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A Comparison of Cargo Trailer Assembly Methods

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Industrial Adhesives & Tapes Division

Introductions

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Abstract: A Comparison of Cargo Trailer Assembly Methods

- The market has been asking for more smooth sided trailers (durability and aesthetics)
- Trailer manufacturers have been exploring various methods of side panel bonding in order to create smooth sided trailers in the most efficient and cost effective way: tape, adhesives & combination of tape and adhesives
- The design and assembly process associated with these three (3) methods differ greatly. A comparison of the various trailer assembly methods, including design, assembly and performance considerations, will be provided in the following presentation.
- Attendees will see the process steps involved and engage the assembly team in a discussion each method.
- 3M has been a trusted member of NATM for over 20 years and works with NATM Technical Committee

Agenda

- Primary Methods for Trailer Panel Assembly
- Assembly Considerations of Different Assembly Methods
- Performance and Aesthetic Considerations of Different Assembly Methods
- Dealer / Customer Considerations of Different Assembly Methods
- Q&A

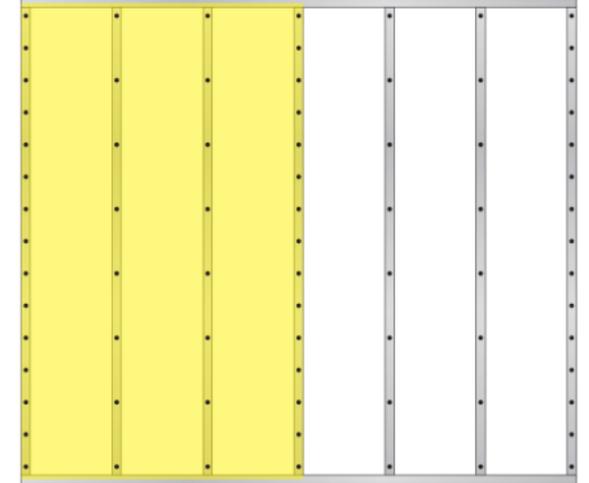
Methods of Assembling Trailers

- Mechanical Fasteners (Screw and Rivets)
- Liquid Adhesive Bonding
- Acrylic Foam Tape
- Liquid and Tape Combo

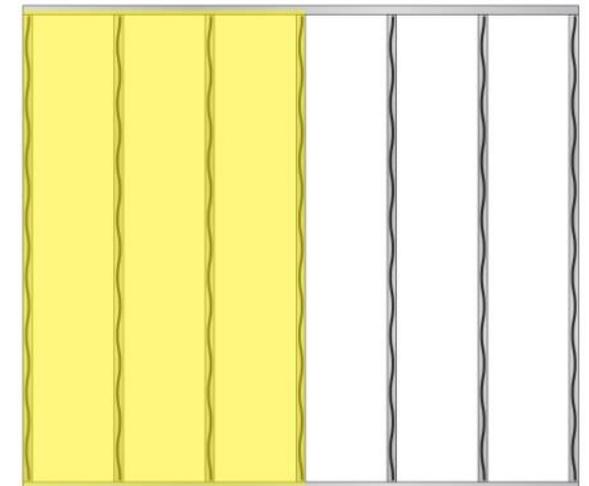


Methods of Assembling Trailers

- Mechanical Fasteners (Screw and Rivets)
 - Attaching side panels to frame with screws or rivets
 - Most common approach seen in the market today
 - Typically chosen due to familiarity of method, ease of training crews, low material cost
- Liquid Adhesive Bonding
 - One or two part liquid adhesives used to bond side panels to frame and bond panel seams
 - Spacer tape used to prevent “squeeze-out” on overlap seam
 - Panels are typically fixtured in place with a few screws or clamps while adhesive cures.
 - Increasing adoption of this method over screwed trailers due to speed of application, durable performance, improved aesthetics



Mechanical Fasteners



Liquid Adhesive

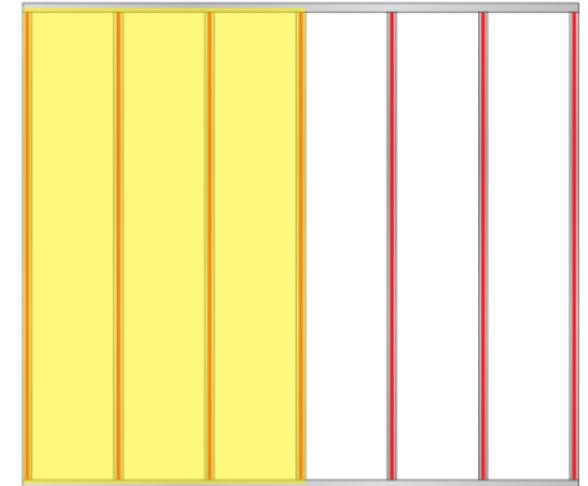
Methods of Assembling Trailers

- Acrylic Foam Tape

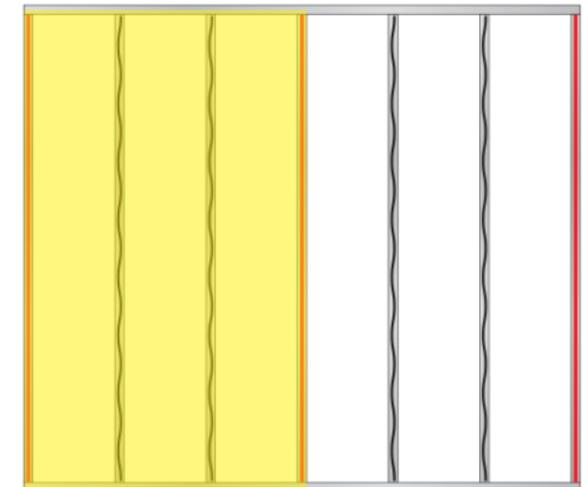
- Panel bonded to frame and overlap seams bonded with a fully cured “double sided” acrylic foam tape
- Durability and performance proven with extensive 3rd party testing and a 25+ year track record
- Chosen due to performance, durability, smooth look and immediate bonding or handling strength

