

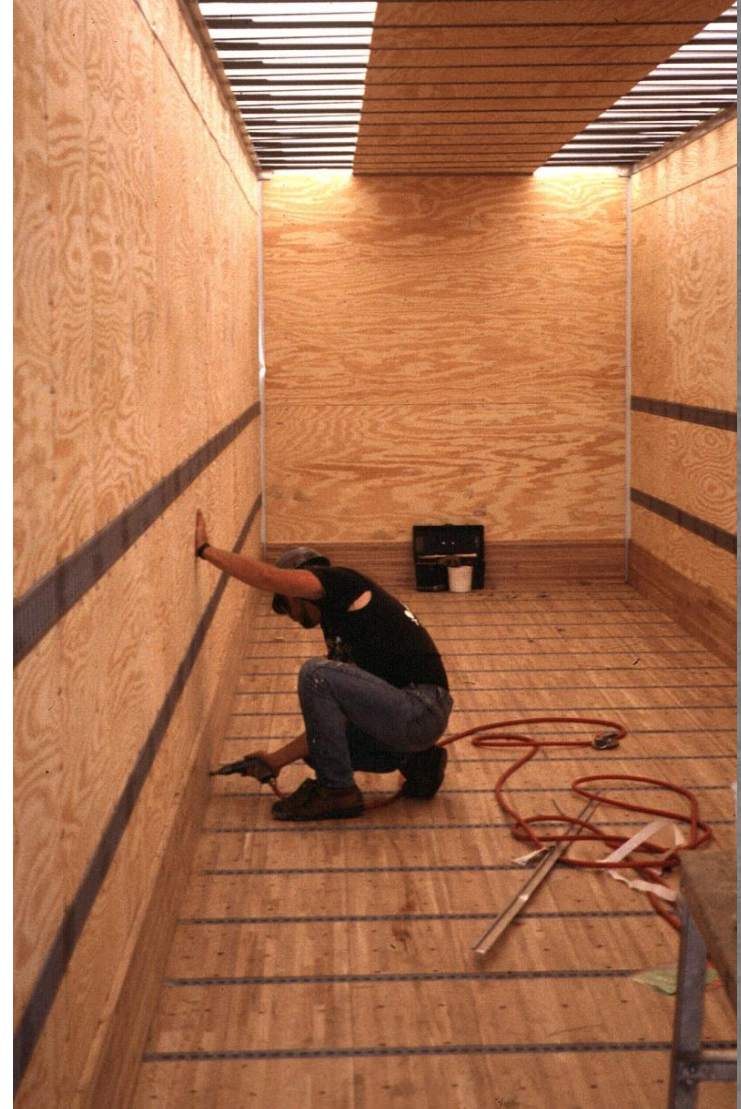


PERFORMANCE PANELS

**PLYWOOD & OSB PANELS:
production, attributes, and industrial
and non-construction applications**

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Performance that you can count on

- ✓ Best quality assurance program
- ✓ Consistent/uniform dimensions
- ✓ Known performance criteria
- ✓ Domestic manufacturers



Performance that you can count on



The manufacturing of plywood uses a lathe to peel the veneer from the water saturated logs into specific thicknesses.

Common veneer thicknesses are: $1/10''$ • $1/8''$ • $1/6''$.

Manufacturing Performance Panels



The veneer is dried to a low moisture content to facilitate the bonding process.

The veneer is cut into full sheet sizes for processing. Plywood panels are typically made into 48" x 96" panels.

Manufacturing Performance Panels



The veneers are sorted into different grades including A, B, C and D.

Common plywood performance categories include: $1/4''$ • $3/8''$ • $15/32''$ • $19/32''$ • $23/32''$ • $1-1/8''$.

Manufacturing Performance Panels



The veneers to be used on the faces of higher grades of plywood are improved by removing defects and replacing those areas with solid wood patches and synthetic fillers.

This process produces A, B and C-Plugged veneers.

Manufacturing Performance Panels



Adhesives are applied to both sides of inner veneers (cross bands) and the veneers or plies are arranged in layers.

The face, center and back veneers are often the size of the full sheet and the direction of the grain is parallel to the length of the panel.

Manufacturing Performance Panels



The direction of the grain in the cross-bands is parallel to the width of the panel.

Cross laminating the direction of the grain in the plies makes the panels stiffer, more dimensionally stable and impact-resistant.

Manufacturing Performance Panels

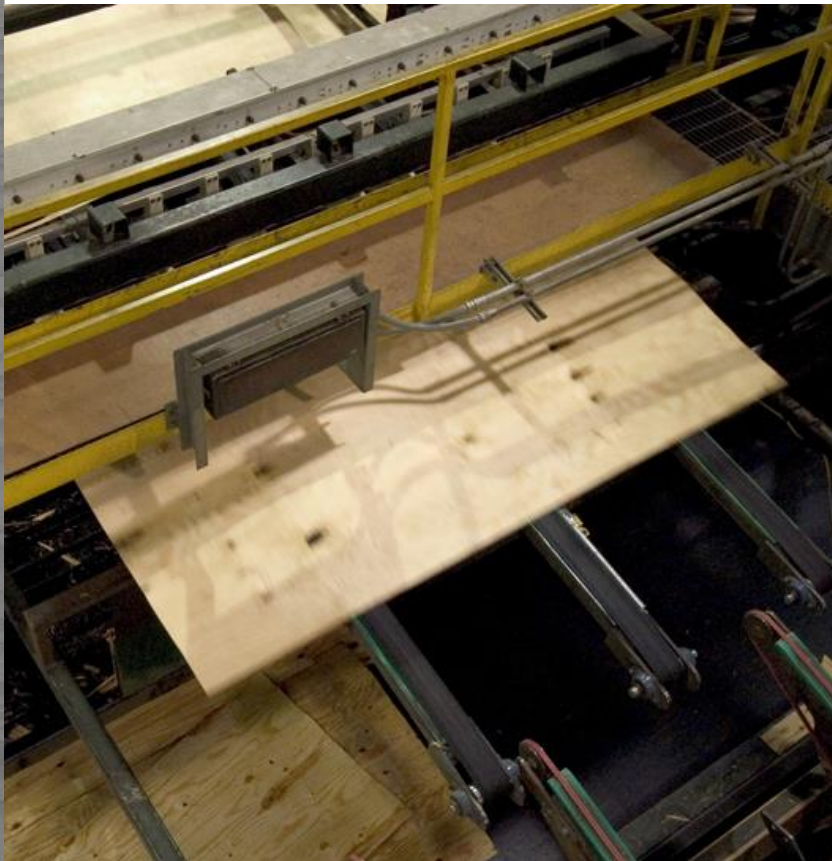


The strong axis of the panel is in the direction of the face grain.

After the veneers are laid-up into panels, they are placed in a press. The resins used to bond the veneers together are activated under heat and pressure.

The resins are water resistant and once appropriately pressed, moisture will not cause the bond to fail.

Manufacturing Performance Panels



The panels are trimmed to width and length.

Most plywood panels are manufactured to a 48" x 96" size, but some mills can manufacture widths up to 60" and lengths up to 144".

