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THE M.C. GILL DOORWAY

New Vistas in Composites

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*"G. Bee,
we're beholden
to zero defects
on our bee-line"*



*"You said a
mouthful, M.C."*

HORIZONTAL INTEGR

Not too awfully long ago, less than 20 years, the M.C. Gill Corporation purchased their honeycomb core requirements from outside sources. At the time it seemed a satisfactory and lasting arrangement.

However, there were some disadvantages. It was not in keeping with the company's philosophy of vertical integration. Although it was adequate for our everyday requirements. It did not allow the company to compete for high volume sales. We did not always get the product as soon as we would have liked, quality control was out of our hands, and, naturally, we felt that prices were higher than they should have been. However, we managed a peaceful coexistence with our suppliers — they did not make sandwich panels and we did not make honeycomb core. The playing field was level with our competitors.

THE STRAW THAT BROKE THE CAMEL'S BACK

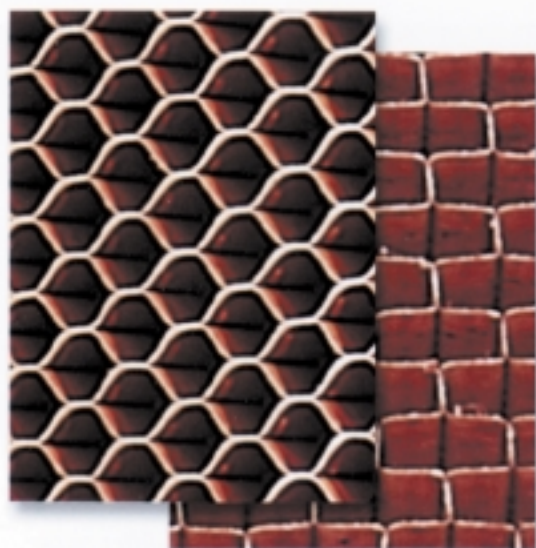
The end to this sometimes tenuous modus operandi came somewhat abruptly when our major honeycomb supplier announced it was going into the

sandwich panel business — a decision it had every right to make, but one that made them our direct competitors. M.C. Gill did not believe that was a survivable way of doing business and that was how we came to manufacture aluminum, then Nomex[®] honeycomb...better known as GILLCORE[®].

FORESIGHT AND PREPARATION PAY OFF

M.C. Gill management are all inoculated with the serum that dictates foresight and preparation, so that when the inevitable opportunity appears we are in a position to take advantage of it. That philosophy bore fruit when a fledgling honeycomb manufacturer presented us with the chance to buy his bare bones paper and aluminum honeycomb manufacturing operation. We did and were thus prepared for what ensued.

There is a bit more to the story than that. Three years passed before we finalized the manufacturing process, purchased more equipment, trained the personnel, and completed the steps necessary to make enough honeycomb for our own needs.



ATION

Then, in 1986, when we made the formal announcement that we would make aramid fiber honeycomb core available to our customers, we had qualified to only three users — McDonnell Douglas and two aircraft component manufacturers. Now, at last count, we are qualified to the specifications of six airframe manufacturers and seven component parts producers.

THE ICING ON THE CAKE

Probably the most rewarding moment to date of our venture into the honeycomb business came in 1996, when Boeing awarded us a three year multi-million dollar contract for considerable quantities of their honeycomb requirements. That contract represented a major commitment on our part because we had to risk the implementation of major expansions of our honeycomb manufacturing process. It was a risk we were willing to take because inherent in the company's commitment to growth is a degree of calculated risk necessary to achieve that growth.

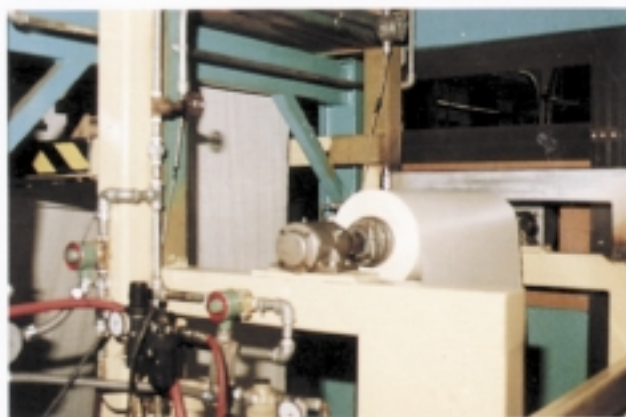
GILLCORE: THE UNIQUE MATERIAL WITH MANY END USES

