Evaluation Report CCMC 12691-R
Posi-Strut® Metal Web Joists

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1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "Posi-Strut® Metal Web Joists," when used as composite wood chord and steel web trusses in floor 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)(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:
    - Sentence 9.23.4.2.(2), Spans for Joists, Rafters and Beams

This opinion is based on CCMC's evaluation of the technical evidence in Section 4 provided by the Report Holder.

Ruling No. 07-05-163 (12691-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 2007-02-20 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 product is a composite wood chord and steel web truss (see Figure 1) used in floor applications. The product is manufactured in six (6) depths with several metal web configurations as outlined in Table 2.1. PS-12i is from the PS-12 series with a special height to match a typical I-Joist depth of 302 mm (11-7/8 in.).

Table 2.1 "Posi-Strut® Metal Web Joists" Truss Depths

"Posi-Strut® Metal Web" Designation	Truss Depth (mm (in.))
PS-10V2	235 (9 1/4)
PS-12	286 (11 1/4)
PS-12i	302 (11 7/8)
PS-13	324 (12 3/4)
PS-14V3	356 (14)
PS-16V3	406 (16)

Parallel wood chords, placed on the flat, are connected with pairs of V-shaped, galvanized metal webs. The parallel chords have dimensions of 38 mm × 64 mm or 89 mm, and are made of either No. 2 or better Spruce-Pine-Fir (S-P-F) lumber or machine stress rated (MSR), kiln-dried lumber. The web elements of the product are manufactured from 0.91-mm-thick hot-dipped G-90 galvanized steel sheets conforming to ASTM A 653/A 653M-13, "Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-dip Process," Grade 40. The mounting teeth are integrally punched into the plate areas at the apex and at the ends of the web element (see Figure 2).

