Stairwell Openings in APA PRI I-Joist Floors

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When designing an APA PRI I-joist floor for a residential structure, the designer is often faced with detailing an unsupported stairwell opening in the floor. The following information simplifies the selection of trimmers and headers, provides guidance on the appropriate detailing for their use, and quantifies hanger capacity requirements for I-joist-to-header and header-to-trimmer intersections.

General

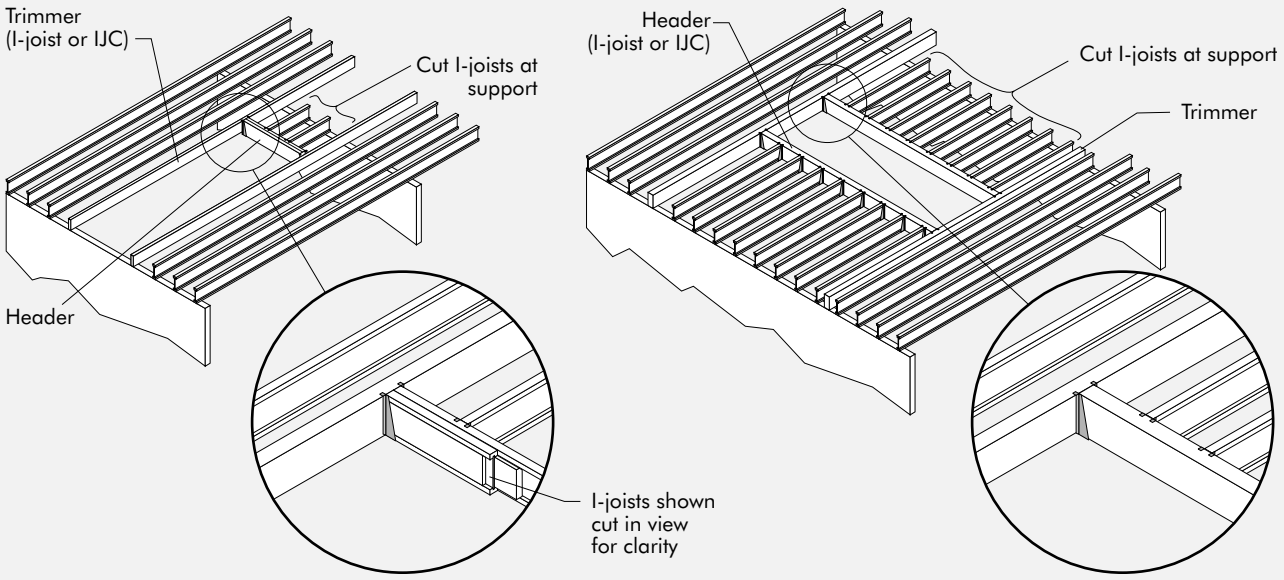
These recommendations are based on the use of APA PRI joists used in either single or multiple maximum allowable spans for residential applications per PRI-400, and on a **total load of 50 psf** for the floor and stair areas. The information provided is appropriate for stairwell openings from **10.5 ft to 12 ft in length and 48 inches in width,** whose long dimension is either running parallel **or** perpendicular to the joist span, as shown in Figure 1. *When these recommendations are followed, it is unnecessary to support the stairwell opening from below with vertical framing members.* For stairwells parallel to the I-joist span, it is also assumed that there is a **non-load-bearing partition load of 64 plf** along one header and one trimmer. For stairwells perpendicular to the I-joist span, there is assumed to be a non-load-bearing partition load of 64 plf along both headers and on the trimmer.

Limitations

The stair stringers may be attached to the header/trimmer at either end of the

FIGURE 1

STAIRWELL OPENINGS IN PRI I-JOIST FLOORS



a. Stairwell Parallel to I-joist Span

b. Stairwell Perpendicular to I-joist Span

TERMS:

Header:	Framing member that supports the cut ends of I-joists
Trimmer:	Framing member that supports the header

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stairwell opening. For stairwells parallel or perpendicular to the I-joist spans, the opening may be placed anywhere in the floor without regard to the support of the floor framing.

Stairwells Parallel to I-Joist Span

The most common method for placing a stairwell in a wood-framed floor is to run the long axis of the opening parallel to the span of the I-joist. This generally requires smaller headers and trimmers than the perpendicular orientation.

