3M™ VHB™ Tapes have been used worldwide in a variety of applications in the construction industry since the introduction of these tapes in 1980. To further support consideration for structural glazing applications, structural performance tests were conducted at an independent 3rd party test facility (Facade Engineering & Weather Performance of Buildings Materials Science & Engineering – CSIRO, Australia, report No. DTF 865) to evaluate 3M™ VHB™ Structural Glazing Tape under stresses that glass panels would typically experience in a glazed curtain wall system or commercial windows.

Calculation of the width of adhesive bond (Structural Bite Width) required for a structurally glazed panel is commonly determined by application of Trapezoidal Load Distribution Theory. This is based on the assumption that rather than remaining flat, a rectangular panel under wind load will deflect in a tributary area fashion. The tensile stress on the structural bond around the perimeter varies, with the peak stress occurring at the center of the longest span:

![Figure 1 - Trapezoidal Model for load Distribution](image)

The calculation for determining the required Structural Bite Width of bonding material to resist the peak wind load stress (Design Pressure) is given by the following calculation:

- Structural Bite Width (mm) = \( \frac{1}{2} \times L \times \text{Design Pressure (kPa)} \)
  Bonding Material Design Stress

- Structural Bite Width (in) = \( \frac{1}{2} \times L \times (\text{ft}) \times \text{Design Pressure (psf)} \)
  Bonding Material Design Stress \times 12 \text{ in/ft}

85 kPa (12 psi) is used as the Bonding Material Design Stress derived by dividing the ultimate tensile failure stress by a safety factor of 5, providing an industry appropriate margin of safety.
Background (continued)

As negative pressure from a suction wind load is applied to glass panels in a curtain wall system, secondary shear forces on the bond may result due to the deflection that occurs in the frame members, in particular the mullions. The material design strength of 3M™ VHB™ Structural Glazing Tape has been well established and in common use in construction applications for 3M™ VHB™ Tapes. The aim of the tests described in this bulletin is to provide further support for the use of 85kPa (12 psi) as the Bonding Material Design Stress in a trapezoidal structural bite width calculation. Furthermore, the tests are designed to validate the calculated Structural Bite Width is also suitable for accommodating secondary shear forces that occur on 3M™ VHB™ Structural Glazing Tape in glazing systems.

Conclusions

3M™ VHB™ Structural Glazing Tape B23F fulfilled all the requirements in the tests conducted as specified by AS4284 test methods. Furthermore, testing of 3M™ VHB™ Structural Glazing Tape B23F was taken beyond the requirements of AS4284:2008 to include proof tests at 2x, 3x and 4.15x the design guideline for 3M™ VHB™ Structural Glazing Tapes, demonstrating no evidence of collapse or tape distress. The results of the tests validate the use of 85 kPa (12 psi) as the material design strength in calculation of the Structural Bite Width in a trapezoidal model calculation, and the test demonstrated at least a 4x safety factor in this design.

Written assessment of use of the trapezoidal approximation for bite width calculation and secondary forces based on the test results by the supervising consulting engineer can be summarized as follows:

1. For most glass panel aspect ratios approximately 2:1, the use of 85 kpa (12 psi) as the material design strength in a trapezoidal approximation is conservative. As the aspect ratio approaches 1:1, the use of the trapezoidal approximation yields structural bite widths up to 5% less than classical plate theory, however the 5% error is well compensated for with the use of a 5x safety factor in the material design strength of 3M™ VHB™ Structural Glazing Tape.

2. The shear stress in the tape due to mullion bending (secondary forces) for the test specimen was calculated at 12.8 kN/m when the test pressure was -2.9 kPa (-60 psf). This can be compared with other cases for example, using the same mullion/glass type in a floor-to-floor configuration, 3.9 m (12.75 ft) high (floor to soffit) with mullions spaced at 1.2m (3.9 ft), using a Serviceability Limit State design pressure of Pz = 1.0 kPa, then the maximum shear in 7mm (0.28 in) wide tape (as per Trapezoidal Model calculation of Structural Bite) is 9.2kN/m, which is less than the shear in the test tape of 12.8 kN/m at 2.8kPa. Therefore, the tape has been tested with a shear well in excess of 9.2kN/m without distress, and will therefore be satisfactory for typical curtainwall situations.
Test Procedure

A sequence of tests were designed and conducted on a test specimen representative for an actual project using 3M™ VHB™ Structural Glazing Tape – the structural glazing of insulated glass unit (double glazed) clerestory windows in the National Portrait Gallery, Canberra, Australia (Figure 2).

