Panelized STRUCTURES

safety | innovation | experience

Construction of Large Low-slope Roofs: Faster, Safer, Lower Cost

Presentation for:

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WoodWorks Wood Products Council

Overview

- History
- What is a Panelized Roof?
- The Erection Methods
- Typical Details
- Some Favorable Characteristics of the Panelized Roof
- Where the System can be used.

History:

Wood has been the prevalent roof structure material for commercial and industrial buildings in the Western states. Initially, these roofs were labor intense, 'hand framed' structures.

Around 1955-56, a panelized roof system was started by Berkeley Plywood. The first panelized roofs consisted of Glulam beams spaced at 20' centers (usually running a span of 40'), with 4x12 purlins running perpendicular to the glulam at 8'-0" o.c.. In between these purlins, a ground assembled panel consisting of 2X4 sub-purlin (or stiffeners) at 24" o.c. to which a sheet of plywood was attached and stacks of these paenls where lifted to the roof.

At roof level, two carpenters place these panels between the 4x12 purlins . Simpson Company (now Simpson Strongtie) was instrumental in developing the connecting hardware (F-hangers) for the system. Labor savings were greatly increased.

In time, the spans of the glulam beams began to stretch out eventually reaching the 60' plus spans. The hinge connectors developed by Simpson Company and cantilevered glulam beam system made this possible. The cantilevered system reduced the depth of the glulam which contributed to the economics of the system. The timber purlin went to 24' between the glulams. The stiffeners placed at 24" o.c. remained both 2x4 and 2x6. ½" structural plywood, with gain running parallel to the stiffeners, now became the norm.

Mill saws were developed that could precision cut 5-1/8" down to 2-1/2" wide members. These 2-1/2" wide purlins began to replace the 4x solid sawn members. This allowed the main glulam carrying members (girders) to be spaced further apart with a 60' x40' grid becoming common practice.

As glulam and plated truss technology developed the 8' o.c. purlin was now replaceable with a long span plated wood truss often using a laminated upper and lower chords. Other highly stressed members in the plated truss were also laminated. This allowed for more wood volume to be taken from the system thus reducing the cost.

When the spotted owl dilemma closed the national forest to public sales and logging, the cost of wood products sky-rocketed. It was than that Panelized Structures challenged Vulcraft Steel Joist Company with an idea of replacing the glulam girders with open web steel girders and replacing the wood purlin with a wood 'nailer' on the open web steel truss. Thus began the birth of the "Hybrid" Panelized Roof System.

What is a panelized roof?

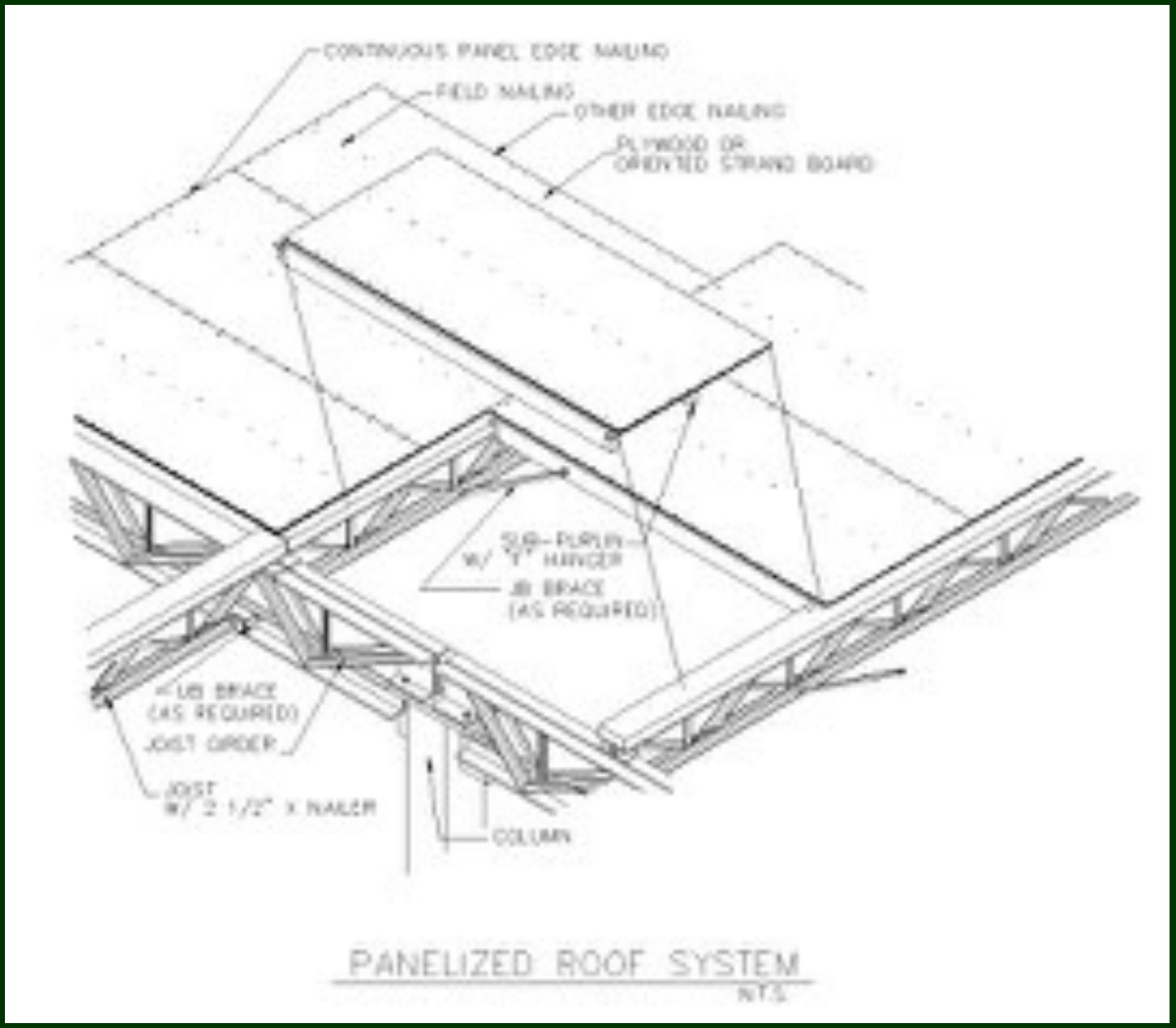
Girders:
Glulam or steel girders spanning column to column

