Evaluation Report CCMC 12787-R
AllJoist® Prefabricated I-Joists

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1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "AllJoist® Prefabricated I-Joists," 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 (NBC) of Canada 2015:

- Clause 1.2.1.1.(1)(a), of Division A, using the following acceptable solutions from Division B:
  - Sentence 4.3.1.1.(1), Design Basis for Wood (CSA O86-14, I-joist qualification)

- Clause 1.2.1.1.(1)(b), of 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 the CCMC evaluation of the technical evidence in Section 4 provided by the Report Holder.

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(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 Sections 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. 09-16-214 (12787-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 2009-08-06 (revised on 2017-03-31) 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 prefabricated wood I-joists that are available in 17 series and include the in-plant finger-jointed flange materials. The products consist of two continuous lumber flanges that are glued to a 9.5-mm-thick or 11.1-mm-thick oriented strandboard (OSB) web that comply with the manufacturer's quality requirements. The lumber flanges are either AllJoist® Proprietary Grade (APG) or in-plant proprietary machine stress-rated (MSR) grade. The flanges may be solid sawn or finger-jointed lumber or proprietary face-bonded composite lumber. The products are available in depths ranging from 235 mm to 610 mm. See Table 2.1 for flange sizes and grades.

The web-flange connection is made by inserting the profiled OSB web into a profiled groove in the centre of the wide face of the flange (both top and bottom flanges.) The flange-to-flange finger joints and web-to-web joints are bonded with a polyurethane emulsion polymer (PEP) adhesive (CCMC 13513-L and CCMC 13512-L, respectively) and the web-to-flange joints are bonded with an emulsion polymer isocyanate (EPI) adhesive (CCMC 13591-L). For all the AJS series, the web-to-web and web-to-flange joints may alternatively be bonded with a phenol-

resorcinol adhesive (CCMC 13051-L or CCMC 13054-L). Except for the AJS-30 and AJS-200 series, all other AJS series flange-to-flange finger joints may alternatively be bonded with a phenol-resorcinol adhesive (CCMC 13213-L).

Table 2.1 Flange Sizes and Grades of the Product Series

Series	Depth (mm)	Web Thickness (mm)	Flange Size (mm)	Grade[1]
AJS-5	241 to 302	9.5	38.1 × 63.5	APG
AJS-10	241 to 406	9.5	38.1 × 63.5	APG
AJS-20	241 to 406	9.5	38.1 × 63.5	MSR
AJS-20v[2]	235 to 406	9.5	38.1 × 63.5	MSR
AJS-24	235 to 406	9.5	38.1 × 89	MSR
AJS-25	241 to 406	9.5	38.1 × 89	MSR
AJS-25	457 to 610	11.1	38.1 × 89	MSR
AJS-25v[2]	235 to 406	9.5	38.1 × 89	MSR
AJS-30	457 to 610	11.1	38.1 × 89	MSR
AJS-110	235 to 406	9.5	38.1 × 63.5	MSR
AJS-140	241 to 406	9.5	38.1 × 63.5	MSR
AJS-150	241 to 406	9.5	38.1 × 63.5	MSR
AJS-150v[2]	235 to 406	9.5	38.1 × 63.5	MSR
AJS-160	241 to 406	9.5	38.1 × 63.5	MSR
AJS-170	241 to 406	9.5	38.1 × 63.5	MSR
AJS-180	241 to 406	9.5	38.1 × 63.5	MSR
AJS-190	235 to 406	9.5	38.1 × 63.5	MSR
AJS-190	457 to 508	11.1	38.1 × 63.5	MSR
AJS-200	241 to 406	9.5	38.1 × 63.5	MSR

Notes to Table 2.1:

(1) Both the APG and MSR lumber flanges are proprietary graded.
(2) The "v" designation indicates that the OSB web strong axis is oriented vertically.

