



Floor Construction

AN EXCERPT OF THE ENGINEERED WOOD CONSTRUCTION GUIDE





FLOOR CONSTRUCTION

Engineered wood floor systems give builders and designers strength, dependable performance and design flexibility. A variety of floor framing and wood structural panel products can be used in floor construction. To select the appropriate products and floor design, it is essential to define the predicted loads and to consider both the structural requirements and compatibility with the finish floor requirements. Table 13 shows the most common finish floor products and the floor systems that are typically recommended for each.

TABLE 13

TYPICAL PANEL FLOOR SPECIFICATIONS BASED ON FINISH FLOOR INSTALLATIONS (All must meet minimum structural requirements^a of IBC or IRC)

Finish Floor	Typical Panel Installation ^b	Example Specification ^b
Carpet and Pad	Single layer of APA Rated Sturd-I-Floor with T&G edges	APA Sturd-I-Floor 24 oc Exposure 1 T&G (for joists spaced 24 inches o.c. or less)
Hardwood Flooring	Single layer of APA Rated Sturd-I-Floor or APA Rated Sheathing	APA Rated Sturd-I-Floor 32 oc Exposure 1 (for joists spaced 24 inches o.c. or less) ^c
Lightweight Concrete with Finish Flooring on Top ^d	Subfloor panel with or without T&G edges installed on joists. Asphalt paper covers subfloor. Lightweight concrete poured on top.	APA Sturd-I-Floor 24 oc Exposure 1 T&G or APA Rated Sheathing 48/24 Exposure 1 (for joists spaced 24 inches o.c. or less)
Vinyl (or other thin resilient floor covering) or Glue-down Carpet	APA Rated Sturd-I-Floor or APA Rated Sheathing Exposure 1 plus minimum Performance Category 1/4 APA Underlayment ^e Sanded Face Exposure 1	APA Rated Sturd-I-Floor ^f 24 oc Exposure 1 or APA Rated Sheathing 48/24 Exposure 1 (for joists spaced 24 inches o.c. or less). Cover with 1/4-inch (or thicker) APA Underlayment ^e Sanded Face Exposure 1
Ceramic Tile ^h	Two layers minimum Performance Category 19/32 APA Rated Sturd-I-Floor ^c Exposure 1	Two layers of minimum Performance Category 19/32 plywood APA Rated Sturd-I-Floor ^c 20 oc Exposure 1 (for joists spaced 16 inches o.c. or less)

a. Floor span rating must equal or exceed joist spacing.

b. Refer to www.apawood.org for installation specifics and alternate installation combinations.

c. Minimum Performance Category 19/32 APA Sturd-I-Floor^f or APA Rated Sheathing for joist spaced 16 inches o.c. Minimum Performance Category 23/32 APA Sturd-I-Floor or APA Rated Sheathing for joist spaced 19.2 inches o.c. or less. See *APA Technical Note: APA Performance Rated Panel Subfloors Under Hardwood Flooring*, Form R280.

d. For gypsum concrete recommendations, contact manufacturer of floor topping.

e. APA Underlayment is always plywood.

f. Plywood APA Rated Sturd-I-Floor with sanded face. Plywood Rated Sturd-I-Floor is underlayment with a span rating.

g. For rough floors, specify minimum Performance Category 11/32 APA Underlayment^f.

h. For other specialty flooring products, including marble and slate, please refer to the finish floor manufacturer's recommendations. Enhanced structural performance may be required for ceramic and natural stone floor products. See *Tile Council of North America (TCNA) Handbook for Ceramic, Glass, and Stone Tile Installation* (www.tileusa.com).

APA Rated Sturd-I-Floor®

APA RATED STURD-I-FLOOR is a span-rated APA proprietary product designed specifically for use in single-layer floor construction beneath carpet and pad. The product provides all of the proven cost-saving and performance benefits of combined subfloor-underlayment construction. It is manufactured in conformance with Voluntary Product Standard PS 1 or PS 2. Plywood APA Sturd-I-Floor meets PS 1 underlayment specifications, but in addition to qualifying as underlayment, Sturd-I-Floor carries a span rating (thin underlayment carries no span rating). Sturd-I-Floor is easy to use and specify because the maximum recommended spacing of floor joists—or span rating—is stamped on each panel. Panels are manufactured with span ratings of 16, 20, 24, 32 and 48 inches. These assume use of the panel continuous over two or more spans with the long panel dimension or strength axis across supports.

Note: The span rating in the trademark applies when the long panel dimension or strength axis is across supports, unless the strength axis is otherwise identified.

Glue-nailing is recommended for STURD-I-FLOOR panels, though panels may be nailed only. Recommendations for both methods are given in Table 14. (See “The APA Glued Floor System,” page 47, for more detailed gluing recommendations.) Always protect smooth panel faces and tongue-and-groove edges from damage prior to and during application. Install with smooth side up. Recommended live loads are given in Table 15.

If long-term exposure to the weather is required, specify Exterior panels.

TABLE 14

APA RATED STURD-I-FLOOR^a

Span Rating (Maximum Joist Spacing) (in.)	Panel Performance Category ^d	Fastening: Glue-Nailed ^b			Fastening: Nailed-Only		
		Nail Size and Type ^e	Maximum Spacing (in.) ^c		Nail Size and Type ^e	Maximum Spacing (in.) ^c	
	Supported Panel Edges ^f		Intermediate Supports	Supported Panel Edges ^f		Intermediate Supports	
16	19/32, 5/8	6d ring- or screw-shank ^g	6 ^h	12	6d ring- or screw-shank	6	12
20 ⁱ	19/32, 5/8	6d ring- or screw-shank ^g	6 ^h	12	6d ring- or screw-shank	6	12
24	23/32, 3/4	6d ring- or screw-shank ^g	6 ^h	12	6d ring- or screw-shank	6	12
	7/8	8d ring- or screw-shank ^g	6	12	8d ring- or screw-shank	6	12
32	7/8	8d ring- or screw-shank ^g	6	12	8d ring- or screw-shank	6	12
48	1-3/32, 1-1/8	8d ring- or screw-shank ^g	6	k	8d ring- or screw-shank ^g	6	k

- Special conditions may impose heavy traffic and concentrated loads that require construction in excess of the minimums shown. See page 48 for heavy-duty floor recommendations.
- Use only adhesives conforming to ASTM D3498 or APA Specification AFG-01, applied in accordance with the adhesive manufacturer's recommendations. If OSB panels with sealed surfaces and edges are to be used, use only solvent-based glues; check with panel manufacturer.
- Increased fastening schedules may be required where floor is engineered as a diaphragm.
- Panels in a given Performance Category may be manufactured in more than one span rating. Panels with a span rating greater than the actual joist spacing may be substituted for panels of the same Performance Category with a span rating matching the actual joist spacing. For example, Performance Category 19/32 Sturd-I-Floor 20 oc may be substituted for Performance Category 19/32 Sturd-I-Floor 16 oc over joists at 16 inches on center.
- See Table 6, page 17, for nail dimensions.
- Supported panel joints shall occur approximately along the centerline of framing with a minimum bearing of 1/2 inch. Fasten panels 3/8 inch from panel edges.
- 8d common nails may be substituted if ring- or screw-shank nails are not available.
- Check with local building official; some local jurisdictions permit nail spacing at 12 inches o.c.
- While span rating is shown as 20 oc, the actual joist spacing is 19.2 inches.
- 10d common nails may be substituted with Performance Category 1-1/8 panels if supports are well seasoned.
- Space nails maximum 6 inches for 48-inch spans and 12 inches for 32-inch spans.

