Fastener solution for composites

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.

The growth of composite materials

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.

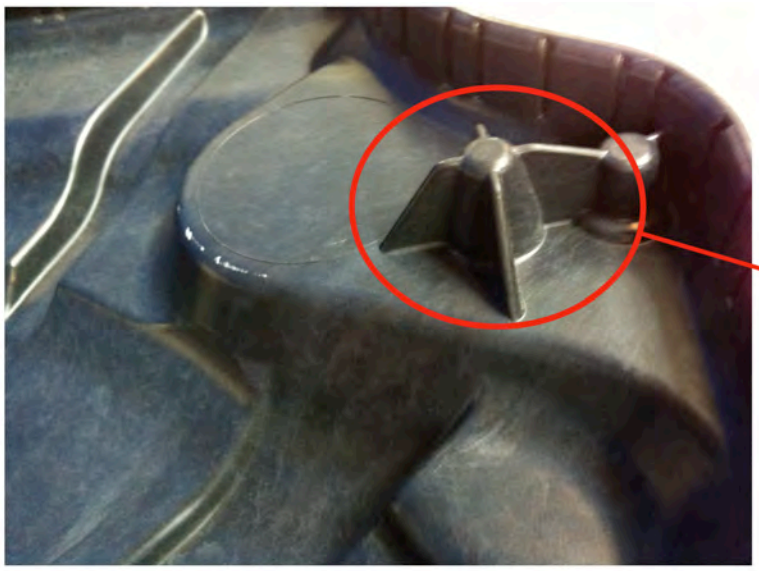
The fastening challenge in composites

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 are often incompatible with composites or require too many compromises to work. Design and process engineers do not want to have to work around the limitations of fastening solutions not designed for use with composites.

Fasteners embedded in composites

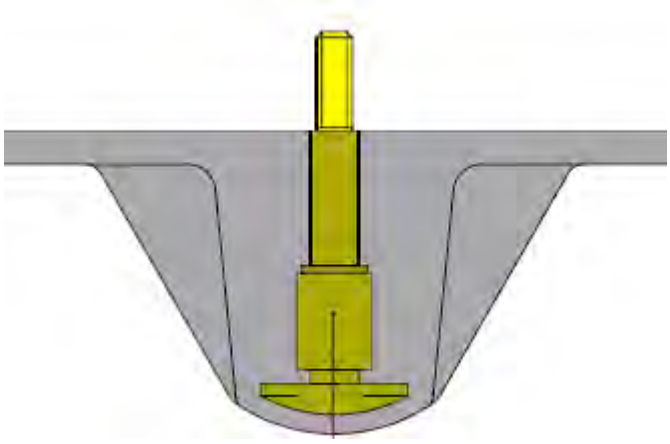
Embedding fasteners in composites is a common requirement and can provide a secure and discrete fastening solution. Integrated into the composite manufacturing process the fasteners become integral to the composite product which supports efficient final assembly. Integrated within the composite mould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



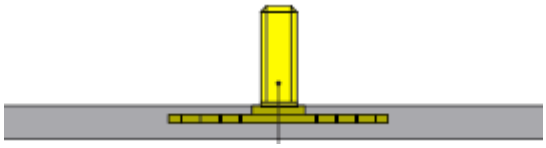
SMC vehicle floor pan with structural reinforcement material built up around traditional fixing solution

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.

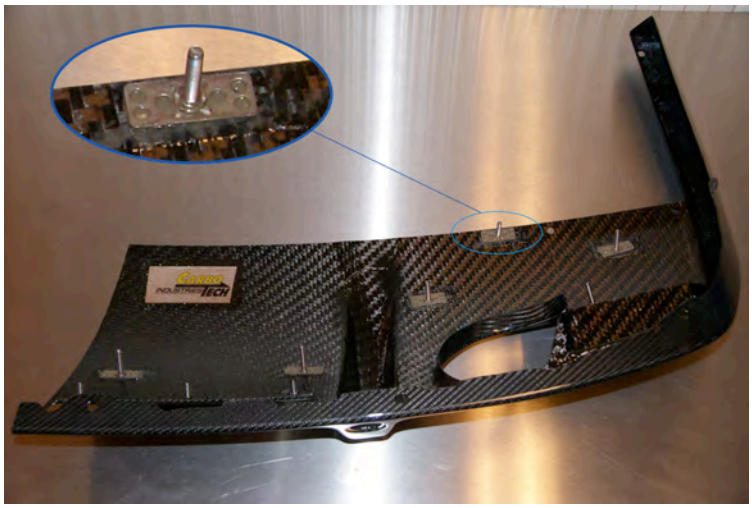
Surface bonding on composites

Many composite applications rely on the creation of very thin structures that do not allow for fasteners to be embedded. In such cases surface bonding a fastener into position can be a very effective and discrete solution, especially where the material must not be weakened by holes or have rivets piercing the material. One secure but discrete fastening solution compatible with such thin panels is the bonding fastener. 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 an Aston Martin, 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.

Aston Martin diffuser held on with 9 bigHeads:



bigHead bonding fasteners come in a wide range of sizes and styles to suit the application:

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

In summary, these are some of the key benefits of using a fastener designed to be surface bonded onto composites as against traditional fasteners not so designed:

- No holes piercing the composite material
- No working loose or rattling of the fastener in use through vibration
- Fully discrete with no “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.
- 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.

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 bigHead.