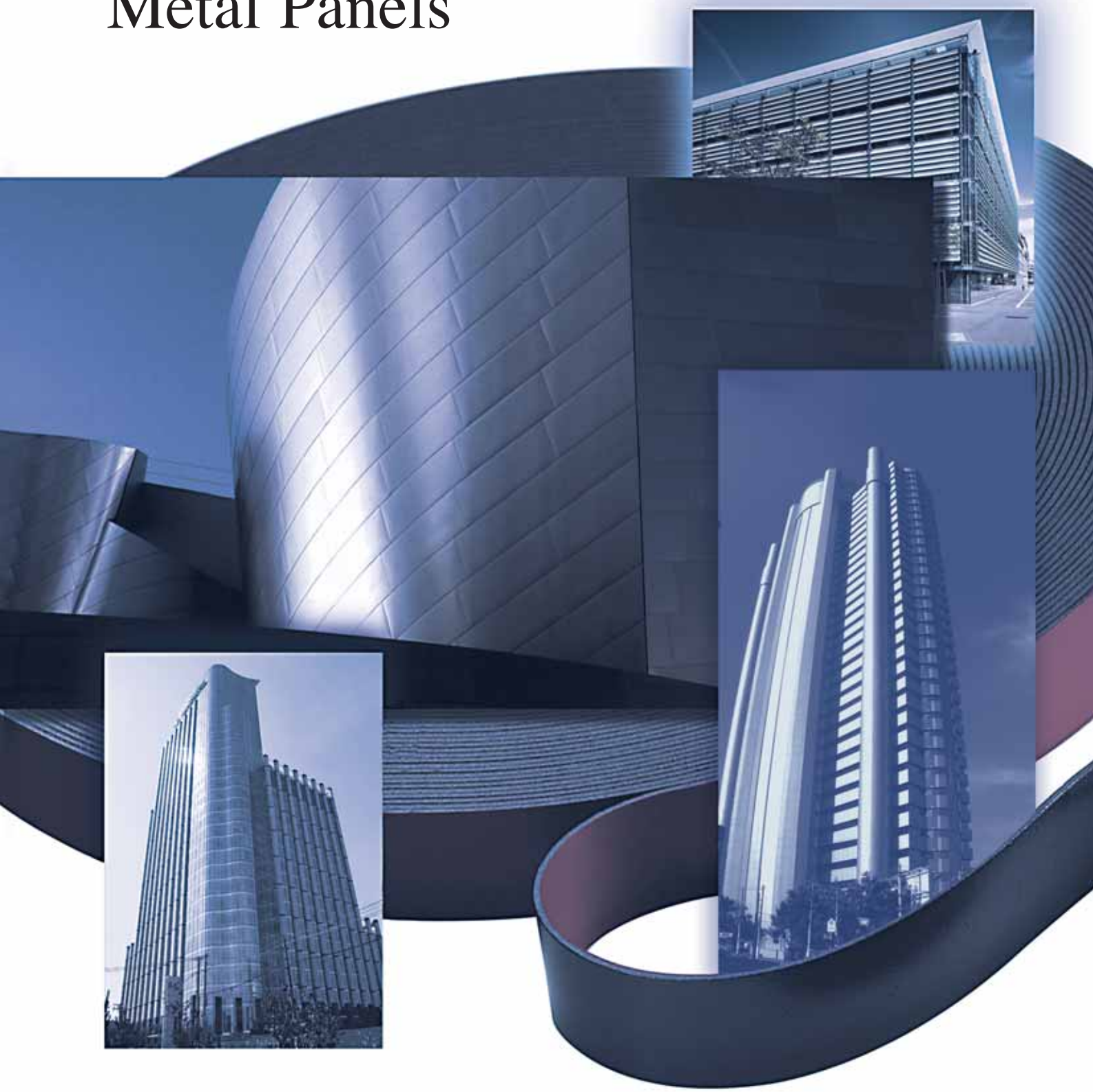
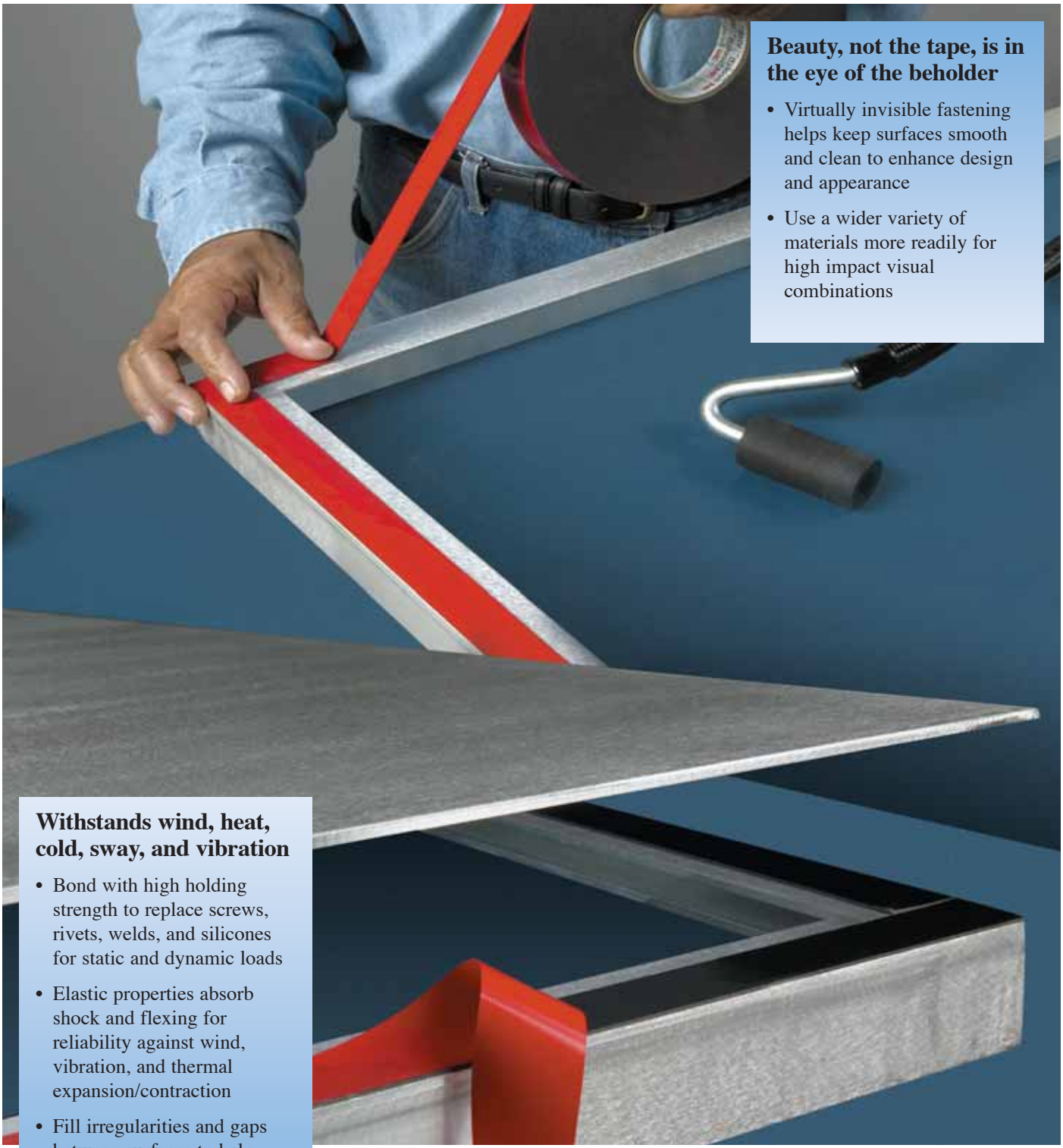
Design Guide for Architectural Metal Panels