The M.C.Gill Corporation manufactures honeycomb for its own use as core material for sandwich panels used primarily for flooring, both as original equipment and replacement parts for commercial passenger aircraft. In addition to flooring panels, other passenger aircraft interior uses for panels we manufacture using Gillicore include class dividers, sidewall, ceiling, galley and liquor carts and lavatory panels...curtain wall fascia panels on buildings, sidewall and roof panels on modular homes...supports for precision acrylic buffing, and highway signs.

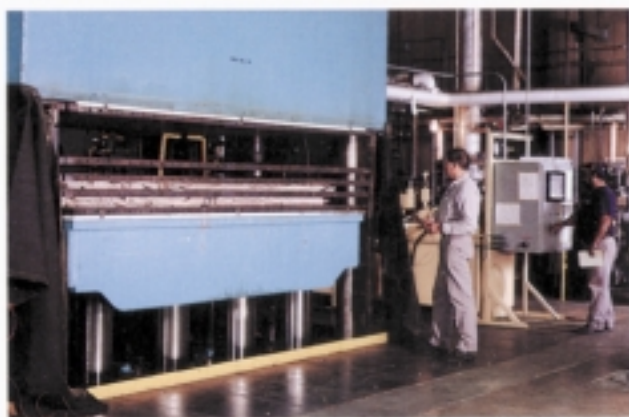
We also manufacture Gillicore as a raw material for further modification by airframe and component manufacturers. With our CNC machines we shape Gillicore to virtually any configuration desired by our customers...for end uses as trailing and leading edges, flaps, ailerons and access panels. Other aviation related uses include doors, nose cones, helicopter blades and radomes. Boat builders use Gillicore for panels to divide berthing areas and staterooms. The bottom line is that honeycomb sandwich panels possess rigidity with low mass; i.e. high specific strength.

Because Nomex honeycomb is such a unique material, we felt there should be interest in how it is manufactured. The pictures and text that follow illustrate the various steps involved to produce the finished product.

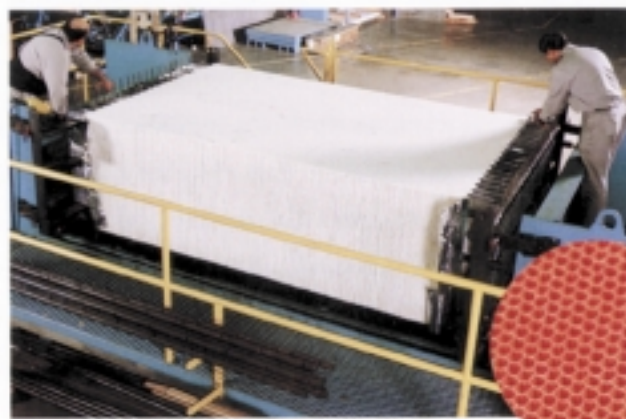
Making Nomex Honeycomb is a Stringent, Complex Process with Many Critically Controlled Operations



1. It starts with the boneycomb print line that will accommodate 36" Nomex paper. After paper feeds from the let-off reel, the print roll (shown in photo 2) prints adhesive lines on the paper which is then fed into the printer oven.



4. Using heat and pressure to activate the offset adhesive lines, the Nomex sheets are bonded together in loaves 60" x 120". This press, installed in 1996, increased capacity 2 1/2 times over the old press.



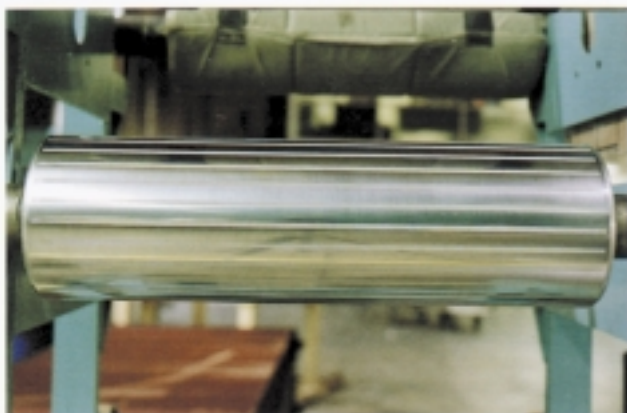
5. After pressing the stacks of individual sheets into loaves, the latter are expanded to the proper length to achieve uniformity in the dimensional cell size specified (see inset).