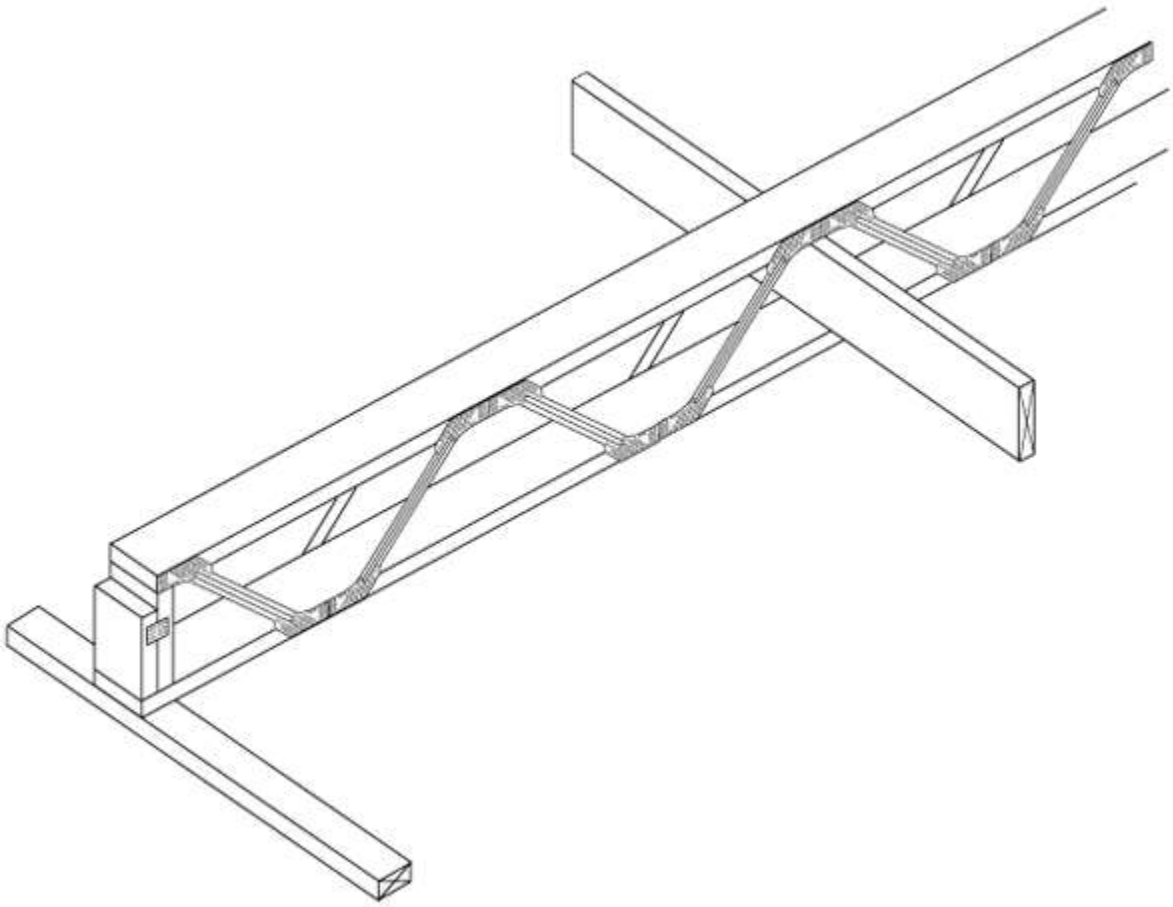

Figure 1. "Posi-Strut® Metal Web Joists" – floor application with strongback

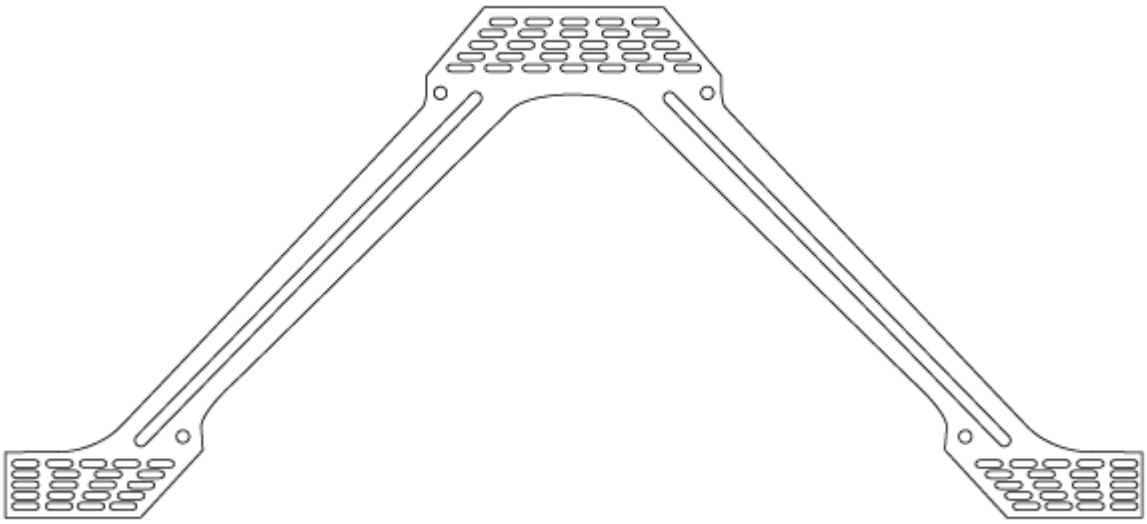

Figure 2. "Posi-Strut® Metal Web Joists" – galvanized steel web element

3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the "Posi-Strut® Metal Web Joists" being used in accordance with the conditions and limitations set out below.

- The product is intended for structural applications, such as floor, ceiling or roof joists, and is 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 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.