3. Conditions and Limitations

The CCMC compliance opinion in Section 1 is bound by the products being used in accordance with the conditions and limitations set out below:

- The products are intended for use in structural applications, such as floor joists, and are intended for dry service use[1] applications only.
- The following pre-engineering information has been provided to CCMC by the manufacturer to demonstrate compliance to Part 9 Buildings for acceptance by the local authority having jurisdiction (AHJ):

i. Pre-engineered Floor Span Charts

When the products are used as floor joists and roof rafters in simple (single) spans or as floor joists in continuous (multiple) span applications supporting uniform loads only, the installation must be in accordance with the span tables (including vibration criteria[2]) found in the document entitled:

- *AllJoist*® *– Specifier Guide – Includes AJS 140/20/25*, April 2018 (revised February 26, 2019)

(1) All lumber, wood-based panels and proprietary engineered wood products are intended for dry service conditions. "Dry service conditions" is defined as the in-service environment in which the average 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 Article 9.3.2.5., Moisture Content, of Division B of the NBC 2015.

(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. The manufacturer should therefore be consulted for span adjustments, if necessary, in these types of installations.

They must be installed in accordance with the manufacturer's installation guidelines noted in the above-mentioned document for those 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. Pre-engineered Installation Details

The manufacturer's pre-engineered details in *AllJoist® – Specifier Guide – Includes AJS 140/20/25* are limited in scope to building designs where the following details are not exceeded:

- rim board maximum vertical load (page 22);
- squash blocks maximum vertical load (page 9);
- blocking panel maximum vertical load (page 9);
- web stiffener requirements (page 10);
- load-bearing cantilever tables (pages 11 and 12);
- cantilever balcony (page 11);
- web hole tables (pages 13 and 14);
- roof joist details (pages 15 and 16); and
- roof uniform load tables (page 21).

iii. Engineering Required

For structural applications beyond the scope and limitations of the above-referenced 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 3i. and 3ii. imply, but are not limited to, the following:

- higher loads/longer spans than manufacturer's pre-engineered details;
- concentrated loads;
- offset bearing walls;
- areas of high wind and high seismicity;
- stair openings;
- design of supporting wall studs/beams when the total load exceeds the NBC 2015 pre-engineered floor/roof joist tables; and
- design of supporting foundation footings when the total load exceeds the NBC 2015 pre-engineered floor/roof joist tables.

The engineer must design in accordance with CSA O86-14 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

The manufacturer provides engineering support and may also be consulted in the use of this proprietary prefabricated I-joist by telephone at 506-735-3561 or by fax at 506-736-0929.

- This product must be identified with the phrase "CCMC 12787-R" along the side of the web or flange of the product. The CCMC number is only valid when it appears in conjunction with the certification mark of APA who will be conducting the third-party quality assurance and product certification.
- Damaged or defective joists must not be used, unless repaired in accordance with written instructions from the manufacturer.

4. Technical Evidence

The CCMC Technical Guide for "AllJoist® Prefabricated I-Joists" sets out the nature of the technical evidence required by CCMC to enable it to evaluate a product as an acceptable or alternative solution in compliance with the NBC 2015. The Report Holder has submitted (i) the CCMC specified testing, summarized in the Appendix; and (ii) derived design values, for the CCMC evaluation. Testing was conducted at independent laboratories recognized by CCMC. The corresponding test results for the product are summarized below.

