ProBalsa®

Technical Manual

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OVERVIEW

ProBalsa is select quality, kiln-dried, end-grain balsa wood suitable as a structural core material in composite sandwich construction. ProBalsa's end-grain orientation gives it exceptional compression and shear properties.

As an added benefit, ProBalsa provides good thermal and acoustic insulation. ProBalsa cored sandwich structures are lightweight, strong, and stiff, which maximizes performance and adds value to marine, aerospace, transportation, and industrial applications.

ProBalsa end-grain balsa core offers high strength and stiffness at a competitive price. Standard ProBalsa has an average density of 155 kg/m^3 (9.7 lb/ft^3) and suits the need for most structural applications. ProBalsa LD7 low-density balsa has an average density of 90 kg/m^3 (5.6 lb/ft^3) and fits applications where high stiffness and low weight are important. ProBalsa HW high-density balsa has an average density of 220 kg/m^3 (13.8 lb/ft^3). ProBalsa HW is suited for static applications requiring extremely high ultimate strength and stiffness.

ProBalsa is a naturally renewable resource. The balsa plant (Ocroma lagopus) grows from a seedling to a mature tree in 4-6 years and can reach a height of over 27 m (90 ft) before dying in 8-10 years. Tropical winds spread balsa seeds throughout the equatorial highlands of Ecuador where mature trees are harvested. The trees are then milled, kiln-dried and converted to ProBalsa end grain, balsa core.

TYPES OF PROBALSA

ProBalsa is an engineered product available in different densities and styles to suit structural design and cost needs.

ProBalsa PB	Our standard density balsa wood product, 155 kg/m^3 (9.7 lb/ft^3), available from 3 mm (1/8 in) thick plain and contoured sheets up to 1219 mm (48 in) thick blocks.
ProBalsa LD7	A low-density alternative, 90 kg/m^3 (5.6 lb/ft^3). Also available in sheets from 3 mm (1/8 in) thick plain and contoured sheets to 1219 mm (48 in) thick blocks.
ProBalsa HW	A high-density balsa core, 220 kg/m^3 (13.8 lb/ft^3). Also available in sheets and blocks.
ProBalsa Pith	Contains the tree heartwood. Pith may be used in statically loaded structures for shape and insulation.

PROBALSA PLUS

ProBalsa Plus is a surface primed version of ProBalsa, which improves installation quality, shortens application time and reduces resin absorption. Surface primed ProBalsa Plus slows capillary action - the tendency to draw liquids via the tiny tubes making up the grain in the core. Capillary action can cause laminate dryness between the laminate and the core by drawing resin or adhesive away from the laminate and into the core. ProBalsa Plus' primer seals the balsa grain, preventing absorption by capillary action.

ProBalsa Plus is ideally suited for RTM, VARTM, vacuum bagging, and other resin injection or resin infusion processes.

STYLES OF PROBALSA

ProBalsa is supplied in two styles: plain and contoured. All sheets are 610 mm (2.0 ft) wide by 1219 mm (4.0 ft) long.

Plain sheets are rigid sheets that have been cut to size and sanded. Plain sheets should be used for making flat parts using vacuum bagging or other positive pressure methods.

Contoured sheets have an open-weave fiberglass scrim affixed to one side with a styrene-soluble thermoplastic adhesive. The sheets are cut in a grid pattern to produce a flexible sheet capable of conforming to a gentle compound surface. These cuts are 25.4 mm (1.0 in) apart in the width direction and 50.8 mm (2.0 in) in the length direction. ProBalsa contoured material is called GS (grid-scored). Contoured ProBalsa may be used with all standard laminating processes including conventional contact molding and resin infusion processes.

SPECIAL CONSIDERATIONS

On request, ProBalsa may be supplied in various forms including but not limited to:

- Large Sheets
- Edge fillet strips
- Hat section shapes
- Kits
- Pre-laminated sandwich panels faced with polyester, epoxy, or wood laminates

Standard sheets can be bonded together to produce large sheets up to 1219 mm (4.0 ft) wide by 2438 mm (8.0 ft). These sheets are ideal for creating large, flat parts.

Fillet strips may be used along the edge of a ProBalsa sheet to provide a smooth transition from sandwich to solid laminate. ProBalsa fillets are attached to a paper carrier, allowing them to bend around curved edges. Fillet strips come in 610 mm (24 in) lengths and standard thicknesses.

Hat section shapes provide a form over which FRP is laid to produce a stiffener, beam, or frame. The balsa core is considered non-structural in this type of application since the FRP takes up the shear stress as well as bending stresses. Hat sections are cut to order.

DIAB supplies pre-cut ProBalsa core kits. ProBalsa core kits may be used in series production where the same part is molded repeatedly. Kits reduce labor and waste while increasing productivity.

ProBalsa panels are a fast way to make structures with flat surfaces. ProBalsa panels are light, stiff, and flat. They can be simply cut and pieced together to make furniture, cabinetry, forms, and simple tooling.

DIAB – AN INTERNATIONAL MARKET LEADER

DIAB develops and sells products and services based on composite sandwich technologies.

Our Mission: We supply materials and solutions that make products light, strong, and competitive.

Over twenty years of experience combined with continuous research and development makes DIAB an international market leader in multi-functional sandwich constructions.