8. After each dip, the loaf is placed in this oven to bake until the resin is cured. Dipping and baking is repeated until the desired density is attained.



9. After the dipping and baking processes are complete, the loaf is tagged as to the cell size, density, and date of manufacture. This information is vital for traceability and for inventory control.



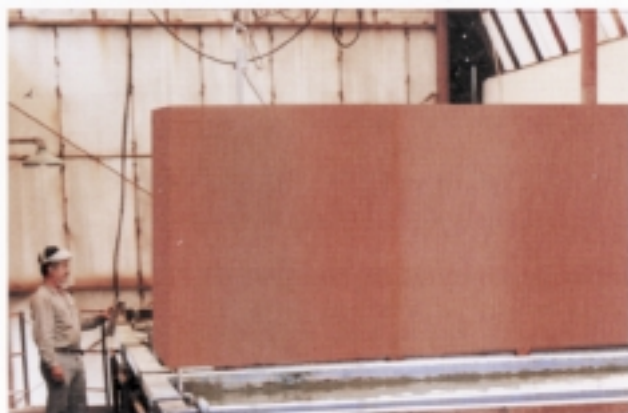
2. A print roll applies parallel adhesive lines onto the Nomex paper. Lines are necessary for bonding the individual sheets during the pressing process (shown on page 4). Sheets are later expanded into hexagonal boneycomb cells.



3. The printed paper comes out of the printer oven onto the conveyor where it is automatically cut into sheets. The adhesive printed paper is next stacked with glue lines alternatively staggered, or offset, sheet to sheet (see inset).



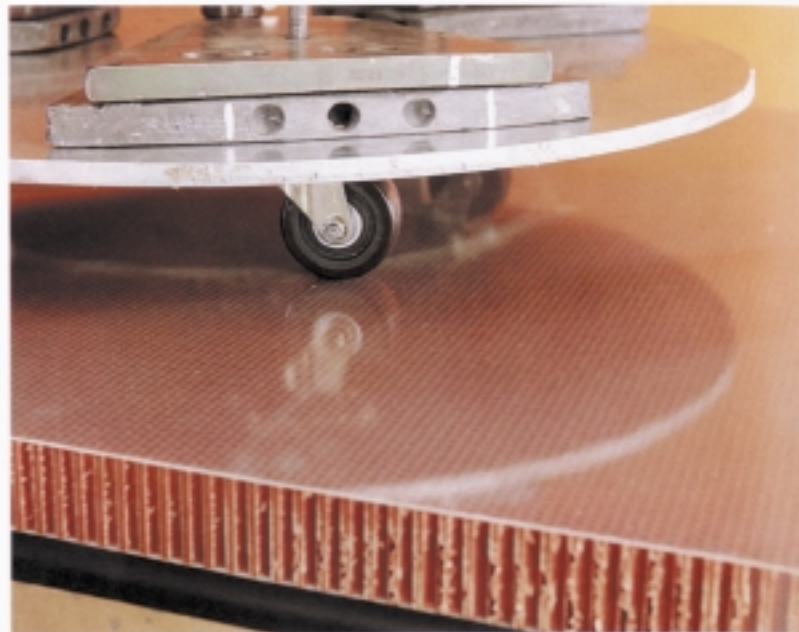
6. Once expanded, the loaf is placed in this heat-set oven to take a permanent "set" prior to dipping. Oven is capable of achieving temperatures in excess of 500°F. Accommodates loaves as large as 5' x 12'.



7. After a loaf is heat-set in a permanent configuration it is dipped a number of times in a tank of phenolic resin.



10. These Femco computer controlled band saws cut loaves into slices of the desired thicknesses. They cut material (see inset) up to 60" wide to virtually any thickness, to a tolerance of $\pm .005$ " across the entire area of the sheet.



Roller Cart Test measures the fatigue resistance of floor panels including honeycomb core. (The clear skin was used for photographic clarity).