4.1 Design Values

Table 4.1.1 Factored Resistances(1) of the Product Series

Series	Permitted to be Labelled as	Joist Depth (mm)	Factored Moment Resistance(2) (N·m)	Factored Shear Resistance (N)	Maximum End Reaction without Stiffeners(3) (N)	Maximum Intermediate Reaction without Stiffeners(4) (N)	Bending Stiffness(5) EI × 10^6 (kN-mm^2)	Shear Coefficient K × 10^6 (N)
AJS-5		241	4 920	8 144	6 670	16 499	521	23.1
		302	6 390	10 461	6 705	16 780	894	29.4
AJS-10		241	6 700	8 144	6 670	16 499	664	23.1
		302	8 705	10 461	6 705	16 780	1 135	29.4
		356	10 480	12 567	6 740	17 061	1 667	34.7
		406	12 120	14 498	6 810	17 307	2 259	39.6
AJS-20	NJ60H	241	7 685	8 144	6 670	16 499	664	23.1
	NJ60H	302	9 985	10 461	6 705	16 780	1 135	29.4
	NJ60H	356	12 020	12 567	6 740	17 061	1 667	34.7
	NJ60H	406	13 900	14 498	6 810	17 307	2 259	39.6
AJS-20v(6)		235	8 295	7 935	7 550	16 500	625	22.7
		241	8 545	8 145	7 550	16 500	664	23.1
		286	10 430	9 830	8 250	17 555	999	27.6
		302	11 105	10 460	8 250	17 555	1 135	29.4
		356	13 365	12 570	8 250	17 555	1 667	34.7
		406	15 460	14 500	8 250	17 555	2 259	39.6
AJS-24		235	8 755	7 898	6 670	18 255	726	23.1
	NJ40U	241	9 020	8 144	6 670	18 255	771	23.6
		286	11 010	9 829	6 705	18 886	1 158	28.0
	NJ40U	302	11 720	10 461	6 705	18 886	1 316	29.8
	NJ40U	356	14 115	12 567	6 740	19 448	1 928	35.1
	NJ40U	406	16 330	14 498	6 810	20 010	2 609	40.5
AJS-25	NJ60U	241	12 095	8 144	6 670	18 255	921	23.1
	NJ60U	302	15 720	10 461	6 705	18 886	1 569	29.4
	NJ60U	356	18 925	12 567	6 740	19 448	2 295	34.7
	NJ60U	406	21 895	14 498	6 810	20 010	3 099	39.6
		457(7)	24 745	21 133	15 727	33 139	4 092	54.7
		508(7)	27 670	22 748	17 482	35 878	5 202	60.9
		559(7)	30 350	24 363	17 482	36 720	6 460	66.7
		610(7)	33 005	25 908	17 482	37 528	7 869	73.4
AJS-25v		235	11 735	7 935	7 550	18 255	867	23.6
		241	12 095	8 145	7 550	18 255	921	24.0
		286	14 765	9 830	8 775	19 380	1 382	28.5
		302	15 715	10 460	8 775	19 380	1 569	30.2

Series	Permitted to be Labelled as	Joist Depth (mm)	Factored Moment Resistance[2] (N·m)	Factored Shear Resistance (N)	Maximum End Reaction without Stiffeners[3] (N)	Maximum Intermediate Reaction without Stiffeners[4] (N)	Bending Stiffness[5] EI × 10^6 (kN-mm^2)	Shear Coefficient K × 10^6 (N)
		356	18 920	12 570	8 775	21 205	2 295	35.6
		406	21 890	14 500	8 775	21 205	3 099	40.5
AJS-30		457[7]	30 620	21 133	15 727	33 139	4 515	54.7
		508[7]	34 235	22 748	17 482	35 878	5 735	60.9
		559[7]	37 555	24 363	17 482	36 720	7 114	66.7
		610[7]	40 835	25 908	17 482	37 528	8 657	73.4
AJS-110		235	3 985	7 898	6 670	16 499	387	22.2
		241	4 110	8 144	6 670	16 499	413	23.0
		286	5 015	9 829	6 705	16 780	626	27.4
		302	5 335	10 461	6 705	16 780	712	28.9
		356	6 425	12 567	6 740	16 956	1 053	34.4
		406	7 295	14 498	6 810	17 131	1 446	39.4
AJS-140		241	5 545	8 144	6 670	16 499	521	23.1
		302	7 205	10 461	6 705	16 780	894	29.4
		356	8 670	12 567	6 740	17 061	1 318	34.7
		406	10 030	14 498	6 810	17 307	1 792	39.6
AJS-150	NJ40H	241	6 370	8 144	6 670	16 499	556	23.1
	NJ40H	302	8 275	10 461	6 705	16 780	954	29.4
	NJ40H	356	9 960	12 567	6 740	17 061	1 405	34.7
	NJ40H	406	11 525	14 498	6 810	17 307	1 909	39.6
AJS-150v		235	6 180	7 935	7 550	16 500	523	22.7
		241	6 370	8 145	7 550	16 500	556	23.1
		286	7 775	9 830	8 250	17 555	839	27.6
		302	8 275	10 460	8 250	17 555	954	29.4
		356	9 960	12 570	8 250	17 555	1 405	34.7
		406	11 525	14 500	8 250	17 555	1 909	39.6
AJS-160		241	6 910	8 144	6 670	16 499	592	23.1
		302	8 980	10 461	6 705	16 780	1 015	29.4
		356	10 810	12 567	6 740	17 061	1 492	34.7
		406	12 505	14 498	6 810	17 307	2 025	39.6
AJS-170		241	7 455	8 144	6 670	16 499	628	23.1
		302	9 690	10 461	6 705	16 780	1 075	29.4
		356	11 660	12 567	6 740	17 061	1 580	34.7
		406	13 490	14 498	6 810	17 307	2 142	40.0
AJS-180		241	8 230	8 144	6 670	16 499	664	23.1
		302	10 690	10 461	6 705	16 780	1 135	29.4
		356	12 870	12 567	6 740	17 061	1 667	34.7
		406	14 890	14 498	6 810	17 307	2 259	40.0
AJS-190		235	8 545	7 898	6 670	16 499	658	22.7
		241	8 805	8 144	6 670	16 499	700	23.1
		286	10 750	9 829	6 705	16 780	1 052	27.6