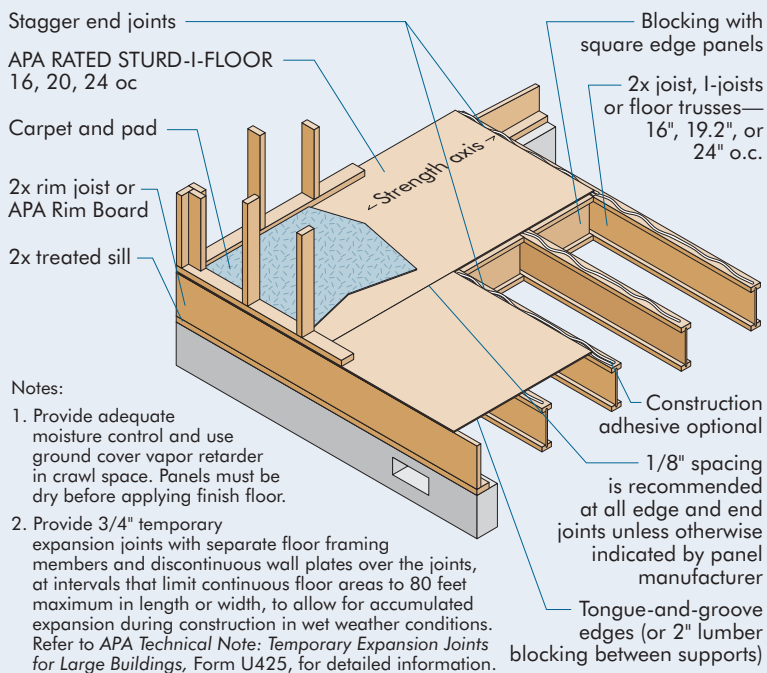
Although STURD-I-FLOOR is suitable for direct application of carpet and pad, an additional thin layer of underlayment is recommended under tile, sheet flooring or fully adhered carpet. This added layer restores a smooth surface over panels that may have been scuffed or roughened during construction or that may not have received a sufficiently sanded surface. When plywood STURD-I-FLOOR with “sanded face” is specified, the surface is also suitable for direct application of resilient floor covering. If a “sanded face” panel is to be used, however, care must be taken during construction to prevent damage or roughening of the sanded face. Tongue-and-groove edges are recommended to be glued under thin floor coverings to assure snug joints.

If the floor has become wet during construction, it should be allowed to dry before application of finish floor, including carpet, underlayment, hardwood flooring and ceramic tile. After it is dry, the floor should be checked for flatness, especially at joints.

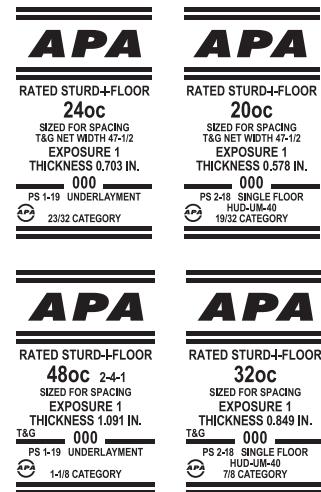
When floor members are dry, make sure fasteners are flush with or slightly below surface of the STURD-I-FLOOR panels just prior to installation of thin floor coverings. Fasteners should be set if green framing will present nail popping problems upon drying. Do not fill nail holes. To minimize the chance of floor squeaks, installers should press panels tightly onto joists by standing on the panel over the joist next to the nailing point. Fill and thoroughly sand edge joints (this step may not be necessary under some carpet and structural flooring products—check recommendations of flooring manufacturer). Fill any other damaged or open areas, such as splits, and sand all surface roughness. Ensure fill compound is fully cured before sanding because it may continue to expand as it cures.

FIGURE 1

APA RATED STURD-I-FLOOR 16, 20, AND 24 oc



TYPICAL FLOOR SHEATHING TRADEMARKS



Sturd-I-Floor 32 oc and 48 oc

Install APA RATED STURD-I-FLOOR 48 oc or 32 oc panels over 2x joists or I-joists spaced 32 inches on center (Figure 2). Install APA RATED STURD-I-FLOOR 48 oc over 4x girders 48 inches on center (Figure 3). For the 48 on center method, supports may be 2x joists spiked together, 4x lumber, glued laminated timber (glulams), lightweight steel beams or wood I-joists or floor trusses. Girders of doubled 2x members should have top edges flush to permit smooth panel end joints.

For a low profile with supports 48 inches on center, beams can be set in foundation pockets or on posts supported by footings so that panels bear directly on the sill. If 4x lumber girders are used, they should be air dried and/or set higher than the sill to allow for shrinkage.

In some applications, particularly in hallways and other heavy traffic areas, greater stiffness in the floor may be desirable. Modifications to the 48-inch framing system, such as addition of straight or diagonal blocking, will increase stiffness considerably.

The APA Glued Floor System

The APA Glued Floor System is based on thoroughly tested gluing techniques and field-applied construction adhesives that firmly and permanently secure a layer of wood structural panels to wood joists.

The glue bond is so strong that floor and joists behave like integral T-beam units. Floor stiffness is increased appreciably over conventional construction, particularly when tongue-and-groove joints are glued. Gluing also helps eliminate squeaks, floor vibration, bounce and nail-popping.

FIGURE 2

APA RATED STURD-I-FLOOR 32 oc AND 48 oc (Over Supports 32" o.c.)

