

The logo consists of the letters 'MPP' in a bold, italicized, sans-serif font. The 'M' and 'P's are connected at the top. The letters are dark red and are set against a white background within a thin red border.

MASS PLYWOOD PANELS BY FRERES LUMBER CO.

DESIGN AND CONSTRUCTION GUIDE



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WHO WE ARE

Freres Lumber Co., Inc. is an Oregon-based premier wood products manufacturing company dedicated to bringing innovative, high-quality and environmentally-sound wood products to market.

Freres Lumber traces its roots to the hills above the Little North Fork of the N. Santiam River in 1922, nurtured by the patriarch of the Freres family, T.G. Freres. The company is almost one hundred years old, and remains a presence in Oregon's Santiam Canyon today, providing local family-wage jobs and producing high-quality wood products. Freres follows sustainable management practices throughout its three operations: Freres Lumber Co., Freres Timber and Evergreen BioPower, LCC, using 100 percent of its materials in beneficial, value-added products. Freres is committed to providing family wage jobs and operates six plants:

Plant 1: Small Log Veneer + Lumber Studmill

Plant 2: Large Log Veneer

Plant 3: Plywood, Sheathing Mill

Plant 4: Veneer Drying

Plant 5: Evergreen BioPower Cogeneration

Plant 6: MPP Facility

Freres is a closely-held family business and its executive team has over 100 years of combined experience in the timber and wood products industries. More than 450 employees support, and are supported by, these operations. The company's team members are what make Freres one of the premier veneer and panel manufacturers in the world.



The company's core values include a deep respect for wood, the forests our fiber comes from, and the benefits to society that wood products provide. We also have a long-running love of innovation, which motivates us to do more with less of one of the world's most valuable resources.

That innovative streak inspired us to evolve from lumber to veneer manufacturing in 1958, it led the company into plywood manufacturing in 1998, and it encouraged us in 2007 to build a cogeneration facility that supplies renewable power to 5,000 homes. Our evolution has led into what could possibly be the most significant new mass timber product in the world, the Mass Plywood Panel, or MPP.

WHAT IS A MASS PLYWOOD PANEL?

Freres's MPP is a patented, veneer-based engineered wood product certified by APA – The Engineered Wood Association. MPP is a Mass Timber Panel assembled with Freres 1.6E LVL panels called lamellas. The lamellas are constructed with density-graded Douglas Fir veneers, which are glued and pressed together, creating a large-format wood platform that can be manufactured in thickness at 1" increments. Freres has engineered MPP to enhance the natural strength of the wood, while adding dimensional stability. It can then be cut precisely to customers' specifications with advanced Computer Numeric Control (CNC) technologies. Floor, roof and wall panels can be manufactured as large as 11'-10" x 48' and up to 12" thick; beams and columns up to 24" thick. All this leads to decreased assembly times and a more economical building solution. MPP is strong and fire-resistant making it an acceptable building material up to 18 stories. It is also lighter, more economical, and more environmentally sustainable than traditional building materials such as concrete and steel.



MISSION STATEMENT

We intend MPP to be the structural building product of choice worldwide. MPP checks the boxes for what architects, engineers, contractors and developers are looking for in a product.

WHY MASS TIMBER

MPP offers the same benefits as other mass timber products available such as:

- Fire resiliency
- Fast construction
- Small labor force
- Ease of installation for subcontractors
- Economical transport
- Low cost foundations
- Small seismic forces
- Environmentally sustainable
- Aesthetically appealing

WHY MPP

There are many benefits to veneer-based products, such as:

- More economical
- Long spans with less wood
- Greater flexibility with design
- Dimensional stability on the jobsite
- Large production volumes
- Smaller tree utilization
- Less waste from harvest to construction

MPP APPLICATIONS

- Floors
- Elevator shafts
- Roofs
- Beams & columns
- Walls & shearwalls

SUSTAINABILITY IN PRACTICE

One of the largest privately-owned, independent wood products manufacturers on the West Coast, Freres has a history of being mindful about its environmental impact and observing sustainable management practices throughout its three operations—Freres Lumber Co., Freres Timber and Evergreen BioPower LCC. Freres has earned its place as a wood product industry leader in sustainable practices through commitment to forest stewardship and continued investment in innovative products and processes.

Sustaining Timberland

Freres's commitment to sustainability starts in the forest. All of their wood comes from a 150-mile radius from the mill and is harvested from sustainably managed forests as a renewable resource. Freres Timber's 17,000 acres of timberland are harvested on a sustained yield basis. This allows Freres Timber to provide high-quality timber today, while managing a healthy forest and providing timber production for future generations.

As a veneer-based product, MPP allows the use of small diameter trees. The preferred tree type can be found in forests that have a suppressed understory; these trees grow slower, are smaller in diameter and are not the best candidate for dimensional lumber. However, they produce denser wood due to the slower growth and therefore yield higher strength values. The veneer process can recover this fiber effectively and efficiently; and therefore, a stronger and stiffer Mass Plywood Panel can be made.

Thinning operations are a perfect means of harvest for these types of trees. Thinning is considered a low impact method of harvest and helps to promote a healthy forest. This is particularly helpful given the excessive wildland fires that are a serious threat to the health and safety of our communities. Thinning would reduce the fuel load and thus reduce the intensity and the spread of wildland fires.

Wasting Nothing

Freres uses 100 percent of the fiber delivered to its plants from timber harvesting. That means the company uses a **zero** waste business model. Freres's veneer products are made with a lathe that peels thin layers from logs as small as 6 inches in diameter.

This process reduces waste since more of the wood goes into the final product than cutting square lumber from round trees. Freres produces and sells residuals such as bark dust, chips and sawdust which are used in a variety of industries such as farms and nurseries.

Renewable Energy - Cogeneration Plant

Recycled urban wood and residuals from manufacturing operations provides renewable bio-mass energy to Freres's Evergreen BioPower cogeneration plant. Biomass energy, a renewable energy, is obtained from combusting wood debris to generate steam, which is then either utilized as heat in manufacturing processes or used to generate electricity. Steam-generated electricity from Freres's cogeneration plant supplies the local utility with enough energy to power more than 5,000 households, while also delivering heat for plant production processes.

MPP: Building the Future with Wood

Multi-story, mass timber buildings are rapidly increasing in popularity for a variety of reasons. From an environmental standpoint, wood is a natural and renewable resource. New engineered Structural Composite Lumber (SCL) products use less wood, are strong and lightweight, and get excellent marks in seismic integrity and fire resistance.



Harvesting and manufacturing wood products requires much less energy than the production of concrete and steel. According to the EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2013), carbon dioxide (CO₂) emitted from iron, steel, and cement production are the first and second largest sources of industrial CO₂ emissions in the U.S. Not only that, but forests absorb CO₂ and store carbon. The timber is harvested for the wood product. The carbon is stored in the product for the lifetime of the structure. Meanwhile, more trees are replanted that pull more CO₂ out of the atmosphere. This is why mass timber is said to be carbon negative.