Build fast to last

3M™ VHB™ Tapes...proven worldwide for greater productivity, design



Beauty, not the tape, is in the eye of the beholder

- Virtually invisible fastening helps keep surfaces smooth and clean to enhance design and appearance
- Use a wider variety of materials more readily for high impact visual combinations

Withstands wind, heat, cold, sway, and vibration

- Bond with high holding strength to replace screws, rivets, welds, and silicones for static and dynamic loads
- Elastic properties absorb shock and flexing for reliability against wind, vibration, and thermal expansion/contraction
- Fill irregularities and gaps between surfaces to help keep out dirt, water, and cleaning chemicals

Bonds panel to aluminum frame

For more than 20 years, engineers worldwide have been specifying 3M™ VHB™ Tapes to permanently bond and seal many surfaces for all the reasons shown here. And in commercial construction from Australia to Brazil, the United States to Switzerland, applications for these double-sided acrylic foam tapes have continued to expand indoors and outdoors for panel to frame bonding and stiffener attachment.

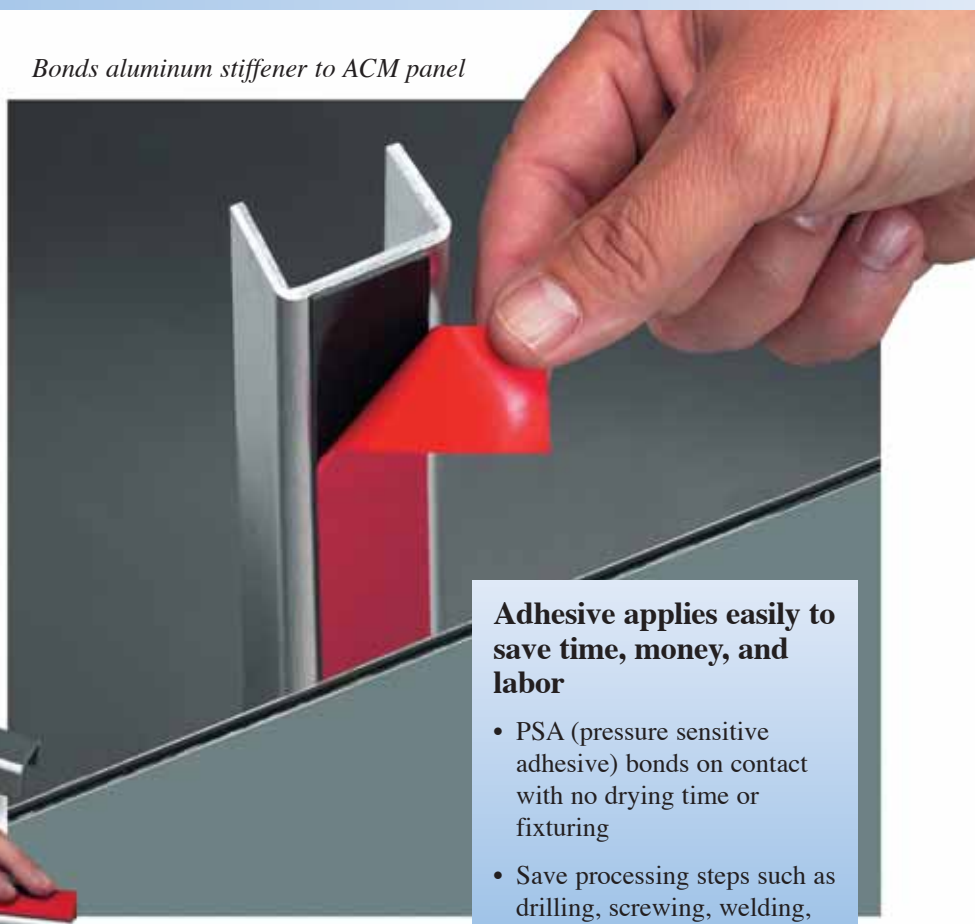
- Cladding
- Column covers
- Curtain wall panels
- Ceiling

