Standard for Composite Steel Deck

CSSBI 12M-84
July, 1984

CANADIAN
SHEET STEEL
BUILDING INSTITUTE

PREFACE

One of the objects of the Canadian Sheet Steel Building Institute is the development of product standards to promote safety and sound construction practices. This Standard is intended to assist specifiers, designers, buyers, fabricators and erectors of composite steel deck by providing information which can be adopted by reference where desired.

The requirements contained herein are in accordance with sound engineering principles, augmented by experience. They include recommended minimum requirements for such factors as grade of steel, base steel nominal thickness, coating designations, loading and deflections, as well as design, fabrication and erection in general.

Composite steel deck is a basic component of a composite slab floor (or roof) which often will also incorporate a composite steel beam framing system. A compatible relationship between the various components is an important consideration when job plans and specifications are being developed. It is hoped that this *Standard for Composite Steel Deck* will provide useful guidance in that respect.

CONTENTS

REFERENCE PUBLICATIONS

This publication makes reference to the following:

National Building Code of Canada

Canadian Sheet Steel Building Institute (CSSBI)

101M Specification for Zinc Coated Structural Quality Steel Sheet for Steel Deck

301M Specification for Electrolytic Zinc Coated, Chromate Treated, Structural Quality Steel Sheet for Steel Deck

Canadian Standards Association (CSA)

CAN3-S136 Cold Formed Steel Structural Members

C22.2 No. 79 Cellular Metal and Cellular Concrete Floor Raceways and Fittings

W59 Welded Steel Construction (Metal Arc Welding)

STANDARD
for
COMPOSITE STEEL DECK

1. SCOPE

1.1 This Standard covers the limit states design, fabrication and erection of composite steel deck in its application as a form for concrete. The Appendix to this Standard provides guidelines for the limit states design of composite slabs incorporating composite steel deck as positive moment reinforcement.

1.2 This Standard applies to composite steel deck sections which have:
(a) a nominal depth of 77 mm or less;
(b) a nominal flute spacing of 406 mm or less; and
(c) interconnecting side laps.

1.3 This Standard does not apply to other types of concrete forming such as steel pans, v-rib or slab form profiles.

2. GENERAL

2.1 This Standard is to govern in those cases where the provisions of building codes, architects' and engineers' plans and specifications are not specific. In the event of any conflict between this Standard and any legal regulations, such regulations shall apply and this Standard shall only supplement as applicable.

2.2 Where reference is made to another publication, such reference shall be considered to refer to the latest revision or edition approved by the organization issuing that publication, unless otherwise noted.

2.3 Where details of design, fabrication or erection are not clearly specified in the plans and specifications furnished by the Buyer, the Fabricator shall furnish all materials required in accordance with the current specifications and standards of the Canadian Sheet Steel Building Institute (CSSBI).

2.4 Supplementary rules or requirements may be necessary for unusual loads, special types of construction or extraordinary conditions such as:
(a) repeated impact load;
(b) moving concentrated load;
(c) diaphragm action;
(d) composite action with supporting beams;
(e) two-way flexural action;
(f) exposure to corrosive environmental conditions; or
(g) conditions that could adversely affect design, fabrication or erection.

3. DEFINITIONS

3.1 **Buyer** means the person, firm or company contracting with the Fabricator or Erector for the supply and installation of composite steel deck.

3.2 **Cellular Composite Steel Deck** means a composite steel deck comprised of an embossed fluted element interconnected with a flat sheet on its underside.

Non-Cellular Composite Steel Deck means a composite steel deck comprised of a single embossed fluted element.

3.3 **Composite Slab** means a structural concrete slab that employs a composite steel deck as positive moment reinforcement.

3.4 **Composite Steel Deck** means a steel deck, either cellular or non-cellular, which acts initially as a form and subsequently as positive moment reinforcement for structural concrete. The cured concrete interlocks with the deck to achieve composite action.

3.5 **Embossments** mean regularly spaced embossments, indentations or lugs on the various surfaces of a composite steel deck for the purpose of achieving composite action by interlocking with the cured structural concrete.

3.6 **Erector** means an erector of composite steel deck, who may also be a Fabricator.

3.7 **Fabricator** means a fabricator of composite steel deck.

3.8 **Span** means the lesser of:
(a) the distance centre to centre of supporting members; or
(b) the clear distance between edges of supports plus the depth of the composite steel deck.