Manufacturing Performance Panels



The higher grade panels are then sanded. Tongue and groove or ship-lap edges may also be milled at this time.

The sanding process can be used to size the panel to a precision thickness.

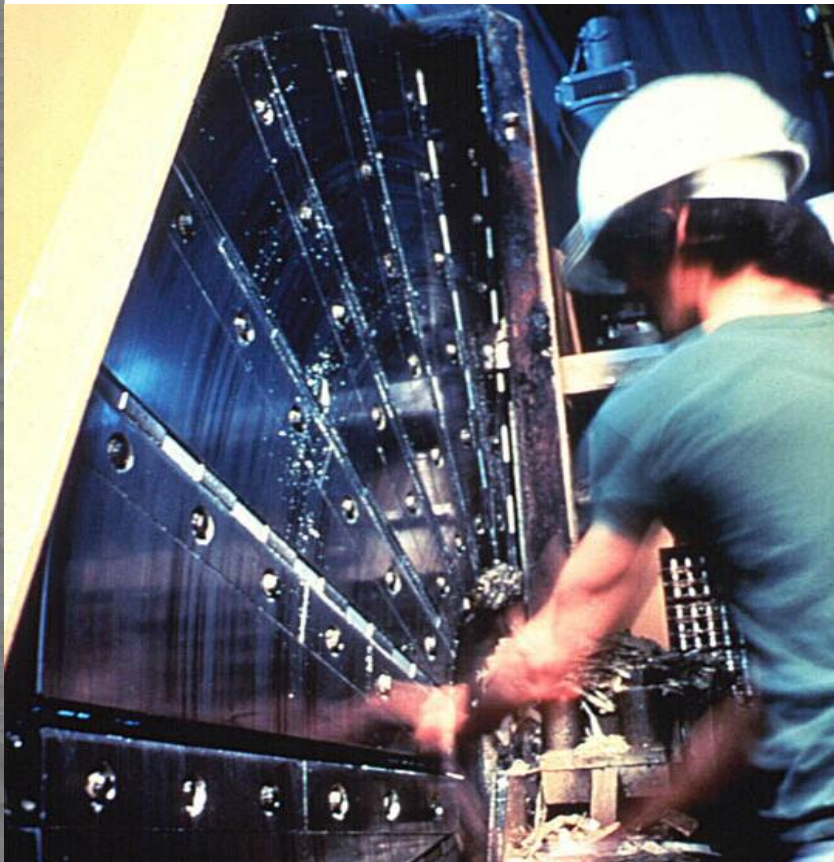
Manufacturing Performance Panels



Some mills have secondary processes that further enhance the panels, like adding overlays to the faces of the plywood, such as MDO or HDO.

The panels are then stacked into units for shipping.

Manufacturing Performance Panels



The manufacturing of Oriented Strand Board (OSB) uses equipment that cuts logs into strands of wood.

The logs are saturated with water prior to this process.

The strands are cut into specific dimensions for pressing into structural panels.

Manufacturing Performance Panels



The strands are then dried to a low moisture content to facilitate the bonding process.

The strands typically range in size from 1" to 3" in width and from 3" to 8" in length.

The strands are cut so that they are strongest when oriented in the direction of their length.



Manufacturing Performance Panels



During the drying process, the strands tumble in a rotating drum which is screened to grade for the correct strand size. Small strand "fines" and inadequate sizes are separated.

The strands move from the dryer to be blended with resins and waxes.

Manufacturing Performance Panels



The strands are placed on a moving mat in layers. The direction of the length of strands in the bottom and top layers is largely in the direction of the length of the panel.

In the middle layer, or layers, the strands are oriented across the panel.

Manufacturing Performance Panels



This cross-laminating of the strong direction in each layer makes the panels stiffer and more dimensionally stable, just as the cross-laminating in plywood.

Unless noted on the panels, the panels are strongest in their long direction.

Manufacturing Performance Panels



The mat of strands is then moved into a press where the resins that bond the panel together are activated under heat and pressure.

The resins are fully waterproof and once appropriately pressed, moisture will not cause the bond to fail.

Manufacturing Performance Panels



From the press, the mat-sized sheets are cut into the final dimension, which is normally 48" in width with lengths of 96", 108" and 120".

Additional sanding and milling of tongue and groove edges can follow. This most often occurs in the manufacture of underlayment grade panels (Sturd-I-Floor).

Manufacturing Performance Panels



The OSB manufacturing process is highly automated. The production is managed and monitored from computerized control rooms.

Commonly available performance categories of OSB include:

**1/4" • 3/8" • 7/16" • 15/32"
19/32" • 23/32" • 1-1/8"**

Manufacturing Performance Panels



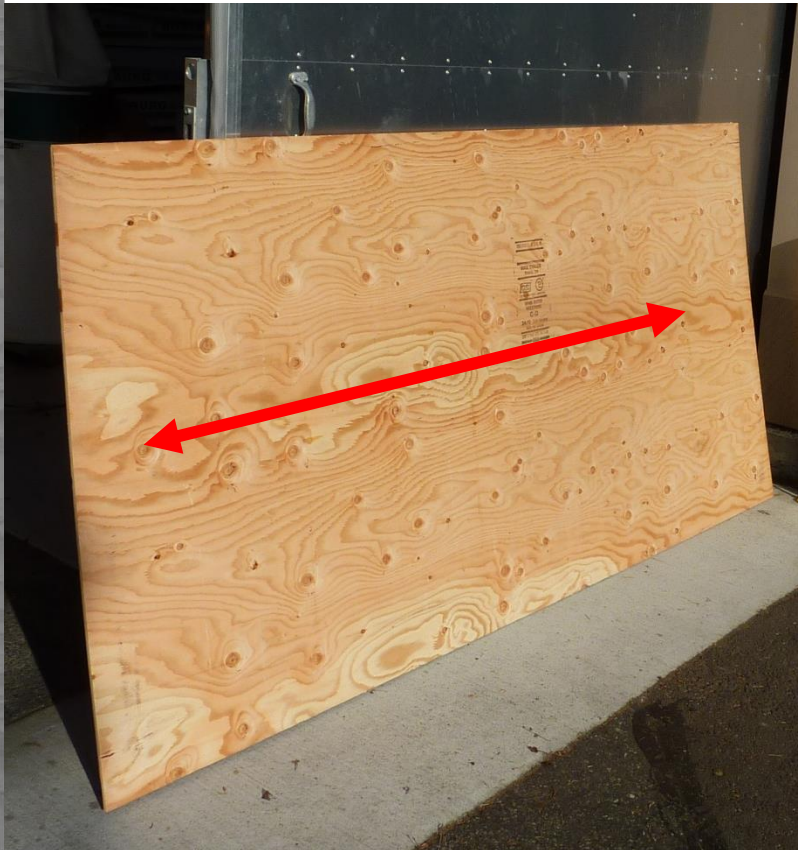
The mat sizes in OSB production vary from 9' to 12' in width and lengths from 24' to continuous in length. This provides almost unlimited sizes to fit many types of end applications.

