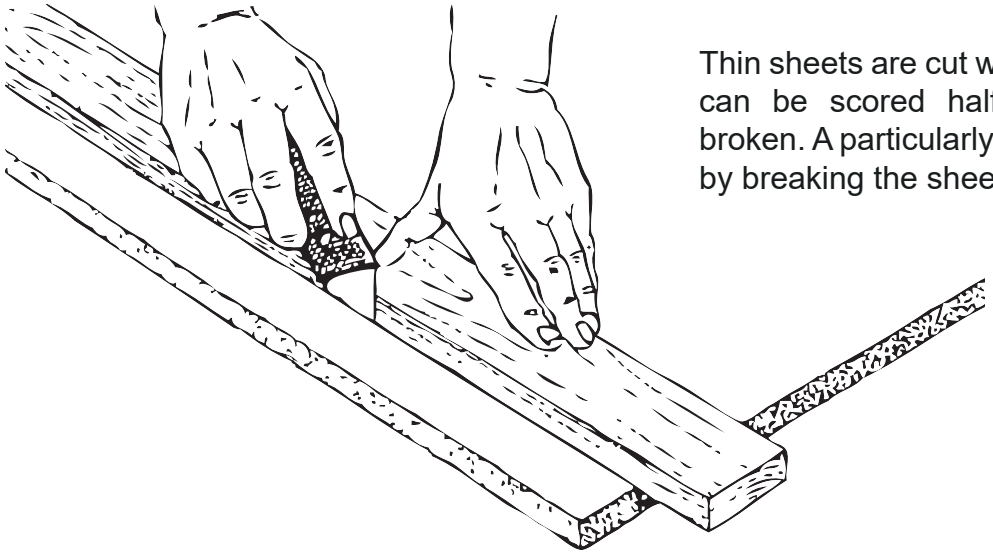
CUTTING & STAMPING

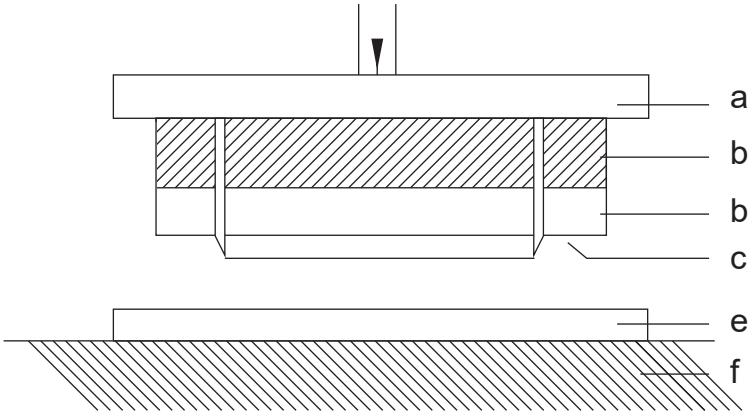
CUTTING



Thin sheets are cut with a knife. Thicker sheets can be scored half-way through and then broken. A particularly clean fracture is obtained by breaking the sheet at the edge of a table.

STAMPING

Parts can be stamped out of thin sheets (max. .4 in. [10 mm] thick) in this way.
The maximum sheet thickness depends on the ROHACELL grade used.

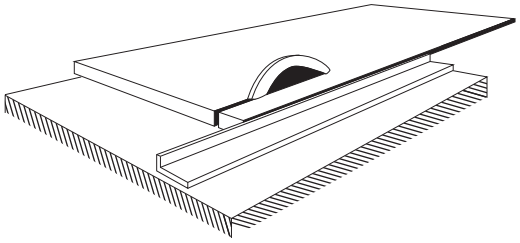


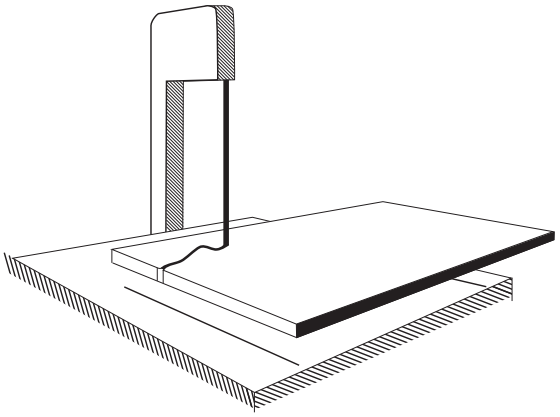
a) force plate
b) mounting
c) steel rule die
d) rubber pad
e) ROHACELL
f) support

