Advantages of Structural Adhesives over Welding, Rivets, and Traditional Fastening Methods

Stronger Than Steel

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“Structural Adhesives” is a term that applies to any type of adhesive used to bond a load bearing joint necessary for the structural integrity of a product. By definition these joints are the most important bonds in the product as a failure is catastrophic to the product’s structure and function. As adhesive materials continue to advance, manufacturers are increasingly interested in when and how to use adhesives in structural bonding and what advantages are offered over welding, rivets and other fasteners. This paper will explain when adhesives are a good choice and compare commonly used structural adhesives to alternative fastening methods.

When to choose adhesives

Adhesives are regularly used in aerospace applications, bonding automotive components and even in sealing submarines and surface boats. These industries have learned to use adhesives due to cost, time, weight, performance and aesthetic improvements or to unlock new possibilities out of reach when using “traditional” fasteners. Appliance manufacturers have also begun to utilize adhesives but the full value of adhesives has yet to be realized in this industry.

Savvy manufacturers can recognize when to choose adhesives over welding or mechanical fasteners and look for indicators in the manufacturing process and product environment. Examples of some key indicators are when products require bonding different metals and are exposed to thermal cycling or if galvanic corrosion is a risk. Adhesives are also indicated if the products will be exposed to water and/or chemicals that may damage or penetrate other fastening methods. These are situations where adhesives offer particular benefits. Adhesives mitigate differential expansion rates and provide an inert barrier between potentially corrosive metals in the first case and provide a watertight seal and chemical resistance in the second case.

Another common reason to choose adhesives is to lower the weight of a final product. The early adopting industries mentioned above are all transportation industries where weight is of critical importance. Even a slight change in weight to an airliner results in massive cost reductions over the life of the plane. However, you don’t have to fly at 30,000 ft. to realize these benefits. Significant fuel savings can be seen by lowering the weight of cars or boats as well and any reduction in weight may make a product more portable or create room for the installation of additional components giving your product new abilities and a competitive advantage.

Cost

The cost savings of adhesives can be realized in several ways. First, adhesives often offer lower material costs per application than mechanical fasteners. Particularly where high end or coated fasteners must be used. Second, there are cost savings due to reduced ordering, shipping and stocking costs. A manufacturer may stock dozens of different shapes and sizes of rivets, screws, bolts and washers that can all be eliminated by a single adhesive. Third, the labor involved with applying adhesives can be less than other fastening methods. Consider the time required to weld metals. The welder needs to set up and gather equipment, perform the weld, inspect and touch up gaps, then file down excess material or sharp points. Finally, the weld needs to be polished and any discoloration needs to be addressed. All of this labor can be eliminated by using an adhesive and even if the adhesive chosen needs to be clamped and given time to cure, no human interaction is necessary during curing.

Time

As mentioned above the labor involved in welding can be significantly reduced with adhesives. But what about nuts and bolts or rivets? Both of these methods nearly always involve multiple attachment points and every attachment point is another touch, repeated work and additional labor required to
produce your product. Adhesives, by comparison, are typically applied across an area of the substrate in a single step. Don’t forget that best practice for threaded assemblies used in structural bonds already requires the application of sealants and adhesives in the form of thread lockers. The application of thread lockers and thread sealants is yet another step that can be eliminated by the switch to structural adhesives.

One and two-part epoxies are the most commonly used structural adhesives. In the past a two-part epoxy has always meant the additional step of ratio mixing to prepare the adhesive for application but recent advancements in technology have resulted in the two part – no mix products available today. These products utilize disposable static mixing wands to mix the perfect ratio of product during application. This further reduces the time adhesive application requires.

What about cure time? A rule of thumb with adhesives is: the longer the curing time, the stronger the final bond. However, while adhesives may require time to reach full strength, many adhesives can reach fixture or handling points in seconds to a few minutes and even where more time is required, no human interaction is needed while curing. In addition, improvements to UV adhesives and even some cyanoacrylates make previously inappropriate adhesives plausible for low stress structural bonds and allow the instant cure feature of these adhesives to be utilized.

Weight

Welding and most mechanical fasteners contain one key ingredient: metal. Metals are heavy when compared to the lightweight polymers of adhesives and even small metal components can add significant weight when multiple fasteners are needed. This is why the aerospace industry, for example, has turned to adhesives as a solution to their light-weighting needs. Not only are the materials significantly different in weight but adhesives spread out the stress of a bond across the entire surface of the bond while spot welding and mechanical fasteners focus stress on specific points. This concentration of stress creates inconsistent performance requirements for the substrates often causing the entire component to be thicker or use additional material to support the concentrated stress at specific points. This additional material in the components and joint faces also adds significant weight to the overall product.