The panels are bundled in units and prepared for distribution.

Performance that you can count on

- ✓ **Strength/Stiffness**
- ✓ **Stable/Flat**
- ✓ **Surface texture**
- ✓ **Workability**
- ✓ **Light in weight**
- ✓ **Environmental +**
- ✓ **Durability**
- ✓ **Unique features**
- ✓ **Surface durability**
- ✓ **Customizability**

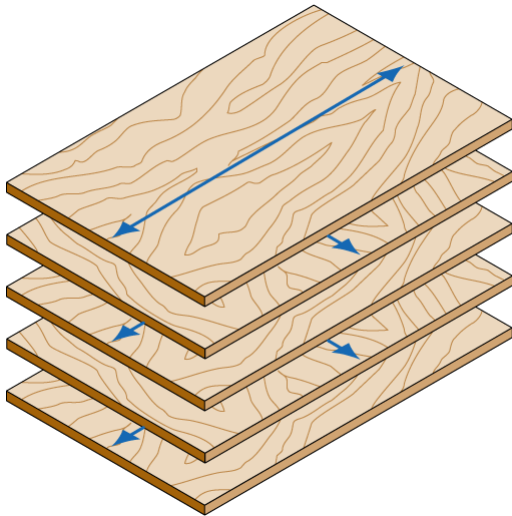
Strength and Stiffness



A little wood science...

- Wood is strongest in the direction of the grain.
- Some species of wood are stronger than others.
- The construction of performance panels impacts the strength.
- The more wood, the greater the strength.

Strength and Stiffness

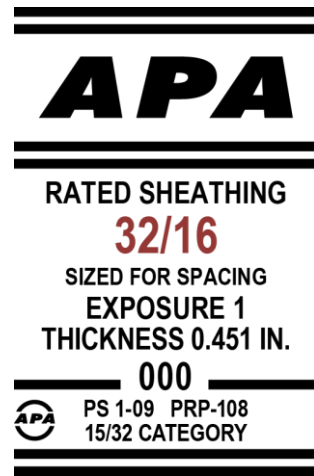


In the manufacture of the panels, the structural axis of the veneers or strands is alternated.

This process gives the panels strength in both directions and greater stiffness.

The strongest orientation of the panels is always the same as the direction of the grain on the panel faces.

Strength and Stiffness



Most trademarks that appear on APA Performance Rated panels indicate the strength of the panel with a single or double digit number that is referred to as the *span rating* of the panel. The greater the number(s), the stronger the panel.

The strongest orientation of the panels is always the same as the grain on the face.

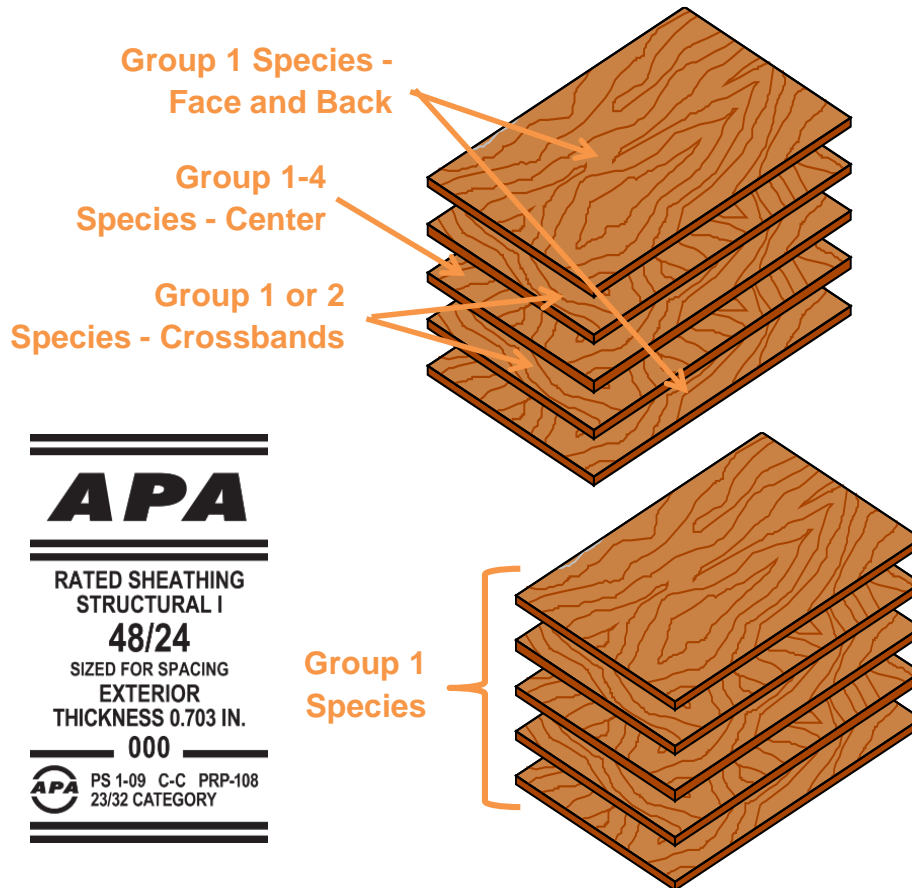
Strength and Stiffness



PS-1 and PS-2 are consensus standards for manufacturing softwood plywood and oriented strand board. The species of wood designated for the manufacture of panels are classified into five groups. Group 1 is the strongest and Group 5 the weakest.

Here, the trademark of a sanded panel indicates that the face and back veneers of the panel are manufactured with Group 1 species.

Strength and Stiffness



Concrete Forming Panels:

- Plyform Class I concrete forming panels have group 1 species faces for high strength and stiffness.
- Structural I Plyform panels are made with all Group 1 species throughout. All other factors being equal, Struc I panels will support the highest loads both along and across the panel.

Strength and Stiffness



The manufacturer and APA test the panels to assure the level of performance represented by the trademark.

Panels are only as strong as the resins that bond the veneers and strands together.

The testing evaluates such characteristics as strength, stiffness, bond durability and dimensional stability.

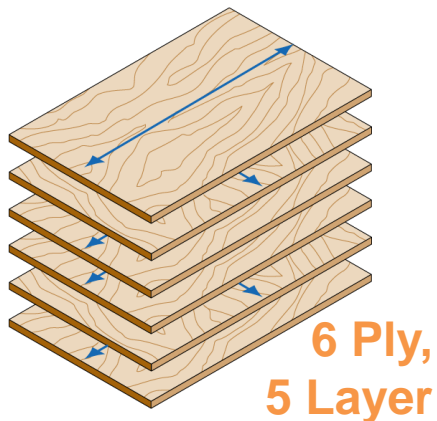
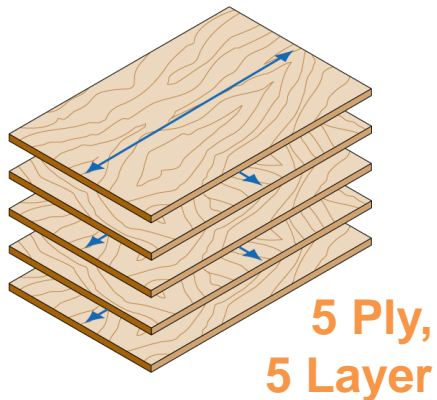
Stable and Flat



The direction of the structural axis of the veneers and strands are alternated, making the panels more dimensionally stable and helping them to remain flat.

