

Available “Cut” Configurations



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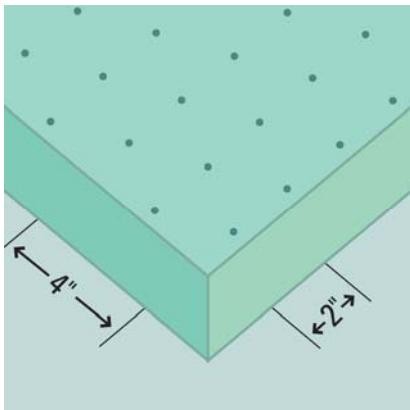


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1. Rigid Sheet

All cores start as rigid sheets of a given thickness, and if significant curvature is not required, for the best structural properties, all cores are best left as rigid sheets. It is the slitting of cores to create “kerfs” to allow rigid sheets to adopt compound curves, that causes the majority of problems in core installation.

2. Perforations



When installing large sheets of rigid core, it is important that there is no air trapped under the core during installation. This is particularly true if the core is being installed over a lap or discontinuity in the laminate, or into core bonding adhesive. To allow air to “leak” out of the core, small 1 mm or 1/8” perforations are often added every few inches. If the core is being vacuum bagged into a core adhesive, you should be able to

see this adhesive being forced through every perforation. During an infusion process, these “perfs” will also allow the transfer of resin from one side of the core to the other, and when combined with grooves, will allow the core itself to act as the resin transfer medium.

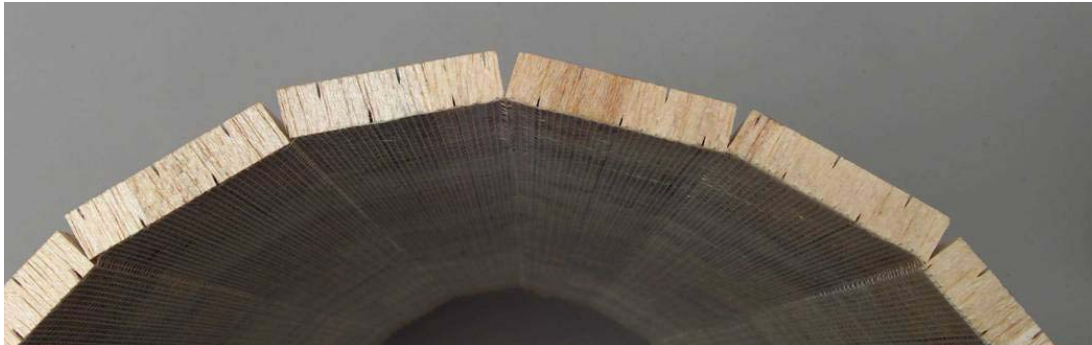
3. Contourable Configurations

If the core needs to adapt to compound curvature of the hull or deck, cuts or “kerfs” need to be added to the core in two directions (0 and 90 degrees).

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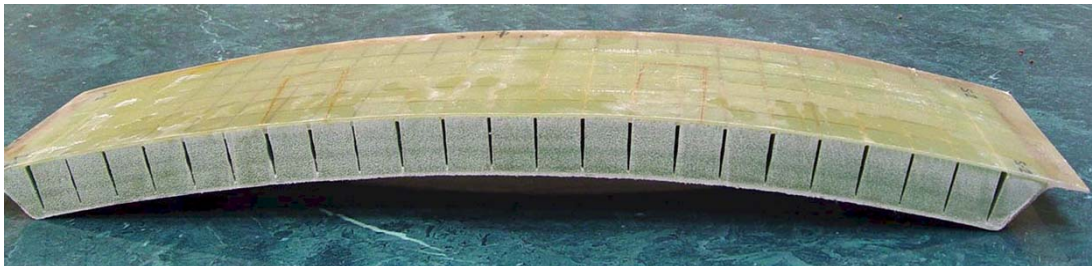
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These kerfs can cause potential problems, especially if not completely filled with resin. Unfilled kerfs can lead to stress concentrations, resulting in earlier shear failure of the core, and can allow the transmission of water throughout the whole laminate. However, for all core installations that do not rely on thermoforming the core under elevated temperature and pressure, contoured configurations with kerfs are a necessary evil.