- MPP uses 20-30% less wood than CLT and in the manufacturing process and typically exceeds structural properties with less overall material.
- Mass timber has greater thermal performance than its more conductive counterparts concrete and steel. Additionally, prefabrication creates a tighter envelope further increasing its thermal performance. To top it off, there is a thermal mass benefit that helps lower the peak temperature swings.
- Producing one ton of concrete emits 8 times more carbon dioxide (CO₂) than lumber used in building. Steel produces 21 times the CO₂. *(According to the EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013).*
- According to Tallwood Design Institute, mass timber manufacturing produces less carbon emissions stores carbon from the harvested trees, and then replanted trees continue to sequester more carbon out of the atmosphere.
- Carbon is further reduced by less transportation and smaller construction equipment required.
- MPP being a veneer based product means it can utilize smaller logs, have a higher fiber recovery, requires less energy to dry, and has overall less waste.



Freres's
cogeneration plant can
supply renewable energy
for its production plus
**5,000
HOMES!**

**MASS
TIMBER**
uses more wood,
stores more carbon and
regrowth sequesters
more carbon.

MPP GREEN BUILDING

Formaldehyde Resins and VOCs

MPP uses a formaldehyde based resin for bonding the veneer pieces together. Formaldehyde is often a big concern when considering Volatile Organic Compounds (VOCs). This organic compound is produced by humans, plants and animals. Just like most things, too much can be a concern; however, studies have shown in engineered wood products that the amount of emittance is insignificant.

So insignificant that raw wood can give you higher exposures of formaldehyde. There is some evidence that the manufacturing processes can even lower VOCs in engineered wood products. Formaldehyde breaks down easily. When emitted in the air it can take less than a few hours to break down. Also, it is easily metabolized in the human body and therefore it won't build up.

As there may be a concern with formaldehyhde in general, evidence suggests that it is not a concern in engineered wood products. This includes plywood panels, the building element used in MPP. The evidence is strong enough that California Air Research Board (CARB) considers it exempt from meeting its stringent standards. CARB is a highly regarded regulatory body commonly adopted in the many green rating programs such as LEED and National Greed Building Council.

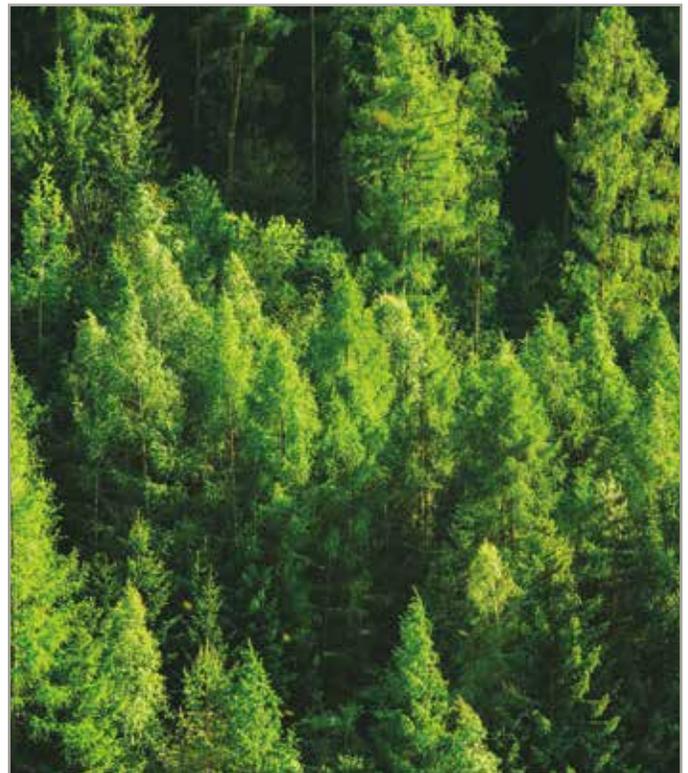
Formaldehyde Table

Source	Expected Exposure, Parts per billion (ppb)
Human Breath	~2
Typical Indoor Air	10-30
Urban Air	5-100
Rural Air	.8-5
Raw Wood	20
Structural Plywood	10-40

*Reference: Formaldehyde and Engineered Wood Products, From No. J330D, ©2018 APA - The Engineered Wood Association

LEED Points

MPP has the potential to earn many points for your next LEED certified building. It inherently aligns with the agencies principals with its reduced energy capabilities and its environmental benefits. Freres is currently taking steps to ensure your LEED project gets the maximum points from the use of MPP. It is going through a Life Cycle Assessment that is expected to be completed in the second quarter of 2019. Also, we are working on getting a complete Green Verification Report through the APA.





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MPP FAST FACTS:

SALVAGE

more of the tree by peeling veneer.

VENEER

is dried to a 4-6% moisture content in as little as 6 minutes.

Minimal drying defects in veneer =

LESS WASTE.

USE

smaller trees from thinning operations with veneer, a low impact means of harvest.

STORAGE & HANDLING

Storage

- Storage location should be level and allow air movement around panels, while protecting from rain, snow, sun and mechanical damage, and be sufficiently elevated off the ground 6-12 inches.
- Cover panels at all times with good quality tarps to protect them from precipitation and ultraviolet (UV) damage.

Handling

- Use wide fabric or plastic belts or other slings that will not mar the wood. If chains or cables are used, provide blocking or padding to protect panels from damage.
- Do not walk on unprotected MPP panels or handle the material with soiled hands or equipment.
- Unload trucks and move panels with lifting equipment. Do not drag, dump or drop panels. Off-loading equipment should be specified to the maximum panel weight of the project.

Final Finish

- Apply stain to a small test section as different colors of stain bring out different characteristics in the wood. When finish sanding is needed, sand in the direction of the grain using 120 grit sandpaper. Follow the application directions for whatever finish product used.



Weather Conditions

- MPP panels are susceptible to adverse weather conditions and precautions must be taken to protect them.
- If unprotected, rain and moisture will cause staining of MPP, as would be the case with traditional plywood.
- If bolts are used with steel connections, ensure they are free of oil. Otherwise this will cause staining. Using galvanized bolts and connectors will minimize this.

UV Damage

- If a portion of the panel has been left uncovered in the sun for a period of time, “UV damage” can occur. UV damage is the result of exposing wood fibre to sunlight. Wood fibres permanently darken when exposed to direct or indirect sunlight.
- UV damage can result from a tear in the wrap or from improperly covering the panel at the project site.
- In general, all wood species change color over time as a result of exposure to natural light and oxidation of the wood fibres. Over the long term, the color differences will even out and in most instances will disappear all together. If it is deemed necessary, the color difference can be corrected in the short term by manually sanding the affected areas to remove the sun tanned marks on the beam.

Cold Weather

- Sudden application of heat to buildings in cold weather can rapidly change the moisture content of the MPP. It is important that care is taken during transit, storage and throughout all stages of construction to avoid rapid changes in MPP moisture content.