Purlin or joist:
Solid sawn timber, glulam purlin, I sections, plated trusses, open web steel josts, at 8' to 10' o.c.

Sub purlin (or stiffeners):
2x4 or 2x6 typically at 24" o.c.
3x or 4x stiffeners are used in heavily nailed diaphragm areas.

Sheathing:
1/2" (15/32) or 5/8" (19/32) thick structural sheathing (OSB or plywood) with 1/8" gaps between adjoining panels to allow for any moisture driven post erection swelling that may occur

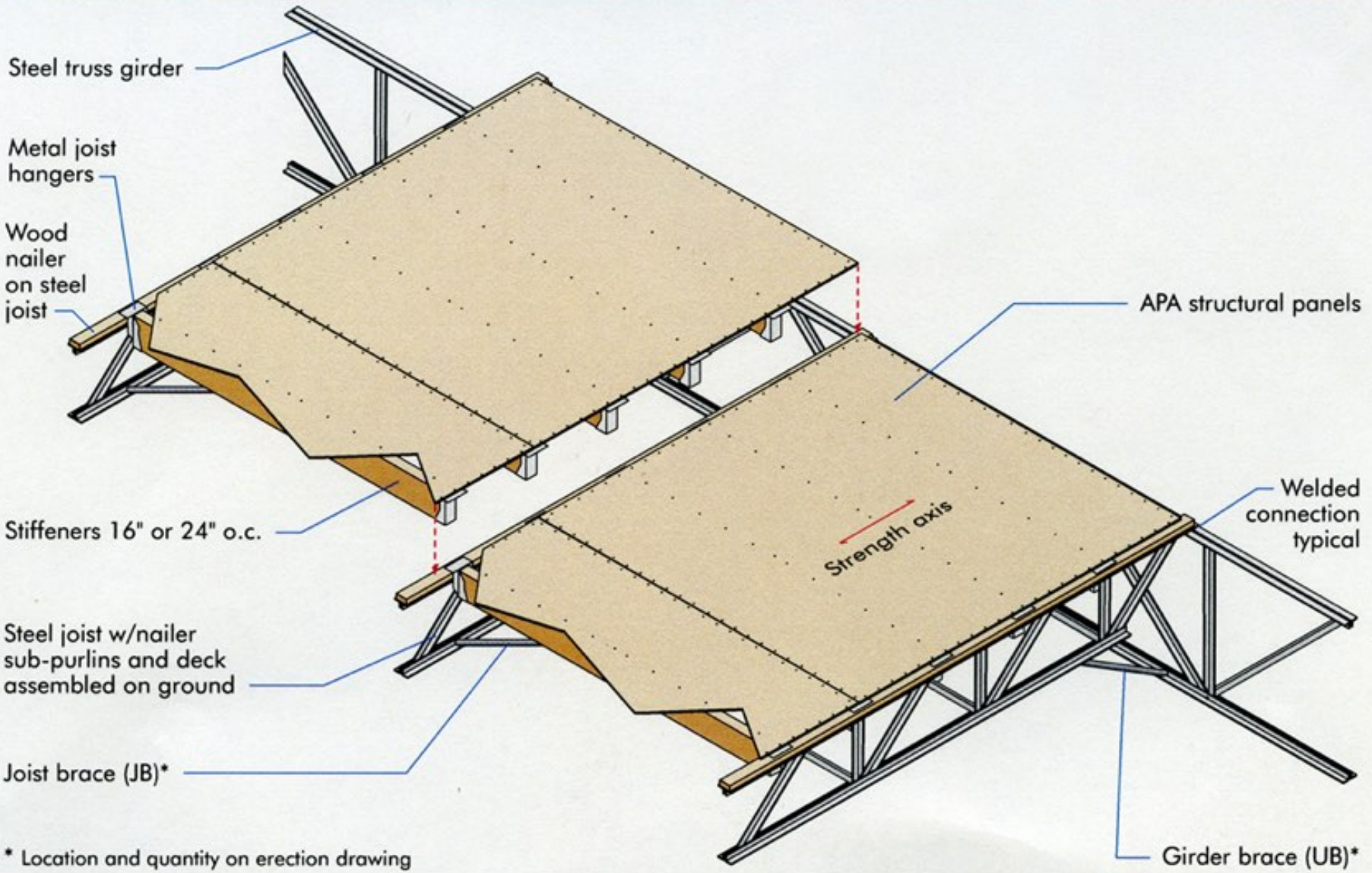
Connecting hardware:
'Simpson' type hardware is commonly used