Series	Permitted to be Labelled as	Joist Depth (mm)	Factored Moment Resistance[2] (N·m)	Factored Shear Resistance (N)	Maximum End Reaction without Stiffeners[3] (N)	Maximum Intermediate Reaction without Stiffeners[4] (N)	Bending Stiffness[5] EI × 10^6 (kN-mm^2)	Shear Coefficient K × 10^6 (N)
		302	11 440	10 461	6 705	16 780	1 195	29.4
		356	13 770	12 567	6 740	17 061	1 754	34.7
		406	15 930	14 498	6 810	17 307	2 375	40.0
		457[7]	18 135	21 133	15 165	33 139	3 154	53.8
		508[7]	20 275	22 748	15 165	33 561	4 023	60.1
AJS-200		241	9 400	8 144	6 670	16 499	735	23.1
		302	12 215	10 461	6 705	16 780	1 256	29.4
		356	14 700	12 567	6 740	17 061	1 841	34.7
		406	17 005	14 498	6 810	17 307	2 492	40.0

Notes to Table 4.1.1:

(1) Factored resistances include ø = 0.9, applied in accordance with CSA O86-14. Additional engineering data and load/span tables are provided by the manufacturer.
(2) Moment resistance must not be increased by any Code-allowed repetitive member use factor.
(3) Minimum end bearing of 38 mm (44.5 mm if I-joist depth ≥ 457 mm).
(4) Minimum intermediate bearing of 89 mm.
(5) The bending stiffness is based on the "shear-free," E.
(6) The "v" designation indicates that the OSB web strong axis is oriented vertically.
(7) These I-joists depths require stiffeners at all bearing locations.

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 the fire performance of the alternative solution is deemed to perform "as well as" that of the Code-specified exposed lumber joists. The engineered joist manufacturer (Report Holder) has submitted to CCMC the fire-protection option for its 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.

4.2.2 Proposed Fire-Protection Options

The manufacturer's solutions for proposed fire protection of their proprietary joists are presented in Appendix B. CCMC has reviewed the fire testing and analysis of the fire-protection options in comparison to the fire performance of unprotected exposed 38 mm × 235 mm (2 × 10) floor joist system[1]. The fire testing demonstrated that the proposed fire-protection options perform "as well as" exposed 38 mm × 235 mm (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 that of the NBC-specified conventional wood-frame construction, or acceptable solution, has been the 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 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 38 mm × 235 mm (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 performs "as well as" the inherent fire performance of exposed 38 mm × 235 mm (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 manufacturer 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. 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 the CAN/ULC-S101 floor test[(2)], are considered by CCMC as having performed as well as exposed 38 mm × 235 mm (2 × 10) lumber joists.