MACHINING

ROHACELL is machined without lubricants on high-speed wood or plastics processing machines employing tools common to this field. Common machining methods include: drilling, planing (including cutting to thickness), milling, sawing and sanding. Make sure that the resultant dust is thoroughly removed by suction.

SAWING

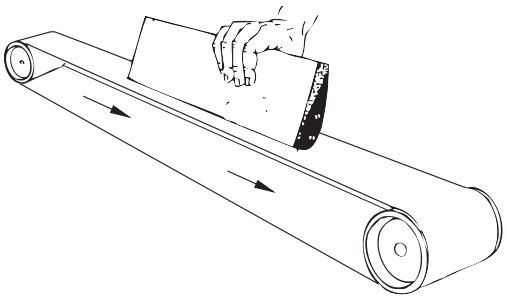


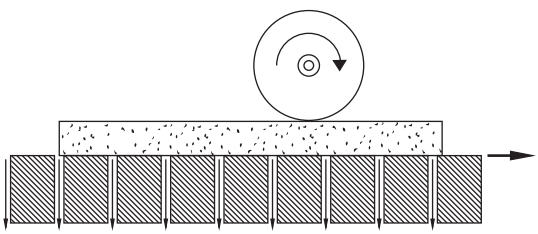


Circular saws are used for cutting sheets to size.
Band and compass saws can be used for cutting shapes.

SANDING

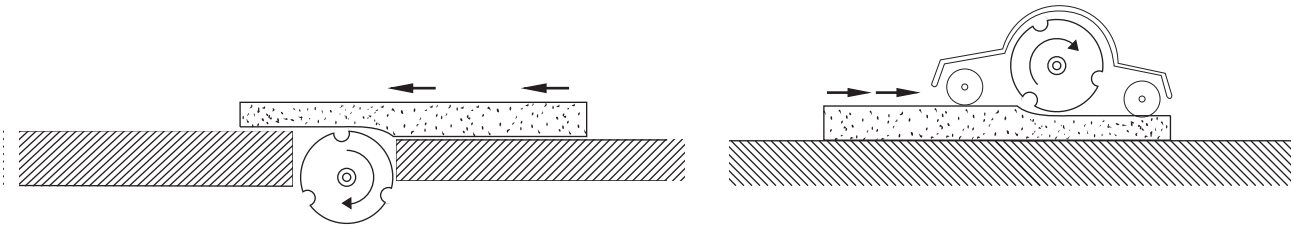
The foam sheet can be shaped by sanding, using a steel template fixed to the sheet. Sanding is either done with an abrasive belt or by hand on a grinding stand. For large parts a board covered with abrasive paper is used, which is drawn across the template by hand. Plane ROHACELL sheets with close thickness tolerances are treated on grinding machines with vacuum table.





