COMPOSITE ENVISIONS KNOWLEDGE HUB
PRACTICAL AND INSIGHTFUL COMPOSITES INFORMATION

COMPOSITE SLEEVING

INTRODUCTION

Composite Sleeving is used worldwide to fabricate products ranging from aerospace grade rocket bodies to the automotive industry in air intakes, the sporting world ranging in fishing rod grips, hiking poles, hockey sticks, and even providing rigid support to prosthetics. Composite sleeving brings a distinct perspective on layup and fabrication as it is versatile, highly conforming, and cost effective, all while providing seamless tubular parts. If it is a circular, tube, or even cone shape that needs composite fabrication, chances are a braided or unidirectional composite sleeve can offer the strength and processes needed to get the job done effectively.

FABRIC OPTIONS

Composite sleeving options come in a variety of braided and unidirectional varieties including Carbon Fiber, Kevlar, Fiberglass, and even hybrid braids. Although designed differently from conventional fabrics, each fiber's braided sleeve will inherently have the same mechanical properties as their conventional fabric options.

Braided composite sleeving has the visual appeal of a (2x2) twill weave with interlocking fabric mechanics that promote evenly distributed loading. (In other words, you cannot beat it.) A composite braided sleeve's ability to expand or contract helps ensure that it can meet an array of changing dimensional part requirements regarding bends and diameter variations. (Think the finger trap we played with as children.) This feature provides a ready-made "net ply shape" with only a length requirement, eliminating the need for designing, cutting, and applying intrigue ply shapes involving multiple overlaps as with laying up with conventional fabrics.

Applicable Notes: Contracting plys in a braided sleeve will provide a "stiffer" performing laminate while stretching the braid over a larger diameter will increase wear resistance in torsional loading.

Unidirectional composite sleeves offer top performance in providing rigid support in a single axial direction. Although any part will often need strength in more than one direction, unidirectional plys offer the highest degree of reinforcement in the axial direction making it a complimenting staple of any composite sleeve layup schedule. When laid up with a braided sleeve ply it will complement the ply structure, providing strength in all directions of the part. (Especially when the braided fabric is "stretched-out" to match a larger diameter)

FABRICATION

Techniques to fabricate may be straightly simple or complex as the contours seen in effective bi-turbo air-intake systems. It is all dependent on the part and tooling options chosen. A basic overview involves tooling such as tubular mandrel, or an air bladder that is prepped for use (Think the tube of a tire). The composite sleeve ply(s) are placed over the mandrel, stretching, or contracting the ply to meet the mandrels contour requirements. Resin is commonly introduced by "painting" it on the sleeve with a small brush after each individual ply is applied to the mandrel. (Like conventional layups, this helps ensure there are no dry spots in the part) Alongside resin cure, pressure may then be applied by means of shrink wrap, shrink tubing, vacuum bagging, or other mechanical techniques as needed to consolidate the plys. Processes for laying up these types of parts is highly similar to that of conventional fabric layups.

TOOLING OPTIONS

"Mandrels" are commonly coined as tooling options in composite sleeving or filament winding applications. Mandrels may even be part of the final laminate itself. In simple applications a mandrel may be a prepped rod made from plastic materials such as PVC or Teflon (HDPE), metal tubes or even wood. In more complicated fabrications mandrels may be machined with variations of changing diameters and complexity of curvature. Mandrels may made strategically out of aluminum with elevated cures to provide ease when demolding. (Think Thermal Expansion) Tooling options may also involve overlaying where the mandrel is part of the laminate's fabrication such as when it is co-bonded over an existing fiberglass tube or laid up over an existing expanding foam. These "overlays" of existing parts can used to produce stronger more rigid parts as required for use. "Bladder" tooling applications may be used and provide an additional avenue of exploration when using sleeves as it produces an easy on and demold system and may be paired with a "clam-shell" type mold to fabricate parts.

The imagination is one of the only limiting factors when fabricating tubular shapes from composite sleeves. When brainstorming mandrels for a new project, the first question that should be asked is, "How do I get the mandrel out after cure?" If there is not a clear-cut solution in more complicated mandrel options, a dissolvable foam or other material may yield a viable option for fabrication. 3D Printed soluble core and other water-soluble tooling applications are common in aerospace and automotive industries worldwide. These options are highly viable in an array of complex applications, in essence, the tooling design can be as intricate as needed and the demolding process will not change.

BAGGING OPTIONS

Additional pressure curing of composite sleeves involves the same types of complexity as it is completely dependent on the part. In simple applications, a heat shrinking tube or shrink wrap, pressure tape can provide adequate pressure for cure of composite sleeve laminates. "Shrink wrap" or tape is versatile in tubular sleeve application and provides additional pressure in cure processes. It may not yield as good of surface finish, but the part will be as sound as the wrapping job with only light sanding required after cure.

Plastic Heat Shrink tubing is another method where the material contracts with applied heat from items such as a controlled heat gun (blow dryer) or other source. This tubing does have limitations in how much they contract to conform in ranging variations of diameters. Verify that any heat shrink tubing will contract as needed and that it will separate from the resin used. The heat shrink method's advantage is ease in application while providing a seamless finish. Simply side it over the sleeve and applied resin and shrink it to conformance. (Starting in the center, working outward in each direction.) Heat-shrink tubing's disadvantage is it will not provide the same pressure found in vacuum bagged part. Which may be perfectly okay as vacuum bag pressure may not always be necessary. If it is necessary, tubular vacuum bags are a common industrial staple for producing the highest performance in consolidating ply stack ups.

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