No Compromise with Quality

Gillcore HD and OX Gillcore HD are routinely subjected to an exhaustive series of quality control tests based on customer specifications which are meant to relate to in-service expectations. The following tests are performed on every block or lot.

CELL COUNT TEST

Ensures that cell sizes and shapes are consistent within any given loaf. The cell size is important because it materially affects the predictability and strength where it is needed — always the smaller the cell the heavier and more dense and the greater the compressive strength of the honeycomb.

COMPRESSIVE STRENGTH TEST

Measures how much force is necessary to crush the core after it has been bonded into a sandwich panel configuration. For example, a fully supported Gillfloor 4417, Ty 1 flooring panel will support 846 psi (60 tons per sq. ft.) before it fails in compression.

PLATE OR CORE SHEAR TEST

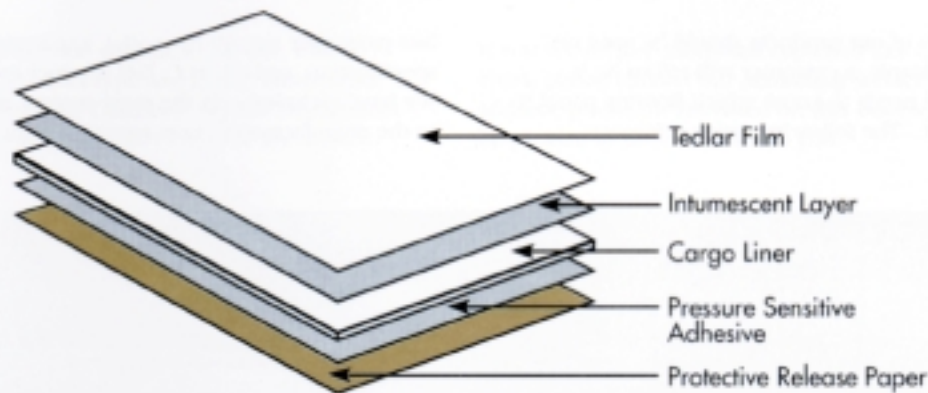
Measures the core's resistance to being delaminated or sheared from a panel's facings when the facings are moved parallel and in opposite directions. Failure results in deformation of the material which weakens it and causes a spongy floor panel, as an example.

DENSITY TEST

In pounds per cubic foot. Ensures that densities remain consistent throughout every sheet of every block, or loaf, and are within tolerance.

GILLPATCH II CONSTRUCTION

The patch itself comprises the five components shown here.



The Tedlar overlay can be cleaned, increases resistance to moisture damage, provides continuity of surface finish, uniformity of color, and after installation makes any subsequent damage to the patch easier to see. The intumescent coating completely covers the patch material and provides an excellent thermal and insulating barrier.

Gillpatch II is thicker (an overall thickness of between .090" and .100") than those used prior to the aforementioned FAA mandate. The reason is that the FAA's Long beach, CA office

recommended the patch meet minimum impact values of the cargo liner it repairs. The thinking was that a patch is of no value if it falls off the first time an object hits it, a premise with which the M.C. Gill Corp. heartily concurs. The patch is also stiffer, but any minor inconvenience caused is more than offset by the superior strength of Gillpatch II and its excellent impact values.

This and our in-service test results should dispel any concern about it being knocked off – even by a glancing side blow.

How It Works

In the event of a fire in the cargo compartment, the coating begins to swell (intumesce) when the temperature reaches 700° to 800° F. and will withstand a temperature of 1700° to 1800° F for at least five minutes. The patch material consists of the same construction as M.C. Gill fiberglass reinforced epoxy resin cargo liner that is certified to FAR 25.855. Once the easy-peel backing has been removed, the pressure sensitive adhesive secures the patch to the area surrounding the cargo liner damage.

How to Order

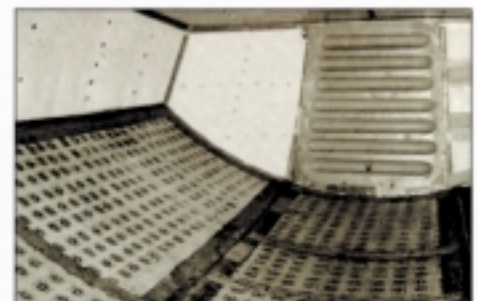
Ordering Gillpatch II is as easy as ordering any of our other products. Simply call our Customer Service Department at 818-443-4022 or fax us at 818-350-5880 with the following information.