3.9 **Thickness** of sheet steel used for composite steel deck means the base steel thickness, exclusive of any coating. **Minimum Thickness** means the least thickness obtained by measurement at any point located at least 10 mm from an edge or corner bend. **Nominal Thickness** means the representative base steel thickness used to establish section properties of the composite steel deck.

4. SHEET STEEL REQUIREMENTS

4.1 **Material**
Sheet steel used for composite steel deck shall conform to one of the following specifications:

(a) CSSBI 101M *Zinc Coated Structural Quality Steel Sheet for Steel Deck; or*

(b) CSSBI 301M *Electrolytic Zinc Coated, Chromate Treated, Structural Quality Steel Sheet for Steel Deck.*

4.2 **Nominal Thickness Limitations**
The nominal thickness of sheet steel used for composite steel deck shall not be less than:

(a) 0.76 mm for a non-cellular section; or

(b) 0.91 mm for a cellular section when chosen for the provision of electrical services.

The nominal steel sheet thickness shall be increased where a greater thickness is required by Canadian Standards Association or Underwriters Laboratories of Canada standards for the application involved.

4.3 **Minimum Base Steel Thickness**
The minimum base steel thickness (excluding any coating) of sheet used for composite steel deck shall not be less than the specified nominal thickness minus its permissible negative deviation (under-tolerance).

4.4 **Minimum Zinc Coating**
Unless conditions require the use of a heavier zinc coating, the minimum zinc coating designation shall be ZF75 (zinc-iron alloy coat) for CSSBI 101M material and ZincGuard 102-C (minimum 31.1 g/m² zinc coating, total both sides, chromate treated) for CSSBI 301M material.

5. FABRICATION

5.1 **General**
Composite steel deck shall be fabricated in accordance with the applicable requirements of CAN3-S136 *Cold Formed Steel Structural Members.* Electrical raceway units shall also conform to CSA Standard C22.2 No. 79 *Cellular Metal and Cellular Concrete Floor Raceways and Fittings.*

5.2 **Tolerances**

5.2.1 Upon completion of fabrication, the depth of composite steel deck shall not be more than 1 mm under the design depth.

5.2.2 Upon completion of fabrication, the actual cover width of composite steel deck shall not exceed the design cover width by more than 10 mm per metre.

5.2.3 The location of an embossment shall be within 6 mm of the location assumed for design and the number of embossments per metre shall not be less than the number assumed for design. The depth of an embossment shall be at least 90 percent of the depth used in the test program conducted to establish composite slab parameters.

6. SAFETY DURING ERECTION

6.1 Minimum safety requirements for composite steel deck erection are outlined in 6.2 to 6.8 inclusive. In the event of any conflict between these requirements and any legal regulations, the regulations shall apply and these requirements shall only supplement.

6.2 All composite steel deck being hoisted to the working level shall be adequately banded and carefully slung employing protected wire rope and a choker type sling or multilift beams.

6.3 All bundles shall be tag-lined during the ascent of the hoisting operation. Bundles shall be placed so as to avoid overloading the supporting structure.

6.4 Composite steel deck, after being laid and aligned, shall be properly secured in place prior to leaving the jobsite at the end of each working day.

6.5 All loose bundles of composite steel deck shall be secured at the completion of each working day.

6.6 All composite steel deck cuttings, strapping, packaging material and other debris pertaining to composite steel deck shall be cleaned up on the floor area each working day and disposed of in a suitable manner.

6.7 Perimeter safety lines, safety lines at discontinued or incomplete construction and barricading of openings shall be the responsibility of the General Contractor.

6.8 Composite steel deck is designed primarily to support uniformly distributed load. Care shall be taken to avoid excessive concentration of loads during concrete placement and temporary storage of materials for sub-trades.

7. GUIDE SPECIFICATION FOR COMPOSITE STEEL DECK

7.1 **General**
The General Conditions shall be and are hereby made a part of this division.

7.2 **Work Included in this Division**

7.2.1 Furnish all labour, materials and equipment necessary to fabricate and, where shown or called for by the tender documents, hoist into position and erect the composite steel deck.

7.2.2 Supply and install accessories where shown or called for by the tender documents (e.g. *cell closures, flashings*).

7.2.3 Field weld steel shear connectors through the low flute of composite steel deck, where shown or called for by the tender documents. Stud welding shall be done in accordance with the requirements of CSA Standard W59 ***Welded Steel Construction (Metal Arc Welding).***

NOTE: The top surface of the flange or chord of the supporting structural member to which shear connectors are to be welded shall be free of paint, dirt, heavy rust, loose mill scale, sand or other materials which could interfere with the welding operation.