- Liquid and Tape Combo/Hybrid

- Attaching panels and overlap seams with a combination of tape and liquid adhesives
- Combines immediate handling strength benefits of tape with easy application of adhesives
- Tape typically used for overlap seams and some of the posts while adhesive used on intermediate posts



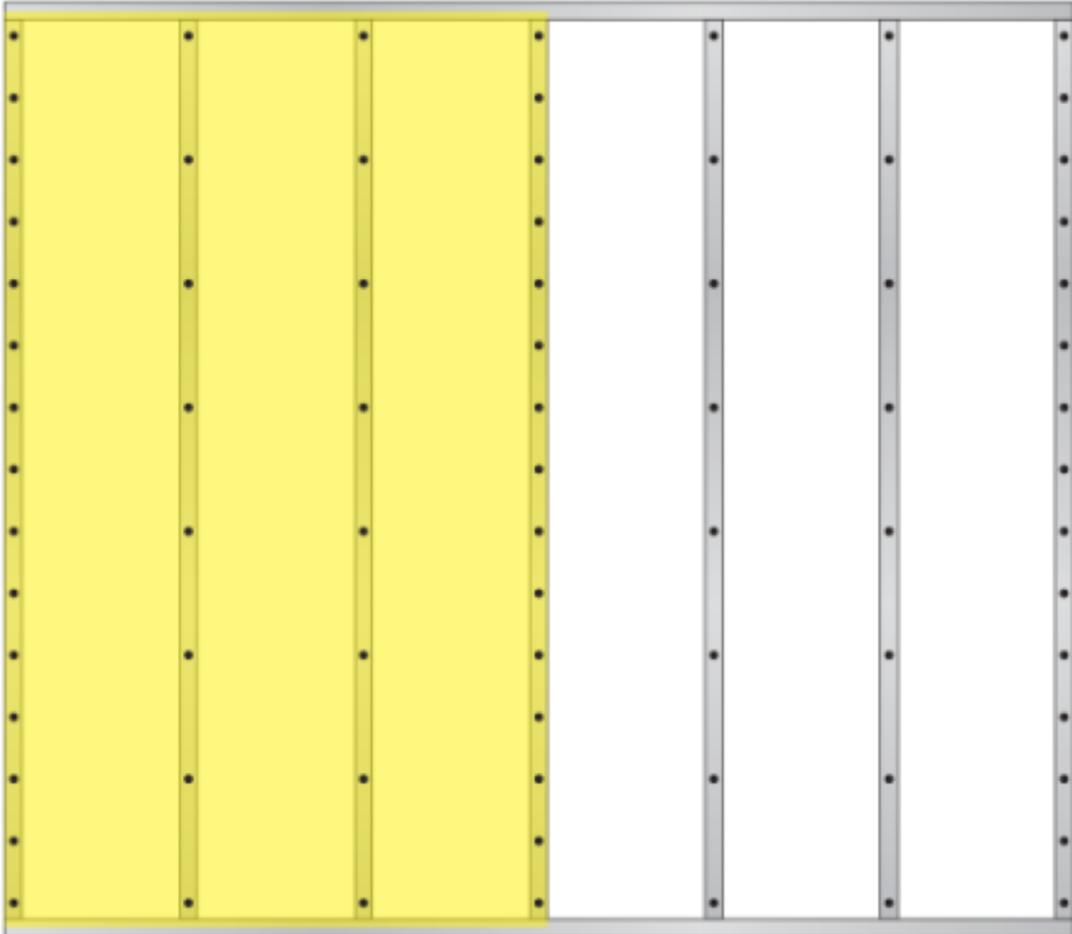
Acrylic Foam Tape



Combo/Hybrid

Process, Performance and Aesthetics Considerations of the Various Assembly Methods

Mechanical Fastener Method



Mechanical Fastener Assembly Considerations

Advantages:

- Immediate holding strength
- Easy to train operators
- No surface preparation required
- Application not affected by temperature

Limitations/Challenges:

- Screw location must be identified to make sure fastener doesn't miss frame (X on posts and 2X at seams)
- Significant tool noise, ergonomic issues and repetitive motion injuries
- Must work off of ladders or scaffolding
- Damage caused by driver slippage
- Screws not recommended on aluminum framed trailers due to the softness of the metal (risk of coming loose)

Mechanical Fasteners Performance/Aesthetic Considerations

Performance concerns:

- Panel fatigue (point stresses)
- Metal to metal contact creates galvanic corrosion
- Reduced durability as screws loosen
- No sealing – water intrusion



Bosch Automotive Proving Grounds:
31% of screws loose after 36,000 simulated miles



Aesthetic Concerns:

