



3M™ VHB™ Tapes in Traffic Sign Assembly

Technical Bulletin

August, 2007

Introduction

This bulletin describes how 3M™ VHB™ Tape can be used in the construction and assembly of traffic signs. Generally, wherever rivets, bolts or welds are commonly used, 3M™ VHB™ Tape can potentially be substituted. The primary advantages for considering the 3M™ VHB™ Tape for traffic sign construction include:

1. Bonds with strength enough to replace rivets, bolts, screws, clips, welds and similar fastening methods in many applications.
2. Virtually invisible fastening eliminates mechanical fasteners in the sign face for improved aesthetics.
3. Use thinner gauge, less expensive material without pull-through or dimpling.
4. Reliably joins many dissimilar materials, both metallic and non metallic, while compensating for differential thermal expansion.
5. Helps reduce assembly time.

3M™ VHB™ Tapes have been used worldwide since the mid-1980's to assemble a variety of traffic signs. Common types of signs where 3M™ VHB™ Tapes have been successfully used include multi-panel signs, mast arm street name signs, overlaying old porcelain enamel signs, work zone signs, barricades, large regulatory warning signs.

The durability of 3M™ VHB™ Tape for traffic sign applications has been demonstrated through testing at the Texas Transportation Institute in December 1990. Signs assembled with 3M™ VHB™ Tape passed static load requirements specified in the 1985 American Association of State Highway and Transportation Officials (AASHTO) Guide. The signs also passed crash impact testing per the evaluation provisions found in the National Cooperative Highway Research Program Report 230, Transportation Research Board, National Research Council, Washington, D.C., March 1981.

A discussion of applications for user evaluation is presented within, followed by recommended procedures for using 3M™ VHB™ Tapes on traffic signs.

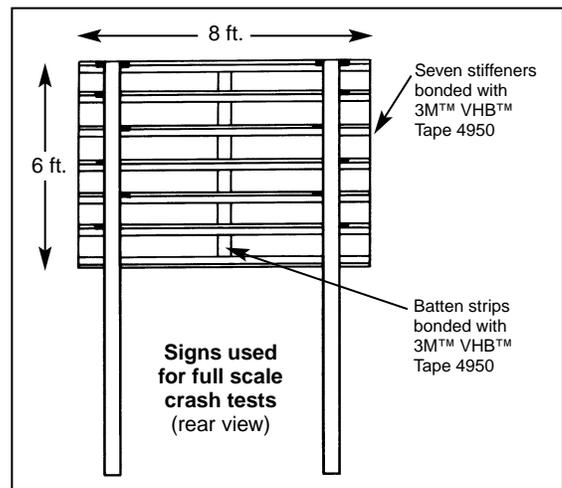
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Full-Scale Crash Tests

Two tests were performed according to NCHRP 230 and the AASHTO 1985 Guide. The tests involved an 1,800 lb. passenger car impacting a highway sign installation at speeds of 20 and 60 mph. The test article was a two-legged highway sign installation made with 2 each 4 ft. x 6 ft. aluminum flat sheet panels joined with 3M™ VHB™ Tape 4950 at the seam. Seven extruded “L” stiffeners were bonded to the panels with the VHB Tape. The sign was attached to the post with standard aluminum post clips.

Ordinarily, two-legged sign installations are tested by impacting both legs of the sign. In the tests performed, only one leg was impacted in order to evaluate the performance of stiffeners bonded with 3M™ VHB™ Tape. One-legged impacts are typically a more severe test than two-legged tests.



Results

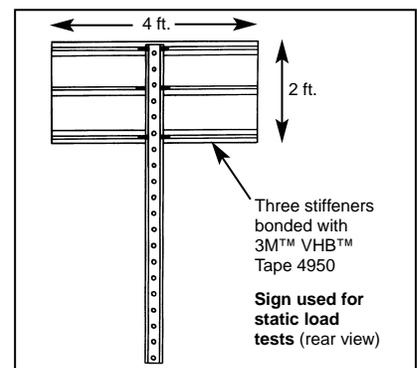
Signs impacted at 20 and 60 mph met the performance criteria specified in NCHRP 230 and the 1985 AASHTO Guide. In the case of the 20 mph crash impact, the impacted leg broke away at the slip base resulting in only minor damage to the bumper of the test passenger vehicle. No damage was done to the sign.

