Panelized Roofs

PROVEN PERFORMERS

APA
THE ENGINEERED
WOOD ASSOCIATION

WOOD
The Natural Choice

Engineered wood products are a good choice for the environment. They are manufactured for years of trouble-free, dependable use. They help reduce waste by decreasing disposal costs and product damage. Wood is a renewable, recyclable, biodegradable resource that is easily manufactured into a variety of viable products.

A few facts about wood.

▪ ***We're growing more wood every day.*** Forests fully cover one-third of the United States' and one-half of Canada's land mass. American landowners plant more than two billion trees every year. In addition, millions of trees seed naturally. The forest products industry, which comprises about 15 percent of forestland ownership, is responsible for 41 percent of replanted forest acreage. That works out to more than one billion trees a year, or about three million trees planted every day. This high rate of replanting accounts for the fact that each year, 27 percent more timber is grown than is harvested. Canada's replanting record shows a fourfold increase in the number of trees planted between 1975 and 1990.

▪ ***Life Cycle Assessment shows wood is the greenest building product.*** A 2004 Consortium for Research on Renewable Industrial Materials (CORRIM) study gave scientific validation to the strength of wood as a green building product. In examining building products' life cycles – from extraction of the raw material to demolition of the building at the end of its long lifespan – CORRIM found that wood was better for the environment than steel or concrete in terms of embodied energy, global warming potential, air emissions, water emissions and solid waste production. For the complete details of the report, visit www.CORRIM.org.

▪ ***Manufacturing wood is energy efficient.*** Wood products made up 47 percent of all industrial raw materials manufactured in the United States, yet consumed only 4 percent of the energy needed to manufacture all industrial raw materials, according to a 1987 study.

Material	Percent of Production	Percent of Energy Use
Wood	47	4
Steel	23	48
Aluminum	2	8

▪ ***Good news for a healthy planet.*** For every ton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbon dioxide.

Wood: It's the natural choice for the environment, for design and for strong, lasting construction.

Panelized wood roofs have been used in commercial construction on the West Coast for more than 40 years, and are becoming increasingly popular in other parts of the U.S. and Canada. Easily adaptable to many designs, wood roof systems are particularly well suited to buildings with low slope roofs. The proven erection efficiency and performance of a panelized wood deck provides significant cost and performance advantages.

The most common panelized wood roof options include the all-wood panelized roof system and the hybrid panelized roof system.

The ***all-wood panelized roof system*** *is anchored by long-span glued laminated timber framing. Builders and designers choose this system for its strength, fast and easy erection and simple, workable connections. Engineered wood is also readily available. This system provides significant cost savings by eliminating the need for steel assembly crews.*

The ***hybrid panelized roof system*** *combines the long spans of steel framing with the proven erection efficiency and performance of a panelized wood roof deck. In the hybrid system, panelized wood components are connected to open web steel joists.*

Tilt-up concrete walls are commonly used in conjunction with the panelized wood roof systems, although reinforced masonry walls are also an option.

DEFINING PANELIZED WOOD ROOFS

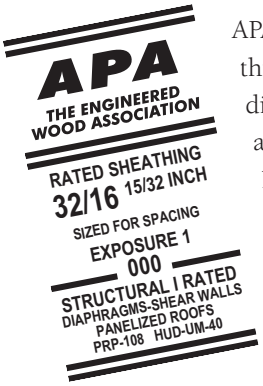
In panelized wood roof construction, wood structural panels are attached to 2x4 or 2x6 dimension lumber sub-purlins or "stiffeners," typically spaced 24 inches o.c. The stiffeners are attached to secondary wood framing members, referred to as purlins. This work is done on the ground level and only one or two workers are needed to complete the assembly sequence on the roof. This minimizes the potential for falls and increases safety on the job site. The photo below shows the assembly of one of these pre-framed sections.