1. Size – Gillpatch II is available in three sizes: 6" x 6", 9" x 9", and 12" x 12".
2. Quantity – There is a minimum order requirement of ten (10) Gillpatch II patches of the same size. A variety pack is also available – it contains ten patches: four each of the 6" x 6" and 9" x 9", and two of the 12" x 12".

We carry Gillpatch in stock and can ship your order within two working days after we receive your verbal or written purchase order; faster if it is an AOG.

The Gillpatch Tradition

The M.C. Gill Corp. has sold hundreds of thousands of Gillpatches since it introduced its first easy-application cargo liner patch in 1962. Just as M.C. Gill's cargo liner became the industry standard, "Gillpatch" has been synonymous with cargo liner repair for more than 30 years. *It just makes good sense to buy your patches from the same source as your cargo liners.*



Hang on to those original Gillpatches!

Gillpatch II complies with FAR 25.855 and must be used for liner repair in Class C and D type cargo compartments. However, the original Gillpatch 6006 still can be used for cargo compartment repairs in Class A, B, and E compartments and, as shown above, as a protective covering for cargo flooring. In this instance, 3' x 6' sheets of Gillpatch are used. The sheets have also been used under carpeting in the passenger compartment to protect the floor. They have a cushioning effect due to the .016" rubber-like adhesive.

In addition to sheets, Gillpatch 6006 (.026" thick) is available in four sizes: 4.5" x 4.5", 6" x 6", 9" x 9", and 12" x 12". A variety kit of 5 pieces 4.5" x 4.5", 3 pieces 9" x 9", and 2 pieces 12" x 12" is also available. Minimum purchase in all cases is 10 kits.



Gillcore HD

FEATURES

Except for OX cores being formable, both it and Gillcore HD share the following features.

- Facilitates high strength-to-weight ratios in sandwich panels
- Thermal tolerance to 325°F continuous service
- Low densities, i.e., 1.8 and 3.0 pcf (in 3/16" cell size)
- Corrosion resistance
- Conformance to rigid smoke, toxicity, and flammability standards
- Excellent fatigue and impact absorbing resistance (dependent somewhat on panel facings).

Physical and mechanical properties are shown in Tables 1 and 2 on page 10.

AVAILABILITY

Gillcore HD can be sliced in sheets as thin as .080" or in blocks as thick as 36". With our electronically controlled horizontal band saws, honeycomb slices have the aforementioned standard tolerance of .005" across the total area of the sheet, although the typical thickness variation is controlled to .0015" of the desired thickness.

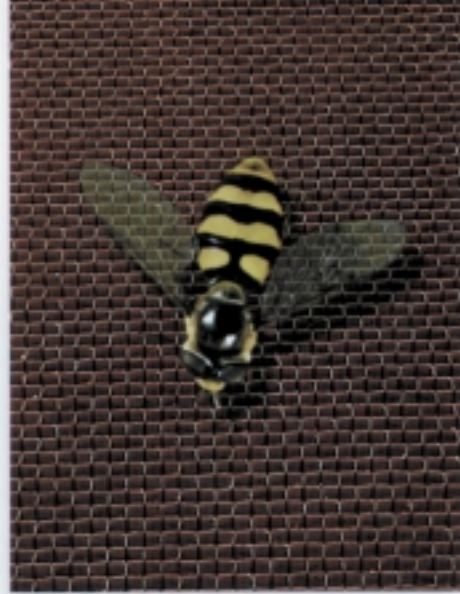
Without splicing, Gillcore HD is available in lengths of up to 144" and widths up to 60". In addition to the cell size and densities mentioned above, Gillcore HD is also available in 1/8" cell size in densities from 1.8 to 9.0 pcf and higher; 3/16" cell size in densities from 3.5 to 6.0 pcf and higher; and 1/4" cell size in densities from 1.5 to 4.0 pcf and higher.

QUALIFIED TO MANY SPECIFICATIONS

The success attained as the result of our almost 20 years' experience manufacturing Gillcore is evidenced by the following qualifications in that period of time.