flexibility, and reliability

Simply clean...

and apply 3M™ VHB™ Tape

Bonds aluminum stiffener to ACM panel

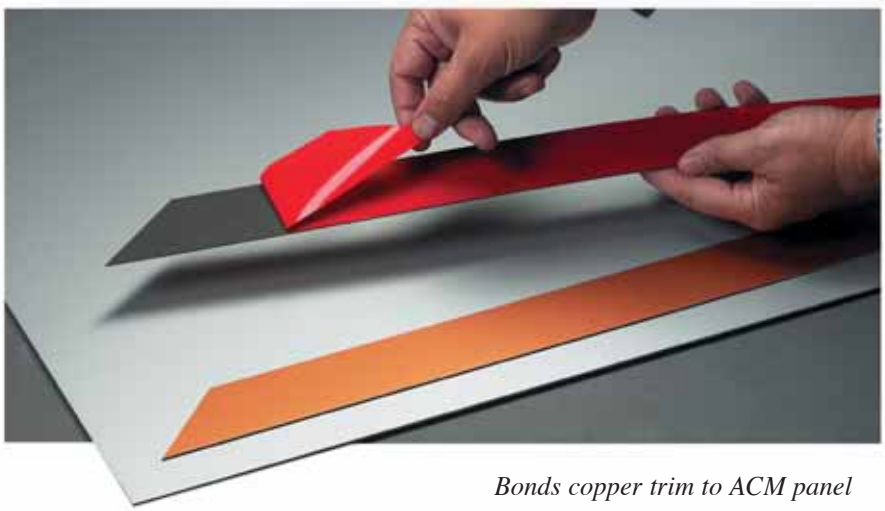


Adhesive applies easily to save time, money, and labor

- PSA (pressure sensitive adhesive) bonds on contact with no drying time or fixturing
- Save processing steps such as drilling, screwing, welding, clean-up, and refinishing
- Easy-to-use; bond metal, glass, and most plastics with minimal surface preparation

Expands the range of design and material options

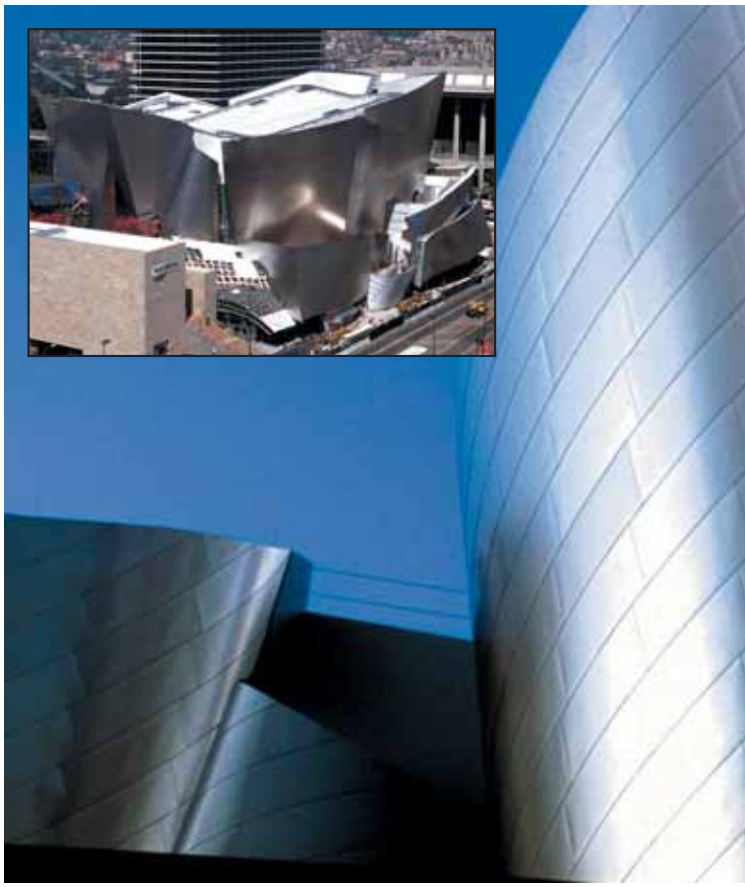
- Join many surfaces including dissimilar materials; tape prevents bi-metallic corrosion
- Use lighter weight and thinner substrates
- Bond most painted and powder coated surfaces, and hard-to-bond plastics such as acrylic and polycarbonate