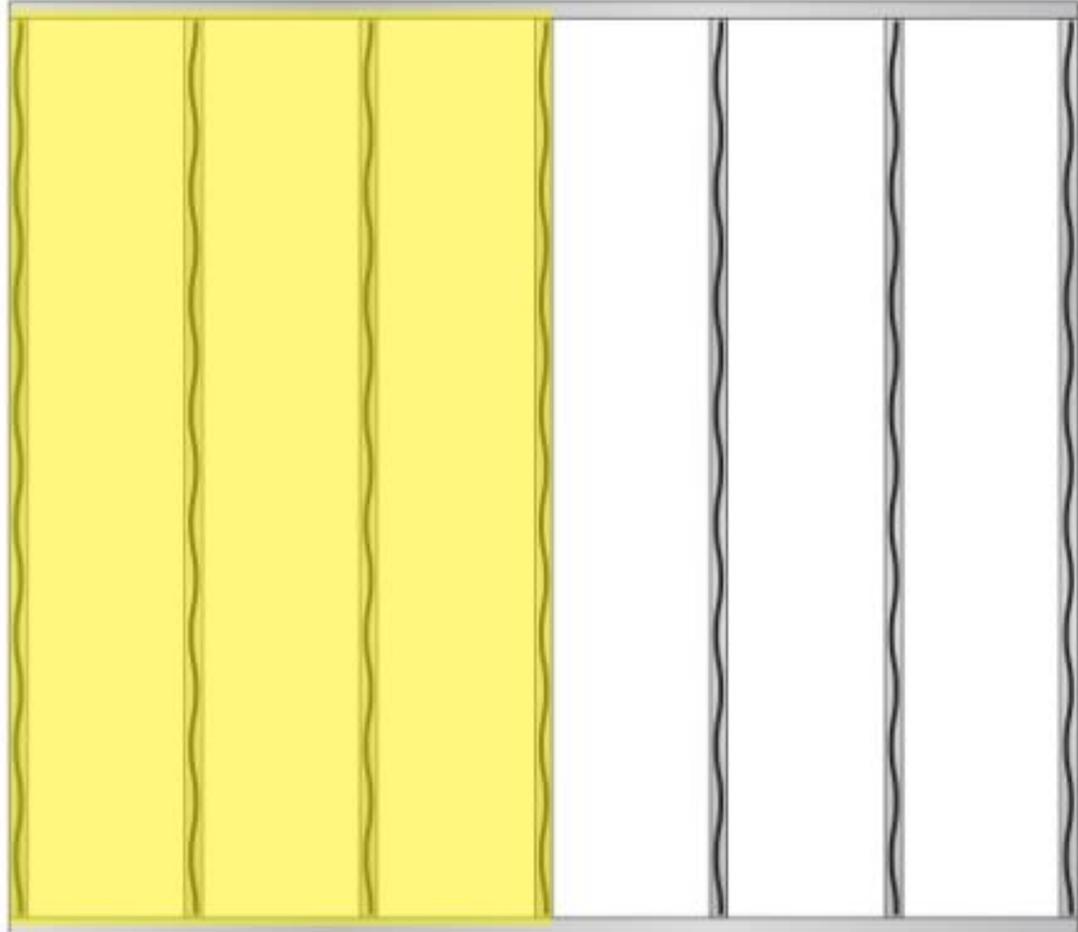
- Visible fasteners
- Fastener and post corrosion
- Panel distortion, dimpling
- Harder to wrap or apply graphics, reduced durability of graphics



Mechanical Fasteners Performance/Aesthetic Considerations



Liquid Adhesives Method



Liquid Adhesive Assembly Considerations

Advantages:

- Easy to apply adhesive onto frame
- Minimal training required
- Application process is quicker than screwed trailers

Limitations/Challenges:

- Some adhesives require surface preparation for adequate performance
- Adhesives don't have immediate handling strength
- Clamping or fixturing required
- Need to prevent adhesives squeeze-out at seams – separate step required
- Panel needs to be applied to frame within certain period of time (open time)
- Cure rates are affected by temperature (assembly and outside storage)

Liquid Adhesive Performance / Aesthetics Considerations

Performance Considerations

- Adhesives provide bonding and sealing
- Adhesives distribute stress over a larger area – minimize stress concentration and fatigue
- Some adhesives have flexibility and elongation to withstand vibration and impact
- Adhesive bead dimension is irregular – could lead to false bonds

Aesthetics Considerations

- Smooth sided trailers, no visible fasteners
- Some adhesives can cause dimpling or read-through due to shrinkage
- “Pillowing” appearance at high temperatures
- Adhesive bead dimension is irregular – could lead to “wavy” appearance
- Uncured adhesive can get on panels, requiring extra clean up

Typical Adhesives Used in Panel Bonding

		Adhesive Sealants		Structural Adhesives	
		Polyurethane	SMP	Acrylic	Epoxy
Advantages		<ul style="list-style-type: none"> - Lowest cost solution - Good flexibility & elongation - Durability 	<ul style="list-style-type: none"> - Minimal surface prep required - Good flexibility & elongation - Durability 	<ul style="list-style-type: none"> - Very high ultimate strength - Relatively fast cure time - Minimal surface prep 	<ul style="list-style-type: none"> - Very high ultimate strength - Faster cure than sealants
	Disadvantages	<ul style="list-style-type: none"> - Long cure time - Very low initial strength - Surface prep required - "Wavy" bondlines 	<ul style="list-style-type: none"> - Long cure time - Low initial strength - "Wavy" bondlines 	<ul style="list-style-type: none"> - More expensive than sealants - Low initial strength - needs fixtured - Can cause dimpling 	<ul style="list-style-type: none"> - More expensive than sealants - Surface prep required - Low initial strength - needs fixtured - Can cause dimpling

