of stiffener | <u>.910</u> | <u>1.405</u> | <u>1.750</u> | - | - | - |
| | | .025 | .020 | .070 | | | |
| 7 | midspan above stiffener | <u>.910</u> | <u>1.435</u> | <u>1.775</u> | - | - | - |
| | | .025 | .060 | .095 | | | |
| 8 | near right edge | <u>.080</u> | <u>.130</u> | <u>.140</u> | <u>.095</u> | <u>.165</u> | <u>.210</u> |
| | | 0 | .005 | 0 | .010 | .020 | .020 |
| 9 | near left edge | <u>.075</u> | <u>.120</u> | - | <u>.070</u> | <u>.130</u> | <u>.165</u> |
| | | .005 | 0 | | .005 | .010 | .010 |
| 10 | midspan of stiffener | <u>.690</u> | <u>1.080</u> | <u>1.360</u> | - | - | - |
| | | .020 | .020 | .035 | | | |
| 11 | midspan above stiffener | <u>.690</u> | <u>1.130</u> | <u>1.370</u> | | | |
| | | .015 | .030 | .005 | | | |
| 12 | near right edge | <u>.050</u> | <u>.095</u> | <u>.110</u> | <u>.075</u> | <u>.135</u> | <u>.175</u> |
| | | .005 | 0 | 0 | .005 | .010 | .010 |
| 3X | Center of panel relative to structure | - | - | - | <u>1.070</u> | <u>1.620</u> | <u>2.000</u> |
| | | | | | .115 | .120 | .140 |
| 7X | Center of panel relative to structure | - | - | - | <u>1.055</u> | <u>1.630</u> | <u>1.980</u> |
| | | | | | .115 | .150 | .120 |
| 11X | Center of panel relative to structure | - | - | - | <u>.775</u> | <u>1.230</u> | <u>1.550</u> |
| | | | | | .050 | .060 | .055 |

REPORTS PERTAIN TO THE SAMPLE TESTED ONLY. INFORMATION CONTAINED REPRODUCED BY 3M WITH PERMISSION.

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Test III-Structural Performance by Static Pressure (ASTM E330) at Non-Ambient Temperature

The specimen was subjected to the following structural loads each held for one minute. Deflections were measured at significant locations during all positive loads.

Low Temperature with the exterior air temperature at -20°F

+ 20 psf

+ 40 psf

+ 60 psf

- 20 psf

- 40 psf

- 60 psf

High Temperature with the exterior panel temperature at 150°F

+ 20 psf

+ 40 psf

+ 60 psf

- 20 psf

- 40 psf

- 60 psf

Results

No damage nor failures were evident.

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Criteria and deflections, in inches, were as follows:

| | <u>Member</u> | <u>Deflection</u> | | |
|----|-------------------------------|---------------------------------------|------------------------|-----------------------|
| | | <u>Measured-Low Temperature Cycle</u> | | |
| | | <u>+20</u> | <u>+40</u> | <u>+60</u> |
| | | <u>psf</u> | <u>psf</u> | <u>psf</u> |
| | Panel relative to structure @ | | | |
| 1 | near left edge | <u>.015</u> - .040 | <u>.020</u> - .020 | <u>.075</u> - .040 |
| 2 | midspan of stiffener | <u>.930</u> .100 | <u>1.370</u> - .020 | <u>1.650</u> .040 |
| 3 | midspan above stiffener | <u>.930</u> .100 | <u>1.370</u> .090 | <u>1.570</u> .015 |
| 4 | near right edge | <u>.085</u> .005 | <u>.120</u> 0 | <u>.150</u> 0 |
| 5 | near left edge | <u>.095</u> .015 | <u>.130</u> .010 | <u>.165</u> .010 |
| 6 | midspan of stiffener | <u>.910</u> .110 | <u>1.335</u> .110 | <u>1.650</u> .110 |
| 7 | midspan above stiffener | <u>.915</u> .105 | <u>1.375</u> .120 | <u>1.605</u> .090 |
| 8 | near right edge | <u>.100</u> .010 | <u>.170</u> .010 | <u>.240</u> .015 |
| 9 | near left edge | - | - | - |
| 10 | midspan of stiffener | <u>.670</u> .040 | <u>1.010</u> .030 | <u>1.300</u> .110 |
| 11 | midspan above stiffener | <u>.660</u> .030 | <u>1.005</u> .040 | <u>1.320</u> .115 |
| 12 | near right edge | <u>.040</u> 0 | <u>.055</u> - .010 | <u>.075</u> - .010 |

REPORTS PERTAIN TO THE SAMPLE TESTED ONLY. INFORMATION CONTAINED REPRODUCED BY 3M WITH PERMISSION.

