Evaluation Report CCMC 13032-R
Nordic I-Joist Series

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Revised:	2020-04-09

1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "Nordic I-Joist Series", when used as joists in floor and roof applications in accordance with the conditions and limitations stated in Section 3 of this Report, complies with the National Building Code 2010:

- Clause 1.2.1.1.(1)(a), Division A, using the following acceptable solutions from Division B:
  - Sentence 4.3.1.1.(1), CAN/CSA-O86-09, Engineering Design in Wood (i.e., Code-specified I-joist qualification)

- Clause 1.2.1.1.(1)(b), Division A, as an alternative solution that achieves at least the minimum level of performance required by Division B in the areas defined by the objectives and functional statements attributed to the following applicable acceptable solutions:
  - Article 9.10.8.10., Application to Houses (Fire rating is not required for single-family houses constructed as per Part 9 of the NBC, conventional wood-frame construction)(1);
  - Sentence 9.23.4.2.(2), Spans for Joists, Rafters and Beams (i.e., alternative floor joist solution) This opinion is based on

CCMC's evaluation of the technical evidence in Section 4 provided by the Report Holder.

(1) Sections 4.2 and 4.3 of this Report provide 'fire protection' options for this proprietary floor joist system as an alternative solution to the acceptable solution in Part 9 for conventional wood-frame floor construction. The proposed joists' fire protection options, referenced in Section 4.2 and 4.3 and listed in Appendix B, are provided to the authority having jurisdiction (AHJ) for information purposes. The fire protection options, proposed and explained in Sections 4.2 and 4.3, are provided by the joist manufacturer and the fire performance has been reviewed by CCMC as performing 'as well as' the inherent fire resistance of exposed lumber floors.

Ruling No. 06-05-149 (13032-R) authorizing the use of this product in Ontario, subject to the terms and conditions contained in the Ruling, was made by the Minister of Municipal Affairs and Housing on 2006-03-02 (revised on 2014-10-27) pursuant to s.29 of the Building Code Act, 1992 (see Ruling for terms and conditions). This Ruling is subject to periodic revisions and updates.

2. Description

The products are a series of prefabricated wood I-joists consisting of two continuous proprietary grade spruce-pine-fir (S-P-F) flanges glued to a 9.5-mm or 11.1-mm-thick oriented strandboard (OSB) web. The flange sizes and grades are listed in Table 2.1 below.

The web-flange connection is made by inserting the profiled OSB web into a tapered groove in the flange's centre. The OSB web material is manufactured in 2 454-mm lengths and end-jointed by glueing a full thickness vee or butt joint.

The web/web joint, flange/web joint and the flange finger joints are bonded with a polyurethane adhesive (see CCMC 13512-L, CCMC 13513-L and CCMC 13591-L).

APA – The Engineered Wood Association (APA EWS trademark) conducts regular audits of the manufacturing plant and the quality assurance program as part of the product certification.

Table 2.1 "Nordic I-joist" Flange Sizes and Grades

Nordic I-Joist	Depth (mm)	Grade	Flange Size (mm)	Web Thickness (mm)
NI-20	235-302	S-P-F No. 2	38 x 63.5	9.5
NI-40	241-406	MSR 1650f-1.5E	38 x 63.5	9.5
NI-40x	200-406	Enhanced[1] 1650f-1.5E	38 x 63.5	9.5
NI-60	200-457	MSR 2100f-1.8E	38 x 63.5	9.5
NI-70	200-457	MSR 1950f-1.7E	38 x 89	9.5
NI-80	200-406	MSR 2100f-1.8E	38 x 89	9.5
NI-80x	457-610	MSR 2100f-1.8E	38 x 89	11.1
NI-90	302-406	MSR 2400f-2.0E	38 x 89	11.1
NI-90x	302-406	Glue laminated wood[2]	51 x 89	11.1

Notes to Table 2.1:

1 "Enhanced" flange material refers to a proprietary grade conforming to additional grade rules specified within the quality control manufacturing program.

2 This flange material is a proprietary grade flange of face-glued lumber elements (3-19 mm x 89 mm) manufactured by Nordic Engineered Wood as a qualified glulam manufacturer.

3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the "Nordic I-Joist Series" being used in accordance with the conditions and limitations set out below.

- The product series are intended for structural applications, such as floor, ceiling or roof joists, and are intended for dry service use[1] applications only.
- The following pre-engineering information has been provided to CCMC by Nordic Engineered Wood to demonstrate compliance with Part 9 of the NBC 2010 for acceptance by the local authority having jurisdiction (AHJ):

i. **Nordic Structures' Pre-engineered Floor Span Charts**

When the products are used to support uniform loads only, the installation must be in accordance with the span tables (including vibration criteria[2]) found in the specifier's guides, in limit states design for Canada, entitled:

1. "Nordic Joist Installation Guide for Residential Floors," dated September 2013;
2. "Nordic Joist Residential Design/Construction Guide," dated January 2014;
3. "Nordic Joist 9-1/4" and 11-1/4" NI-40x I-Joists," dated September 2013;
4. "Nordic Joist Residential I-Joists," dated September 2013;
5. "Nordic Joist Light-Commercial I-Joists," dated September 2013; and
6. "Nordic Joist, Roof Details," dated September 2013.

The products must be installed in accordance with Nordic Engineered Wood's installation guidelines noted in these documents for applications falling within the scope of the documents. Applications outside the scope of these installation guidelines shall require engineering on a case-by-case basis.

ii. **Nordic Structures' Pre-engineered Installation Details**

The products must be installed in accordance with Nordic Engineered Wood's pre-engineered details outlined in the documents specified in 3(i) above, where the following details are not exceeded:

- rim board maximum vertical load;
- squash blocks maximum vertical load;
- blocking panel maximum vertical load;
- web stiffeners requirements; stair opening header;
- loadbearing cantilever load table;
- cantilever balcony;
- web hole tables;
- roof joist details; and
- roof uniform load tables.

iii. **Engineering Required**

For structural applications beyond the scope/limitations of the above-referenced Nordic Engineered Wood's publications or when required by the AHJ, the drawings or related documents must bear the authorized seal of a professional engineer skilled in wood design and licensed to practice under the appropriate provincial or territorial legislation.

Installations beyond the scope/limitations of 3(i) and 3(ii) imply, but are not limited to, the following:

- higher loads/longer spans than the manufacturer's pre-engineered details;
- concentrated loads;
- offset bearing walls;
- areas of high wind or high seismicity;
- stair openings;
- design of supporting wall studs/beams when the total load exceeds the NBC 2010 pre-engineered floor/roof joist tables; and
- design of supporting foundation footings when the total load exceeds the NBC 2010 pre-engineered floor/roof joist tables.