We strive for excellence – not only in materials but also in technical assistance and documentation. Extensive experience with sandwich composites and a global presence enable us to give strong support to our customers whenever and wherever needed.

AN ISO 9001 COMPANY

DIAB is ISO 9001 certified. This certification means DIAB operates a quality management system approved by the International Standards Organization. Our customers can count on product consistency, dependable delivery, and unparalleled service.

PROBALSA TYPE APPROVALS

ProBalsa core materials are approved by all major marine classification societies including American Bureau of Shipping, Lloyd's Register of Shipping, Det Norske Veritas and Gemanischer Lloyds.

Our type approvals mean ProBalsa products are recognized and meet the physical and structural standards established by these classification societies.

AVERAGE NOMINAL PHYSICAL PROPERTIES

Property	Units	LD7 Light Weight	PB Standard	HW Heavy Weight
Nominal Density (ASTM C 271)	kg/m^3 lb/ft^3	90 5.6	155 9.7	220 13.8
Compressive Strength (ASTM C 365)	MPa psi	5.4 783	12.7 1,842	21.9 3,176
Compressive Modulus (ASTM C 365)	MPa psi	1,850 268,250	4,100 594,500	6,840 991,800
Tensile Strength (ASTM C 297)	MPa psi	7.0 1,015	13.5 1,958	20.6 2,987
Shear Strength (ASTM C 273)	MPa psi	1.6 232	3.0 435	4.5 653
Shear Modulus (ASTM C 273)	MPa psi	96 13,920	166 24,070	237 34,365

Nominal Moisture Content**:** 12%

Coefficient of Linear Expansion:

Longitudinal	1.1×10^{-6} cm/cm/°C	2.0×10^{-6} in/in/°F
Radial	4.6×10^{-6} cm/cm/°C	8.0×10^{-6} in/in/°F
Tangential	6.8×10^{-6} cm/cm/°C	12.0×10^{-6} in/in/°F

N.B. Shrinkage and swelling of wood due to moisture changes will overshadow thermal expansion.

CHARACTERISTICS – LD7

Property	Unit	Value	Test Procedure
Density	kg/m^3 lb/ft^3	90 5.6	ASTM C 271
Minimum Density	kg/m^3 lb/ft^3	64 4.0	ASTM C 271
Compressive Strength	MPa psi	5.4 783	ASTM C 365
Minimum Compressive Strength	MPa psi	2.6 377	ASTM C 365
Compressive Modulus	MPa psi	1,850 268,250	ASTM C 365
Minimum Compressive Modulus	MPa psi	920 133,400	ASTM C 365
Tensile Strength	MPa psi	7.0 1,015	ASTM C 297
Minimum Tensile Strength	MPa psi	3.9 566	ASTM C 297
Shear Strength	MPa psi	1.6 232	ASTM C 273
Minimum Shear Strength	MPa psi	0.9 131	ASTM C 273
Shear Modulus	MPa psi	96 13,920	ASTM C 273
Minimum Shear Modulus	MPa psi	59 8,555	ASTM C 273
Thermal Conductivity 23°C	$W/(m \cdot °C)$ $Btu \cdot in/(ft^2 \cdot h \cdot °F)$	0.052 0.35	ASTM C 177
Moisture Content	%	12	ASTM D 2016
Minimum Moisture Content	%	8	ASTM D 2016
Water Absorption 24 hours 48 hours Saturation	%	350 490 1,060	ASTM C 272