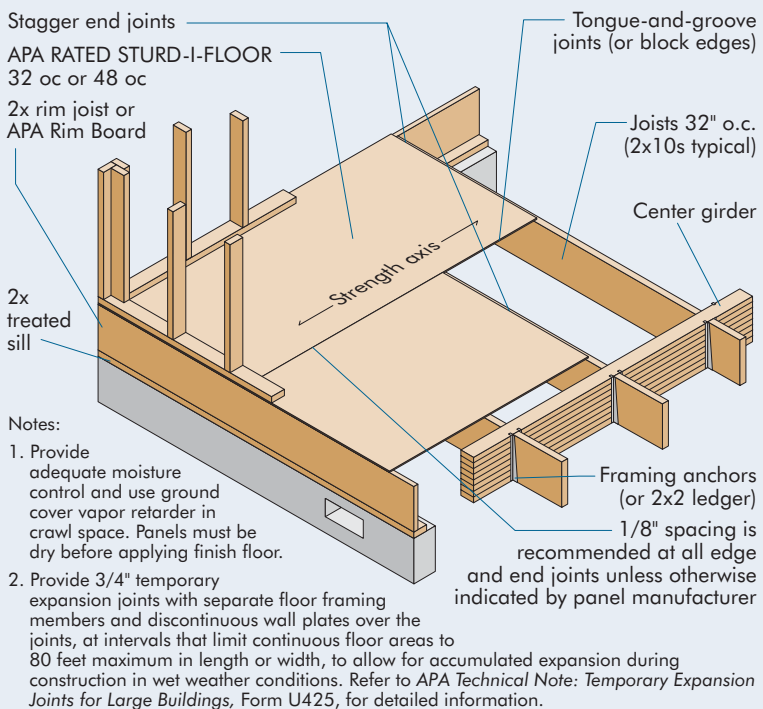
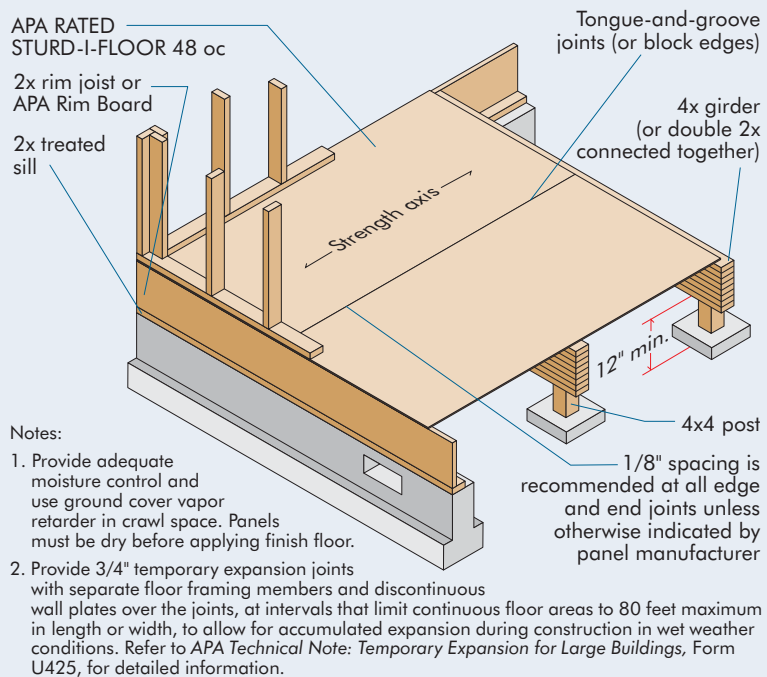


FIGURE 3

APA RATED STURD-I-FLOOR 48 oc (Over Supports 48" o.c.)



Field-glued floors go down quickly, even in cold weather, using ordinary construction materials and techniques. And like many other panel assemblies that provide excellent sound control, the APA Glued Floor System is ideal for multifamily construction. The large panels with glued tongue-and-groove joints reduce the number of cracks that can “leak” airborne noise.

The system is normally built with Span Rated STURD-I-FLOOR panels (Figure 4), although double-layer floors are also applicable. In both cases, STURD-I-FLOOR and subflooring panels should be installed continuous over two or more spans with the long dimension or strength axis across supports.

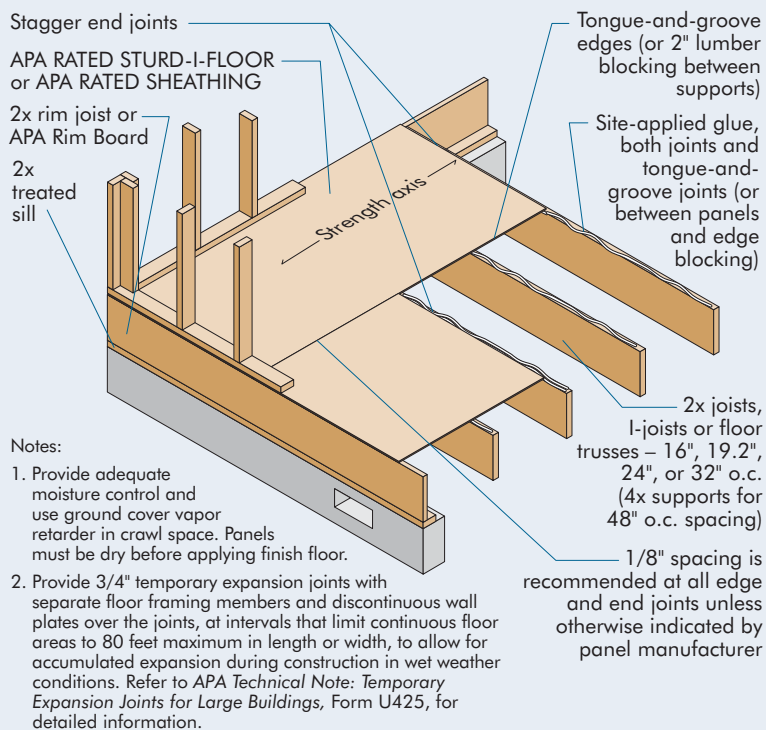
Panels recommended for glued floor construction are tongue-and-groove APA RATED STURD-I-FLOOR for single-floor construction and APA RATED SHEATHING for the subfloor when used with a separate underlayment layer or with structural finish flooring. An additional layer of underlayment should be applied in areas to be finished with resilient floor coverings, such as tile, linoleum, vinyl or fully adhered carpet. If plywood STURD-I-FLOOR with “sanded face” is specified, the surface is suitable for direct application of resilient floor covering and an additional layer is not required. If a “sanded face panel” is to be used, however, care must be taken during construction to prevent damage or roughening of the sanded face. Exposure 1 or Exterior panels have suitable bond performance for applications subject to moisture during or after construction, as in bathrooms and utility rooms.

Tongue-and-groove panels are highly recommended for single-floor construction. Before each panel is placed, a line of glue is applied to the joists with a caulking gun. The panel tongue-and-groove joint should also be glued, although less heavily, to avoid squeeze-out. If square-edge panels are used, edges must be supported between joists with 2x4 blocking. Glue panels to blocking to minimize squeaks. Blocking is not required under structural finish flooring, such as wood strip flooring, or if a separate underlayment layer is installed.