3.1. Saw Cut Kerfs

The simplest way to cut a series of parallel kerfs is to use a gang of thin saw blades, usually located 30 mm apart. The thickness (or thinness) of the blade, and thus the width of the kerf is determined by both the density and thickness of the core. You can imagine that thick, high density cores will put a lot of load on the blades, so that as cores get thicker and as they get denser, the blade thickness, and thus the kerf width, will increase.



The problem with saw cut kerfs is that they are more difficult to fill with resin or core bond adhesive, and during resin infusion can lead to “race tracking” as the resin races through the kerfs, leaving dry spots in the laminate behind. However, saw cut

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kerfs can be placed on the “compression” or concave side of the core curvature, allowing the kerfs to close rather than open, thus narrowing the kerf. Saw cut kerfs, when opened up on the tension or convex side of a laminate, when completely filled with resin (as they should be) can also cause cosmetic problems as these lines of thick resin shrink upon curing, causing core block “print through” to the gelcoat.

3.2. Knife Cut

To minimize the kerf width, knives are often used. These can be sharp razor type knives that drag through the core at an angle, or circular “pizza” type knives that roll through the core to cut the kerfs. In both cases these knives too have their limitation on thickness and density before they start to tear or crush the core, rather than cutting. Obviously, as with saw cutting, it is the higher density, thicker cores that cause the problems. However, unlike saw cuts, once the limiting condition is reached, there is not another knife alternative. At this point saw cutting is the only alternative.

However, balsa cores are always knife cut, never saw cut. That’s because the end-grain nature of balsa results in the knife actually splitting the wood, rather than cutting the wood. Also with balsa, the knife spacing and resulting core module size is different in each direction. Rather than being a 30 mm x 30 mm or 1-1/2” x 1-1/2” square module as seen on most foam cores, balsa modules are always 1” x 2” rectangles. As with foam cores, balsa too has restrictions on both the thickness and density of core that can be cut, but balsa is never saw cut.

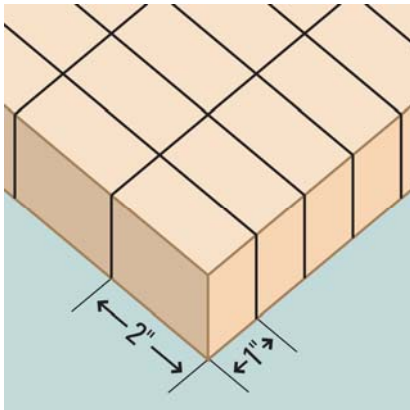
The obvious disadvantage of knife cut kerfs is that the kerfs cannot compress, as they do with saw cut kerfs. Therefore, knife cut cores can only bend in the direction that allows the kerf to open. This also creates a problem with forcing resin into the knife cut kerf, especially on the top side or compression side of a concave curvature. This is more of a problem with single, double and triple cut cores than with CK or scrimmed configuration.

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3.3. CK or Scrimmed and Scored



The first attempt to create a controllable core configuration that would allow the hand lay-up of core into the compound curvature of something like a sailboat hull, was the CK or ContourKore configuration from the Baltek Corp. in the mid to late '60s. This occurred soon after the introduction of end-grain balsa core. To date, the application of a fiberglass scrim to one side of the core, and then slicing almost all the way through the core to the

scrim on the other side is still the most common method of making a rigid panel controllable, whether it's balsa, foam, or plastic honeycomb. There are several variations of scrim available varying in the number of fibers per inch in each direction.

If the core is knife cut CK, then it will essentially bend in one direction only, that is, in the direction that will allow the kerfs to open. If it is saw cut CK then it can bend in two directions, since the saw cut kerfs will compress.

The method of scrim adhesion is a topic of some discussion in the core business. All foam cores to my knowledge have the scrim applied to the core with a “hot melt” system, where heat is applied to the scrim as it is being pressed to the core by a heated roller, melting a plastic adhesive to the surface of the core. However, scrims can be applied to balsa cores with either hot melt or adhesives. Alcan Baltek have long maintained that the “dot matrix” method of scrim adhesion, where in the adhesive is applied in a dot pattern over the fiberglass scrim, produces a better skin to core bond since the laminating resin can now work its way under the scrim in the areas where there is no adhesive to greatly increase the area of bond between the skin and the core. The hot melt system will prevent this direct contact between the laminating resin and the core, potentially weakening the bond. This is more important in balsa since the skin to core bond is so much higher than in foam cores. You

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do not want to create a situation where the skin to core bond is weaker on the scrim side than the non scrim side of the core.