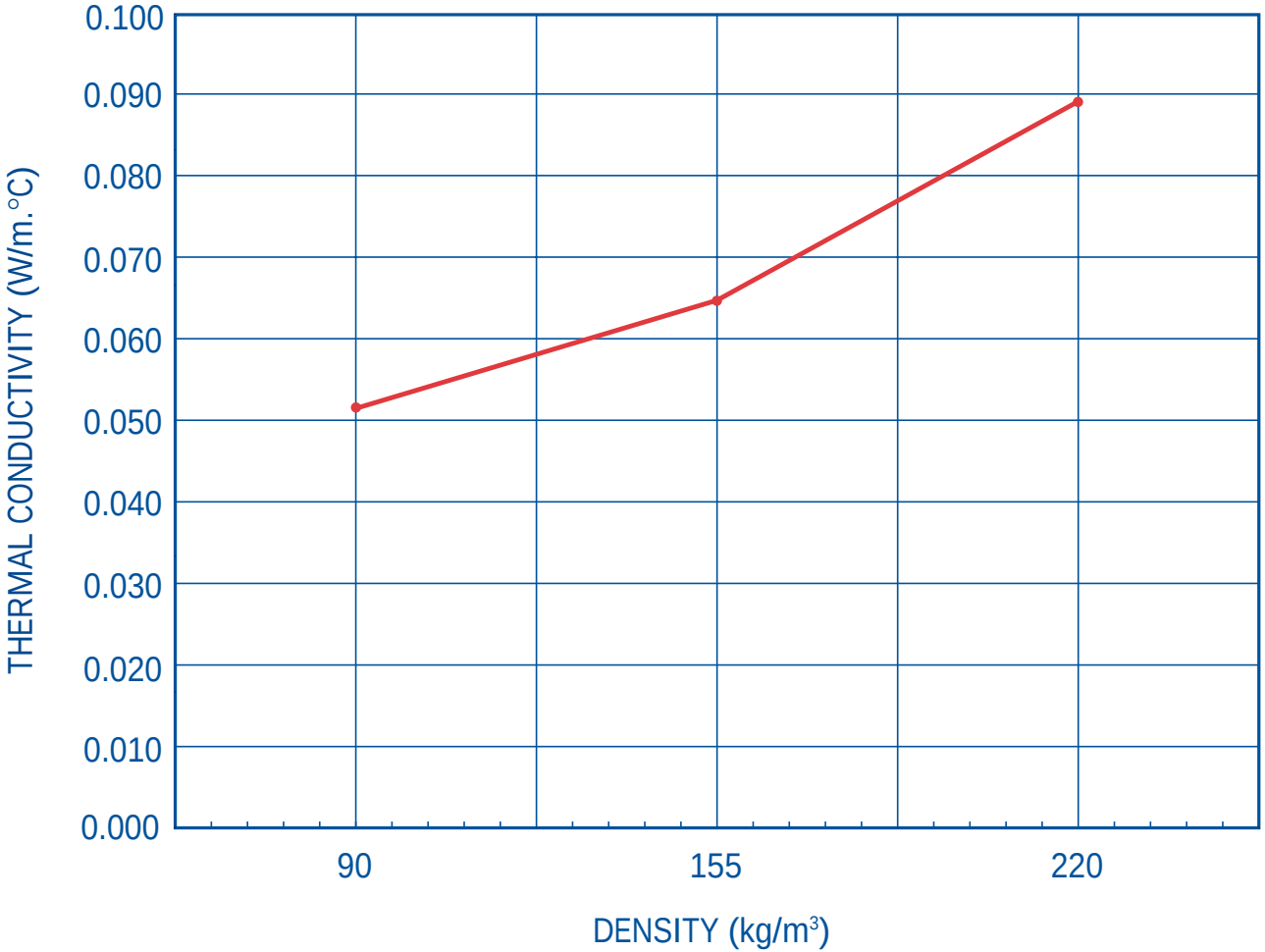
CHARACTERISTICS – PB

Property	Unit	Value	Test Procedure
Density	kg/m^3 lb/ft^3	155 9.7	ASTM C 271
Minimum Density	kg/m^3 lb/ft^3	121 7.6	ASTM C 271
Compressive Strength	MPa psi	12.7 1,841	ASTM C 365
Minimum Compressive Strength	MPa psi	6.4 928	ASTM C 365
Compressive Modulus	MPa psi	4,100 594,500	ASTM C 365
Minimum Compressive Modulus	MPa psi	2,000 290,000	ASTM C 365
Tensile Strength	MPa psi	13.5 1,957	ASTM C 297
Minimum Tensile Strength	MPa psi	7.5 1,087	ASTM C 297
Shear Strength	MPa psi	3.0 435	ASTM C 273
Minimum Shear Strength	MPa psi	1.8 261	ASTM C 273
Shear Modulus	MPa psi	166 24,070	ASTM C 273
Minimum Shear Modulus	MPa psi	100 14,500	ASTM C 273
Thermal Conductivity 23°C	W/(m · °C) Btu · in/(ft^2 · h · °F)	0.064 0.44	ASTM C 177
Moisture Content	%	12	ASTM D 2016
Minimum Moisture Content	%	8	ASTM D 2016
Water Absorption 24 hours 48 hours Saturation	%	225 310 625	ASTM C 272