Table 1 is a guide for determining the suggested (minimum capacity) I-joist requirement or the capacity of other engineered wood members required to frame the headers and trimmers seen in Figure 1a.

Caution: In situations where the stairwell runs parallel to the floor joists and the floor joists are installed over two or more spans, the header supporting the continuous floor joists may be subjected to uplift loads caused by the floor joists it supports. Cutting the interrupted joists at the center support will eliminate this uplift load. If this method is selected, the designer will have to insure that the maximum allowable ***simple*** *span for the I-joist is not exceeded. An alternative method would be to leave the floor joists continuous over the interior support and design the header and hangers for the resulting uplift loads.*

Stairwell Design and Detailing

The strength and stiffness requirements for headers and trimmers of stairwells fabricated in APA PRI I-joist floors in residential structures are shown in Table 1. The header and trimmer requirements can be satisfied by the use of single or double I-joists, or engineered wood headers or trimmers in I-joist-compatible depths (IJCs). Glulam beams or laminated veneer lumber are recommended (see Tables A1, A2a, and A2b). Double I-joist construction is covered in Appendix B along with the proper sizing of backer blocks for use with hangers. *The use of more than two I-joists is not recommended due to the difficulty in adequately connecting the joists together.*

TABLE 1

REQUIRED HEADERS AND TRIMMERS FOR STAIRWELL OPENINGS PARALLEL TO PRI I-JOIST FLOOR

Max. I-Joist Clear Span (ft)	Header Requirements[1]				Joist to Header Hanger Requirement[2]
	Suggested I-joist	Alternative IJC			
		Moment (lbf-ft)	Shear (lbf)	EI (10^6 lb-in.^{2})	
14	(1 ea) 9-1/2" PRI-30	875	875	15	Type A
16	(1 ea) 9-1/2" PRI-50	975	975	17	Type A
18	(1 ea) 9-1/2" PRI-40	1,075	1,075	19	Type A
20	(1 ea) 11-7/8" PRI-40	1,175	1,175	20	Type A
22	(1 ea) 11-7/8" PRI-80	1,275	1,275	22	Type A

Max. I-Joist Clear Span (ft)	Trimmer Requirements				Header to Trimmer Hanger Requirement[2]
	Suggested I-joist	Alternative IJC			
		Moment (lbf-ft)	Shear (lbf)	EI (10^6 lb-in.^{2})	
14	(2 ea) 9-1/2" PRI-50	6,125	1,900	270	Type A
16	(2 ea) 11-7/8" PRI-50	7,600	2,050	390	Type A
18	(2 ea) 11-7/8 PRI-70	9,225	2,200	530	Type A
20	(2 ea) 11-7/8 PRI-70	11,000	2,350	700	Type A
22	(2 ea) 11-7/8 PRI-90	12,925	2,450	920	Type A

Notes: 1. Header length not to exceed 48".
2. Type A face or top-mounted hanger – 1450 lbf.

Headers: The stairwell header may be made up of the single I-joist as specified in Table 1, although some designers may prefer to use a double I-joist for framing. Also provided are minimum moment, shear, and stiffness (EI) requirements for IJC engineered wood products that may be used in lieu of the I-joist. If another I-joist is going to be substituted for the specified I-joist, all of the design capacities of the desired I-joist must be checked against those for the suggested I-joist.

Install backer blocks (see Appendix B) behind any face- or top-mounted hangers attached to an I-joist or double I-joist header.

The headers are attached to the trimmers with metal hangers, as shown in Figure 1. Select hangers that are sized to fit the dimensions of the single I-joist, double I-joist or engineered wood headers and

TABLE 2

REQUIRED HEADER AND TRIMMER CAPACITIES FOR STAIRWELL OPENINGS PERPENDICULAR TO PRI I-JOIST FLOORS

Max. I-Joist Clear Span (ft)	Header Requirements[1]				
		Alternative IJC Requirement			Joist to Header Hanger Requirement[2]
	Suggested I-joist	Moment (lbf-ft)	Shear (lbf)	EI (10^6 lb-in.^{2})	
14	(2 ea) 9-1/2" PRI-30	5,400	1,800	232	Type A
16	(2 ea) 9-1/2" PRI-60	6,300	2,100	278	Type A
18	(2 ea) 11-7/8" PRI-60	7,200	2,400	325	Type A
20	(2 ea) 11-7/8" PRI-90	8,100	2,700	371	Type A
22	(Use Alternative IJC)	9,000	3,000	419	Type A