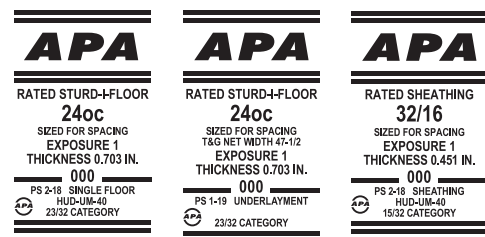
Only adhesives conforming with ASTM D3498 or Performance Specification AFG-01 developed by APA are recommended for use with the glued floor system. A number of brands meeting this specification are available from building supply dealers. If OSB panels with sealed surfaces and edges are to be used, use only solvent-based glues; check with panel manufacturer. Always follow the specific application recommendations of the glue manufacturer.

FIGURE 4

APA GLUED FLOOR SYSTEM



TYPICAL FLOOR SHEATHING TRADEMARKS



Application

For best results, follow these application procedures:

1. Snap a chalk line across joists 4 feet in from wall for panel edge alignment and as a boundary for spreading glue.
2. Spread only enough glue to lay one or two panels at a time or follow specific recommendations of glue manufacturer. Wipe any mud, dirt or water from joists before gluing.
3. Lay first panel with tongue side to wall and nail in place. This protects the tongue of next panel from damage when tapped into place with block and sledgehammer.
4. Apply a continuous line of glue (about 1/4-inch diameter) to framing members. Apply glue in a serpentine pattern on wide areas.
5. Apply two lines of glue on joists where panel ends butt to assure proper gluing of each end.
6. After first row of panels is in place, spread glue in groove of one or two panels at a time before laying next row. Glue line may be continuous or spaced, but avoid squeeze-out by applying a thinner line (1/8 inch) than on joists.
7. Tap second-row panels into place, using a block to protect groove edges.
8. Stagger end joints in each succeeding row, where possible. A 1/8-inch space between all end joints and edges, including tongue-and-groove, is recommended. Use a spacer tool to assure accurate and consistent spacing.
9. Complete all nailing of each panel before glue sets. (See Table 14.) Check the glue manufacturer’s recommendations for allowable time. Warm weather accelerates glue setting. Use 6d ring- or screw-shank nails for panels with a Performance Category of 3/4 or smaller and 8d ring- or screw-shank nails for thicker panels. See Table 6 for nail dimensions. Space nails per Table 14. Closer nail spacing may be required for diaphragm construction. Finished deck can be walked on and will carry construction loads without damage to glue bond.

TABLE 15

RECOMMENDED UNIFORM FLOOR LIVE LOADS FOR APA RATED STURD-I-FLOOR AND APA RATED SHEATHING WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS^a

Sturd-I-Floor Span Rating	Sheathing Span Rating	Minimum Panel Performance Category	Maximum Span (in.)	Allowable Live Loads (psf) ^b							
				Joist Spacing (in.)							
				12	16	19.2	24	32	40	48 ^c	
16 oc	24/16, 32/16	7/16 ^d	16	185	100						
20 oc ^e	40/20	19/32	19.2	270	150	100					
24 oc	48/24	23/32	24	430	240	160	100				
32 oc	NA	7/8	32		405	295	185	100			
48 oc	NA	1-3/32	48			425	290	160	100	55	

- a. Panels 24" or wider applied over two spans or more, dry; normal load duration assumed.
- b. 10 psf dead load assumed. Live load deflection limit is l/360.
- c. 4x nominal or double 2x framing.
- d. 19/32 is minimum Performance Category of Rated Sturd-I-Floor.
- e. While span rating is shown as 20 oc, the actual joist spacing is 19.2 inches.

APA Panel Subflooring

The span ratings in Table 16 apply to APA RATED SHEATHING grades only and are the minimum recommended for the spans indicated. The spans assume panels continuous over two or more spans with the long dimension or strength axis across supports. The span rating in the trademark applies when the long panel dimension or strength axis is across supports unless the strength axis is otherwise identified.

TABLE 16

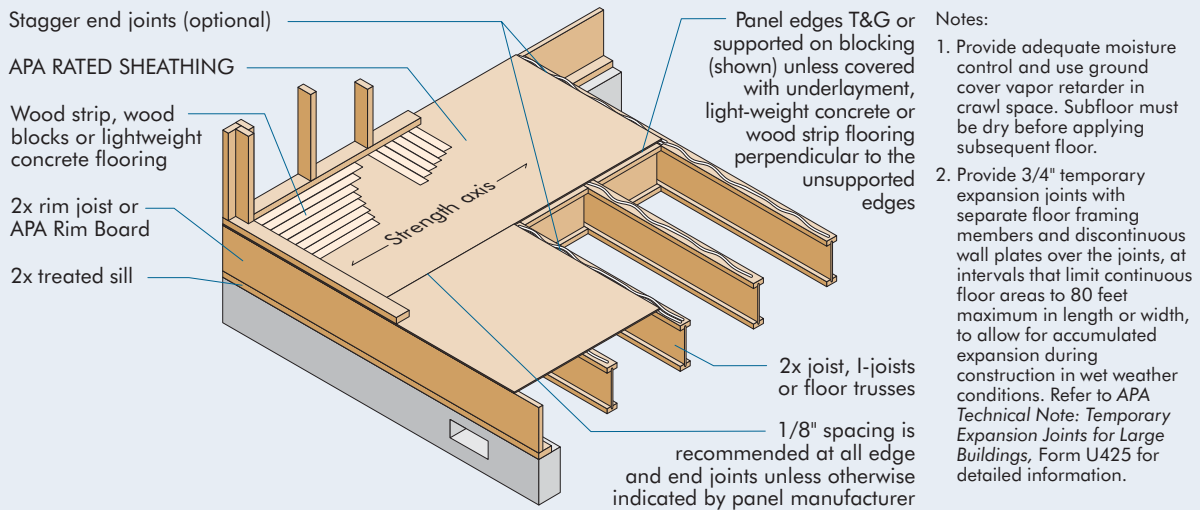
APA PANEL SUBFLOORING (APA RATED SHEATHING)^{a,b}

Panel Span Rating	Panel Performance Category	Maximum Span (in.)	Nail Size & Type ^{c,d}	Maximum Nail Spacing (in.)	
				Supported Panel Edges ^e	Intermediate Supports
24/16	7/16	16	6d common	6	12
32/16	15/32, 1/2	16	6d common ^f	6	12
40/20	19/32, 5/8	19.2 ^f	8d common	6	12
48/24	23/32, 3/4	24	8d common	6	12

- a. For subfloor recommendations under ceramic tile, refer to Table 18. For subfloor recommendations under gypsum concrete, contact manufacturer of floor topping.
- b. APA RATED STURD-I-FLOOR may be substituted when the span rating is equal to or greater than tabulated maximum span.
- c. Other code-approved fasteners may be used.
- d. See Table 6, page 17, for nail dimensions.
- e. Supported panel joints shall occur approximately along the centerline of framing with a minimum bearing of 1/2 inch. Fasteners shall be located 3/8 inch from panel edges.
- f. Span may be 24 inches if a minimum 1-1/2 inches of lightweight concrete is applied over panels.

