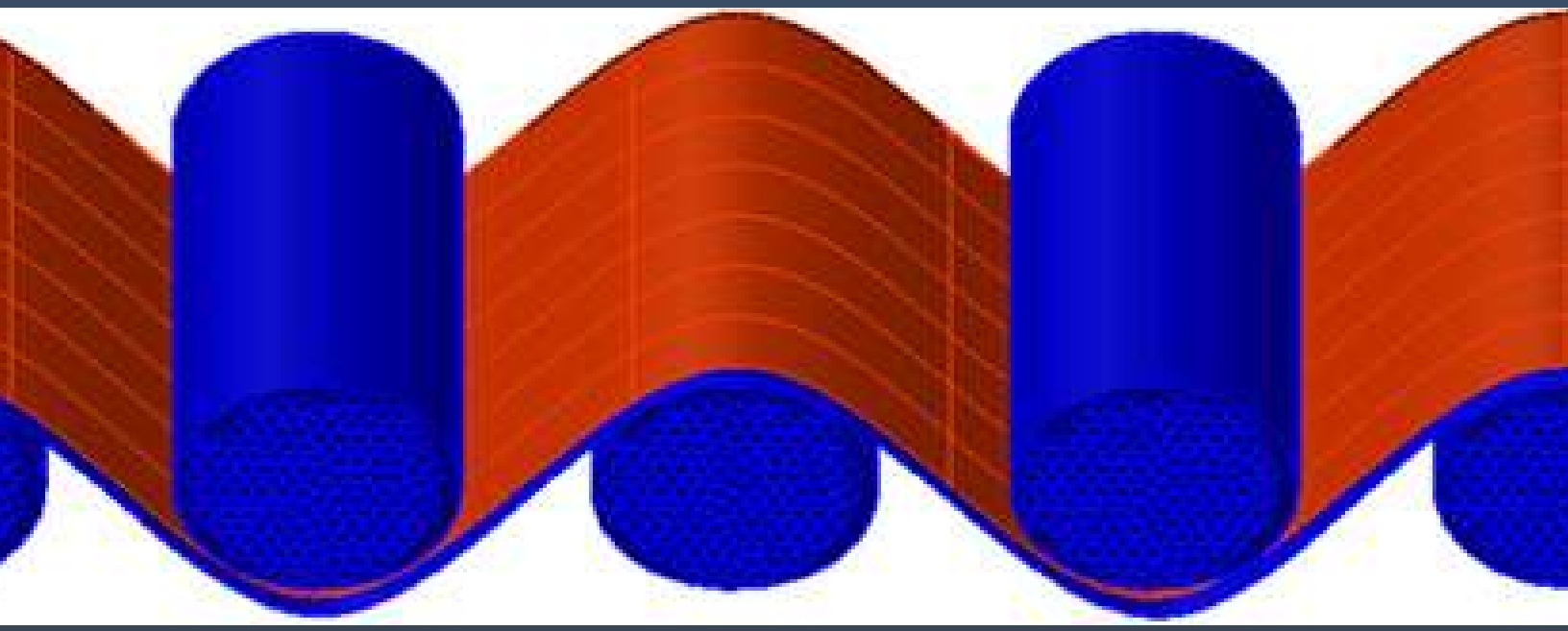
COMPOSITE ENVISIONS KNOWLEDGE HUB
PRACTICAL AND INSIGHTFUL COMPOSITES INFORMATION