The entire pre-framed panelized unit is then lifted into position at the roof level using high-lift capacity forklifts. In the all-wood system, the purlins are attached to the primary glulam beams using pre-engineered metal hangers. The free edge of the wood decking for each panelized unit is nailed to the framing edge of the previously placed unit. Pre-framed panel ends attached to the main glulam beams complete the assembly. The pre-framed roof sections speed the erection process and add strength, dimensional stability, and high diaphragm capacity to the roof.

In the hybrid system, these panelized wood components are connected to open web steel joists with wood nailers. The entire panelized unit is assembled on the ground and then lifted into position at the roof level, where the steel joists are welded or bolted to primary steel trusses. The free edge of the wood decking for each panelized unit is nailed to the framing edge of the previously placed unit. Preframed panel ends attached to the main steel trusses complete the assembly.

Structural Panels

APA Rated Sheathing or APA Rated Structural I sheathing is recommended for the structural decking. Panels are installed with their long dimension parallel to the stiffeners that support panel edges. The wood panel sheathing acts as a diaphragm element that resists and transfers lateral loads from wind or earthquakes. Panel thickness and fastening schedules are determined by gravity loads, the required shear load capacity and the wind uplift resistance needed. The lumber stiffeners are designed to resist gravity loads and to function as the supporting elements for the wood sheathing. The nailed connections that are used in the panelized system simplify design calculations.



APA Rated Sheathing, typically plywood or oriented strand board (OSB), is available in a variety of thicknesses and span ratings. OSB panels are manufactured in sizes up to 8x24 feet. These large-dimension panels reduce the amount of perimeter fastening required and speed construction. For additional information on wood structural panels, refer to *APA Engineered Wood Construction Guide,* Form E30.

APA Rated Sheathing is manufactured by members of APA and bears the APA trademark on each panel. The trademark is the manufacturer's assurance that the product conforms to the standard shown on the trademark.

Glulam Beams

In some roof designs, the main glulam beams are designed as cantilevered systems to optimize structural performance. Both single- and double-cantilevered beams are used depending on bay spacings and building geometry. Cantilevered beams are specified as balanced lay-up combinations, such as 24F-V8 Douglas-fir or 24F-V5 southern pine.

Another popular design uses simple-span glulam girders, spanning column-to-column, in 30- to 60-foot lengths. Unbalanced combinations, such as 24F-V4 Douglas-fir or 24F-V3 southern pine, can be specified. Simple-span girders are recommended for their ease of installation and their ability to be used with seismic connectors.

Glulam beams manufactured by APA members bear the *APA EWS* trademark, signifying that the manufacturer is committed to a rigorous program of quality verification and testing and that products are manufactured in conformance with ANSI Standard A190.1, American National Standard for Structural Glued Laminated Timber or with a manufacturer's building code evaluation report.

Purlins in All-Wood Roofing System

The secondary wood framing members, or purlins, are placed 8 or 10 feet o.c. These purlins may take many forms depending on the spacing between the main glulam beam lines and designer or owner preference. Narrow, resawn glulam beams that are 2-1/2 inches wide and 18 to 27 inches or greater in depth are one option.