The engineer must design in accordance with CAN/CSA-O86-09 and may use, as a guide, the *Engineering Guide for Wood-Frame Construction*, published by the Canadian Wood Council.

iv. **Engineering Support Provided by Manufacturer**

Nordic Engineered Wood does provide engineering support in conjunction with Nordic Engineered Wood product support. Nordic Engineered Wood offers the following support contact information:

Telephone: (514) 871-8526

E-mail: info@nordicewp.com

- These products must be identified with the phrase "CCMC 13032-R" along the side of the flange. This CCMC number is only valid when it appears in conjunction with the APA EWS certification mark.
- Damaged or defective joists must not be used, unless repaired in accordance with written instructions from the manufacturer.

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1 *All lumber, wood-based panels and proprietary engineered wood products are intended for "dry service conditions." "Dry service" is defined as the in-service environment under which the equilibrium moisture content (MC) of lumber is 15% or less over a year and does not exceed 19% at any time. Wood contained within the interior of dry, heated or unheated buildings has generally been found to have a MC between 6% and 14% according to season and location. During construction, all wood-based products should be protected from the weather to ensure that the 19% MC is not exceeded in accordance with the NBC 2010, Division B, Article 9.3.2.5.*

2 *In cases where concrete topping is applied or bridging/blocking is used and joists are installed at the maximum spans, the current vibration criteria may not address all occupant performance expectations. Nordic Engineered Wood should therefore be consulted for span adjustments, if necessary, in these types of installations.*

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4. Technical Evidence

The Report Holder has submitted technical documentation for CCMC's evaluation. Testing was conducted at laboratories recognized by CCMC. The corresponding technical evidence for this product is summarized below.

4.1 General

4.1.1 Design Values

Table 4.1.1 Product Engineering Properties[1]

Joist Depth (mm)	Joist Series	EI[2] (×10^6 kN·mm^2)	M_r[3] (N·m)	V_r[4] (N)	K[5] (×10^3 kN)	Factored Uniform Vertical Load Resistance[6] (kN/m)
235	NI-20	396	5 660	7 580	21.40	48.7
	NI-40x	568	6 335	8 210	21.40	
	NI-60	623	8 300	8 210	21.40	
	NI-80	872	11 760	8 210	21.40	
241	NI-20	416	5 840	7 860	21.97	48.7
	NI-40	554	6 165	8 430	21.97	
	NI-40x	626	6 540	8 430	21.97	
	NI-60	663	8 590	8 430	21.97	
	NI-70	872	11 545	8 430	21.97	
	NI-80	930	12 145	8 430	21.97	
286	NI-20	637	7 115	9 410	26.02	48.7
	NI-40x	898	7 970	9 900	26.02	
	NI-60	996	10 440	9 900	26.02	
	NI-80	1 389	14 795	9 900	26.02	
302	NI-20	726	7 565	9 970	27.49	48.7
	NI-40	947	7 995	10 390	27.49	
	NI-40x	1 065	8 480	10 390	27.49	
	NI-60	1 136	11 130	10 390	27.49	
	NI-70	1 478	14 960	10 390	27.49	
	NI-80	1 570	15 740	10 390	27.49	
	NI-90	1 725	19 800	13 520	27.49	
	NI-90x	1 765	21 345	14 430	27.49	

Table 4.1.1 Product Engineering Properties[1] (cont.)

Joist Depth (mm)	Joist Series	EI[2] ($\times 10^6$ kN·mm^2)	M_r[3] (N·m)	V_r[4] (N)	K[5] ($\times 10^3$ kN)	Factored Uniform Vertical Load Resistance[6] (kN/m)
356	NI-40	1 383	9 630	12 150	32.38	48.7
	NI-40x	1 550	10 215	12 150	32.38	
	NI-60	1 676	13 405	12 150	32.38	
	NI-70	2 149	18 015	12 150	32.38	
	NI-80	2 302	18 955	12 150	32.38	
	NI-90	2 517	23 835	14 920	32.38	
	NI-90x	2 612	25 740	15 520	32.38	
406	NI-40	1 885	11 160	13 830	37.01	48.7
	NI-40x	2 106	11 840	13 830	37.01	
	NI-60	2 293	15 550	13 830	37.01	
	NI-70	2 913	20 895	13 830	37.01	
	NI-80	3 134	21 975	13 830	37.01	
	NI-90	3 406	27 645	16 360	37.01	
	NI-90x	3 573	29 540	16 360	37.01	
457	NI-60	2 924	17 590	14 040	41.64	45.0
	NI-80x	4 015	24 780	16 570	41.64	31.0
508	NI-80x	5 082	27 770	17 200	46.26	31.0
559	NI-80x	6 288	30 770	17 760	50.89	31.0
610	NI-80x	7 634	33 770	18 260	55.51	31.0

Notes to Table 4.1.1:

1 The tabulated values are for the standard term of load duration (K_D = 1.0). All values, except for EI and K, shall be permitted to be adjusted for other load durations as permitted by the NBC.

2 Bending stiffness (EI) of the I-joists

3 Factored moment resistance (M_r) of the I-joists, which cannot be increased by any Code-allowed system effect factor

4 Factored shear resistance (V_r) of the I-joists

5 Coefficient of shear deflection (K). For calculating uniform load centre-span deflection of the I-joist in a simple-span application, use the following equation:

$$\text{deflection} = \frac{5wL4}{384EI} + \frac{wL_2}{K}$$

where w = load (kN/mm), L = span (mm), EI and K are taken from Table 4.1.1

6 Factored uniform vertical load resistance of the I-joist when used as blocking (i.e., squash blocks).

Table 4.1.2 Product Factored Reaction Resistances [1] [2] [3] [4]

