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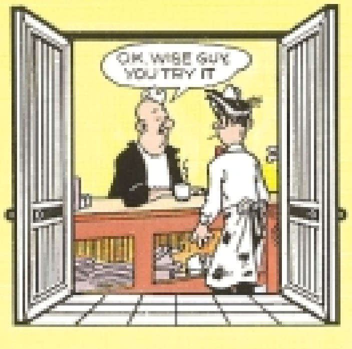

THE M.C.GILL DOORWAY

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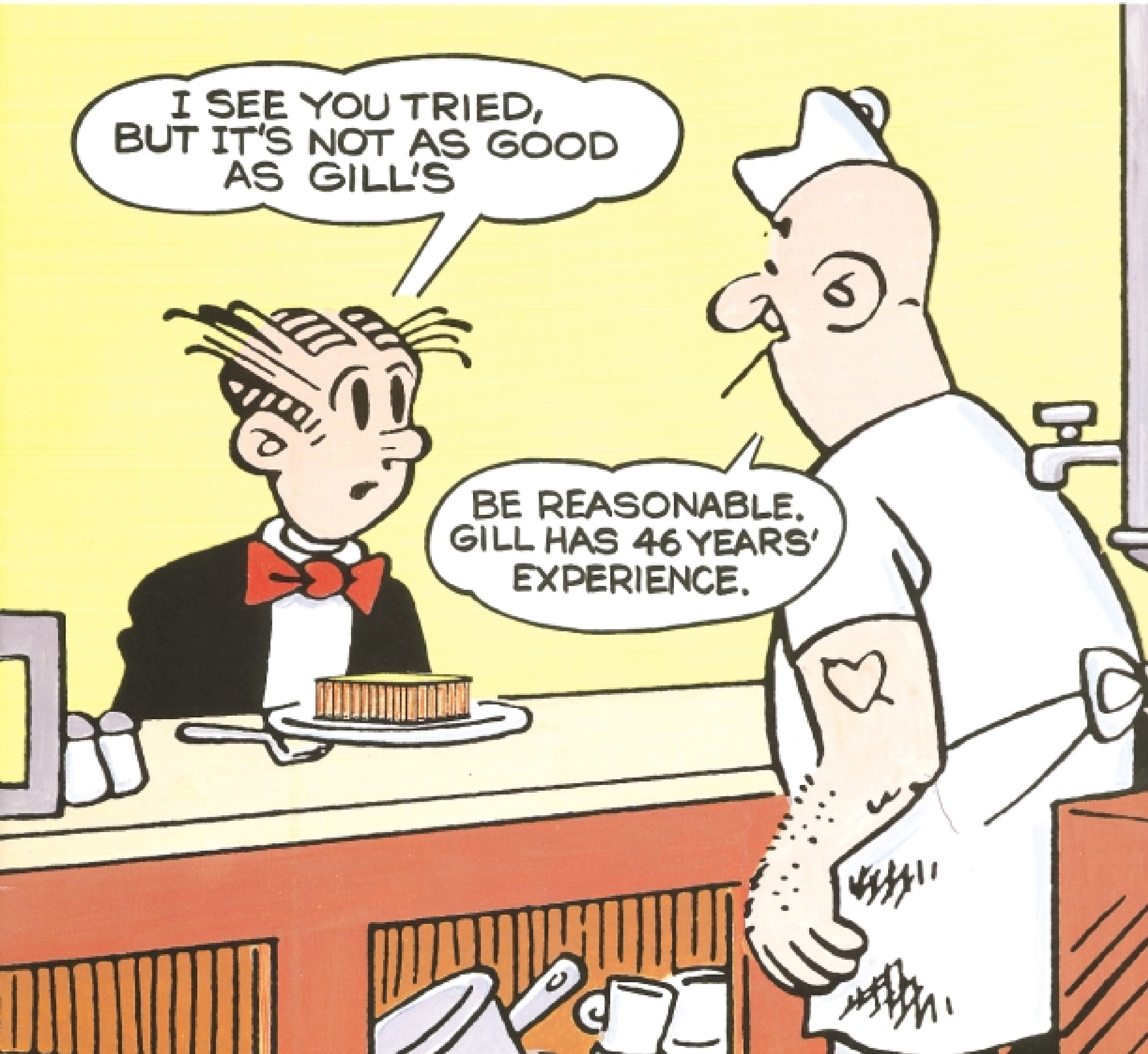
SANDWICH PANEL REVIEW...PART 4



Helpful Hints About Sandwich Panels

Introduction: *This issue of the M. C. Gill Doorway is Part 4 and the final issue in our Sandwich Panel Review series. Part 1 dealt with a general overview of sandwich panels and their components; Part 2 covered the same subject matter but in much greater depth; and Part 3 explored some of the preliminary design calculations necessary for designing panel constructions to meet specific applications. Part 4 brings together updated Helpful Hints articles that have appeared in past Doorways. Our readers have told us that the Helpful Hints are very useful reference materials, and having them incorporated into one issue should make them doubly helpful. If you did not receive any or all of the previous issues of this series, please contact our Marketing Services Department and we will be pleased to send them to you.*

CALCULATING WEIGHTS OF SANDWICH PANELS

The M. C. Gill Corp. has constructed a simple nomograph to enable a quick calculation of the weight of a given sandwich panel configuration. For accuracy, you must know the following:

1. The panel thickness and type and thickness of the facings, in inches.
2. Density of core, lbs/cubic foot (ft³).
3. Weight of adhesive, lbs/square foot (ft²).

The answer is read on the red horizontal line in the center of the nomograph in lbs/ft². To convert to kg/m² multiply: lbs/ft² x 4.93.

The use of the nomograph is best illustrated by a sample problem.

Find the weight per sq. ft. of a sandwich panel .532″ overall thickness with ¼″ cell, and .004″ thick foil aluminum honeycomb core with .020″ top face and .012″ bottom aluminum face.

Preliminary figures:
Total skin thickness: .020″ + .012″ = .032″
Core thickness: .532″ − .032″ = .500″
Core density: From Table 1 the density for ¼″ cell − .004″ foil aluminum honeycomb is 8.1 lbs/ft³.

Enter skin thickness vs. weight chart at .032″ on the skin thickness ordinate and follow that line horizontally until it intersects with the line for aluminum, go vertically down to the bottom of the graph and stop at the skin weight, .47 lb/ft².

Next, enter core thickness vs. core weight chart at .5″ core thickness and go horizontally until intersection with the 8.1 lbs/ft³ density line. Go vertically up to the top of the graph and stop at the core weight, .325 lb/ft².

Draw a line connecting the skin weight and core weight. The point at which this line intersects the total panel weight line is the answer, in this case .935 lb/ft².

 Blondie cartoon characters © 1992 King Features Syndicate Inc.

Adhesive Weight: The nomograph is based on a standard adhesive weight of 0.06 lb/ft²/face (0.12 lb/ft² of panel). If the adhesive weight is known to differ from this figure, a correction should be made. Typical total adhesive weights are given below.