Scrim and scrim adhesion is an interesting topic, because the scrim itself contributes nothing to the strength of the laminate and can reduce the skin to core bond. The scrim is there only to hold the modules of core together to make the installation of the core easier. In this respect it is identical to the scrim being used to hold small tiles in place during installation in a bathroom or shower. Once the core is in place the scrim has served its only purpose. It is for that reason that a number of higher end builders will remove the scrim after installation by peeling or grinding it off. Peeling the scrim has the added benefit of revealing any poorly bonded core modules, since these will inevitably pull away with the scrim, and will need to be rebedded in place. So the strength of the scrim bond to the core should just be sufficient to hold the modules in place when handling and installing the core. However, if the bond is not aggressive enough, blocks of core can fall off the scrim during installation or processing the core before installation (kit cutting, etc). This condition, not surprisingly, is called “block fall-off”. This is the paradox of scrim adhesion – The better the bond between the scrim and the core, the better chance exists for a weaker bond between the skin and the core since the scrim will separate the skin from direct contact with the core. The weaker the bond between the scrim and the core, the better chance the resin from the skin laminate will penetrate beneath the scrim to bond directly with the core, but the greater chance of “block fall-off” when handling the core.

Until recently, all scrims have been in a 0-90 configuration, and reasonably tightly packed. Within the last few years however, a Texas company called Ply-Tech has introduced a more widely spaced tri-axial hot melt scrim that has been adopted by some core manufactures. However, as with all scrim materials, the bond between the skin and the core should be evaluated to confirm that it is not being compromised by the presences of the scrim, specifically in hot melt applications where the

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hot melt glue can spread over the core surface, not allowing the laminating resin to contact the core directly. This particularly true with balsa cores where the skin to core bond is extremely high in the absence of a scrim, so you don't want the scrim to jeopardize that bond. With scrim, as with nuclear disarmament, trust but verify.

3.4. Single Cut

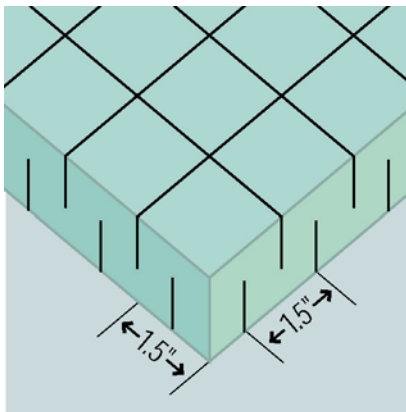
The number of cuts in a core can dramatically affect the amount of additional resin a core consumes. This is especially important on curved surfaces where the kerfs will open up to allow the sheet to contour to shape. In order to reduce the number of cuts to a minimum, as well as to reduce the cost of a contourable core, the Single Cut configuration was developed. The SC configuration consists of kerfs running one direction only on one side (say zero degrees), and in the opposite direction on the other side (say at 90 degrees). The cuts should be deep enough so that the kerfs overlap each other, allowing air and resin to flow through the core. However, there are some caveats in its use. If the single cuts are saw cut, the kerfs will open in tension on the convex side of the core, and close in compression on the concave side. This provides a pretty contourable configuration for gradual curvature in both directions, and will adapt somewhat to compound curves. However, the saw cuts will consume more resin or core bond adhesives, and will be more difficult to fill, especially in hand lay-up. . Knife Cut SC configurations reduce the amount of resin required to fill the kerfs, but produce problems of their own. The knife cuts will open in tension, but will not close in compression. Therefore, SC knife cut cores are not as pliable as their saw cut brethren, and essentially bend in one direction only, making it difficult to adapt to a compound curvature. In addition, because the knife cuts on the compression side of the core (concave side) close up under compression, it is hard to force resin into these compressed kerfs, especially in hand lay-up, resulting in no bond between the modules and potential source of shear failure of the core. Therefore, single knife cut configurations should be used sparingly.