When Applying Heat to Buildings

- Gradually increase the heat in the building over a two to three week period, up to normal temperatures. This will ensure a gradual change in the moisture content of the MPP. The slower the moisture content in the wood equalizes with the moisture content in the air, the better.
- Do not direct any forced air heating systems onto the MPP.
- Regulate all heating units, remembering that hot air rises and temperatures at the ceiling can reach 100° F plus.
- Maintain normal relative humidity in the building and monitor if necessary.
- ****Important**** It is recommended to apply the final finish to the MPP before heat is applied (if applicable). This will help to regulate the change in moisture content.

Freres Lumber Co., Inc. voids its warranty if the above conditions and recommendations are not followed.





FINISHED LOOK

Industrial Appearance

Unless otherwise specified, the finished appearance of MPP will be an industrial finish where one or both faces are left exposed, with knots and other defects conforming to veneer-grade standards outlined in PS1. Panels will include open and close knot defects up to 1.5" across the grain and the appearance will be consistent with rotary-peeled Douglas Fir veneer. Freres follows all criteria guidelines for PS1 standard C-grade knots, in particular.

Architectural Appearance

Customers can specify an appearance grade on one or both faces of the panel. We can add a cross-layer of ½" thick min., 4' wide by 8-10' long material to skin the panel. Materials such as marine-grade fully-repaired Douglas Fir. Materials with controlled knot sizes, sanded and puttied, knot free, variety of grooved panels, variety of textures, different species, charred and other finishes that can be sourced that meet the 4'x8-10' dimensions.

Architectural panels will be purchased from supplier partners specializing in appearance-grade material, then adhered to the face of the structural panel.



DIFFERENT FACE SHEET EXAMPLES



Supplier: Hardel Mutual Plywood Corp.

STRUCTURAL OPTIMIZATION

MPP can save money by using less wood for your next job by:

- Minimizing panel thickness with 1-inch increments.
 - Each inch of thickness saves an average of 20% volume
- Equivalent spans with less wood
 - 6-inch MPP can typically replace a 5-ply (t=6.875") CLT panel
 - Use a 5-inch MPP and save 20% on material from 6" MPP and 38% from 5-ply CLT
- 2 way span capabilities
 - The veneer base of MPP can be laid up for a more balanced minor and major axis capacity.
- Greater flexibility in lay ups will mean that particular application can get optimize structurally and economically.
 - Future layups will provide similar spans with a reduced cost.

FIRE DESIGN

MPP has proven fire performance.

- MPP has a 2-hour floor rating and a 1.5-hour wall rating with 6-inch panels.
- Use a char rate of 1.5"/hr to optimize the design.
- Thicker effective cross section after char depth
 - With smaller laminations MPP doesn't take the hit when the effective char rate reaches a cross lamination.

WASTE LESS IN YOUR MPP DESIGN

Maximize wood use:

- Due to trimming MPP most efficient widths are 11'-10", 9'-10", 7'-10", 5'-10", and a 3'-10"
- Currently lengths are optimized between 32'-48' or multiples of 48'; assume 1-inch of waste between panels (60' press is expected in late 2019). Reference pages 16-17 "*MPP Design Tips*" for more saving techniques.

Minimize expensive CNC features by maximizing saw use.

- Curved panels, reentrant corners, half lap joints, plunge cuts for MEP typically require more time intensive router work.
- Consider windows/door/MEP cut outs with the saw and then hand finished on site or in the plant.

PRODUCTION CAPABILITY

- The 24-inch press opening allows for multiple panels to be manufactured at a time.
- A press load can consist of (4) 6-inch panels, or (6) 4-inch panels, or (12) 2-inch panels, or (3) 8-inch panels.
- That is, respectively, about 18,430 ft², 27,650 ft², and 36,860 ft² of floor area per day at the current production rate.

FUTURE PROJECTS

- Up to 24"x24" columns
- Up to 24"x24" beams in plank orientation
- Up to 24"x48" beams in edge wise orientation
- Lengths up to 60' or multiples of 60'
- Optimized layups that will maximize performance for different applications and minimize cost
 - More economical long span layups
 - Longer span layup
 - Horizontal wall orientation
 - 2-way slabs

SPECIFICATION GUIDE

Quality Assurance

The processes at the MPP plant undergo APA sites inspection. We have a verified and audited Quality Management System (QMS) program by the APA. The QMS includes ongoing material testing and traceability per the APA product report.

Materials:

- LVL: Douglas Fir, Larch, certified under ASTM D5456.
- MPP: Douglas Fir, Larch, certified under PRG 320-2018.

Design

MPP panels are treated like CLT panels for design. Reference the CLT Handbook and the NDS for more details. All design shall be provided by a licensed professional.