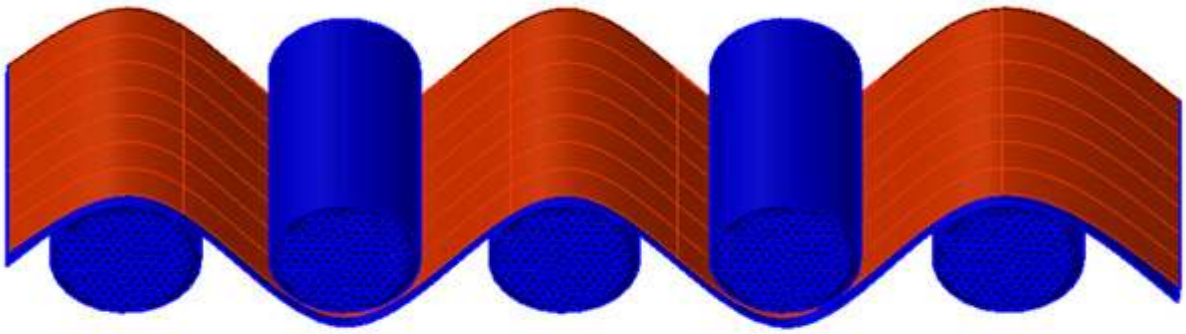


WHY MANY THIN LAYERS ARE BETTER THAN A FEW THICK LAYERS

COMPOSITE ENVISIONS

MANY LAYERS VS FEWER LAYERS

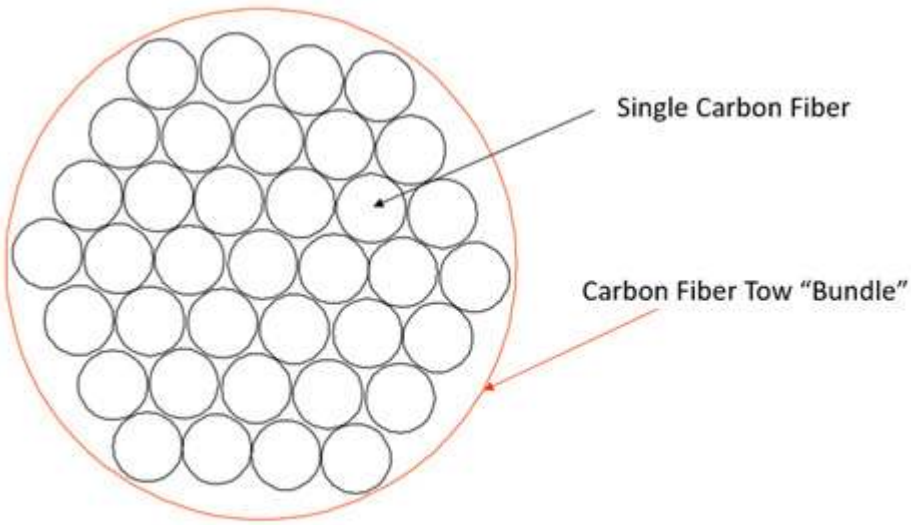
INTRODUCTION



Fiber tows displayed in a 3D woven cross section

When choosing a specific fabric for a given project, there is more than just the selection of carbon vs fiberglass or Kevlar. In fact, after the fiber type has been selected, the weave types, twills, directions may also give anyone, (beginner to expert) a dumbfounded head scratch. Especially true in carbon fiber selection, the differences in twills, unis, and woven fabrics carry much more than just aesthetic appeals, these characteristics are responsible for the fabrics final performance properties such as stiffness in differing load directions, ultimate strengths, and how a composite performs under repeated loading over time.

But what do the numbers such as 3k or 12k even mean when it comes to carbon fiber selection? It is easy for one to think that a few layers of the thickest carbon fiber available is going to achieve the same part as one that has an additional number of thinner layers, and dimensionally this is true. One can get a good looking composite flat laminate from any of the choices. However, can each of them produce a lasting complex laminate structure capable of withstanding day in and day out use? Maybe not. Often the difference of composite structure comes from more than the naked eye