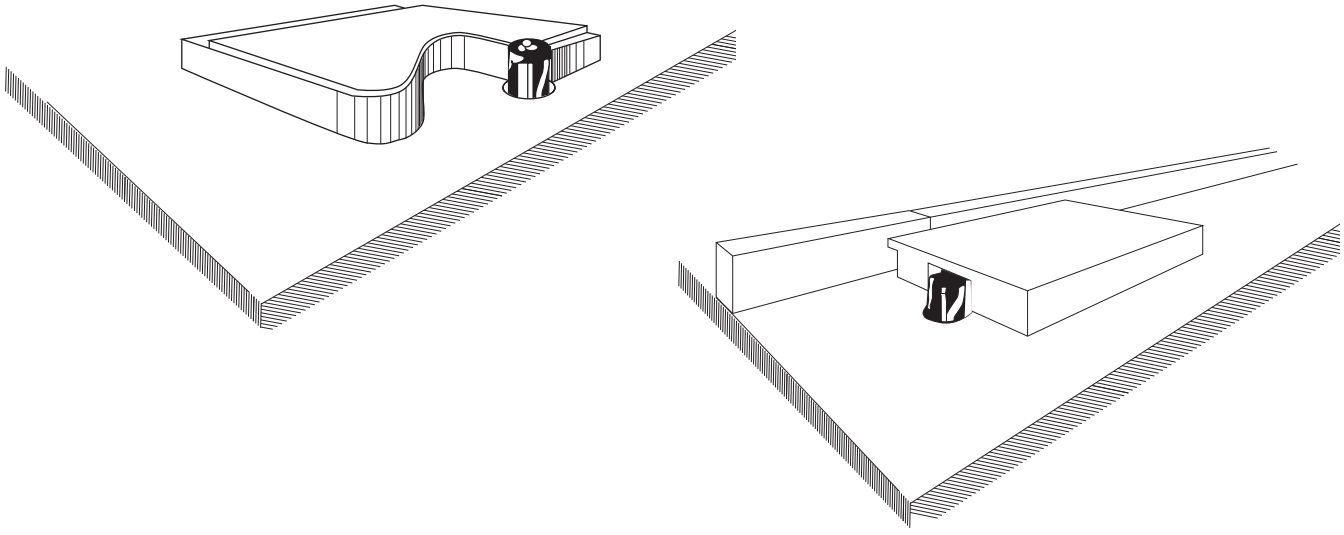
PLANING

The common planing machines used for wood are also used to plane edges and surfaces. It is equally possible to work with a thicknessing machine. Since the foam is more easily crushed than wood, the profile of the feed rollers may be reproduced. Chip removal should therefore be sufficiently deep for the impression to disappear. The contact pressure of the rollers should be matched to the compressive strength of the foam plastic, too. If the roller pressure is too high, the outer parts of the cells are most likely to be destroyed. This is noticeable through the “felt like feel” of the foam surface. Rubber-covered rollers have also proved useful.



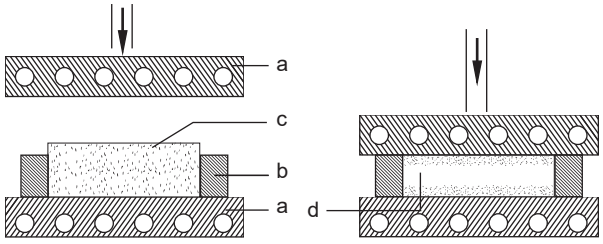
MILLING

Grooves, rabbet and other profiles can be cut with a routing cutter. With due care, the material can be cut to web widths of .08 in. (2 mm). Parts matching the contours of a template can be produced with a suitable milling cutter.

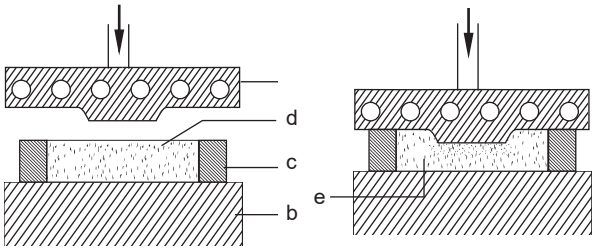


COMPRESSING ROHACELL

ROHACELL sheets with an integral structure are produced in a press which can be cooled and heated.
A cold, suitably oversized ROHACELL sheet is placed between heated platens at 320 - 356 °F (160 - 180 °C) and then the press closed immediately. The specific molding pressure should be about 30% less than the compressive strength of the particular ROHACELL grade at 68 °F (20 °C). As the heat penetrates into the ROHACELL sheet, the outer cells correspondingly give way and are squeezed flat. The procedure gives a higher density in this layer. The molding time depends on the desired degree of compression until the thickness stop is reached. The sheet must now be cooled to about 176 °F (80 °C) before it can be taken out of the press. This prevents the flattened cells from recovering their original shape. The method also serves for partial compression of molded articles. In practice, this procedure is also utilized for sandwich parts with thin skins in order to increase the bending stiffness of the sandwich. Another important fact is that the indentation resistance is considerably improved through the higher density of the edge zones. During hot curing of the adhesives or resins, the outer surface is compressed until the desired thickness stop is reached.