Joist Depth (mm)	Joist Series	Intermediate Reaction (N)				End Reaction (N)			
		89-mm Brg. Length		140-mm Brg. Length		45-mm Brg. Length		102-mm Brg. Length	
		With Brg. Stiffeners		With Brg. Stiffeners		With Brg. Stiffeners		With Brg. Stiffeners	
		No	Yes	No	Yes	No	Yes	No	Yes
235	NI-20	16 500	16 570	17 620	17 620	7 130	7 130	7 580	7 580
	NI-40x	16 500	16 570	17 800	17 900	7 970	7 970	8 210	8 210
	NI-60	16 500	16 670	17 830	17 900	7 970	7 970	8 210	8 210
	NI-80	16 500	18 040	18 110	18 110	8 210	8 210	8 210	8 210
241	NI-20	16 920	17 030	18 080	18 080	7 270	7 270	7 860	7 860
	NI-40	16 920	17 030	18 460	18 570	8 250	8 420	8 420	8 420
	NI-40x	16 920	17 030	18 460	18 570	8 250	8 420	8 420	8 420
	NI-60	16 960	17 130	18 500	18 710	8 250	8 420	8 420	8 420
	NI-70	16 960	18 750	18 850	18 850	8 420	8 420	8 420	8 420
	NI-80	16 960	18 750	18 850	18 850	8 420	8 420	8 420	8 420
286	NI-20	19 970	20 150	21 380	21 380	8 350	8 350	9 410	9 410
	NI-40x	19 970	20 150	23 170	23 380	8 780	9 900	9 900	9 900
	NI-60	20 010	20 400	23 240	23 700	8 780	9 900	9 900	9 900
	NI-80	20 010	22 150	23 940	23 940	9 340	9 900	9 900	9 900

Table 4.1.2 Product Factored Reaction Resistances [1] [2] [3] [4] (cont.)

Joist Depth (mm)	Joist Series	Intermediate Reaction (N)				End Reaction (N)			
		89-mm Brg. Length		140-mm Brg. Length		45-mm Brg. Length		102-mm Brg. Length	
		With Brg. Stiffeners		With Brg. Stiffeners		With Brg. Stiffeners		With Brg. Stiffeners	
		No	Yes	No	Yes	No	Yes	No	Yes
302	NI-20	21 060	21 270	22 570	22 570	8 740	8 740	9 970	9 970
	NI-40	21 060	21 270	24 850	25 100	8 950	10 390	10 390	10 390
	NI-40x	21 060	21 270	24 850	25 100	8 950	10 390	10 390	10 390
	NI-60	21 100	21 550	24 920	25 450	8 950	10 390	10 390	10 390
	NI-70	21 100	23 380	25 770	25 770	9 480	10 390	10 390	10 390
	NI-80	21 100	23 380	25 770	25 770	9 480	10 390	10 390	10 390
	NI-90	23 550	23 550	25 770	25 770	9 830	10 390	13 230	13 520
	NI-90x	29 280	29 280	29 280	29 280	12 390	14 430	13 230	14 430
356	NI-40	21 980	22 190	24 780	25 030	9 300	11 870	10 880	12 150
	NI-40x	21 980	22 190	24 780	25 030	9 300	11 870	10 880	12 150
	NI-60	22 050	22 890	24 850	26 640	9 440	11 870	10 880	12 150
	NI-70	23 380	25 560	26 820	28 610	10 220	11 870	10 880	12 150
	NI-80	23 380	25 560	26 820	28 610	10 220	11 870	10 880	12 150
	NI-90	23 550	25 560	26 820	28 610	10 220	11 870	13 230	14 920
	NI-90x	29 280	29 280	29 280	29 280	12 640	15 520	13 230	15 520
406	NI-40	22 850	23 060	24 710	24 960	9 620	13 160	10 880	13 830
	NI-40x	22 850	23 060	24 710	24 960	9 620	13 160	10 880	13 830
	NI-60	22 920	24 150	24 780	27 770	9 900	13 160	10 880	13 830
	NI-70	25 560	27 590	27 800	31 280	10 880	13 160	10 880	13 830
	NI-80	25 560	27 590	27 800	31 280	10 880	13 160	10 880	13 830
	NI-90	25 560	27 590	27 800	31 280	10 880	13 160	13 230	16 360
	NI-90x	29 280	29 280	29 280	29 280	12 850	16 320	13 230	16 360
457	NI-60	19 660	25 420	22 890	28 890	10 360	14 040	12 990	14 040
	NI-80x	21 870	26 820	23 030	31 030	9 130	13 340	12 990	16 570

Joist Depth (mm)	Joist Series	Intermediate Reaction (N)				End Reaction (N)			
		89-mm Brg. Length		140-mm Brg. Length		45-mm Brg. Length		102-mm Brg. Length	
		With Brg. Stiffeners		With Brg. Stiffeners		With Brg. Stiffeners		With Brg. Stiffeners	
		No	Yes	No	Yes	No	Yes	No	Yes
508	**NI-80x**	22 400	28 930	23 940	32 120	9 270	14 360	13 340	17 200
559	**NI-80x**	22 920	31 070	24 820	33 210	9 410	15 410	13 690	17 760
610	**NI-80x**	23 450	33 170	25 730	34 300	9 550	16 430	14 040	18 250

Notes to Table 4.1.2:

1 The tabulated end and intermediate reaction values must not be greater than the bearing capacity of the flanges based on the specified compressive strength perpendicular to grain of 5.3 MPa when determined in accordance with CAN/CSA-O86. Consult with the manufacturer for the factored compressive strength perpendicular to the grain of the flange for bearing design.

2 The tabulated values are for the standard term of load duration (K_D = 1.0) and are permitted to be adjusted for other load durations as permitted by the NBC.

3 Factored reaction resistance is permitted to be increased over that tabulated for the minimum bearing length by linear interpolation of the reaction resistance between the minimum and maximum bearing lengths. Extrapolation beyond the minimum and maximum bearing lengths is beyond the scope of this Table.

4 The manufacturer must be consulted for the design of web stiffeners, where web stiffeners are required.

4.2 Additional Performance Data Submitted by the Report Holder

This section is beyond the scope of CCMC's opinion in Section 1 related to the evaluation of structural performance in Section 4.1. The performance of the fire protection options has been reviewed by CCMC and is presented as additional information for AHJs.

4.2.1 Background

The following information is intended to be used by the AHJ when it is deemed that fire performance of the alternative solution perform 'as well as' the code-specified exposed lumber joists. The engineered joist manufacturer (Report Holder) has submitted to CCMC the fire protection options for their proprietary joist system when used in single-family houses (unsprinklered). The submission was in response to the decision by the Canadian Commission on Construction Materials Evaluations (CCCME) as outlined in Section 4.3 of this Report.

4.2.3 Proposed Fire Protection Options

The manufacturer's solutions for proposed fire protection of their proprietary joists are presented in Appendix B. The CCMC has reviewed the fire testing and analysis of the fire protection options compared to the fire performance of unprotected exposed 38x235mm (2×10) floor joist system(1). The fire testing demonstrated that the proposed fire protection options perform 'as well as' exposed 38x235mm (2×10) lumber joists. It should be noted that the NBC exempts single-family houses constructed using conventional wood-frame construction, in accordance with Part 9, from requiring a fire-resistance rating (see Article 9.10.8.10. of Division B of the NBC 2015). The proposed fire protection options for proprietary alternative floor joists are not to be considered in sprinklered single-family houses or where fire-resistance-rated assemblies are required.