Max. I-Joist Clear Span (ft)	Trimmer Requirements				
		Alternative IJC			Header to Trimmer Hanger Requirement[2]
	Suggested I-joist	Moment (lbf-ft)	Shear (lbf)	EI (10^6 lb-in.^{2})	
14	Use Alternative IJC	11,200	3,900	562	Type B
16		14,600	4,400	818	Type B
18		18,400	4,800	1,152	Type B
20		22,600	5,300	1,548	2,700 lbf
22		27,200	5,700	2,021	3,000 lbf

Notes: 1. Header length not to exceed 12 feet.
2. Type A face- or top-mounted hanger – 1450 lbf
Type B face- or top-mounted hanger – 2500 lbf

that have a minimum capacity of 1,450 lbf for all applications in Table 1. (See "Header to Trimmer Hanger Requirements" in Table 1.) The largest total hanger capacity required at each end of the header is 1,450 lbs. As also shown in Table 1, under "Joist to Header Hanger Requirement," hangers of the same 1,450 lbf capacity may also be used where the floor I-joists intersect the header.

Trimmers: Like headers, Table 1 also gives the required moment, shear, and stiffness capacities for use in selecting alternative IJC engineered wood products.

For headers and trimmers alike, Appendix A contains capacities for a number of common IJC LVL and glulam products to assist the designer in selecting the proper size when the engineered wood option is used.

Stairwells Perpendicular to I-Joist Span

Often the floor plan or architectural details of the building are such that it is not possible to orient the stairwell axis parallel to the I-joist span. In such cases, the trimmers are placed parallel to the I-joist span and support the headers by way of metal hangers. The headers, in turn, support the cut ends of the floor joists also via metal hangers. This relationship can be seen in Figure 1b. In addition to the header load, the trimmers are designed to carry the concentrated loads of the stair stringers.

Caution

Because the headers intersect the span of the floor joists over a large length (up to 12 ft), in cases where the floor joists are used continuous over multiple spans, special design consideration must be given to the adjacent clear span to insure adequate floor performance. To eliminate design problems and allow maximum flexibility in locating the stairwell, consider limiting the maximum allowable spans for continuous floors containing stairwells perpendicular to I-joist spans to those given for single span floors.

Upward thrust acting on the header adjacent to a center support can be eliminated by cutting the I-joists at the center of the support, thus providing two simple spans where the I-joists are interrupted by the headers. An alternative method would be to leave the floor joists continuous over the interior support and design the header and hangers for the resulting uplift loads.

Stairwell Design and Detailing

For a given maximum I-joist clear span, Table 2 gives the required moment, shear, and stiffness capacities for both the headers and trimmers.

When the stairwell is framed perpendicular to the I-joist span, the trimmers run parallel to the I-joist span and are placed up to 12 ft apart. The headers form the long-side boundaries of the stairwell, carry the weight of the cut floor joists and are connected to the trimmers with metal hangers. The required capacity of these hangers is given in Table 2 under the column entitled "Header to Trimmer Hanger Requirement." The required capacities for the metal hangers supporting the floor joists where they intersect

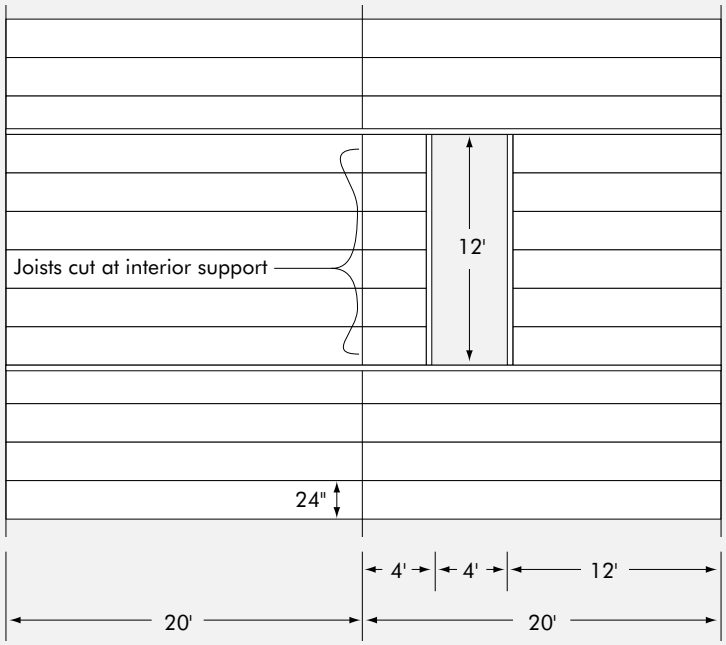
the headers is also given in Table 2 under "Joist to Header Hanger Requirement."

