Standard for Composite Steel Deck

CSSBI 12M-96
October, 1996

CANADIAN
SHEET STEEL
BUILDING INSTITUTE

PREFACE

One of the objects of the Canadian Sheet Steel Building Institute is the development of standards which promote safety, performance and good practice. 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. This Standard replaces the previous edition dated July 1984, revised December, 1988.

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 intended that this *Standard for Composite Steel Deck* will provide useful guidance in that respect.

The material presented has been prepared for the general information of the reader and includes recommended minimum requirements for grade of steel, base steel design thickness, metallic coating designations, loading and deflections, as well as design, fabrication and erection in general. While the material is believed to be technically correct and in accordance with recognized practice at the time of publication it does not obviate the need to determine its suitability for a given situation. Neither the Canadian Sheet Steel Building Institute nor its Members warrant or assume any liability for the suitability of the material for any general or particular application.

ISBN 1-895535-38-7

CONTENTS

REFERENCE PUBLICATIONS

This publication makes reference to the following:

National Building Code of Canada

American Society for Testing and Materials (ASTM)

A653/A653M Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A792/A792M Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

Canadian Sheet Steel Building Institute (CSSBI)

S2 Criteria for the Testing of Composite Slabs

S3 Criteria for the Design of Composite Slabs

Canadian Standards Association (CSA)

CSA- S136 Cold Formed Steel Structural Members

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

W47.1 Certification of Companies for Fusion Welding of Steel Structures

W59 Welded Steel Construction (Metal Arc Welding)

STANDARD
for
COMPOSITE STEEL DECK

1. SCOPE

1.1 This Standard cover the limit states design, fabrication and erection of composite steel deck in its application as a form for concrete. Criteria for the testing and limit states design of composite slabs incorporating composite steel deck as positive moment reinforcement are contained in CSSBI publications S2 and S3 respectively.

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.

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

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

3.9 **Design Thickness** of sheet steel used for composite steel deck means the base steel thickness, exclusive of any coatings used to establish section properties of the deck. **Minimum Thickness** means the least thickness obtained by deducting the maximum under-tolerance permitted by CSA-S136 from the design thickness.

4. SHEET STEEL REQUIREMENTS

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

a) ASTM A653/A653M *Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*; or
b) ASTM A792/A792M *Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.*

4.2 **Design Thickness Limitations**
The design 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 design 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 design thickness minus the maximum under tolerance permitted by CSA Standard S136.

4.4 **Minimum Metallic Coating**
Unless conditions require the use of a heavier metallic coating, the minimum zinc coating designation shall be ZF75 (zinc-iron alloy coat) for ASTM A653/A653M material, and AZ150 (aluminum-zinc alloy coat) for ASTM A792/A792M material.

5. FABRICATION

5.1 **General**
Composite steel deck shall be fabricated in accordance with the applicable requirements of CSA-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 as applicable.

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 metallic coated sheet steel, conforming to ASTM A653/A653M *Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process* or ASTM A792/A792M *Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process* with a base steel design 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 metallic coating designation shall be ZF75 (zinc-iron alloy coat) for ASTM A653/A653M material, AZ150 (aluminum-zinc alloy coat) for ASTM A792/A792M material. The base steel design thickness and/or metallic 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 metallic coating designation to that specified for the composite steel deck. The base steel design 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 review. The Buyer shall return one copy 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 metallic 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: CSSBI publication S3 provides criteria for limit states design of composite slabs. CSSBI publication S2 provides criteria for testing composite slabs.

7.6.2 The non-composite structural properties of composite steel deck shall be calculated in accordance with CSA-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 CSA-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 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:

$$\Delta = \frac{5W_1L^4}{384E_sI}\gamma_p$$

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 = 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 Erector and such erection work shall be carried out by trained erection crews, all in accordance with the Fabricator's and these specifications. Erectors shall be qualified in accordance with CSA Standard W47.1 *Certification of Companies for Fusion Welding of Steel Structures*. Welders shall be qualified for deck welding by the Canadian Welding Bureau.

7.8.2 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 minimum size in accordance with CSA-S136 *Cold Formed Steel Structural Members*.

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) condensations 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 (dark grey to dull black on aluminum-zinc alloy coated sheet) to red rust. On material where wet storage stain has occurred, it should be noted that a nominal amount of white or gray 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**

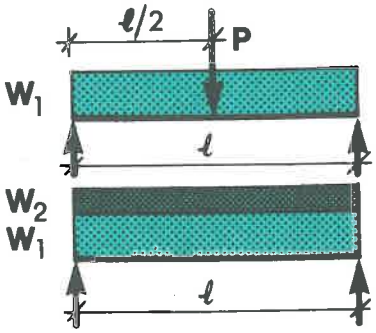
7.12.1 Remove all debris of this trade and leave work ready for other trades.