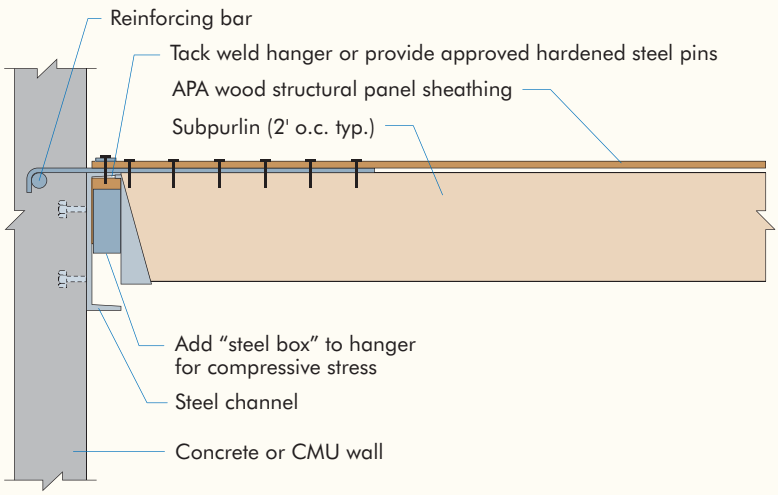
For glulam beam spacings of approximately 40 feet or less and relatively light roof design loads, pre-fabricated lightweight wood I-joists, or "I-purlins," are an economical purlin alternative. I-purlins can be specified for an 8 or 10 feet o.c. application. They can have depths up to 30 inches, depending on the span and loading conditions. They are highly cost competitive and minimize the use of wood fiber through their structurally efficient shape. The photo above shows the use of I-purlins in a panelized roof. One of the advantages of using I-purlins is the ability to cut holes in the webs for mechanical duct work, wiring and sprinkler lines.

Another purlin alternative is a glulam truss composed of glulam chords and webs that are interconnected with heavy metal gusset nail plates. When spaced 8 feet o.c., these trusses allow the designer to use larger column grid spacings between the main glulam beams. Pre-framed panelized sections of up to 72 feet in length are feasible with these laminated truss purlins. This enables a contractor to erect a roof unit of over 500 square feet in one lifting sequence.

Regardless of the purlin system used, these large panelized units are assembled more quickly and easily on the ground, enabling construction crews to complete large commercial roof framing projects in much less time and with lower construction costs than traditional all-steel systems. In addition, it reduces labor time on the roof decks, improving job site safety.

FIGURE 1

SUBPURLIN-TO-WALL CONNECTION



ALTERNATIVE CONNECTION

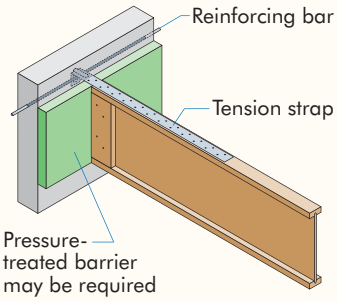
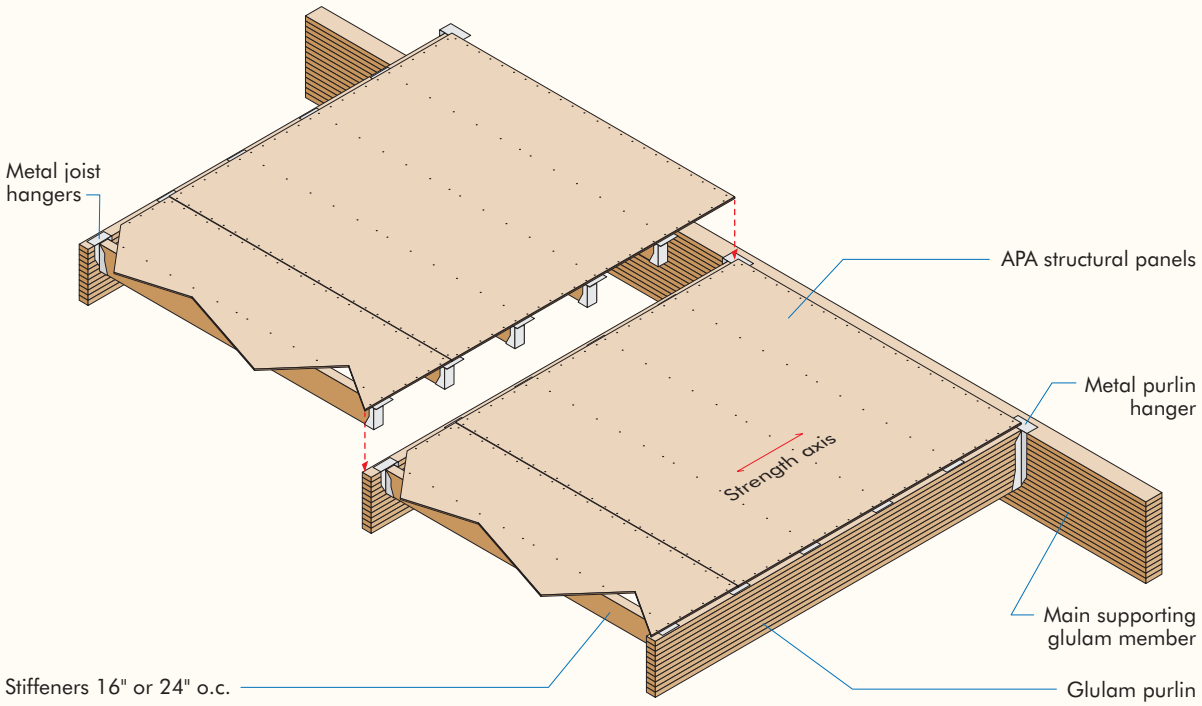