Adhesive Weight (lbs/ft² of panel)

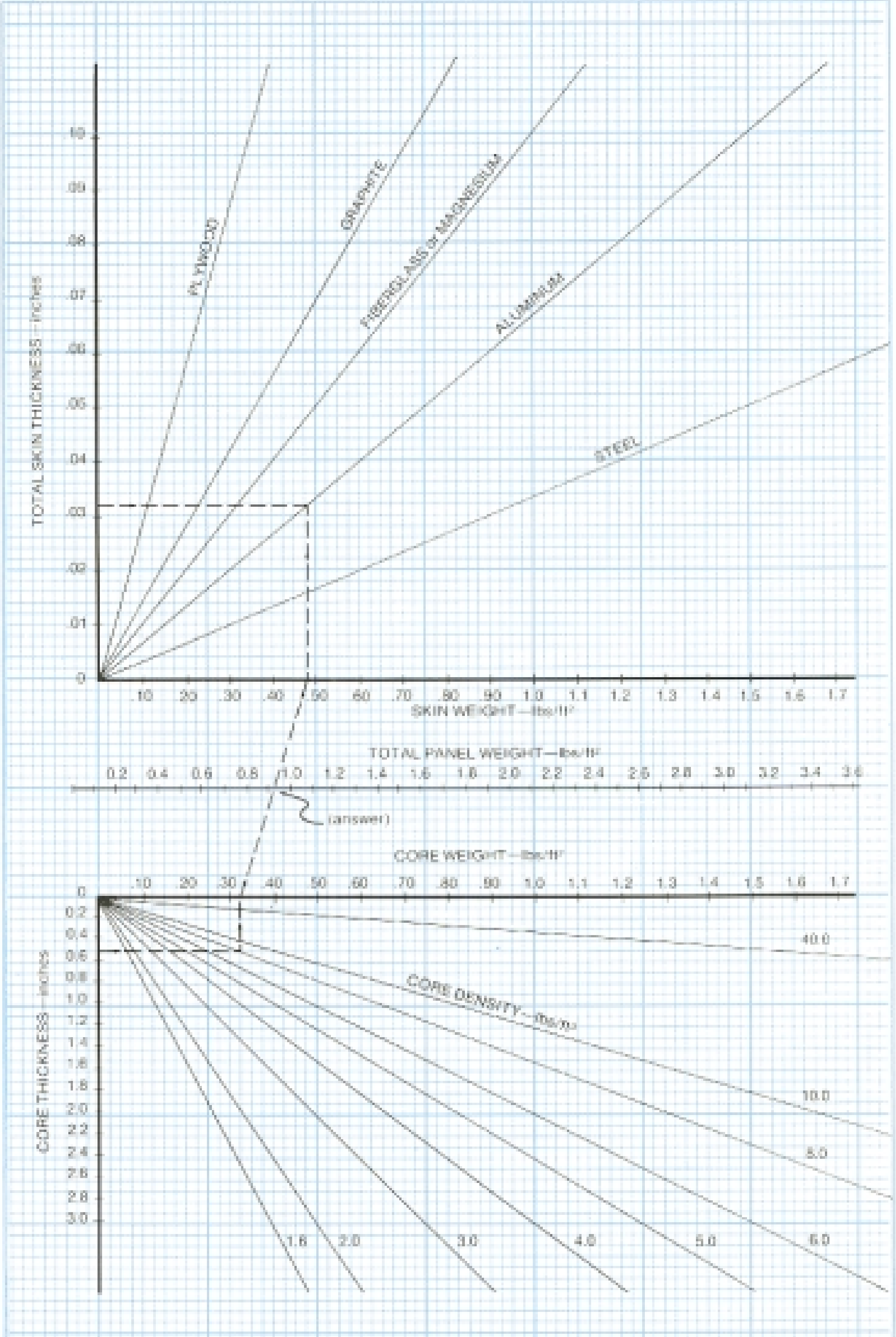
0.12	honeycomb core—all skins
0.09	end grain balsa wood core and metal skins
0.06	foam core—all skins
0.15	balsa core and fiberglass skins

For convenience some of the common types of sandwich cores and their densities are presented in Table 1.

TABLE 1
Core Density by Type
(lbs/ft³)

Density	Core Type
1.6	¼″ cell, .0007″ foil, alum. honeycomb
2.0	polystyrene and 2 lb. polyurethane foams
2.3	¼″ cell, .001″ foil, alum. h.c.
3.1	³⁄₁₆″ cell, .001″ foil, alum. h.c.
4.0	4 lb. polyurethane foam
4.3	¼″ cell, .002″ foil, alum. h.c.
4.5	¼″ cell, HRP glass/phenolic h.c.
4.5	⅛″ cell, .001,″ alum. h.c.
5.0	⅛″ cell, HRH10 Nomex® h.c.
5.7	³⁄₁₆″ cell, .002″ foil, alum. h.c.
8.1	⅛″ cell, .002″ foil, alum. h.c.
9.5	balsa wood, aircraft grade
40	plywood

Many other types of cores have their density called out in their name, i.e., 5#/ft³ ¼″ cell HRP10 honeycomb. Because the density is given these types were not listed here.



THE NOMOGRAPH IS BASED ON THE FOLLOWING FORMULA:

$$W_p = K_s t_s + \frac{t_c d_c}{12} + W_a$$

where:
W_p = weight of panel, lbs/ft²
t_s = total thickness of skins, in.
t_c = thickness of core, in.
d_c = density of core, lbs/ft³
W_a = total weight of adhesive, lbs/ft²

K_s = multiplying constant:
7 for graphite skins
10 for fiberglass skins
15 for aluminum skins
30 for steel skins
0.33 for wood skins

DRILLING GILL PANELS

For any work requiring center-to-center hole tolerances of ±.030" or less, we recommend the use of a drill template with hardened steel drill bushings and a carbide shear bore drill bit. Good tooling will speed production and provide accuracy when repeating the hole pattern. For small jobs (less than 15 holes), a removable bushing (slip renewable) may be used. It is not as accurate as pressed bushings, but the tooling cost will be reduced.

For holes requiring close tolerance diameters (±.005" or less), a pilot hole should first be drilled through a bushing, then the hole counterbored with a carbide shear bore bit to the final diameter. Sandwich panels with soft cores (foam, honeycomb or balsa) should also be counterbored through the back skin — a pilot hole in soft cores will not hold the counterbore pilot steady. Use a drill press or a portable drill guide to simplify drilling holes 90° to the material surface.

Drilled holes can be slightly larger than actually needed for tooling and drill bushings. A user may drill holes and install inserts of .250" into a replacement floor panel where only .216" is needed. This allows enough margin for the panel to line up with the hole pattern, and is usually acceptable when using "floating" inserts or when a mating part is not involved. To prevent delamination when drilling through sandwich panels, apply a steady pressure to the drill, allowing the bit to cut rather than forcing it through the material. Select the maximum rpm that doesn't give spindle chatter, and use a particle board or wood backing piece where the drill exits the material.

Stack drilling is a good way to drill identical holes in several pieces, if they are firmly clamped together. However, center-to-center tolerance will usually suffer, especially on the last few pieces in the stack. When drilling deep holes lift the drill occasionally to clear away the chips to prevent galling and to produce a cleaner, fuzz-free hole.

Metal facings .032" and less generally require bits different from those used on thicker material. Drill points should be sharpened with smaller lip-relief angles to prevent drills from "hogging in" when penetrating the thin skin. Drills should have short flutes and heavy web construction. Consult a knowledgeable vendor before buying specific application bits.

Reaming holes in fiberglass is usually not necessary if the hole is drilled with a diamond hole saw. If it is necessary, use an expansion type, straight-flute carbide reamer with a back rake of 5° on the blades. For tapping holes in fiberglass, bond in tapped metal inserts with epoxy adhesive as tapped fiberglass is not particularly durable. If a laminate is to be tapped, use a fine thread tap and cut a chamfer around the hole to assure a sound first thread and avoid delamination. For blind holes allow room for clearance of 2-3 threads at the bottom of the hole to avoid the possibility of stripping the threads.

Selecting Drill Bits

Selection of the proper drill bit involves several factors, among them, size of the job, type of material, cost and drill life. The following considers the pros and cons of four of the most often used types of bits. If questions arise, the drill bit vendor should be contacted.

• High Speed Steel

1. Lowest initial cost, readily available.
2. Short drill life, especially when drilling fiberglass (about 500 holes between sharpening). This can be improved if a hard flash of chrome plating (.003"-.005") is put on the bit.