CONSTRUCTION RESEARCH LABORATORY, INC.

7600 N. W. 79th AVENUE • MIAMI, FLORIDA • 33166

(305) 592-9222 • FAX (305) 594-9148

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Criteria and deflections, in inches, were as follows:

| <u>Member</u> | <u>Deflection</u> | | | |
|-------------------------------|--|---------------------|----------------------|-----------------------|
| | <u>Measured - High Temperature Cycle</u> | | | |
| | <u>+20</u> | <u>+40</u> | <u>+60</u> | |
| | <u>psf</u> | <u>psf</u> | <u>psf</u> | |
| Panel relative to structure @ | | | | |
| 1 | near left edge | <u>.140</u> .015 | <u>.230</u> .015 | <u>.275</u> -.020 |
| 2 | midspan of stiffener | <u>1.0+</u> .110 | <u>1.735</u> .090 | <u>2.060</u> -.050 |
| 3 | midspan above stiffener | <u>1.0+</u> .110 | <u>1.765</u> .070 | <u>2.090</u> -.050 |
| 4 | near right edge | <u>.100</u> 0 | <u>.150</u> 0 | <u>.155</u> -.010 |
| 5 | near left edge | <u>.110</u> .010 | <u>.165</u> .010 | <u>.195</u> 0 |
| 6 | midspan of stiffener | <u>1.0+</u> .080 | <u>1.625</u> .080 | <u>1.970</u> .020 |
| 7 | midspan above stiffener | <u>1.0+</u> .080 | <u>1.630</u> .075 | <u>1.970</u> 0 |
| 8 | near right edge | <u>.110</u> .005 | <u>.175</u> .010 | <u>.200</u> 0 |
| 9 | near left edge | <u>.085</u> .005 | <u>.135</u> .005 | <u>.165</u> 0 |
| 10 | midspan of stiffener | <u>.820</u> .075 | <u>1.815</u> .080 | <u>2.280</u> .005 |
| 11 | midspan above stiffener | <u>.820</u> .075 | <u>1.900</u> .070 | <u>2.0+</u> .015 |
| 12 | near right edge | <u>.055</u> .010 | <u>.080</u> .005 | <u>.105</u> 0 |

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TEST SEQUENCE NO. 3

Large missile impact (ASTM E1996)

Cycled pressure (ASTM E1886)

Test I-Large missile impact (ASTM E1996)

Each panel was impacted at the center and near the bottom right corner with a 9 lb. Southern Pine 2 x 4 traveling at 50 fps.

Results

No unacceptable damage nor failures of tape adhesion was evident. There was penetration of the missile to the roomside of the specimen at the bottom right corner of Panel 4956. There was no pullout, loosening, nor other damage of any tape evident.

* * * * *
The hole in Panel 4956 was sealed.
* * * * *

Test II-Cycled pressure (ASTM E1886)

Each panel was subjected to cycled static pressure structural loads with each cycle being one to three seconds in duration, as follows:

POSITIVE LOADS

600 cycles @ 0 to 20 psf

70 cycles @ 0 to 24 psf

1 cycle @ 0 to 52 psf

NEGATIVE LOADS

600 cycles @ 0 to 20 psf

70 cycles @ 0 to 24 psf

1 cycle @ 0 to 52 psf

Results

The specimen was subjected to static pressure loads of -10 psf and +10 psf and inspected for tape separation.

No damage nor failures were evident.

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Each panel was additionally subjected to cycled static pressure structural loads with each cycle being one to three seconds in duration, as follows:

POSITIVE LOADS

600 cycles @ 0 to 30 psf

70 cycles @ 0 to 36 psf

1 cycle @ 0 to 78 psf

NEGATIVE LOADS

600 cycles @ 0 to 30 psf

70 cycles @ 0 to 36 psf

1 cycles @ 0 to 78 psf

Results

The specimen was subjected to static pressure loads of -15 psf and +15 psf and inspected for tape separation.