Bonds copper trim to ACM panel

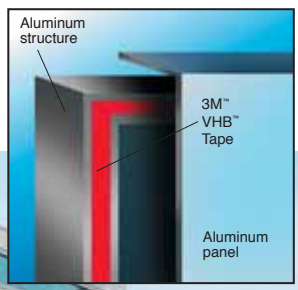
systems • Canopies • Decorative metal trim • And more...

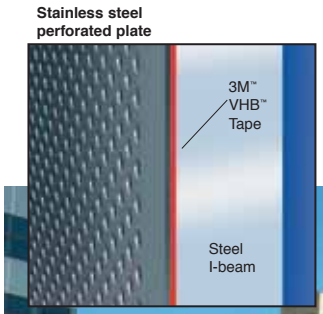
Plaza Centenário,
Sao Paulo, Brazil
Architect: Carlos Bratke, 1995
Aluminum stiffeners
bonded to ACM panels.

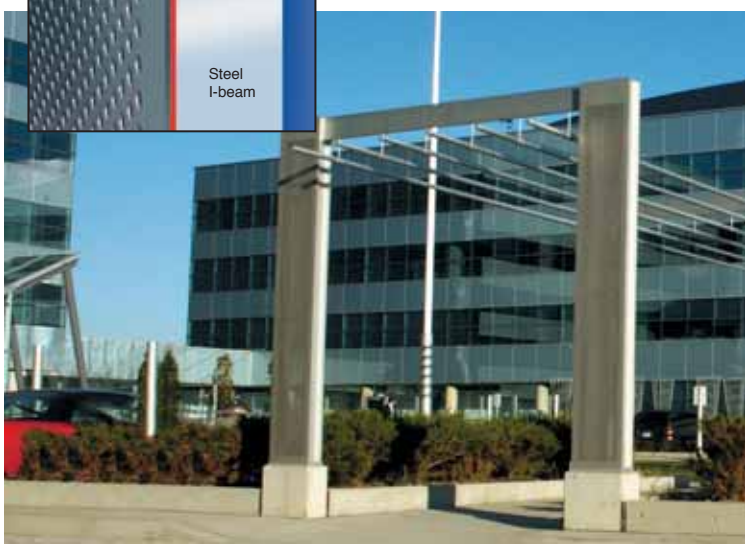


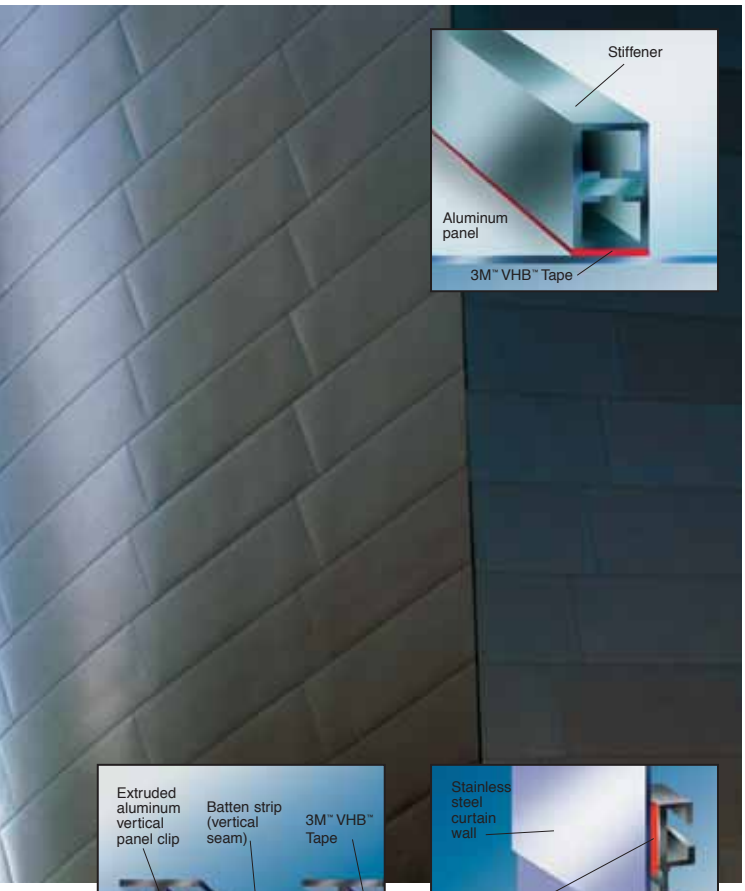
Walt Disney Concert Hall,
Los Angeles, CA, USA
Architect: Frank O. Gehry
Curtain wall: Permasteelisa, 2003
Stiffener and frame attachment.