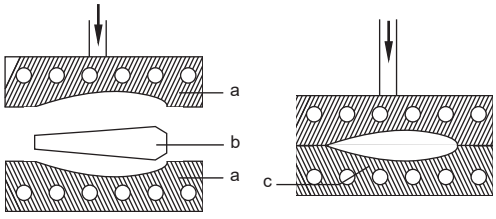
a) heatable and coolable press
b) thickness stop
c) uncompressed ROHACELL
d) partially compressed ROHACELL



a) heatable and coolable press
b) support
c) thickness stop
d) uncompressed ROHACELL
e) partially compressed ROHACELL

MOLDING WITH COMPLEX EXTERIOR CONTOURS

After heating the ROHACELL part to be molded to the forming temperature (338 - 374°F [170 - 190 °C], depending on material grade), it is placed in a heated mold and brought to the required geometrical form by compression. The molding must be cooled down to about 176 °F (80 °C) before it can be taken out of the mold.
The described method is far more cost-effective than other techniques, because there is no machining to a precise exterior contour.



a) heatable and coolable mold
b) rough-cut ROHACELL part
c) compressed ROHACELL molding

FORMING

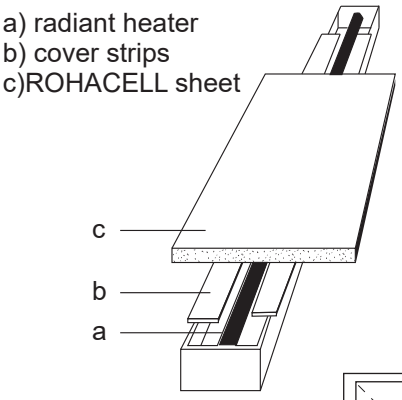
Moldings can be relatively simply produced from ROHACELL sheets. The smallest attainable bending radius is about twice the sheet thickness.

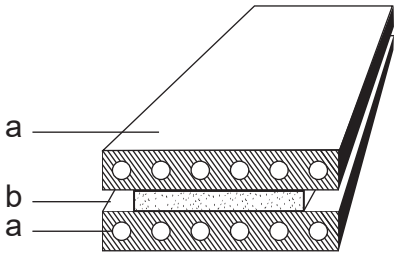
Heating the ROHACELL sheets

Before heating the ROHACELL sheets, they should be dried for 2 hrs. at 248 °F (120 °C), using a heating cabinet with air circulation. ROHACELL becomes thermoelastic and can therefore be formed at a temperature of 338 to 374 °F (170 - 190 °C).

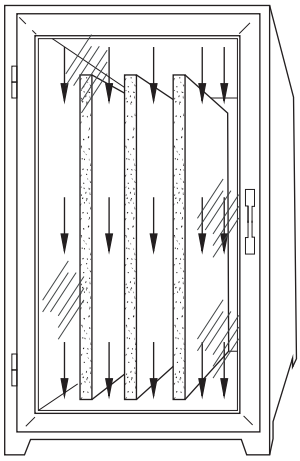
The required forming temperature depends on the degree of shaping, the pretreatment and the density. The heating time for ROHACELL sheets in a heating chamber with air circulation that has been brought to forming temperature is about 1 min/0.04 in. (1 min/mm) sheet thickness. Care must always be taken so that the hot air sweeps uniformly over both sides of the foam plastic sheets and that no heat is allowed to accumulate. This method is particularly suitable for the manufacture of prototypes.