PANELIZED ROOF SYSTEM

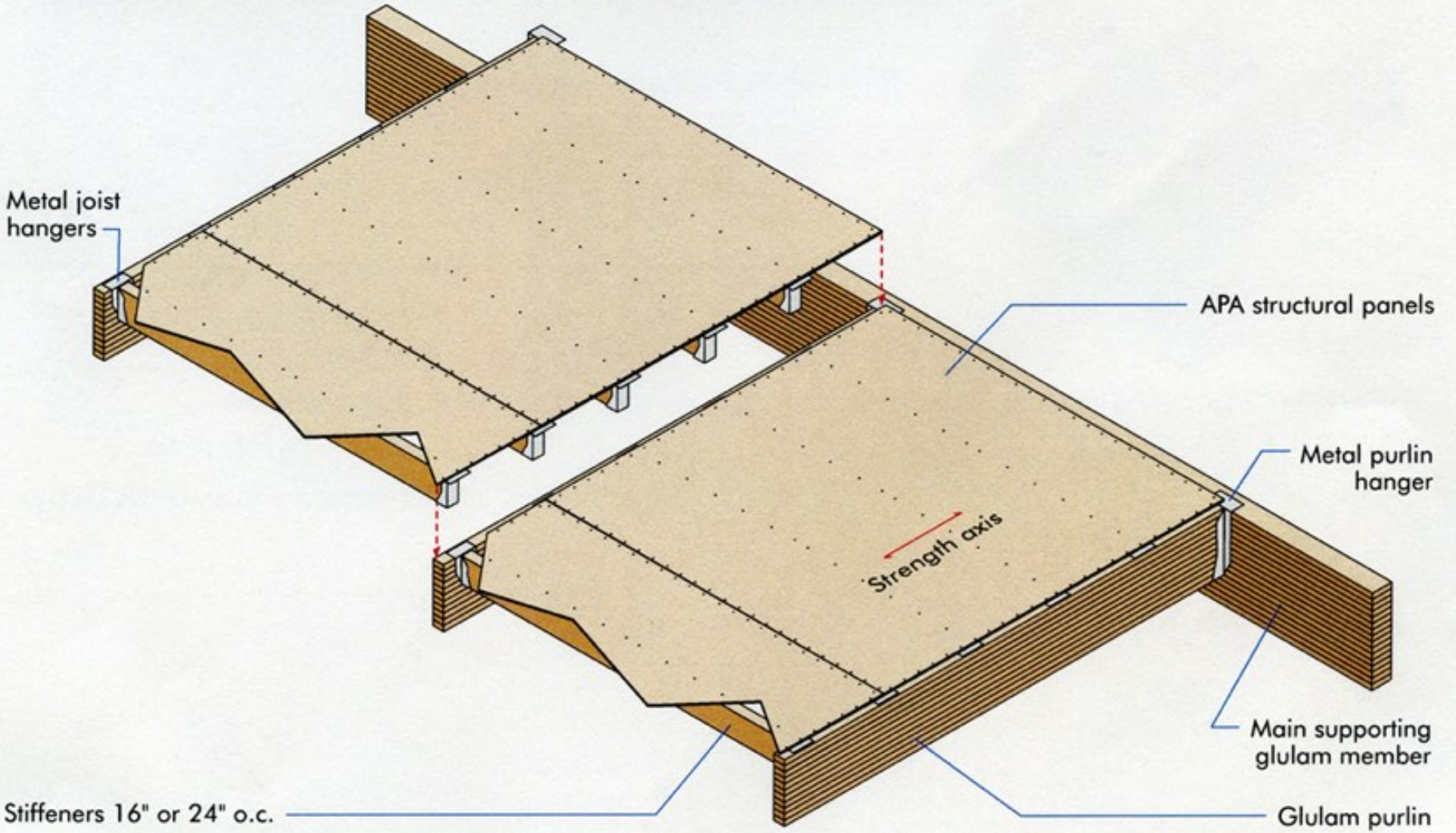
N.T.S.