7.3 **Work Not Included in this Division**

7.3.1 All collateral materials (e.g. ***formwork, screed flash, concrete, welded wire mesh, reinforcing steel, fire-proofing).***

7.3.2 Forming openings in the composite slab and cutting the composite steel deck after concreting.

7.3.3 Reinforcing or structural framing around holes or openings.

7.3.4 Field painting of composite steel deck.

7.3.5 Cutting and drilling of holes for the attachment of suspended ceiling hangers, or for the attachment of any work of other trades.

7.3.6 Bearing plates, shelf angles, diagonal supports and other structural steel required to support composite steel deck.

7.3.7 Supply and installation of tape or metal covers for abutting ends.

7.4 **Material**

7.4.1 Composite steel deck shall be formed of zinc coated sheet steel, conforming to CSSBI 101M ***Zinc Coated Structural Quality Steel Sheet for Steel Deck*** or CSSBI 301M ***Electrolytic Zinc Coated, Chromate Treated, Structural Quality Steel Sheet for Steel Deck,*** with a base steel nominal thickness of 0.76 mm or greater for non-cellular sections, and 0.91/0.91 mm or greater for cellular sections intended for the provision of electrical services. The minimum zinc coating designation shall be ZF75 (zinc-iron alloy coat) for CSSBI 101M material or ZincGuard 102-C (minimum 31.1 g/m² zinc coating, total both sides, chromate treated) for CSSBI 301M material. The base steel nominal thickness and/or zinc coating shall be increased where necessary in order to satisfy structural, electrical, specified fire resistance rating, or other requirements as called for by the tender documents.

7.4.2 Cell closures and flashings shall be supplied of similar material and zinc coating designation to that specified for the composite steel deck. The base steel nominal thickness shall not be less than 0.76 mm.

7.5 **Drawings and Specifications**

7.5.1 The Buyer shall provide complete architectural and structural plans, specifications, and approved structural steel support spacings correctly dimensioned.

7.5.2 The composite steel deck Erector shall submit . . . copies of erection drawings for approval. The Buyer shall return one copy with his approval, or with such corrections as he may deem necessary.

7.5.3 Erection drawings shall show clearly the location of various sheet lengths, sheet quantities, sheet thicknesses, and zinc coating designations.

7.5.4 When changes are made by the Buyer, the cost of such changes shall be the basis for re-negotiating the contract.

7.6 **Design (General)**

7.6.1 In the absence of laws, regulations, ordinances and specifications to the contrary, structural design of composite steel deck as a form shall be in accordance with 7.6.2 to 7.7 inclusive. The structural design of composite slabs shall be in accordance with good engineering practice based on performance tests conducted by or on behalf of the Fabricator.

NOTE: The Appendix contains guidelines for limit states design of composite slabs.

7.6.2 The non-composite structural properties of composite steel deck shall be calculated in accordance with CAN3-S136 ***Cold Formed Steel Structural Members.***

7.6.3 Wherever structural framing permits, and subject to reasonable limitations for handling, composite steel deck shall be fabricated to span continuously, as a form, over at least three supports.

7.6.4 Electrical raceway units shall conform to CSA Standard C22.2 No. 79 *Cellular Metal and Cellular Concrete Floor Raceways and Fittings.*

7.6.5 Resistance welds used to interconnect top and bottom elements of cellular sections shall be designed in accordance with CAN3-S136 *Cold Formed Steel Structural Members*, and shall have a maximum spacing of 225 mm parallel to the direction of flutes. Resistance welding procedures and equipment shall be satisfactory to the Canadian Welding Bureau.

7.7 Design of Deck as a Form

7.7.1 **Strength:** Composite steel deck shall resist the effects of the combined loads due to wet concrete, deck, and the following minimum construction live loads applied separately:

(a) 1 kPa uniform load; or

(b) 2 kN/m transverse line load at the centre of the span (may be assumed to have a width of 300 mm).

Figure 1 (given on page 7) illustrates the loading diagrams that produce maximum bending moments for one, two and three equal spans.

7.7.2 **Deflections:** Calculated deflections shall be based on the load W_1 uniformly distributed. The maximum midspan deflection shall be limited to $L/_{180}$ or 20 mm whichever is smaller. Deflections shall be calculated as follows:

For single span:

$$\Delta = \frac{5\, W_1 L^4}{384\, E_S\, I}\ \gamma_p$$

For two equal spans:
Δ = 0.42 times single span value.