CHARACTERISTICS – HW

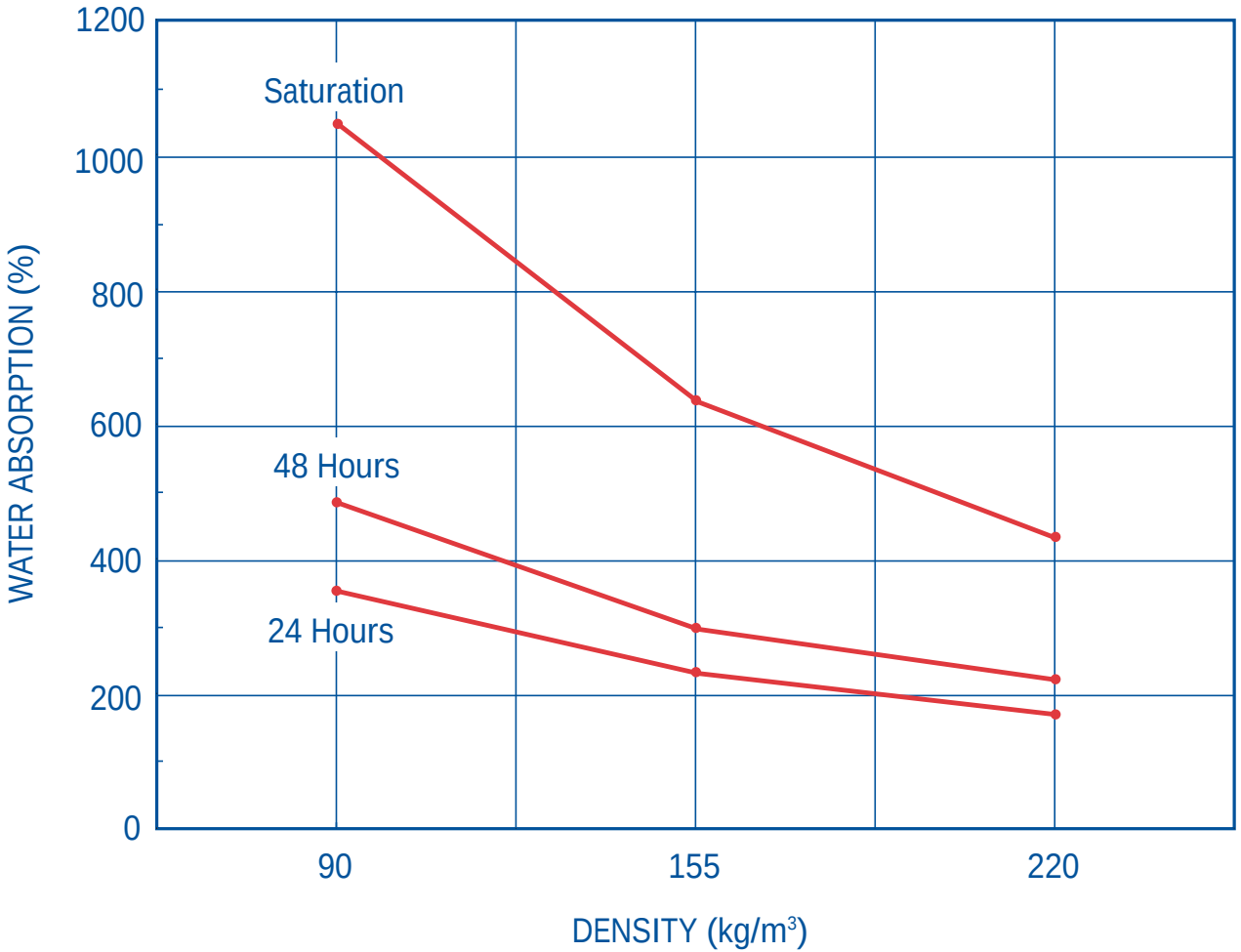
Property	Unit	Value	Test Procedure
Density	kg/m^3 lb/ft^3	220 13.8	ASTM C 271
Minimum Density	kg/m^3 lb/ft^3	185 11.6	ASTM C 271
Compressive Strength	MPa psi	21.9 3,175	ASTM C 365
Minimum Compressive Strength	MPa psi	13.8 2,001	ASTM C 365
Compressive Modulus	MPa psi	6,840 991,800	ASTM C 365
Minimum Compressive Modulus	MPa psi	4,300 623,500	ASTM C 365
Tensile Strength	MPa psi	20.6 2,987	ASTM C 297
Minimum Tensile Strength	MPa psi	14.0 2,030	ASTM C 297
Shear Strength	MPa psi	4.5 652	ASTM C 273
Minimum Shear Strength	MPa psi	3.2 464	ASTM C 273
Shear Modulus	MPa psi	237 34,365	ASTM C 273
Minimum Shear Modulus	MPa psi	170 24,650	ASTM C 273
Thermal Conductivity 23°C	W/(m · °C) Btu · in/(ft^2 · h · °F)	0.086 0.60	ASTM C 177
Moisture Content	%	12	ASTM D 2016
Minimum Moisture Content	%	8	ASTM D 2016
Water Absorption 24 hours 48 hours Saturation	%	170 230 445	ASTM C 272

THERMAL CONDUCTIVITY



Thermal conductivity at 23°C as a function of density according to ASTM C 177 and ASTM C 271.

WATER ABSORPTION



Water absorption at 22°C as a function of density
acc. to ASTM C 272 and ASTM C 271.

In recent years, many test programs have been conducted using relatively thick, 50 mm (2 in) balsa wood for use in ship structures. An unusual phenomenon has been observed with regard to the shear strength and failure modes for balsa cores. When testing thick balsa cores in accordance to ASTM C 273 or ASTM C 393, the values for shear strength were much lower than the values previously presented in manufacturers' data sheets. This phenomenon is due to the fact that the shear strength of balsa is dependent on the thickness of the sample being tested. This effect is documented in honeycomb cores due to cell wall instability, as related to wall thickness and height. Balsa wood has been described as a micro-cellular honeycomb, which helps explain why it is susceptible to these effects.

BALSA CORE TESTING

Most balsa core manufacturers test their products at 12.7 mm (0.5 in) thickness since this is the most popular thickness of balsa. However, the shear strength values for 12.7 mm (0.5 in) balsa should not be used for designing structures with balsa cores greater than 12.7 mm (0.5 in) thick. The balsa core should be tested in a thickness similar to the end application. In addition, ASTM C 273 should be used to determine shear properties of the core.

SHEAR STRENGTH REDUCTION FOR THICKNESS

Recommended reduction factors for balsa shear strength vs. thickness are listed below.

Thickness mm (in)	Shear Strength Reduction %
12.7 (0.5)	0
25.4 (1.0)	14
50.0 (2.0)	28

MORE INFORMATION

For more information, consult the following sources:

1) Balsa Wood Design Values; C. Kilbourn, DIAB Inc, 1999

2) Mil Handbook 23-A

3. Shear Strength of Balsa Cored Sandwich Panels; D. McGeorge & Brian Hayman, Det Norske Veritas, Norway, 1998

General test conditions are 23°C ± 2°C (73°F) and 50 ±10% relative humidity if no other temperatures are specified. Test samples are taken from random sheets in the production line.

