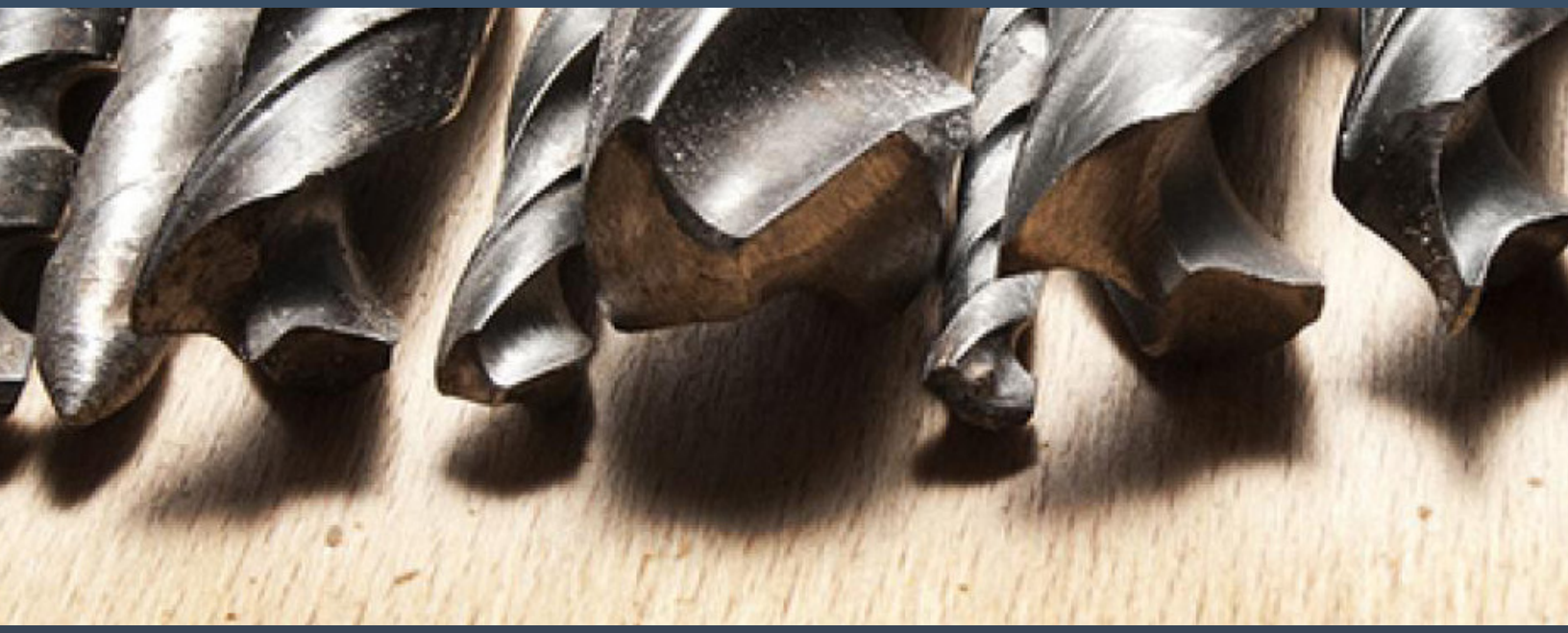
COMPOSITE ENVISIONS KNOWLEDGE HUB
PRACTICAL AND INSIGHTFUL COMPOSITES INFORMATION



DRILLING COMPOSITES - WHAT TO LOOK OUT FOR

COMPOSITE ENVISIONS

DRILLING COMPOSITES

INTRODUCTION

Drilling is one of the most challenging aspects in secondary processing of composite fabrication. To most effectively drill or machine of machine this material it is important to understand what makes these composites different. Because although composites have metal like characteristics in material properties, they are very different in a sense of how they are processed through drilling and machining processes. Because metals are good conductors of heat, drilling is much easier. Composites, on the other hand, insulate heat and are abrasive to cutting tools, resulting in increased wear of cutting tools, drill bits and even the parts themselves.

UNDERSTANDING CHALLENGES

Drilling into a composite laminate causes (2) unique scenarios to incur. As a drill bit spins through a laminate, it splinters and fractures the existing fibers as it goes through to create the hole. In addition, excess heat generation, by friction, may cause the resin to reach a point beyond its respective Tg or service temperature. This in turn can cause delamination, or separation between resin and fabric in the structure of the laminate. Often these issues are overlooked but are critical in the lifespan of any composite part that is machined or drilled.

Although laminate parts are (1) piece, the resin, and the fibers transfer energy or loading differently. Ultimately the fibers in the composite are responsible for carrying the load of the laminate. Because composite structures are anisotropic, the loading placed on a laminate part by a drill bit, or other machining tool, is transferred through these fibers differently. The fiber's response of this loading is highly dependent on the structure of the laminate.

Without any additional science class, this means that factors such as ply orientation, thickness, geometry of the cut, hole size, and resin type all play a critical factor in the success of a drilled hole. The challenge in drilling is that each composite part may need a different approach. And if the laminate is thicker in some regions or uses a different ply structure, a single part could need to be drilled and machined differently as well.