FIGURE 5

APA PANEL SUBFLOORING



Recommended live loads are given in Table 15. Spans are limited to the values shown because of the possible effect of concentrated loads. Nailing recommendations are given in Table 16. Other code-approved fasteners may be used. APA panel subflooring may also be glued for added stiffness and to reduce squeaks using nailing recommendations in Table 14.

Long edges should be tongue-and-groove or supported with blocking unless:

1. A separate underlayment layer is installed with its joints offset from those in the subfloor. The minimum Performance Category of underlayment should be 1/4 for subfloors on spans up to 24 inches and 11/32 or larger panels on spans greater than 24 inches.
2. A minimum of 1-1/2 inches of lightweight concrete is applied over the panels.
3. 3/4-inch wood strip flooring is installed over the subfloor perpendicular to the unsupported edge.

If the floor becomes wet during construction, it should be allowed to dry before application of finish floor, including underlayment, hardwood flooring, ceramic tile and other flooring. After it is dry, the floor should be checked for flatness, especially at joints.

APA RATED SHEATHING Exposure 1 may be used where temporary exposure to moisture or weather is expected during construction. However, only Exterior panels should be used where long-term exposure to moisture or weather will be required.

In some nonresidential buildings, greater traffic and heavier concentrated loads may require construction in excess of the minimums given. Where joists are 16 inches on center, for example, panels with a span rating of 40/20 or 48/24 will give additional stiffness and strength. For beams or joists 24 or 32 inches on center, 1-1/8 Performance Category panels (APA RATED STURD-I-FLOOR 48 oc) will provide additional stiffness and strength.

APA Panel Floor Diaphragm

Floor framing members sheathed with wood structural panels behave as diaphragms. Diaphragms are typically a flat structural unit acting like a deep, thin beam. Floor diaphragms transfer lateral forces generated from wind, seismic and soil loads. Many floor diaphragms are not designed; they are built following the prescriptive provisions of the building code. In some cases, diaphragms must be designed to resolve significant lateral loads. For designed cases, refer to Table 40 and “APA Panel Roof Diaphragms” on page 84.

For more information about diaphragm design, see *APA Design/Construction Guide: Diaphragms and Shear Walls*, Form L350.

Lightweight Concrete Over APA Panels

APA Rated Sheathing or Sturd-I-Floor panels are an excellent base for lightweight concrete floors. See “APA Rated Sturd-I-Floor,” page 45, or “APA Panel Subflooring,” page 50, for application recommendations. For gypsum concrete recommendations, contact manufacturer of floor topping. Install panels continuous over two or more spans with the strength axis across supports. Use a moisture barrier when recommended by concrete manufacturer. See “Noise Transmission Control” and Figure 39 on page 96 for an illustration of a typical assembly.

APA Plywood Underlayment

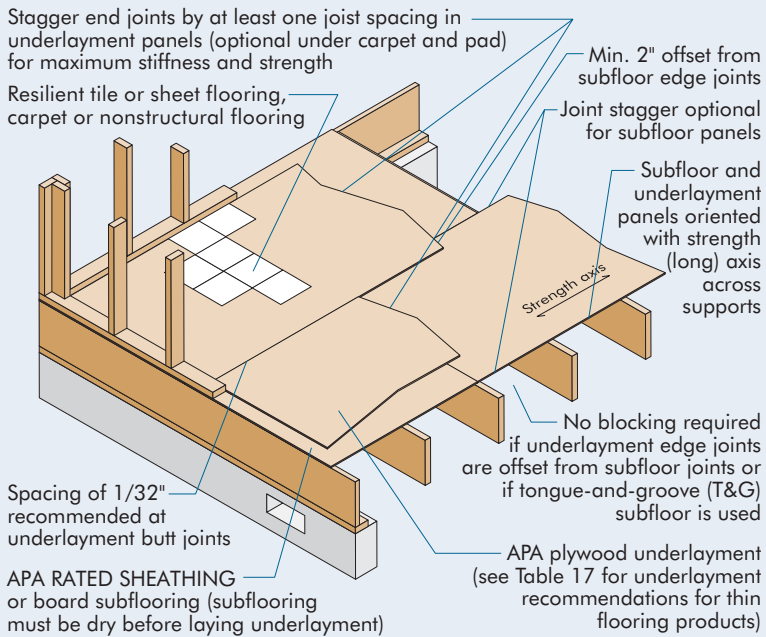
APA Underlayment is a special grade of plywood that has enhanced resistance to face-veneer punctures. This is accomplished by imposing special limitations on the face veneer thickness, species of the face veneer and voids beneath the face veneer. Other grades, such as A-C Exterior, are only suitable if they have the additional underlayment designation or “Plugged Crossbands Under Face” noted in the trademark. Plywood meeting the underlayment standard in PS 1 will have the word “Underlayment” in the trademark (see example on page 11). Plywood Sturd-I-Floor, however, also meets the enhanced puncture-resistance requirements for underlayment, in addition to being span rated. (See “APA Rated Sturd-I-Floor,” page 45.) Refer to *APA Data File: Selection, Installation and Preparation of Plywood Underlayment for Resilient Floor Covering*, Form L335, for installation recommendations.

Underlayment grades of plywood have a solid, touch-sanded surface for direct application of carpet and pad. For areas to be covered with resilient floor covering, specify panels with “sanded face,” or certain other grades as noted in Table 17. Special inner-ply construction of underlayment resists dents and punctures from concentrated loads. Applied as recommended, plywood underlayment is also dimensionally stable and eliminates excessive swelling and subsequent buckling or humps around nails.

Always protect plywood underlayment against physical damage or water prior to application. Panels should, however, be allowed to equalize to atmospheric conditions by standing individual panels on edge for several days before installation.

FIGURE 6

INSTALLATION OF APA PLYWOOD UNDERLAYMENT



Install plywood underlayment, smooth side up, immediately before laying the finish floor. For maximum stiffness, place face grain across supports. Edge joints of underlayment panels should be offset by at least 2 inches from joints of subfloor panels. Underlayment end joints should be offset from subfloor end joints by at least one joist spacing, and underlayment end joints should be offset from floor joists by 2 inches, so that nails miss the framing (to minimize the chance of nail pops).