At 60 mph, the impact at the leg generated sufficient torque on the sign installation to shear off many post clips causing the sign to break away from both posts. The sign fell to the ground with all stiffeners and batten strips remaining firmly bonded in place.

Static Load Tests

The static load tests were conducted on a standard one legged 3 lb. per ft. U-channel post with a 2 ft. x 4 ft. horizontal panel sign. The sign was attached to the U-channel post with three (3) 4 ft. stiffeners that were bonded to the sign panel with 3M™ VHB™ Tape 4950. The load was applied perpendicular, or normal, to the plane of the sign panel at the horizontal centerline of the panel and offset from the vertical centerline of the panel by a distance of 0.6 ft.

The test load was increased incrementally until the design load of the sign was reached. The design load is 8 sq. ft. (2 ft. x 4 ft.) times wind pressure (P) in pounds per square feet (psf) (from the 1985 AASHTO Guide). The sign is required to withstand wind velocity of 90 mph which is equivalent to a static load of 266.9 lbs. on a 8 sq. ft. panel. When this load was applied at 0.6 ft. off the vertical centerline of the panel, a moment of 160.1 ft.-lb. was imparted to the post. After the normal load of 266.9 lbs. was reached, the load was removed and plastic deformation (i.e., permanent set) to the sign panel and post was measured and recorded. The normal load was reapplied and increased until the system (i.e., the sign installation) failed. Load at failure was recorded.



Results

The specified static load of 266.9 lbs. caused no permanent deformation to the sign installation. The load was removed and reapplied until deformation occurred. The load at failure was recorded at 530 lbs. Inspection revealed that the post yielded under the load of 530 lbs. The equivalent wind velocity for this static load is 162 mph. There was no apparent degradation of the adhesive bond when the post failed.

The complete test report compiled by the Texas Transportation Institute can be obtained from 3M on request. The purpose of the testing was to evaluate the performance of 3M™ VHB™ Tape 4950 constructed traffic signs when subjected to rigorous testing.

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Part 1: Application Ideas A. Attaching Panel Stiffeners

Panel stiffeners are used as part of the construction of guide, regulatory or warning signs to reduce wind deflection and provide a medium to fasten the sign onto the post. There are a variety of methods available to attach the stiffeners with mechanical fasteners. Some common methods are shown in Figure 1.

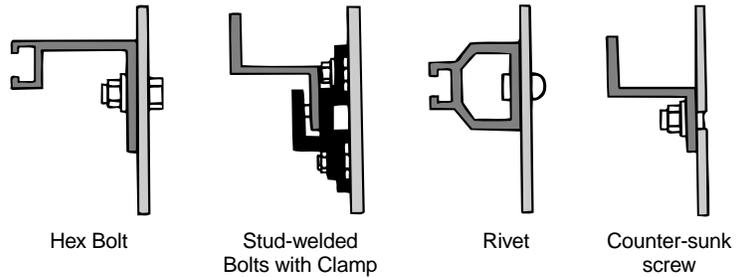


Figure 1: Some common methods for attaching stiffeners with mechanical fasteners

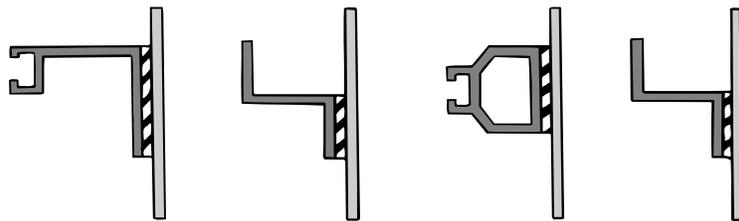


Figure 2: Attaching stiffeners with 3M™ VHB™ Tape instead of mechanical fasteners. The tape is represented by the symbol:  Not to scale.

In each example, 3M™ VHB™ Tape can potentially be used in place of these mechanical or fusion fastening methods. See Figure 2.

Whether using bolts, rivets or screws to attach stiffeners, drilling through the sign face is necessary. The mechanical fastening devices will then often leave blemishes on the sign face. Using stud welds can eliminate surface blemishes, however costly 0.125 in. aluminum is usually required to prevent dimpling.

Bonding stiffeners with 3M™ VHB™ Tape eliminates the drilling or welding process steps and leaves the sign face intact. When the tape is applied across the entire length of the stiffener, the tape will uniformly distribute stress over the bonded area, eliminating the concentrated stress of rivets, bolts, welds or other mechanical fastening techniques. Since stress is distributed across the stiffener, thinner gauge aluminum can often be used without the risk of a mechanical fastener pulling through the surface.