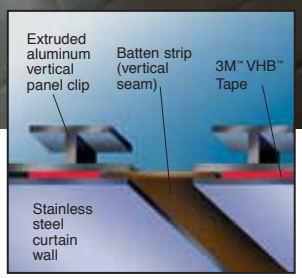
Price Waterhouse,
Mexico City, Mexico
Construction:
Salvador Diaz Dupont,
2001
Aluminum panels
bonded to frame.



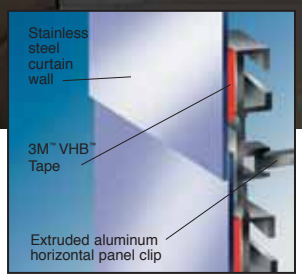




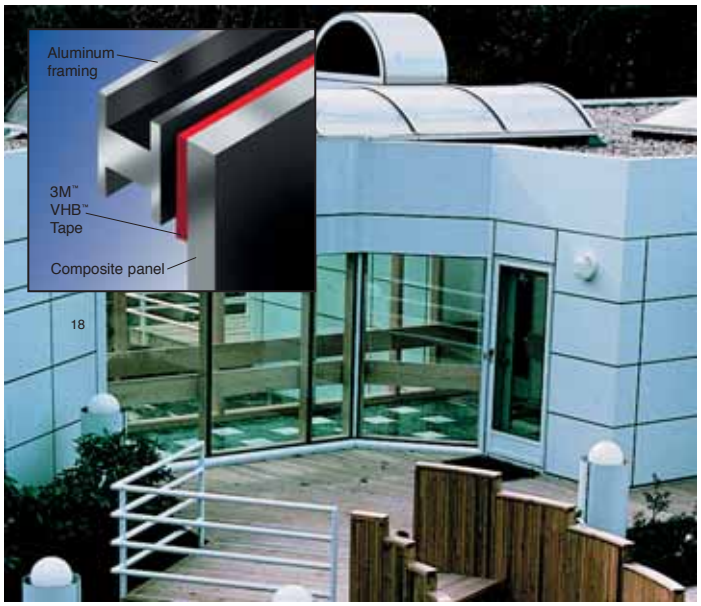




Vertical seam

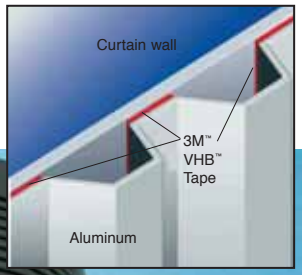


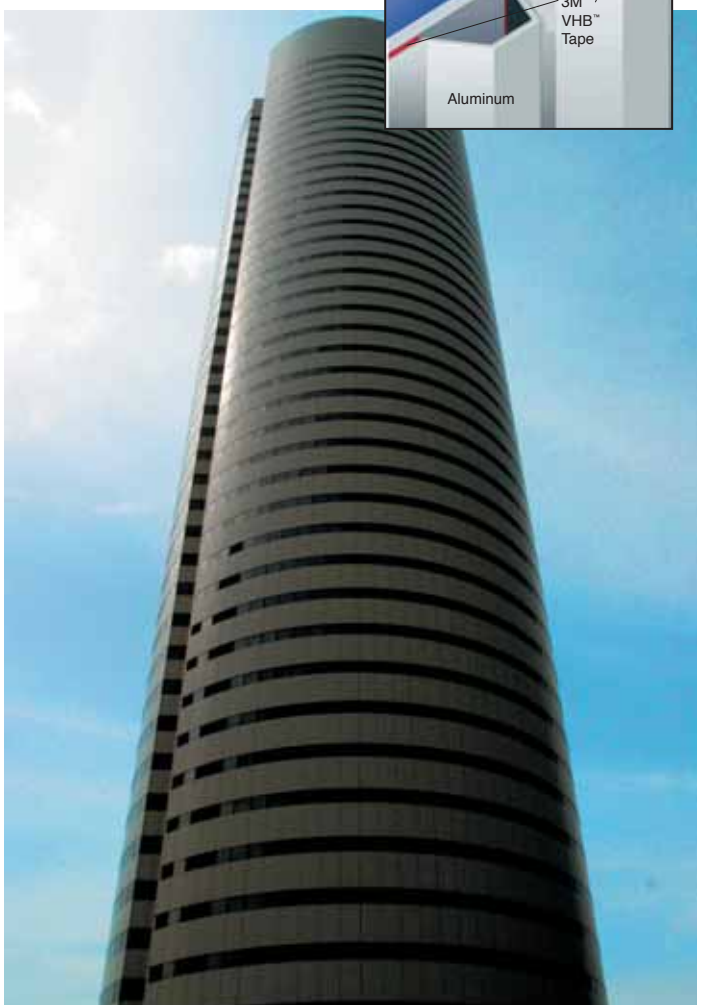
Horizontal seam



Shaffner Building,
St. Joseph, MI, USA
Architect: Shaffner and Associates, 1986
Aluminum composite panels bonded to aluminum framework.