TABLE 17

APA PLYWOOD UNDERLAYMENT^a

Plywood Grades ^b	Application	Minimum Plywood Performance Category	Fastener Size and Type ^c	Maximum Fastener Spacing (in.) ^d	
				Panel Edges ^e	Intermediate
APA UNDERLAYMENT, APA C-C Plugged EXT, APA RATED STURD-I-FLOOR (19/32 or larger Performance Category)	Over smooth subfloor	1/4	1-1/4" x 0.099" (minimum) ring- or screw-shank nails ^f	3	6 each way
	Over lumber subfloor or uneven surfaces	11/32		6	8 each way

- a. For underlayment recommendations under ceramic tile, refer to Table 18.
- b. In areas to be finished with resilient floor coverings such as tile or sheet vinyl, or with fully adhered carpet, specify Underlayment, C-C Plugged or veneer-faced STURD-I-FLOOR with “sanded face.” Underlayment A-C, Underlayment B-C, Marine EXT or sanded plywood grades marked “Plugged Crossbands Under Face,” “Plugged Crossbands (or Core),” “Plugged Inner Plies” or “Meets Underlayment Requirements” may also be used under resilient floor coverings.
- c. See Table 6, page 17, for nail dimensions.
- d. Fasteners for 5-ply plywood underlayment panels and for panels with a Performance Category greater than 1/2 may be spaced 6 inches on center at edges and 12 inches each way intermediate.
- e. Fasten panels 3/8" from panel edges.
- f. Use 1-1/2" x 0.099" (minimum) ring- or screw-shank nails for underlayment panels with a Performance Category of 19/32 to 3/4.

Begin fastening at one edge next to a preceding panel. Assuring that the panel is uniformly flat, continue by fully fastening toward opposite edge. If power-driven fasteners are used, foot pressure should be applied near the fastener to ensure firm contact between the underlayment and subfloor. Make sure fasteners are flush with, or just slightly below, surface of underlayment just prior to installation of resilient floor coverings such as tile, or sheet vinyl. See Table 17 for underlayment recommendations for thin flooring products. Fill and thoroughly sand edge joints. This step may not be necessary under some carpet and structural flooring products—check recommendations of flooring manufacturer. Fill any other damaged or open areas, such as splits, and sand all surface roughness. Ensure fill compound is fully cured before sanding because it may continue to expand as it cures.

The plywood underlayment needed to bridge an uneven floor will depend on roughness and loads applied. Although a minimum 11/32 Performance Category is recommended, 1/4 Performance Category plywood underlayment may also be acceptable over smooth subfloors, especially in remodeling work. See Table 17.

Where floors may be subject to temporary moisture, use panels with exterior glue (Exposure 1) or APA C-C PLUGGED Exterior. APA C-D PLUGGED is not an adequate substitute for underlayment grade since it does not have equivalent face veneer puncture resistance.

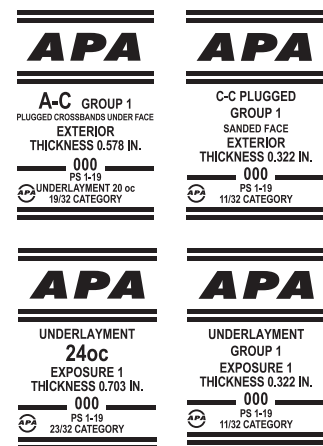
Hardwood Flooring Over APA Panel Subfloors

APA panel subfloor spans for all wood flooring products including solid strip and plank, engineered wood and parquet flooring are limited to maximum spacing of floor framing listed in Table 16. For improved stiffness, spans reduced from the maximum are recommended by the National Wood Floor Association (NWFA)^a. NWFA also recommends the use of minimum 19/32 Performance Category wood structural panels as a subfloor material when joists are spaced at 16 inches on center. For wider spacing, thicker panels are recommended.

Because wood flooring is sensitive to moisture, it is critical that subflooring panels are dry before the flooring is installed. Use a moisture meter calibrated to the specific subflooring panels to measure the moisture content of the subfloor. Do not install wood flooring unless subfloor moisture level is within a range consistent with the wood flooring manufacturer's recommendations. Whether the home is built over a crawl space or basement, make sure that those spaces are dry. Unvented crawl spaces should be well-drained, properly insulated and adequately ventilated. Unvented crawl spaces should be well sealed and insulated around the perimeter and be conditioned using the house's mechanical heating and cooling system, where required by the International Residential Code. APA recommends that both vented and unvented crawl spaces have a properly installed 6-mil minimum polyethylene vapor retarder over the ground. The vapor retarder should also extend up the crawl space perimeter walls where required by the International Residential Code.

Follow the recommendations of the NWFA for the wood flooring product being used for its storage and handling and for acclimatizing the flooring prior to installation on the subflooring. Also see APA Technical Notes: *APA Performance Rated Panel Subfloors under Hardwood Flooring*, Form R280, and *Prevent Callbacks in Wood Flooring Installation*, Form T350.

TYPICAL UNDERLAYMENT TRADEMARKS



a. National Wood Flooring Association, 111 Chesterfield Industrial Boulevard, Chesterfield, Missouri 63005; Phone (800) 422-4556 (USA); (636) 519-9663 (local and international); www.nwfa.org.

Ceramic Tile Over APA Plywood Floors

Recommendations for several plywood floor systems suitable for application of ceramic tile are given in Table 18, based on specifications of the Tile Council of North America (TCNA)^a. In designing such a floor system, expected live loads, concentrated loads, impact loads and dead loads, including weight of the tile and setting bed, need to be considered. For additional details and assemblies, see *Technical Topic: Ceramic Tile Over Wood Structural Panel Floors*, Form TT-006, at www.apawood.org.