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



* Location and quantity on erection drawing

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

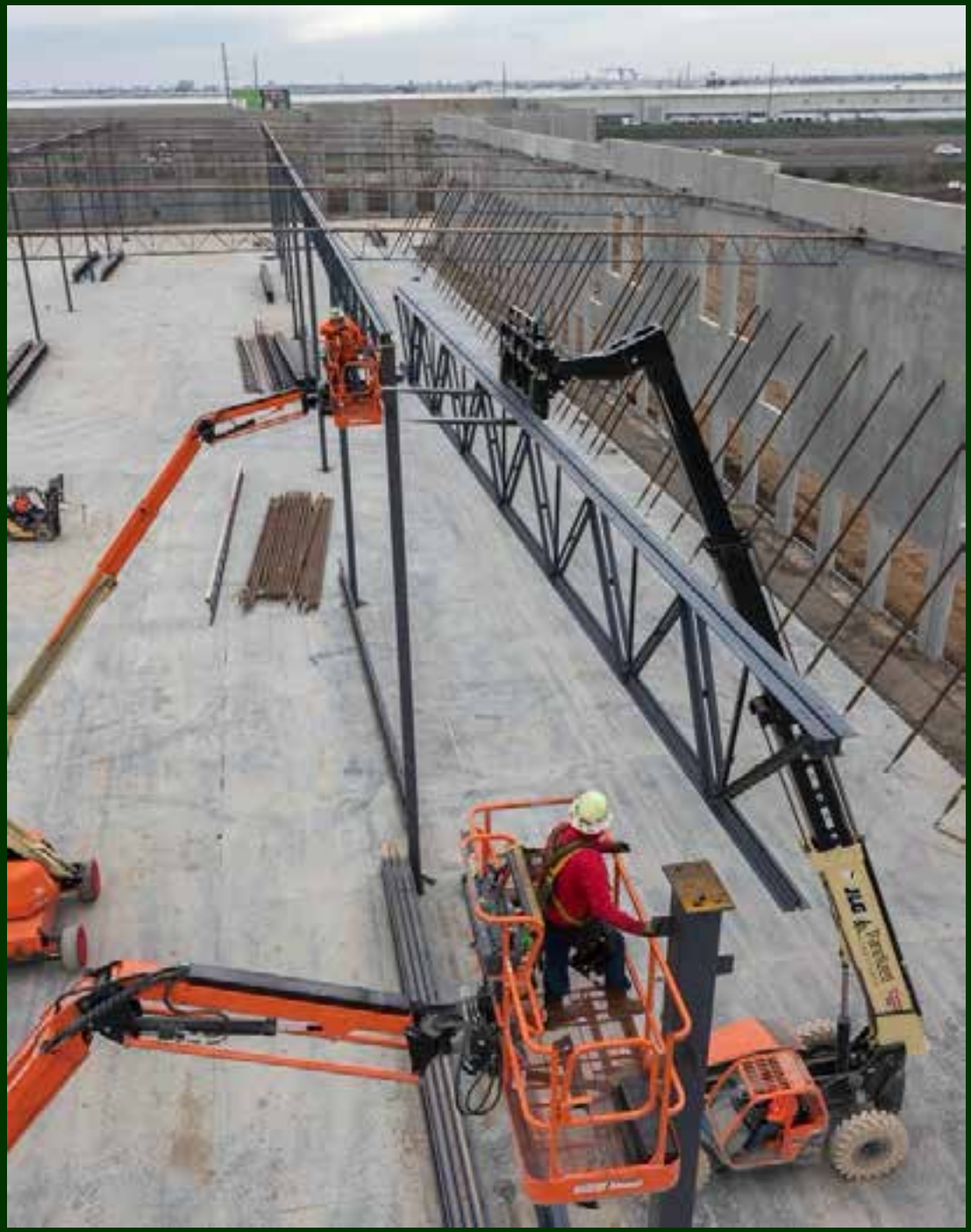


Erection Methods

Columns, supporting Glulams or SJI steel girders, are erected and braced per OSHA Standards with 'tie-trusses'.

Large panels of either 8' or 10' by bay length spacing are assembled on the ground using the purlin or open web joist. Usually a 5-6 man crew works the ground assembly area. Typically the length of the panels are 40' to 60'. These are 'erection' nailed only (this allows movement of sheathing to conform to elevation changes in roof system). Roof penetrations (sky lights and RTUs) are framed as part of the on-ground assembly process.

The large panels are lifted into place using forklifts with engineered spreader bars to properly support the large panel edge during erection process.
As each large panel is erected, it is securely fastened by nailing wood members and welding steel members. Lifting equipment must not be removed until each large panel is securely fastened into the roof structure. Typically only a two man crew is needed to join the large panels together at roof level.
When a sizable section of roof is erected (~50,000 sq. ft.) the 'nailer' crew (using pneumatic nail guns) will complete the nailing process.
To protect against adverse affects from delays due to of large amounts of rain, it is recommend that roof membrane be applied as quickly as possible following directly behind the completed roof structure sections.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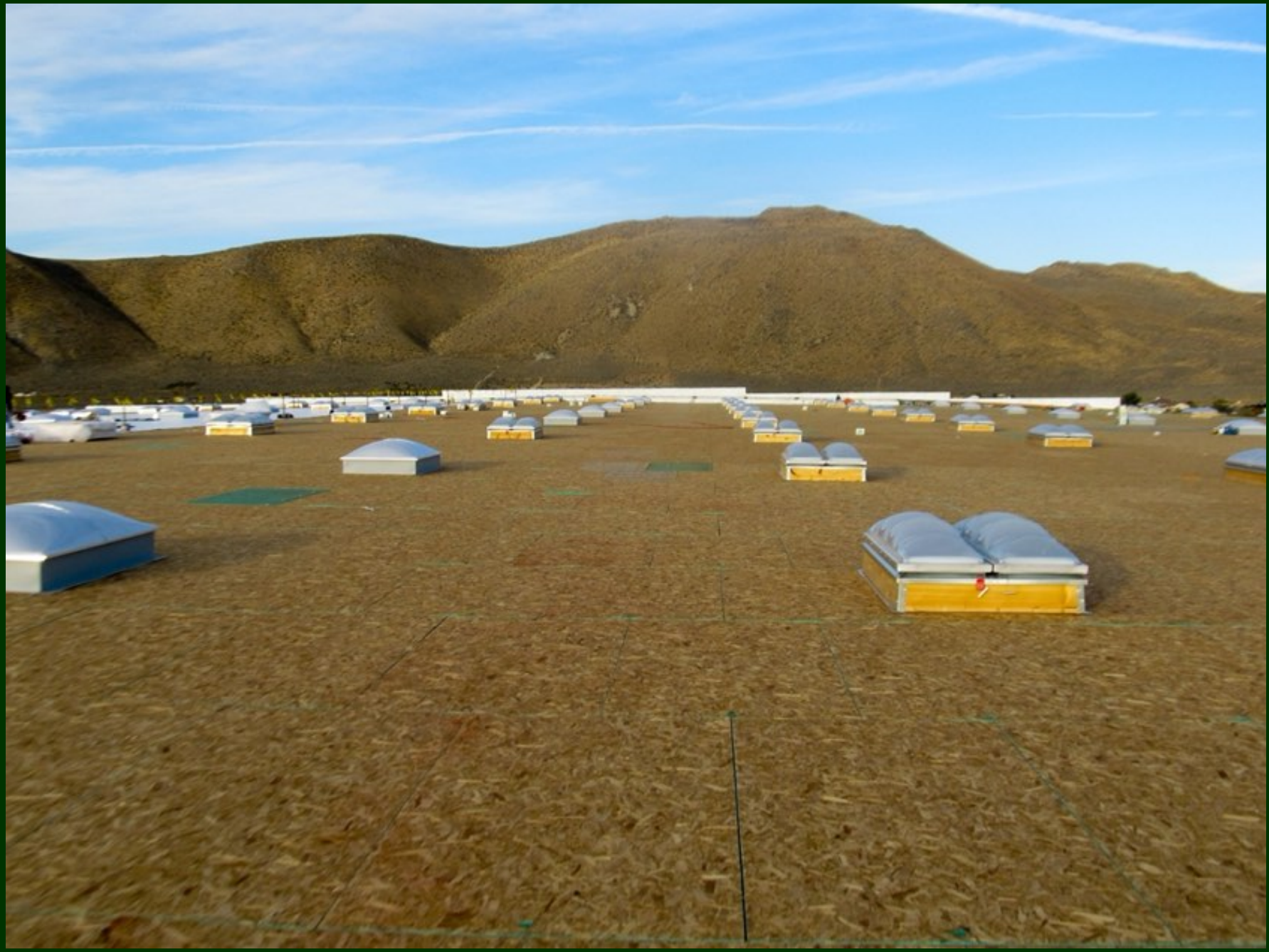


