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Technical Advisory for Design and Materials Engineers to Achieve Capacity, Efficiency and Sustainability Goals

3M Bonding & Assembly Design Solutions for Weight Reduction in the Rail Industry

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Rolling stock weight reduction is a key priority if the rail industry is to meet its capacity, efficiency, sustainability and operating cost-reduction goals.

In the quest for overall weight reduction, rail OEMs are exploring the use of new vehicle architectures, materials and construction

methods. Joining and bonding solutions using high-performance adhesives and tapes are a significant enabler of lightweighting in the rail sector, providing safe, durable and cost-effective solutions to many challenging assembly applications. 3M has adhesive bonding technologies that can speed up assembly processes and lighten the load by reducing the number of mechanical fasteners needed in rail carriage assembly.

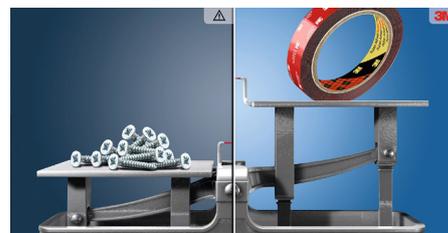
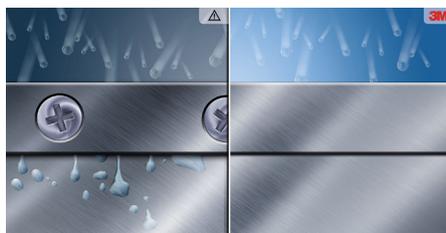
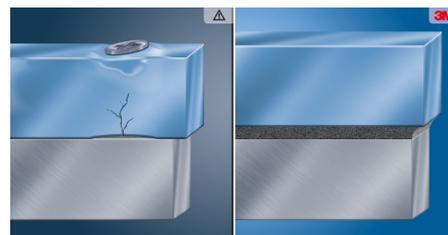
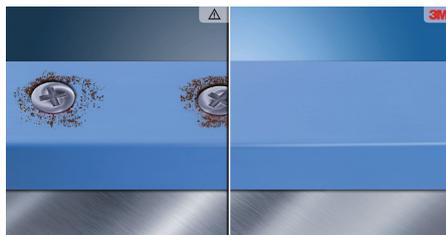
Our technologies can also support in bonding composites which enable lighter constructions.

Advanced materials create new manufacturing challenges. They include the need to create durable connections between dissimilar materials. Thus, avoiding stress peaks around fasteners and preventing water ingress and corrosion getting into and between components. OEMs also need

construction technologies that work reliably and consistently in the production environment. Advanced adhesive bonding technologies such as 3M™ VHB™ Tapes and the Scotch-Weld™ Structural Adhesives allow manufacturers to achieve those aims. Adhesive bonding allows structural connections to be made between many different materials. This is a significant advantage in designs that include both metal and composite or polymer components. Where dissimilar metals are joined, such as aluminium body panels to a steel frame, an adhesive or taped joint provides electrical insulation, reducing the incidence of galvanic corrosion.

With the correct joint design, adhesive bonding ensures loads are carried by the entire joint, allowing the use of thinner, lighter materials. Bonded joints can secure and seal a structure in a single operation and they can also be designed to reduce the transmission of sound and vibration. For carriage interior components, bonding using 3M™ Scotch-Weld™ Structural Adhesives and 3M™ VHB™ Tapes gives designers the opportunity to save weight while also creating systems that are robust and easy to look after. Advances in the chemistry of adhesives mean that lightweight, low-surface energy polymers such as polypropylene (PP) and thermoplastic polyolefin (TPO) can now be bonded reliably, without the need for costly and time-consuming surface treatments. Reclosable tapes, such as 3M's Dual Lock™ range, allow the installation of removable panels or upholstery elements with a clean aesthetic finish.

To capture the full performance



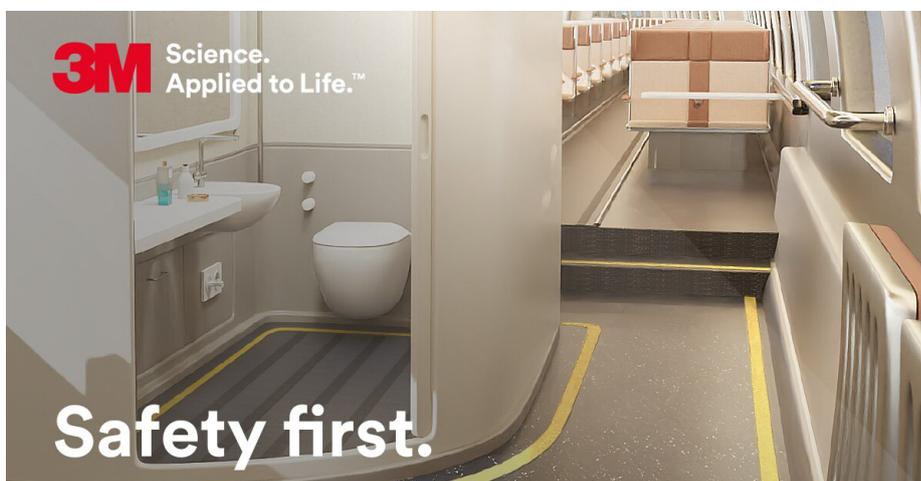
and weight reduction benefits available from the use of adhesive bonding, it is important that the joint design and choice of adhesive are appropriate for the applied loads, operation conditions and the characteristics of the materials involved. The strength of a joint depends on both the quality of adhesion achieved, the cohesive strength of the cured adhesive and a selection of an adhesive with an appropriate stiffness (modulus of elasticity). The joint design must also consider the most appropriate mode of failure for the joint.

In safety-critical applications such as rail passenger car interiors, materials must comply with

stringent fire, smoke and toxicity (FST) regulations. While these requirements were once seen as a barrier to the adoption of certain materials, 3M has made significant progress in the development of adhesives and tapes with excellent FST performance.

At 3M, we are continuing to develop a range of innovative products to streamline and ensure the quality of future rolling stock delivery. 3M's industry-leading range of adhesive and tape solutions for interior and exterior designs is vast, offering both bonding and fastening solutions.

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