In general, the more layers of wood and the thicker the panel, the greater the dimensional stability of the panel.

Stable and Flat



The way the panel is manufactured can also help the panels to be more dimensionally stable and to remain flat. Dimensional stability is impacted by:

- A balance in the number and thicknesses of veneers
- Type of wood species used
- Other variables in the construction of the panels

Stable and Flat




A little wood science...

- Unlike metals, plastic and glass, wood is relatively stable when exposed to temperature change; however, it is hygroscopic and does expand and contract as it absorbs and releases moisture. When properly sealed, wood will resist water absorption.

Surface texture

VENEER GRADES

<p>A Smooth, paintable. Not more than 18 neatly made repairs, boat, sled, or router type, and parallel to grain, permitted. Wood or synthetic repairs permitted. May be used for natural finish in less demanding applications.</p>	
<p>B Solid surface. Shims, sled or router repairs, and tight knots to 1 inch across grain permitted. Wood or synthetic repairs permitted. Some minor splits permitted.</p>	
<p>C-Plugged Improved C veneer with splits limited to 1/8-inch width and knotholes or other open defects limited to 1/4 x 1/2 inch. Wood or synthetic repairs permitted. Admits some broken grain.</p>	
<p>C Tight knots to 1-1/2 inch. Knotholes to 1 inch across grain and some to 1-1/2 inch if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed. Stitching permitted.</p>	
<p>D Knots and knotholes to 2-1/2-inch width across grain and 1/2 inch larger within specified limits. Limited splits are permitted. Stitching permitted. Limited to Exposure 1 or Interior panels.</p>	

The surface texture of panels can vary based on the grade of veneers used in the faces, the surfacing process during manufacture and the addition of other surface materials, such as resin saturated paper, plastics, hardboard or metals.

Panels with A, B, and C-Plugged faces will be largely solid. C and D grade faces will have voids in the face veneer.

Surface texture

- A** - Smooth, paintable. Not more than 18 neatly made repairs.
- B** - Solid surface. Repairs, and tight knots to 1”.
- C-Plugged** - Improved C veneer. Knotholes or other open defects limited to ¼” x ½”.
- C** - Tight knots to 1-1/2”. Knotholes to 1” across grain. Occasional 1-1/2” knothole.
- D** - Knots and knotholes to 2-1/2”. Occasional 3” knothole..

Available grades will either be smooth, such as sanded or touch sanded as with many underlayment grades, or left rough as found in sheathing grades.

Panels identified with two letters, such as A-C, A-B, and C-D, have those letter grade veneers on their face and back surfaces, respectfully.

Surface texture



In many applications rough, unrepaired surface panels can be used. These panels are commonly used as structural components that require limited appearance qualities.

Typical grades would be Rated Sheathing, C-C, or C-D.

Surface texture



Sanded Performance Panels have one or more surfaces with an A, B or C-plugged grade veneer. A and B grade veneers are sanded smooth. C-Plugged veneers are touch sanded which means there could be some irregularities in the smoothness of the surface.



Typical grades would be A-B, A-C, B-C and Underlayment (designed to provide a smooth underlayment surface for thin floor coverings).

Surface texture



Panels can be manufactured with a thin overlay material made from resin saturated paper, as well as plastics or fiberglass. These overlays provide the panel with extremely smooth and hard surfaces.

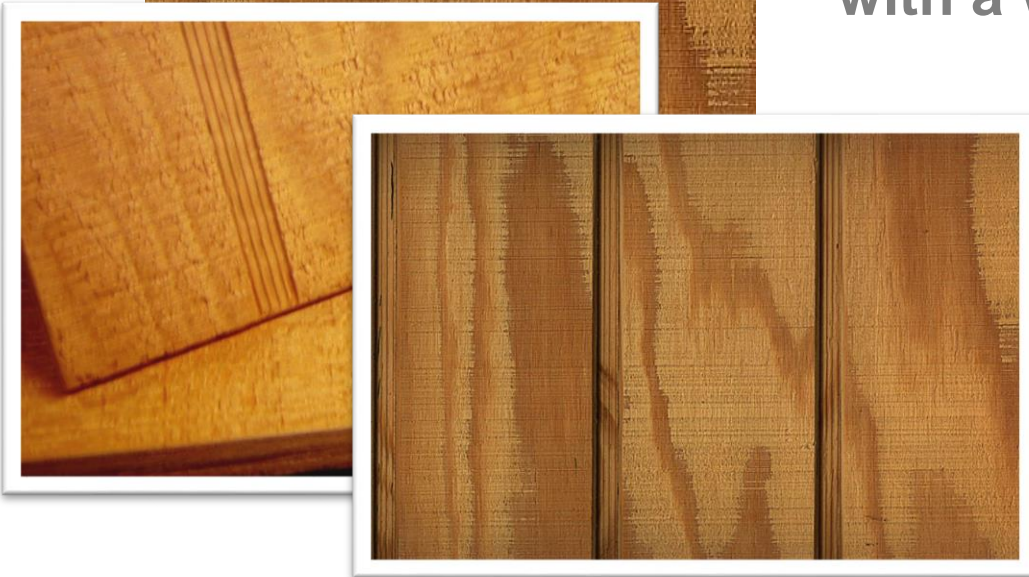


The resin saturated paper overlays are made in two types, Medium Density Overlays (MDO) and High Density Overlays (HDO). HDO overlays have a higher level of resin content, making the surface slicker and harder.

Surface texture



Performance Panels can even be manufactured with a rough or distressed texture as well as with a wide variety of grooves.