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Part 1: Application Ideas (Continued) B. Splicing Multi-Panel Signs

The separate panels of a multi-panel sign are spliced together with batten strips. These batten strips are commonly riveted onto the aluminum panels, creating many protrusions through the sign face and its reflective sheeting. See Figure 3. Since sign copy is usually laid out before the panels are spliced together, the layout job is often slow and tedious to minimize placing the copy where rivet heads will be and to avoid moving the panels with respect to one another.

3M™ VHB™ Tape can be used in place of rivets to bond the batten strips. See Figure 4. With this method, assembly time can be reduced since there is no drilling and riveting. Since the panels can be spliced together before copy layout and since there are no rivet heads projecting through the sign face, copy layout is often quicker.

C. Overlaying Porcelain Enamel Signs

In many instances old opaque porcelain enamel signs need to be upgraded to include a reflective sign face. Upgrade options range from replacing the entire sign to overlaying a new reflective sign face onto the existing sign structure. Overlaying the existing sign using mechanical fasteners may require on-site drilling into the porcelain face.

A new sign face can be directly bonded onto the existing porcelain using 3M™ VHB™ Tape. Typical application may involve bonding the tape on the perimeter of the overlay and pressing the overlay in place. (See Recommended Taping Procedures for application detail.) Aluminum overlays as thin as 0.040 in. have been bonded to porcelain signs using 3M™ VHB™ Tapes.

Note: Bonding an overlay directly onto existing reflective sheeting is not recommended. The sheeting is not designed to support the load of the overlay. Where overlaying reflective sheeting is desired, the user must first remove the sheeting in any area where the tape will be bonded.

D. Single Post Mount with Stiffeners

Some regulatory and warning signs are large enough to require two posts to hang the sign. Bolts are normally fastened through the sign face, then into the post. These signs can be hung with a single post mount using 3M™ VHB™ Tape and channel stiffeners. The 3M™ VHB™ Tape bonds the stiffeners to the sign, and the stiffeners are then bolted or clamped onto the post. See Figure 5. The cost of the additional stiffeners can often be offset by the savings achieved by eliminating the second post and eliminating the time to drill the sign when using mechanical fasteners.

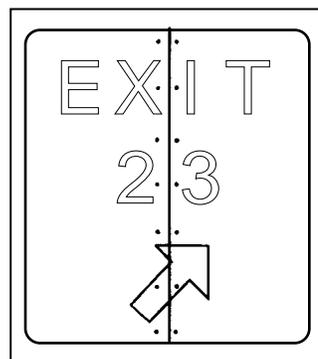


Figure 3: Riveted batten strip creating protrusions through the sign face.

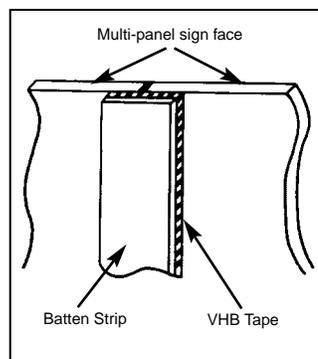


Figure 4: Splicing a multi-panel sign with 3M™ VHB™ Tape.

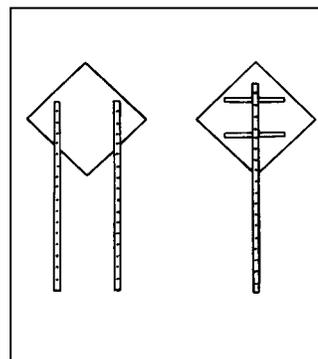


Figure 5: Comparison of a double post mount and a single post mount using 3M™ VHB™ Tape to bond stiffeners.