Certifications + Approvals

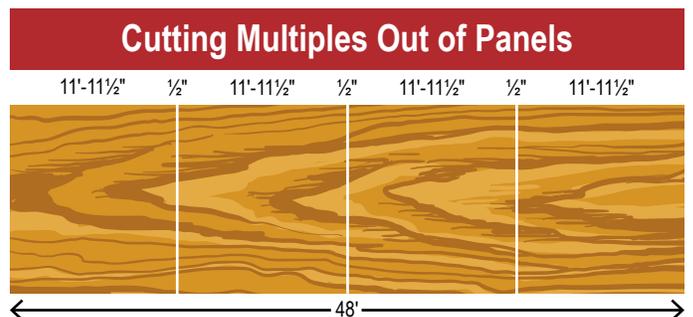
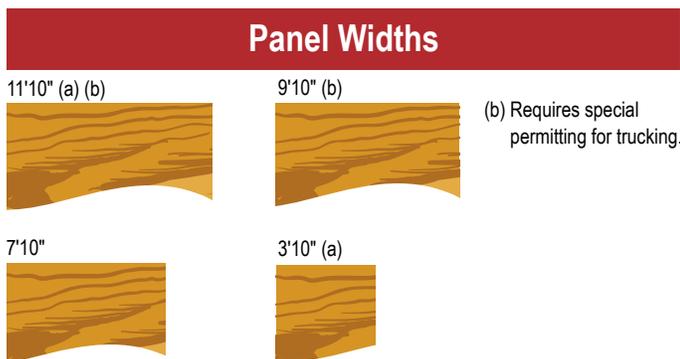
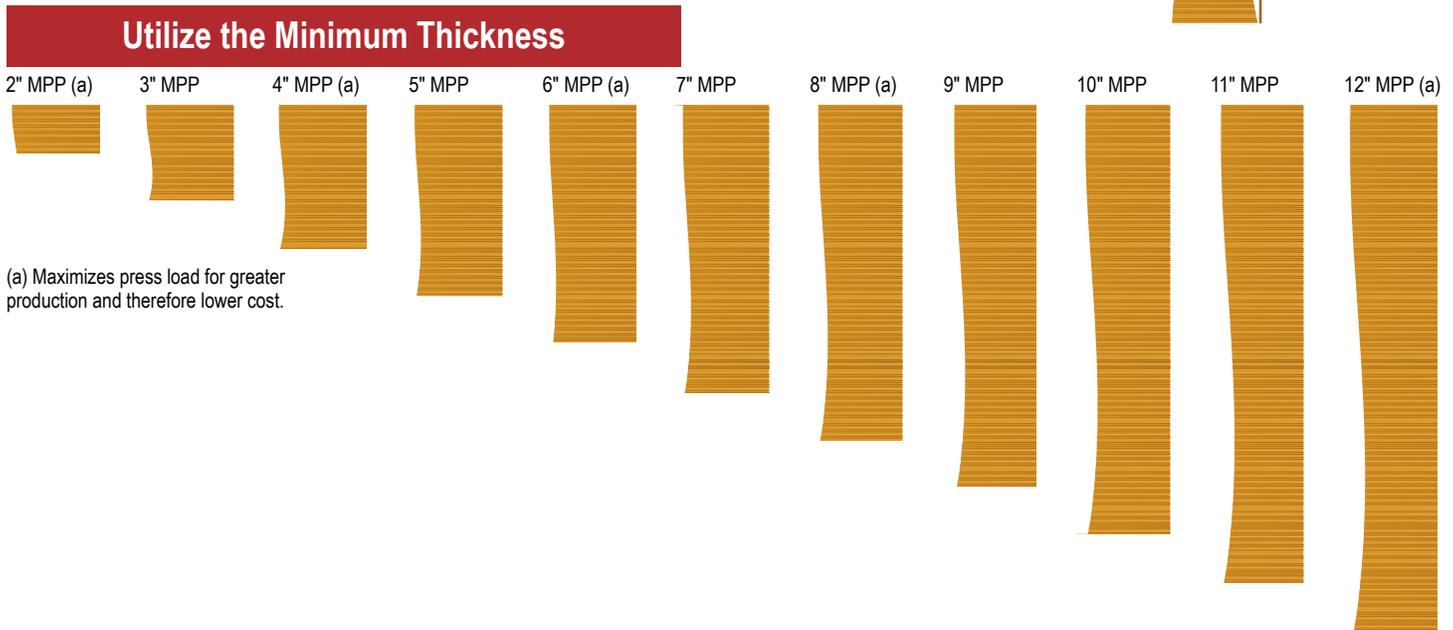
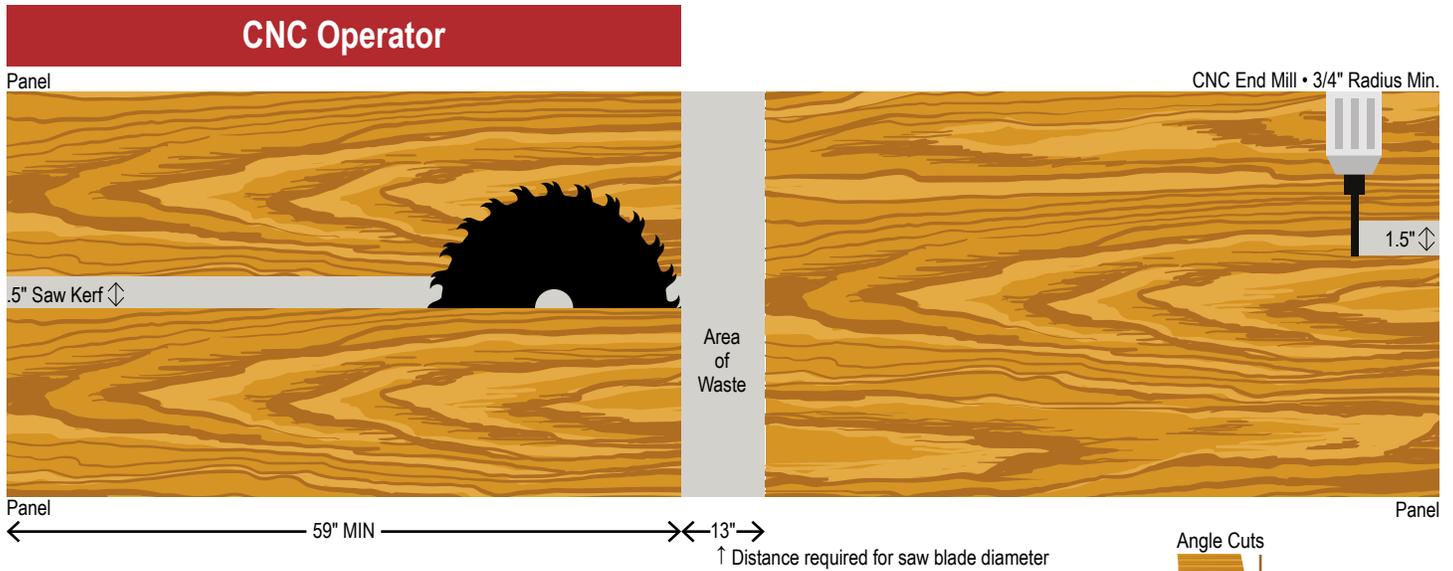
MPP is certified by
APA—The Engineered Wood
Association under ANSI/APA PRG 320 standards.
APA Product Report PR-L325 issued in June 2018.



Panel properties

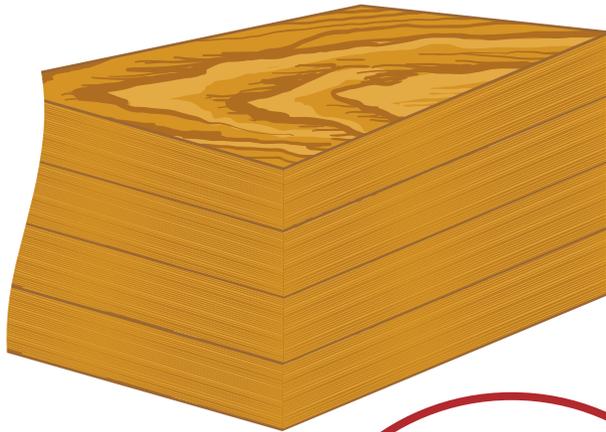
Maximum Trimmed Panel Length:	32-48 ft and multiples of 48 ft
Trimmed Panel Widths:	11'-10", 9'-10", 7'-10", 5'-10", and a 3'-10"
Thickness:	2", 3", 4", 5", 6", 7", 8", 9", 10", 11", & 12"
Moisture Content:	8% + or - 3%
Glue Specs:	Meets adhesive requirements under PRG-320. MPP Panels are CARB exempt.
Wood Species:	Douglas Fir
Squareness:	Unless specified otherwise the length of the two panel length corners shall not vary by more than 1/8"
Straightness:	± 1/16" deviation of straight edge
Dimensional Tolerances:	Thickness + or - 1/16" or 2% of panel thickness, whichever is greater. Width + or - 1/8" of panel width Length + or - 1/4" of panel length
Linear Expansion:	.16% along .27% across
R-Value:	1.25 per inch
K-Value (thermal conductivity):	.798