![Figure 2 – Actual arrangement an orientation of Clerestory Window Glazing – National Portrait Gallery](image)

In order to adequately observe the effects of mullion bending, a three panel part facade test specimen was constructed using the same frame members and glass type. The test specimen was installed into the test chamber with a 90° rotation compared to the orientation of the glazing in the National Portrait Gallery in order to fit into the test chamber (Figure 3).

The wind load design pressure of the panels for the actual building was -1.66 kPa (-35 psf) for the 1765 mm (70 in) L x 2400 mm (95 in) W insulated glass unit panels -10.38 mm (0.41 in) laminated external, 12 mm (0.5 in) air space, 8 mm (0.31 in) annealed internal. This panel size and wind load would normally require at least 18 mm (0.71 in) width 3M™ VHB™ Structural Glazing Tape as the structural bite. However, in order to ensure that the properties of the tape were adequately tested without the limitation of glass panel or frame failure, the structural bite width in the test specimen was scaled down to 10 mm (0.4 in) width 3M™ VHB™ Structural Glazing Tape B23F. This resulted in a design wind load for the 3M™ VHB™ Structural Glazing Tape bond of -0.96 kPa (-20 psf) while maintaining a design wind load of -1.66kPa (-35 psf) for the glass & frame.

Structural performance tests were conducted according to AS4284:2008. Additionally, proof tests at 2x, 3x and 4.15x the structural load were conducted and each held for one minute. Deflections at 22 points on the tests specimen were measured in order to assess the secondary forces applied to the glass – frame bond.

![Figure 3 – Test Chamber setup & panel orientation Portrait Gallery](image)
Test Specimen Set-up

Figure 4 – Test Window Frame Elevation

Structural Performance & Design Stress Proof
Tests of 3M™ VHB™ Structural Glazing Tape
Figure 5 – Mullion detail

IGU Glass Type:
10.38 mm laminated external, 12 mm air space, 8 mm annealed internal

2 mm Aluminum Extrusion Frame (Powder-coated)

Spacer blocks providing static load support

3M™ VHB™ Structural Glazing Tape B23F
10 mm (0.4 in) width
2.3 mm (0.090 in) thick
Figure 6 – Head & Sill detail

3M™ VHB™ Structural Glazing Tape B23F
10 mm (0.4 in) width

Plywood cover over remaining test chamber
Figure 7 – Jamb Detail

3M™ VHB™ Structural Glazing Tape B23F
10 mm (0.4 in) width

Timber block static load support
Ground
Summary of Results

The following table summarizes the results of the structural performance & proof load tests.

Table 1 – Results of Structural Load

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Parameter</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Performance Test</td>
<td>AS4284:2008</td>
<td>+0.96 kPa &amp; -0.96 kPa (+20 psf &amp; - 20 psf)</td>
<td>Pass</td>
</tr>
</tbody>
</table>

Figure 7 – AS4284:2008 Structural Performance Test Pressure Sequence

Table 2 - Results of proof load tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Test Pressure kPa (psf)</th>
<th>% of Design Load for 3M™ VHB™ Structural Glazing Tape</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proof Load Tests</td>
<td>AS4284:2008</td>
<td>-1.44 (-30)</td>
<td>150%</td>
<td>No Collapse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2.9 (-60)</td>
<td>300%*</td>
<td>No Collapse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-3.3 (-69)</td>
<td>344%*</td>
<td>No Collapse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-4.0 (-84)</td>
<td>417%*</td>
<td>No Collapse</td>
</tr>
</tbody>
</table>

*Not a requirement of AS 4284:2008 or ASTM E330
Product Use

All statements, technical information and recommendations contained in this document are based upon tests or experience that 3M believes are reliable. However, many factors beyond 3M’s control can affect the use and performance of a 3M product in a particular application, including the conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user’s knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user’s method of application.

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If the 3M™ VHB™ Tape is proved to be defective within the warranty period stated above. THE EXCLUSIVE REMEDY, AT 3M’S OPTION, SHALL BE TO REFUND THE PURCHASE PRICE OF OR TO REPAIR OR REPLACE THE DEFECTIVE 3M™ VHB™ TAPE. 3M shall not otherwise be liable for loss or damages, whether direct, indirect, special, incidental, or consequential, regardless of the legal theory asserted, including negligence, warranty, or strict liability.

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