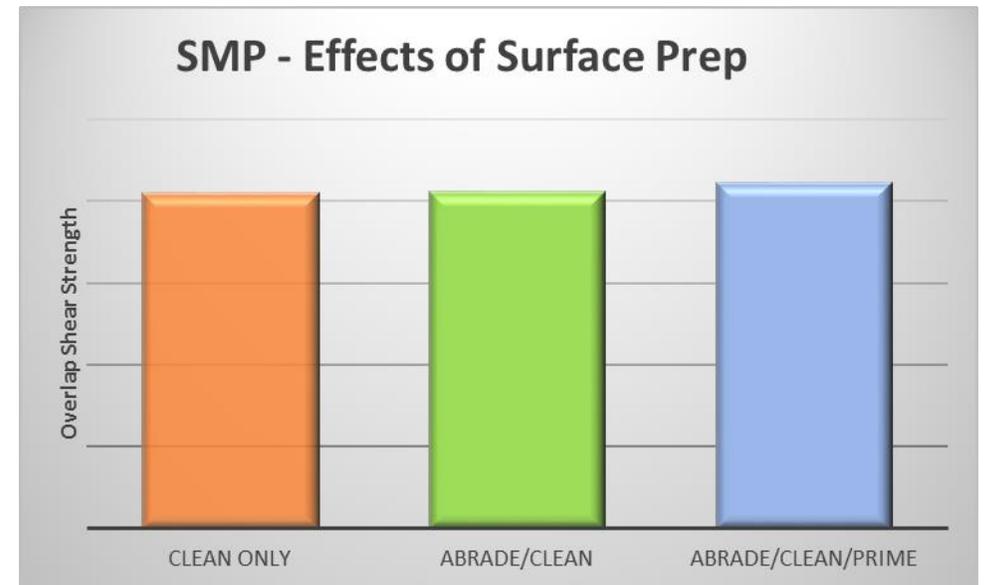
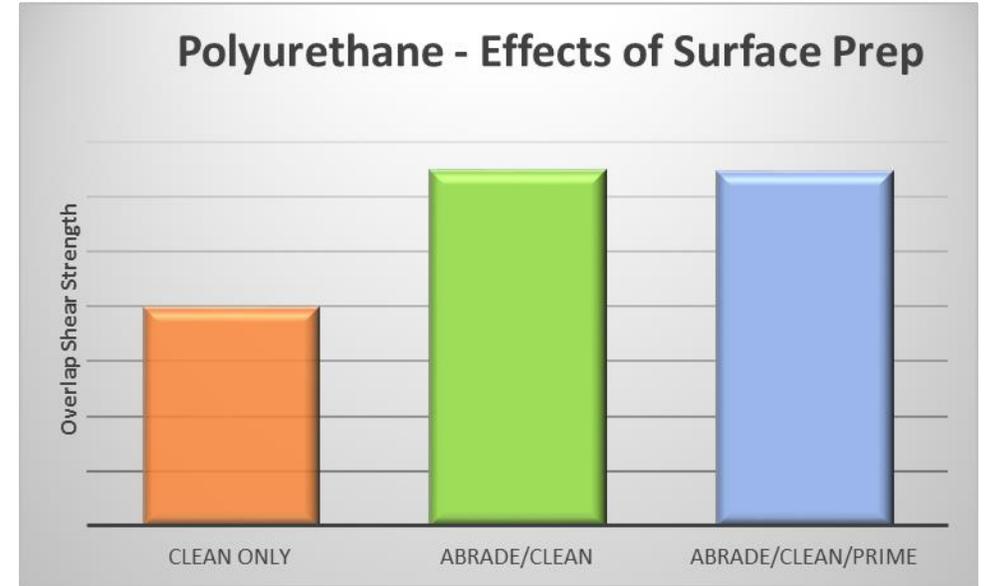
Adhesive Sealant Technology Considerations

Polyurethane Adhesive Sealants

- Lowest cost solution
- Surface prep required on aluminum and steel
- Great overall adhesion and durability

Silane Modified Polymer (SMP)

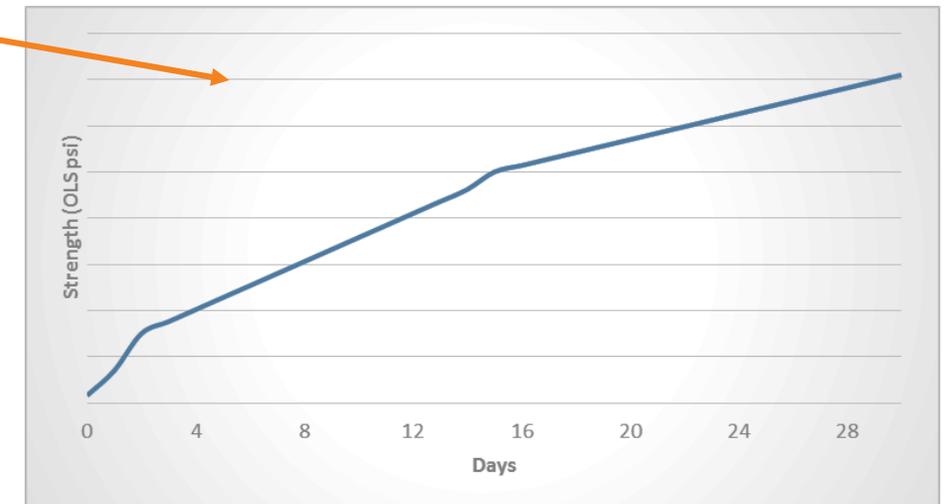
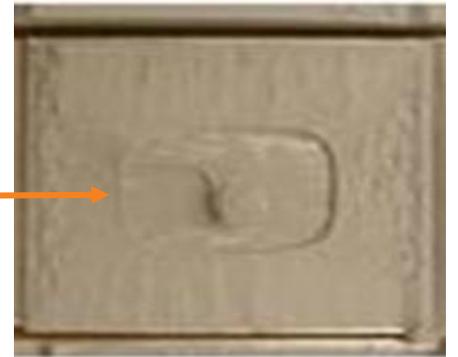
- Similar performance to polyurethanes
- Typically, NO primer needed for aluminum and steel
- Little higher cost, but eliminates priming step



Adhesive Sealant – Rate of Strength Build

CAUTION: Adhesive sealants take a long time to build strength and ultimately cure

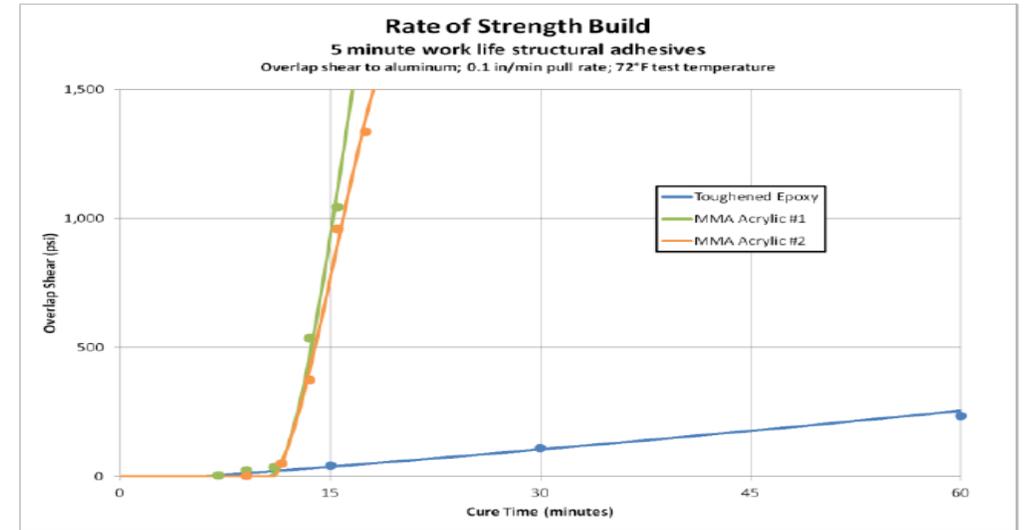
- Adhesives sealants are a moisture curing technology
- When sandwiched between two pieces of metal, they have to cure from the outside in
- This can take 14 – 28 days
- Risk of delamination due to thermal expansion/contraction of the panel if not adequately cured
- **RECOMMENDATIONS:**
 - Allow 14 days to build strength before exposing to environment
 - Use acrylic foam tape in combination with sealant to keep panel secure while curing