Heating is much simpler and more dependable between heating plates, which you can easily make yourself. This method can be recommended for series production. Radiant heaters can be used to warm up thin sheets of ROHACELL up to 0.24 in. for line bending. A vacuum forming machine may be used to mold these same sheets.





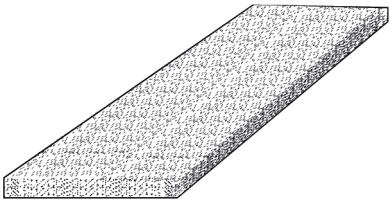
a) heatable plate
b) ROHACELL sheet



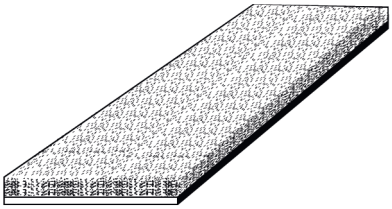
Heating in a cabinet with air circulation

Caution:
The forming temperature is close to the foaming temperature, so that it must be accurately controlled in order to prevent post-foaming. This is particularly important when warming up the ROHACELL sheet by means of radiant heaters.

Avoiding unduly fast cooling
Since the heat capacity of the rigid foam is low because of its small mass and the sheet surfaces cool quickly because of the multitude of cut cells which act as “cooling vanes”, the blanks must be protected against cooling while they are moved from the heating cabinet or the heating plates to the forming device.
Unduly fast cooling is avoided by covering the ROHACELL sheets on all sides with cotton cloth, thin aluminium foil, glass fabric or silicone rubber. The foam plastic is heated and formed together with this cover. The cover is intended to keep the ROHACELL sheet just long enough at the necessary forming temperature until forming is finished. With simple moldings a cover on one side is often sufficient if the work is done fast. The cover must be applied to that side of the ROHACELL sheet which is subject to tensile stress during forming.



ROHACELL sheet covered all around

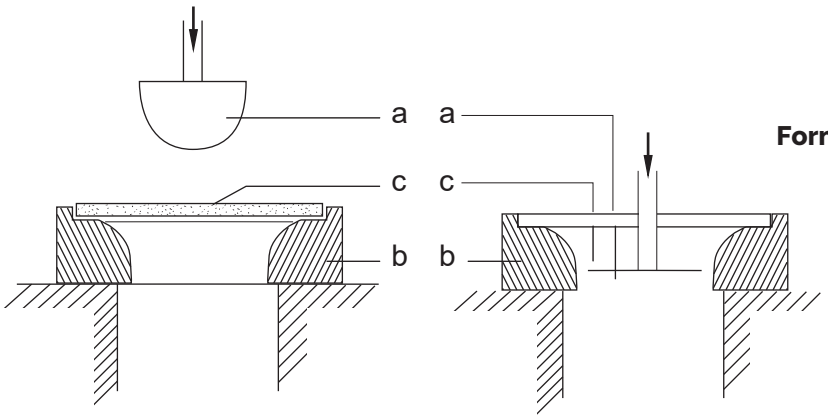


ROHACELL sheet covered on one side only

For series production, the heating plates and the forming tool can be put in such a position that, when the heated ROHACELL blank is quickly and automatically taken from the heating plates to the forming tool, there is often no need for any cover.