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(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 CAN/ULC-S101 time-temperature curve, the floor joists loaded to in-service loads and structural joist failure as the criterion.

Report Holder

Boise Cascade Company
70 rue Industrielle
St. Jacques, NB E7B 1T1

Tel.: 506-735-3561
Fax: 506-736-0929
Email: DomLavoie@BC.com
Web site: www.bc.com

Plant(s)

Saint-Jacques, NB

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2020-04-10

Appendix A

The design values obtained from testing to ASTM D 5055-04, "Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists," as specified in CAN/CSA-O86-01, "Engineering Design in Wood," are summarized below. The manufacturer's published pre-engineered joist spans were designed in accordance with CSA O86-14.

Table A1 Additional Test Information for the Product Series

Property	Test Information
Shear capacity	The shear capacity of the products was established by testing as per ASTM D 5055. Qualification and quality control tests were used to establish the applicable coefficient of variation, CV_w, and the reliability normalization factor from CAN/CSA-O86-01 was used to determine the specified strength.
Moment capacity	The moment capacity qualification was carried out using the analytical method in accordance with ASTM D 5055. Quality control tests and qualification tests were used to establish the 5th percentile based on a normal distribution. The Weibull coefficient of variation, CV_w, was standardized at a conservative 15% and the reliability normalization factor from CAN/CSA-O86-01 was used to determine the specified strength.
Stiffness	A bending test program of varying depths was used to confirm the stiffness capacity. The following formula was used to predict mid-span deflection: $deflection\ \Delta = \frac{5wL^4}{384EI} + \frac{wL^2}{K}$ where EI = shear-free E × I, from Table, w = uniform load (kN/m), L = span (mm), K = shear deflection factor
End joints	End joints were qualified as part of the flange tension qualification. The flanges are finger-jointed at the plant and regular tension testing is conducted.
Creep	Specimens were tested for creep performance as per ASTM D 5055, whereby two specimens in each I-joist series group are loaded to 1.5 times the design resistive moment capacity and the average deflection recovery must exceed 90% of the deflection between 1.5 times total load and the basic dead load deflection (20% design).
Bearing length	A minimum of 10 specimens was tested for three bearing lengths at various I-joist depths, including the extreme depths. A linear regression was performed on the averages of the tested depths to obtain the remaining values. Tests were conducted to qualify a minimum end bearing of 38 mm (44.5 mm if I-joist depth ≥ 457 mm) and 89 mm. Qualification 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.
Adhesive qualification	The flange-to-flange finger joints and web-to-web joints are bonded with a PEP adhesive (CCMC 13513-L and CCMC 13512-L, respectively) and web-to-flange joints are bonded with an EPI adhesive (CCMC 13591-L). For all the AJS series, the web-to-web and web-to-flange joints may alternatively be bonded with a phenol-resorcinol adhesive (CCMC 13051-L or CCMC 13054-L). Except for the AJS-30 and AJS-200 series, all the other AJS series flange-to-flange finger joints may alternatively be bonded with a phenol-resorcinol adhesive (CCMC 13213-L).
Web stock	The web stock complies with CAN/CSA-O325.0-92, "Construction Sheathing," and/or Product Standard, PS 2.
Manufacturing quality assurance	The manufacturing quality assurance program includes requirements specified in ASTM D 5055 and is verified by the third-party agency APA as part of the product certification. The quality assurance program also includes proprietary grading, random sampling and ongoing testing at the plant. The third-party certification agency ensures that the quality control measures are adequate to maintain the published design values at each plant.

Note to Table A1:

(1) Design values were developed in accordance with the referenced standards found herein. The requirements met have not changed in the current editions of the standards referenced in CSA O86-14.

