Overview of **Elastomeric Cauls** *and Pressure Intensifiers*

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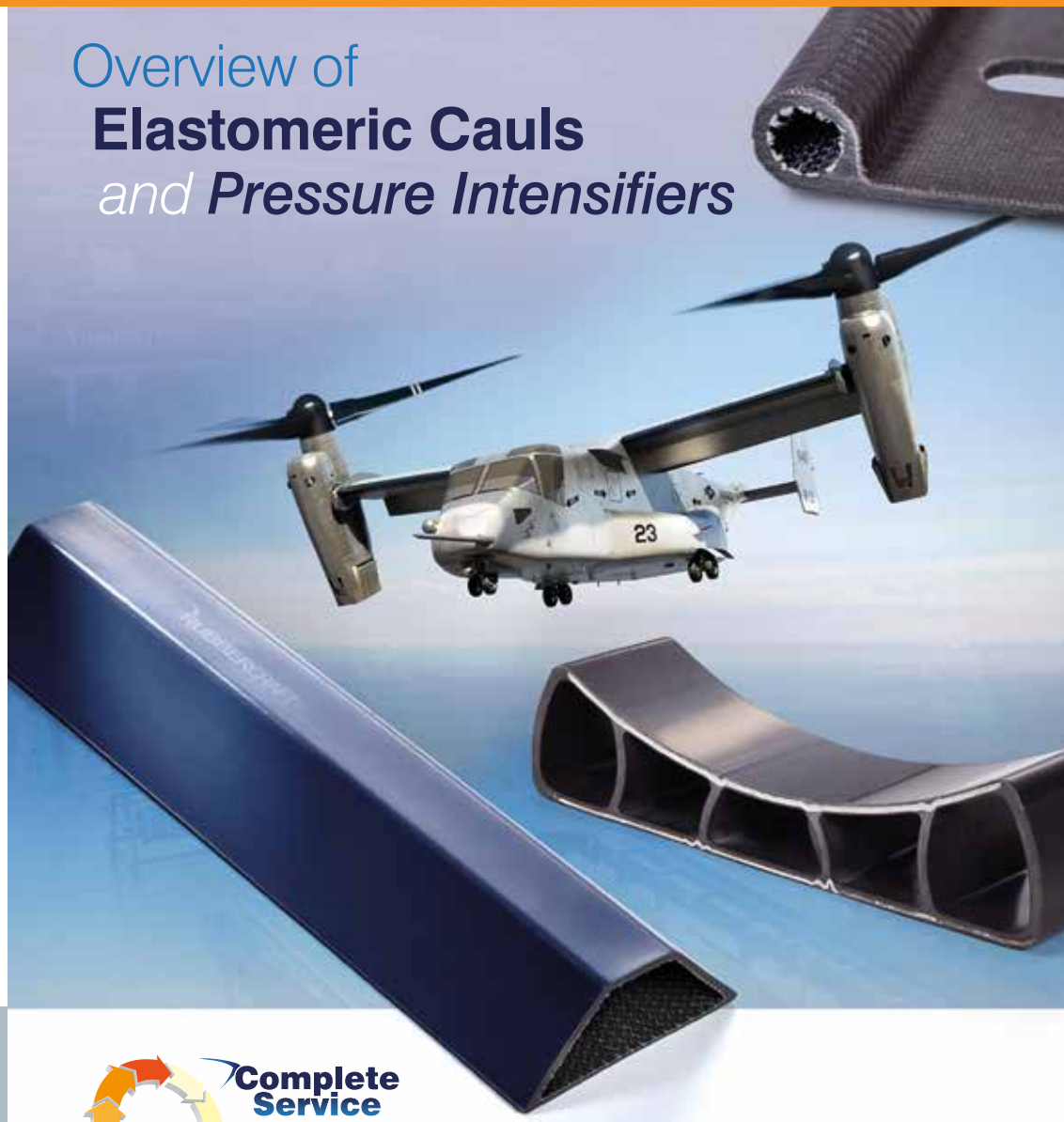

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Overview of **Elastomeric Cauls** *and **Pressure Intensifiers***

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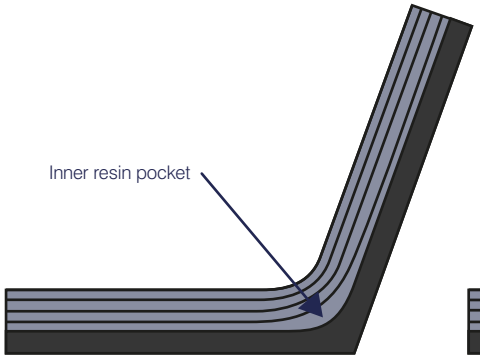
Elastomeric cauls and pressure intensifiers are designed to improve laminate quality by creating an even pressure distribution on the composite during debulk and/or cure.