1. Structural composite lumber, as defined in CSA O86 and evaluated by CCMC, is considered to have equivalent fire performance to lumber for joists of the same size.

4.3 Additional Health and Safety Data Identified by Third Parties

This section is beyond the scope of CCMC's opinion in Section 1 related to the evaluation of structural performance in Section 4.1. The performance of the fire protection options has been reviewed by CCMC and is presented as additional information for AHJs.

4.3.1 Canadian Commission on Construction Materials Evaluations (CCCME) – Fire Safety

The minimum fire performance of innovative structural materials or 'alternative solutions' as compared to the NBC-specified conventional wood-frame construction or 'acceptable solution' has been a subject of analysis and discussion for several years among fire officials, provincial and territorial regulators and AHJs. The NRC fire tests(1) conducted between 2002 and 2008 demonstrated that the innovative structural joist systems tested and which are currently in the marketplace (i.e., I-joists, C-channel steel joists, metal-plated wood trusses and metal-web trusses) had a time-to-collapse below the performance of exposed 38x235mm (2×10) lumber joists (which is considered the benchmark or 'acceptable solution'). At the May 2018 and October 2019 meetings of the CCCME, the Commission directed CCMC to provide 'floor fire performance information' to the local AHJs across Canada to aid their decision making on whether the fire performance of floors (i.e., the time to evacuate before failure occurs) for alternative joist systems is to perform 'as well as' the inherent fire performance of exposed 38x235mm (2×10) lumber joists. Testing has been carried out that follows the principles expressed in Appendix D of Division B of the NBC. Following the direction of the CCCME, this CCMC Evaluation Report has been modified to provide this manufacturer's information.

The CCCME asked CCMC to review and validate the fire-test data from manufacturers, and publish the fire performance to assist the AHJ's decision regarding fire protection for alternative solutions to exposed lumber floor joists of conventional wood-frame construction. The CCMC has agreed to review the proposed fire protection alternatives and provide the AHJ with valid fire protection options. It is confirmed that the I-joist fire protection solutions submitted by this manufacturer have been reviewed by CCMC and are outlined in Appendix B. These joist fire protection options, tested by following the principles of CAN/ULC-S101 floor test(2), are considered by CCMC as having performed as well as exposed 38x235mm (2×10) lumber joists.

(1) Fire Performance of Houses. Phase I. Study of Unprotected Floor Assemblies in Basement Fire Scenarios, RR-252, 2008-12-15

(2) Essentially following the ULC S101 time-temperature curve, the floor joists loaded to in-service loads and structural joist failure as the criterion.

Report Holder

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Date modified:
2020-04-10

APPENDIX A

The characteristic values meeting ASTM D 5055-08a, "Standard Specification for Establishing and Monitoring Structural Capacities of Pre- fabricated Wood I-Joists," as specified in CAN/CSA-O86-09, are summarized below. The manufacturer's published pre-engineered joist spans were designed in accordance with CAN/CSA-O86-09.

Table A1. Additional Product Testing Information

Property	Test Information
Shear capacity	The shear capacity of the specimens was established by combining data in accordance with ASTM D 5055-04. Data from quality control (QC) tests were used to establish the applicable coefficient of variation, CV_w, and the reliability normalization factor from Table 13.2.3.2 of CAN/CSA-O86-01 was used to determine the specified strength.
Moment capacity	The moment capacity qualification was carried out using the analytical method based on the characteristics of the flange material, with confirmatory testing in accordance with ASTM D 5055-04. Data from QC tests were used to establish the applicable coefficient of variation, CV_w, and the reliability normalization factor from Table 13.2.3.2 of CAN/CSA-O86-01 was used to determine the specified strength.
Stiffness	An appropriate test program was used to confirm the stiffness capacity. The following formula was used to predict mid-span deflection: $\text{deflection} = \frac{5wL^4}{384EI} + \frac{wL^2}{K}$ where w = load (kN/mm), L = span (mm), EI and K are taken from Tables 4.1.1.1 and 4.1.1.2
End joints	End joints were qualified as part of the flange tension qualification. The flanges are in-plant finger-joined, and regular tension testing is conducted.
Creep	Specimens were tested for creep performance in accordance with ASTM D 5055-04. The specimens recovered more than 90% of the basic dead load deflection.
Bearing length	End and intermediate reactions were tested and calculated in accordance with ASTM D 5055-12 and CAN/CSA-O86-09 where the applicable coefficient of variation, CV_w, and the reliability normalization factor from Table 13.2.3.2 of CAN/CSA-O86-01 was used to determine the specified strength.
Adhesive qualification	The web/web joint, flange/web joint and flange finger joints are bonded with a polyurethane adhesive (see CCMC 13512-L, CCMC 13513-L and CCMC 13591-L).
Web stock	The web stock complies with CAN/CSA-O325.0-92, "Construction Sheathing."

Appendix B

B-1 CCMC Important Note from the CCMC Registry of Product Evaluations

Fire Performance of Innovative Structural Products in Houses

This Registry contains opinions on the suitability-for-use of products intended as structural elements in houses. Although historically there has been no need to regulate the structural fire performance of houses, an inherent intent of the National Building Code of Canada (NBC) is that occupants have sufficient time to escape from a building in the event of a fire.

There are many factors that may determine whether that intent is achieved. The fire endurance of structural elements may be one. However, its importance may be minimized by other factors such as combustible content load, early warning devices, smoke movement and toxicity, and fire department response time; all contributing to the overall system performance. Research is underway within the NRC Construction Research Centre to determine the critical factors that affect occupant escape from houses.

Some innovative structural products have been used in the marketplace for several years and have gained the confidence of design professionals, code authorities and users with respect to their performance under typical fire scenarios in today's house system. Some newer products have not been in service long enough to have gained that confidence and may present a more obvious concern.

Unless otherwise stated, innovative structural products for houses have not been evaluated in the context of the NBC intent noted above. As is the case for all innovative products, designers and authorities need to exercise judgment in considering the use of innovative structural products for houses.

B-2 Nordic I-Joist Series Joists – Fire Protection Options

The following seven (8) options of I-joist floor fire protection alternative solutions are provided by the manufacturer[1]. These floor assemblies have demonstrated fire performance as good as conventional wood-frame 38x235mm (2×10) exposed-floor construction.