Structural Adhesives Technology Considerations

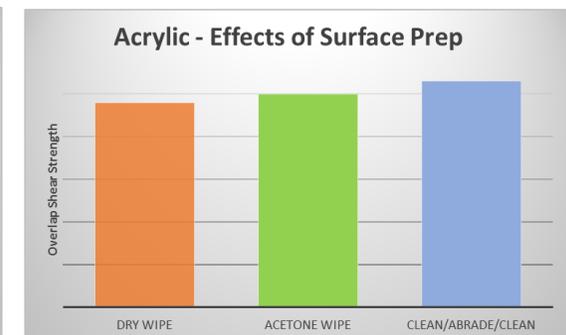
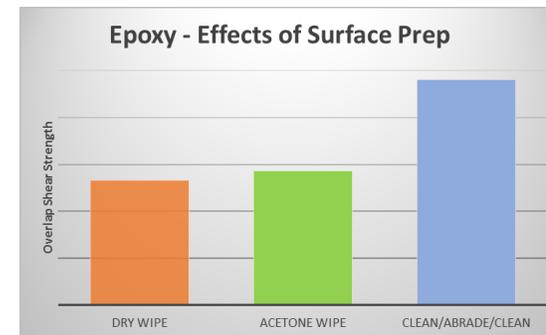
Acrylic adhesives

- Fast rate of strength build (10-20 minutes to handling strength)
- Minimal surface prep required
- Plenty strong for panel bonding



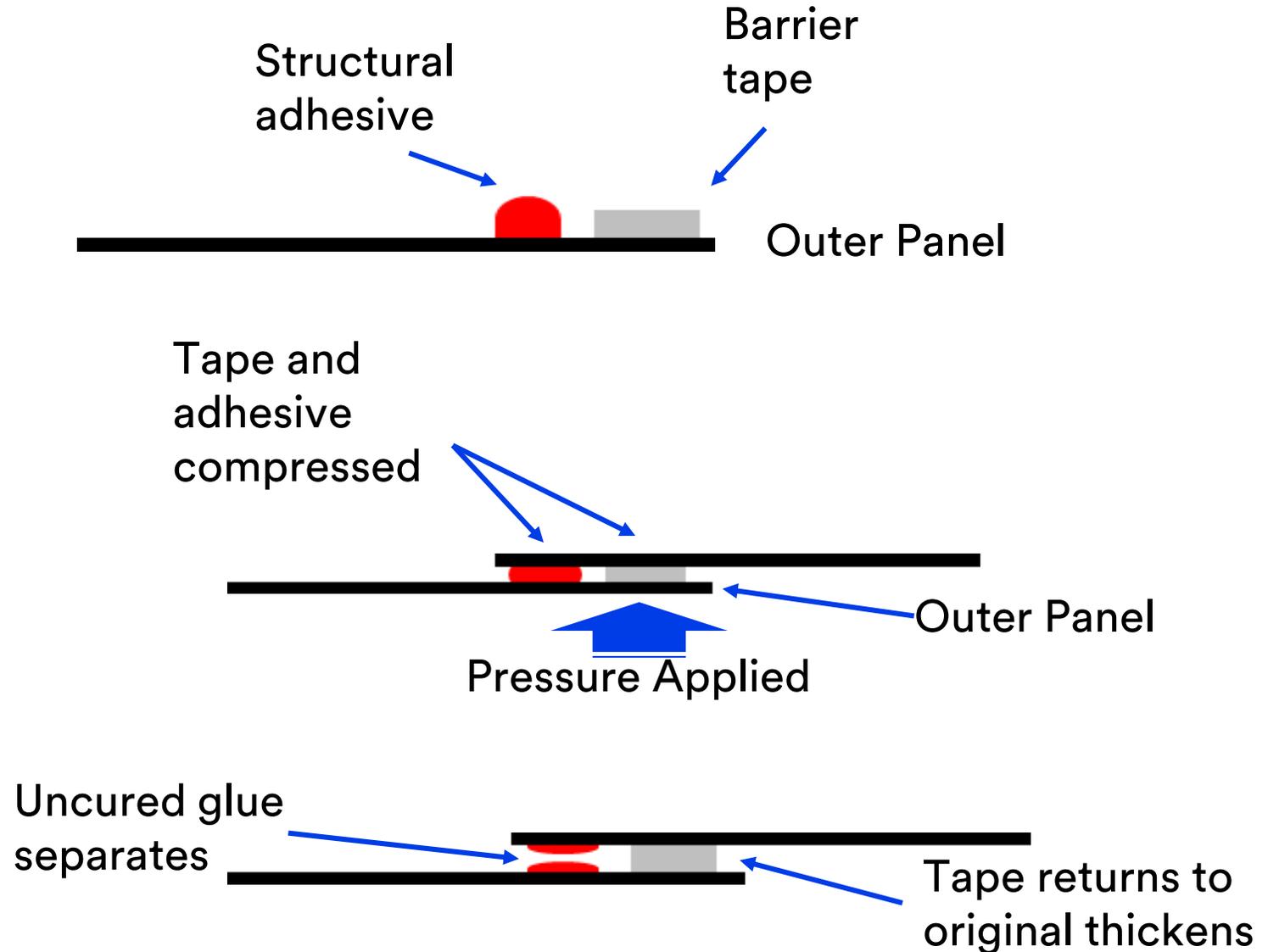
Epoxy adhesives

- Slower rate of strength build (hours)
- Typically require more surface prep than acrylics
- Strongest overall performance
 - May not be needed for this application
 - More common in bus/truck applications