All samples are conditioned for a minimum of 2 hours at 23°C (73°F) and 50 ±10% before testing.

DENSITY

Specimen densities are tested in accordance with ASTM C 271. Specimens are cuboids with 50 mm (2 in) by 50 mm (2 in) faces and respective height.

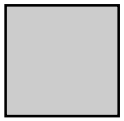
MOISTURE CONTENT

Through research conducted at DIAB, it has been proven that the moisture content in balsa significantly affects its physical properties. Moisture content of the balsa must be 12% (± 4%) at time of fabrication for optimum properties.

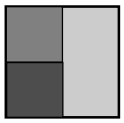
Moisture content is tested in accordance with ASTM D 2016 (Method B - Electronic Moisture Meter Method).

COMPRESSIVE STRENGTH

To obtain compressive strength, two types of samples are tested. The first type is a uniform density sample, which is made up of only one board. The second type, the non-uniform sample, is made up of at least three boards of balsa.



Uniform Sample



Non-Uniform Sample

For design purposes, it is recommended that the non-uniform sample values be used as a matter of safety. Values for the non-uniform samples are included in this guide.

The flatwise compressive strength of the balsa wood is determined in accordance with ASTM C 365. Samples tested are cubes with 50 mm (2.0 in) sides.

COMPRESSIVE MODULUS

As in testing for the compressive strength, the compressive modulus is also tested in uniform density and non-uniform density samples.

The flatwise compressive modulus of the balsa wood is determined in accordance with ASTM C 365. Samples are cuboid with faces 50 mm (2.0 in) by 50 mm (2.0 in) and respective height.

TENSILE STRENGTH

Samples tested for tensile strength are uniform density samples since it has been shown that the non-uniform density samples will have a tendency to fail at the lowest density board (of the sample) which makes the test inconclusive.

The tensile strength of the balsa wood in the flatwise plane is determined in accordance with ASTM C 297. Samples are cuboid with faces 50 mm (2.0 in) by 50 mm (2.0 in) and 12.7 mm (0.5 in) in height.

SHEAR STRENGTH

Both uniform and non-uniform density samples are tested for shear strength. For non-uniform density samples, shear strength results are based on the average density of the sample tested since the specimens are composed of more than one board.

The shear strength of balsa wood in the flatwise plane is determined in accordance with ASTM C273. Samples are 152 mm (6 in) long by 63.5 mm (2.5 in) wide by 12.7 mm (0.5 in) thick. Specimens are tested in the tensile direction.

SHEAR MODULUS

As in testing for the shear strength, the shear modulus is also tested in uniform density and non-uniform density samples.

The shear modulus of balsa wood in the flatwise plane is determined in accordance with ASTM C 273. Samples are 152 mm (6 in) long by 63.5 mm (2.5 in) wide by 12.7 mm (0.5 in) thick. Specimens are tested in the tensile direction.

SHEAR STRAIN

The shear strain of balsa is very small. On average, shear strain is between 0.5% and 2%.

The shear strain of balsa wood in the flatwise plane is determined in accordance with ASTM C 273. An extensometer is used for measuring the strain. Samples are 152 mm (6 in) long by 63.5 mm (2.5 in) wide by 12.7 mm (0.5 in) thick. Specimens are tested in the tensile direction.

WATER ABSORPTION

The amount of water that balsa wood can absorb is dependent on the density of the material. Balsa is capable of absorbing more than six times its own weight at the nominal density of 155 kg/m^3 (9.7 lb/ft^3). The amount of water absorbed by a sample will vary with time.

The water absorption of balsa is determined in accordance with ASTM C 272. Samples are cuboids with 73 mm (2.9 in) by 73-mm (2.9 in) faces and 12.7 mm (0.5 in) tall.

INTRODUCTION

Many important characteristics of composite sandwich materials deal with how they behave when exposed to fire. These properties include:

- Oxygen Index
- Flame Spread
- Smoke Generation
- Toxicity

For the sake of health and safety, these properties should be considered anywhere people risk exposure to burning composites. This is especially true in the context of passenger vehicles, such as planes, buses, ferries and trains.

The values given for ProBalsa in this section are related to the core itself and not to sandwich panels. The fire, smoke, and toxicity (FST) properties will normally improve in combination with a properly selected skin.

OXYGEN INDEX (OI)

Oxygen index is the minimum percentage of oxygen required in the surrounding air to sustain a fire. Air normally contains 21% oxygen. Materials that have an oxygen index greater than 21 are said to be self-extinguishing. ProBalsa has an oxygen index of 24. Oxygen index of ProBalsa was determined according to ASTM D 2863

FLAME SPREAD INDEX

Flame spread index is a measure of the surface flammability of a material when exposed to a radiant heat source. The average flame spread index for ProBalsa is 187. Most transportation authorities have a requirement for flame spread index of not more than 35. The surface flammability of ProBalsa was determined according to ASTM E 162.

SMOKE GENERATION

The smoke produced during a fire is itself a hazard. Smoke can impair breathing and disorient people by reducing visibility. Therefore, it is important to test materials for smoke generation. There are various pieces of equipment to measure smoke generation from burning materials. Two examples are the NBS (National Bureau of Standards) and the OSU (Ohio State University) smoke chambers.