FIGURE 2

WOOD PANELIZED ROOF SYSTEM
(8' x 8' or larger — APA Structural Panel Strength Axes Perpendicular to Supports)



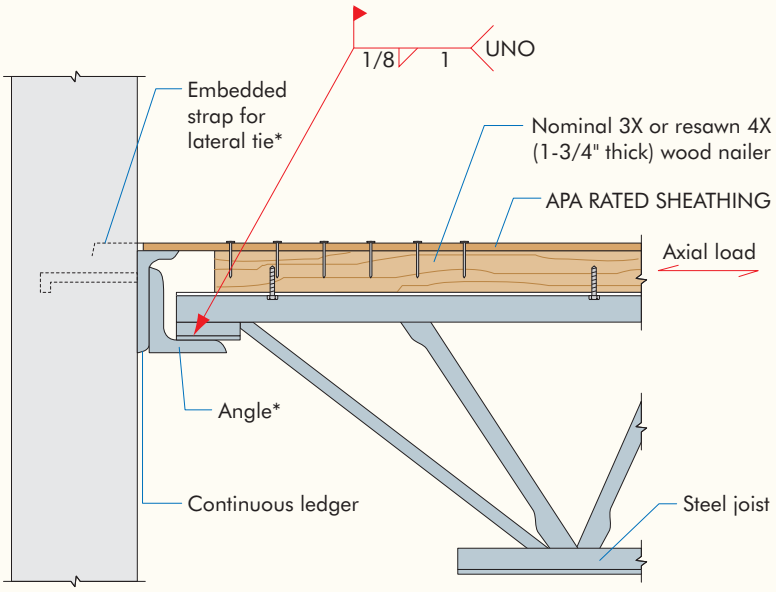
Steel Joists

Steel joists in the hybrid panelized system are typically placed 8 feet o.c. The panelized units can be prefabricated with lengths up to 72 feet or greater depending on the ability to design and handle larger units. This enables a contractor to erect a roof unit over 500 square feet in one lifting sequence.

Specifications for the steel joists and main steel trusses used in framing the hybrid system should be in accordance with Steel Joist Institute (SJI) recommendations. Due to the relatively long spans involved, bracing to avoid lateral buckling is a key design consideration for these components, particularly during the erection sequence.