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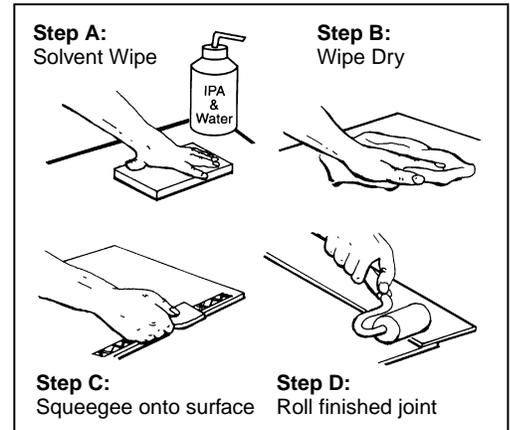
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Part 2: Recommended Taping Procedures

Required Surface Preparation for All Applications

1. **Application Temperature:** The ideal tape application temperature range is 70°F to 100°F (21°C to 38°C). Initial tape application to surfaces at temperatures below 50°F (10°C) is not recommended unless using 3M™ VHB™ Tape 4951, which can be applied at temperatures as low as 32°F (0°C).
2. **Cleaning:** All surfaces to be bonded must be cleaned with a solvent such as a 50:50 mixture of isopropyl alcohol (rubbing alcohol) and water. Then wipe the surface with a clean, dry cloth to remove solvent. (Steps A & B). Do not use oil-based solvents such as turpentine that can inhibit adhesion. **Note:** When using solvents, be sure to follow the manufacturer's precautions and directions for use for handling such materials.
3. **Abrading:** Adhesion to metal surfaces can be improved by lightly abrading the surface with a solvent saturated abrasive pad such as a Scotch-Brite® Pad. Metal with corrosion or other surface debris or any reclaimed metal **MUST** be abraded before taping. Recleaning the surface with solvent is necessary after abrading. It is not necessary to abrade conversion coated aluminum that is free of surface debris.
4. **Rub Down Pressure:** Bond strength is dependent on the amount of adhesive-to-surface contact. Firm application pressure is necessary to help develop adhesive contact and improve bond strength. (Steps C and D.) Enough pressure should be applied so that both surfaces fully contact the tape. Generally, this means that the tape should experience 15 psi (or 100 kPa).
5. **Dwell Time:** After application, the bond strength will increase as the adhesive flows onto the surface. At room temperature approximately 50% of the ultimate strength will be achieved after 20 minutes, 90% after 24 hours, and 100% after 72 hours. In some cases, bond strength can be increased and ultimate bond strength can be achieved more quickly by exposing of the bond to elevated temperatures [e.g. 150°F (66°C)] for 1 hour.

Important: Failure to follow these recommended procedures may result in bond failure. Some local air quality regulations limit the use of some cleaning solvents. Consult your local regulations before using IPA in this application.



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Part 2: Recommended Taping Procedures (Continued)

Assembly Steps for Bonding Stiffeners:

1. Determine the amount of tape to be used from the procedures below. (See Tape Usage.)
2. All surfaces to be bonded must be cleaned with a 50:50 mixture of isopropyl alcohol and water. Metal surfaces can be lightly abraded to improve initial bond strength. Recleaning is necessary after abrading. (See Required Surface Preparation.)
3. 3M™ VHB™ Tape should be applied to a clean, dry, well unified surface of the stiffener with a J-roller or tape applicator.
4. Laminated panels should be aligned in the desired position and the stiffeners placed in the proper location for bonding to the panel.
5. Make sure that the sign surface where the stiffener is to be bonded is clean and dry.
6. Align the stiffener in position and remove the release liner. Press the stiffener in place on the panel. A J-roller can be used to aid in laminating the stiffeners to the panels. A flat firm surface should be used to support the sign panels while pressure is being applied. Repeat Steps 2 - 6 until all the stiffeners are bonded to the panels.

Bonding Batten Strips on Multi-Panel Signs:

1. All surfaces to be bonded must be cleaned with a 50:50 mixture of isopropyl alcohol and water. (See Required Surface Preparation.)
2. Apply a strip of the 3M™ VHB™ Tape along both longitudinal edges of the batten strip.
3. Align the batten strip on the panel seam so that both edges of the two panels are covered with tape.
4. Remove release liner and apply batten strip to panel seams. A J-roller can be used to aid in laminating the batten strip to the panels.

Overlaying Old Porcelain Enamel Signs:

1. Remove copy and legend from the porcelain background.
2. Clean the perimeter of the porcelain sign with a 50:50 mixture of isopropyl alcohol and water. (See Required Surface Preparation.)
3. Determine the amount of tape to be used from the procedures below. (See Tape Usage.)
4. Clean the surface of the overlay sign with the 50:50 isopropyl alcohol and water mixture. (See Required Surface Preparation.)
5. Apply the 3M™ VHB™ Tape to the perimeter of the overlay panel(s).
6. When desired alignment is achieved, press the overlay onto the porcelain sign and roll the edges with a J-roller. Generally, if the perimeter of an overlay is taped with a continuous strip of 3M™ VHB™ Tape it will support the weight of the overlay sign. Review the Tape Usage section below to determine the recommended amount of tape to use and whether additional tape is necessary.