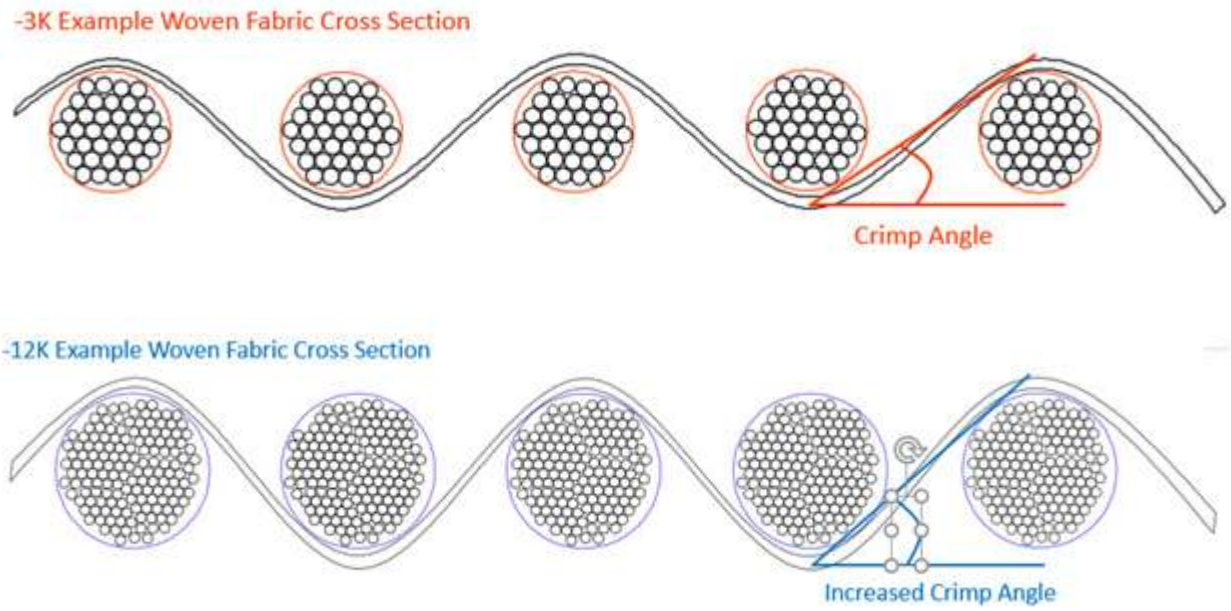
3K = 3,000 Single Fibers within a Tow
12K = 12,000 Single Fibers within a Tow

can see. Below is a guide for when and why to use more (thin) layers or less (thick) layers in a composite structure.

RESIN CONSUMPTION

One thing that is very important in composite structures is that the laminates are completely "wet-out". This means that each of the carbon fibers are surrounded or enclosed by a matrix of resin. This is usually consumed by the area inside of the orange area inside a tow bundle. When using a 3K Carbon or other fabric, it is easier for the resin to surround the fibers and wet through the fabric layer(s) completely. There is simply less surface area that the resin must fill. 12K Carbon Fibers, on the other hand, may take an additional 4x the amount of resin to properly wet out fibers.

Importance: If a laminate is not completely wet out, the composite part is not worth its weight in paper. In a composite structure, the fibers do most of the work. However, the resin holds the fibers together, enabling the composite system to carry loads within the tow and composite structure. Proper resin amounts and wet out are imperative to high performance composites.



CRIMP ANGLE

Even when a composite structure is wet out, there are additional advantages when using more thin layers of 3K over that of a 12K. A characteristic of Carbon Fiber or other fabric weaves or twills is called a "Crimp-Angle". (Shown below) A crimp angle is the angle in which fibers are drawn back and forth as a weave is made. Unidirectional fibers have no crimp

angles but woven fabrics especially, are susceptible these high angles. The higher the crimp angle, the weaker a part may become over time. The tighter woven fabrics are packed in, additional stresses are placed upon the fibers as they are subjected to loading. Over time these high angles may lead to fabrics weakening over time. A 3K Woven fabric is inherently going to have less crimp angle than that of a comparable 12K woven fabric. The fact is, as 12K woven fabrics are denser, the crimp angles are then increased. This increase may or may not affect the final use of the composite, this is dependent of the products end use. Over time, laminates subjected to repeated loading benefit by having a woven fabric that has less crimp angle such as that of a 3k fabric compared to that of a 12k fabric. For parts used for more visual purposes on simple contours, a 3K woven fabric would have no advantage over a 12K.

WORKABILITY

With flat or simple parts with little to no curvature and that are not subject to repeated loadings, there is not as much of an advantage of using a 3K woven fiber over that of 12K. In fact, the advantage of using fewer layers of 12K over additional layers of 3K lies in fabricating simple parts from woven fabrics. When parts are going over a range of contours with complex ply shapes, the value of thinner layers lies in the ability to layup fabric plys to a higher degree of laminate quality and overall performance properties over time. For the same reason there are twill and type woven fabrics that make layup over contours more achievable and keep the fibers arranged in a way that optimizes their performance.

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