For three or more equal spans:
Δ = 0.53 times single span value.

Where,

Δ = calculated deflection, mm

W_1 = uniform load due to concrete slab and steel deck, kPa

L = deck span, mm

E_S = modulus of elasticity of deck steel = 203 000 MPa

I = composite steel deck moment of inertia, mm^4/m of width

γ_p = ponding factor = 1.10

NOTE: Calculated deflection is relative to supporting members. For unequal spans, or where additional loads resulting from the deflection of supporting structural members are required to be taken into account, an analysis is necessary.

7.8 Erection of Composite Steel Deck

7.8.1 All erection work shall be the responsibility of the Fabricator and such erection work shall be carried out by the Fabricator's trained erection crews, or the Fabricator's approved Erector, all in accordance with the Fabricator's and these specifications.

NOTE: Since composite steel deck is an engineered product, it is desirable to have single source responsibility for fabrication and erection. If erection is to be carried out by others, the specification writer should so indicate.

7.8.2 The composite steel deck shall be placed and adjusted to final position on the supporting structure before being permanently fastened thereto. If structural supports are not in proper alignment, the problem shall be reported to the General Contractor in order that the necessary corrections be made before proceeding with the work.

7.8.3 Establishment of the datum line for positioning electrified cellular composite steel deck units shall be the responsibility of the General Contractor.

7.8.4 Composite steel deck shall be adequately connected to structural supports. The maximum spacing of fastenings shall be 400 mm along bearing supports. Where arc spot welds are used they shall have a 20 mm minimum top diameter. Welders shall be qualified for deck welding by the Canadian Welding Bureau.

7.8.5 Side laps of adjacent units shall be fastened at intervals not exceeding 600 mm on centre. For thicknesses greater than 0.91 mm, side laps may be welded using 25 mm long welds.

7.8.6 The Erector shall install all flashings or closures at openings and columns shown or called for by the tender documents.

7.8.7 All cellular composite steel deck units intended for electrical raceways shall be properly levelled. Abutting ends shall be in alignment within 3 mm both vertically and horizontally.

7.8.8 Bottom elements of cellular composite steel deck units shall not be separated from each other at abutting ends by more than 12 mm.

7.8.9 No holes shall be made in the walls of cells used as raceways other than those necessary for proper installation of the cellular composite steel deck. Such holes shall be adequately covered to prevent entry of concrete.

7.8.10 Any internal projection in a cell, due to welding or other operations, that could damage conductor insulation shall be removed or rendered harmless.

7.9 **Limitations**

7.9.1 Any damage or alterations by others to the composite steel deck, including that due to construction loads applied at any time, shall not be the responsibility of the Erector or Fabricator.

7.10 **Access**

7.10.1 Access for unloading bundles of deck onto the structure shall be provided by the General Contractor.

7.11 **Storage of Materials on Site**

7.11.1 Composite steel deck shall normally be delivered to the jobsite as required for erection, but if site storage becomes necessary, the following requirements shall be observed:

(1) tilt bundles for drainage;

(2) block bundles off the ground for effective drainage and ventilation;

(3) block long bundles to prevent sagging; and

(4) store away from chemically corrosive substances (e.g. *salt, cement, fertilizer)* away from materials that could contaminate the surface (e.g. *diesel oil, paint, grease)* and away from site traffic.

NOTE: Moisture can cause wet storage staining of deck material and usually occurs in one or more of three ways: (1) condensation from high humidity and/or temperature cycling; (2) wet shipping conditions; or (3) wind-driven rain penetration (outdoor storage). The usual progression is from visible water staining to unsightly white staining to red rust. On material where wet storage stain has occurred, it should be noted that a nominal amount of white staining is not detrimental to the functioning of the product and is usually considered acceptable.

7.11.2 Areas for storage shall be provided by the General Contractor as close to the building as is practicable.

7.11.3 Protection against damage shall be provided by the General Contractor.

7.12 **Cleanup**

7.12.1 Remove all debris of this trade and leave work ready for other trades.

Appendix: Guidelines for Limit States Design of Composite Slabs

A.1 **General**

Composite slabs shall be proportioned on a limit states design basis to resist the load effects stated in the *National Building Code of Canada.*

A.2 **Strength of Composite Slabs**

The determination of the ultimate limit states load for each combination of deck profile, embossment pattern, deck coating and concrete type, shall be determined on the basis of full scale composite slab tests conducted in accordance with good engineering practice. The Fabricator shall publish loads, for use in design, which do not exceed loads determined by test or derived therefrom. If requested, the Fabricator shall provide test reports substantiating his published values.