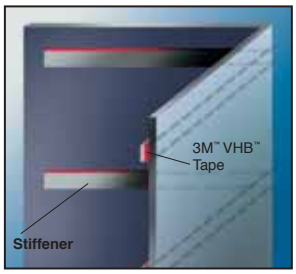
Temasek Tower,
Singapore
Architect: Architects 61, 1985
Aluminum stiffeners
bonded to curtain wall panels.





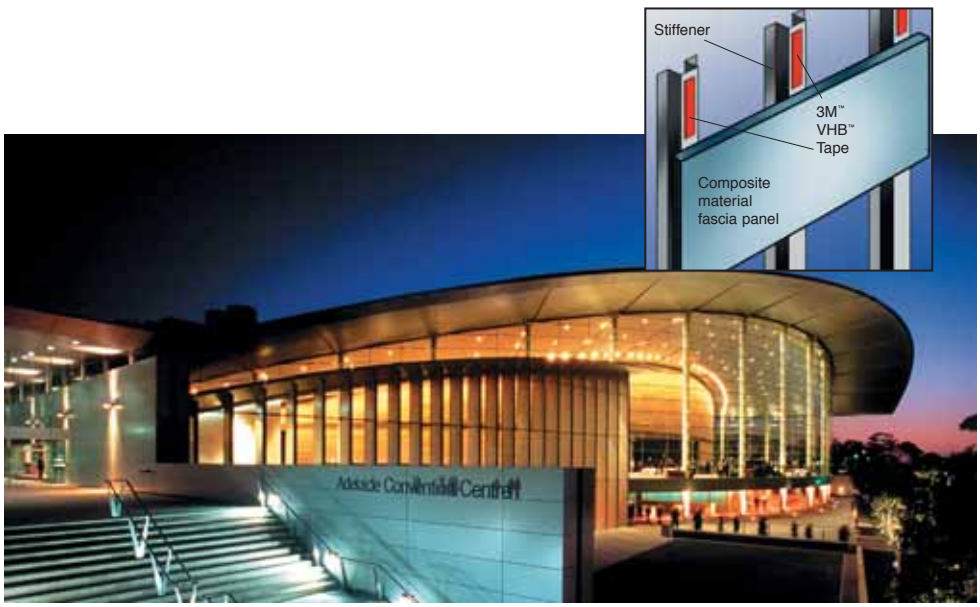
Toronto Bell Building,
Toronto, ONT, Canada
2000
Perforated stainless steel
plate bonded to I-beam.

High holding power and long term reliability



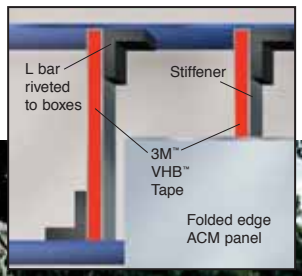
Cladding cover

Dearborn Center,
Chicago, IL, USA
Fabricator:
Copper Sales Una-Clad, 2003
Stiffeners bonded to exterior
metal trim cladding.



Adelaide Convention Centre,
South Australia
Architect: Woods Bagot
with Skidmore,
Owings & Merrill, 2001
Aluminum composite panel
bonded to galvanized frame.

O'Hare Airport,
Chicago, IL, USA
Architect: Custom Products of Southgate, CA, 1987
Mirror-finish composite ceiling panels bonded to a suspension frame.

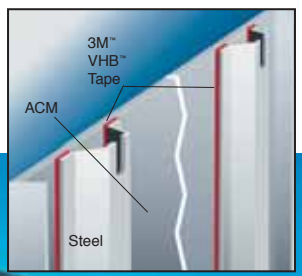


Jurong West Telephone Exchange, Singapore
ACM panels attached to stiffeners.

Applies easily

Tamedia Building,
Zurich, Switzerland
Facade design: Soder AG, 2001
Glass steps bonded to
varnished steel frame.

Jumeirah Beach Hotel,
Dubai, UAE
Curtain wall design:
Schmidlin AG, 1998
Aluminum panels bonded to
steel stiffeners.

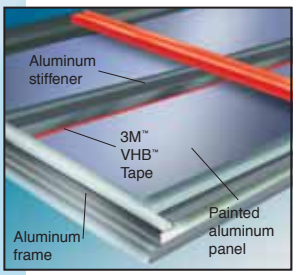


BankBoston,
Sao Paulo, Brazil
Architect: Skidmore,
Owings & Merrill and
Julio Neves
partnership, 2002
Stainless steel panels
bonded to aluminum
tray frame.

to permanently bond many materials flat or curved

Aeroporto Fortaleza,
Fortaleza, Brazil
Architect: Claudio Silva, 1997
Stainless steel panels bonded
to steel frame.

Samsung Medical Center,
Seoul, South Korea
Architect: Samoo Architects and Engineers, 1995
Aluminum stiffeners bonded to aluminum panels.



A. Structural Performance Tests

Architectural metal panels assembled using 3M™ VHB™ Tapes were given structural performance tests at Construction Research Laboratory (Miami, FL). Each panel measured 1524 mm x 2438 mm and was built with a perimeter frame and three stiffeners attached to the aluminum or ACM sheet using only VHB tape. The tests were performed according to ASTM E330 "Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference". The panels survived pressures up to 5.7 kPa in both directions, which corresponds to a sustained wind speed of 355 kph. The VHB tapes demonstrated excellent performance, even after the panels and stiffeners themselves had shown permanent deformation in these simulated high winds.