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

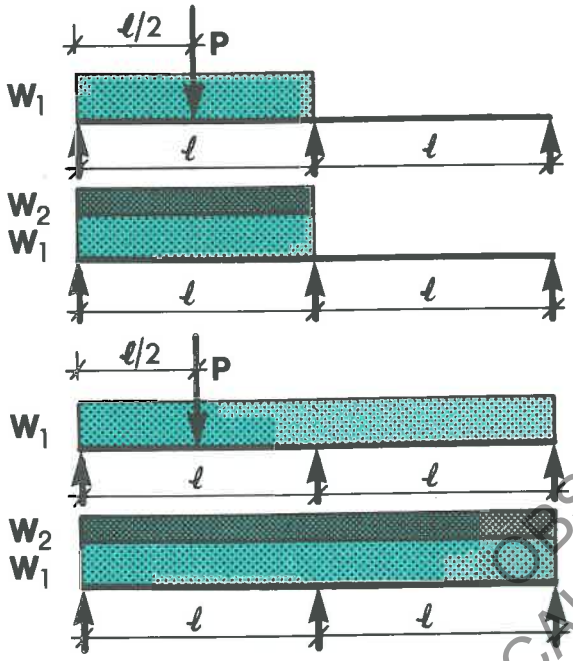
Note: *The dead load factor, α_D = 1.25, provides some allowance for the ponding of wet concrete.*

FIGURE 1: LOADING DIAGRAMS AND FACTORED MOMENT EQUATIONS (N-mm/m of deck)



$M_r \geq 0.125\alpha_D W_1 \ell^2 + 0.250\alpha_L P \ell \times 10^3$

$M_r' \geq 0.125 (\alpha_D W_1 + \alpha_L W_2) \ell^2$

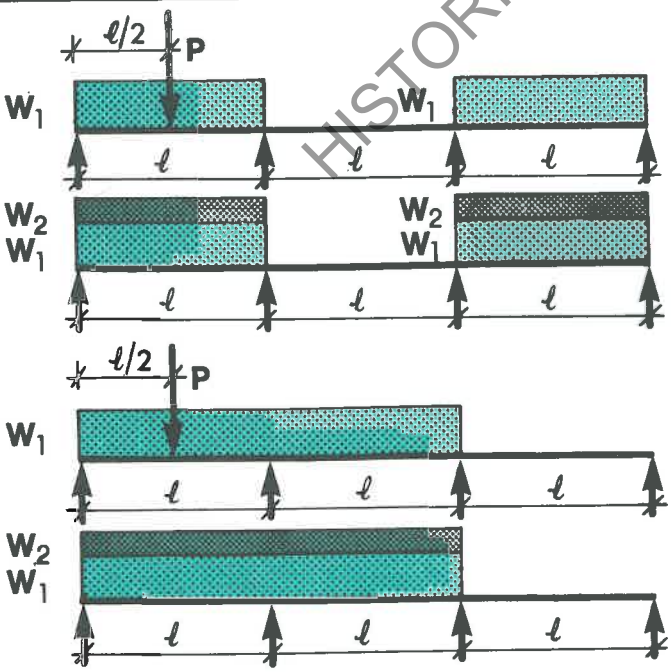


$M_r \geq 0.096\alpha_D W_1 \ell^2 + 0.203\alpha_L P \ell \times 10^3$

$M_r \geq 0.096 (\alpha_D W_1 + \alpha_L W_2) \ell^2$

$M_r' \geq 0.125\alpha_D W_1 \ell^2 + 0.094\alpha_L P \ell \times 10^3$

$M_r' \geq 0.125 (\alpha_D W_1 + \alpha_L W_2) \ell^2$



$M_r \geq 0.101\alpha_D W_1 \ell^2 + 0.200\alpha_L P \ell \times 10^3$

$M_r \geq 0.101 (\alpha_D W_1 + \alpha_L W_2) \ell^2$

$M_r' \geq 0.117\alpha_D W_1 \ell^2 + 0.100\alpha_L P \ell \times 10^3$

$M_r' \geq 0.117(\alpha_D W_1 + \alpha_L W_2) \ell^2$

CANADIAN SHEET STEEL BUILDING INSTITUTE

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, lightweight steel cladding, lightweight steel framing and steel building systems for commercial, industrial and institutional applications as well as similar products and systems for residential and 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 the Canadian Standards Association and the National Research Council.

CSSBI Member Companies are voluntarily committed to maintaining high industry standards in the design, manufacture and installation of cold formed steel building products and systems. Specifying requirements to CSSBI Standards and dealing with CSSBI Member Companies, can provide added assurance of quality construction. Only CSSBI Member Companies are authorized to display the CSSBI logo on drawings, stationary, company literature and advertising.

FABRICATOR MEMBER

PRODUCER MEMBER

ASSOCIATE MEMBER

652 Bishop St. N., Unit 2A, Cambridge, Ontario N3H 4V6 • Telephone (519) 650-1285 • Fax (519) 650-8081

Printed in Canada

ISBN 1-895535-38-7