A.3 **Deflection of Composite Slabs**

(a) The immediate deflection of the composite slab due to live load shall be computed in accordance with conventional elastic theory applied to reinforced concrete requiring the transformation of steel areas to equivalent areas of concrete. The deflection of a single span composite slab with uniform loading shall be calculated as follows:

$$\Delta = \frac{5 W_L L^4}{384 E_c I_d}$$

where,

Δ = calculated deflection, mm

W_L = specified live load, kPa

L = span, mm

I_d = averaged moment of inertia of the cracked and uncracked sections, mm^4/m of slab width

E_c = modulus of elasticity of concrete
= $w_c^{1.5} 0.043 \sqrt{F'_c}$, MPa
F'_c = specified compressive strength of concrete, MPa
w_c = mass density of concrete, kg/m^3

NOTE: For cases other than a simple span or for non-uniform loads, the deflection of the composite slab shall be calculated using conventional elastic theory.

(b) Unless otherwise required, the deflection computed in accordance with (a) above shall be limited to L/360.

A.4 **Slab Reinforcement and Crack Control**
Composite slabs shall have minimum shrinkage and temperature reinforcement in accordance with Table 1 unless a greater amount is required by the specified fire resistance rating.

In Table 1 the following definitions apply:
D = overall depth of composite slab, mm
d_d = overall depth of composite steel deck, mm
h = concrete cover slab thickness, mm

TABLE 1
Minimum Shrinkage and Temperature Reinforcement

Concrete Thickness $h = (D - d_d)$	Minimum Area of Reinforcement Required
$h \leq 80$ mm	60 mm^2/m of slab width
80 mm $< h <$ 150 mm	(3h-180) mm^2/m of slab width
150 mm $\leq h$	(1.8h) mm^2/m of slab width

Where designed for continuity over structural supports, composite slabs shall have negative moment reinforcement as required in conventional reinforced concrete. When the composite slab is not designed for continuity over structural supports, the effects of cracking of the concrete shall be considered and adequate crack control measures shall be taken where necessary.

NOTE: Shrinkage and temperature reinforcement alone is not intended to resist negative bending moments. Additional reinforcement must be provided as required by a structural design if negative bending is to be resisted.

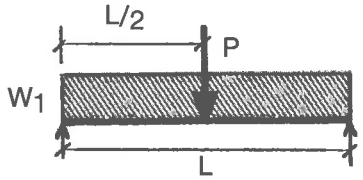
The recommended minimum temperature and shrinkage reinforcement, usually in the form of welded wire mesh, if properly placed and if good concreting practices such as low water/cement ratio, low slump and proper curing are followed, will often be sufficient to cause the shrinkage and temperatures stresses to be relieved in small local cracks rather than accumulating over greater distances. It is recommended that the mesh be placed approximately 25 mm below the top surface of the concrete, particularly in areas of negative moments, such as over supports, where the bending stresses in the top portion of the concrete add to the shrinkage stresses.

For applications where a higher degree of crack control is required, the designer should refer to recognized standards of concrete practice and design such as CSA Standard A23.3 "Code for the Design of Concrete Structures for Buildings."

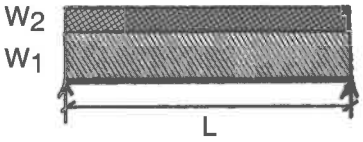
In Figure 1:
P = assumed transverse construction line load = 2 kN/m
W_1 = uniform load due to concrete slab and steel deck, kPa
W_2 = assumed construction live load = 1 kPa
L = deck span, mm
α_L = load factor for construction live load = 1.50
α_D = load factor for construction dead load = 1.25
M_r = factored positive moment resistance, N.mm
M'_r = factored negative moment resistance, N.mm

NOTE: The dead load factor, $\alpha_D = 1.25$, includes an allowance for the effects of ponding of wet concrete.