• Tungsten Carbide

1. Higher initial cost but longer life. Can be resharpened.
2. In cutting fiberglass:
   a. Up to 3/16" diameter, grind drill bit to have a slight negative rake on the cutting tip.
   b. Over 3/16" diameter, use slow helix drill, ground to 55° point (sharp).
   c. For blind holes 3/16" and larger, use a fast helix bit ground to a 90° point.
   d. Recommended for large run production requirements only.

• Diamond-grit Edged (hole saws)

1. For fiberglass only. Most expensive, but longest lasting, fastest and smoothest cutting. Recommended for high volume only. Forty grit recommended for most Gill products. Can be recoated at near initial cost.
2. Will drill a hole 3 times as fast as a carbide drill.
3. Dust collection system is mandatory.
4. Cannot be used with drill bushings or slip-renewables.

• Solid Carbide Shear Bore

1. Fairly expensive, but very good for fiberglass.
2. Must be returned to manufacturer for sharpening.
3. Produces clean, fuzz-free holes in most facings without delamination.
4. Excellent for drilling clean, accurate holes in unidirectional S-2 glass,® and carbon-faced panels to .750" thick. Cuts quickly without tearing, delaminating or fuzzing the fibers around the hole.

For 90 percent of our work, we use general purpose high speed steel, jobbers length drill bits because we do very little high volume drilling. For hand held drills we use jobbers length aircraft drill bits. There are special bits for "plastics," but they are not designed for reinforced thermoset plastics. Finally, for stainless steel we use cobalt-steel drill bits.

(Continued at bottom of next page)

SPLICING SANDWICH PANELS

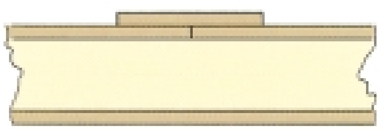
Some people may be reluctant to buy or use spliced sandwich panels, believing that the splices inherently weaken the panel. While it is true that splices create another variable which has to be carefully controlled, the data in Table 2 clearly demonstrates that when spliced properly a sandwich panel suffers little or no loss in strength.

Size limitations of standard materials sometimes make it necessary to put a splice in a sandwich panel to make a large size. In this article we summarize our test data on sandwich panel splices, testing seven splicing techniques with the two most meaningful tests we know.

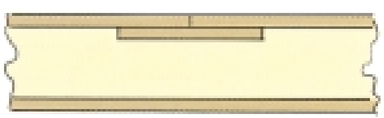
There are three types of splices that can be put into a sandwich panel — as shown in the following illustrations. Note: Doublers are not drawn to scale.

1. Splicing Skins

1a. Butt splice of one skin, no doubler.

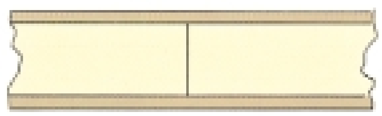


1b. Butt splice, with doubler outside panel.
Doubler width: 3 times panel thickness.
Doubler thickness: same as face skin.

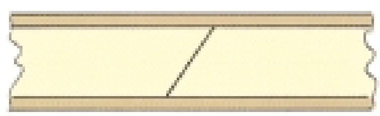


1c. Butt splice, with doubler inside panel.
Doubler width and thickness: same as 1b.

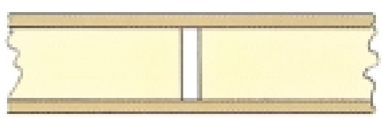
2. Splicing Core



2a. Butt splice, no adhesive at the joint.

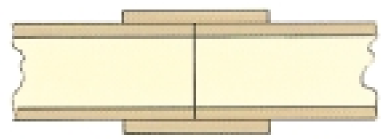


2b. 45° scarf splice, adhesive bonded.

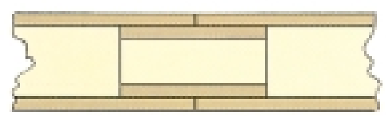


2c. Poorly done butt splice, ¼" gap in core (an example of poor workmanship).

3. Splicing Entire Sandwich Panel



3a. Butt splice, overlapping doublers.
Doubler width: 3 times panel thickness.
Doubler thickness: 2 times face skin thickness.



3b. U-splice with inlaid sandwich panel.
Inlaid panel width: 3 times the thickness of the spliced panel. Inlaid panel thickness, d−2t where:
d = thickness of spliced panels;
t = average thickness of skins of spliced panels.

TEST METHODS

We felt two tests would adequately show the effect of a splice on the strength of a sandwich panel.

1. 20" span flexure: With the splice located in the center of the span this test simulates the worst condition for stress on the splice. This test measures how much the splice has affected the load bearing capability of the panel.

2. In-plane shear: With the splice located in the center of the panel. Many panels are loaded as shear panels, such as side walls of a tank. This test will detect any change in panel shear strength.

CONCLUSION

The splicing creates another variable which must be closely controlled, but if properly done the mechanical strengths will not be significantly lowered, as indicated in Table 2 on the following page.

(Cont'd. from Page 4)

Drill Speed

The speed of a drill bit is usually measured in surface feet per minute (sfm) and is calculated from the formula:

$$\text{sfm} = 0.26 \times \text{rpm} \times \text{drill bit diameter (inches)}$$

In general, the faster a drill bit turns, the fewer holes it can drill before sharpening; however, fast drill speeds allow a higher production rate. Consequently, on every job a drill speed has to be chosen that will allow a high rate of production without entailing excessive drill bit costs.

The following tabulation, excerpted from the *Metal Cutting Tool Handbook*, indicates recommended drill speeds for the more common types of facing materials used on M.C. Gill sandwich panels.

Material	sfm (Surface feet per minute)	
	Carbide	High Speed Steel
Aluminum	150-550	200-300
Glass reinforced plastic	50-125	30-80
Graphite	50-125	30-80

TABLE 2—MECHANICAL TESTS ON SPLICED SANDWICH PANELS .375" thick sandwich panels made from .011" 2024T3 aluminum skins bonded to aluminum honeycomb, ¼" cell, 4.3 pcf density	20" flex—2 pt. load Ultimate load-lbs.	20" flex—2 pt. load deflection @ 100# load-in.	20" rack shear-lbs.
No Splice			
Unspliced panel (control panel for comparison)	210	.41	23,000
1. Splicing Skins			
1a. Butt splice skin, no doubler	91	failed	13,200
1b. Butt splice skin, doubler outside of panel	232	.40	22,000
1c. Butt splice skin, doubler inside panel (recommended procedure) doubler is t thick and 3d wide	254	.40	22,000
2. Splicing Core			
2a. Butt splice (our recommended procedure with no adhesive seepage at the joint)	240	.39	22,000
2b. 45° scarf splice	220	.40	21,000
2c. Butt splice poorly done (¼" gap)	172	.41	19,000
3. Splicing Entire Sandwich Panel			
3a. Butt splicing 2 panels, overlapping doublers doublers are 2t thick and 3d wide (recommended procedure)	237	.40	20,000
3b. U-splice with spline, inlaid panel panel is 3d wide	187	.40	20,000

NOTES: d = thickness of panels t = thickness of skins

Have We Got A Deal For You!

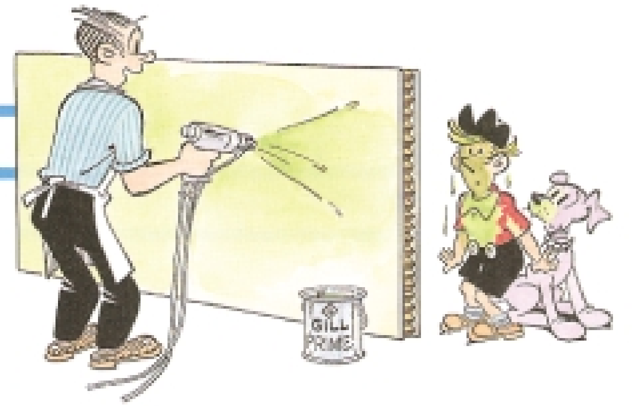
Binders for past Doorway issues

In a recent questionnaire we sent to our readers we asked if they save back issues of the Doorway. Almost all of the replies were in the affirmative. Keeping past issues for reference purposes is a good idea and very helpful, but finding a place to keep them may be a different matter entirely. If you're like many of us here at the M.C. Gill Corp., you've commandeered an old three-ring binder, punched holes in each issue and filed them for future reference.