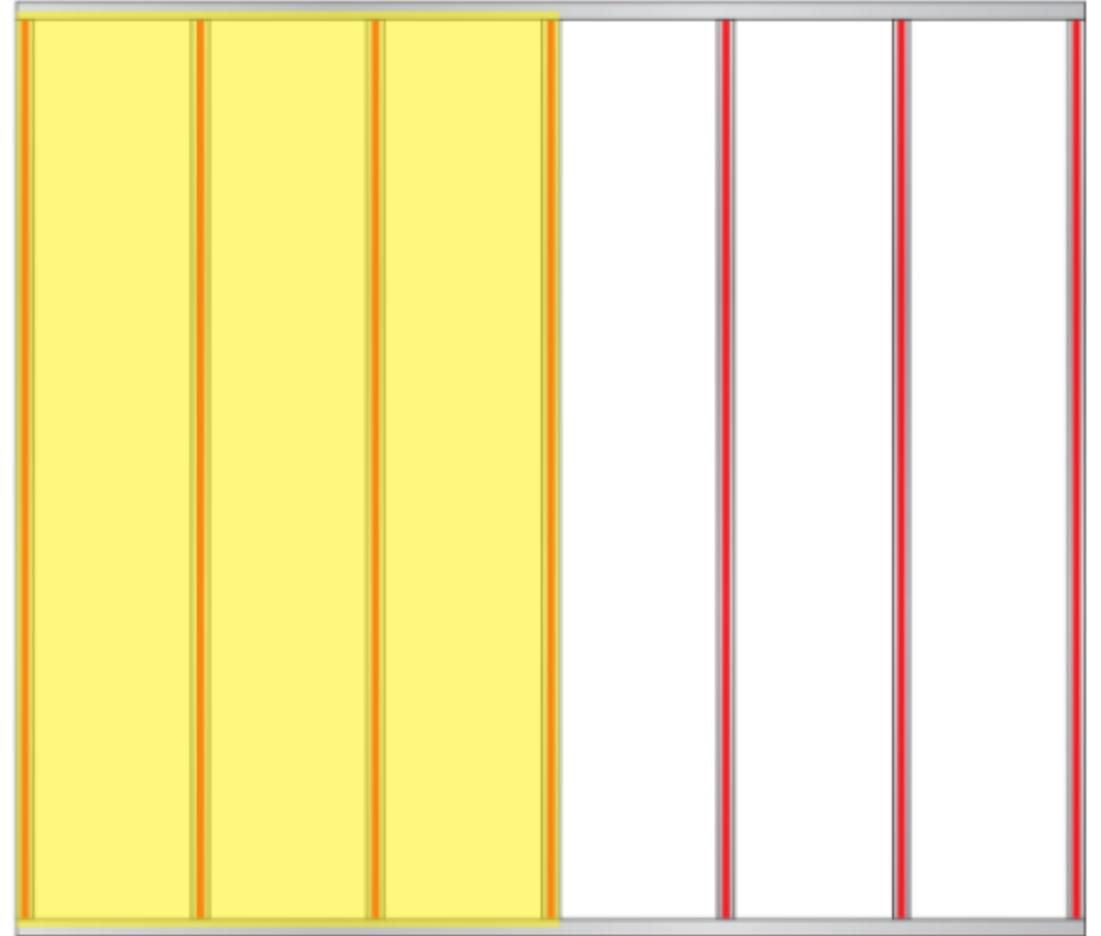


Structural Adhesive Caution – False Bonds

- Common issue when using liquid adhesives with an open-cell foam barrier tape
- Pressure on the bond “flattens” the adhesive
- Adhesive separates upon recovery of the foam



Acrylic Foam Tape Method



Acrylic Foam Tape Assembly Considerations

Advantages:

- Ease and convenience of tape
- Flexibility in assembly process
 - Pre- tape panels
 - Pre-tape posts (prior to frame set)
 - [Automation possibilities \(video\)](#)
- Immediate handling strength
 - Fully cured – No fixturing or cure time
 - Can be shipped immediately after assembly
- Bonds dissimilar materials
- Opportunity for lightweighting

Limitations/Challenges:

- Some surface preparation required
- Planarity of bonded substrates
- Some design change required
 - Unconstrained design
- Operator training required
- Process is important, but easy to learn
- Application temperature should be >50F

Acrylic Foam Tape Performance Considerations

- Proven performance and durability
Bosch study – 100,000 miles with no delamination* (screws failing at 36,000)
- Closed cell acrylic adhesive core allows bonding and sealing
- Stresses distributed across entire bond line
- Viscoelastic material: energy absorbing and stress relaxation
- Noise, Vibration and Harshness (NVH): reduced noise (41%) and vibration (30%)
- Allows unconstrained panel movement caused by thermal expansion and contraction
- Bonds dissimilar materials, eliminating galvanic corrosion
- Surface preparation and contact pressure critical to making good bond
- Unconstrained design is optimal to allow for expansion and contraction of panel