Smoke generation of balsa wood has been determined according to ASTM E 662. Smoke generation tests can be performed under flaming mode, during which a flame is applied directly to the material, or under pyrolysis, during which only heat is applied. When testing ProBalsa, the values produced under pyrolysis are generally higher than those produced during flaming mode. A typical smoke density value under pyrolysis for 10 mm (0.4 in) thick ProBalsa is 150 after 240 seconds. Most transportation authorities require a value no more than 200 after 240 seconds.

TOXICITY

Burning and combustion not only release heat, but they also produce residual products such as char and smoke. Standards have been established to dictate the types and quantities of combustion products allowed for certain materials. Because the regulated components are highly toxic, the quantity allowed is usually small enough that they are measured in parts per million (ppm). Toxicity of ProBalsa was determined according to BSS 7239. Typical values of toxic gasses for ProBalsa in ppm after burning for 4 minutes are listed in the table below.

Type of gas	ProBalsa Tested Amount (ppm)	FAA Maximum (ppm)
CO	155	3500
HCN	3	150
HCl	37	500
HF	2	50
SO2	42	100
NO2	1	100

ProBalsa comes packaged in corrugated cardboard boxes. Sheets are bundled in moisture proof bags to maintain the moisture content of the balsa and to protect it from contamination.

TRANSPORT

The packages shall be transported on covered trailers/lorries or in containers. The boxes shall be placed on pallets of the same size as the boxes or placed on an even support.

The packages may be transported in a vertical position if needed.

HANDLING

The packages should be handled with great care in order to avoid damages.

Packages that are strewed may be lifted with a forklift if pads are used to distribute the load.

STORAGE

ProBalsa should be stored on pallets in a dry environment. Do not use a box knife to open the box. Remove the box lid and use one bag of ProBalsa at a time.

Balsa absorbs moisture from the environment causing it to swell, shrink, and warp. High moisture content can contaminate some resin systems. After the moisture proof bags are opened take every precaution to protect ProBalsa from water, dust and other contaminates by re-closing the bag.

Do not store ProBalsa near oxidizers such as MEKP. Store away from heat and fire. Balsa dust is flammable.

There are a number of ways to machine ProBalsa. This section covers the most commonly used methods:

- Sawing
- Sanding
- Drilling

It is in no way a complete set of instructions. The intention of this manual is to give guidance based on our internal experiences. The contents will cover the basic parameters and principles of machining ProBalsa. We strongly recommend that trials be performed prior to choosing a final setup. Maintaining machinery and tools is very important to ensuring a good cut.

If in doubt about machining, please contact DIAB Technical Services for further advice.

SAWING

Depending on the operation and the density of the material, the following methods may be used.

CROSS-CUT SAWING

Cross-cut sawing can be used on any density of balsa and on many sandwich panels. The recommended parameters when cross-cut sawing ProBalsa are:

Cutting speeds 50-60 m/s (164-197 ft/s).
350-400 mm (14-16 in) blades, 54-96 teeth
Alternately or trapezoidal sharpened teeth. (See fig. 1-4)

Please note that the feed speed must be decreased on sandwich panels and on higher densities.

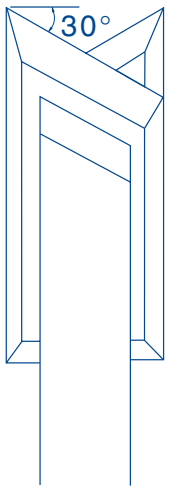


Figure 1. Alternatelly sharpened blade, rear view.

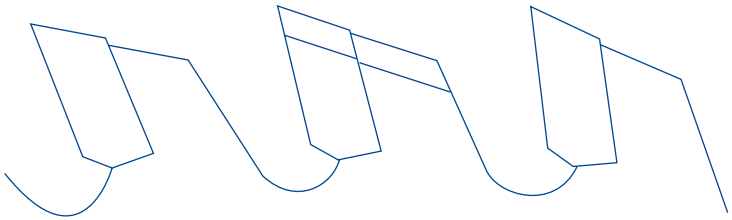


Figure 2. Alternatelly sharpened blade, side view.

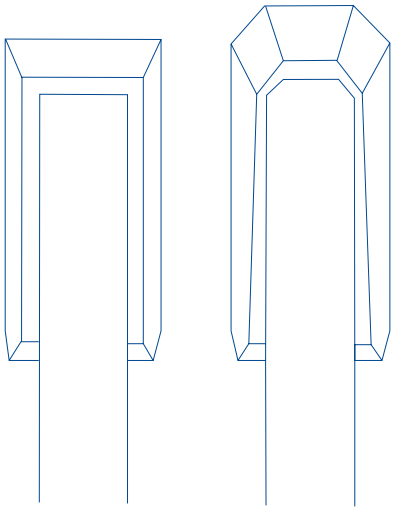


Figure 3. Trapezoidally sharpened blade, rear view.

