



Evaluation Report CCMC 13474-R

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Open Joist TRIFORCE™ Series

1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that “Open Joist TRIFORCE™ 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 2005:

- Clause 1.2.1.1.(1)(a), Division A, using the following acceptable solutions from Division B:
 - Sentence 4.3.1.1.(1) Design Basis for Wood (CAN/CSA-O86-01, reliability-based joist strength qualification and stiffness 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:
 - 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 4.1 provided by the Report Holder.

2. Description

The “Open Joist TRIFORCE™ Series” are parallel chord trusses with diagonal wood webs. The top and bottom chords are available in either 2x3 or 2x4 finger-jointed proprietary grade lumber (see Figure 2.1). The diagonal web members are short 2x2 pieces of lumber and finger-jointed into the top and bottom chords. The joists have a trimmable end-section at one end and an end post at the other end. The trimmable end section is an 803-mm long OSB web section, which is similar to an I-joist, and may be trimmed in the field a maximum of 610 mm (24 in.) (i.e. 194 mm (7 5/8 in.) remaining). The chord sizes are outlined in Table 2.1.

The chord fingerjoints and the web-to-chord connections are all adhered with a phenol-resorcinol adhesive meeting CSA O112.7, “Phenol, Resorcinol and Phenol-Resorcinol Resin Adhesives,” (CCMC 12917-L). The OSB web complies with CAN/CSA-O325.0-92, “Construction Sheathing,” and PS-2.

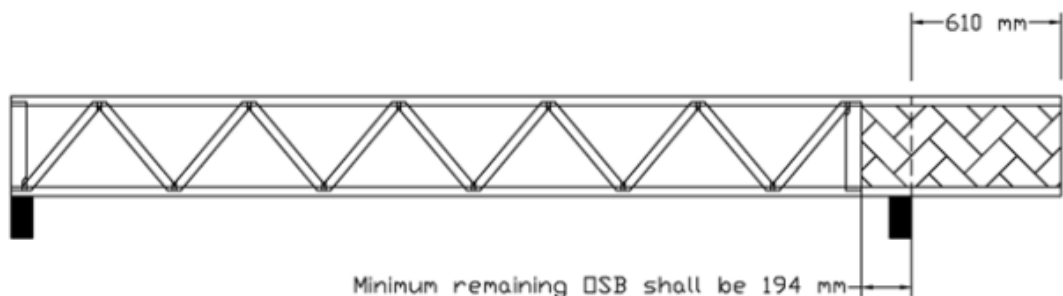


Figure 1. “Open Joist TRIFORCE™ Series” showing maximum joist OSB end-trimming permitted

Table 2.1 “Open Joist TRIFORCE™ Series” product description

Series	Joist Depth (mm)	Flange Material ⁽¹⁾	Dimensions (depth x width) (mm)	Diagonal Material	Dimensions (depth x width) (mm)	Trimmable End
OJ-314	241 - 406	G14	38.1 x 63.5	G14	38.1 x 38.1	9.5-mm OSB
OJ-315	241 - 406	G15 - 1.5E	38.1 x 63.5	G14	38.1 x 38.1	9.5-mm OSB
OJ-318	241 - 406	G18 - 1.8E	38.1 x 63.5	G14	38.1 x 38.1	9.5-mm OSB
OJ-320	241 - 406	G20 - 2.0E	38.1 x 63.5	G14	38.1 x 38.1	9.5-mm OSB
OJ-414	241 - 406	G14	38.1 x 88.9	G14	38.1 x 38.1	9.5-mm OSB
OJ-415	241 - 406	G15 - 1.5E	38.1 x 88.9	G14	38.1 x 38.1	9.5-mm OSB
OJ-418	241 - 406	G18 - 1.8E	38.1 x 88.9	G14	38.1 x 38.1	9.5-mm OSB
OJ-420	241 - 406	G20 - 2.0E	38.1 x 88.9	G14	38.1 x 38.1	9.5-mm OSB

Note to Table 2.1:

⁽¹⁾ All lumber is from the SPF species group and is subject to proprietary visual grading rules, is third-party certified and is subjected to periodic tension testing by Intertek Testing Services.

3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the “Open Joist TRIFORCE™ Series” being used in accordance with the conditions and limitations set out below.

- The products are intended for use in structural applications, such as floor, ceiling or roof joists, and are intended for dry service use⁽¹⁾ applications only.

(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 Article 9.3.2.5., Moisture Content, of Division B of the NBC 2005.

The product follows a manufacturing quality assurance program that is monitored by a third-party certification organization, Intertek Testing Services (ITS). The manufacturing quality assurance program, which is greatly based on the principles of ASTM D 5055, “Establishing and Monitoring Structural Capacities of Prefabricated

Wood I-Joists,” has been adapted to include requirements specific to the product and is verified by ITS as part of the product certification through regular audits. In addition, each joist is proof-tested for a period of 3 to 5 seconds.