* Acrylic Foam Tape: 3M™ VHB™ Commercial Vehicle Tape CV62F/CV45F

Acrylic Foam Tape Aesthetics Considerations

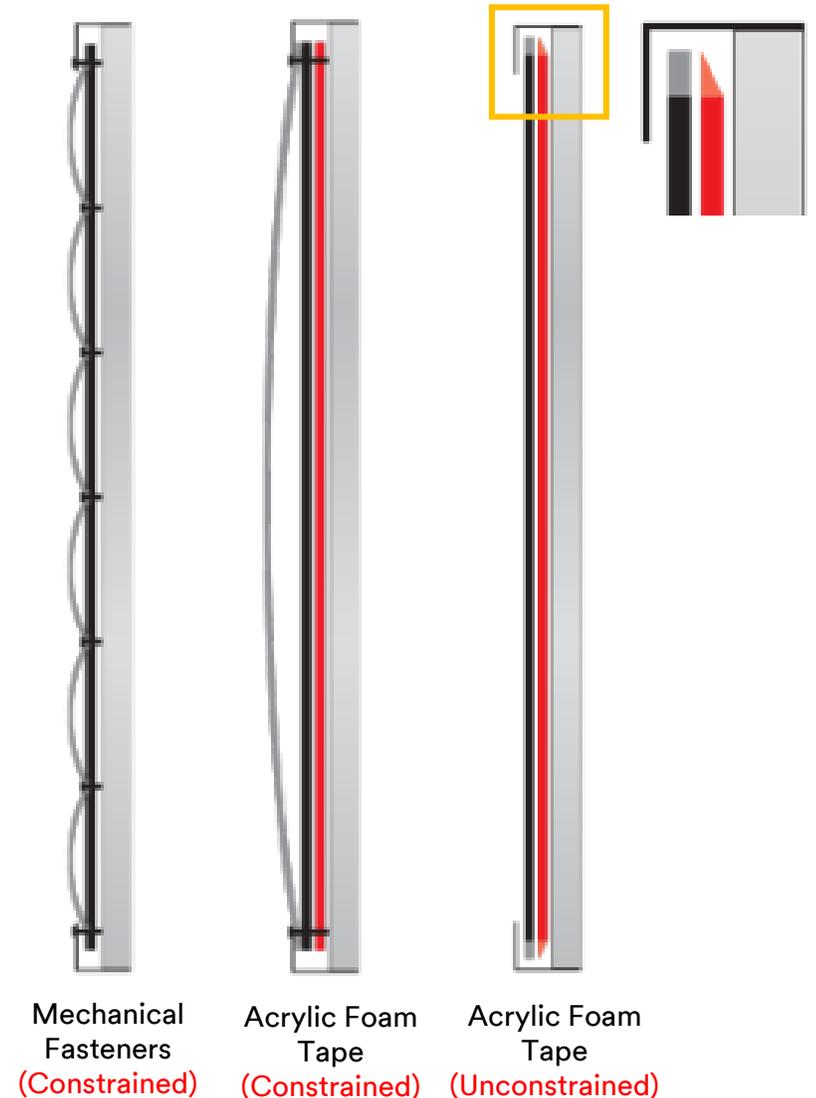
Aesthetics Considerations:

- Ultimate smooth-sided appearance (unconstrained design)
- Improved appearance and durability of graphic overlays
- Protective film stays on sidewall panel throughout production



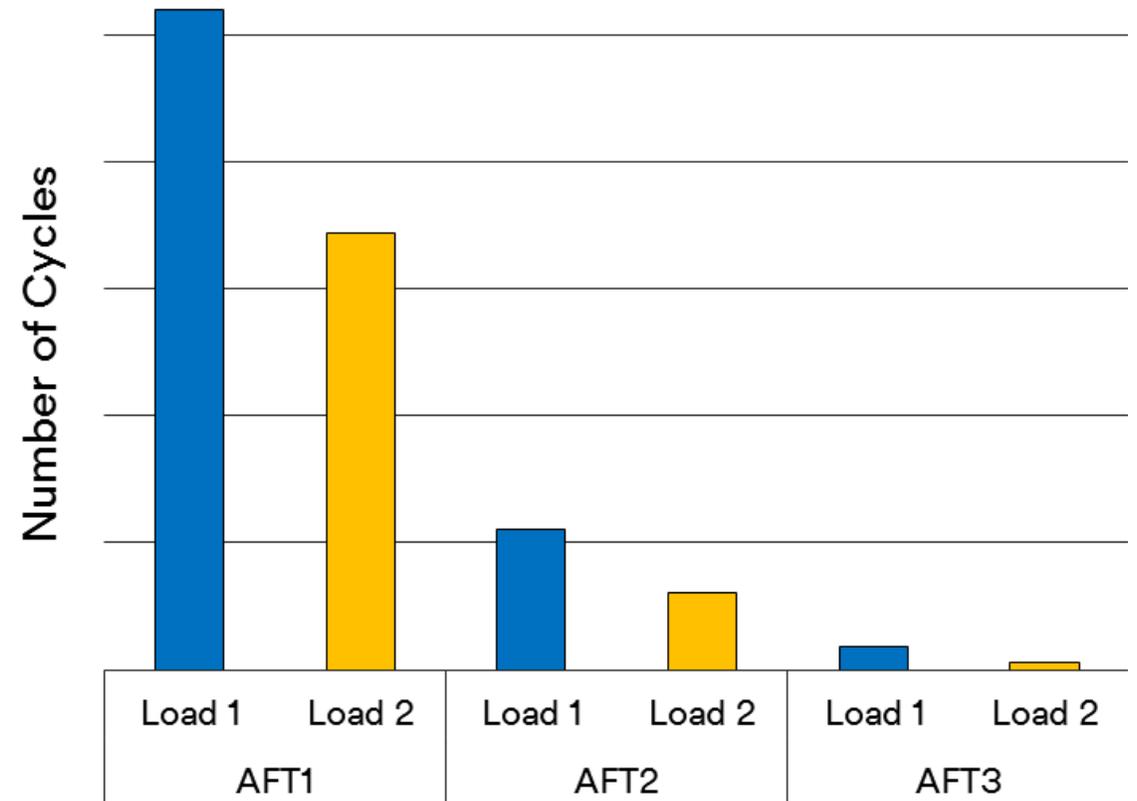
Acrylic Foam Tape Technical/Design Considerations

- Need to design for thermal expansion & contraction
- Stress can cause popping of panels
- Unconstrained design is optimal
- Things to try and prevent:
 - Screw through panel
 - Screw right above panel preventing expansion
 - Pinch extrusion up against panel