- The following pre-engineering has been provided to CCMC by MiTek Canada Inc. to demonstrate compliance to Part 9, Housing and Small Buildings, for acceptance by the local authority having jurisdiction (AHJ):

  i. MiTek Canada Inc's Pre-engineered Floor Span Charts
  When the product is used to support uniform loads only, the installation must be in accordance with:

  - "Posi-Strut® Maximum Clear Span Tables," (including vibration criteria[(2)], in limit states design for Canada), dated October 2018; and
  - "MITEK POSI-STRUT Installation Guidelines," dated October 2018.

  The product must be installed in accordance with MiTek Canada Inc.'s installation guidelines noted in these documents for those applications falling within the scope of the documents. Applications outside the scope of these installation guidelines require engineering on a case-by-case basis.

  (2) In cases where concrete topping is applied or strongbacks are used, and joists are installed at the maximum spans, the current vibration criteria may not address all occupant performance expectations. MiTek Canada Inc. should therefore be consulted for span adjustments, if necessary, in these types of installations.

  ii. MiTek Canada Inc.'s Pre-engineered Installation Details
  MiTek Canada Inc.'s pre-engineered details within 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:

  - floor span tables;
  - strongback installation details;
  - top chord installation details; and
  - rim board and ribbon details.

  iii. Engineering Required
  For structural applications beyond the scope/limitations of the above-referenced MiTek Canada Inc. 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 (i) and (ii) imply, but are not limited to, the following:

  - perimeter rim board/ledger resistance;
  - 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 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, "Engineering Design in Wood," and may use the Canadian Wood Council's "Engineering Guide for Wood Frame Construction" as a guide.

Additional installation details include:

- the assembly drawings must show the size of truss, the species and quality of the chord used, the product model number, and the relative location of the different truss types in the building assembly;
- the minimum end-bearing area must be 38 mm;
- the manufacturer's instructions on required strongbacks and glued subfloor (adhesive conforming to CAN/CGSB-71.26-M88, "Adhesive for Field-Gluing Plywood to Lumber Framing for Floor Systems") must be followed;
- notching or drilling of the wood chords is not allowed;
- the nailing pattern for the wood subfloor must conform to the NBC 2015; and
- ends of joists must be restrained to resist uplift and rollover. The top chord must be laterally supported at 600 mm on centre.

Fabrication of Joist

The scope of this CCMC evaluation is the metal web product and the capacity of joists that may be fabricated by a third-party using these metal webs. When the product is used as floor joists, the truss fabrication details must be followed by the authorized truss fabricator. The fabrication instructions are contained in the document "Manufacturing the Posi-Strut® Metal Web Floor System," dated October 1, 2018, and are to be used in conjunction with TPIC-2014, "Truss Design Procedures and Specifications for Light Metal Plate Connected Wood Trusses (Limit States Design)," published by the Truss Plate Institute of Canada (TPIC).

The AHJ must request conformity with respect to fabrication of the "Posi-Strut® Metal Web Joists" in the same manner as requested for light metal-plated roof trusses. The tooth-like projections of the metal webs must be fully pressed into both sides of the chords. The structural chords must be clearly grade-marked as S-P-F No. 2 or MSR grades and must contain less than 19% MC during the fabrication. Knots or wanes under the bearing point of the web plates are not permitted.

iv. Engineering Support Provided by Manufacturer

MiTek Canada Inc. provides engineering services in conjunction with "Posi-Strut® Metal Web Joists" specifications and offers the following support contact number for their Canadian offices:

MiTek Technical Support: 800-268-3434

The metal web components must be identified with "CCMC 12691-R" on the shipping box. In the field, the metal webs on the completed joists are identified by the joist depth/model identification (e.g., PS-10V2).

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 Factored Shear Resistances[1] for the Product

"Posi-Strut® Metal Web" Designation	Truss Depth (mm (in.))	Maximum Factored Web Shear (N (lbf.))			
		Compression Webs		Tension Webs	
		Single Web[2]	Double Web[2]	Single	Double Web
PS-10V2	235 (9 1/4)	4 181 (940)	5 426 (1 220)	4 181 (940)	5 426 (1 220)
PS-12	286 (11 1/4)	4 657 (1 047)	5 484 (1 233)	5 142 (1 156)	5 787 (1 301)
PS-12i	302 (11 7/8)	4 644 (1 044)	5 141 (1 156)	5 084 (1 143)	5 822 (1 309)
PS-13	324 (12 3/4)	5 150 (1 158)	5 929 (1 333)	5 186 (1 166)	6 129 (1 378)

Table 4.1.1 Factored Shear Resistances[1] for the Product (cont.)