So, in the interests of bookcase and desktop beautification, we are pleased to announce that we now have available three-ring binders (illustrated above) that will accommodate about seven or eight years (28 to 30 issues) of past Doorways.

We believe you'll appreciate having your Doorways in their own binder, and if you agree just contact the Marketing Services Department with your request.

PAINTING SANDWICH PANELS



Once in a while our customers require that the facings on M.C. Gill sandwich panels be painted or primed. Painting know-how is readily available but the following relates specifically to the coating of our panels and involves several factors.

1. The resin system and reinforcement used to construct the panel facing.
2. Surface preparation.
3. The actual painting.

Panel Facings Construction

M.C. Gill panels are basically ready to accept paint as produced. Our fiberglass panels typically have a faint characteristic surface texture of the woven cloth. Sometimes, there may be some shallow depressions which can often be tolerated, but may require filling and a very light sanding if a very smooth painted surface is required.

Resin System. The resin system greatly affects the success of subsequent painting. The following systems are listed in the order of ease of paint application:

a. Polyester (easiest to paint). Quality laminators produce panel facings with few if any voids; the extent of surface voids is a good indicator of the laminator's competency.

b. Epoxy (harder to paint due to the possibility of residual mold release on the surface). If we are advised when the order is placed that the panel facing(s) is to be painted, we will produce an epoxy surface free of residual mold release.

c. Phenolic or Polyimide (very difficult). Painting a surface constructed with either of these resins is not advised. If painting is absolutely necessary, the surface should be completely coated with filler and sanded smooth.

Reinforcement. Because most of our sandwich panel facings are reinforced with fiberglass, you should encounter few problems. However, Kevlar® reinforced plastic is more difficult to paint and under no circumstances should it be sanded before painting due to Kevlar's tendency to "fuzz."

Surface Preparation

Proper preparation almost always boils down to four factors: sanding (or not sanding); the use of filler putty; use of solvent to clean the surface; and a primer coat prior to painting. Based on our experience the following guidelines generally apply:

a. Avoid sanding if at all possible. Direct roughing of the faces creates more problems than it solves. Any air voids just beneath the surface will be opened up by sanding and it becomes a never-ending process. Worse yet is sanding into the glass fibers, as the exposed fibers can cause pinholes in the paint. Most hot pressed facings do not have a resin rich surface or gel coat and, as a result, the fibers are quite close to the surface. If sanding is necessary, we suggest very light sanding with a 240 grit paper.

b. The use of filler putty should be kept to an absolute minimum. Like sanding, filling can be very time consuming. However, if surface voids must be filled to avoid a pinhole surface, such as with some phenolic faces, filler putty must be used. Aircraft grade fillers are widely touted as being sprayable and we normally use a spatula to accomplish filling on the first try.

c. Wiping the surface with a solvent is not recommended. It is almost impossible to wipe off the thin film of solvent before it evaporates, in which case the contaminants have simply been spread around. A dry rag, a rag dampened with plain water, or a very mild detergent wipe followed by a wipe with water-dampened rag gives better results. If a solvent wipe is mandatory, we suggest MEK solvent applied with a clean cotton cloth and a second wipe with a dry rag before the solvent dries (change rags frequently if the surface is large). Personnel should always wear rubber gloves and work in properly ventilated areas when using MEK.

d. Priming should be done if the paint manufacturer recommends it. Primers can improve adhesion, though for many interior applications paint directly applied to the facing is adequate. Polyurethanes and epoxies are costly paints but are proven coatings and superior adhesion justifies the expense.

Paint Application

Spraying is the most common method of application. Use the pressure and nozzle system recommended by the paint manufacturer. Dust must be kept to a minimum; use a tack rag just prior to painting and paint in a dust-free environment. Final film thickness of 1.2 to 2 mils is usually recommended; coverage should be about 300 to 400 sq. ft. per gallon.

Two thin coats give better results than one thick coat. Apply the first coat then a second before the first coat is totally dry to assure good bonding between the two coats. Minor filling of the first coat can be done but it must be dry enough so that the filler will spread.

Another Alternative — Overlays

Because voids in the surface always result in paint pinholes that require extensive rework, customers sometimes prefer an overlay. Tedlar® (polyvinyl fluoride film) is a lightweight overlay which we can bond directly onto the facing. Our patented Gillcoat system of fusing a colored resin system or pattern directly into the panel face during pressing provides a thicker and more abrasion resistant surface. It is also possible to bond on decorative overlays, the aircraft version of wallpaper. Please advise us in advance when our panels are to be painted — we can contribute suggestions and recommendations for the most effective approach, in terms of appearance and expense. Having coated our products for more than 46 years, plus observing our customers' coating experiences, we believe we are knowledgeable in this rather limited field.

CUTTING AND ROUTING SANDWICH PANELS

CUTTING: When cutting any sandwich panel, especially one with unidirectional facings and/or aluminum honeycomb core, it is imperative to clamp the panel to a backing sheet to avoid delamination. This can be accomplished in one of three ways:

First, a backing sheet ¼" to ½" thick of wood or particle board is required. The backing sheet should be clamped, not bonded, to the bottom facing of the panel to be cut, if the direction of the blade is moving top to bottom. If the blade is moving in a bottom to top direction, the backing sheet should be clamped to the top facing. Length of the backing sheet must be equal to the length of the cut, and width should extend at least two inches on either side of the cut. If a C-type clamp is used, the width of the backing sheet must extend over the saw table top so that the bottom of the clamps will clear the sides of the saw table. The clamps should be placed as close as possible to the cut and care should be taken not to dent or otherwise mar the top facing. The second method is to apply pressure only to the top facing so that the saw table acts as the backing sheet. A third would be to use a vacuum table. In most shops that perform an extensive amount of panel cutting this type of equipment is already in place, and can be done using a radial arm or table-top saw. Although not inexpensive, any facility where cutting panels is a daily routine is well advised to make the investment.

With Band Saws: We do not cut our standard products with band saws because the cut is slow and too difficult to control. Band saws can be used for making rough cuts to loose tolerances.

A fence should be used to control the cut as much as possible. Most M.C. Gill products may be cut with a standard 8-10 teeth/inch band saw. It will dull rapidly; but, even when dull, it gives a fair cut and is inexpensive to replace. We have cut sandwich panels that have stainless steel or titanium skins with a band saw, because circular saws won't make this cut very well.

With Circular Saws: We use circular saws to do 98% of our finished product cutting. For worker comfort, safety and cleanliness, a good vacuum system to collect dust at the saw blade is a must. We normally use 12" to 16" diameter carbide tipped or diamond saw blades. Diamond blades are coated at 40 grit. Carbide blades, which have gullets between the teeth, are used for difficult-to-cut materials, such as metal faced sandwich panels or thick aluminum; diamond blades should not be used to cut aluminum. The more teeth per inch on a saw blade, the finer the cut. We use 12" blades with 60 to 72 teeth, alternating raker set. Recommended blade speeds are shown in the following tabulation. The performance of common type saw blades for difficult materials is given in Table 3.