The details of the following fire protection floor assemblies are outlined in the Figures 1 to 8, below.

1) Fire Protection of Floors FP-01 – 12.5 mm (1/2 in.) Gypsum Board Attached to Bottom of Flange;
2) Fire Protection of Floors FP-02 – 12.5 mm (1/2 in.) Gypsum Board Attached Directly to Web;
3) Fire Protection of Floors FP-03 – 12.5 mm (1/2 in.) Gypsum Board Attached Directly to Sides of Flange;
4) Fire Protection of Floors FP-04 – Mineral Wool Insulation[2];
5) Fire Protection of Floors FP-06 – 12.5 mm (1/2 in.) Gypsum Board Installed on Top of the Bottom Flange;
6) Fire Protection of Floors FP-07 – 15.8 mm (5/8 in.) Gypsum Board Installed on Top of the Bottom Flange;
7) Fire Protection of Floors FP-09 – Rockwool SAFE'n'Sound® Mineral Wool Insulation.[2]
8) Fire Protection of Floors - FP Nordic FP-01 – 11mm (7/16 in.) Plywood/OSB Attached to Each Side of Web

(1) Note. These floor assemblies and supporting fire test data have been provided to CCMC by the I-joist industry in collaboration with the APA-Engineered Wood Association. The floor assemblies, Figures 1 to 7, contained herein reviewed by the CCMC provide equivalent fire performance to exposed 38x235mm (2×10) lumber joists, and are a subset of those published in APA System Report SR-405G dated April 2019.

(2) Note. For assemblies where mineral-fibre insulation is installed to provide joist protection in a fire, as per 2015 NBC, Sentence 9.25.2.3. (7), any insulation that may be subjected to mechanical damage is to be protected by a covering such as gypsum board, plywood, particleboard, OSB or hardboard.

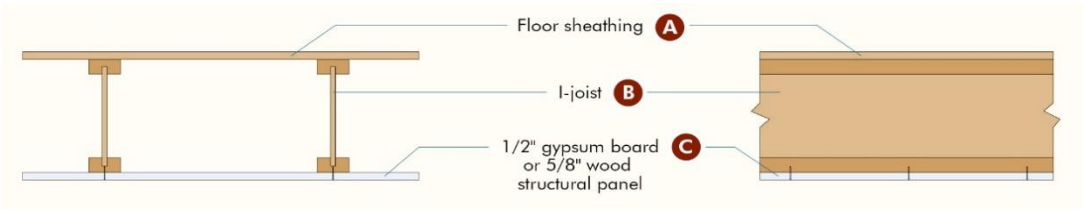
Table B2. Applicable Nordic Series Joists for Fire Protection Assemblies based on Flange Size.

Product	Flange Size (width × thickness) (mm)	Fire Protection Assembly
NI-20	38 x 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09, FP Nordic FP-01
NI-40	38 x 63.5	
NI-40x	38 x 63.5	
NI-60	38 x 63.5	
NI-70	38 x 89	
NI-80	38 x 89	
NI-80x	38 x 89	
NI-90	38 x 89	
NI-90x	51 x 89	

Figures 1 to 7 of Fire Protection Assemblies

The following floor assembly design (Figure 1) is the default alternative solution for all cases and where the manufacturer has not undertaken any specific testing to show equivalency to exposed 38x235mm (2×10) lumber with proprietary joist fire protection options.

1/2-IN. GYPSUM BOARD ATTACHED TO BOTTOM OF FLANGE



A. Floor sheathing: materials and installation in accordance with the NBC 2015.

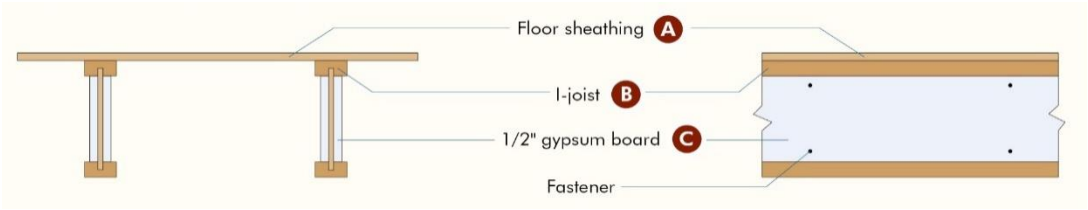
B. I-joist: installation in accordance with Section 3 of this Report. Maximum 24 in. on centre spacing. Applicable to all flange sizes. Minimum web thickness of 9.5 mm (3/8 in.).

C. 12.5 mm (1/2 in.) gypsum board: materials and installation in accordance with the NBC 2015. 1×3 (nominal) wood furring strips are permitted to be installed perpendicular to the bottom flange of the I-joists at 400 mm (16 in.) on centre provided that the gypsum boards are directly attached to the furring strips using 32 mm (1-1/4 in.) Type W drywall screws at 300 mm (12 in.) on centre. Gypsum board not required to be finished with tape and joint compound.

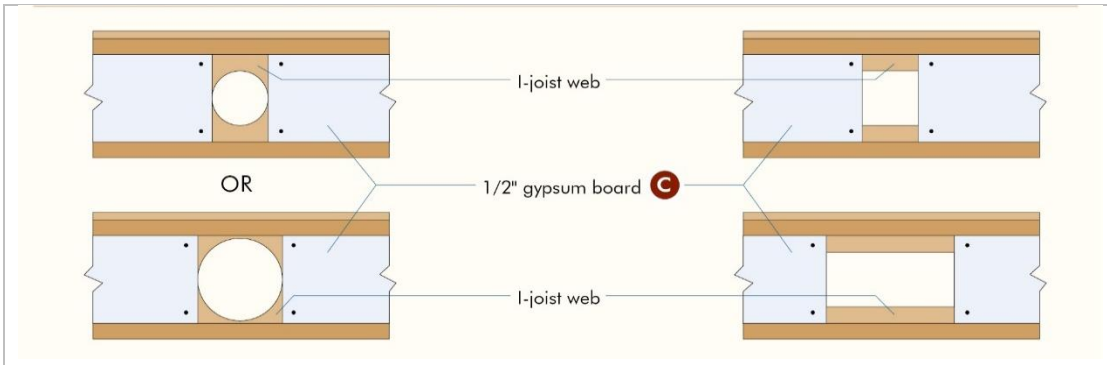
Figure 1. Fire Protection of Floors FP-01 – Fire Protection: 12.5 mm (1/2 in.) Gypsum Board Attached to Bottom of Flange.

