Outperforming Mechanical Fasteners: Using Structural Adhesives for Structural Applications
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As times change and products become more sophisticated, manufacturing techniques must be refined to accommodate new needs in structural applications. Mechanical fasteners and welding are traditional joining methods that many manufacturers are comfortable with, however, these methods are not always the most practical solution for modern assembly. Mechanical fasteners can drive up costs, limit options for materials, and cause fatigue, metal distortion or tearing.

Structural applications need strong adhesives or tapes that can outperform mechanical fasteners and provide a clean, durable design. Industrial adhesives are an easy alternative that solves the problems presented by traditional joining methods.

Problems with Mechanical Fasteners

Traditional joining methods can present difficulties in the assembly process. Metal distortion and tearing under heavy loads, or fatigue, reduces reliability and longevity of assembly parts. To address this issue, manufacturers may try and decrease the gap size between rivets or bolts, inflating the number of needed fasteners and associated purchasing and labor costs.

Even welding can damage metals, by causing heat distortion or burn-through, especially with lighter weight substrates. Also, energy and labor is often needed to return the welded parts to a condition suitable for painting.

Sustainability in production is a hot-button issue that is only going to escalate. A lot of pressure is on manufacturers to decrease fuel use, energy consumption and contaminant emissions. The best way to do that is to reduce the weight of materials being produced, and use the lighter-weight materials in lieu of traditional heavy metals.

Unfortunately, traditional joining methods usually aren't as effective as adhesives when joining lighter-weight materials, so reducing weight for sustainability's sake becomes a difficult task. Lighter composite or plastic materials cannot always be easily welded, and thin sheet metal parts are prone to distortion and tearing at the concentrated points where through-part fasteners like rivets and bolts are placed.

While mechanical fasteners can often provide structural strength, the level of holding power that they provide can be overkill for many common applications. In this way, mechanical fasteners are used out of convenience rather than necessity, when there are more simple and effective joining options available.

Choosing Adhesives

Selecting industrial adhesives for structural applications opens the door to opportunities that would not be possible when relying on mechanical fasteners or welding options.

Adhesives are great options for thin, lightweight materials. Where mechanical fasteners may rip though and damage a thin substrate, an adhesive bond provides even load distribution across the surface area of the joint area. This reduces the potential for fatigue damage, lengthens the life of the bond and product, and drastically reduces replacement or repair costs. Thinner and

lighter materials can be cheaper to manufacture than heavy metals, so using adhesives with these types of materials in assembly can effectively drive down costs, as well.

Adhesives allow manufacturers to diversify the materials used in their assemblies in other ways, besides simply using different kinds of metal. Using adhesives opens up options for more composite and plastic use, which can help manufacturers decrease material costs and improve the aesthetics of the end product.

Where mechanical fasteners can limit design options for structural applications, adhesives expand them. Adhesives can be applied in areas that are inaccessible to mechanical fastening during final assembly, allowing new designs that further reduce weight, costs and labor. From an aesthetics standpoint, adhesives can reduce and eliminate unsightly screw and rivet points and weld lines, leaving a smooth, uninterrupted surface without grinding after welding.

Adhesives allow manufacturers to bond dissimilar materials, such as metal to composites or plastics instead of metal to metal. Differentiating materials in assembly opens up a multitude of design options, and allows manufacturers to diversify their products and make them much more functional. Mechanical fasteners would not be a good option for joining metal to many composites, because drilling holes for fasteners would likely crack the material. When joining plastics to metal, thermal cycling can lead to fractures within the plastic.

Despite extraordinary advances in adhesive technology, many manufacturers continue to doubt adhesive strength. The below video from 3M Assembly Solutions shows how adhesives and tapes actually outperform metal fasteners in a test of strength and durability:

Industrial Adhesives and Tapes vs. Metal Fastener Drop Test Video

This video shows that adhesives and tapes can out-perform mechanical fasteners for applications with lighter weight substrates through their load-distribution capabilities. Adhesive sealants provide high elongation, flexibility and gap filling. Toughened epoxies are ideal for applications that need a more rigid solid combination of impact resistance and strength. 3M™ VHB™ Tapes are easy and convenient; yet provide excellent impact load resistance on thin substrates.

When put to the test against mechanical fasteners and rivets, 3M adhesives and tapes emerge victorious with superior hold, even stress distribution and seamless design.

Adhesive Solutions to Bonding Challenges

With more manufacturers choosing substrates than traditional metals, the right adhesives can be solutions for hard-to-bond materials.

Low surface energy (LSE) plastics like polyethylene, TPO, HDPE, PP and some powdercoats can be hard to bond because of their chemical composition. Typically, these materials will require extensive surface preparation processes before even beginning the joining process.

Thermal methods like friction or ultrasonic welding are considered solutions for LSE plastics. However, these methods are typically expensive and require ongoing tooling, which is not ideal for products that have short runs or need frequent design changes.

Even adhesives don't always solve the surface preparation issue, however some specialty adhesives, like 3M™ Scotch-Weld™ Structural Plastic Adhesive DP8010 Blue, can bond LSE materials and even reduce or eliminate the surface preparation steps.

Low Surface Energy Adhesives Put to the Test Video

Another challenge is trying to bond oily metal. Oily metals often require extensive preparation and cleaning which creates extra work. Unfortunately, these steps are necessary because the oil can interfere with robust bond formation.

That said, two-part structural acrylic adhesives are able to absorb most oils from metal surfaces, allowing the metals to bond without extensive cleaning first. This eliminates those tedious steps, saving the manufacturer time and money.

Adhesives: Going Beyond Strong

Though many manufacturers are comfortable with traditional fastening methods, modern design and sustainability factors render mechanical fasteners and welding to be less effective than alternative joining methods for many applications.

Adhesives are extremely effective to remedy the issues presented by mechanical fasteners, including metal distortion and tearing, and expensive repairs or replacements. Not only do adhesives provide a more effective alternative to traditional joining methods, they also allow manufacturers to choose from a wider variety of substrates, bond dissimilar or hard-to-bond substrates, and explore different design avenues to create unique and superior products.

Many people continue to misjudge the strength of adhesives. How could glue be suitable for a huge application? People may think that way, but an adhesive bond is not to be underestimated. The video below will show how just a thin layer of adhesive can hold thousands of pounds:

Epoxy Adhesive Strength Test *Video*

Imagine what adhesives could do for you and your design.

Going Beyond Strong with Tapes

For many applications, industrial strength tapes are a great option to provide even stress distribution and excellent strength in replacing rivets and spot welds. Tapes offer manufacturers a distinct bonding advantage by spreading stress loads across the entire length of the joint, permanently adhering materials with a powerful bond. Especially critical for metal fabrication, 3M™ VHB™ Tapes provide high holding power and long-term reliability for bonding stiffeners to panels, or panels to framework. In addition, 3M™ VHB™ Tapes' elastic properties absorb shock and flexing for reliability against wind, vibration, and thermal expansion or contraction.

Industrial strength tapes simplify the manufacturing process with ease of application. 3M™ VHB™ Tapes bond on contact, facilitating quick and easy assembly. They can be cut into precise shapes and sizes for custom applications. 3M™ VHB™ Tape's closed cell, acrylic construction stands up to water, dirt, dust and chemicals, protecting the bond and the overall product.

Visit 3M.com/assemblysolutions for more information on how 3M can help solve your assembly challenge.

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