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Tape Usage Guide for Traffic Sign Assembly

As a general rule, four square inches of 3M™ VHB™ Tape should be used for each pound 4 in.² / lb (60 sq. cm/kg) to be supported in static load. More or less tape may be required depending on the particular application. User evaluation is therefore required to determine optimal tape usage. For most traffic sign applications where the 3M™ VHB™ Tape is used to bond stiffeners onto a sign face, the static load that the tape must support is equal to the weight of the sign face. To determine the amount of tape to use for aluminum signs while following the 4 in.²/lb (60 sq. cm/kg) guideline, follow the procedure outlined below:

- 1) **Sign Surface Area:** Multiply the dimensions of the sign face, in feet, to determine the sign's surface area.

$$\begin{array}{ccccccc} \text{_____} & \text{ft} & \times & \text{_____} & \text{ft} & = & \text{_____} & \text{ft}^2 \\ \text{Length} & & & \text{width} & & & \text{(a)} & \text{of sign surface} \\ & & & & & & & \text{area.} \\ \\ \text{_____} & \text{m} & \times & \text{_____} & \text{m} & = & \text{_____} & \text{m}^2 \end{array}$$

- 2) **Sign Weight:** Multiply the surface area, (a), by the appropriate weight per square foot (square meter), from table below, for the particular thickness of aluminum being used to determine the static load of the sign face.

Thickness in. (mm)		Weight lb/ft ² (kg/sq.m)	
.063	1.6	0.907	4.42
.080	2.0	1.15	5.61
.100	2.5	1.44	7.02
.125	3.0	1.80	8.78

From Table 7.4 of the
ASTM Chart for sheet
and plate weights

$$\begin{array}{ccccccc} \text{_____} & \text{ft}^2 & \times & \text{_____} & \text{lb/ft}^2 & = & \text{_____} & \text{lbs. of static load} \\ \text{(a)} & & & \text{from Table} & & & \text{(b)} & \\ \\ \text{_____} & \text{m}^2 & \times & \text{_____} & \text{kg/m}^2 & = & \text{_____} & \text{kg, of static load} \end{array}$$

- 3) **Square Inches of Tape:** Multiply pounds of load, (b), by 4 in.² of tape per pound to determine the amount of tape required to support the load.

$$\begin{array}{ccccccc} \text{_____} & \text{lbs.} & \times & 4 & \text{in.}^2/\text{lb.} & = & \text{_____} & \text{in.}^2 \text{ of tape.} \\ \text{(b)} & & & & & & \text{(c)} & \\ \\ \text{_____} & \text{kg.} & \times & 60 & \text{cm.}^2/\text{kg.} & = & \text{_____} & \text{cm.}^2 \text{ of tape.} \end{array}$$

- 4) **Lineal Feet of Tape:** To convert the required square inches of tape into lineal feet of 1-inch wide tape to be applied to stiffeners, simply divide the required square inches, (c), by 12 in. /lineal ft.

$$\begin{array}{ccccccc} \text{_____} & \text{in.}^2 & \div & 12 & \text{in.}/\text{ft} & = & \text{_____} & \text{lineal feet of 1-inch wide tape} \\ \text{(c)} & & & & & & \text{(d)} & \text{required to support the weight} \\ & & & & & & & \text{of the sign face} \\ \\ \text{_____} & \text{cm.}^2 & \div & 2.5 & \text{cm.} & = & \text{_____} & \text{lineal cm of 2.5 cm wide tape} \\ & & & & & & & \text{required to support the weight} \\ & & & & & & & \text{of the sign face} \end{array}$$

Note: This guide is intended to show how much tape, when properly applied, is required to support the weight of the sign face. More tape may be necessary to fully cover all the stiffeners used to prevent wind deflection for a particular sign design. User evaluation is required to determine optimal tape usage for a specific application.

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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.

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.

Limitation of Remedies and Liability

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.

ISO 9001:2000

This Industrial Adhesives and Tapes Division product was manufactured under a 3M quality system registered to ISO 9001:2000 standards.



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