The following fire resistance designs, Figures 2 to 7, provided by the manufacturer provide fire performance as good as to 2×10 dimensional lumber exposed floor joists.

12.5 MM (1/2 IN.) GYPSUM BOARD ATTACHED TO WEB



INSTALLATION REQUIREMENTS AT WEB HOLES



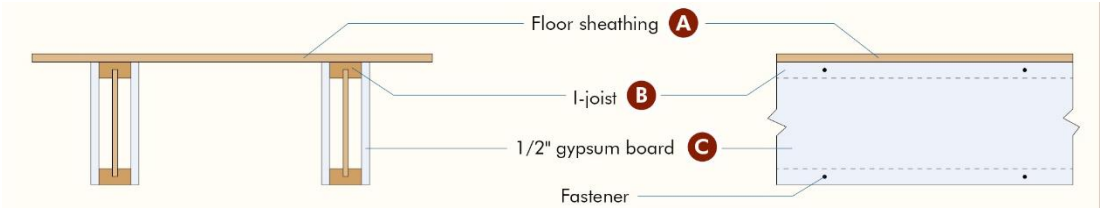
A. **Floor sheathing: materials and installation in accordance with the NBC 2015.**

B. **I-joist: installation in accordance with Section 3 of this Report. Maximum 24 in. on centre spacing. Minimum flange size of 38 mm (1-1/2 in.) thick × 50 mm (2 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.). At hole location, fasteners shall be installed 25 mm (1 in.) from the edge and end of the gypsum board.**

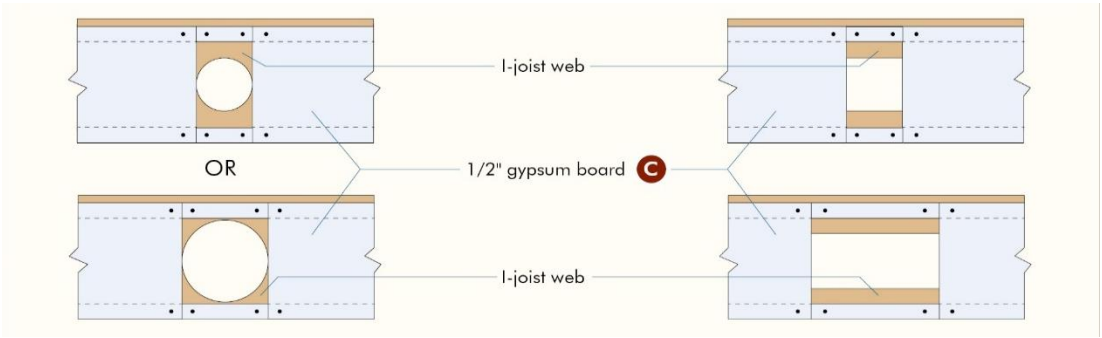
C. **12.5 mm (1/2 in.) gypsum board: materials (over entire length of I-joist) not required to be finished with tape and joint compound. Fasteners: minimum 25 mm (1 in.) screws (Type W or Type S) or nails installed 25 mm (1 in.) from edges and ends and 400 mm (16 in.) on center, top and bottom. Fasteners may be staggered from top to bottom.**

Figure 2. Fire Protection of Floors FP-02 – Fire Protection: 12.5 mm (1/2 in.) Gypsum Board Attached Directly to Web

12.5 MM (1/2 IN.) GYPSUM BOARD ATTACHED TO SIDES OF FLANGE



INSTALLATION REQUIREMENTS AT WEB HOLES



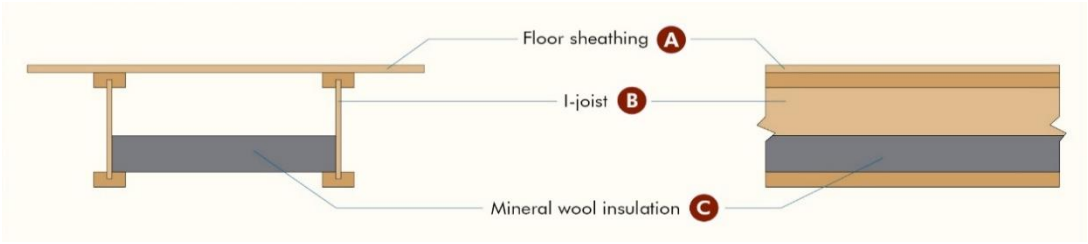
A. **Floor sheathing: materials and installation in accordance with the NBC 2015.**

B. **I-joist: installation in accordance with Section 3 of this Report. Maximum 600 mm (24 in.) on centre spacing. Minimum flange size of 28.5 mm (1-1/8 in.) thick × 44.5 mm (1-3/4 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.). At hole location, fasteners shall be installed 12.5 mm (1/2 in.) from the edge and 1 in. from the end of the gypsum board. Maximum fastener spacing shall be no more than 8 in. on gypsum board above and below the hole.**

C. **12.5 mm (1/2 in.) gypsum board: materials (over entire length of I-joist) not required to be finished with tape and joint compound. Fasteners: minimum 25 mm (1 in.) screws (Type W or Type S) or nails installed 12.5 mm (1/2 in.) from edges and 1 in. from ends, and 400 mm (16 in.) on centre, top and bottom. Fasteners may be staggered from top to bottom.**

Figure 3. Fire Protection of Floors FP-03 – Fire Protection: 12.5 mm (1/2 in.) Gypsum Board Attached Directly to Sides of Flange.

MINERAL WOOL INSULATION



A. Floor sheathing: materials and installation in accordance with the NBC 2015.

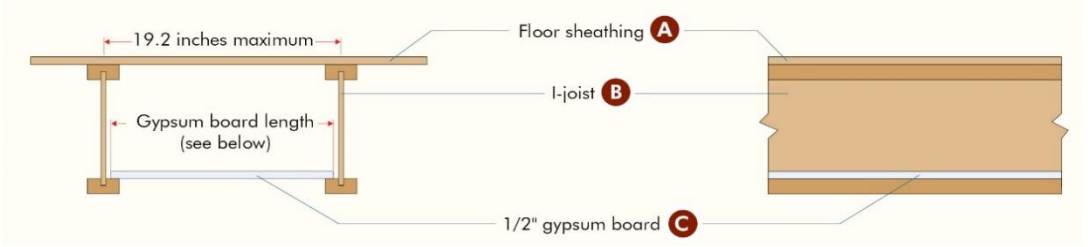
B. I-joist: installation in accordance with Section 3 of this Report. Maximum 487 mm (19.2 in.) on centre spacing. Minimum flange size of 28.5 mm (1-1/8 in.) thick × 44.5 mm (1-3/4 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.).