Surface texture

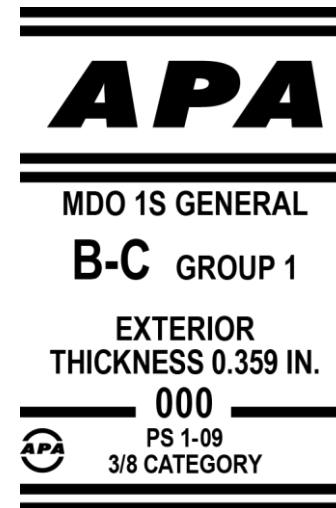
Typical APA trademarks



Rough/Sheathing



Smooth/Sanded



Overlay/MDO

Workability

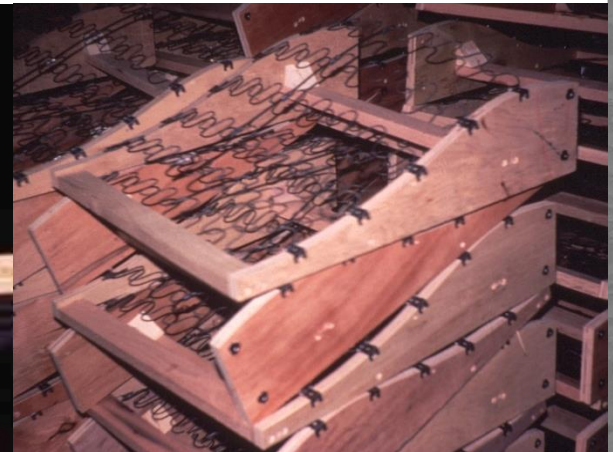
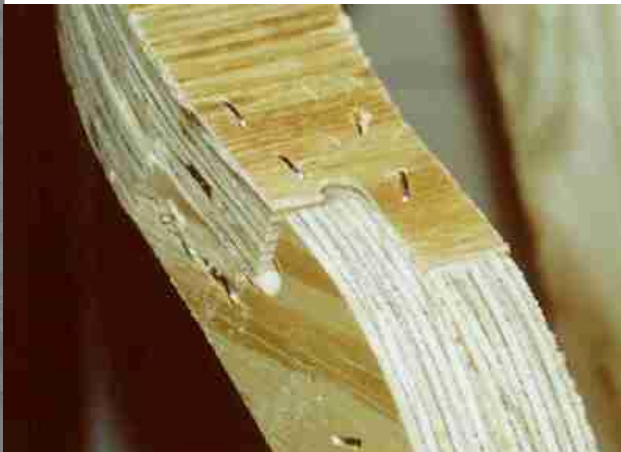


Performance panels can easily be shaped and sized to meet almost any dimensional requirement.

Saws, routers, sanders, drills and other commonly available tools easily cut and mill panels into required sizes and shapes.

Workability

Performance panels can be held in place with a variety and combination of fasteners. Common fasteners include nails, staples, screws, bolts, dowels, and many types of adhesives.



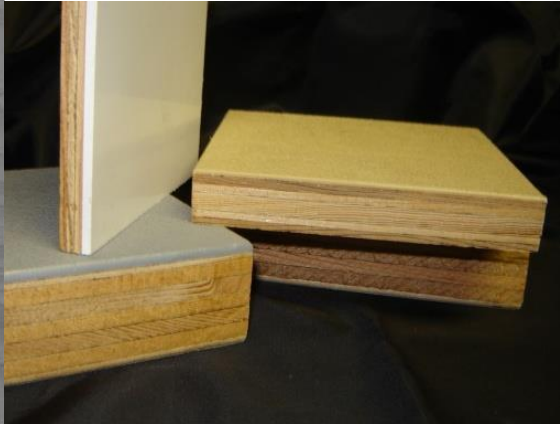
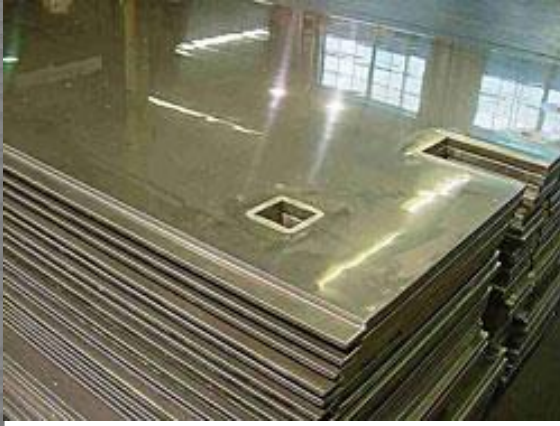
Workability



Bending, curving, notching. Performance Panels can be milled and shaped in many ways, while still retaining their structural capabilities.



Workability



Performance Panels are compatible with many other products and are commonly overlaid with materials in addition to resin saturated paper. These overlay products include metals, melamines, plastics and other polymers, such as fiberglass.

This process utilizes special resins to bond the overlays to the surface of the panels.

Workability



The upholstered furniture industry has embraced the functionality, performance and economy of Performance Panels.

The use of panels has allowed this industry to produce stronger and more innovative and unique furniture designs.

Relatively light in weight

There are times when both strength and light weight are desired in a component. Performance Panels have a high strength-to-weight ratio.

Panels are made from over 70 different species of wood. Group 1 woods are the strongest and densest wood species.

Table 1. Classification of Species

Group 1	Group 2	Group 3	Group 4	Group 5	
Apitong ^{(a)(b)}	Cedar, Port Orford	Maple, Black	Alder, Red	Aspen	Basswood
Beech, American	Cypress	Mengkulang ^(a)	Birch, Paper	Bigtooth	Poplar, Balsam
Birch	Douglas-fir 2 ^(c)	Meranti, Red ^{(a)(d)}	Cedar, Alaska	Quaking	
Sweet	Fir	Mersawa ^(a)	Fir, Subalpine	Cativo	
Yellow	Balsam	Pine	Hemlock, Eastern	Cedar	
Douglas-fir 1 ^(c)	California Red	Pond	Maple, Bigleaf	Incense	
Kapur ^(a)	Grand	Red	Pine	Western Red	
Keruing ^{(a)(b)}	Noble	Virginia	Jack	Cottonwood	
Larch, Western	Pacific Silver	Western White	Lodgepole	Eastern	
Maple, Sugar	White	Spruce	Ponderosa	Black (Western Poplar)	
Pine	Hemlock, Western	Black	Spruce	Pine	
Caribbean	Lauan	Red	Redwood	Eastern White	
Ocote	Almon	Sitka	Spruce	Sugar	
Pine, Southern	Bagtikan	Sweetgum	Engelmann		
Loblolly	Mayapis	Tamarack	White		
Longleaf	Red Lauan	Yellow Poplar			
Shortleaf	Tangile				
Slash	White Lauan				
Tanoak					

Relatively light in weight



The weight of Performance Panels is a function of the thickness and density, the species of wood, and the construction of the panel. Panels can vary in weight by 20% or more.

The manufacturer should be contacted for more specific information regarding the weight of panels.

Environmentally Friendly

Performance Panels are manufactured from a renewable resource – trees!

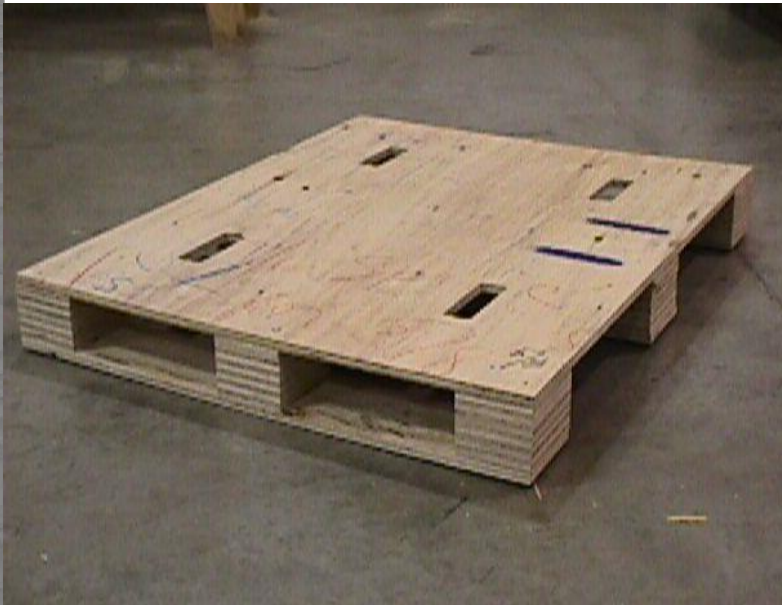
- **1/3 of the U.S. is forested**
- **27% more timber is grown than harvested**
- **Manufacturing wood panels consumes far less energy than the manufacture of steel, aluminum, glass or plastics**
- **Renewing our forests produces oxygen, absorbs carbon dioxide and creates a healthier environment**

Environmentally Friendly



Performance Panels have negligible formaldehyde emissions. Because formaldehyde levels associated with phenolic resin bonded products are so low, the U.S. Environmental Protection Agency (EPA) has exempted these products from all additional testing and certification requirements.