MPP DESIGN TIPS

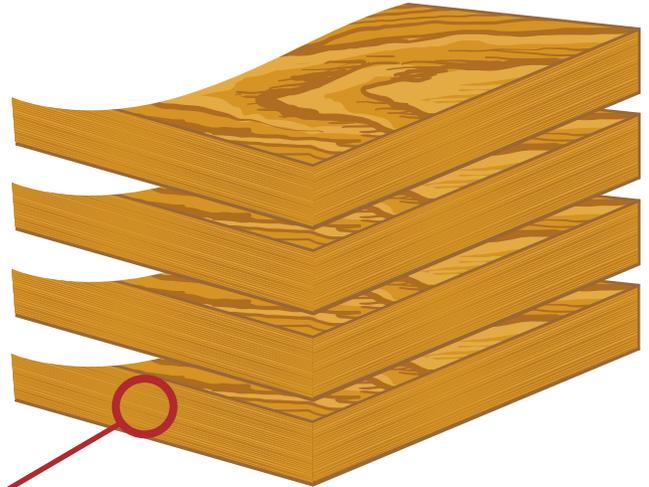


MPP LAYUP

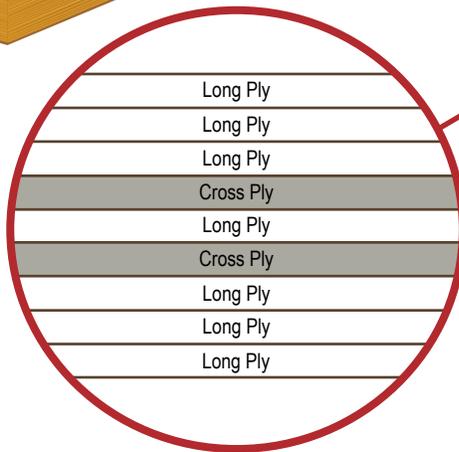
Completed MPP (4" shown)



The lamellas are made from Freres 1.6E LVL product.



Lamella Veneer Layup



9 plies of 1/8" thick douglas fir veneer presses together
 • 7 plies in low span direction
 • 2 cross plies

Maximum Press Loads



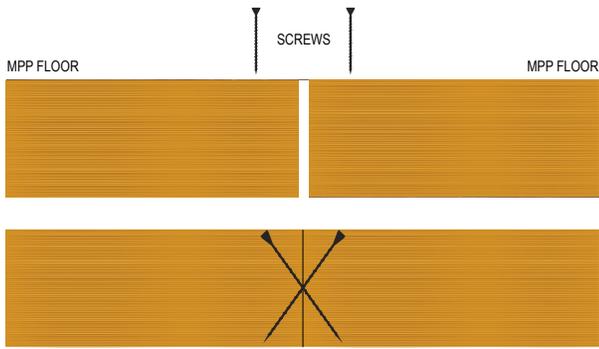
- Maximize press loads to minimize cost by designing with the exact same size panel. (different size panels require different press loads)
- The example above shows (6) 4" panels being pressed simultaneously.

CNC machine in Mass Plywood Panel Plant 6

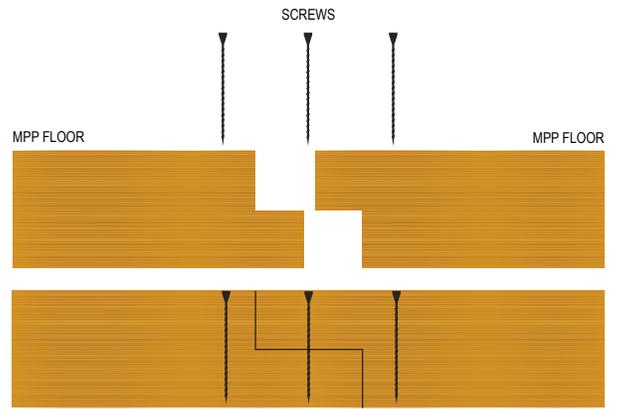


CONNECTION DETAILS

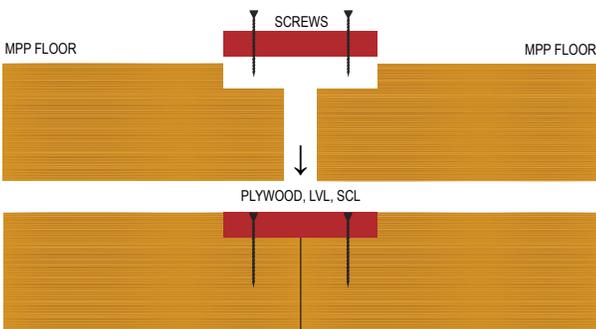
TOE-NAILED SCREWS WITH BUTT-JOINT



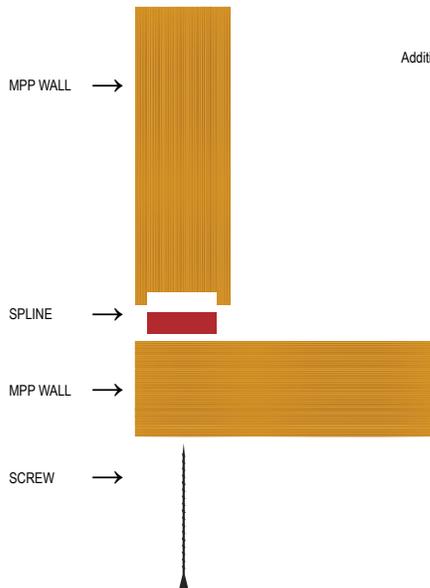
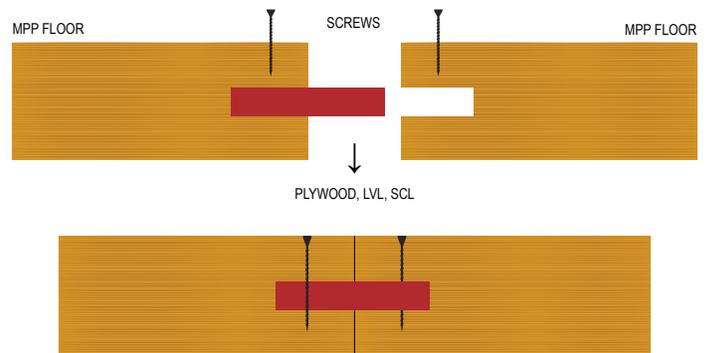
HALF LAP



SINGLE SURFACE SPLINE

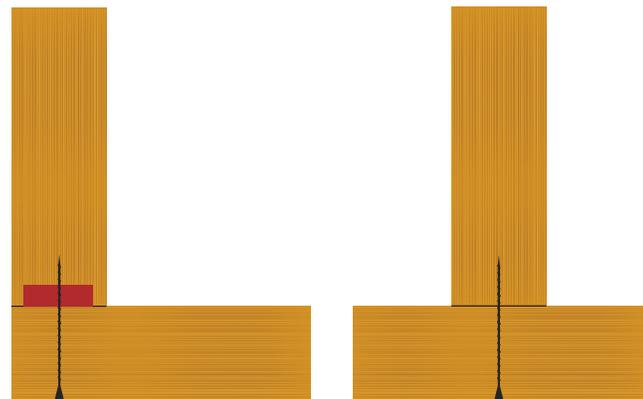


CENTER SPLINE JOINT



WALL JOINT

Additional joint specifications available in the CLT Handbook.