C. Mineral wool insulation: minimum 46.5 kg/m³ (2.9 lb/ft³) (nominal) and 50 mm (2 in.) thick mineral wool insulation made of rock slag, complying with ULC S702 with CCMC Listing, installed without gaps between individual batts as shown with stay wire insulation supports, spaced no more than 600 mm (24 in.) apart and no more than 100 mm (4 in.) from ends of batts. Minimum 40 kg/m³ (2.5 lb/ft³) (nominal) and 50 mm (2 in.) thick mineral wool insulation shall be permitted if the I-joists are spaced no more than 400 mm (16 in.) on centre. Use minimum 387 mm (15.25 in.) and 470 mm (18.5 in.) wide batts when I-joist spacing is 400 mm (16 in.) and 487 mm (19.2 in.) on centre, respectively.

Note. As per 2015 NBC, Sentence 9.25.2.3. (7), any insulation that may be subjected to mechanical damage is to be protected by a covering such as gypsum board, plywood, particleboard, OSB or hardboard.

Figure 4. Fire Protection of Floors FP-04 – Fire Protection: Mineral Wool Insulation.

12.5 MM (1/2 IN.) GYPSUM BOARD



Joist spacing	Required length for gypsum boards
300 mm (12 in.)	282.5 mm (11-1/8 in.) ± 3.2 mm (1/8 in.)
400 mm (16 in.)	384.2 mm (15-1/8 in.) ± 3.2 mm (1/8 in.)
487 mm (19.2 in.)	467 mm (18-3/8 in.) ± 3.2 mm (1/8 in.)

Note:
Gypsum board lengths shown above provide at least a 6 mm (1/4 in.) bearing on the top of the bottom flange in each I-joist as installed. For other joist spacings, the required gypsum board lengths shall be adjusted so that the required gypsum board lengths are determined based on a full bearing on the flange at one end of the joist spacing, while maintaining at least a 6 mm (1/4 in.) bearing at the other end. If double joists are used, the required gypsum board lengths shall be reduced from the table above by a length equal to the flange width.

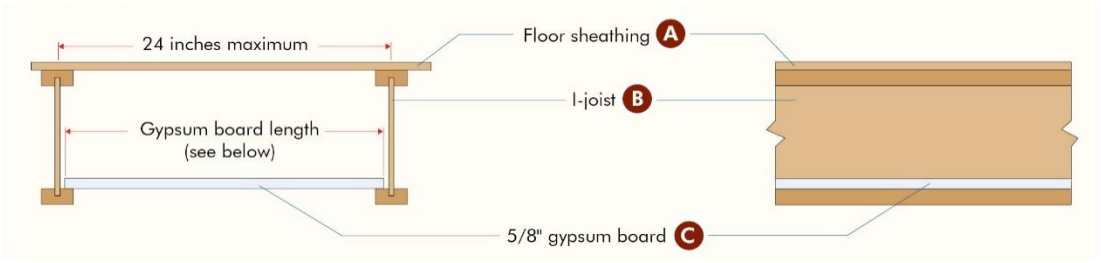
A. Floor sheathing: materials and installation in accordance with NBC 2015.

B. I-joist: installation in accordance with Section 3 of this Report. Maximum 487 mm (19.2 in.) on centre spacing. Minimum flange size of 28.5 mm (1-1/8 in.) thick × 50 mm (2 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.).

C. One layer of 12.5 mm (1/2 in.) lightweight or normal weight (nominal 7.3 kg/m² (1.5 psf) minimum) gypsum wall board meeting ASTM C 1396, installed on the top of the bottom flange. Mechanical fastener or adhesive attachment to the top of the bottom flange is not required.

Figure 5. Fire Protection of Floors FP-06 – Fire Protection: 12.5mm (1/2-in.) Gypsum Board Installed on Top of the Bottom Flange.

15.8 MM (5/8 IN.) GYPSUM BOARD



Joist spacing	Required length for gypsum boards
300 mm (12 in.)	282.5 mm (11-1/8 in.) ± 3.2 mm (1/8 in.)
400 mm (16 in.)	384.2 mm (15-1/8 in.) ± 3.2 mm (1/8 in.)
487 mm (19.2 in.)	467 mm (18-3/8 in.) ± 3.2 mm (1/8 in.)
600 mm (24 in.)	587 mm (23-1/8 in.) ± 3.2 mm (1/8 in.)

Note:
Gypsum board lengths shown above provide at least a 6 mm (1/4 in.) bearing on the top of the bottom flange in each I-joist as installed. For other joist spacings, the required gypsum board lengths shall be adjusted so that the required gypsum board lengths are determined based on a full bearing on the flange at one end of the joist spacing, while maintaining at least a 6 mm (1/4 in.) bearing at the other end. If double joists are used, the required gypsum board lengths shall be reduced from the table above by a length equal to the flange width.

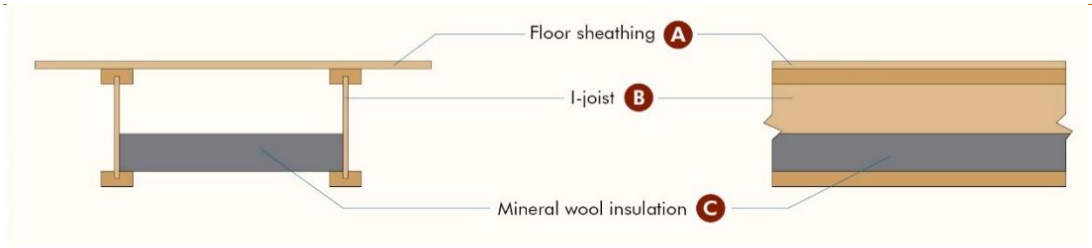
A. Floor sheathing: materials and installation in accordance with the NBC 2015.

B. I-joist: installation in accordance with Section 3 of this Report. Maximum 600mm (24 in.) on centre spacing. Minimum flange size of 28.5 mm (1-1/8 in.) thick × 50 mm (2 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.).

C. One layer of 15.8 mm (5/8 in.) lightweight or normal weight (nominal 9.3 kg/m^2 (1.9 psf) minimum) gypsum wall board meeting ASTM C 1396, installed on the top of the bottom flange. Mechanical fastener or adhesive attachment to the top of the bottom flange is not required.

Figure 6. Fire Protection of Floors FP-07 – Fire Protection: 15.8mm (5/8-inch) Gypsum Board Installed on Top of the Bottom Flange.