This product must be identified with the phrase “CCMC # 13474-R” along the side of the joist. This CCMC number is only valid when it appears in conjunction with the WHI Certification Mark of Intertek Testing Services. In addition, there must be an indication that clearly identifies the proper orientation for the joist installation in order to prevent the wrongful reverse installation.

- The following pre-engineering has been provided to CCMC by Distribution Toiture Mauricienne to demonstrate compliance to Part 9 buildings for acceptance by the local authority having jurisdiction (AHJ):

i) Open Joist's 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 guide, in Limit States Design for Canada, entitled:

- “Open Joist TRIFORCE™ Series” Maximum Spans, dated July 2009, v1.0 (Limit States Design for Canada);
- “Open Joist TRIFORCE™ Series” Installation Guide, Installation Details, dated March 2010.

The products must be installed in accordance with “Open Joist TRIFORCE™ Series” installation guidelines noted in the above-mentioned documents 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.

(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. Distribution Toiture Mauricienne should therefore be consulted for span adjustments, if necessary, in these types of installations.

ii) Open Joist's Pre-engineered Installation Details

The pre-engineered details in the documents outlined in (i) above are limited in scope to building designs where the anticipated loads on the following structural details are not exceeded:

- maximum trimmable length (610 mm);
- web stiffener details;
- squash blocks;
- floor span tables.

iii) Engineering Required

For structural applications beyond the scope/limitations of the documents referenced in (i) above 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 (i) and (ii) imply, but are not limited to, the following:

- rim board resistance;
- load-bearing cantilever tables;
- 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/span exceeds the NBC 2005 pre-engineered floor/roof joist tables; and
- design of supporting foundation footings when the total load/span exceeds the NBC 2005 pre-engineered

floor/roof joist tables.

The engineer must design in accordance with CAN/CSA-O86, "Engineering Design in Wood," 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

Distribution Toiture Mauricienne may provide engineering services in conjunction with "Open Joist TRIFORCE™ Series" product specification and offers the following contact number: (800) 567-8644.

4. Technical Evidence

CCMC's Technical Guide for "Open Joist TRIFORCE™ Series" 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 2005. The Report Holder has submitted (i) the CCMC specified testing, summarized in the Appendix, and (ii) derived design values as outlined below, for CCMC's evaluation. Testing was conducted at independent laboratories recognized by CCMC. The corresponding test results for "Open Joist TRIFORCE™ Series" are summarized below.

4.1 NBC 2005 Compliance Data for “Open Joist TRIFORCE™ Series” on which CCMC Based its Opinion in Section 1

4.1.1 General

4.1.1.1 Design Values

Table 4.1.1.1.1 Engineering properties of “Open Joist TRIFORCE™ Series” products

Series	Depth (mm)	Flange Width (mm)	Mr ⁽¹⁾ (N·m)	Vr ⁽²⁾ (N)	EI (kN·mm ²)	K (kN)	Joist Weight (N/m)
OJ-314	241	63.5	4 868	6 140	4.878E+08	11 929	39.42
	302	63.5	6 303	8 828	8.166E+08	16 470	40.88
	356	63.5	7 548	10 214	1.183E+09	20 532	41.61
	406	63.5	8 577	10 670	1.590E+09	24 355	43.07
OJ-315	241	63.5	5 947	6 140	5.226E+08	11 929	39.42
	302	63.5	7 700	8 828	8.749E+08	16 470	40.88
	356	63.5	9 268	10 214	1.267E+09	20 532	41.61
	406	63.5	10 743	10 670	1.703E+09	24 355	43.07
OP-318	241	63.5	8 054	6 140	6.272E+08	11 929	39.86
	302	63.5	10 427	8 828	1.050E+09	16 470	41.32
	356	63.5	12 550	10 214	1.521E+09	20 532	42.05
	406	63.5	14 549	10 670	2.044E+09	24 355	43.51
OJ-320	241	63.5	8 294	6 140	6.968E+08	11 929	39.86
	302	63.5	10 738	8 828	1.166E+09	16 470	41.32
	356	63.5	12 924	10 214	1.690E+09	20 532	42.05
	406	63.5	14 981	10 670	2.271E+09	24 355	43.51
OJ-414	241	88.9	6 800	6 140	6.829E+08	14 792	47.16
	302	88.9	8 803	8 828	1.143E+09	20 423	48.62
	356	88.9	10 543	10 214	1.656E+09	25 460	50.08
	406	88.9	11 979	10 670	2.225E+09	30 200	51.54
OJ-415	241	88.9	8 340	6 140	7.317E+08	14 792	47.45
	302	88.9	10 797	8 828	1.225E+09	20 423	48.91
	356	88.9	12 996	10 214	1.774E+09	25 460	50.37
	406	88.9	15 065	10 670	2.384E+09	30 200	51.83
OJ-418	241	88.9	11 471	6 140	8.780E+08	14 792	47.45
	302	88.9	14 852	8 828	1.470E+09	20 423	48.91
	356	88.9	17 876	10 214	2.129E+09	25 460	50.37
	406	88.9	20 723	10 670	2.861E+09	30 200	51.83
OJ-420	241	88.9	11 654	6 140	9.755E+08	14 792	47.45
	302	88.9	15 088	8 828	1.633E+09	20 423	48.91
	356	88.9	18 159	10 214	2.365E+09	25 460	50.37
	406	88.9	21 051	10 670	3.179E+09	30 200	51.83