TABLE 18

APA FLOOR SYSTEMS FOR CERAMIC TILE FLOORING BASED ON THE TILE COUNCIL OF NORTH AMERICA HANDBOOK FOR CERAMIC, GLASS, AND STONE TILE INSTALLATION

TCNA No.	Service Classification ^{a,b}	Max. Joist Spacing (in. o.c.)	Underlayer Layer	Subfloor Layer	Comment
F141	Light Commercial	16	Mortar bed (1-1/4" minimum, 2" maximum)	19/32" Exposure 1 T&G plywood	—
F142	Residential	16	19/32" Exposure 1 plywood	19/32" Exposure 1 T&G plywood	—
F143	Residential or Light Commercial	16	Light commercial – 19/32" Exposure 1 plywood	19/32" Exposure 1 T&G plywood	15/32" plywood underlayment layer gives "Residential" performance
F144	Residential or Light Commercial	16	Cementitious backer units or fiber cement underlayment	23/32" Exposure 1 T&G plywood	19/32" plywood subfloor gives "Residential" performance
F145	Light Commercial	16	3/4" Minimum to 1-1/2" maximum mortar bed	23/32" Exposure 1 T&G plywood	Cleavage membrane plus metal lath
F146	Light Commercial	16	Coated glass-mat backer board	19/32" Exposure 1 T&G plywood	—
F147	Residential	24 ^c	3/8" Exposure 1 plywood plus uncoupling membrane	23/32" Exposure 1 T&G plywood	4" x 4" or larger tile only
F148	Residential	19.2	Uncoupling membrane	23/32" Exposure 1 T&G plywood	3" x 3" or larger tile only
F149	Residential	24	19/32" Exposure 1 plywood	23/32" Exposure 1 T&G plywood	8" x 8" or larger tile only
F150	Residential or Light Commercial	16	Light commercial – 19/32" Exposure 1 plywood	19/32" Exposure 1 T&G plywood	15/32" plywood underlayment layer gives "Residential" performance
F151	Residential	24	Coated glass-mat backer board	7/8" Exposure 1 T&G plywood	8" x 8" or larger tile only
F152	Residential	24 ^c	3/8" Exposure 1 plywood	23/32" Exposure 1 T&G plywood	4" x 4" or larger tile only
F155	Residential	24	19/32" Exposure 1 plywood	23/32" Exposure 1 T&G OSB or plywood	OSB subfloor OK
F160	Light Commercial	24	3/8" plywood	23/32" Exposure 1 T&G plywood	8" x 8" or larger tile only
F170	Light Commercial	16	Fiber-reinforced gypsum panel	19/32" Exposure 1 T&G plywood	—
F175	Light Commercial	16	Cementitious-coated foam backer board	19/32" Exposure 1 T&G plywood	8" x 8" or larger tile only
F180	Light Commercial	16	Poured gypsum minimum 3/4"	23/32" Exposure 1 T&G plywood	—

Continued on next page

a. Tile Council of North America, Inc., 100 Clemson Research Blvd., Anderson, South Carolina 29625, phone (864) 646-8453, www.tcnatile.com.

TABLE 18 (Continued)

APA FLOOR SYSTEMS FOR CERAMIC TILE FLOORING BASED ON THE TILE COUNCIL OF NORTH AMERICA HANDBOOK FOR CERAMIC, GLASS, AND STONE TILE INSTALLATION

TCNA No.	Service Classification ^{a,b}	Max. Joist Spacing (in. o.c.)	Underlayment Layer	Subfloor Layer	Comment
F185	Residential	19.2	Cementitious self-leveling	23/32" Exposure 1 T&G plywood	—
RH122	Light Commercial	16	Poured gypsum minimum 3/4"	23/32" Exposure 1 T&G plywood	—
RH123	Light Commercial	16	Cementitious self-leveling minimum 1/2"	23/32" Exposure 1 T&G plywood	—
RH130	Residential or Light Commercial	16	Light Commercial – 19/32" Exposure 1 plywood	19/32" Exposure 1 T&G plywood	15/32" plywood Underlayment layer gives "Residential" performance
RH135	Residential or Light Commercial	16	Various backer boards	Light commercial – 23/32" Exposure 1 T&G plywood	19/32" plywood subfloor gives "Residential" performance
RH140	Residential	19.2	Cementitious self-leveling	23/32" Exposure 1 T&G plywood	—
RH141	Light Commercial	16	Cleavage membrane reinforced 1-1/4" minimum to 2" maximum mortar bed	19/32" Exposure 1 T&G plywood	—

- a. Order of increasing serviceability: Residential, Light Commercial, Moderate and Heavy.
- b. As typically performed, the ASTM C627 Robinson-Type Floor Tester delivers three simultaneous, dynamic, 300-pound concentrated wheel loads moving in a 30-inch-diameter circle over the surface of test assembly. The number of cycles the system withstands without failure determines its Service Classification. One criterion used to determine failure is a maximum deflection of L/360 under the three concentrated loads.
- c. 1-1/2 inch net support width permitted with 8x8 inches or larger tile—otherwise 2-1/4 inches net support width is required.

APA Panel Stair Treads and Risers

Builders and manufacturers use APA panels for treads and risers of both site-fabricated and prefabricated stairs in closed-riser stairways. Risers support the front and back of the tread, creating a very short effective span.

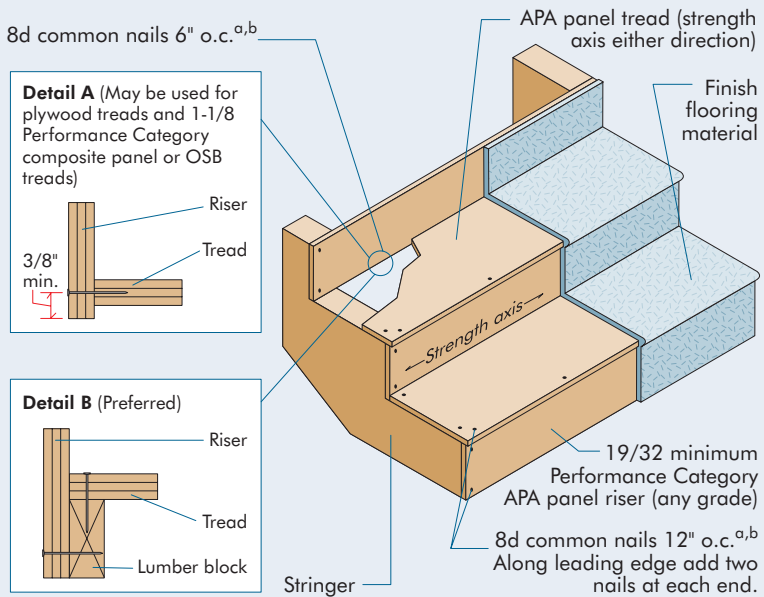
APA panel stair treads may be used interchangeably with boards when the system is to include closed risers. Maximum span between stringers is 42 inches (check local code requirements). Rounded nosing may be machined into the tread but should be covered by a finish flooring material such as carpet and pad in order to prevent excessive wear or damage to veneers exposed by rounding. Risers may be any available APA panel grade with a Performance Category of at least 19/32. Panel grade and Performance Category recommendations for the treads are given in Table 19. Glue is recommended to improve stiffness of connections and to eliminate squeaks. Apply construction adhesive meeting ASTM D3498 or APA Performance Specification AFG-01 to all joints, with particular attention to the connection at the back riser. Regardless of where glue is used, nail all edges of treads as indicated in Figure 7. Detail A is the simplest system, but Detail B is preferred since it eliminates end-grain nailing at the back riser and may be used for all recommended panels.