ROCKWOOL SAFE'n'SOUND® MINERAL WOOL INSULATION



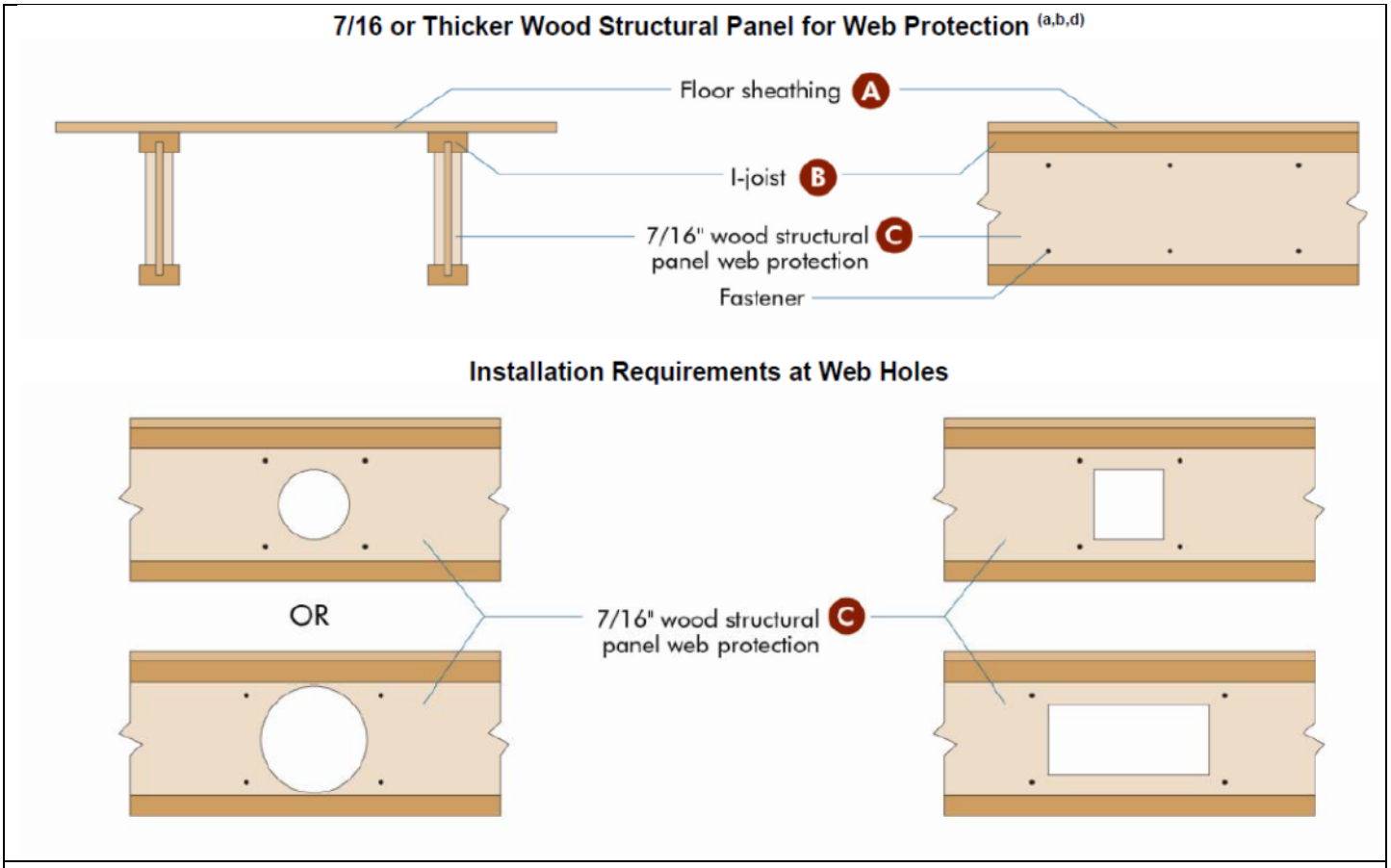
A. Floor sheathing: materials and installation in accordance with the NBC 2015.

B. I-joist: installation in accordance with Section 3 of this Report. Maximum 600 mm (24 in.) on centre spacing. Minimum flange size of 28.5 mm (1-1/8 in.) thick × 50 mm (2 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.).

C. Mineral wool insulation: Rockwool SAFE'n'SOUND® minimum 40 kg/m^3 (2.5 lb/ft^3) (nominal) and 75 mm (3 in.) thick mineral wool batt insulation made of rock or furnace slag (ASTM C 665 Type 1-compliant) installed as shown with insulation stay wire supports, spaced no more than 600 mm (24 in.) apart and no more than 100 mm (4 in.) from ends of batts. Use minimum 387 mm (15.25 in.), 470 mm (18.5 in.) and 584 mm (23 in.) wide batts when I-joist spacing is 400 mm (16 in.), 487 mm (19.2 in.) and 600 mm (24 in.) on center, respectively.

Note. As per 2015 NBC, Sentence 9.25.2.3. (7), any insulation that may be subjected to mechanical damage is to be protected by a covering such as gypsum board, plywood, particleboard, OSB or hardboard.

Figure 7. Fire Protection of Floors FP-09 – Fire Protection: Rockwool SAFE'n'Sound® Mineral Wool Insulation.



A. Floor sheathing: materials and installation in accordance with the NBC 2015.

B. I-joist: installation in accordance with Section 3 of this Report. Maximum 600mm (24 in.) on centre spacing. Minimum flange size of 38 mm (1-1/2 in.) thick × 63.5 mm (2.5 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.). At each hole location, the 11mm (7.16 in.) or thicker wood structural panels shall be cut with the web hole on both sides of the I-joist to allow for the passage of wire, pipe or duct, in accordance with web hole requirements for the NI-Series I-joists.

C. Wood structural panel for web protection: Min. 11mm(7/16 in.) CSA O325 compliant plywood or OSB. The panel-to-panel joints shall be tight with a joint gap of 1.6mm (1/16 in.) or less, not requiring to be finished with tape of joint compound. Fasteners: Each panel shall be fastened with 2 rows of 12.5mm (1/2 in.) x 25.4 mm (1 in.) construction staples at 230mm (9 in.) on center and 25.4mm (1 in.) from the top and bottom flange. Fasteners may be staggered from top to bottom. At web hole locations, fasteners shall be installed 25.4 mm (1 in.) from the edge of the hole, top and bottom.

Figure 8. Fire Protection of Floors (FP Nordic FP-01) – Fire Protection: 11mm(7/16 in.) Plywood/OSB each side of web.