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Fastener solution for composites

White Paper

Fastener Solution for Composites

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The recommendations and advices mentioned must be adequately checked by the reader in practical use and be approved as suitable for its application. Changes reserved.

ASSEMBLY TECHNOLOGY EXPERT

FASTENER SOLUTION FOR COMPOSITES

Introduction

As composite materials grow both in range and volume of applications, the challenge to find the right fastening solution continues to grow. This paper explores some trusted fastening solutions within this fast growing market.

What is a composite?

Composites are materials engineered from two or more constituent materials with different physical or chemical properties. The two main categories of constituent materials making up the composite are the matrix and the reinforcement. Examples of matrices are resins, ceramics, polymers or cements. Examples of reinforcements are fibres, sandwich cores or aggregate. The matrix material surrounds and supports the reinforcement material and the reinforcement material imparts its special mechanical and physical properties to enhance the matrix properties. Composite materials are formed into a shape during their manufacture, typically in a mould cavity or on a mould surface. The synergy between the two materials results in a composite material with properties unavailable from the individual constituent materials. The wide variety of matrix and reinforcing materials available provides engineers with significant design freedom and greater potential to optimise their product's form and function.

The ability to combine different constituent materials to create superior new composite materials allows engineers to target improvements in cost, weight, strength and handling as their product applications and manufacturing processes demand.

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The growth of composites

The development of composites and plastics and their migration into applications habitually dominated by traditional materials such as wood and metal is a significant trend. Lighter, stronger, versatile and more mechanically stable, modern composite materials have found a home in almost every industrial sector. The issue of reducing weight or "light-weighting" has become central to innovation in the automotive sector, accentuated by high oil prices and regulatory pressure to reduce carbon emissions.

Initially, lightweight composite materials such as carbon fibre were only used in very high end applications such as aerospace and super cars, as costs were very high and production processes slow. Increasingly, major car makers are introducing carbon fibre into their luxury models and many are examining ways to replace structural elements traditionally made in heavier metal with lightweight carbon fibre. As the volumes of carbon fibre production increases, the costs will fall and the number of applications in premium and standard car models will increase.

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The fastening challenge in composites

The expansion of lightweight composite materials presents challenges as well as opportunities. One of the key challenges is how to securely fasten to such materials. Traditional fastening systems designed for sheet metal, such as rivets, bolts and clinched fixings designed for metal are often incompatible with composites or require too many compromises to work. Weld studs designed for metal cannot be effectively welded to plastic for example. Lightweight panel composites need to be kept thin and not thickened to hold a traditional fastener in position. Thin carbon panels do not improve with piercing or drilling.

In short, design and process engineers liberated by composite materials do not want to be limited by fastening solutions not designed for use with composites.

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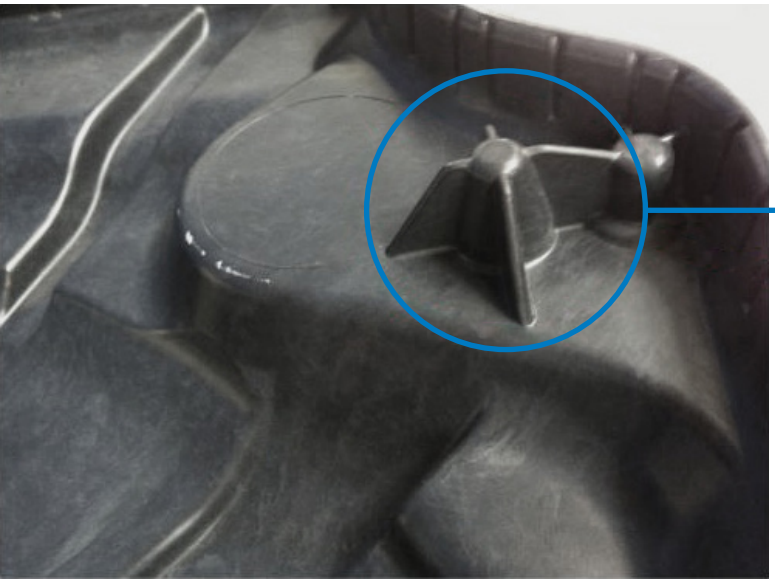
Fasteners embedded in composites