Heavy Duty Plywood Floors

Above-grade plywood floors may be designed to support forklift trucks in areas of heavy loading or to support relatively high loads imposed by warehouse shelving or stacked storage. Heavy-duty plywood floors also make excellent mezzanine decks and vibration-resistant surfaces for mounting computer equipment. Tables 20 and 21 give plywood recommendations for uniform and concentrated (e.g., forklift traffic) loads. These assume the use of plywood continuous over two or more spans with face grain across supports. Structural edge support must be provided where high concentrated loads occur. Where no lift-truck use is expected, 2-inch wood framing is adequate. In addition to providing structural strength, a wearing surface should be provided to resist crushing wood cells and avoid abrasion whenever an industrial floor is subject to hard wheel or caster traffic. An expendable layer of plywood or a dense wear surface, such as tempered hardboard, should be used if wheels are small, hard or heavily loaded.

FIGURE 7

APA PANEL STAIR TREADS AND RISERS



- a. Predrill tread end grain at mid-thickness with 3/32" bit. Maintain at least 3/8" edge distance in riser.
- b. See Table 6, page 17, for nail dimensions.

TABLE 19

APA PANEL STAIR TREADS

Panel Grade ^a	Minimum Performance Category	
	Nail Glued	Nailed-Only
APA RATED STURD-I-FLOOR	19/32	23/32

a. Other appropriate APA panel grades may be substituted for Sturd-I-Floor, providing minimum thickness complies with recommendations above.

TABLE 20

PS 1 PLYWOOD SPAN RATING OR PERFORMANCE CATEGORY RECOMMENDATIONS FOR UNIFORMLY LOADED HEAVY DUTY FLOORS^a (Deflection limited to 1/240 of span.)

Uniform Live Load (psf)	Center-to-Center Support Spacing (in.) (Nominal 2-Inch-Wide Supports Unless Noted)					
	12 ^b	16 ^b	19.2 ^b	24 ^b	32	48 ^c
50	32/16, 16 oc	32/16, 16 oc	40/20, 20 oc	48/24, 24 oc	48 oc	48 oc
100	32/16, 16 oc	32/16, 16 oc	40/20, 20 oc	48/24, 24 oc	48 oc	1-1/2 ^d
125	32/16, 16 oc	32/16, 16 oc	40/20, 20 oc	48/24, 24 oc	48 oc	1-3/4 ^d , 2 ^d
150	32/16, 16 oc	32/16, 16 oc	40/20, 20 oc	48/24, 48 oc	48 oc	1-3/4 ^e , 2 ^d
200	32/16, 16 oc	40/20, 20 oc	48/24, 24 oc	48 oc	1-1/8 ^e , 1-3/8 ^d	2 ^e , 2-1/2 ^d
250	32/16, 16 oc	40/20, 24 oc	48/24, 48 oc	48 oc	1-3/8 ^e , 1-1/2 ^d	2-1/4 ^e
300	32/16, 16 oc	48/24, 24 oc	48 oc	48 oc	1-1/2 ^e , 1-5/8 ^d	2-1/4 ^e
350	40/20, 20 oc	48/24, 48 oc	48 oc	1-1/8 ^e , 1-3/8 ^d	1-1/2 ^e , 2 ^d	
400	40/20, 20 oc	48 oc	48 oc	1-1/4 ^e , 1-3/8 ^d	1-5/8 ^e , 2 ^d	
450	40/20, 24 oc	48 oc	48 oc	1-3/8 ^e , 1-1/2 ^d	2 ^e , 2-1/4 ^d	
500	48/24, 24 oc	48 oc	48 oc	1-1/2 ^d	2 ^e , 2-1/4 ^d	

- a. Use plywood with T&G edges, provide structural blocking at panel edges or install a separate underlayment.
- b. A-C Group 1 sanded plywood panels may be substituted for span rated Sturd-I-Floor panels (1/2 Performance Category for 16 oc; 5/8 Performance Category for 20 oc; 3/4 Performance Category for 24 oc).
- c. Nominal 4-inch-wide supports.
- d. Group 1 face and back, any species inner plies, sanded or unsanded, single layer. Numbers given are Performance Categories.
- e. All-Group 1 or Structural I plywood, sanded or unsanded, single layer. Numbers given are Performance Categories.

TABLE 21

PS 1 PLYWOOD SPAN RATING OR PERFORMANCE CATEGORY RECOMMENDATIONS FOR FLOORS CARRYING FORK-TRUCK TRAFFIC^{a,b,c} (Plywood grade is all-Group 1 or Structural I A-C or C-C Plugged, except where 1-1/8 STURD-I-FLOOR 48 oc is noted.)

Tire Tread Print Width (in.)	Load per Wheel (lbs.)	Center-to-Center Support Spacing (in.) (Minimum 3-Inch-Wide Supports)			
		12	16	19.2	24
3	500	48 oc	48 oc	48 oc	48 oc
	1000	1-1/4	1-1/4	1-1/4	1-1/4
	1500	1-1/2	1-3/4	1-3/4	1-3/4
	2000	2	2	2-1/4	2-1/4
5	1000	48 oc	48 oc	1-1/8	1-1/8
	1500	1-1/8	1-1/8	1-1/4	1-1/4
	2000	1-1/4	1-1/2	1-1/2	1-3/4
	2500	1-1/2	2	2	2
	3000	1-3/4	2	2-1/4	2-1/4
7	2000	1-1/8	1-1/8	1-1/4	1-1/4
	3000	1-1/4	1-1/2	1-1/2	1-3/4
	4000	1-3/4	1-3/4	1-3/4	2
	5000	2	2	2-1/4	2-1/2
	6000	2-1/4	2-1/2	2-3/4	3
9	3000	1-1/4	1-1/4	1-1/4	1-1/4
	4000	1-1/2	1-1/2	1-3/4	1-3/4
	5000	1-3/4	1-3/4	2	2
	6000	2	2	2-1/4	2-1/4
	7000	2-1/4	2-1/4	2-3/4	2-3/4

- a. Structural blocking (3x4 or 2x6 min.) required at all panel edges. Support blocking with framing anchors of adequate capacity or similar devices.
- b. Provide a wearing surface such as Plyon, polyethylene or a separate layer of plywood, hardboard or other hard surface when loads are due to casters, or small, hard wheels. A wearing surface should also be considered for areas where fork-truck traffic is stopping, starting or turning in a tight radius.
- c. Use ring- or screw-shank nails with length sufficient to penetrate framing 1-1/2 inches or panel thickness, whichever is greater. Space nails maximum 4 inches o.c. at panel edges and 8 inches o.c. at intermediate supports.

Floor Construction

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:

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