Blade Diameter	Revolutions Per Minute	Surface Feet Per Minute
8	4500	9400
10	4000	10500
12	3600	11300
16	3450	14500

TABLE 3—CUTTING M.C. GILL SANDWICH PANELS

Panel Construction	Blade Type	Comments
Fiberglass/wood	Carbide tip	Best, although dulling will occur. A grit blade will clog rapidly.
Fiberglass/balsa	Diamond grit	Best, but will clog. Can be quickly cleaned with chemical stripper. Lasts longest.
	Carbide tip	Good, except it dulls rapidly.
	Carbide grit	Satisfactory for small number of cuts.
Fiberglass skin/paper or Nomex honeycomb or foam	Diamond grit	Best.
	Carbide tip	Possible. Make sure blade is sharp.
	Carbide grit	Possible, some tendency to clog.
1) Alum. face/wood or foam 2) Alum. face/alum. honeycomb 3) Fiberglass/alum. honeycomb	Carbide tip only	All other blades are unsuitable.
Titanium or steel skins/any core	Band saw (Carbide tip)	Cuts with difficulty and will make a rough cut. Should buy panels finished to size.
	Carbide tip	Dulls rapidly, not recommended.
Unidirectional glass or graphite*/any core	Diamond grit	Best. Others may delaminate the fibers.
Kevlar/Nomex (over 25% resin content)	Diamond grit	Best, although will leave slight fraying at cut edges.
	Carbide tip	Possible.
Reminder: Make sure any blade is reasonably sharp. Even the recommended blades require periodic sharpening to obtain satisfactory cuts.		
Our standard saws are:	14" diamond grit	Standard slot, 4 reliefs.
	12" carbide tip	60-72 teeth.

**Because graphite dust will short out electric motors, a vacuum system should be used to collect the dust at the point of the cut.*

CUTTING AND ROUTING SANDWICH PANELS

ROUTING: When routing panels with very soft skins (such as 3003H14 aluminum) the aluminum will tend to gall on the bit, greatly shortening the bit life. Care must be taken to keep the bit clean.

Diamond grit router bits are not recommended, except for special applications. They are relatively expensive and must be cleaned frequently. They can, however, be re-coated with diamond grit when they wear out. Recoating costs approximately 80% of the cost of a new blade. A special carbide router bit, resembling a round file, is used for most of our fiberglass routing, especially epoxy. Carbide bits are fairly inexpensive, and can be re-sharpened for approximately one-half the cost of a new bit.

For most aluminum/balsa type panels, we recommend a 2-flute, spiral downcut, 1/4" high speed steel router bit because the cut is clean. These bits are very inexpensive and are thrown away when dull.

When selecting a router bit from Table 4, keep in mind that characteristics of the individual materials to be routed may influence the cutter selection. These factors include resin content, degree of cure and number of parts to be routed. Therefore, this table should be used as a guide only, and adjustment made for particular applications.

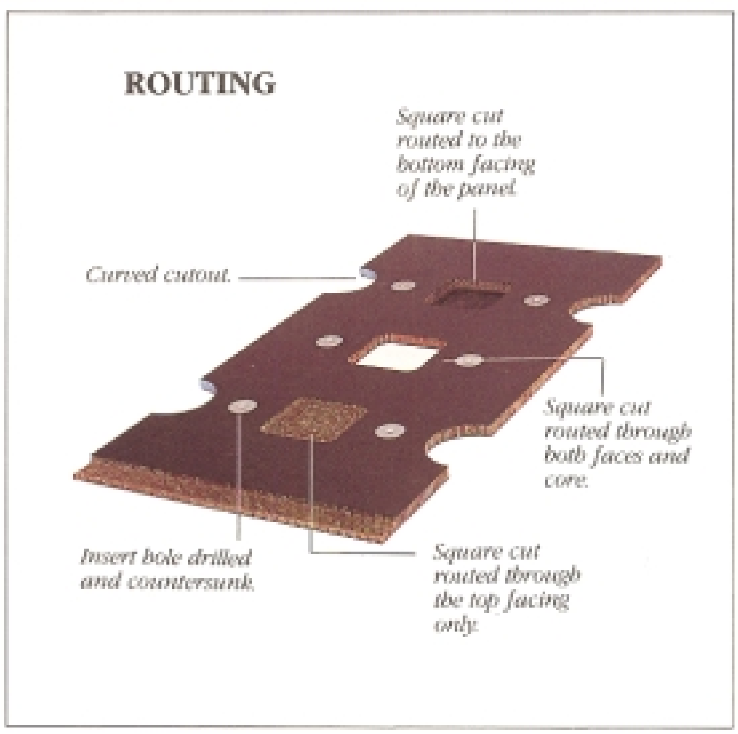
TABLE 4—ROUTING M.C. GILL SANDWICH PANELS

We employ a router to make contoured cuts. The accuracy of the cut depends upon the accuracy of the tooling. Routing can be done to ±1/32" tolerances quite easily. We select our router bits according to the following chart.

Panel Construction	Type of Router Bit	Comments
Aluminum/wood	Solid carbide/spiral 2 flute	Best, dulls rapidly, can be sharpened.
Steel/wood	Carbide tip/spiral 2 flute	Good, dulls rapidly. Not as expensive as solid carbide.
	High speed steel	Not recommended—dulls and may break.
Fiberglass/balsa	Special fiberglass	Best, inexpensive, can be sharpened. Best with rigid laminates.
	Diamond grit	Will cut and clog, longest life, can be cleaned.
	Carbide tip	Dulls rapidly, not recommended.
Aluminum/aluminum	2 flute—straight or spiral, H SS steel	Good, least expensive, but dulls, can be sharpened.
	2 flute—straight or spiral, carbide tipped	Best, longest life, but more expensive.
Fiberglass or graphite/paper or Nomex honeycomb	Diamond grit	Clogs, can be cleaned, smoother cut, more expensive. Best for graphite.
	Carbide	Good, doesn't clog, less expensive.
	Carbide (Titanium coated)	Best, least expensive.

This panel is being cut on a table saw using a diamond grit blade with a backing piece (in this case, plywood) under the panel.

This panel is being cut on a table saw using a carbide tip blade with a backing piece (plywood) under the panel. (Note: the blade guard on the saw has been raised for purposes of photographic clarity only. O.S.H.A. and standard safety procedures dictate this blade guard remain in a down position at all times when the saw is in use.)



REPAIRING DELAMINATED SKINS

We believe that our customers seldom will have to repair delaminations on our panels, but we take this opportunity to pass on what we have learned.

Corner and Edge Delamination

Corner and edge delamination can usually be satisfactorily repaired to preserve the integrity of the panel, using a high quality room temperature curing adhesive. First, follow the adhesive application directions to the letter. Second, lay the panel flat with the delaminated skin on top and spread the adhesive uniformly on *both* surfaces to be bonded. Third, turn the panel over so that the delaminated skin is facing down and apply pressure evenly over the delaminated area using clamps or weights sufficient for intimate contact until the adhesive hardens. Be sure to protect the surface the panel rests on from adhesive seepage. Remember, a) *thoroughly* mix the adhesive in proper proportions, if mixing is required; b) evenly coat both bonding surfaces with the adhesive; and, c) maintain uniform pressure during the adhesive cure.

Do not move the panel until the adhesive has cured. Cure time can be observed empirically by feeling the adhesive that has squeezed out at the bond line or checking the excess adhesive left in the container used for application. Some epoxy adhesives do not develop full strength for a week at room temperature but can be handled after approximately 18 hours at 70°F.

Blister Delamination

A blister in a sandwich panel facing can be repaired, but it could be an indication that the bonding of the entire panel is faulty. Exercise careful judgement in deciding whether to repair or replace structural panels.

Generally speaking, a blister in a solid core, e.g., end grain balsa wood, can be repaired by drilling one or more small holes, about 1/32," in the blistered skin and then injecting a thin adhesive into the blister through the holes with a syringe. Once the adhesive is in place, apply uniform pressure over the blistered area with clamps, weights, or vacuum bag until the adhesive has cured. Again, take precautions against adhesive seepage.