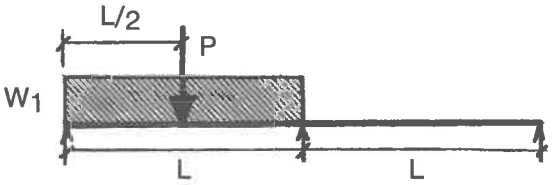
FIGURE 1: LOADING DIAGRAMS AND MAXIMUM MOMENT EQUATIONS



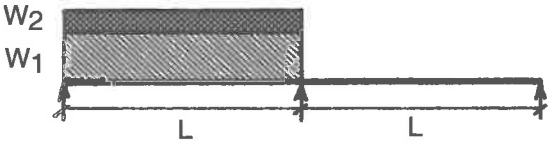
$M_r \geq 0.125\alpha_D W_1 L^2 + 0.250\alpha_L P L x 10^3$ (N.mm/m of deck)



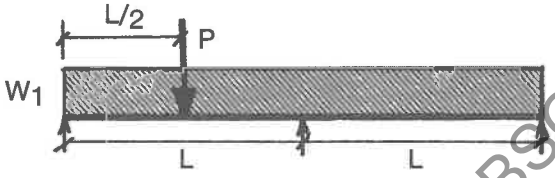
$M_r \geq 0.125(\alpha_D W_1 + \alpha_L W_2)L^2$ (N.mm/m of deck)



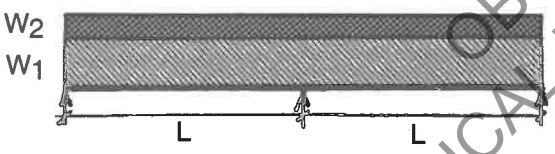
$M_r \geq 0.096\alpha_D W_1 L^2 + 0.203\alpha_L P L x 10^3$ (N.mm/m of deck)



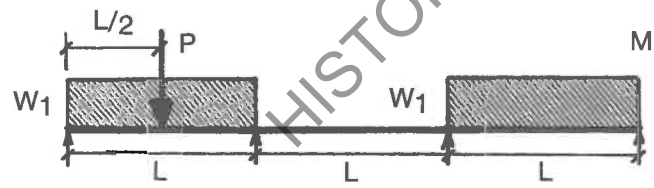
$M_r \geq 0.096(\alpha_D W_1 + \alpha_L W_2)L^2$ (N.mm/m of deck)



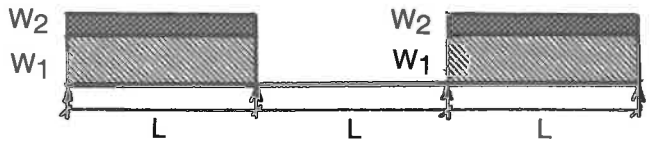
$M_r' \geq 0.125\alpha_D W_1 L^2 + 0.094\alpha_L P L x 10^3$ (N.mm/m of deck)



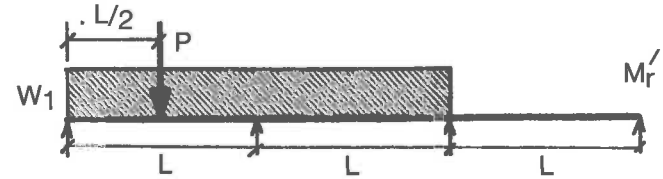
$M_r' \geq 0.125(\alpha_D W_1 + \alpha_L W_2)L^2$ (N.mm/m of deck)



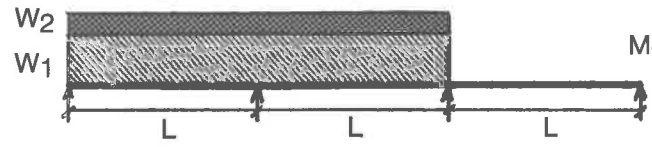
$M_r \geq 0.101\alpha_D W_1 L^2 + 0.200\alpha_L P L x 10^3$ (N.mm/m of deck)



$M_r \geq 0.101(\alpha_D W_1 + \alpha_L W_2)L^2$ (N.mm/m of deck)



$M_r' \geq 0.117\alpha_D W_1 L^2 + 0.100\alpha_L P L x 10^3$ (N.mm/m of deck)



$M_r' \geq 0.117(\alpha_D W_1 + \alpha_L W_2)L^2$ (N.mm/m of deck)

The Canadian Sheet Steel Building Institute, the national association of the structural sheet steel industry, promotes the use of sheet steel in building construction through engineered design and standards of quality and performance. Activities focus on sheet steel building products and steel building systems for commercial, industrial and institutional applications and similar products and systems for farm applications.

The Institute provides information regarding the standards of design, fabrication and erection, and offers technical assistance in the use of cold formed and pre-engineered steel products. The CSSBI also represents its members in technical matters connected with government, and provides liaison with organizations such as Canadian Standards Association and National Research Council.

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