Headers: Because of the increased load on the headers when the stairwells are located perpendicular to the floor joists, it is often impractical to use double I-joists for these applications. For this reason, Table 2 provides the suggested double I-joist, where appropriate, as well as the required allowable bending, shear, and stiffness capacities for the headers for these spans. IJC engineered wood products such as LVL or glulam beams are encouraged for these applications because of their size compatibility, superior performance, ease of use, and low moisture content. See Tables A1, A2a, and A2b for moment, shear and stiffness capacities for some commonly available LVL and glulam members in I-joist-compatible depths. If other I-joists are substituted for the suggested joists, all of the design properties for the desired I-joist must be checked against those for the suggested I-joists.

Trimmers: Most double I-joists do not have the capacity for use as trimmers in situations where the stairwell is placed perpendicular to the floor joists. As such, in the "Trimmer Requirements" section of Table 2, only IJC requirements for moment, shear, and stiffness are given. Again, Tables A1, A2a, and A2b are provided for selecting glulam beams or LVL.

FIGURE 2

DESIGN EXAMPLE – STAIRWELL PERPENDICULAR TO I-JOIST SPAN



Design Example

Given

A designer's plan for a residential floor called for the use of a 14" PRI-80 over two 20-foot spans. The joists are to be placed at 24 inches on center and placed continuously over the center span. A stairwell whose long axis is oriented perpendicular to the span of the I-joists is to be placed in the floor, as shown in Figure 2.

Stairwell Design

Check of floor design: As the stairwell is to be placed perpendicular to the I-joist span, check both the simple and multiple maximum spans for a 14" PRI-80 floor joist to insure that the required span is less. (For maximum allowable spans, see Design/Construction Guide: *I-Joists for Residential Floor Construction,* Form No. X710.) Maximum allowable simple span for a 14" PRI-80 at 24 inches on center is 22 ft-8 in.> 20 ft – **OK.** Maximum allowable multiple span for a 14" PRI-80 at 24 inches on center is 23 ft-11 in. > 20 ft – **OK.**

Design header and trimmer: Use an IJC header and trimmer with a depth of 14 inches to frame the opening. From Table 2, for an I-joist span of 20 ft, the maximum moment, shear and EI requirements for a header are 8,100 lbf-ft, 2,700 lbf and 371 x 10^6 lb-in.^{2}, respectively. For trimmers, these values are 22,600 lbf-ft, 5,300 lbf and 1,548 x 10^6 lb-in.^{2}

LVL Solution:

Select header: Try an LVL header 1-3/4 in. wide by 14 in. deep. (See Table A1)

Moment capacity available = 13,552 ft-lb, 8,100 ft-lb required **– OK**

Shear capacity available = 4,655 lbf, 2,700 lbf required **– OK**

Stiffness available = 800 x 10^6 lb-in.^{2}, 371 x 10^6 lb-in.^{2} required **– OK**

Select trimmer: Try an LVL trimmer 5-1/4 in. wide by 14 in. deep.

Moment capacity available = 40,655 ft-lb, 22,600 ft-lb required **– OK**

Shear capacity available = 13,965 lbf, 5,300 lbf required **– OK**

Stiffness available = 2,401 x 10^6 lb-in.^{2}, 1,548 x 10^6 lb-in.^{2} required **– OK**

Required capacities for hanger selection: Floor joist to header hanger capacity required – from Table 2 **– Type A (1,450 lbf)**

Header to trimmer hanger capacity required – from Table 2 **– 2,700 lbf**

Glulam Solution:

Select header: Try a Douglas-fir 24F, glulam header 3-1/2 in. wide by 14 in. deep. (See Table A2a)

Moment capacity available = 22,867 ft-lb, 8,100 ft-lb required **– OK**

Shear capacity available = 7,840 lbf, 2,700 lbf required **– OK**

Stiffness available = 1,441 x 10^6 lb-in.^{2}, 371 x 10^6 lb-in.^{2} required **– OK**

Select trimmer: Try a Douglas-fir 24F, glulam trimmer 5-1/2 in. wide by 14 in. deep.