A blister in a honeycomb core sandwich panel presents more of a problem and syringe injection is not normally the solution. If the blister is close to a panel edge, it is better to peel back the skin from a corner until the blistered area is exposed and then repeat the procedure to repair corner and edge delamination described above.

If the blister is in the center of a honeycomb panel, the following alternatives are available.

1. Plug. Remove the skin around the blister with a hole cutter and cut a piece (plug) of the same facing material as close to the size of the area of exposed core as possible; apply adhesive to core and plug, place the plug in the cut-away section and apply pressure until adhesive cures. This type of repair is cosmetic and protects honeycomb cells from filling with liquids but does nothing for the load carrying ability of the panel.

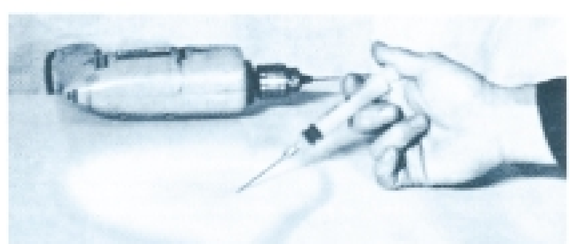
2. Patch. Remove the skin around the blistered area, cut a piece of the same facing material so that it covers the exposed core plus a minimum of two inches around all sides of the exposed area, i.e., a 2" diameter blister requires a 6" diameter patch. Apply adhesive to the patch and the entire area the patch covers (including the exposed core), and apply pressure until adhesive cures.

3. Plug and patch. Place a core plug over the blistered area as described in 1. above and immediately affix a patch over the plug (2. above), again making sure the size of the patch extends beyond the plug a minimum of 2" in all directions. Apply pressure evenly over the patch until the adhesive cures.

4. Replace facing. Peel off the entire skin and bond on a new one in the same manner as an edge delamination. This repair method probably should not be attempted unless adequate facilities are available to apply an even pressure over the entire new facing until the adhesive cures completely.

In the first three instances above, filling the honeycomb core with a filler such as epoxy resin may be advisable to maintain structural integrity. Where only a patch is used, filling the core to a point level with the top of the surrounding facing may be called for to avoid dimpling over the cut out area after the patch is in place and pressure applied.

Edge delamination — coat both skin and core with carefully mixed epoxy adhesive. Always apply pressure while adhesive cures.



Blister delamination — using a 10cc syringe, inject blister with thin epoxy adhesive. Apply pressure until adhesive cures.

EDGE CLOSURE DESIGN

A major design consideration for raw stock sandwich panels is closing out the edges. Exposed edges are a weakness in the design because the light weight core is easily susceptible to damage from the environment. Proper edge closure protects both the adhesive and the core itself. Balsa wood, Nomex and paper honeycomb are core materials most susceptible to environmental damage. Properly designed edge closure is essential in optimizing the end use, but with the various alternatives available selecting the proper method often presents the design engineer with a dilemma.

Purpose of Edge Closeouts

Edge closure can serve the following purposes:

1. Seal the panel from weather, moisture and contaminants;
2. Improve appearance;
3. Improve mechanical strength and stability of panel;
4. Provide solid attachment points for fastening or joining; and,
5. Serve special purposes or create shapes for a given application.

The type of edge close-out depends on the purpose or end use. Table 5 summarizes the most common design considerations.

Application Methods

Sealers, like paint, are applied by brush.

Epoxy potting compounds are usually applied with a spatula or trowel. The core is removed around the edge and the grout is then applied.

Tapered close-outs are part of the manufacturing process and must be executed while the panel is being produced. The core is either machined to shape or slightly compressed.

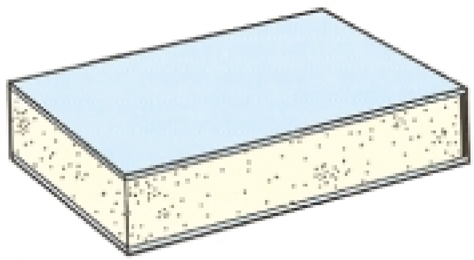
Structural shapes can be bonded in place during the manufacturing process or as a secondary operation after the panel is made, although this generally provides lower structural strengths. The thickness of the edge-closure must be within .015" of the overall panel thickness. Core tolerances are generally ±.010" so thickness is critical when bonding edge extrusions inside the panel facings.

Various types of edge closures are illustrated on Pages 12 and 13.

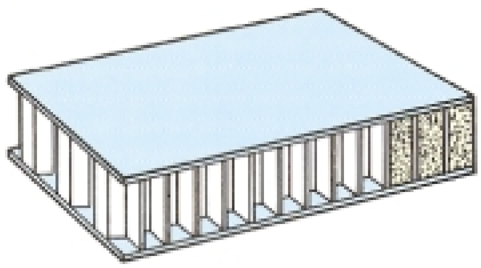
TABLE 5—CONSIDERATIONS FOR EDGE CLOSURE

Edge Close Out	General Comments	Cost Factor	During or After Panel Assembly	Weight	Structural Capacity	Environmental Moisture Protection	Problems Due To Thickness Tolerance	Typical Applications
Sealed Edge (epoxy)	A two-part epoxy can seal solid cores like balsa wood and foam.	Very Low	After	Very Light	None	Fair	None	Solid core panels in interior applications.
Potted Edge	Usually a 45 pcf epoxy grout to seal honeycomb panels.	Low	After	Medium	Minimal	Good	None	Weather proof applications, neither structural nor decorative.
Solid Edge	High density foam, plywood or hardwood, e.g., spruce.	Low	Foam-During; Wood-After	Medium	Foam-Fair; Wood-Good	Foam-Good Wood must be sealed	Critical	Low cost with good mechanical strength. Wood for interior application only. "End grain" wood superior to flat grain. Good for doors.
Formed Facings	Many design variations; either frp or metal facings will work.	Medium	Before	Light	Low-Fair	Metal-Good Frp-Excellent	Average	Interior decorative panels. Weather sealed panels.
Snap-on Moldings	Plastic or metal; good in decorative applications. May want to seal with adhesive.	Medium	After	Light	None	Fair	Less than average	Easy to do at customer's shop after cutting to size. Often used in galley panel applications. Core should be sealed.
Sheet Metal	Many variations; can be mechanically fastened or bonded.	Medium	Either	Light-Medium	Fair	Fair to Excellent	Average	High volume jobs, especially commercial grade.
Standard Extrusions	Limited number of thicknesses available.	High	Either	Varies-Usually Heavy	Excellent	Excellent	Critical	Structural applications. If bonded during panel assembly, it may cause warp problems.
Special Extrusions	Often best choice for high volume structural parts.	Very High	Usually During	Heavy	Excellent	Excellent	Critical	Structural. Cargo pallets and places where fastening to panel is a problem.
Compressed or Machined Core	Core is slightly compressed or machined to tapered close-out.	Medium-High	Before	Light	Good	Good	Critical	To fit into custom designs. Helicopter panels.

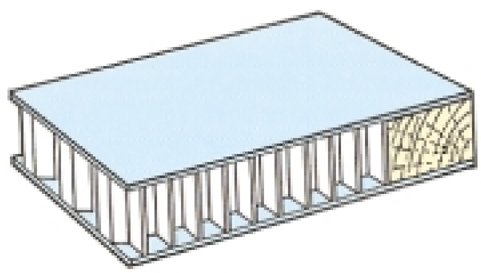
EDGE CLOSURE DESIGN (Cont'd.)



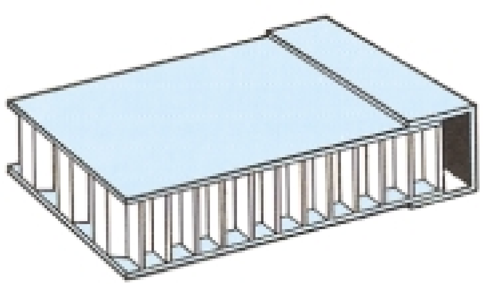
1. A solid core can be sealed with special epoxy paint sealers.