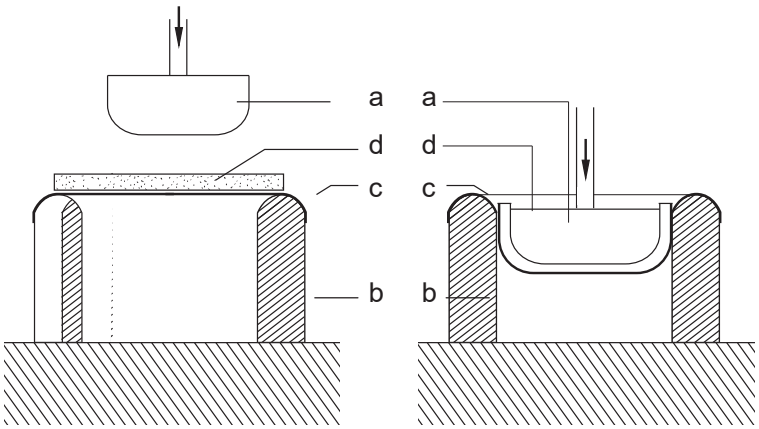
DESIGN OF THE FORMING TOOLS

Tools which are not heated can be used for simple parts when the degree of forming is small. Tool temperatures of 176 to 212 °F (80 - 100 °C) may be necessary when more complex parts have to be formed.
The foam plastic cools quickly because of its low heat capacity, and once the formed part has cooled down to 176 °F (80 °C) it may be removed from the tool.
With simple parts, the molds are not subjected to a substantial amount of heat, so that hardwood molds are adequate. Polyester and epoxy resin molds are also used. The advantage of these non-metallic molds is that the ROHACELL surfaces do not cool down so quickly during forming because of the relatively poor heat conductivity. Metal molds should be thermostatically controlled.



Forming of a hemisphere from ROHACELL

a) force plug b) annular mold c) ROHACELL

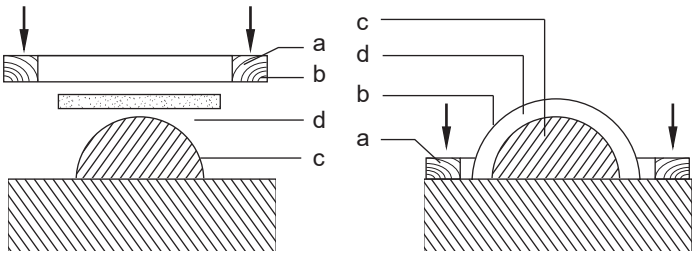


Forming ROHACELL with stretch rubber

a) force plug b) mold c)stretch rubber d) ROHACELL

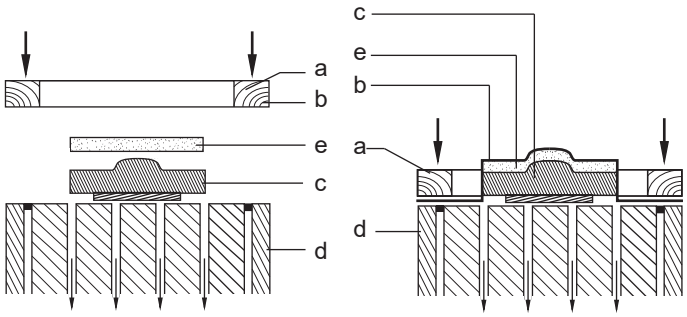
In order to ensure that the ROHACELL sheet can be drawn into the mold without much resistance, the edges should have large radii. If the radii are too small, the edge is squeezed into the heated foam at the start of forming and impedes further sliding. Cracks at these points will then be unavoidable. Forming itself should be done uniformly and quickly. Abrupt forming must be avoided.

Forming ROHACELL with stretch rubber



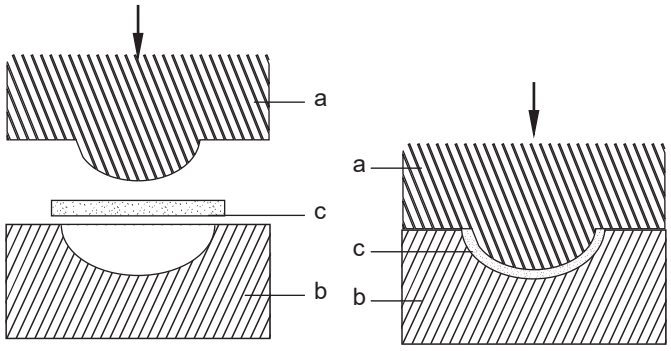
a) frame b) stretch rubber c) mold d) ROHACELL