FIGURE 3

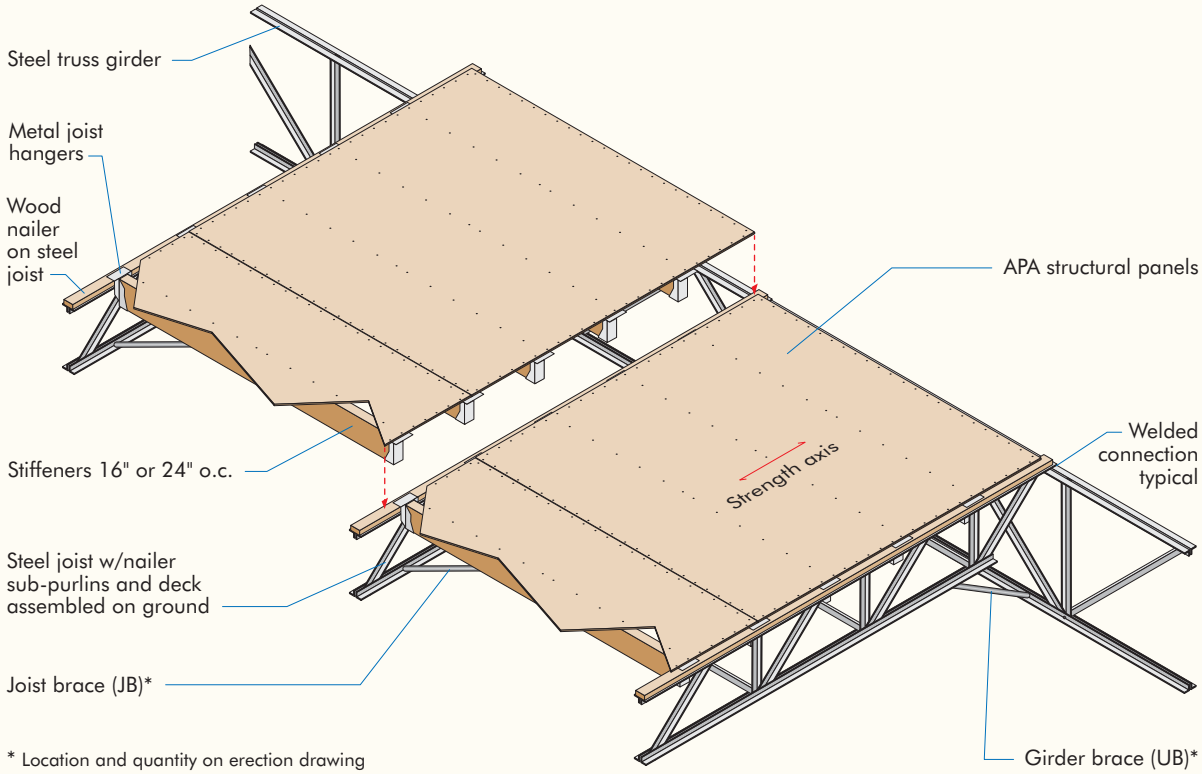
EXTERIOR LOAD BEARING WALL



* To be sized by engineer of record

FIGURE 4

HYBRID PANELIZED ROOF SYSTEM
(8' x 8' or larger — APA Structural Panel Strength Axes Perpendicular to Supports)



* Location and quantity on erection drawing

Connectors

Virtually all of the connectors used in the panelized roof system are available "off the shelf" from a number of suppliers. These range from the nail-on 2x4 or 2x6 stiffener hangers to the more complex cantilever hinge connectors for the main glulam beam lines. The availability of pre-engineered hangers greatly simplifies the specification and installation of the entire system. The panelized roof system is connected to the walls through the use of wood or steel ledgers. Additional tie plates and straps may be required depending on lateral load design requirements. The photos below illustrate these pre-engineered metal connectors. Other engineered connectors for low-slope roofs are given in the APA brochure, *Lateral Load Connections for Low-Slope Roof Diaphragms,* Form Z350.