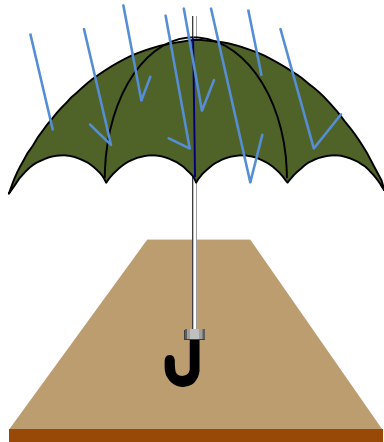
Environmentally Friendly



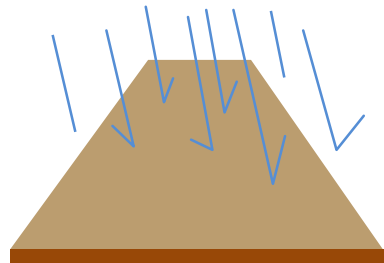
For packaging applications, Performance Panels are exempt from the requirements to further heat or chemically treat the wood under the **Guidelines for Regulating Wood Packaging Materials in International Trade (ISPM No. 15)**.



Durability



EXPOSURE 1



EXTERIOR

Performance Panels are made to last. The phenolic-based resins that bond the veneers and strands together are water resistant. However, panels are manufactured with different bond durability classifications. Exposure 1 type panels are designed to be exposed to moisture temporarily, such as during construction, while Exterior type panels can be exposed indefinitely.

Durability

The bond durability classification is found on the trademark of Performance Panels.

Performance Panels, which are exposed to high moisture, decay-prone environments, such as with boat seats, docks or decks, can be pressure treated with a preservative.



Durability



Performance Panels are impact and split resistant. The cross-lamination of plywood helps the panels distribute the impact loads throughout the panel. Plywood performs extremely well in high impact environments, such as in the materials handling industry.

Unique Features

A little wood science...

- Performance Panels have many unique features.
- Panels are dimensionally stable during temperature changes.
- The thermal resistance of panels, or R value, equals about .6 for 1/2" thick panels.
- Panels can be used effectively in environments where the temperature does not exceed 200° F.

Unique Features

A little wood science...

- Performance Panels are not a good conductor of electricity as long as the panels' moisture content is low.
- Panels have a permeability rate of 1 perm when exposed to low moisture levels.
- Panels have a unique capability to help control noise by both absorbing and reflecting sound.

Unique Features

A little wood science...

- Performance Panels are highly resistant to many chemicals. When the chemical reagent has a pH above 2 and below 10, the weakening effect on plywood is minimal with moderate exposure at room temperature.
- Panels with MDO or HDO overlays are even more resistant to chemicals.
- Plywood can be effectively pressure-preservative-treated and fire-retardant-treated.

Surface Durability



Performance Panels have varying degrees of wear resistance depending on the species of wood in the surface veneers and the construction of the panel.

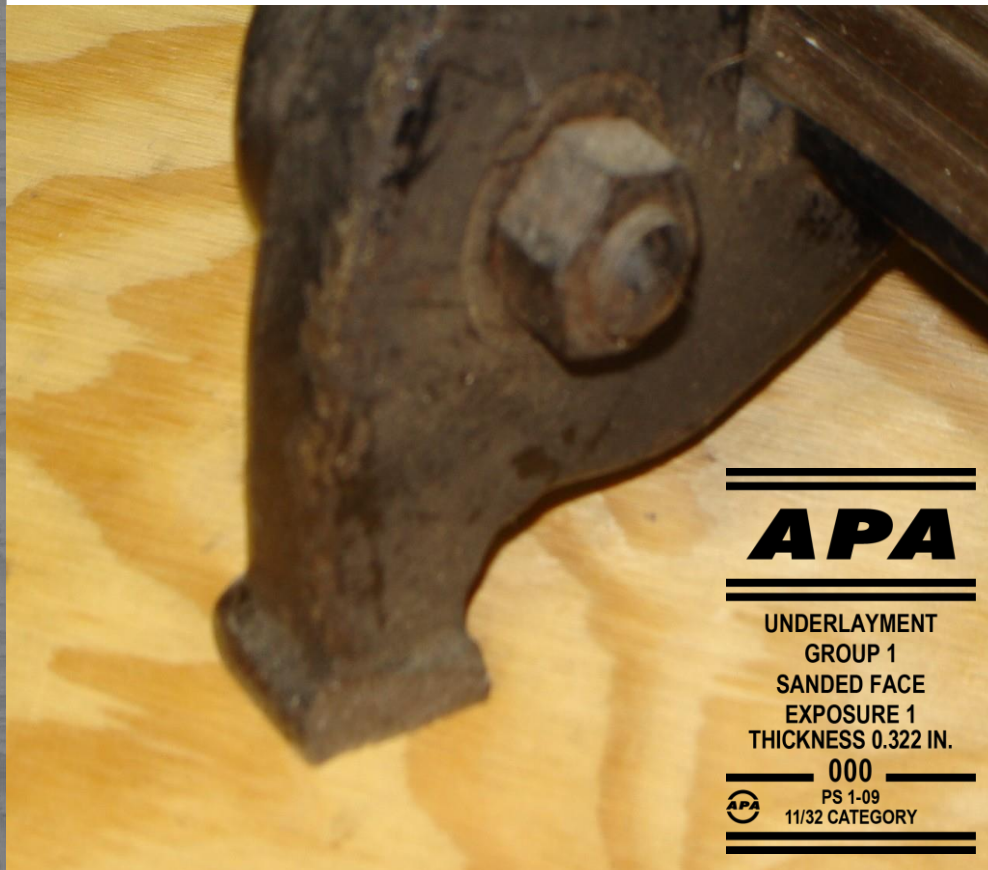
This type of application must be thoroughly evaluated to make sure that the surface veneer can handle the wear type and loads that account for the wearing and crushing forces.

Surface Durability



A common application for Performance Panels is for floors or decking material. If heavy loads are being moved over panels, such as on a mezzanine floor, panels with enhanced surfaces need to be considered. Such enhancements include poly and hardboard overlays.