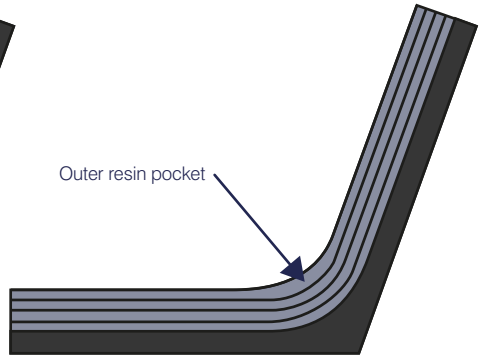
Certain types of features can lead to defects related to inconsistent per-ply thickness or resin rich pockets; cauls and intensifiers are employed to counter these effects.

Several common types of defects are shown below.

Preform Bridging

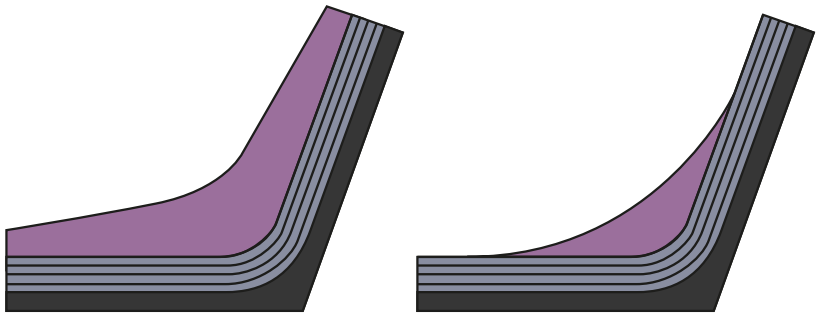


Bag Bridging



On inner corners, it is typical to see an defect referred to as “preform bridging”. This defect can be caused by improper technique in the application of the plies, or by inadequate debulking of the plies. Typically, after the manual application of several prepreg plies, there should be a debulk operation to consolidate the laminate. Another cause of preform bridging can be coefficient of thermal expansion differences in the materials. For instance, if metal tooling with relatively high CTE is used, the tooling will expand during the cure cycle, and carbon fiber plies will bridge over the corner, even if they were applied perfectly.

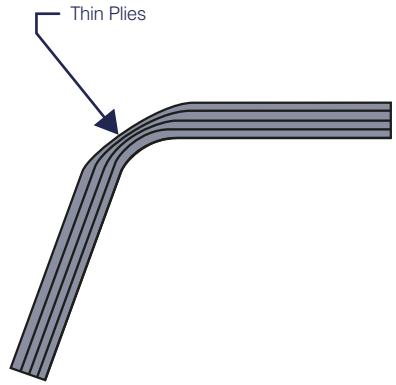
Defects in inner corners are also caused by the bridging of the vacuum bag or related materials like peel ply and breather. If there is a resin pocket near the surface of the composite opposite the tool, then this may be the cause. When no caul is being used, it is critical to have sufficient material in the corner. The vacuum bag should be pleated (folded) so that a fold runs down the length of the corner. Rubber cauls or pressure intensifiers are often used under the vacuum bag to ensure that proper pressure is applied, and these types of defects are avoided.



Caul (left) and intensifier (right) ensure proper pressure transfer and improve laminate consistency

Thin Corners

Another type of common defect is thinning on outer corners. This effect can be caused by the expansion of the mold during cure, if the mold is not made from a low CTE material like carbon fiber or invar steel. Rubber mandrels, which all have high CTEs compared to other materials, can easily cause this type of defect. In most cases, the preform should be debulked on a separate tool that represents the geometry of the mold tool in its fully expanded at-temperature condition. The corner thinning effect is also commonly caused by the vacuum bag or related materials being drawn over the corner. A rubber caul can prevent this type of defect, by ensuring an even pressure distribution.