- Aim Aircraft AIM-M-1013
- Bell Helicopter (Textron) 299-947-103
- Boeing BMS 8-124
- Cessna CMNPO83, Ty II, Cl 4, Gr 1.8, 3.0, and 6.0
- FAR 25.853
- Lockheed LCM 28-1041
- Lockheed C28-105
- Lockheed-Georgia STM28-105. [1/8 - 1.8 (1.5) and 1/8 - 3.0 (2)]
- McDonnell Douglas DMS 1974
- Naval Sea Systems Command
Drawing No. 803-5959189: GPR Sandwich
Construction Bulkheads for Surface Ships
- Northwest Technical NMS 200
- Raytheon/Beech BS 23732
- Vought 10425.1957
- Weber WMS 711

Also, Gillcore meets the requirements of Rockwell LB0130-022 and Mil-C-81986.



OX Gillcore HD

In response to requests from many of our customers, we developed OX (over-expanded) Gillcore HD and it, too, can be purchased as core-only or as part of a finished sandwich panel. The core itself contains the same raw materials as Gillcore HD—aramid fiber paper and phenolic resin—but the cells are over-expanded from the traditional hexagonal to a rectangular shape.

The over expansion allows the honeycomb, as well as sandwich panels using it for core, to be curved or formed into simple configurations in the "W" (warp, or width) direction. This feature results in a multiplicity of additional honeycomb applications where light weight and rigidity are required. Utilizing

this forming capability, the following represent just a few of the simple contoured shapes which can be provided:

- **Curved interior aircraft panels for sidewalls, ceilings, galleys, and lavatories**
- Environmental systems ducting
- Radomes
- Exterior aircraft panels including trailing and leading edges, flaps, ailerons, access panels, and doors
- Ship and boat panels such as those dividing berthing areas and staterooms
- Pleasure and racing boat hulls.

RECTANGULAR CELLS ALLOW FORMING AND CONTOURING



OX CORE MAKES SIMPLE CURVATURE EASY



USE OX CORE FOR RADICAL CURVATURE

TABLE 1
PHYSICAL AND MECHANICAL PROPERTIES OF GILLCORE HD
 BASED ON .500" THICK SLICES UNLESS STATED OTHERWISE.
 TYPICAL AVERAGE VALUES.

PROPERTY	TEST METHOD	UNIT (Eng/Metric)	1/8 CELL (± 10%)					3/16 CELL (± 10%)
NOMINAL DENSITY			1.0 PCF	3.0 PCF	4.0 PCF	8.0 PCF	9.0 PCF	6.0 PCF
BARE COMPRESSION	MIL-STD-401B	lb/sq in (kg/sq m)	95 (66,792)	327 (229,905)	609 (428,172)	2,011 (1,413,882)	2,145 (1,508,094)	994 (698,856)
STABILIZED COMPRESSION	MIL-STD-401B	lb/sq in (kg/sq m)	132 (92,806)	317 (222,874)	624 (438,718)	2,173 (1,527,780)	2,456 (1,726,750)	1,120 (787,443)
SHEAR - L Direction Ultimate Load Modulus	MIL-STD-401B	lb/sq in (KPa) lb/sq in (GPa)	102 (703) 4,371 (30.1)	178 (1,227) 8,408 (57.9)	367 (2,230) 10,200 (70.3)	573 (3,951) 17,100 (117.9)	526 (3,627) 19,418 (133.9)	590 (4,068) 17,000 (117.2)
SHEAR - W Direction Ultimate Load Modulus	MIL-STD-401B	lb/sq in (KPa) lb/sq in (GPa)	48 (331) 2,010 (13.9)	100 (689) 3,823 (26.4)	226 (1,558) 7,100 (49.0)	441 (3,041) 12,800 (88.3)	345 (2,379) 11,996 (82.7)	388 (2,675) 9,900 (68.3)
WATER MIGRATION	MIL-STD-401B	number of contiguous cells	3.23	1.43	1.26	1.00	1.47	1.08
FLAMMABILITY - 60 Second Vertical Self-Extinguishing Time Burn Length Drip Extinguishing Time	BSS 7230	second inch (mm) second	0.1 1 (25) 0	1.6 1.9 (48) 0	1.1 2.7 (69) 0	1.3 2.9 (74) 0	0.1 0.5 (13) 0	1.9 1.6 (41) 0