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 "AllJoist® Prefabricated I-Joists" – Fire-Protection Options

The following seven (7) options of I-joist floor fire-protection alternative solutions are provided by the manufacturer[(1)]. These floor assemblies have demonstrated fire performance that performs as well as conventional wood-frame 38 mm × 235 mm (2 × 10) exposed floor construction.

The details of the following fire protection floor assemblies are outlined in the Figures 1 to 7, 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)]

(1) 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 contained herein reviewed by CCMC provide equivalent fire performance to exposed 38 mm × 235 mm (2 × 10) lumber joists and are a subset of those published in APA System Report SR-405G, dated April 2019.

(2) For assemblies where mineral-fibre insulation is installed to provide joist protection in a fire, as per NBC 2015, 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, oriented strandboard (OSB) or hardboard.

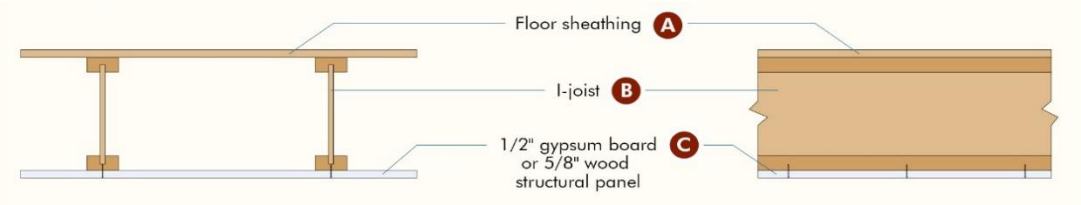
Table B2. Applicable "AllJoist® Prefabricated I-Joists" for Fire Protection Assemblies based on Flange Size

Product	Flange Size (thickness x width) (mm)	Fire Protection Assembly
AJS-5	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-10	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-20	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-20v	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-24	38.1 × 89	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-25	38.1 × 89	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-25	38.1 × 89	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-25v	38.1 × 89	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-30	38.1 × 89	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-110	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-140	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-150	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-150v	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-160	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-170	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-180	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-190	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-190	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09
AJS-200	38.1 × 63.5	FP-01, FP-02, FP-03, FP-04, FP-06, FP-07, FP-09

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 38 mm × 235 mm (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.

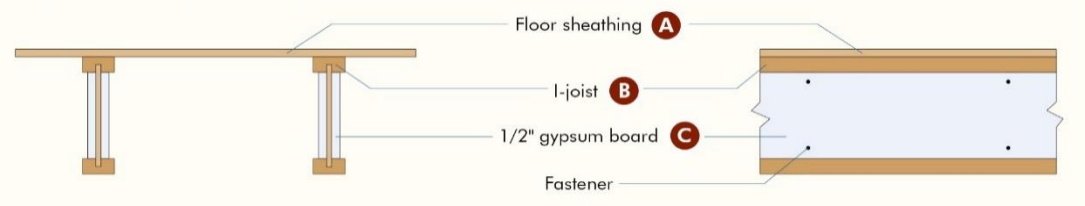
B. I-joist: installation in accordance with Section 3 of this Report. Maximum 24 in. on centre spacing. Applicable to all flange sizes. Minimum web thickness of 9.5 mm (3/8 in.).

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.