Typical Details


19 8:52 AM


19 8:52 AM


HERMASTRAND
HERMASTRAND
HERMASTRAND
HERMASTRAND


YOUNGSTOWN

Favorable characteristics of the panelized roof

Speed, Value & Safety

Time of erection

One crew can easily erect 20,000 sq. ft. of roof structure each day. Time and again the completed (ready for roof membrane) 20,000 sq. ft. of erected roof structure has been accomplished. On larger building, where space allows the use of several crews, 60,000 sq. ft. of structure has been erected. An example is 2.2 million sq. ft. in L.A. area erected in less than 7 weeks – over 60k sq ft per day

Floor space free of construction prefab debris during erection process and sub trades can move in quickly

When the roof system is erected, the construction floor space is uncluttered during the construction process. Only the space under the erection area is off limits to other trades. Once these areas are erected, other trades can move in and underneath to do any roof attached work. Fire protection, HVAC, electrical and other trades need not wait (no sparks flying or hot slag dropping).

Advantages of the “Hybrid” Roof

- The fast erection process cuts construction times - a typical 100,000 square foot warehouse roof takes approximately 2-3 weeks to erect.
- The panelized method reduces labor 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.
- Expensive Double-Frame structural expansion joints can be eliminated since thermal expansion of the wood roof deck during cyclic temperature changes is insignificant.

No expansion joints

2500' long buildings have been erected with no structural expansion joints.
This eliminates the need for double brace frames on these larger buildings

Advantages of the "Hybrid" Roof

- Open-web steel joists are spaced eight to ten feet on center, reducing the total number of joists required while offering effective fire sprinkler coverage. Sprinkler lines and other mechanical equipment can be attached to the steel framing or wood.
- Roof penetrations for skylights and roof drains are more easily flashed since all openings are framed using wood construction.
- Wood roofs allow compound slopes and abrupt slope changes to be more easily incorporated for roof drainage, thus eliminating the need for costly crickets or sloped insulation.
- Hybrid roofs that combine wood diapragms with steel framing are allowed by all of the model building codes for buildings of unlimited area with sprinkler systems.
- Wood roofs offer excellent resistance to wind uplift forces since the attachment of the wood panels to the framing is highly resistant to fatigue failure.

Roof members can be warped to achieve drainage at walls

- No crickets needed.

Attachments to roof system for other trades is simplified with wood roof members.

Simple lags screws or nails are used to attach to wood members.

High FM Wind uplift rating

A 135 mph FM rated wind up lift rating has been assign to the panelized wood roof system.

TABLE 1

WIND SPEEDS AND PRESSURES[1]

Maximum Wind Velocity (mph, 3 second gust)	Roof Corner Uplift Design Pressure (psf)	Required FM Rating
85	33	1-75
90	37	1-75
100	45	1-90
110	55	1-120
120	65	1-135

[1] Exposure B, enclosed structure, Zone 3 of a flat roof, height 30 feet.