WIND UPLIFT

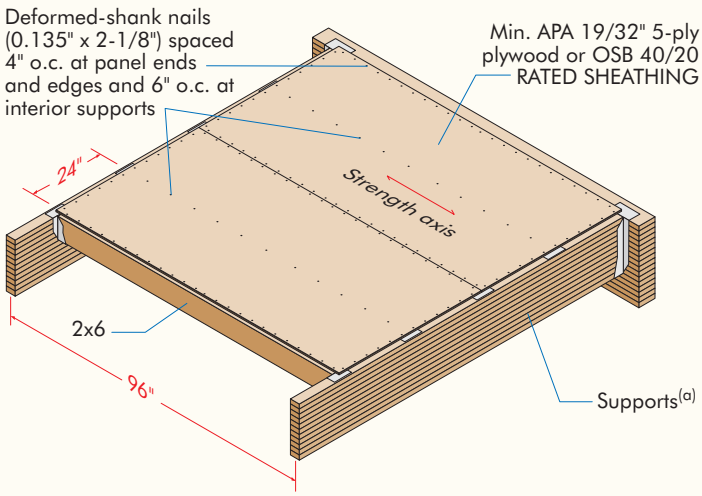
Wood structural panels provide a solid substrate to which the built-up or modified bitumen roofing is applied. When adequately attached to supports and other roofing layers, plywood and OSB contribute to one of the most solid and stable roof systems available.

For the hybrid system, diaphragm shear capacity and wind uplift requirements are important considerations when specifying the attachment of the wood nailer to the top chord of the steel joists. The nailer, which is typically attached to the joist with bolts or screws, makes it possible to connect the wood stiffeners and wood structural panels to the joists with standard nailing techniques. The nailer attachment laterally supports the top chord of the steel joist and transfers horizontal shear and wind uplift forces.

Figure 5 illustrates a panelized roof system that meets the panel attachment requirements for the FM Class 1-135 Windstorm Classification. For additional information on designing panelized roofs to withstand wind uplift, see APA's publication, *Wind-Rated Roofs*, Form G310.

FIGURE 5

FM CLASS 1-135 WITH ARMA ROOF COVERING[b]



(a) Design in accordance with local building code requirements for roof loads and anchorage. All framing must be minimum net thickness of 1-1/2 inches No. 2 Douglas-fir or southern pine or equivalent. For wood I-joists, follow manufacturer's recommendations for minimum nail spacing.

(b) To install panels with strength axis parallel to supports spaced 24" o.c., as illustrated, see minimum panel requirements listed in Table 2 of APA publication, *Wind-Rated Roofs,* Form G310.

Airaid Filter Warehouse, Phoenix, AZ

All-Wood Panelized Wood Roof System

When it came time for Airaid Filter, a company specializing in high performance air filters, throttle body spacers and intake systems, to build a larger warehouse to accommodate the company's growth, owner John Levitz chose an all-wood roof system.

"This was less expensive with the cost of steel at the time," said Levitz. "The insurance premium was also lower. In case of fire, wood structural systems survive intense heat, where steel is known to buckle and repair costs are higher."

Completed in 2005, the 51,500-square-foot warehouse included 15/32-inch Stuctural-I OSB. The pre-framed panels, which were constructed on the ground and then lifted into position using a scissor lift, were attached to glulam purlins ranging in sizes of 2-1/2 x 30 inches x 48 feet, and 2-1/2 x 25-1/2 inches x 40 feet (24F-V4/DF). Glulam beams were used for the warehouse columns, some measuring 12-1/4 x 12 inches and others 12-1/4 x 15 inches.

Photo courtesy of The Structures Group.

The primary framing system was also constructed of glulam beams, which ranged in size from 5-1/8 x 24 inches to 6-3/4 x 39 inches (24F-V4/DF and 24F-V8/DF). The beams spanned distances of 24 and 60 feet. The building's roof structure cost $4.85 per square foot (installed cost).