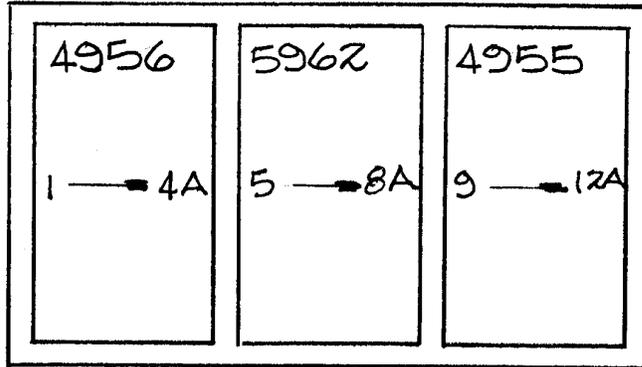
At +15 psf, a 6" long tape separation was observed at the right side of the three stiffeners of Panel 5962.

Respectfully submitted,
CONSTRUCTION RESEARCH LABORATORY, INC.

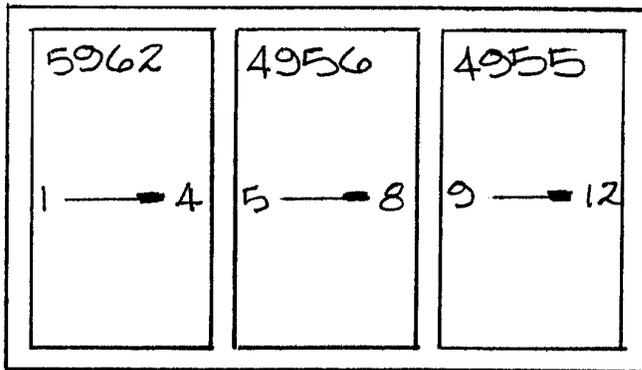


A. A. Sakhnovsky
AAS/pc

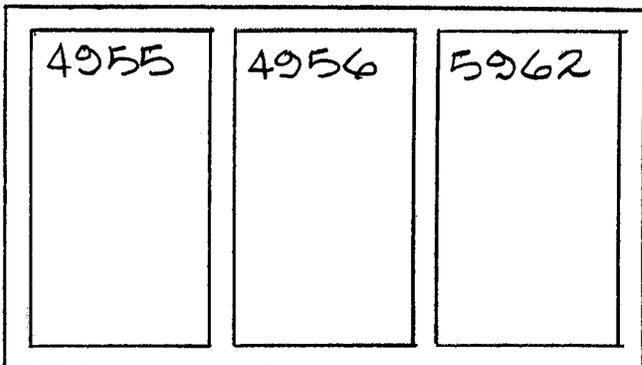
TEST
SEQUENCE
NO. 1



TEST
SEQUENCE
NO. 2



TEST
SEQUENCE
NO. 3



Structural Performance Tests of 3M™ VHB™ Tapes in Architectural Metal Panels

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Limited Warranty

3M warrants for 24 months from the date of manufacture that 3M™ VHB™ Tape will be free of defects in material and manufacture. 3M MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. This limited warranty does not cover damage resulting from the use or inability to use 3M™ VHB™ Tape due to misuse, workmanship in application, or application or storage not in accordance with 3M recommended procedures. AN APPLICATION WARRANTY EXPRESSLY APPROVED AND ISSUED BY 3M IS AN EXCEPTION. THE CUSTOMER MUST APPLY FOR A SPECIFIC APPLICATION WARRANTY AND MEET ALL WARRANTY AND PROCESS REQUIREMENTS TO OBTAIN AN APPLICATION WARRANTY. CONTACT 3M FOR MORE INFORMATION ON APPLICATION WARRANTY TERMS AND CONDITIONS.

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ISO 9001:2000

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Industrial Business Industrial Adhesives and Tapes Division

3M Center, Building 21-1W-10, 900 Bush Avenue
St. Paul, MN 55144-1000
800-362-3550 • 877-369-2923 (fax)
www.3M.com/industrial



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