"Posi-Strut® Metal Web" Designation	Truss Depth (mm (in.))	Maximum Factored Web Shear (N (lbf.))			
		Compression Webs		Tension Webs	
		Single Web[2]	Double Web[2]	Single	Double Web
PS-14V3	356 (14)	4 804 (1 080)	6 138 (1 380)	4 804 (1 080)	6 138 (1 380)
PS-16V3	406 (16)	5 249 (1 180)	6 138 (1 380)	5 249 (1 180)	6 138 (1 380)

Notes to Table 4.1.1:

(1) Shear resistances were determined empirically and adjusted for limit states design in accordance with CSA O86. The factored resistance includes Φ= 0.90. These design values are valid for the following conditions:

- lumber chords with mean relative density (SG) = 0.42 or greater;
- dry service and normal temperature conditions;
- standard term loading;
- the teeth are fully embedded into the wood chord having less than 19% MC during fabrication;
- the lumber below the tooth area is sound and free of wane, loose knots, knot holes, decay, end splits or end shake;
- metal webs are placed on both sides of the truss, directly opposite each other, using a hydraulic press; and
- no increase in design values for load-sharing conditions is applied.

(2) Single and double web designs were tested as per configurations below to obtain maximum shear capacity.

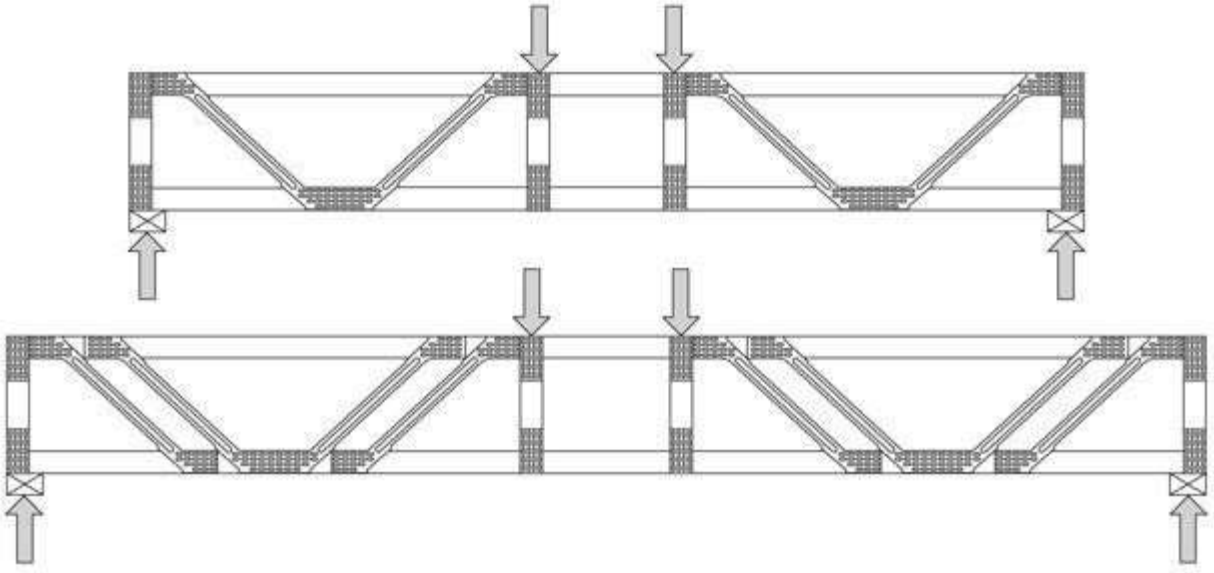

Figure 3. Maximum shear capacity testing configuration for single and double web designs