TABLE 2
PHYSICAL AND MECHANICAL PROPERTIES OF OX GILLCORE HD

DESIGNATION	CELL SIZE DENSITY (GAUGE)	COMPRESSIVE STRENGTH		PLATE SHEAR			
				"L" DIRECTION		"W" DIRECTION	
				STRENGTH (MIN. AVG. PSI)	MODULUS (MIN.AVG. KSI)	STRENGTH (MIN. AVG. PSI)	MODULUS (MIN.AVG. KSI)
HD 3/16-1.8	3/16-1.8 (2)	70	85	45	1.5	42	2.2
HD 3/16-3.0	3/16-3.0 (2)	230	280	90	2.2	90	4.5

DESIGN CONSIDERATIONS

A few years ago, **THE PLASTICS PRODUCTS DESIGN HANDBOOK** was published by Marcel Dekker, Inc. Part A dealt with Materials and Components and the chapter on sandwich panels was written by Phillip Gill, then in charge of the Research and Development lab at M.C. Gill Corp. Although not limited to aramid fiber honeycomb, a significant part of the work concerns that material. The table of contents is listed at the right and if you are interested in obtaining a copy of that chapter please write, fax, or phone the Marketing Services Department at the numbers listed on the cover and we will send you a reprint.

Table of Contents from **PLASTICS PRODUCTS DESIGN HANDBOOK** Chapter 10, Sandwich Panels

- I. Introduction
- II. Uses
- III. Test Methods
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 - B. Panel Tests
 - C. Special Tests
- IV. Facings
- V. Sandwich Panel Cores
- VI. Adhesives
 - A. Thermostat Adhesives
 - B. Contact Adhesives
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 - A. Author's Viewpoint
 - B. Surface Preparation
 - C. Applying Adhesives
 - D. Assembling Components
 - E. Applying Heat and Pressure
 - F. Splicing Sandwich Panels
 - G. Attachment Details
 - H. Inspection of Completed Parts
- VIII. End Enclosures and Fasteners
- IX. Panel Design — Flat Panels Under Normal Loads
 - A. Design Considerations
 - B. Sandwich Panels as Beams
 - C. Sandwich Panels as Plates
- X. Panel Design — Flat Panels Loaded as Columns
- XI. Durability
- List of Symbols
- References



THE FUNNY SIDE

The world is full of willing people— some willing to work, the rest willing to watch them.

★★★★

Foods that are the same color can be substituted for each other and they have exactly the same caloric content, e.g., pistachio ice cream for spinach or white chocolate for mushrooms. Brown is a universal food color so chocolate can be substituted for anything.

★★★★

The shorter the time between flights, the greater the distance between gates.

★★★★

Bingo is easier said than won.

★★★★

Take up in-line skating and you'll make a whole new set of friends— ambulance drivers, emergency room technicians, and physical therapists.

★★★★

Tell someone his father was dishonest and he'll get mad. Tell him his great-grandfather was a pirate and he'll boast.

★★★★

The journey of a thousand miles begins with wondering if you turned out the lights.

★★★★

The trouble with cats is that they have the same look on their faces whether they're looking at a moth or a serial killer.

★★★★

Two wrongs don't make a right but they do make a good excuse.

Trivia

If you think constantly and anxiously about your health you're a valetudinarian.

★★★★

It takes 200,000 frowns to make a wrinkle.

★★★★

61 percent of Americans earning less than \$30,000 a year believe "the meek shall inherit the earth." 36 percent of those earning more than \$60,000 also believe it.

★★★★

A cow eats approximately 100 lbs of grass a day.

★★★★

There are 11,000,000 milk cows in the U.S.

★★★★

The average number of squirts in a gallon of milk is 345.

★★★★

Your tax dollars at work:
\$34.6 million for screw worm research.
\$11.5 million to modernize a power plant at the Philadelphia Naval yard, targeted for closure.
An unspecified amount spent by HUD to operate 500 housing units in Philadelphia which did NOT exist.
\$1 million to Sudan for delivery of powdered milk, which was found unfit for human consumption.

★★★★

There are 110 different meanings for the word "run"; 91 for the word "take"; and 84 each for the words "break", "turn" and "set".

★★★★

All mammals have tongues.