When it comes to machining parts in the composite industry, extensive research has been performed for precise machining and drilling methods that have gone into CNC programs to control process variations. Feed rates, point angles, cutting temperatures, drill geometries, thrust forces, cutting forces and other aspects are parameters used to calculate and pinpoint precise process parameters for effectively drilling parts. Although most do not have a manufacturing facility producing thousands of parts, the concepts are the same for holes being drilled by hand or by a simple drill press.

DRILL BIT MATERIALS

Because composites insulate heat, tool wear in cutting tools result in higher turnover for drill bits. Materials used in drilling of composite parts must have high abrasion resistance & hardness to effectively drill through composite parts repeatedly and effectively. Sharp drill bits should always be used as dull drill bits will cause quality issues such as delamination and hole splintering.

High speed steel is not a great option due to its poor resistance to heat and wear. However, it is a good option if there are only 5-10 holes needing to be drilled. After which, these types of bits will become dull and delamination will incur.

Carbide drill bits are better for composite application as they are harder and have better wear resistance. When they are coated with tungsten it also helps increase surface hardness. This also results in less delamination of the parts. Carbide is well suited for hand drilling operations as it is strong and forgiving to variations in human operations. Carbide bits may either be sold as “solid carbide” or “tipped”. Tipped bits generally offer a cheaper solution when drilling compared to solid carbide bits. The carbide tip provides additional wear resistance over high speed steel, lasting much longer, and can be used by hand drilling processes. Solid carbide bits are more expensive but cut through fibers without fraying or delamination, withstanding 100s of cuts. It is not usually advised to use solid carbide in hand drilling processes as solid carbide is brittle. Usually Solid Carbide drill bits are used with a drill press. Carbide Drill bits may also be coated with tungsten to increase surface hardness.

Diamond Grit / Coated drill bits are widely used throughout the composite industry to provide a smooth finish and offer a longer lifespan than that of carbide bits. Often these types of bits are also used for materials such as tile, stone, and brick. These are generally the most expensive type of drill bits but stay sharper longer, offering the longest life for a bit.

HANDIWORK

When hand drilling composite laminates, allow the drill bit to do the work instead of hand pressure. The additional pressure applied by hand or in the feed rate has proven to increase tool wear and onset of delamination on the hole’s exit surface. Adequate selection with drill bits is key, a good sharp tool will quickly tell in quality and ease of drilling throughout the process. When a change is noticed in how easy the bit is going through the part, or any quality change is evident, change the drill bit or cutting tool. As a drill bit wears it will be evident in how much more force will need to be used for the drill to go through a part. Higher feed rates with worn drill bits are not a good combination and will hinder part quality.

For standard twist drills, a point angle of ~120º is a good starting point. The highest rotational speeds usually give the best results in a composite laminate given the temperature exposure to the composite resin is not too high. If using a drill bit, keep speeds of around 300-5000

rpms.

Tip: Drill a Pilot hole (~.098”) in diameter as a starting point in the drilling process. There is nothing to say the hole must be cut in one pass. A pilot hole will help with dimensional stability and easily place your hole for larger sizes. In some laminates, as part of the hand drilling process, drill bits tend to move around or travel before biting into the material. Pilot holes also decrease the chance of high temperature exposure to the composite as less material may be taken from the laminate at a time for a given pass.

IN RESPECT TO THE FABRIC

0º laminates or Uni-directional composites pose a challenge to conventional hand drilling processes as the fibers may splinter more easily than that of twill, CSM, or woven fibers. Special attention must be paid to these laminates. Higher speeds and sharp drilling tools must be used. Placing a piece of tape on the exit side of the hole will aid in mitigating delamination and splintering of fibers in the drilling process.

Tip: Shorter length drill bits are also less prone to breaking as solid carbide bits tend to be brittle.

Fiberglass laminates are generally a little easier to cut through than that of Carbon Fiber and Kevlar. Carbon Fiber laminates are generally harder to cut through and Kevlar poses issues with fraying and fizziness when drilling.

For fiberglass laminates, challenges may arise from Gel-coated surfaces. As a tip, use masking tape in an “X” pattern and start drilling, slowly, in reverse with a small amount of pressure added to the laminate. As the gelcoat is passed, the tape can be removed, and drill placed back into the forward position to complete the hole.

For carbon fiber and fiberglass laminates, solid carbide dagger type drill bits may be used to produce quality holes in laminate thicknesses up to 1/4”. In thicker laminates, pilot holes are recommended. When not used, Solid Carbide tapered drill bits offer a one pass solution for drilling processes that are thicker than a 1/4”.

As with cutting Kevlar, drilling may pose challenges in aspects of fuzziness and fraying of fibers. To mitigate this, use a solid Carbide Brad Point Drill. Its design aids in eliminating the fray by keeping fibers in tension while they are sheared. Also mitigating delamination chances in Kevlar reinforced laminates.

When drilling thicker laminates, heat will be a bigger issue than that of thinner parts. To mitigate this issue, spraying the laminate or wet drilling should be considered to keep resin temps low. Understanding the temperatures in which a given resin type may be able to withstand can be found using its service temperature in the resin’s technical data sheet. Drill

bits can exert enough friction on the laminate to cause it to be able to burn skin if touched. Ensure the composite does not see these types of temperatures.

Composite Envisions LLC
8450 Development Court
Wausau, WI 54401 USA
+1 715-842-0101
info@compositeenvisions.com
https://compositeenvisions.com/

COMPOSITE ENVISIONS