Notes to Table 4.1.1.1.1:

- (1) The factored moment resistances (with Φ included) listed are for standard term load duration and shall not be increased by any Code-allowed repetitive member system factor.
- (2) The factored shear resistances (with Φ included) for standard term load duration is the web tension resistance at the first web/bottom flange joint from the end bearing.
- (3) Mid-span deflection shall be predicted using the following formula:

$$\text{deflection} = \frac{5wL^4}{384EI} + \frac{wL^2}{K}$$

where: w = load (kN/mm), L = span (mm), EI from Table 4.1.1.1.1, and K from Table 4.1.1.1.1.

Table 4.1.1.1.2 End reaction properties of “Open Joist TRIFORCE™ Series”

Q _r ⁽¹⁾⁽²⁾ (N)							
OJ-300	Bearing End		2x3 Post End		OSB End Panel ⁽³⁾		
	Flange		38.1 mm	88.9 mm	38.1 mm	38.1 mm	88.9 mm
	Web Stiffener ⁽⁴⁾		N/A	N/A	No	Yes	No
OJ400	Depth	241 mm	10683	13339	7343	9772	9827
		302 mm	11232	14099	7495	11862	9827
		356 mm	11723	14779	7631	13732	9827
		406 mm	12184	15420	7758	15493	9827

Notes to Table 4.1.1.1.2:

- (1) The end reaction resistances (with Φ included) are reference design values for standard term duration load.
- (2) End reactions require a minimum bearing length of 38.1 mm; interpolation between bearing length is permitted.
- (3) The OSB section is adjustable up to 610 mm (24 in.) without any modification of the tabulated limit states design properties.
- (4) Web stiffeners shall be installed in accordance with the product's installation details.

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APPENDIX A

The design values obtained from testing to CCMC's Technical Guide for “Open Wood-Web Floor Trusses with Trimmable End Section(s) (Proof-Loaded)” and reliability normalization factors as per CAN/CSA-O86-04 are summarized below.

Table A1. Additional test information for “Open Joist TRIFORCE™Series”

Property	Test Information
Shear capacity	Ten specimens for each depth of the OJ-314 series (40 specimens) were tested and the characteristic values and 2-P Weibull coefficient of variation, CV_w , were established. The reliability normalization factor was determined following the CSA Standard Procedure to determine the reliability-based specified strength for limit states design.
Moment capacity	The moment capacity was determined based on the analytical method and confirmed by testing. For the analytical method, a minimum of 53 specimens were tension tested for each proprietary grade and size of chord (i.e. 424 specimens). For verification testing, ten joist specimens for three depths of all 4 series (i.e. 120 specimens) were tested. For all tests the characteristic values and 2-P Weibull coefficient of variation, CV_w , were established. The reliability normalization factor was determined following the CSA Standard Procedure to determine the reliability-based moment resistance for limit states design. In addition, further testing was conducted to investigate the effect of web-to-chord and chord-to-chord fingerjoints coinciding. No adverse effects on joist strength were observed.
Stiffness	<p>An appropriate test program was used to confirm the stiffness capacity. The following formula was used to predict mid-span deflection:</p> $\text{deflection} = \frac{5wL^4}{384EI} + \frac{wL^2}{K}$ <p>where: w = load (kN/mm), L = span (mm), EI from Table 4.1.1.1.1, and K from Table 4.1.1.1.1.</p>
End joints	End joints were qualified as part of the flange tension qualification by the finger-jointed lumber supplier certified by a C.O. The manufacturer conducts periodic tension tests to confirm the chord tension specified strength.
Creep	Specimens were tested for creep performance in accordance with: (i) ASTM D 5055 and (ii) the 24-hr CCMC creep and recovery test. The ASTM D 5055 specimens recovered more than 90% of the basic dead load deflection. All specimens passed the CCMC creep and recovery criteria.
Bearing length	The product reaction properties listed in Table 4.1.1.1.2 are specific to bearing lengths shown for the end post and OSB web end, with and without web stiffeners. A minimum of ten specimens were tested for each combination of bearing length configuration for the shallowest and deepest joist (i.e. 117 specimens). The characteristic values and 2-P Weibull coefficient of variation, CV_w , were established. The reliability normalization factor was determined following the CSA Standard Procedure to determine the reliability-based specified strength for limit states design.

Adhesive qualification	The chord fingerjoints and the web-to-chord fingerjoints are all adhered with a phenol-resorcinol adhesive complying with CSA O112.7-M1977, "Resorcinol and Phenol Resorcinol, Resin Adhesives for Wood (Room- and Intermediate-Temperature Curing)." (CCMC 12917-L)
Web stock	The OSB web stock complies with CAN/CSA-O325.0-92, "Construction Sheathing."