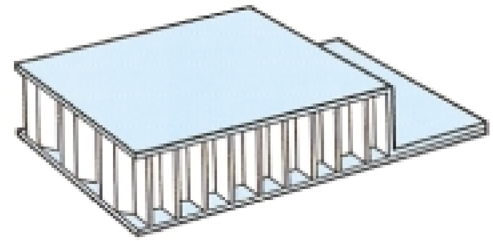
2. For a potted edge the core is removed, then potting compound is inserted with a trowel.



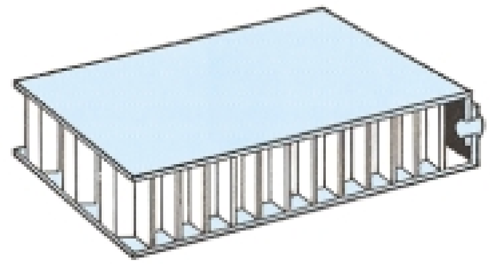
3. Solid edge. High density foam, hardwood or metal is bonded in place during or after panel is made.



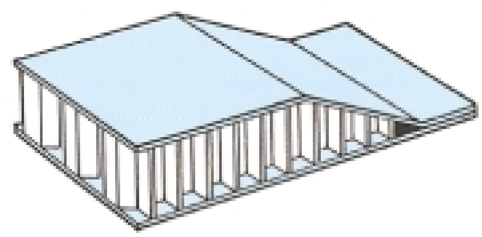
4. Formed metal or plastic is snapped on and/or bonded after panel is made. It can be tapered for tight fit.



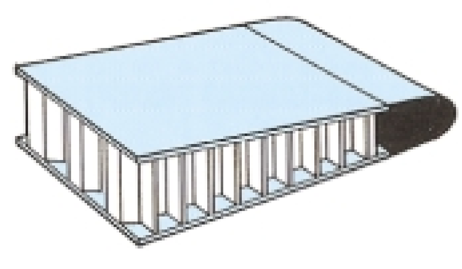
5. Formed facings. One skin is formed to fit over the edge, then bonded to other facing during panel assembly.



6. Formed facings. Skins have to be formed prior to panel assembly. Can be bonded or riveted together.

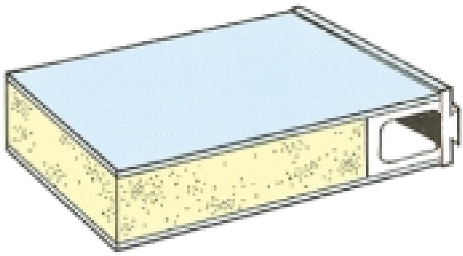


7. Tapered core requires close tolerance work in bonding operation. Core is machined to taper.

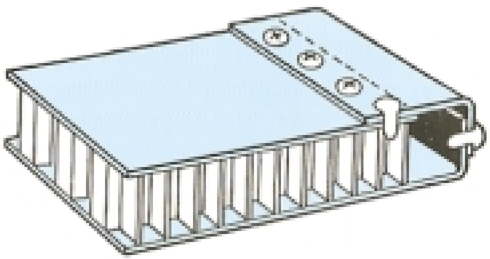


8. Special shaped extrusion for aerodynamic or other purpose is bonded in place.

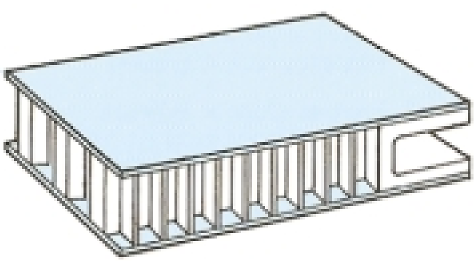
EDGE CLOSURE DESIGN (Cont'd.)



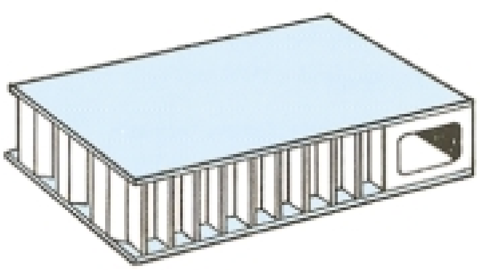
9. Special extrusion is designed to facilitate later fastening operations in structural strength applications.



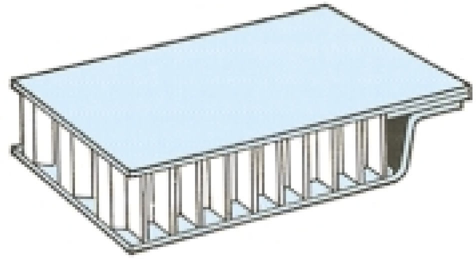
10. Sheet metal is mechanically fastened, or bonded, after panel is made.



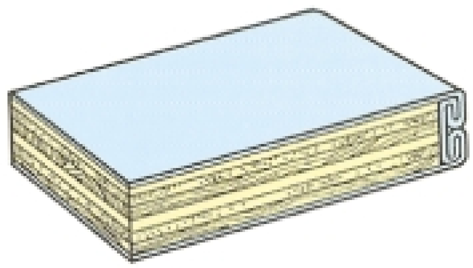
11. Structural shape is bonded into panel during or after panel assembly.



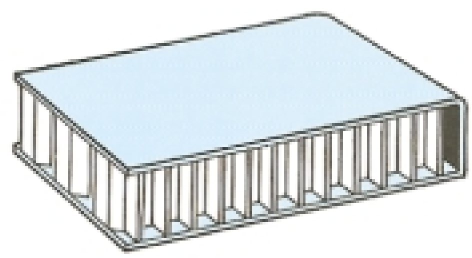
12. Structural shape is bonded into panel, sealing edge and providing mechanical strength.



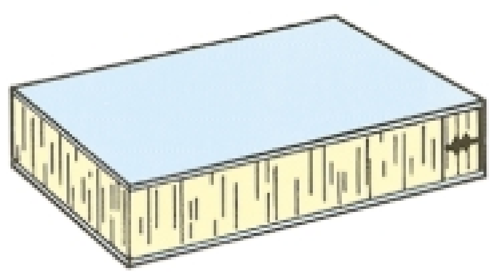
13. Zee-type edge is bonded in place after panel is made.



14. Plywood core with metal facings turned over and lock seamed to channel insert.



15. Formed facings. One skin is formed to fit over the edge.



16. Slot in core is routed, then T extrusion is bonded in place.

HOW TO AVOID GALVANIC CORROSION

A perennial cause of premature failure of aircraft parts and components is galvanic, or electro-chemical, corrosion. The more noble of two metals in contact with an electrolyte, normally water, causes an electro-chemical attack on the less noble metal. Eventually the less noble material becomes so corroded it has to be replaced. However, with proper selection of materials and protective coatings, galvanic action can be either eliminated or greatly reduced.

All metals have a characteristic electric potential. When metals of different potential are in contact in the presence of an electrolyte (moisture, acid, etc.), a low energy current flows between the metals, resulting in the corrosion of the metal with the higher potential (least noble).

We have made a chart showing the relative potential for galvanic corrosion of a number of widely used metals. The more widely separated the metals are on the chart, the more likely corrosion will occur. For instance, 2024 aluminum will corrode in the presence of 410 stainless (active), but corrosion would be more severe in the presence of 410 stainless (passive). Metals in the same grouping normally do not cause galvanic corrosion on each other, i.e., titanium and 304 stainless (passive). If the cathode (most noble) metal is large compared to the anode (least noble) metal, the corrosion will be much more severe than if the sizes were reversed. For instance, bronze fittings can usually be used in steel water lines with only minor corrosion of the steel, but if steel fittings are used in a copper line they corrode rapidly.