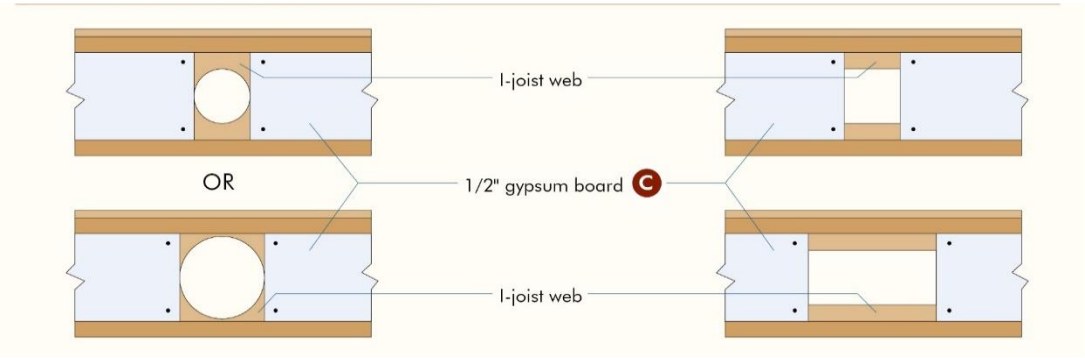
Figure 1. Fire Protection of Floors FP-01 – Fire Protection: 12.5 mm (1/2 in.) Gypsum Board Attached to Bottom of Flange

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



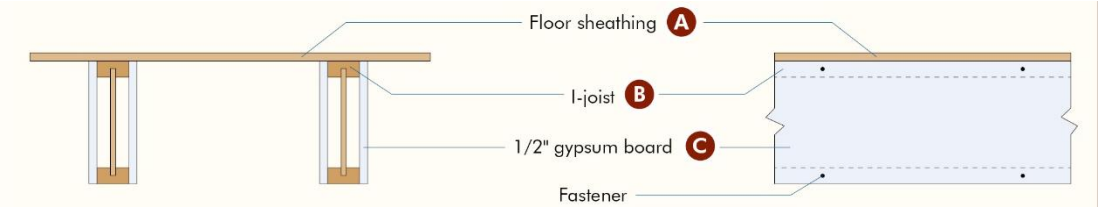
A. Floor sheathing: materials and installation in accordance with the NBC 2015.

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.

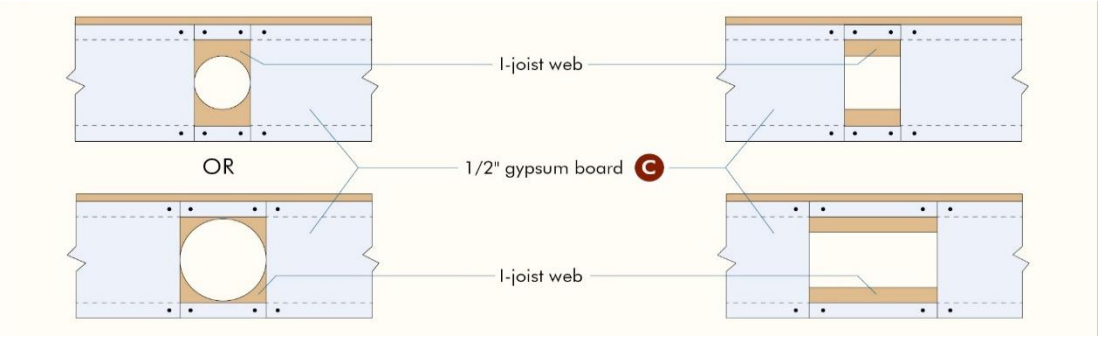
C. 12.5 mm (1/2 in.) gypsum board: materials (over entire length of I-joist) not required to be finished with tape and joint compound. Fasteners: minimum 25 mm (1 in.) screws (Type W or Type S) or nails installed 25 mm (1 in.) from edges and ends and 400 mm (16 in.) on center, top and bottom. Fasteners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



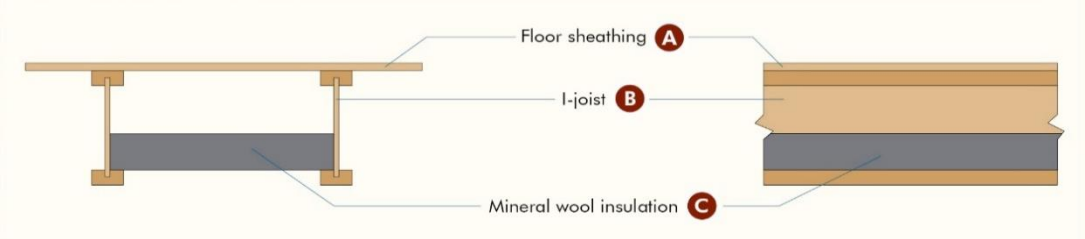
A. Floor sheathing: materials and installation in accordance with the NBC 2015.