Pier 1 Distribution Center, Dupont, WA

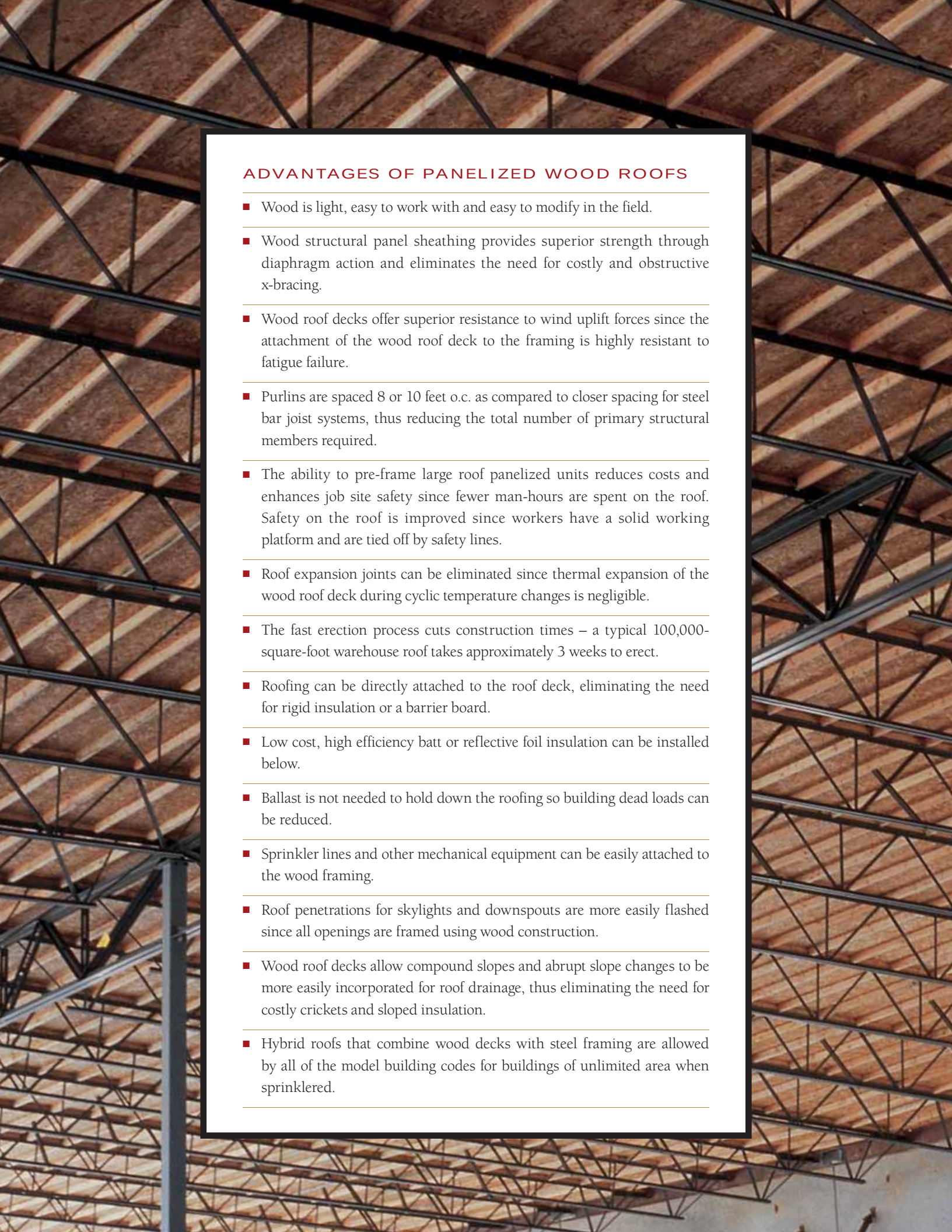
Hybrid Panelized Wood Roof System

Pier 1 Imports, a retail chain offering customers casual home furnishings and décor, chose the hybrid panelized wood roof system for its new distribution center in Dupont, Wash., completed in early 2006.

"The hybrid system was much more efficient, which also resulted in lower cost," said Mike Nelson, roof erection contractor and vice president of Wood-lam Structures. "Utilizing the hybrid system means the building is erected faster and is much, much safer. Instead of the conventional way and having workers 40 feet in the air, you have modulars on the ground; so instead of 20 workers on the roof deck, we end up with only two or three. So safety is a big advantage," he added.