A duplicate set of panels constructed using VHB tapes was subjected to non-ambient temperature structural performance tests. The panels were subjected to positive and negative pressures up to 2.9 kPa at cold -29ºC, ambient 32ºC, and hot 66ºC outside air test temperatures, which were the most extreme temperatures obtainable in this specific test configuration. Subsequent inspection showed VHB tapes withstood these wind pressures at the temperature extremes, and provided excellent performance despite the panels and stiffeners exerting high stresses on the tapes at all three test temperatures.

Aluminum panels of another design were bonded with VHB tape and tested in accordance with AS 2047 "Windows in Buildings" by the CSIRO Division of Building, Construction and Engineering (Australia). The panels were subjected to differential pressures up to 7.0 kPa with no signs of failure. This pressure represents a wind speed of approximately 390 kph.

B. Hurricane Impact and Pressure Cycling Tests

Architectural metal panels assembled with VHB tapes were subjected to impact and pressure cycling tests to determine their ability to survive a hurricane or other high wind event. This testing was also performed at Construction Research Laboratory (Miami, FL). The impact test was performed 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. The impacts resulted in heavy damage to the panels, frame, and stiffeners, but the VHB tapes held fast and even expanded to maintain contact with both dented surfaces.

The same panels were then given the pressure cycling sequence specified by Dade County Specification PA-203 using the test method provided in 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". This resulted in a total of 1,342 pressure cycles (in the positive and negative wind directions) on the panels using a building design pressure of 1.9 kPa. Visual inspection after the test indicated the VHB tapes had maintained full contact to all stiffeners with no loss of adhesion. The pressure cycling sequence was then repeated using a building design pressure of 2.9 kPa for an additional 1,342 cycles. Two VHB tapes maintained complete adhesive contact with the stiffeners after this additional pressure cycling, indicating excellent performance throughout the hurricane-related tests.

C. Fire Tests

Several VHB tapes were bonded between pieces of aluminum (similar to architectural metal panel applications) and tested by the Warrington Research Centre (United Kingdom) for fire performance according to British Standard 476 Part 6 "Method of Test for Fire Propagation for Products" and Part 7 "Surface Spread of Flame Test for Materials". No surface spread of flame occurred, and the products complied with the requirements for a Class 0 surface.

A different VHB tape bonded in a similar construction was tested to AS 1530 III "Early Fire Hazard Properties of Materials" by the CSR Concord Research & Development Centre (Australia). This testing yielded the following fire rating indices:

Ignitability	= 0
Spread of Flame	= 0
Heat Evolved	= 0
Smoke Developed	= 0

D. Weathering Resistance

Bonds made with VHB tapes have been exposed on outdoor weathering decks in Arizona, Florida, Minnesota, and Japan to collect data on the long-term weathering resistance of VHB tapes. These tests typically showed full bond strength retention after 5 years of exposure in these real-life weather tests, at which point the tests were discontinued.

Numerous accelerated aging tests have also been performed which subject a bond made with VHB tape to heat, humidity, and concentrated UV light exposure to simulate outdoor weather conditions. For example, tests have demonstrated that VHB tape bond strength, as performed in a dynamic overlap shear test, typically maintains its original performance even after 7000 hours of exposure to these harsh conditions, at which point the tests were discontinued.

E. Solvent Resistance

Test results show no effect on VHB tape bond performance after splashes or incidental contact with a wide variety of solvents (such as fuels, alcohols, adhesive removers, weak acids, and weak bases).

F. Adhesive Properties

VHB tapes are ideal for bonding to a variety of substrates, including most metals, glass, plastics, composites, and painted surfaces. Each product in the VHB tape family has specific features, including the ability to bond to different types of materials. Determination of whether a specific VHB tape is fit for a particular application should include adhesion testing with the actual substrates.

G. Compatibility with Silicone Sealants

VHB tapes have been tested for compatibility with several different silicone sealants using the procedure described in ASTM C1087 "Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems". The results showed VHB tapes to be compatible with silicone sealants, with no noticeable color change and no loss of adhesion to glass substrates.

H. Sealing

3M™ VHB™ Tapes can provide an excellent seal against moisture. They also form an excellent barrier to prevent galvanic corrosion between dissimilar metals.

Architectural metal panels with a perimeter frame attached only with VHB tapes were subjected to water leakage tests 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" at Construction Research Laboratory (Miami, FL). The results indicated that, with proper tape application and perhaps a small amount of silicone sealant over the tape seams, that VHB tape can provide an excellent seal against water penetration.

I. Design Considerations

Static Loads - As a general rule, 4 sq in of 3M VHB tape per 1 kg (equals 60 sq cm per 1 kg) should be used to support static tensile or shear dead loads. While this guideline includes some safety factors, a different amount of VHB tape may be required depending on the particular application.

Dynamic Loads - For dynamic tensile or shear loads (such as wind loads), a design strength of 12 psi (85 kPa) can generally be used for most VHB tapes, while a design strength of 9 psi (60 kPa) should be used for the VHB tape 5952 series. These guuidelines provide a safety factor of at least 5. These values can easil be adjusted to incorporate a different safety factor. For example, a safety factor of 3 would result in a design strength of 20 psi (140 kPa) for most VHB tapes, and 15 psi (106 kPa) for the VHB tape 5952 series.