Performance

Consider what is happening when you use a mechanical fastener or threaded assembly to attach two substrates. Often the first step in the process is to create a hole in both substrates. This not only creates additional contamination routes that can compromise the interior of your product but the act of creating a hole in your product is actually damaging structural integrity. The strongest and most resilient component is not one with a dozen holes in it but a solid undamaged piece. Adhesives cause no damage to your product when bonding components so choosing adhesives can improve product quality and overall structural integrity simply by doing no harm!

Welding also poses risks to your product. Welding by its nature requires high heat to melt the filler material. This heat can often discolor and even warp the host metals. The risk of warpage becomes even greater when bonding different types of metals. Each metal has different thermal expansion rates and the weld will begin experiencing thermal stress even as it starts to cool. Once shipped, thermal
cycling in the environment will continue stressing the joint, adding to the load already carried. Adhesives mitigate substrate expansions and contractions by providing a semi-flexible bond that can absorb some of the stress from these changes.

What about when sound or extreme vibration is a factor? Adhesives have an edge here too. In fact, when vibration is encountered, best practice in manufacturing calls for thread lockers, an adhesive designed to assist threaded assemblies, to ensure nuts and bolts don’t back out or loosen. Adhesives also have a quieting effect due to their visco-elastic properties. Sound vibrations are dampened as they pass through adhesive bonds. This advantage is of key importance for appliances such as washing and drying machines. Customer trends in this industry show consumers demanding more eye-appealing products and easier access to devices by bringing the laundry rooms upstairs. As these appliances move out of the basement and into living spaces, a quieter machine becomes an important selling point.

As mentioned in the section on the low weight advantages of adhesives, mechanical fasteners damage a product by creating holes in the substrate and focusing stress into points while adhesives do not damage the substrate and distribute the stress a joint bears evenly improving the quality and reliability of the bond. Many adhesives also boast water resistant and even chemical resistant properties and can seal a joint as they fasten pieces together. With other methods, even welding, additional sealants are often needed to ensure a perfect seal.

Which is stronger? Advanced structural adhesives can offer stronger bonds than mechanical fasteners. Hernon Manufacturing, for example, offers structural adhesives with the highest impact resistance available under the product name “Fusionbond.” These adhesives routinely beat common screws and rivets in impact tests and withstand shear stress tests better than steel test strips which stretch and break before the adhesive bond. (See front cover) Finally, adhesives offer advantages in quality when corrosive agents are involved. Even common water can cause mechanical fasteners to rust and seize up or fail over time when the right adhesives will be unaffected.

Aesthetics

Speaking of rust, mechanical fasteners are notorious for creating long rust streaks after exposure to water. Welding too can gather pockets of “dirty water” that can stain or freeze, expanding and damaging the product. In addition, welding leaves unsightly slag that must be filed down and then polished before painting and even then, welds often form obvious lumps or change the texture under paint layers. Rivets and bolts, by their nature, will need to stick out on both sides of the bonded substrates. Adhesives, on the other hand, are often hidden between substrates allowing for smooth, beautiful exteriors. This last point becomes critical when appliances are designed for medical environments where smooth, uninterrupted exteriors are needed to reduce holes and crevices where bacteria can propagate.

New Possibilities

Adhesives offer a secret weapon to manufacturers. Adhesives can be pre-applied when a part or joint is accessible and cured later using chemical, anaerobic or UV light activating methods. Using adhesives, bonds can be formed in places and at times when mechanical fasteners and welds are impractical.
or impossible methods. This frees process engineers to be truly creative and allows new efficiencies that are out of reach with “traditional” fastening methods. When adhesives are the planned fastening method from the initial design stages of a product, then bonding surfaces for adhesives can be built in rather than retrofitted and the unique advantages of adhesives can be fully utilized.

The reasons to choose adhesives for structural bonding are comprehensive. Cost, time, weight, performance and aesthetics all play a role in the decision. For most manufacturing applications, adhesives have crossed a critical point in advancement now successfully competing with alternative bonding methods on strength and longevity while offering clear advantages in manufacturing process, cost, quality and appearance. While the advantages of adhesives are clear, how to select the right adhesive for your application may not be. Most adhesive manufacturers offer expert advice and are pleased to discuss your product and manufacturing methods in depth to ensure you get the exact right adhesive. Some manufacturers, such as Hernon Manufacturing, will even go the extra mile, creating custom formulas and even designing custom automated dispensing machines to ensure integration into your assembly process goes smoothly.