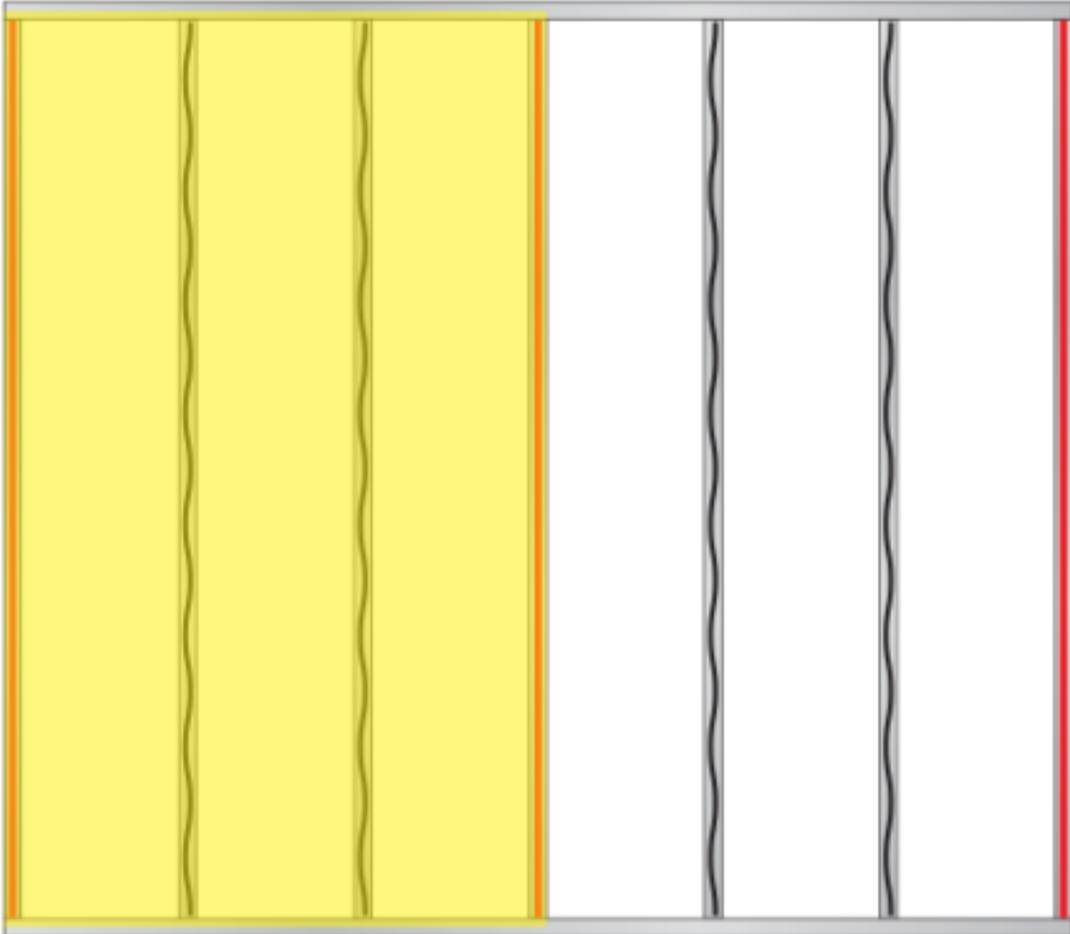


Acrylic Foam Tape Technical/Design Considerations

- Not all foam tapes are created equally
 - Various acrylic adhesives
 - Various core densities
 - Firm, Conformable, Soft
- Poor tape selection can lead to failure
- Cyclic Fatigue Test– potential predictor of tape failure (core strength)



Liquid & Tape Combo Method



Liquid & Tape Combo Assembly Considerations

Advantages:

- Leverages benefits of tape and adhesive
- Immediate green strength from the tape
- Holds panel in place while adhesive cures
- Can be shipped immediately after assembly
- Speed of applying adhesive
- Assembly flexibility
 - Pre-taping panel seams and staging of panels

Limitations/Challenges:

- Some surface preparation required
 - Substrate dependent
- Operator training required
 - Process is important, but easy to learn
 - Two different methods requires additional training
- Uncured adhesive can get onto panel surface causing rework
- Proper bead thickness is critical

Liquid & Tape Combo Performance/Aesthetics Considerations

Performance Considerations

- Tape and adhesive sealants both have viscoelastic properties
- Tape and adhesive sealants both provide bonding and sealing
- Tape is holding panel in place while adhesive is curing
- Newer assembly method, not as many years with proven track record
- Potential false bonds if not enough adhesive applied

Aesthetics Considerations

- Still a smooth sided trailer, good aesthetics
- Adhesive bead dimension is irregular – could lead to “wavy” appearance
- Improved appearance and durability of graphic overlays

Summary – Wrap up

	Process	Performance	Aesthetics
Fasteners	Easy, time consuming	Loosen over time, corrosion and leaking	Least attractive
Liquids	Easy, fast application, needs fixturing	Good long term performance, need to ensure full cure	Smooth look, potential for dimpling, waviness, or read-through
Tape	More steps required, but immediate holding power	Proven long term durability, can ship immediately	Smoothest look
Tape and Adhesive Combo	More steps required, immediate holding power, leverage speed of adhesive application	Good performance, tape holds during cure	Smooth look, potential for waviness

There are pros and cons to each application method – need to determine what makes the most sense for your operation and your customer base

Dealer and Customer Considerations of the Various Assembly Methods

Dealer and Trailer Owner Considerations

How dealers sell smooth sided trailers sell for a 10-15% premium

- Aesthetics
- Durability
- Water resistant
- Weight reduction
- Reduction in NVH
- Minimal warranty/rework



Dealer and Trailer Owner Considerations

Customer Wants	Smooth-sided Trailer	Mechanical Fastener
Durability	Flexes with thermal expansion and contraction	May become loose during thermal expansion and contraction
	Absorbs vibration; helps maintains the bond and seals against water and dirt intrusion	May become loose over time which can lead to leaks
	Separates dissimilar metals to help prevent galvanic corrosion	Dissimilar metals can come in contact leading to galvanic corrosion
Aesthetics	Smooth appearance even in the sun's heat	Expands into a quilted pattern in the sun
	Improved appearance of graphics	Surface dotted with rivets and screws
Reduced Noise	Bonded panels stay tight helping to reduce rattling	Rigid metal-to-metal attachment of mechanical fasteners transfer sound
	Viscoelastic properties help provide sound damping	

Trailer Build Demo

Frequently Asked Questions

- We have seen taped trailers fail in the past. How can you explain that?
 - Constrained design
 - Wrong tape
 - Surface prep or process
- The process of taping seems slower than adhesives or fasteners.
- What about two-component adhesive sealant technology?
- How strong does a bond really need to be?



Questions?