Moment capacity available = 35,933 ft-lb, 22,600 ft-lb required **– OK**

Shear capacity available = 12,320 lbf, 5,300 lbf required **– OK**

Stiffness available = 2,264 x 10^6 lb-in.^{2}, 1,548 x 10^6 lb-in.^{2} required **– OK**

Required capacities for hanger selection: Floor joist to header hanger capacity required – from Table 2 **– Type A (1,450 lbf)**

Header to trimmer hanger capacity required – from Table 2 **– 2,700 lbf**

APPENDIX A

Alternative I-Joist Compatible (IJC) Headers and Trimmers

TABLE A1

APA PRL-501 LVL BEAM CAPACITY

LVL Depth (in.)	LVL Thickness											
	1-3/4"			3-1/2"			5-1/4"			7"		
	Moment (ft-lb)	Shear (lb)	EI (x10^6 lb-in.^{2})	Moment (ft-lb)	Shear (lbf)	EI (x10^6 lb-in.^{2})	Moment (ft-lb)	Shear (lb)	EI (x10^6 lb-in.^{2})	Moment (ft-lb)	Shear (lb)	EI (x10^6 lb-in.^{2})
9-1/2	6,361	3,159	250	12,723	6,318	500	19,084	9,477	750	25,446	16,635	1,000
11-7/8	9,940	3,949	488	19,879	7,897	977	29,819	11,845	1,465	39,758	15,793	1,954
14	13,552	4,655	800	27,103	9,310	1,601	40,655	13,965	2,401	54,206	18,620	3,201
16	17,407	5,320	1,195	34,814	10,640	2,389	52,221	15,960	3,584	69,627	21,280	4,779

LVL capacities based on a minimum:
E = 2,000,000 psi
F_b = 2,900 psi x $(12/d)^{1/8}$
F_v = 285 psi

TABLE A2a

DOUGLAS-FIR GLULAM BEAM CAPACITY

Glulam Beam Depth (in.)	Glulam Beam Thickness								
	3-1/2"			5-1/2"			7"		
	Moment (ft-lb)	Shear (lbf)	Stiffness (10^6 lb-in.^{2})	Moment (ft-lb)	Shear (lbf)	Stiffness (10^6 lb-in.^{2})	Moment (ft-lb)	Shear (lbf)	Stiffness (10^6 lb-in.^{2})
9-1/2	10,529	5,320	450	16,546	8,360	707	21,058	10,640	900
11-7/8	16,452	6,650	879	25,853	10,450	1,382	32,904	13,300	1,758
14	22,867	7,840	1,441	35,933	12,320	2,264	45,733	15,680	2,881
16	29,967	8,960	2,150	46,933	14,080	3,397	59,733	17,920	4,301

Glulam capacities based on a minimum:
E = 1,800,000 psi
F_b = 2,400 psi x volume factor at max. I-joist span (16" o.c.)
F_v = 240 psi

TABLE A2b

SOUTHERN PINE GLULAM BEAM CAPACITY

Glulam Beam Depth (in.)	Glulam Beam Thickness								
	3-1/2"			5-1/2"			7"		
	Moment (ft-lb)	Shear (lbf)	Stiffness (10^6 lb-in.^{2})	Moment (ft-lb)	Shear (lbf)	Stiffness (10^6 lb-in.^{2})	Moment (ft-lb)	Shear (lbf)	Stiffness (10^6 lb-in.^{2})
9-1/2	13,161	5,985	525	20,682	9,405	825	26,323	11,970	1,050
11-7/8	20,565	7,481	1,026	32,316	11,756	1,612	41,130	14,963	2,051
14	28,583	8,820	1,681	44,917	13,860	2,641	57,167	17,640	3,361
16	37,333	10,080	2,509	58,667	15,840	3,942	74,667	20,160	5,018