Surface Durability



Underlayment grade panels are manufactured with a reinforced surface that is more puncture resistant and can better resist point loads on the face of the panel.

Underlayment grade will often be noted on the trademark.

Surface Durability



MDO and HDO overlays provide a durable surface to the panels. The overlays resist penetration from most chemicals and create a hard, slick finish that deflects impacts, such as when concrete is poured against the panels. These forming panels can be used for multiple pours.

Surface Durability



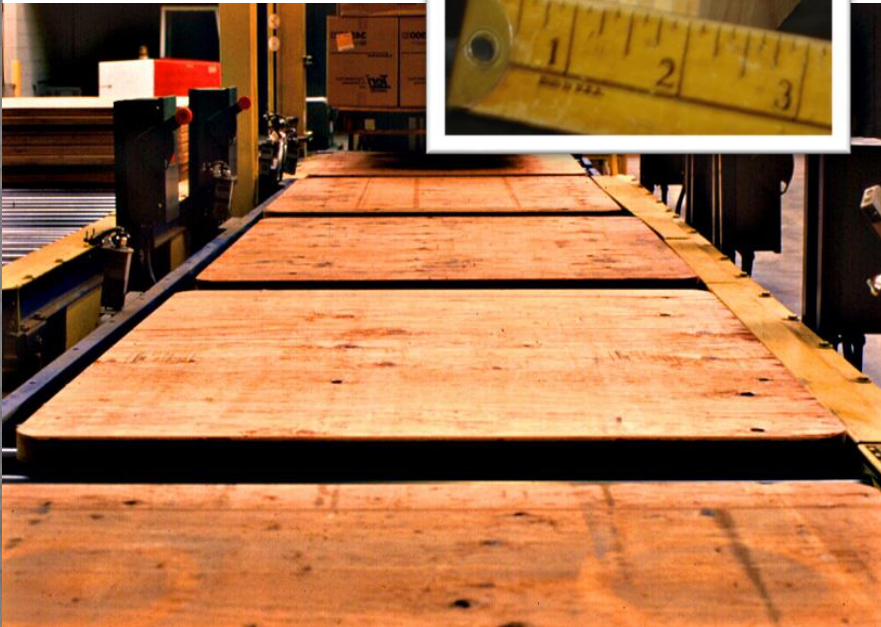
MDO and HDO overlaid panels can be made to receive paint. The surface is very smooth and conceals grain transfer when the panels are exposed to high moisture situations. Overlaid panels also resist wear from wind and weather.

Customization



Performance Panels can be manufactured in many different sizes. Plywood can be made in thicknesses up to 2-1/2" and more.

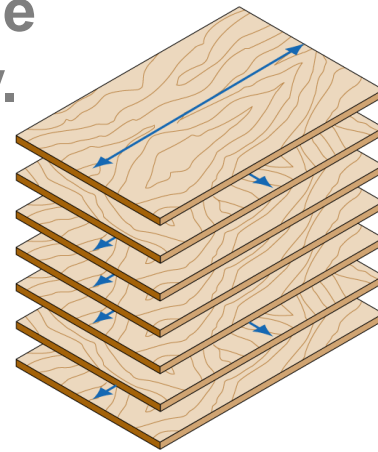
A common application for thick panels is for slave pallets that often support loaded pallets in automated storage and retrieval systems.



Customization

Performance Panels can be manufactured with varying lay-up of the plies. Shown below is a common custom ply arrangement that is used in the upholstered furniture industry.

These panels have tight core veneers and center plies that accommodate edge fastening with nails, staples and dowels.



**5-layer, 7-ply
(3 parallel center plies)**



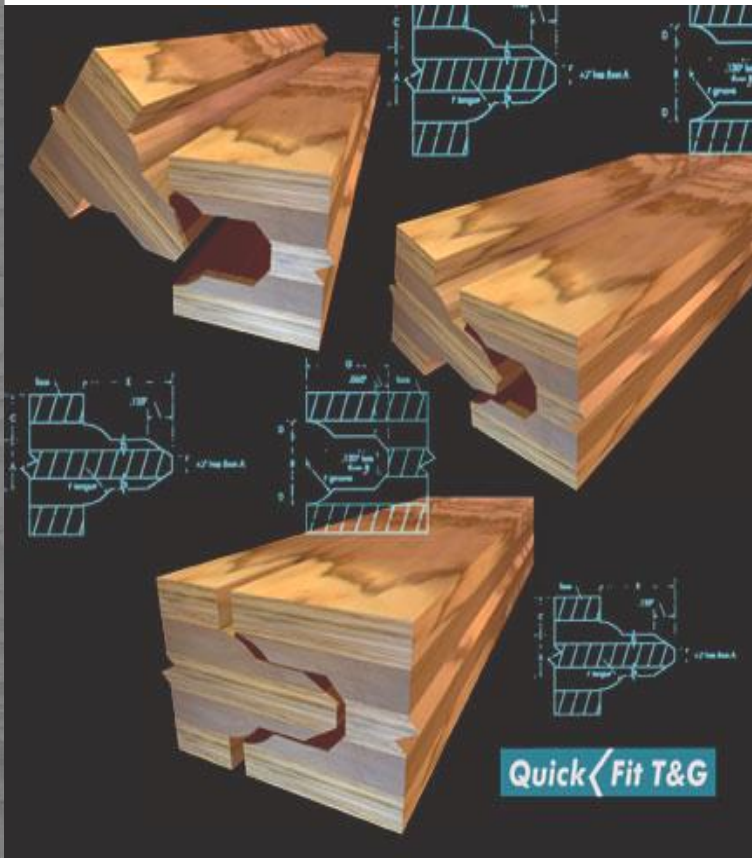
Customization



Plywood panels can be joined together at edges and ends with a process called scarf jointing, making the panels longer, wider or both.

Because OSB is produced in large mats, potential sizes are nearly unlimited.

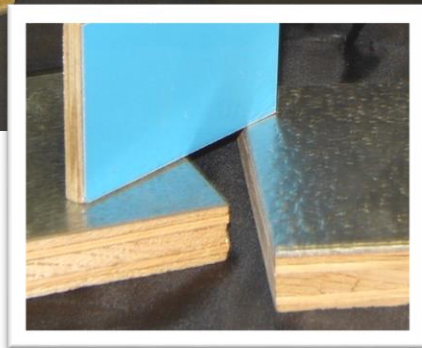
Customization



More than a custom feature, many Performance Panels are readily available with a tongue and groove milled into their long edges. The T&G joint supports the edges so that loads are transferred from one panel to the adjacent panel.

T&G joints can also be milled into the short edges of the panels or all sides if desired.