Fastener Design for Freres 1.6E LVL and MPP Lamellas

Equivalent Specific Gravity (S.G.)						
Grade	Nails				Bolts	
	Withdrawal Load		Lateral Load		Lateral Load	
	Installed in Edge	Installed in Face	Installed in Edge	Installed in Face	Installed in Face	
				Parallel to Grain	Perpendicular to Grain	
1.6E	0.42	0.41	0.41	0.60	0.42	0.63

PANEL PROPERTIES

MPP ASD Reference Design Values

MPP Lay-UP	Lay-Up ID	Thickness, ¹ _p (in)	Weight (lbs./ft ²)	Weight (lbs./ft ²)	Major Strength Direction				Minor Strength Direction			
					(F _b S) _{eff,f,o} (lbf-ft/ft)	(EI) _{eff,f,o} (10 ⁶ lbf-in. ² /ft)	(GA) _{eff,f,o} (10 ⁶ lbf/ft)	(V) _{s,o} (lbf/ft)	(F _b S) _{eff,f,9o} (lbf-ft/ft)	(EI) _{eff,f,9o} (10 ⁶ lbf-in. ² /ft)	(GA) _{eff,f,9o} (10 ⁶ lbf/ft)	(V) _{s,9o} (lbf/ft)
F16	F16-2	2	37	6.2	1,110	16	0.82	2,190	210	2.8	0.17	695
	F16-3	3	37	9.3	1,870	51	1.23	2,190	355	9	0.26	695
	F16-4	4	37	12.3	3,325	122	1.64	2,925	630	21	0.34	930
	F16-5	5	37	15.4	5,200	238	2.05	3,650	985	42	0.43	1,160
	F16-6	6	37	18.5	7,500	410	2.46	4,375	1,420	72	0.69	1,390
	F16-7	7	37	21.6	10,200	652	2.66	5,100	1,930	114	0.81	1,630
	F16-8	8	37	24.7	13,325	973	3.04	5,825	2,525	170	0.91	1,860
	F16-9	9	37	27.	16,850	1,385	3.42	6,575	3,200	242	1.04	2,090
	F16-10	10	37	30.8	20,825	1,900	3.8	7,300	3,950	333	1.15	2,320
	F16-11	11	37	33.9	25,175	2,529	4.18	8,025	4,775	443	1.27	2,550
	F16-12	12	37	37.0	29,975	3,283	4.56	8,750	5,675	575	1.38	2,775

MPP Wall Table Loading Table (Axial Loads Only) in kips

Lay-Up ID	Thickness inches	Wall Height																								
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
F16-2	2	52	29	15	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F16-3	3	82	68	42	26	17	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F16-4	4	111	104	82	56	39	28	21	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F16-5	5	140	135	121	96	70	52	40	31	25	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F16-6	6	168	165	155	136	109	84	65	52	42	34	29	24	-	-	-	-	-	-	-	-	-	-	-	-	-
F16-7	7	197	193	186	173	150	122	98	79	64	53	45	38	33	28	-	-	-	-	-	-	-	-	-	-	-
F16-8	8	225	222	217	206	189	163	136	112	93	77	65	56	48	42	37	32	-	-	-	-	-	-	-	-	-
F16-9	9	253	251	246	238	224	203	177	150	126	106	90	77	67	59	51	46	41	36	-	-	-	-	-	-	-
F16-10	10	279	277	272	265	253	235	211	184	158	136	117	101	88	78	69	61	54	49	44	40	-	-	-	-	-
F16-11	11	310	308	304	299	290	276	257	231	204	177	154	134	117	103	91	81	72	65	59	53	49	45	-	-	-
F16-12	12	338	336	333	328	321	309	293	271	245	217	191	168	148	130	116	103	93	83	75	69	63	57	53	49	45

- NOTES:**
- 1) For use in dry condition.
 - 2) $P_r = F_c A_{parallel} C_D C_M C_T C_P$. Where slenderness ratio exceeds 50 to 1, no value is given.
 - 3) C_D , C_M and C_T are assumed to be 1.
 - 4) Table for preliminary analysis only.
 - 5) Table does not account for eccentric axial loading nor wind loads.
 - 6) Major force direction is parallel to wall height.
 - 7) For different loading conditions, consult with Freres Lumber Co., Inc. Technical Support.

LAMELLA AND LVL PROPERTIES

Allowable Stress Design Properties (L-324 Report)

Property		Design Stress (psi) 1.6E LVL
Bending (F_b) ^(d)	Joist ^(d)	1,900
	Plank	3,000
Modules of Elasticity (E) ^(f)	Joist	1,600,000
	Plank	1,400,000
Horizontal Shear (F_v)	Joist	255
	Plank	90
Compression Perpendicular to Grain (F_{ci})	Joist	750
	Plank	600
Tension parallel to grain (F_t) ^(g)		1,300
Compression parallel (F_{ci})		2,400

Depth, d (in.)	3-1/2	5-1/2	7-1/4	9-1/4	9-1/2	11-1/4	11-7/8	14	16	18	24
1.6E	1.23	1.14	1.09	1.04	1.04	1.01	1.00	0.97	0.95	0.93	0.89

- NOTES:** For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1lbf = 4.448 N, 1 psi = 6.9 kPa.
- (a) The tabulated values are design values for normal duration of load. All values, except for E, are permitted to be adjusted for other load durations as permitted by the code. The design stresses are limited to conditions in which the average moisture content is less than 16 percent at maximum.
- (b) Joist = load parallel to glueline, plank = load perpendicular to glueline.
- (c) The tabulated values are limited to LVL with a thickness of 1 inch.
- (d) Tabulated bending stress (F_b) may be increased by 4 percent when the member qualifies as a repetitive member as defined in the NDS.
- (e) The tabulated values are based on a reference depth of 12 inches. For other depths, when loaded edgewise, the allowable bending stress (F_b) shall be modified by $(12/d)^{16}$ as shown in the following table, where d = member depth in inches. For depths less than 3-1/2 inches, the factor for the 3-1/2 inch depth shall be used.
- (f) Apparent modulus of elasticity.
- (g) The tabulated values are based on a reference length of 4 feet. For lengths longer than 4 feet, the allowable tensile stress shall be modified by $(4/L)^{17}$, where L = member length in feet. For lengths shorter than 4 feet, use the tabulated value unadjusted.