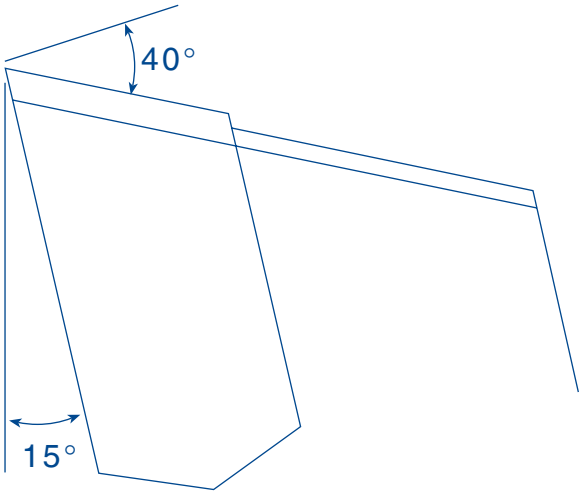


Figure 4. Trapezoidally sharpened blade, side view.

BAND SAWING

A band saw can be used to cut balsa without problems. On densities greater than 155 kg/m^3 (9.7 lbft^3), the feed speed must be considerably decreased. When sawing sandwich panels, it is highly recommended that trials be performed prior to final machining. The recommended parameters for band sawing ProBalsa are:

Cutting speeds 30-35 m/s (98-115 ft/s).
4 teeth per inch.
0.9 mm (1/32 in) blade thickness
10-13 mm (25/64-33/64 in) wide blades
Hook-shaped teeth (See fig 5)

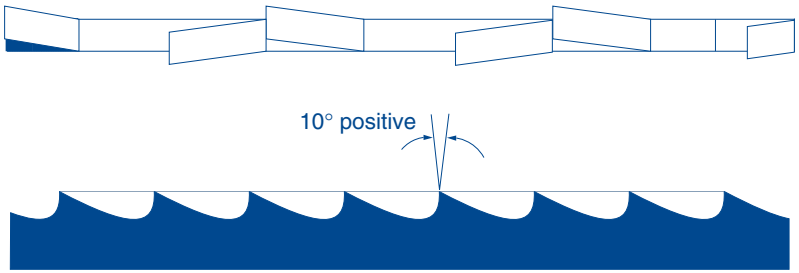


Figure 5. Band-saw blade, top and side view.

HORIZONTAL SAWING

This type of sawing makes use of a standard saw blade with the following characteristics:

20 mm (25/38 in) wide blade
3 teeth per inch.
Standard setting (every other tooth) to 1.5mm (1/16 in)
Hook-shaped teeth (See fig. 5)
Cutting speed 45-50 m/s (148-164 ft/s)
Feed speed 0.5-2 m/min (1/32-1/8 ft/s) depending on density.

SANDING

Recommended sanding parameters for ProBalsa are as follows:

Standard sandpaper used with ProBalsa is 36-60 grit. (Sandpaper as fine as 240-300 grit has been used.)
Sandpaper speed should be 25 m/s (82 ft/s).

Sand Paper Grit	Cut Size mm (in)	Feed Rate m/min (ft/min)
36	0.50 (0.02)	6.0 (20)
60	0.25 (0.01)	6.0 (20)
60	1.30 (0.05)	3.5 (12)

The feed speed strongly depends on the density machined. It varies from 3 m/min (10 ft/min) for high-density balsa to 6 m/min (20ft/in) for low-density balsa. The maximum amount of material that should be removed is 3 mm (0.118 in) per cylinder and pass, but 1 mm (0.039 in) is recommended as a starting value.

DRILLING

When drilling ProBalsa, standard types of drill bits may be used. The recommended cutting speed is 40 m/s. When drilling sandwich panels constructed with ProBalsa, the skin materials will determine which drill bit is best.

ProBalsa has been used successfully with all types of manufacturing processes including but not limited to hand lay-up, RTM, VARTM, vacuum consolidation, and pre-preg. ProBalsa requires some special considerations when used with some of these processes.

HAND LAY-UP, SPRAY-UP, AND VACUUM CONSOLIDATION

In hand lay-up, spray-up, and vacuum consolidation processes, a simple step should be followed to ensure a quality laminate. Balsa naturally tends to transport fluids through the material in the direction of its grain. For this reason, the core should be pre-wet with catalyzed resin before installation if standard ProBalsa, not ProBalsa Plus, is being used. If this step is not taken, the laminate can become 'resin starved' and result in a poor bond between the skin and core.

HIGH-TEMPERATURE/PRE-PREG PROCESSING

ProBalsa can withstand processing temperatures in excess of 120°C (250°F) with minor degradation of its physical properties. Care must be taken when raising the temperature above the boiling point of water while processing; 100°C (212°F) at atmospheric pressure. When the residual moisture in the balsa is heated above its boiling point, it is converted to steam which can easily contaminate the bond between the face and core. This potential problem can be avoided by drying the core in an oven at 120°C (250°F) before use. The core should be weighed at intervals until the weight becomes constant. At this point the balsa will be dry and will not pose a problem when processing with pre-pregs at temperatures above the boiling point of water. The balsa should be processed within 4 hours of drying in the oven.

Note that the boiling point of water is lower when the pressure is lowered, such as under a vacuum bag. For example, at normal atmospheric pressure (1 atm), water boils at 100°C (212°F). At 0.5 atm, water boils at 82°C (180°F).

Processing ProBalsa at temperatures above 150°C (302°F) can result in checking and cracking within the individual balsa timbers.