Customization

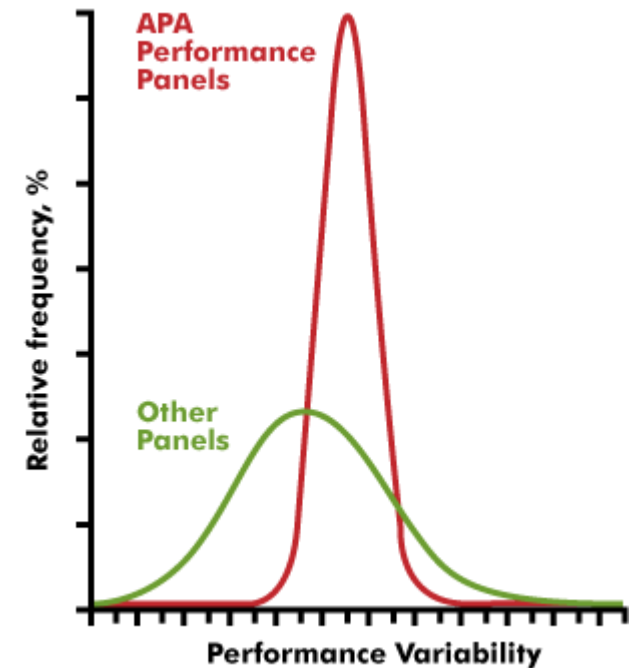


Performance Panels can be overlaid with many types of decorative or protective products, including plastics and other polymers, even metals. Typically these types of overlays are applied by secondary manufacturers that can be identified by the manufacturer of the Performance Panels. Non-overlaid, rough surfaces are also available.

Performance that you can count on

Less variance in:

- ✓ Performance capabilities
- ✓ Dimensions
- ✓ Supply and availability
- ✓ Yield



Application Review



Upholstered Furniture



Engineered Wood Pallet

Application Review



Retail Fixtures



Mass Transit Car Floors

Application Review



Truck Trailer Liner



Painted Furniture

Application Review



Boats



Component Parts

Application Review



Reels



Bus Floors

Application Review



Concrete Forming - MDO



BB Plyform

Application Review



Institutional Cabinets



Slave Pallets

Application Review



Recreational Vehicles



Industrial Shelving

Application Review



Commercial Furniture



Containers and Crating

Application Review

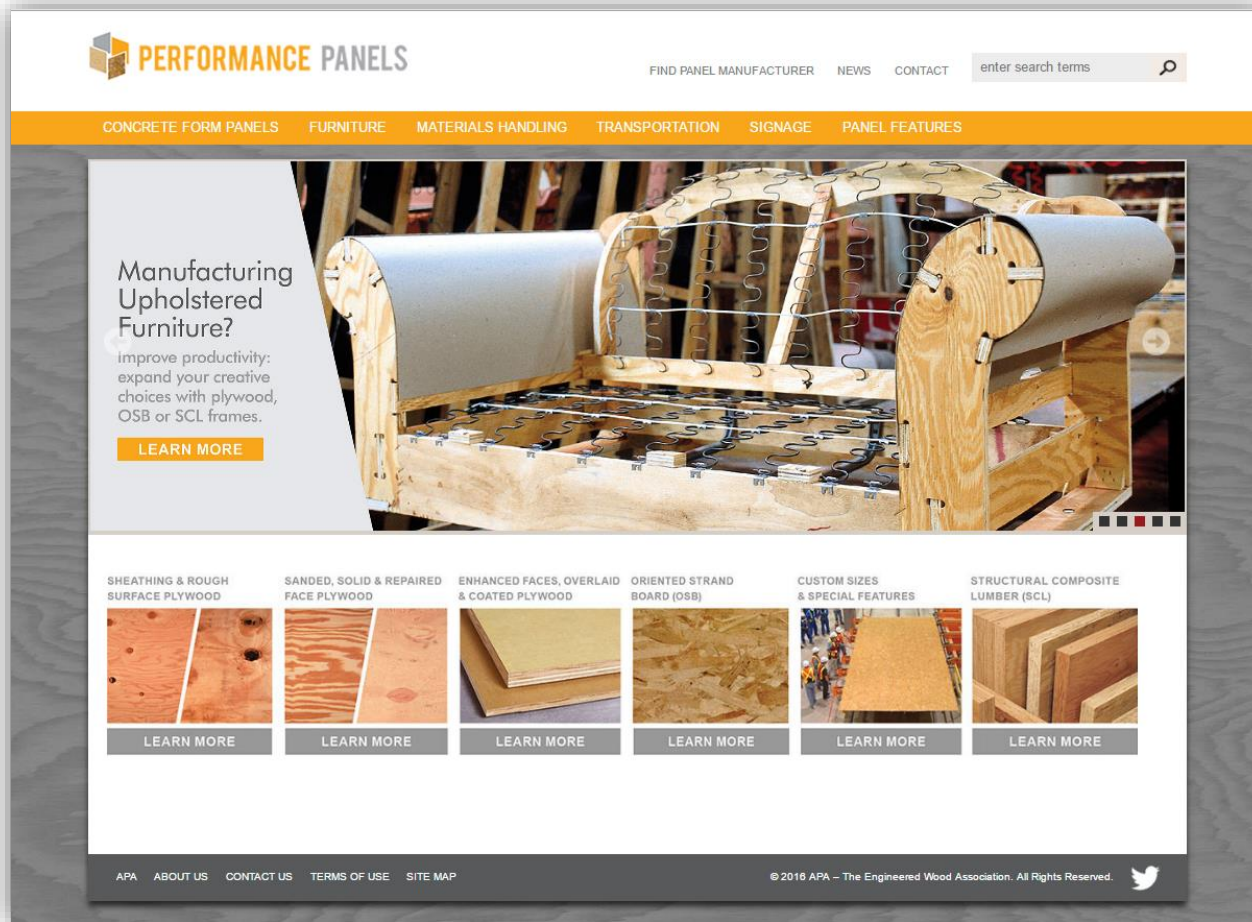


Agricultural Bins



Traffic Signage

For more information, visit PerformancePanels.com



The screenshot shows the Performance Panels website homepage. At the top left is the logo. To the right are navigation links: FIND PANEL MANUFACTURER, NEWS, CONTACT, and a search bar with the text "enter search terms". Below this is an orange navigation bar with links: CONCRETE FORM PANELS, FURNITURE, MATERIALS HANDLING, TRANSPORTATION, SIGNAGE, and PANEL FEATURES. The main content area features a large image of a wooden chair frame with springs and upholstery. To the left of this image is a text block: "Manufacturing Upholstered Furniture? Improve productivity: expand your creative choices with plywood, OSB or SCL frames." Below this is a "LEARN MORE" button. Below the main image is a grid of six product categories, each with a small image and a "LEARN MORE" button: SHEATHING & ROUGH SURFACE PLYWOOD, SANDED, SOLID & REPAIRED FACE PLYWOOD, ENHANCED FACES, OVERLAID & COATED PLYWOOD, ORIENTED STRAND BOARD (OSB), CUSTOM SIZES & SPECIAL FEATURES, and STRUCTURAL COMPOSITE LUMBER (SCL). At the bottom is a footer with links: APA, ABOUT US, CONTACT US, TERMS OF USE, SITE MAP, and a copyright notice: © 2016 APA – The Engineered Wood Association. All Rights Reserved. There is also a Twitter icon.

Photo Credits

Olympic Panel – slides 37, 42, 48, 60 and 73