MPP Maximum Span Floor Table

Lay-Up ID	Thickness inches	Vibration Controlled Span (feet)	Load Controlled Spans Live Load				
			40 PSF	50 PSF	75 PSF	100 PSF	150 PSF
F16-2	2	7.80	8.28	7.73	6.74	6.10	5.31
F16-3	3	10.41	11.99	11.38	9.91	8.99	7.82
F16-4	4	12.95	15.78	15.06	13.26	12.02	10.46
F16-5	5	15.31	19.43	18.57	16.57	15.02	13.06
F16-6	6	17.55	22.95	21.98	19.86	18.00	15.66
F16-7	7	19.69	26.40	25.32	23.16	20.99	18.25
F16-8	8	21.76	29.77	28.60	26.30	23.99	20.86
F16-9	9	23.76	33.06	31.80	29.31	26.98	23.47
F16-10	10	25.56	36.15	34.81	32.14	29.83	25.89
F16-11	11	27.62	39.43	38.02	35.21	32.98	28.68
F16-12	12	29.47	42.52	41.05	38.09	35.81	31.29

- NOTES:**
- 1) Single Span, Uniform Load, Major Force Direction Only.
 - 2) Total Loads include live load, MPP weight, 20 psf concrete topping weight, and 15 psf additional loading.
 - 3) Live Load Deflection limit = Span (L)/360, Total Load Deflection Limit = L/240.
 - 4) Vibration controlled spans calculated using concepts outlined in the

- MPP Handbook and assume a bare floor.
- 5) Deflection calculated following guidance from APA Technical Topics TT-123.
 - 6) When designing for vibration, use the vibration span for any loading condition that does not produce a span shorter than the vibration span.

MPP Maximum Span Floor Table with 2" concrete

Lay-Up ID	Thickness inches	Vibration Controlled Span (feet)	Load Controlled Spans Live Load				
			40 PSF	50 PSF	75 PSF	100 PSF	150 PSF
F16-2	2	7.80	7.53	7.24	6.66	6.10	5.31
F16-3	3	10.41	10.94	10.53	9.72	8.99	7.82
F16-4	4	12.95	14.45	13.93	12.89	12.02	10.46
F16-5	5	15.31	17.85	17.22	15.96	15.00	13.06
F16-6	6	17.55	21.15	20.43	18.98	17.86	15.66
F16-7	7	19.69	24.40	23.59	21.95	20.68	18.25
F16-8	8	21.76	27.58	26.70	24.89	23.48	20.86
F16-9	9	23.76	30.71	29.75	27.78	26.24	23.47
F16-10	10	25.56	33.64	32.61	30.48	28.80	25.89
F16-11	11	27.62	36.80	35.71	33.45	31.66	28.68
F16-12	12	29.47	39.76	38.61	36.23	34.33	31.29

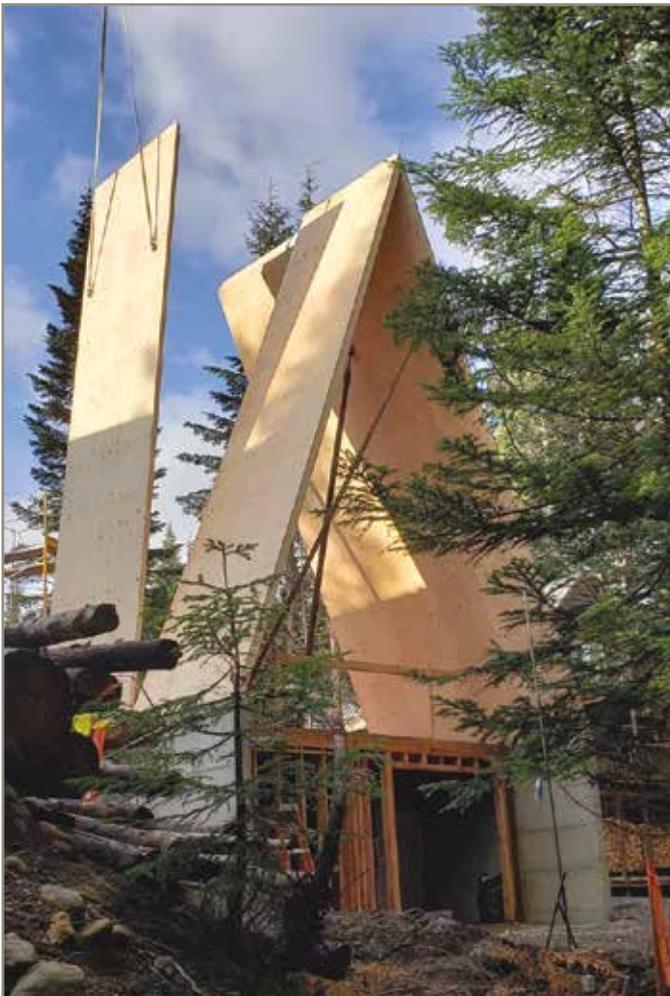
- NOTES:**
- 1) Single Span, Uniform Load, Major Force Direction Only.
 - 2) Total Loads include live load, MPP weight, 20 psf concrete topping weight, and 15 psf additional loading.
 - 3) Live Load Deflection limit = Span (L)/360, Total Load Deflection Limit = L/240.
 - 4) Vibration controlled spans calculated using concepts outlined in the

- MPP Handbook and assume a bare floor.
- 5) Deflection calculated following guidance from APA Technical Topics TT-123.
 - 6) When designing for vibration, use the vibration span for any loading condition that does not produce a span shorter than the vibration span.

MPP Maximum Span Roof Table

Lay-Up ID	Thickness inches	Snow Load, Unfactored															125% Non-Snow Load		
		20 PSF			30 PSF			40 PSF			55 PSF			100 PSF			20 PSF		
		L/360	L/240	L/180	L/360	L/240	L/180	L/360	L/240	L/180	L/360	L/240	L/180	L/360	L/240	L/180	L/360	L/240	L/180
F16-2	2	9.47	10.43	11.96	8.80	9.70	11.11	8.28	9.13	10.47	7.48	8.48	9.46	6.10	7.01	7.73	9.47	10.43	11.96
F16-3	3	13.60	14.99	17.17	12.70	13.99	16.04	11.99	13.22	15.15	11.02	12.31	13.74	8.99	10.32	10.97	13.60	14.99	17.17
F16-4	4	17.78	19.59	22.45	16.67	18.37	21.05	15.78	17.40	19.88	14.73	16.25	17.97	12.02	13.80	14.45	17.78	19.59	22.45
F16-5	5	21.75	23.97	27.47	20.46	22.55	25.85	19.43	21.41	24.31	18.19	20.06	22.07	15.02	17.25	17.86	21.75	23.97	27.47
F16-6	6	25.56	28.16	32.28	24.12	26.58	30.47	22.95	25.30	28.57	21.55	23.76	26.04	18.00	20.66	21.20	25.56	28.16	32.28
F16-7	7	29.25	32.24	36.96	27.68	30.52	34.99	26.40	29.11	32.64	24.84	27.39	29.85	20.99	23.91	24.44	29.25	32.24	36.96
F16-8	8	32.83	36.19	41.49	31.16	34.34	39.12	29.77	32.82	36.58	28.07	30.96	33.56	23.99	27.12	27.63	32.83	36.19	41.49
F16-9	9	36.31	40.02	45.89	34.54	38.07	43.05	33.06	36.45	40.36	31.24	34.45	37.14	26.98	30.28	30.73	36.31	40.02	45.89
F16-10	10	39.58	43.65	50.07	37.71	41.60	46.87	36.15	39.88	44.06	34.21	37.75	40.65	29.83	33.26	33.80	39.58	43.65	50.07
F16-11	11	42.99	47.39	54.06	41.06	45.27	50.52	39.43	43.48	47.59	37.39	41.24	44.02	32.98	36.48	36.78	42.99	47.39	54.06
F16-12	12	46.21	50.94	57.71	44.21	48.75	54.08	42.52	46.88	51.05	40.38	44.54	47.34	35.81	39.52	39.72	46.21	50.94	57.71

- NOTES:** 1) Single Span, Uniform Load, Major Force Direction Only and Unfactored for duration of load.
 2) Total Loads include live load, MPP weight, 15 psf additional loading.
 3) Deflection limits are for live loads. Total load deflection limits for live load deflections of L/360, L/240 and L/180 are respectively L/240, L/180 and L/120.