There are many things to consider when designing with balsa wood core materials. Although balsa is an engineered product, it still retains many properties of a natural material. Some of the key things to consider are density variation, thickness, and part size vs. timber size.

A CHAIN IS ONLY AS STRONG AS ITS WEAKEST LINK

This cliché holds true for balsa core materials due to the dependence of their physical properties on density. Balsa cores are made up of individual timbers that can have density differences as great as 160 kg/m^3 (10lb/ft^3) between them. Due to the high areal density variation, there is a high variation of physical properties from timber to timber. Therefore, minimum values should be used when designing with balsa cores, especially when designing relatively small parts.

SIZE MATTERS

As mentioned previously, the thickness of the balsa core must be taken into account and a reduction factor applied when designing with balsa cores greater than 12.7 mm (0.5 in) thick (see Shear Strength Vs. Thickness section).

PART SIZE VS. TIMBER SIZE

When designing parts on a small scale, approaching 2 to 4 times timber size, a reduction in design values is necessary due to the influence of timber density variation within the sheets. In addition, balsa is highly orthotropic.The properties of the timbers must be expressed with respect to cylindrical coordinates due to the growth rings of balsa trees. In traditional composite design, a Cartesian coordinate system is used to describe the properties of laminates. Therefore, it is difficult to address the properties of each individual balsa timber within the sheet.

MATERIAL SAFETY DATA SHEET

SECTION I	**PRODUCT IDENTIFICATION**
Product Name:	ProBalsa
General or Generic ID:	Wood panel balsa, finished
D.O.T. Hazard Classification:	ORM-C no label required
Manufacturer's Name:	DIAB Inc
	315 Seahawk Drive
	DeSoto, Texas 75115
Information Telephone #:	(972) 228-7600
Chemical Emergency during Transit:	In the United States Call **Infotrac** at Telephone #: (800) 535-5053
Last Revision Date:	06/28/99
SECTION II	**HAZARDOUS INGREDIENTS**
Components	Non-Hazardous in available state
SECTION III	**PHYSICAL AND CHEMICAL CHARACTERISTICS**
Boiling Point	N/A
Vapor Pressure	N/A
Vapor Density	Solid, not applicable
Specific Gravity	0.05 – 0.350
Evaporation Rate	N/A
Percent Volatile by Volume	N/A
Solubility in Water by Weight	N/A
Description	Light brown, wood grain

SECTION IV	FIRE AND EXPLOSION HAZARD DATA
Flash Point	Greater than 400° F (200°C) [ASTM D1929]
Auto-ignition	Greater than 750° F (400°C)
Flammability Limits in Air	Not determined
Hazardous Decomposition Products	None known
Extinguishing Media	Water, water Fog, $C0^2$, dry chemical
Special Fire Fighting Procedures	None
Unusual Fire and Explosion Hazards	Product may smolder unless doused with water
Oxygen Index	24

SECTION V	REACTIVITY DATA
Hazardous Polymerization:	Will not occur
Stability:	Stable
Incompatibility (Avoid Contact With):	Strong oxidizers can cause ignition and subsequent burning.
Conditions to Avoid:	Exposure to open flame or excessive heat.
Hazardous Decomposition Products:	Carbon monoxide, carbon dioxide, and traces of low molecular weight hydrocarbons and organic acids.

SECTION VI — HEALTH HAZARD DATA

Effects of Overexposure:	Eyes –	Can cause mild irritation, redness, tearing
	Skin –	Exposure causes no known effect
	Breathing –	Excessive inhalation of dust from product can cause asphyxiation due to coating the lung tissues
	Swallowing –	No adverse health effect known
Emergency/First Aid Procedures:	Eyes –	Flush with large quantities of water, including upper and lower eyelids. Seek medical attention if irritation persists.
	Skin –	Do not blow off dust, wash with soap and water.
	If Breathed –	If asphyxia is apparent, remove individual to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, administer artificial respiration. Keep person warm, quiet, and get medical attention.
	If Swallowed –	If large quantities have been ingested, seek prompt medical attention.
Effects of Chronic Exposure:		No adverse chronic health effects are known for this product, but enhanced allergic conditions may occur for certain people. We do not know of any medical conditions that might be aggravated by exposure to this product.

SECTION VII PRECAUTION FOR SAFE HANDLING AND USE

Protective Equipment to be Used

Respiratory Protection:	Where use results in generation of dust from product, use of dust/mist respirator is recommended.
Ventilation:	Where use results in generation of dust from product, provide sufficient mechanical (general and/or local exhaust) ventilation or vacuum assisted dust collection to prevent explosive concentrations of airborne dust from developing.
Protective Clothing:	Gloves not necessary. Normal work clothes covering arms and legs.
Eye Protection:	Goggles are recommended in those cases where use results in generation of dust.
Precautions to be Taken in Handling and Storing:	Product is combustible. Use reasonable care and caution.

SECTION VIII WASTE DISPOSAL

Dust collection equipment should be used when machining large quantities of material. Floor dust may be collected with normal ship vacuum or by sweeping.

Balsa dust does not contain any hazardous substances.

Waste Disposal Method:	DIAB suggests that all local, state and federal regulations concerning health and pollution be reviewed to determine approved disposal procedures. Contact DIAB if there are any disposal questions.

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Material Safety Data Sheet – may be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

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