Following are some general design guidelines to help avoid electro-chemical corrosion.

• Maintain constant stress, especially in fasteners. Irregular loading contributes to corrosion development.

• Separate or prime dissimilar metals with a dielectric material such as insulation or paint.

• Avoid combinations where the least noble metal is small, for example, a fastener should be slightly more noble (smaller potential) than the assembly it is holding.

• Utilize sacrificial corrosion, if necessary, by coupling parts to be protected to pieces of less noble metal which are not functional. The less noble metal then corrodes sacrificially.

• It should come as no surprise that the M.C. Gill Corp. encourages the use of fiberglass, which presents no corrosion problems even in the worst circumstances.

These corroded aluminum flooring panels were removed from the galley of a DC9. This amount of corrosion is typical for aluminum in "wet" areas. Gillfloor 5166 eliminates this type of failure.

CORRODING END

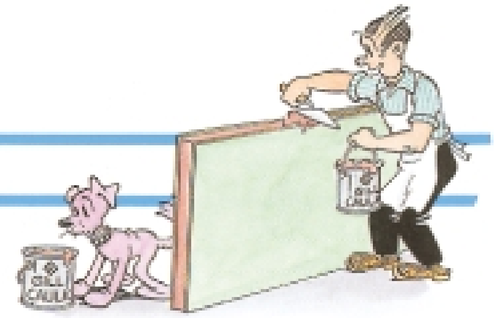
(Anode, least noble, +, high potential)

1. Magnesium
   Magnesium alloys
2. Zinc
3. Aluminum A1100 (2S)
4. Aluminum 7075-T6
5. Cadmium
6. Aluminum 2024-T4 (17 ST)
7. Steel or Iron
   Cast Iron
8. Stainless 410 (active)
9. Ni-Resist cast iron
10. Type 304 stainless (active)
    Type 316 stainless (active)
11. Lead tin solders
    Lead, Tin
12. Nickel
    Inconnel (active)
    Hastelloy alloy C (active)
13. Brasses, Copper, Bronzes
    Copper Nickel alloy
    Monel nickel-copper alloy
14. Silver solder
15. Nickel (passive)
    Inconnel (passive)
16. Stainless 410 (passive)
    Titanium
    Stainless 304 (passive)
    Stainless 316 (passive)
    Hastelloy alloy C (passive)
17. Silver
18. Graphite, Gold, Platinum

PROTECTED END

(cathode, most noble, —, low potential)

SEALING SANDWICH PANELS



Many aircraft grade sandwich panel applications require that panel edges be sealed against moisture which would otherwise deteriorate the core and/or the adhesive bond line. Sealants and potting compounds are normally used, often as an added protection when structural shaped extrusions are used. The choice of sealant largely depends on the panel's core material.

For Foam Core. A heavy latex paint or thin paste is acceptable and can be applied with a brush. Most sealants will work reasonably well with closed cell foams because they have low moisture absorption. The alternative is to rout back 1/4″ around the perimeter and apply caulking compound with a spatula. This method is more time consuming and expensive, and the additional sealing obtained is marginal.

For Honeycomb Core. A potting compound is recommended. However, because it takes up considerable volume it must:

- Be light weight;
- Not become brittle, especially for panels in which the end use subjects it to considerable flexure;
- Adhere to the facings;
- Pass FAR 25.853 flammability requirements; and,
- Be easy to work with.

With regard to application, different aircraft maintenance operations have different priorities. Most prefer a one-part sealing system which avoids problems due to the short "pot life" of a two-part compound. No time or effort are required to mix catalysts. Cartridge guns for one-part systems can be used (although there are cartridge guns that will accommodate two-part compounds as well). Others (including the M.C. Gill Corp.) prefer to use a spatula to apply the heavy pastes required to seal honeycomb. If three to ten panels can be stacked and clamped together, a spatula application becomes even more desirable.

For Balsa Core. This core should always be sealed. A thin waterproof urethane paint coating is preferred for ease of application (it can be brushed on). A two-part thin epoxy will seal a little better but requires mixing for catalyzation and is therefore more time consuming. Heavier pastes are more difficult to apply properly and they are beneficial only if the core is routed out 1/4″ around the perimeter. A spatula should be used with this type of sealant.

Note: There is a common misconception that if moisture comes into contact with an end grain balsa core, it will ultimately penetrate the entire core, rendering it useless. In fact, because the wood grain runs perpendicular to the facings, the end grain construction normally limits moisture penetration around a point in the balsa to no more than 1/2″. However, the adhesive is critical in this situation because some adhesives absorb moisture which may cause bond failure to occur to some extent around the penetration point.

NEWS FLASH

M.C. GILL FLOORING PANELS FLY WITH AIRBUS

The M.C. Gill Corporation has received approval from Deutsche Airbus for three recently developed sandwich panels — Gillfab 4205, Gillfab 4322 and Gillfab 4323 — to be used as replacement flooring for the A320/A321.

They are the only replacement panels to have received qualification to Airbus Industrie/Deutsche Airbus Technical Specification 5360 M1B 000100, Issue 3.

Gillfab 4205 is now qualified for the A320's passenger and cockpit compartment flooring; Gillfab 4322 is qualified for use as flooring in the containerized cargo compartment; and Gillfab 4323 is approved for flooring in the bulk cargo compartment. All three products feature a construction of fiberglass cloth reinforced phenolic resin bonded to an aramid honeycomb core and all share low smoke emission characteristics.

Trivia

The walking speed of the average American woman is 256 feet per minute; of the average American man, the average is 245.

* * * *

U.S. Senate rules "limit" a senator to using his name *only* eight times per page on his newsletter.

* * * *

The geographic center of the population in the United States moves west 58 feet per day, and south 29 feet per day.

* * * *

In 1962, 74 percent of all practicing physicians belonged to the American Medical Association; today, the percentage is 45.

* * * *

TRIVIA GOOF

Once in a while, an error will crop up in one of our Doorway articles (our fellow employees are the most eager to point them out) that we can't explain away by blaming a gremlin in our printer's press room. However, we recently experienced a first when one of our readers called to point out a glitch in one of our Trivia items.

In the Summer 1991 issue, we stated that "Madrid's 1811 earthquake rang Boston's church bells." Violating one of M.C.'s cardinal principles that "To assume is to err" we naturally figured that Madrid, Spain, was the location of the jolt. Reader Jim Sapp of McDonnell Douglas, St. Louis, however, was quick to point out that the quake occurred in *New* Madrid, which is in Missouri, not Spain.

Sure enough, a quick check revealed that Jim had his facts straight. Thanks, Jim. We stand corrected.

M.C. GILL CORP. • SINCE 1945

THE FUNNY SIDE

The headmaster of an exclusive prep school was astounded to see one of the students wipe his fork on the tablecloth. "Do you do that at home?" he demanded icily. "No sir," the boy replied. "At home we have clean forks."

* * * *

One ad agency copywriter to another, "Hi! What's new and improved?"

* * * *

Overheard at a class reunion: "I lead a life of wine, women and song — it's cheaper than gas, food and rent."

* * * *

Scientist to a colleague: "I'm not afraid of the unknown. It's the stuff we already know that scares me."

* * * *

From a personnel manager: "Confident? Look at his resume. It's the first time I've seen 'omnip-otence' listed under job skills."

* * * *

A group of first graders was asked to complete the sentence, "My mother cooks the best…" One boy replied, "that she can."

* * * *

On an eighth grade vocabulary test one young man defined "biography" as the story of a person's life and "autobiography" as the story of a person's car.

* * * *

The Sunday school teacher asked her class, "Does anyone know where to find the Beatitudes?" Answered one little boy, "Did you look in the Yellow Pages?"

* * * *

There are two sorts of losers — the good loser and the one who can't act.

* * * *