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.

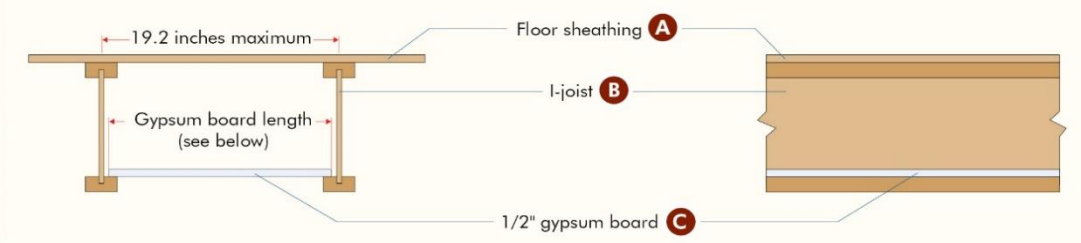
B. I-joist: installation in accordance with Section 3 of this Report. Maximum 487 mm (19.2 in.) on centre spacing. Minimum flange size of 28.5 mm (1-1/8 in.) thick × 44.5 mm (1-3/4 in.) wide. Minimum web thickness of 9.5 mm (3/8 in.).

C. Mineral wool insulation: minimum 46.5 kg/m^3 (2.9 lb/ft^3) (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/m^3 (2.5 lb/ft^3) (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 NBC 2015, 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.*	

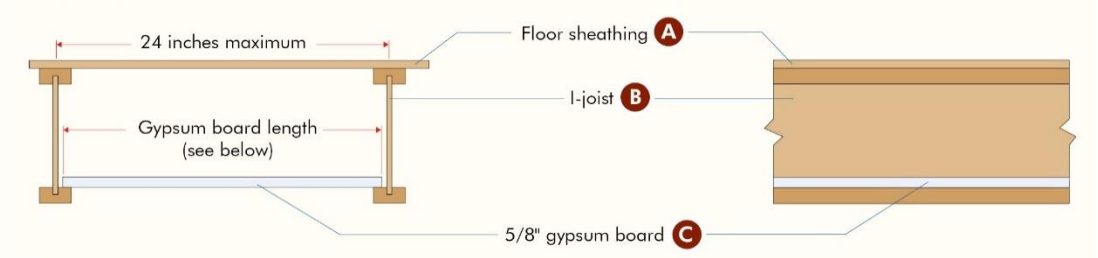
A. Floor sheathing: materials and installation in accordance with NBC 2015.

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/m^2 (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: 12.5 mm (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.*	

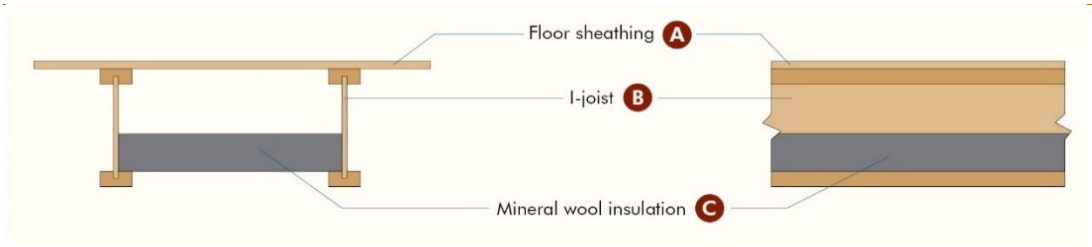
A. **Floor sheathing: materials and installation in accordance with the NBC 2015.**

B. **I-joist: installation in accordance with Section 3 of this Report. Maximum 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. **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 NBC 2015, 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