MPP Do More with Less

Less \$ with Less Material
and Less Waste



GLOSSARY

Mass Plywood Panel (MPP) is a mass timber panel similar in application to Cross Laminated Timber that was developed, produced and patent pending by Freres Lumber Co., Inc. Layers of Structural Composite Lumber are assembled and glued to produce a panel up to 12' wide and 48' long meeting the requirements of ANSI/APA PRG 320, and designed to be used in the construction of mid-rise to high-rise structures.

Cross Laminated Timber (CLT) is a wood panel product made from glueing layers of solidsawn lumber together. Each board layer is oriented perpendicular to adjacent layers and glued on the wide faces of each board, usually in a symmetric way so that the outer layers have the same orientation. An odd number of layers is most common but there are configurations with even numbers as well. Regular timber is an anisotropic material, meaning that the physical properties change depending on the direction at which the force is applied. By gluing layers of wood at perpendicular angles, the panel is able to achieve better structural rigidity in both directions.

Structural Composite Lumber (SCL) is an engineered wood product designed for structural use, SCL is manufactured from wood strands or veneers bonded with adhesives and created using a layering technique where the outcome is a block known as a billet. Similar to conventional sawn lumber and timber, SCL products are used for common structural applications and include laminated veneer lumber (LVL), parallel strand lumber (PSL), laminated strand lumber (LSL) and oriented strand lumber (OSL).

Laminated Veneer Lumber (LVL) is a high-strength engineered wood product made from veneers bonded together under heat and pressure. It is used for permanent structural applications including beams and rafters.

Computer Numeric Code (CNC) machines are electro-mechanical devices that manipulate machine shop tools using computer programming inputs. Machining is a general way to transform a piece of material like plywood and arrive at a finished product, like a wall with cutout doors and windows. CNC relies on digital instructions from a Computer Aided Manufacturing (CAM) or Computer Aided Design (CAD) file. The CNC machine interprets the design instructions into cutting instructions.

PRG 320 The ANSI/APA PRG 320 standard covers the manufacturing, qualification and quality assurance requirements for CLT.

American Society for Testing and Materials (ASTM) is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

E2 CLT This is a particular CLT layout as specified in the ANSI/APA PRG 320 standard utilizing Machine Stress Rated (MSR) Douglas Fir and Larch lumber in order to improve the performance of the panel. MPP is often compared to the performance of the E2 CLT since both utilize machine graded numbers for input selection.

International Building Code (IBC) is a model building code developed by the International Code Council (ICC). It has been adopted for use as a base code standard by most jurisdictions in the United States.

Plywood is a manufactured wood product; a structural material consisting of two or more layers of veneer glued and pressed together with the direction of grain altering, usually sold in sheets of four by eight feet.

APA - The Engineered Wood Association is a trade organization representing manufacturers of plywood, OSB, glued laminated timber, I-Joists, Rim Board® and structural composite lumber (SCL). The Association has three main functions: 1) research to improve wood structural panel (plywood and OSB) and other engineered wood products and systems, 2) quality inspection and testing to assure the manufacture of high-quality wood structural panel and engineered wood products, and 3) promotion of engineered wood products and building systems. Commonly referred to as "APA," and previously known as the American Plywood Association.



Engineered Wood Products are structural wood products manufactured by bonding together wood strands, veneers, lumber or other forms of wood fiber to produce a larger and integral composite unit with superior performance characteristics. These high-performance building components achieve predictable and reliable performance characteristics with the efficient use of natural resources.

Mass Timber is a product category and framing style characterized by the use of large, solid wood panels for wall, floor and roof construction. Mass timber panels are six feet or more in width or depth.

Parallel Strand Lumber (PSL) is a composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.25 inches (6.4 mm) or less and their average lengths are a minimum of 300 times the least dimension of the wood strand elements. PSL is one of several structural composite lumber (SCL) types.

Laminated Strand Lumber (LSL) is a type of engineered wood with strips of wood that once would have been considered too weak, small or misshapen to use—pressed together to transform the scrap wood into solid joists and studs. LSL lumber is most commonly shaped into framing boards; it is used for other applications.

Oriented Strand Lumber (OSL) is a composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inch (2.54 mm) or less and their average lengths are a minimum of 75 times and less than 150 times the least dimension of the wood strand elements. OSL is one of several structural composite lumber (SCL) types.

Oriented strand board (OSB), also known as flakeboard, is a type of engineered wood similar to particle board, formed by adding adhesives and then compressing layers of wood strands (flakes) in specific orientations.

International Code Council (ICC) evaluation service is one of a number of organizations that studies applications for new proprietary products that fall outside the scope of the model code. Evaluation reports are then issued that indicate product equivalency to specific sections of the code

Scarf Joint is an angled or beveled joint in plywood splicing pieces together. The length of the scarf is 5 to 12 times the thickness.

Tongue and Groove Joint is a system of jointing in which the rib or tongue of one member fits exactly into the groove of another. A specially designed APA tongue-and-groove panel edge joint is particularly efficient in transferring the load across the joint. Some APA-rated STURD-I-FLOOR T&G panels measure 47-1/2 inches across the face.

Veneer is a thin sheet of wood laminated with others under heat and pressure to form plywood, or used for faces of composite panels. Also called “ply.”

Veneer Grade is the standard grade designations of softwood veneer used in panel manufacture. Veneer grade designations for plywood are outlined in product standard PS1-09. Veneer grades for engineered wood products are based on tested strength and density properties.

California Air Resources Board (CARB) is the “clean air agency” in the government of California. Established in 1967 when then-governor Ronald Reagan signed the Mulford-Carrell Act, combining the Bureau of Air Sanitation and the Motor Vehicle Pollution Control Board, CARB is a department within the cabinet-level California Environmental Protection Agency.



CONTACT

Our sales and engineering team is available to assist with your project.
Contact us early in the design phase, our capabilities are always evolving.



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MPP DESIGN GUIDE PHOTOS BY: LAUREN RENNAN, CHARLENE VOGEL PHOTOGRAPHY, SHANNA HALL PHOTOGRAPHY



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MASS PLYWOOD PANELS BY FRERES LUMBER CO.