TABLE 2

MINIMUM WOOD STRUCTURAL PANEL REQUIREMENTS FOR PANELIZED ROOF SYSTEMS (Panel Strength Axis Parallel to Supports)[1]

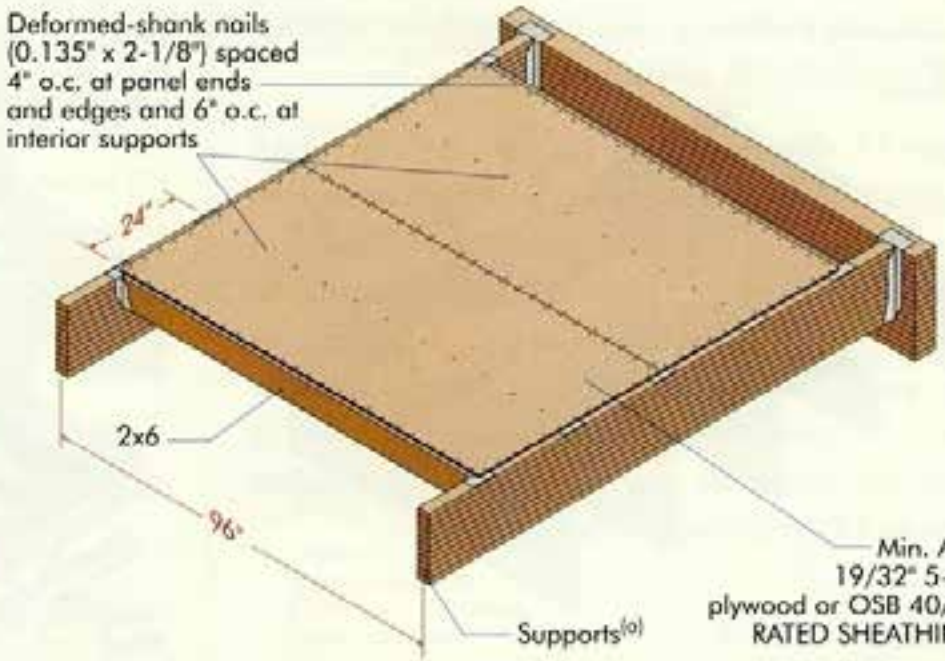
FM Class[2]	Minimum Panel Thickness (in.) and Span Rating	Additional Requirements
1-60	15/32 – 32/16	5-Ply Plywood or OSB
1-75	15/32 – 32/16	5-Ply Plywood or OSB
1-90	19/32 – 40/20	4-Ply Plywood or OSB
1-105	19/32 – 40/20	5-Ply Plywood or OSB
1-120	19/32 – 40/20	5-Ply Plywood or OSB
1-135	19/32 – 40/20	5-Ply Plywood or OSB

[1] Minimum thickness is critical due to fastener holding requirements. For additional cross-panel strength, stiffness and fastener-holding capacity without additional thickness, specify APA Structural I Rated Sheathing.

[2] Based on roof corner uplift design pressures from the IBC and ASCE 7-05 for Enclosed, Exposure B and roof height 30 feet.

FIGURE 10

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.

Figure 10 illustrates a panelized roof system that meets the panel attachment requirements for the various FM Windstorm Classifications.

Heights & Areas of Type V-b Buildings with "Hybrid" Roofs

One Story Buildings with Hybrid Roofs can have heights up to 60' and the area is unlimited

<u>Allowable Heights</u>
Table 503 shows 40' max for Type V-b bldgs. + 20' for sprinklers per 504.

504.2 Automatic sprinkler system increase. Where a building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1, the value specified in Table 503 for maximum height is increased by 20 feet (6096 mm) and the maximum number of stories is increased by one.