Forming ROHACELL with stretch rubber



a) frame b) stretch rubber c) mold
d) vacuum table 3)ROHACELL

Forming in the tool



a) force plug b) mold c) ROHACELL

BONDING

Owing to the large number of available adhesives and the multitude of materials which may be bonded to ROHACELL, it is difficult to provide complete information on the application methods and amounts of adhesives, as well as on the drying and curing lines. However, in case of special problems we will be glad to look for a practical solution together with the adhesive manufacturers. For most bonding problems ROHACELL offers the decisive advantages of solvent resistance and heat distortion resistance for hot curing up to 320 °F (160 °C).
Practically all commercial adhesives can therefore be used.

The bond between the adhesive and ROHACELL is much improved through mechanical anchoring in the cut cells.

It is essential that the ROHACELL surfaces are freed from dust by suction or blowing with oil-free compressed air before bonding.

Since ROHACELL is highly impervious to solvent diffusion. Great care must be taken. When large areas of ROHACELL are bonded to ROHACELL or other diffusion-tight materials by solvent-based adhesives. The adherends are well devolatilized after the adhesive has been applied to both sides before they are joined together under pressure. Joints made with these adhesive systems (generally rubber based) normally remain somewhat elastic and have good peel strength. When it is possible to hot-cure the joint, the quality of the bond can be greatly improved.

Owing to the good heat transfer which is required, heat-sealing can only reasonably be done where thin material layers are to be bonded to ROHACELL; e.g. for laminating with metal sheets or decorative paper sheeting.
Emulsion adhesives are not recommended.

The solvent-free systems include hot-melt adhesives, reactive adhesives and adhesive films. Reactive adhesives like epoxy and polyester resins should be allowed to cure under sufficient pressure (1.25 - 43.5 psi/0.05 - 0.3 N/mm2) or be very fluid during application so that the cells of the foam are well filled.
The cure can be accelerated by heat (up to 320 °F/160 °C).
The joints become very hard and rigid.
Adhesive films and hot-melt adhesives need heat for bonding and can therefore normally be heat-cured.
Adhesive films must be sufficiently thick (.02 - .04lbs/ft2/100 — 200 g/m2) in order to anchor them firmly in the cut ROHACELL cells.

Some adhesive films, such as phenolics, give off volatile constituents while curing. They should therefore be warmed-through with gentle pressure.
Before pressing for bonding, the press should be briefly opened again to allow the volatile constituents to escape.

When hot-melt films are used, it has frequently proved useful to perforate them before bonding in order to avoid air bubbles.

For the purpose of better deaeration in difficult cases, prior grooving of the ROHACELL sheet surfaces will help. Grooves about .04 - .06 in. (1 - 1.5 mm) deep and .08 in. (2 mm) wide have proved useful.

When ROHACELL is to be bonded to other materials, the adhesive may generally be selected according to its suitability for these materials.

To obtain perfectly straight sandwich panels, it is important for both sides of the ROHACELL sheet to be simultaneously bonded to the skin. Both skins must be of the same material and have the same thickness. Equally important are uniform heating and cooling on both sides.

To prevent core compression during hot press bonding we recommend starting with a ROHACELL core .02-.04 in. (0.5 —1 mm) over thickness and closing the press to stops.

APPLICATION OF LAMINATES

The usual laminating methods like hand lay-up and molding techniques can be used. In order to obtain good peel strengths, pressures of at least 1.25 psi/0.05 N/mm2 are desirable. Hot curing is recommended for the short cycle times. ROHACELL tolerates up to 320 °F (160 °C), but in that case the press should be run to a stop (see also “Bonding”). When polyester resins are used there is no need to seal the foam plastic surface, because it is resistant to styrene.