The 450,000-square-foot building used steel columns and SJI steel joist purlins. APA trademarked PS 1-95 1/2-inch x 4-foot x 10-foot panels were used for the roof panels, which were lifted into position using 10,000-pound reach forklifts and man lifts. The grids were spaced 50 x 52 feet. The building's roof structure cost $4.50 per square foot (installed cost).

Photo courtesy of Wood-lam Structures, Inc.



ADVANTAGES OF PANELIZED WOOD ROOFS

- Wood is light, easy to work with and easy to modify in the field.
- Wood structural panel sheathing provides superior strength through diaphragm action and eliminates the need for costly and obstructive x-bracing.
- Wood roof decks offer superior resistance to wind uplift forces since the attachment of the wood roof deck to the framing is highly resistant to fatigue failure.
- Purlins are spaced 8 or 10 feet o.c. as compared to closer spacing for steel bar joist systems, thus reducing the total number of primary structural members required.
- The ability to pre-frame large roof panelized units reduces costs and enhances job site safety since fewer man-hours are spent on the roof. Safety on the roof is improved since workers have a solid working platform and are tied off by safety lines.
- Roof expansion joints can be eliminated since thermal expansion of the wood roof deck during cyclic temperature changes is negligible.
- The fast erection process cuts construction times – a typical 100,000-square-foot warehouse roof takes approximately 3 weeks to erect.
- Roofing can be directly attached to the roof deck, eliminating the need for rigid insulation or a barrier board.
- Low cost, high efficiency batt or reflective foil insulation can be installed below.
- Ballast is not needed to hold down the roofing so building dead loads can be reduced.
- Sprinkler lines and other mechanical equipment can be easily attached to the wood framing.
- Roof penetrations for skylights and downspouts are more easily flashed since all openings are framed using wood construction.
- Wood roof decks allow compound slopes and abrupt slope changes to be more easily incorporated for roof drainage, thus eliminating the need for costly crickets and sloped insulation.
- Hybrid roofs that combine wood decks with steel framing are allowed by all of the model building codes for buildings of unlimited area when sprinklered.

ABOUT *APA – THE ENGINEERED WOOD ASSOCIATION*

APA – The Engineered Wood Association is a non-profit trade association of and for structural wood panel, glulam timber, wood I-joist, laminated veneer lumber, and other engineered wood product manufacturers. Based in Tacoma, Washington, APA represents approximately 150 mills throughout North America, ranging from small, independently owned and operated companies to large integrated corporations.

Always insist on engineered wood products bearing the **mark of quality** – the APA or *APA EWS* trademark. Your APA engineered wood purchase is not only your highest possible assurance of product quality, but an investment in the many trade services that APA provides on your behalf. The Association's trademark appears only on the products manufactured by member mills and is the manufacturer's assurance that the product conforms to the standard shown on the trademark.

For more information on panelized roofs

apawood.org – Visit APA's web site to read more on the benefits of panelized wood roofs or to find a product manufacturer.

Visit the APA Member and Product Directory for a list of manufacturers who produce the glulam, laminated truss purlins, I-purlins and wood structural panels used in panelized wood roof construction.

Panelized wood roof systems can be designed for wind uplift resistance. Download APA publications, *Wind Rated Roofs,* Form G310; *Lateral Load Connections for Low-Slope Roof Diaphragms,* Form Z350; and other related publications, including project case studies at apawood.org/publications.

srea.org – Find a roof erector, panelized wood roof examples, helpful industry links and more on the Structural Roof Erectors Association web site.

We have field representatives in many major U.S. cities and in Canada
who can help answer questions involving APA trademarked products.
For additional assistance in specifying engineered wood products, contact us:

APA – THE ENGINEERED WOOD ASSOCIATION

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