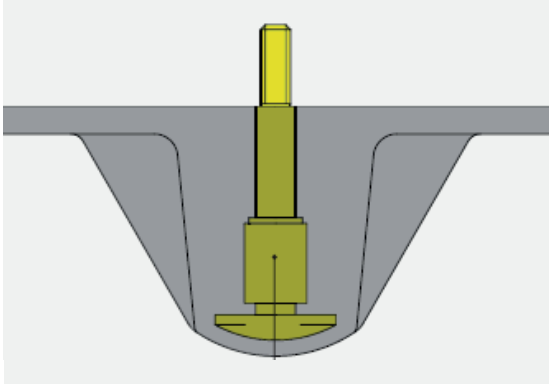
Embedding fasteners in composites is a common requirement and can provide a secure and discrete fastening solution. Integrated into the composite manufacturing process the fasteners become integral to the composite product which supports efficient final assembly. Integrated within the composite mould tool, no secondary work is required and the fastener is fully integrated in the composite product. Embedded fasteners can be very discrete and very stable. These are some of the clear benefits in embedding a fastener.

However, embedding a fastener that has not been designed to be embedded can lead to design compromises and process inefficiencies. These compromises can weaken the composite product or increase its thickness and weight. The example below shows how plastic is built up on this floor pan around a traditional bolt for no other reason than to hold it securely in position.

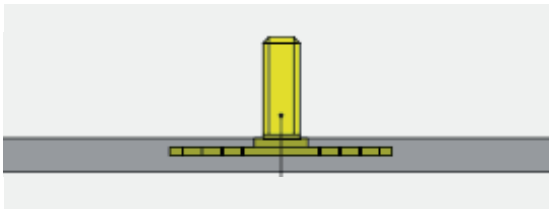


SMC vehicle floor pan with structural reinforcement material built up around traditional fixing solution

Seen in cross section you can see how the traditional bolt requires significant composite material to anchor it securely in position:



Alternatively, a bonding fastener such as a bigHead can be used, which is designed to be embedded in the composite material without the need for the material to be thickened. The thin flat head, shown in cross section below and which is perforated to allow the flow of composite material, helps transfer the load efficiently into the composite structure. The same threaded stud fastening is provided with potentially higher tensile and torsional strengths. Different levels of tensile and torsional strengths can be achieved by using different size and shape heads.



In summary, these are some of the key benefits of using a fastener designed to be embedded in composite as against a traditional fastener not so designed:

- Weight saving of the fastener; bigHead fasteners can be 66% lighter than traditional bolts as used in the example above.
- Space saving, as no additional composite material needs to be built up to anchor the bolt.
- Weight saving, as less composite material is used.
- Reduced composite curing times, as less composite material is used.
- Higher tensile and torsional loads can be withstood with bigHead designs.
- Design optimisation with the fastener designed around the composite product.

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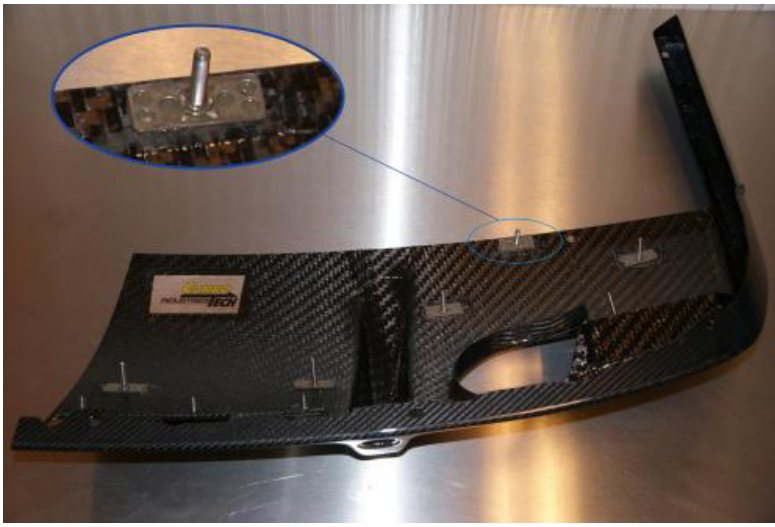
Surface bonding on composites

Many composite applications rely on the use of thin structures. Carbon fibre reinforced plastics, used for automotive body panels, are a good example of this. Such composite panels are often only a few millimetres thick. plores some trusted fastening solutions within this fast growing market.

