Composite Engineer's Viewpoint

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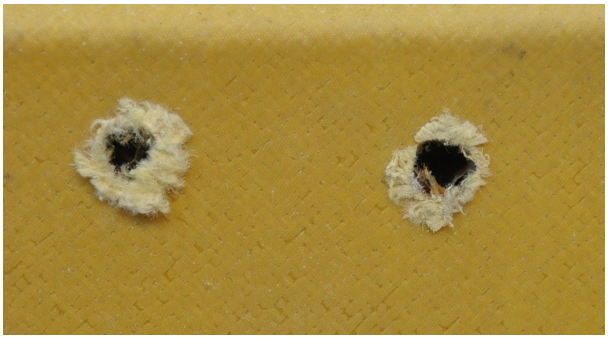
Mechanically Fastened Joints in Composite Structures
Part 3 – Fastener Hole Preparation

In the next article we will discuss the Fastener hole preparation – drilling and reaming the fastener hole requires care so as not to damage the exit side of the hole and thus reduce bearing strength in composite structures. I also welcome questions, comments and your point of view. Feel free to contact me via r.heslehurst@adfa.edu.au. I may publish your questions and comments, and my response in future newsletters.

The drilling of fastener holes in composite materials is not a simple process. Because of the nature of the composite material several issues arise when drilling and general machining is undertaken. The abrasive nature of the fibre system will increase drill bit wear and reduce the drilling operation speed. Also, the heat generated during drilling must be carefully controlled as well as the potential of hole damage if the drilling feed speed is too high.

There is a range of drill bit types specially designed for composite materials. These drill bits will be different for glass, boron, carbon (graphite), Kevlar, etc and as such the fibre vendors will provide advice on the drill bit type. Composites Vol. 21, Introduction to Post-Processing and Assembly, F.C. Campbell, pp. 615-673, ASM International, 2001, gives a good overview of the types of drill bits for various composite materials. An example of the effect of using a standard carbide drill bit on Kevlar fibre composites is illustrated below, where fuzzing of the Kevlar fibres is obvious. To aid in the drilling of composite structures control of both drill speed and feed speed is required. The following table gives some recommendations for drill speed and feed speed in some of the common fibre composites.



Drilling Operation Damage of Kevlar Structure
(photo by Rik Heslehurst)

The drilling process can or will generate heat and for composite materials excessive heat will damage the resin system of the fibre/resin system. Hence control of the heat generated is required. The use of oil based coolants is **not recommended** based on potential long-term

degradation of the matrix from absorbed oil contamination. The recommended process of cooling the drilling operation is to use water or chill air. In combination with the use of water or chilled air is to regularly retracting the drill from the hole. This aspect of the drilling process is known as peaking.

Recommended Drill Speeds and Feed Speeds in Graphite or Carbon Composite Materials
(*Source - ASM Int Engineered Materials Handbook, Vol 1*)

Maximum Hole Diameter mm	Feed Speed mm/rev	Rotational Speed rev/min
3.967	0.025-0.040	2,800
4.763	0.025-0.040	2,800
6.350	0.025-0.040	2,800
7.938	0.045-0.055	1,800
9.525	0.045-0.055	1,800

Finally the most common problem of the drilling process is hole damage. Hole damage can be seen as exit hole damage (delaminations of backside plies), internal delaminations and fibre resin pull out. All three damage types are overcome with appropriate drill speeds and feed speeds. Back side delaminations can also be controlled with back side support boards or specially designed drill bits.

Hole Back Surface Delamination Damage from Drilling
(photo by Rik Heslehurst)

In the next article we will discuss fastener installation – likewise to hole preparation, fastener installation requires careful consideration not to damage the composite laminate and thus reduce bearing strength in composite structures. I also welcome questions, comments and your point of view. Feel free to contact me via r.heslehurst@adfa.edu.au. I may publish your questions and comments, and my response in future newsletters.