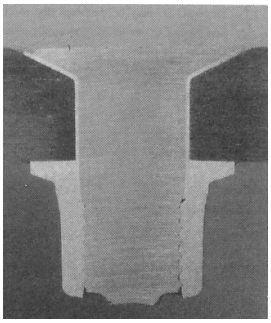
Composite Engineer's Viewpoint

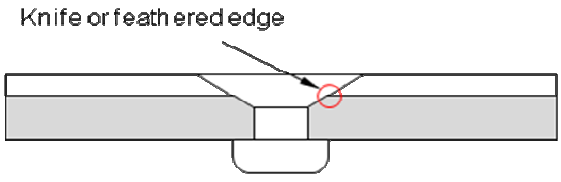
Rik Heslehurst PhD, MEng, BEng(Aero)
FIEAust, FRAeS, CPEng

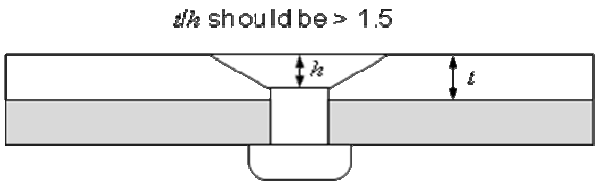
Mechanically Fastened Joints in Composite Structures
Part 4 – Fastener Installation

Fastener installation, like hole preparation, requires careful consideration so as not to damage the composite laminate. Fastener installation does require a level of care and caution. The installation needs to be carefully considered because the fastener installation process will be in a through-the-thickness direction and excessive installation forces can cause delaminations internally or on the back surface of the laminate. Of greatest concern is the installation of interference fasteners. Interference fasteners tend to create large through-the-thickness forces during installation that will cause delaminations. There are a couple of ways of overcoming such damage with interference fasteners. The first approach is to install a sleeve in the hole that expands with interference fastener installation and provides the lateral tight fit without creating excessive interlaminar stresses during installation. There are several blind fasteners on the market that will provide this automatically during fastener installation. A tapered bolt system will also provide interference fit during the final stages of fastener torque with lateral loads only. However, hole-fastener-fit tolerance limits should be observed when interference fit is not required.

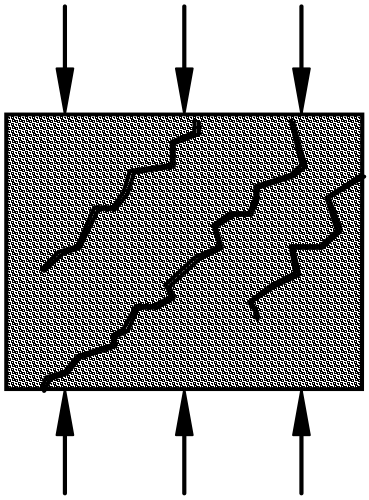


Countersunk fasteners will typically reduce the bearing strength due to a relative increase in the fastener tipping. The fastener tipping can also initially cause delaminations if not sized and drilled correctly. Such issues are of major importance with thin structures. The introduction of a knife or feathered edge will result in delaminations in a short period of time.





Fastener torque is known to improve the fatigue strength and overall bearing load transfer efficiency in bolted/riveted joints. Whilst this is still true in metallic structures, with composite structures the limit is with the through-the-thickness compressive stresses and thus clamping fastener forces must be closely controlled so not to crush the matrix material. Recommended torque values are based on the through-the-thickness strength of the matrix material. For a typcal carbon based epoxy matrix composite material the matrix dominated through-the-thickness strength is limited to $\sigma_z =$ 20 MPa. Thus for a given washer diameter the torque of the fastener is restructured to:



$$T = \frac{\sigma_z D_w^3}{1.658}$$

In the next article we will discuss the bolted joint corrosion – the attachment of composite and metal structures with metal bolts can be a source of corrosion damage of the metal if appropriate installations practices are not followed.

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.