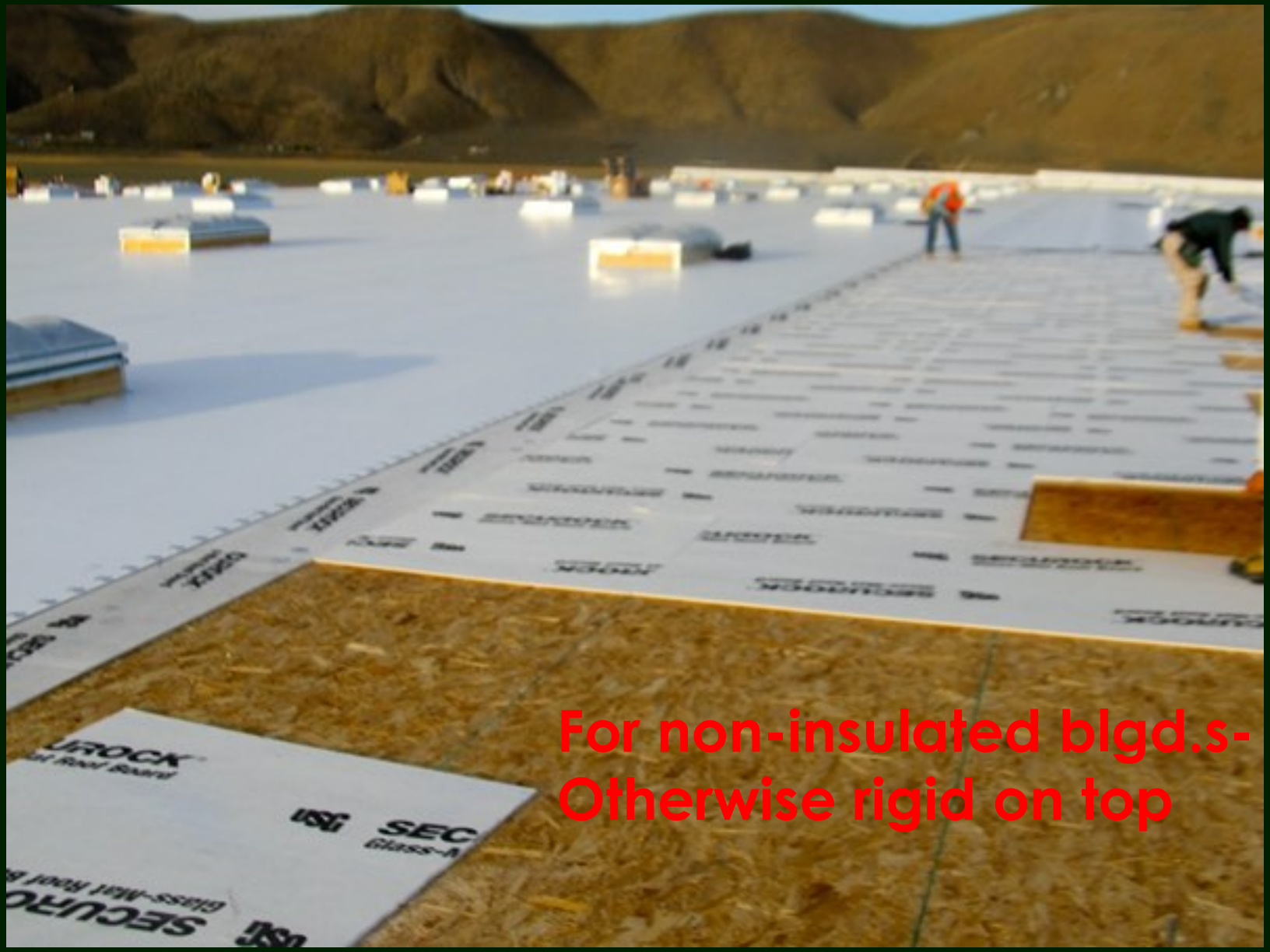
<u>Allowable Area</u>
IBC Section 507.3 permits the area of a one-story, Group B, F, M or S building to not be limited when the building is provided with an automatic sprinkler system throughout in accordance with Section 903.3.1.1 (NFPA 13) and is surrounded and adjoined by public ways or yards not less than 60 feet in width.

Safe erection methods

A 100% tie off procedure is used during the erection process. 80% of the construction process takes place on the ground only 20% at roof levels. Tie-off anchors installed at strategic locations on the large panels to which each worker must connect while working the leading edge. There is no shaking out and 'hand-laying' deck like other systems. Panelized erection used throughout the construction process.

Safety

Roof membrane can be attached directly to sheathing using a thin dens deck or softening sheet.



The "Hybrid" Roof and High Diaphragm Loads

These wood roof diaphragms can resist 1800plf shear loads as shown in the NDS and SDPWS

WOOD

TABLE 2306.3.1(2)
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL BLOCKED DIAPHRAGMS UTILIZING MULTIPLE ROWS OF FASTENERS (HIGH LOAD DIAPHRAGMS) WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE[1] FOR WIND OR SEISMIC LOADING[2,3,4]

PANEL GRADE[5]	COMMON NAIL SIZE OR STAPLE[6] GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER AT ADJOINING PANEL EDGES AND BOUNDARIES[8]	LINES OF FASTENERS	BLOCKED DIAPHRAGMS					
						Cases 1 and 2[9]					
						Fastener Spacing Per Line at Boundaries (inches)					
						6		4		2	
						Fastener Spacing Per Line at Other Panel Edges (inches)					
						6	4	4	3	2	2
Structural I grades	8d	1 1/4	5/16	2	2	565	805	870	1,150	—	—
				3	2	700	915	1,005	1,330	—	—
				4	3	870	1,220	1,345	1,500	—	—
				2	2	635	880	965	1,275	—	—
				3	2	780	1,095	1,210	1,600	—	—
				4	3	965	1,350	1,485	1,700	—	—
			7/16	2	2	730	1,025	1,130	1,505	—	—
				3	2	905	1,270	1,400	1,700	—	—
				4	3	1,125	1,580	1,740	1,700	—	—
	10 gage wire	1 1/2	5/16	2	2	620	870	960	1,275	1,700	1,700
				3	2	770	1,080	1,190	1,585	1,700	1,700
				4	3	955	1,340	1,475	1,700	1,700	1,700
			7/16	2	2	690	970	1,070	1,425	1,700	1,700
				3	2	860	1,205	1,325	1,700	1,700	1,700
				4	3	1,065	1,495	1,645	1,700	1,700	1,700

The "Hybrid" Roof Structure is ***Green***

- open-web trusses are made from recycled steel.
- lumber comes from managed forests, where companies are planting more trees than they are harvesting.
- OSB is produced from faster growing northern species, not old growth coastal, making good use of the forest resource.

Green!

Carbon foot print very low.

Green Building/LEED

Energy and Atmosphere

EA Credit 1: Optimize Energy Performance

This point will be enhanced by the use of a radiant barrier such as Thermastrand or Polar Ply. A percentage improvement in the building performance by using radiant barrier O.S.B. can be achieved with less lighting required.

Material & Resources

MR Credit 2.1 and 2.2: Construction Waste Management

Points are garnered by simply separating the wood cut-offs and steel waste into recycling bins that are provided by the general contractor.