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3.5. Double Cut



To introduce more curvature into panels without applying a scrim, the Double Cut (DC) configuration is often used. Some core manufacturers are limited to supplying CK or scrimmed configuration to only 5/8" thickness, so DC is the only other alternative for thicker cores. With DC, the core is cut in a 0-90 pattern on one side with the cut extending 60% to 80% the thickness of the core. The core is flipped over and a similar 0-90

pattern of kerfs is applied to the other side, but off-set by half a module width in each direction, so the cuts on each side are off-set from each other. As with SC, the cuts do overlap, allowing air and resin to easily flow through the core. However, since there is now virtually twice the number of cuts in the core as in the comparable CK or Scrimmed and Scored configuration, resin absorption by the DC core also is almost twice as much as the CK equivalent. This is especially true with saw cut configurations. DC knife cut suffers the same difficulty as SC knife cut; that is the kerfs compress on the compression side of the core, making it difficult to fill these kerfs with resin, creating potential shear failure points.

3.6. Triple Cut

To allow increased flexibility of a DC type configuration to better match the contourability of a scrimmed CK configuration, especially by core manufacturers who cannot supply CK configurations over 5/8" thick, the Triple Cut (TC) configuration was introduced. TC has a DC configuration on one side, but three times the number of cuts in one direction on the other side. Obviously, TC, which is only offered by one manufacturer, is only available in knife cut. Although popular at first, concerns did soon arise. It's obvious that if DC absorbs almost twice the amount of resin, TC will absorb substantially more. It's also obvious that this large number of cuts on one

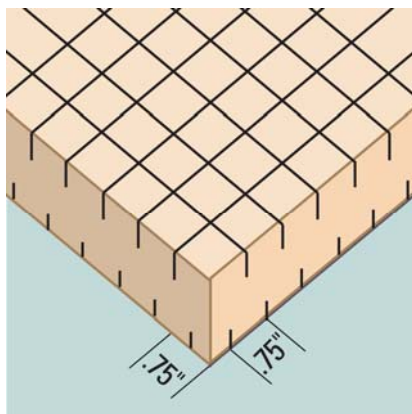
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side, if not adequately filled with resin, will transmit and absorb a large amount of water. Even if filled with resin, the large amount of resin starts to determine the core properties, especially in shear elongation. That is, a linear core with Triple Cuts filled with resin becomes a brittle core. Needless to say, in most applications, TC should be avoided.

4. Infusion Groove



When vacuum infusion was first introduced, it often incorporated a separate infusion medium on the surface of the laminate. However, it soon became apparent that the core itself, if grooved and perforated properly, could act as this infusion medium. Therefore, almost all core manufacturers, except the honeycombs, now offer some configurations of grooves and perms to allow the core to transmit the resin through the laminate in a

vacuum infusion process. Some have grooves on both sides, some on one side only. In some, the perforations are coordinated with the grooves, in others not. Some even offered grooves at 45 degrees, but now most offer predominantly at 0 and 90 degrees. However, if you are infusing, or considering infusion, by all means consider using the core as the infusion medium.

If a separate infusion medium is used, such as in the SCRIMP process, then conventional CK or DC contourable configurations can be used for vacuum infusion, since the resin flow tends to be through the core vertically, not predominantly horizontally. However, if you try to use these configurations as the primary flow medium, the larger module size will leave white dry spots in the center of each module that didn't fully infuse as the resin rushed past in the kerfs and isolated these spots. It is

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for that reason that infusion grooves at about $\frac{3}{4}$ " are much closer together than conventional kerfs.

5. Thermoforming

As mentioned above, the vast majority of core problems can be traced to problems associated with the kerf systems. It goes without saying that for flat panels, rigid sheet (with perforations) should be used. However, for curved panels, the only way to use rigid sheet is to thermoform the core into the proper shape. This can only be done with foam cores, specifically PVCs, PETs, and SANs. However, some recent research has shown that perhaps even fiber reinforced polyurethanes can also be thermoformed. All core manufacturers can supply information on temperatures and time in the oven for different densities and thicknesses of their cores. Rather than heating the core in an oven, catalytic heaters can also be used to heat the core. However, only once the core is heated does the fun begin. At that point the heated and very pliable core has to be placed under a vacuum bag on the mold to force the core to proper shape. Some builders use straps to force the core to shape, but the straps themselves can distort the core locally. Cores that have been thermoformed must be installed under a vacuum bag to compensate for any spring back in the core as it cools.

6. AL600 Coating on Balsa

Although not a cut configuration, the AL600 resin coating is a surface treatment for BALTEK® balsa cores that is designed to reduce the absorption of water vapor, and reduce the amount of resin absorption during hand lay-up, or especially vacuum bagging. However, the AL coating will not prevent resin absorption during vacuum infusion.