Thermal Expansion/Contraction - VHB tapes perform well in applications where the two bonded surfaces experience contraction and expansion relative to each other. VHB tapes can typically tolerate differential shear movement up to 3 times their original thickness. Since bonds made with VHB tapes will be more flexible than other joining methods, suitable design modifications may be needed to achieve required stiffness.

Tape Thickness - The optimal thickness of VHB tape for a particular application depends on the size, rigidity, and flatness of the substrates, as well as the amount of application pressure applied to mate the surfaces together. In general, thicker tapes will handle greater mismatch and differential thermal expansion between surfaces, and provide better contact and sealing.

J. Other References

The above technical background provides only a brief summary about the performance of VHB tapes in construction applications. For complete details and more technical information, please refer to the following documents:

1. Technical data page: “VHB Tapes for Construction Applications”
2. Technical bulletin: “Structural Performance Tests of VHB Tapes in Architectural Metal Panels”
3. Technical bulletin: “Surface Preparation for 3M VHB Tape Applications”
4. Technical bulletin: “3M VHB Tape Durability”

K. Important Note

The details about each architectural metal panel application (such as panel design, materials, surface preparation, selected VHB tape, and building-specific requirements) can affect the use and performance of a VHB tape. Therefore, VHB tapes should be thoroughly evaluated by the user under actual use conditions with intended substrates to determine whether a specific VHB tape is fit for a particular purpose and suitable for user’s method of application, especially if expected use involves extreme environmental conditions.

L. Warranty

VHB tapes can provide the strength needed in the assembly of architectural metal panels. Please refer to the Limited Product Warranties on page 12.

3M™ VHB™ Tapes for Architectural Metal Panels

Product Number	Tape Thickness w/o Liner Mils	Description	Adhesive Type	Temperature		Solvent Resistance	Relative Adhesion		Application Ideas
				Short	Long		HSE	LSE	
4941 4941F 4956 4956F 4991	1.1 mm 1.1 mm 1.55 mm 1.55 mm 2.3 mm	Dark gray, closed-cell acrylic foam carrier. Conformable. Good adhesion to many painted metals. Plasticizer resistant.	Acrylic	121°C	93°C	High	High	Med	Attach stiffeners and trim to metal sheet or painted ACM panels. Bond and seal perimeter frame to metal sheet or ACM panels.
4950 4912 4959	1.1 mm 2.0 mm 3.0 mm	White, closed-cell acrylic foam carrier. General purpose adhesive.	Acrylic	149°C	93°C	High	High	Low	Attach stiffeners and trim to bare metal panels. Bond and seal perimeter frame to bare metal panels.
5952 5962	1.1 mm 1.55 mm	Black, closed-cell acrylic foam carrier. Conformable. Good adhesion to many painted surfaces, including powder coatings.	Synthetic	149°C	121°C	High	High	Med	Attach stiffeners and trim to painted ACM panels. Bond and seal perimeter frame to painted ACM panels.

Relative Adhesion: HSE – High Surface Energy LSE – Low Surface Energy

Note: This technical information and data should be considered representative or typical only and should not be used for specification purposes.

Bonding methods using Structural Adhesives.

Adliswil Indoor Swimming Pool

Hybrid joining with 3M™ DP810 mixed adhesive and with 3M™ acrylic foam adhesive assembly tape 4664. The latest innovation from the 3M company. The facade elements, made of tempered (enamelled) glass, were bonded to the aluminium angle profiles. This type of hybrid joining provides maximum load carrying capacity, is invisible and is also extremely economical in both production and installation.

Finishing, masking, and protecting metal surfaces

Beyond bonding with 3M™ VHB™ Tape, 3M industrial technologies can help you finish, mask, and protect the surfaces of architectural metal panels.

3M Abrasive Systems:
From a wide selection of 3M non-woven abrasive products you can find wheels and discs to quickly deburr, blend and finish any metal. Special construction runs cool and long for cost-effectiveness.

3M™ Masking Tapes:
With this extensive line you have choices in holding power, paint edge sharpness, temperature resistance, and clean removal to meet the productivity and quality requirements of any painting method.

3M™ Protective Films:
To protect metal surfaces during processing, shipping and installation, these polyethylene films offer combinations of adhesive sticking power and removability for the demands of various conditions.

Limited Product Warranties
3M warrants for 12 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 warranty does not cover damage resulting from the use or inability to use 3M VHB tape due to misuse, workmanship in application, or application r storage not in accordance with 3M recommended procedure.

Industrial Adhesives & Tapes Division
3M UK PLC

3M Centre, Cain Road
Bracknell, Berkshire
RG12 8HT
Tel : 0870 60800 50
Fax: 0870 60700 99
website: www.3M.com/uk/tag
E-mail: bondingsolutions.uk@mmm.com

Industrial Adhesives & Tapes Division
3M Ireland

Adelphi Centre
Upper Georges Street,
Dun Laoghaire
Co. Dublin, Ireland
Tel : 01 280 3555
Fax: 01 280 3509

CJ1085
PE-BE-SB-27

Printed in Belgium - 2005