Glulam capacities based on a minimum:
E = 2,100,000 psi
F_b = 3,000 psi x volume factor at max. I-joist span (16" o.c.)
F_v = 270 psi

APPENDIX B

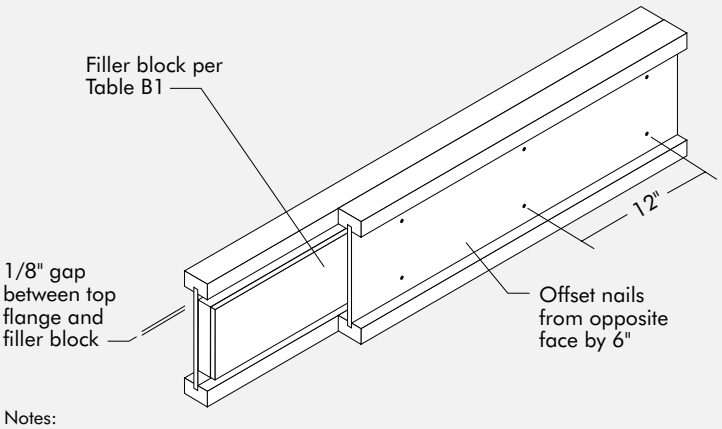
I-Joist Construction Details

DOUBLE I-JOIST CONSTRUCTION

Where two I-joists are used together, as in the case of stairwell headers or trimmers, the I-joists shall be attached in accordance with Figure B1 with the requisite filler blocking sized as shown in Table B1.

FIGURE B1

DOUBLE I-JOIST CONSTRUCTION



Notes:

1. Support back of I-joist web during nailing to prevent damage to web/flange connection.
2. Leave a 1/8-inch gap between top of filler block and bottom of top I-joist flange.
3. Filler blocks are required for double I-joists at point loads, such as at hanger locations, and full length under parallel partition walls.
4. Nail joists together with two rows of 10d nails at 12 inches o.c. (clinched when possible) on each side of the double I-joist. Total of 4 nails per foot required.

TABLE B1

FILLER BLOCK REQUIREMENTS FOR DOUBLE PRI I-JOIST CONSTRUCTION

Flange width (in.)	PRI depth (in.)	Filler block size (net size)
1-1/2	9-1/2	1-1/8" x 6" high
	11-7/8	1-1/8" x 8" high
1-3/4	9-1/2	1-3/8" x 6"
	11-7/8	1-3/8" x 8"
	14	1-3/8" x 10"
	16	1-3/8" x 12"
2-5/16	11-7/8	2" x 8"
	14	2" x 10"
	16	2" x 12"
2-1/2	9-1/2	2-1/8" x 6"
	11-7/8	2-1/8" x 8"
	14	2-1/8" x 10"
	16	2-1/8" x 12"
3-1/2	11-7/8	3" x 8"
	14	3" x 10"
	16	3" x 12"

Note: A minimum utility grade, SPF (south) or better for solid-sawn lumber and APA Rated Sheathing or Sturd-I-Floor grade for wood structural panels is required for filler block construction.

BACKER BLOCK CONSTRUCTION

Size backer blocks in accordance with Table B2. When backer blocks are used in conjunction with face-mounted hangers, install a second block on the back side of the I-joist if a filler block is not present.

Before installing a backer block to a double I-joist, drive three additional 10d nails through the webs and filler block where the backer block will fit. Clinch nails. Install backer tight to top flange. Use twelve 10d nails to install backer block, clinch when possible. Blocks must be long enough to permit required nailing without splitting.

TABLE B2

BACKER BLOCK SIZE

Flange Width (in.)	Material Thickness Required (in.)	Minimum Backer Block Depth (in.)	
		Top-Mounted Hanger	Face-Mounted Hanger
1-1/2	19/32	5-1/2	For 1-1/2" thick flanges use joist depth less 3-1/4", or For 1-5/16" thick flanges use joist depth less 2-7/8".
1-3/4	23/32	5-1/2	
2-5/16	1	7-1/4	
2-1/2	1	5-1/2	
3-1/2	1-1/2	7-1/4	

Notes:

1. Blocks must be long enough to permit required nailing without splitting.
2. The minimum grade backer block material required is Utility grade S-P-F (south) or better lumber or APA Rated Sheathing grade or Sturd-I-Floor wood structural panels.

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