Table 4.1.2 Deflection Factors for "Posi-Strut® Metal Web Joists"

"Posi-Strut® Metal Web" Designation	Truss Depth (mm (in.))	Deflection Factor (α)	
		Stiffness Matrix Method(2)	Factor Beam Method(1)
PS-10V2	235 (9 1/4)	1.263	1.431
PS-12	286 (11 1/4)	1.243	1.456
PS-12i	302 (11 7/8)	1.248	1.497
PS-13	324 (12 3/4)	1.248	1.497
PS-14V3	356 (14)	1.345	1.499
PS-16V3	406 (16)	1.338	1.517

Notes to Table 4.1.2:

(1) Deflection of the metal web wood truss can be estimated as:

$$\Delta = \alpha \times \frac{5wL^4}{384EI}$$

where

α = the deflection factor for the specific metal web truss using beam method and is calculated as the ratio of measured deflection from testing to calculated deflection based on beam model using the bending stiffness of the chords
w = uniform distributed service load
L = span
E = modulus of elasticity of the lumber chord
I = moment of inertia of the chord area only

(2) MiTek Canada software uses the stiffness matrix method for their truss analysis. The deflection factor for the stiffness matrix method is calculated as the ratio of measured deflection from testing to calculated truss deflection using matrix analysis. MiTek Canada software incorporates the deflection factor in the final deflection output.

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Appendix A

Additional Test Information for "Posi-Strut® Metal Web Joists"

The design values obtained from testing to CCMC's Technical Guide for "Posi-Strut® Metal Web Joists," following the principles in CAN/CSA-O86, are summarized below. The manufacturer's published pre-engineered joist spans were designed in accordance with CAN/CSA-O86.

Table A1. Additional Test Information for "Posi-Strut® Metal Web Joists"

Property	Test Information
Shear capacity	A multitude of shear specimens were tested for the target SG groups of S-P-F. A regression analysis was then conducted for ultimate loads versus the wood failure and metal failure modes. The characteristic values were then determined using standardized Coefficient of Variation (COV) for the failure modes. Reliability normalization factors were applied in accordance with CAN/CSA-O86 procedures to obtain limit states design shear resistance values.
Moment capacity	Determined analytically in accordance with engineering principles consistent with TPIC-2007 and CAN/CSA-O86.
Stiffness	Stiffness capacity was tested to establish the deflection factor for a 1-h duration of the target live load of L/360. The following formula may be used to predict mid-span deflection: $$\Delta = \alpha \times \frac{5wL^4}{384EI}$$ where α = the deflection factor from Table 4.1.2 for the specific metal web truss using the beam method w = load (N/mm) L = span (mm) E = the modulus of elasticity of the chord I = moment of inertia of the chord area only
End bearing length	The minimum end bearing is based on the maximum shear capacity or the compression perpendicular limitation of the chord or supporting bottom plate.
Creep	Full-scale 24-h creep and recovery tests were conducted for six (6) pairs of trusses. The truss designs tested were governed by serviceability, and moment capacity or shear capacity.
Metal web requirements	The metal webs are manufactured from galvanized sheet steel conforming to Grade 40 of ASTM A 653/A 653M. The placement of metal webs complies with Article 12.8.1.3 of CAN/CSA-O86. Minimum galvanizing must be G90 coating class.
Manufacturing quality assurance	**Posi-Strut® Metal Web** The manufacture of the proprietary metal web is governed by MiTek Canada Inc.'s in-plant quality control manual administered by MiTek for the production of their proprietary metal products. **Posi-Strut® Metal Web Trusses/Joists** The manufacture of the finished floor trusses, as with the fabrication of roof trusses, is governed by the MiTek Canada Inc.'s truss fabrication quality assurance program administered by their licensees (truss fabricators).