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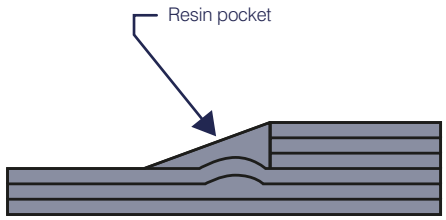
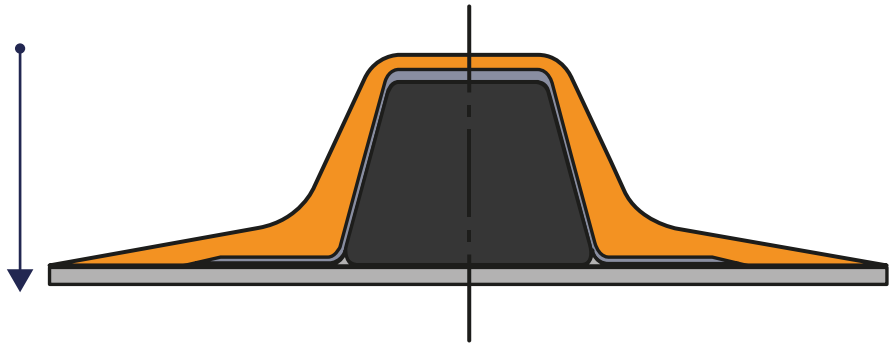
Low Pressure Ply Bumps

Resin Pockets and variations in per ply thickness can also be caused by steps in the laminate where several plies drop off at once. In this case, the vacuum bag, breather, or peel ply may bridge over the gap and create a low pressure area. The per-ply thickness may increase in this area due to the low pressure condition. Elastomeric cauls can be employed to prevent this type of defect.

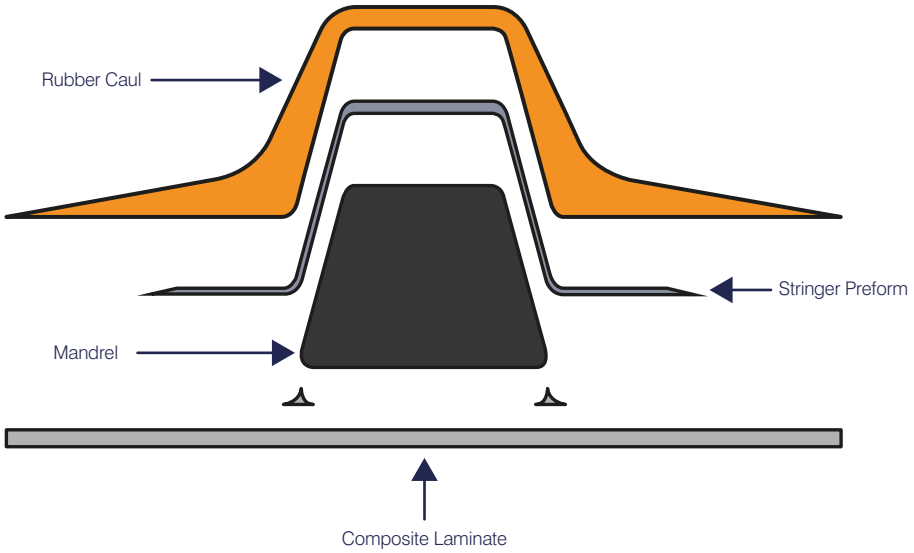




Often a part can be made without a caul, but it may be more time consuming, more variable, and require more operator skill and attention. The use of the caul may make certain defects less likely and thus reduce the scrap rate and touch labor associated with fabricating the part. In other cases the caul may simply be used to improve the surface finish of the part, and to eliminate the mark-off on the part surface associated with vacuum bagging.

It is designed to be used in combination with a solid mandrel. In this case a thin release layer may be used under the caul, or bonded to the caul. The breather and vacuum bag would go over the caul.

An expanded view of a “butterfly caul” is shown below.



A hat stringer formed with a mandrel is shown without (left) and with (right) a caul. Significant bag bridging created unacceptable variations in per-ply thickness in the part shown in the image to the left. This bridging was eliminated by the use of a caul in the image on the right.