In these cases, without sufficient material to embed a fastener, a surface bonded fastener can be a very effective and discrete solution. Bonded to the surface with adhesive, a bonding fastener can provide a secure fixing than does not pierce or damage the composite panel.

The example below shows a carbon fibre diffuser for a car, attached with bigHead bonding fasteners. Discrete and very strong, the bigHead fasteners are surface bonded on the inside of the diffuser with a structural adhesive. This bonded solution is completely invisible from the "A-side" as there are no rivets, drill holes or visible "shadows". The structural integrity of the single composite panel is fully maintained. Due to the unique design of the perforated "Head", the glue flows through the holes and locks the fastener into position, achieving high stability and strength. Bonded in position by the Tier 1 supplier, the diffuser is ready for final assembly at the OEM.



Carbon fibre composite diffuser held on with 9 bigHeads

Depending on the application, various bonding fastener designs are possible to compliment rather than compromise the final design and function of the composite part.

Alternative fasteners requiring a hole to be drilled or pierced through the panel can weaken the panel. Piercing a carbon fibre reinforced panel will break or damage the reinforcing carbon fibres which are, by definition, there to provide reinforcement and structural integrity. Depending on the position, size and quantity, the holes in the panel may lead to degradation and failure of the composite under stress. Composites can fail on the microscopic or macroscopic scale. Compression failures can occur at both the macro scale or at each individual reinforcing fibre in compression buckling. Tension failures can be net section failures of the part or degradation of the composite at a microscopic scale where one or more of the layers in the composite fail in tension of the matrix or failure of the bond between the matrix and fibres. Due to the complexity and variation of composite materials it would therefore be necessary to include the piercing or drilling of holes into any pre-construction strength testing and analysis if the behaviour of a composite panel so fastened.

In summary, these are some of the key benefits of using a fastener designed to be surface bonded onto composites rather than pierced or drilled into position:

- No holes piercing the composite material
- Fully discrete with no visibility including "shadowing" through to the "A surface"
- Design optimisation with the fastener designed for the application
- Optimised tensile and torsional loading, depending on the Head design and adhesive used.
- No working loose or rattling of the fastener in use through vibration
- Simple to apply with no specialised tooling

The surface bonded solution does rely on the adhesive for the critical bond between composite structure and fastener. The performance and reliability of adhesives has continued to grow and they are now commonly used and relied upon in numerous applications. The range of adhesives is very large, but almost any structural adhesive will be compatible with a bonding fastener such as the bigHead. There is also a significant range of adhesive curing speeds available on the market, from several seconds to hours, to ensure compatibility with the assembly process. Much work is also being done on the efficiency of adhesive delivery, from hand held devices to fully automated robot cells.

bigHead® bonding fasteners come in a wide range of sizes and styles to suit the applicatio

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Summary

It is no longer necessary for design engineers working in composites to compromise their product design or function by using fasteners designed for non-composite applications. In doing so, they risk their product quality and customer satisfaction.

Excellent fastening solutions designed for composites, offering design flexibility and functional reliability, have become well established over many years in applications across a wide range of industries. The quality of these solutions has been fully tested by world leading companies in the automotive, marine, construction, energy and general manufacturing industries. To find out how these tried and tested solutions can work for you, and to receive assistance in optimising your composite fastening solution, contact Bossard.

If you need further assistance or have special finish requirements, please check out our contact page at **www.bossard.com** and talk to your nearest Bossard customer service representative.