MR Credit 7: Certified Wood

This credit is based on a *minimum* of 50% of the total dollar cost for all wood products used in the roof structure (the wood nailer on the joists is excluded). These materials must be provided by an FSC certified lumber or O.S.B. sheathing manufacturer. Any combination of O.S.B. and lumber to achieve that percentage can be used.

Longevity

Buildings erected in the 50s are still functional today! The owner of Panelized Structures built some of them. Solid and working as designed for over 50 years!

Value

It makes dollar sense!

Since the inception of the Hybrid roof structure system, the cost has consistently been less than the all steel system.

White walls, sky lights and foil faced sheathing virtually eliminate the need for lighting

These low-slope (‘flat’) roofs are perfect for solar panel use saving more dollars (electricity)

Where can the system be used?

Warehouses

Retail stores

Office floor and roof

Bulk & Ag Storage

Food Processing

Wine Industry

Manufacturing

Auto Dealerships

Covered Sports Centers

Etc.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PSI's home office – two story, tilt wall bldg


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DP DERMODY PROPERTIES
Customers
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HONDA
E&J Gallo Winery
FRANZIA
ProLogis
TRADER JOE'S
PETCO
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DELICATO FAMILY VINEYARDS
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Ford
WinCo FOODS
kraft foods
SAVE MART SUPERMARKETS
PANATTONI
PORT of WEST SACRAMENTO
CVS pharmacy
TARGET
THE HOME DEPOT
ups
TSC TRACTOR SUPPLY Co
7UP
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CHRYSLER
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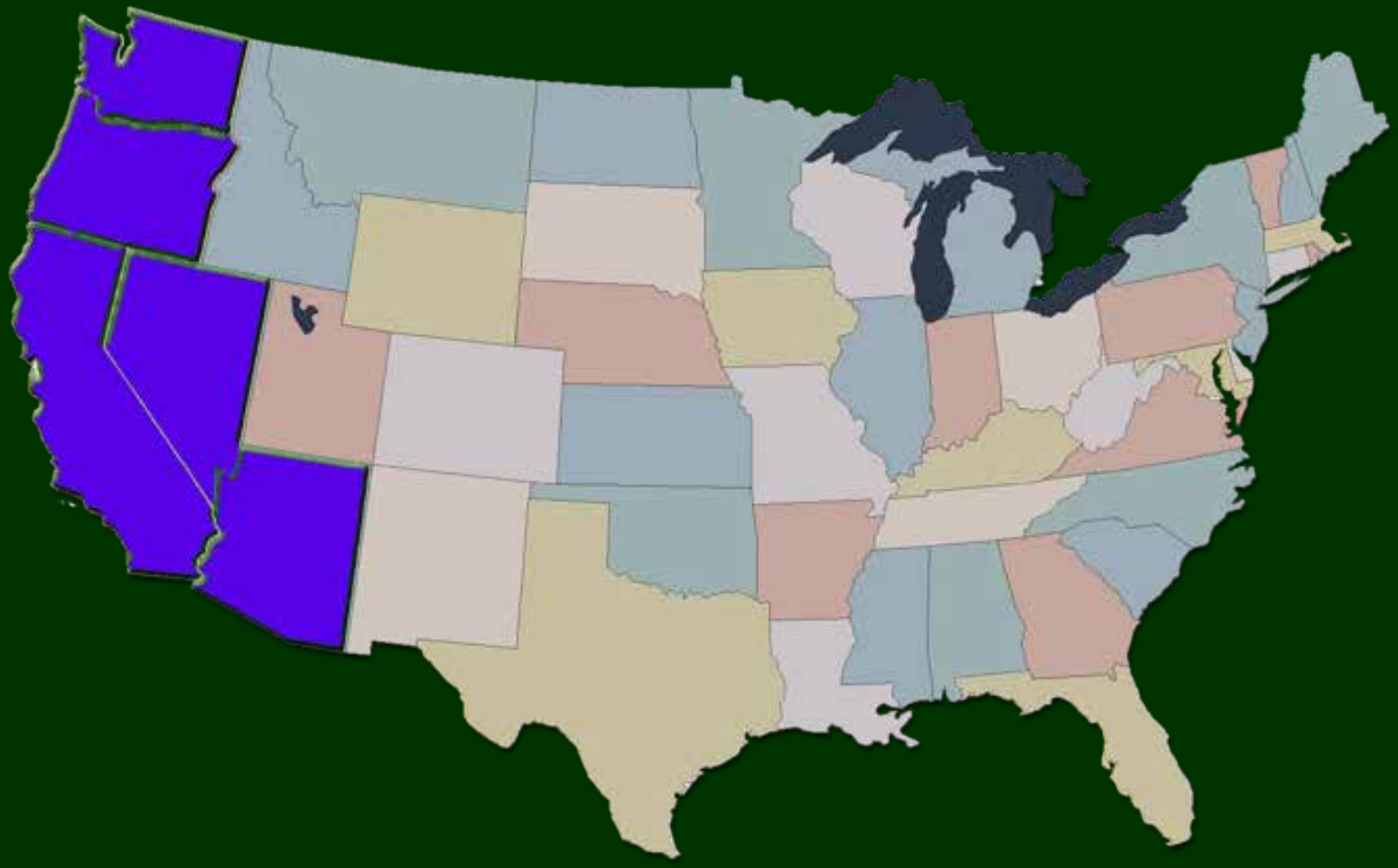
Walgreens
The Pharmacy America Trusts
SAFEWAY

Primary Wood Roof Construction Regions



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Thank you!

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www.panelized.com

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