If the molding pressure is to be applied with a vacuum bag, the ROHACELL sheet may for the sake of better venting, be perforated with holes about .08 in (2 mm) in diameter at intervals of about 2 in. (5 cm). Before laminating, the ROHACELL surfaces must be completely free from dust in order to ensure good adhesion of the resins. Sandwich parts are also made with the prepregs usual in aircraft construction.
Pressing on and curing is either done in an autoclave or in a mold. The first layer on ROHACELL should be a resin-rich prepreg in order to have sufficient resin for anchoring in the cut cells and thus to achieve good bond strength.
Before applying the prepregs, the ROHACELL surfaces should be freed from dust by suction or by blowing with oil free compressed air.
When prepregs are used which release volatile constituents during the curing process, e.g. water from phenolic resin prepregs, the removal of the volatiles, e.g. from an autoclave, must be ensured by suction. If curing takes place in a molding tool, the press must be briefly opened again when the prepregs are warmed through, so that the bulk of the volatile constituents can escape. In the case of matrix systems, which are cured at very high temperatures, the ROHACELL core may yield excessively when curing takes place in an autoclave or a press without a stop. Better results are then achieved with ROHACELL WF.

In any case it is recommended whenever possible to run the tool against a stop, particularly when curing takes place in molding tools, in order to avoid exceeding the lower tolerance limit through thermoelastic creep.
When relatively brittle skins are used, phenolic resin prepregs, the bond strength can be considerably increased by applying an elastic primer or hot-melt adhesive film to the ROHACELL core. ROHACELL is a foam plastic with closed cells. During bonding or when a laminating resin is applied, the resins only penetrate the open pores of the cut surface. The bond strength obtained in this way is very good for ordinary purposes
A peel test is often performed to provide information on the bond strength of a skin on the core, although this test does not really resemble practical conditions.

A peel force generally only acts on the sandwich after the skins have failed for reasons of stability (e.g. creasing or wrinkling) or strength (cracking or compression), which is most likely to occur in practice.

PAINTING

ROHACELL can be painted or sprayed with most commercial paints (including nitrocellulose lacquers). Most emulsion paints of the kind used in the building trade are chemically basic. These paints are unsuitable, because ROHACELL does not resist alkaline media. For smooth and glossy surfaces the foam plastic is first filled and sanded. Spraying fillers, e.g. polyester fillers, are also suitable for this purpose. If a paint with grain effect is to be applied, spray-filled surfaces need not be sanded before painting.
When joints or damaged areas on ROHACELL parts have to be filled and then sanded, the filler should have about the same sanding behaviour as the ROHACELL grade in order to get a perfect transition from the filled area to the adjoining foam plastic. You can prepare such a filler yourself according to the following formulations:

Formulation 1:
90 parts by wt. filler
20 parts by wt. thinner
15 parts by wt. microballoons

The amount of added microballoons depends on the ROHACELL grade to be filled. The more microballoons are added, the easier is the sanding. The thinner is used to vary the consistency so that the filler can be smoothly applied.

Formulation 2:
100 parts by wt. pore filler
25 parts by wt. microballoons.

The amount of added microballoons again depends on the ROHACELL grade to be sanded. For the sake of better adhesion, the ROHACELL area to be filled is first brushed once with pore filler before the filling compound is knifed on. Filling greatly raises the compressive strength of the foam plastic surface. Particularly decorative and resistant surfaces are obtained by metal flame spraying. Aluminium, bronze, copper and iron may be sprayed on.

THE PRODUCTION OF PREPREG (SMC) MOLDINGS WITH ROHACELL 71

Prepregs are SMC's. Their main constituents are unsaturated polyester resins, textile glassfiber, fillers and auxiliaries. They are applied in steel tools at 248 - 320 °F (120-160°C). For the manufacture of sandwich parts with SMC skins and ROHACELL 71 as the core material, a molding pressure of about 116 psi/0.8 N/mm2 has proved beneficial. This specific molding pressure should only be applied until the mold cavity is filled by the flowing prepreg. Afterwards it is reduced to about 58 psi/0.4 N/mm2 and kept constant until the end of the curing cycle. The press temperature should be 248 - 266 °F (120-130°C).
This processing technique has proved useful where normally reactive and free-flowing SMC resins are used.