CSSBI 12M-2015:

Standard for Composite Steel Deck

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PREFACE

One of the objectives of the Canadian Sheet Steel Building Institute is the development of standards to promote safety, performance and good practice. This Standard is intended to assist specifiers, designers, buyers, manufacturers and erectors of composite steel deck by providing information which can be adopted by reference where desired. This Standard replaces the previous edition dated October 2013.

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.

REFERENCE PUBLICATIONS

This publication makes reference to the following:

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)

CAN/CSA-S136	*North American Specification for the Design of 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*
W59	*Welded Steel Construction (Metal Arc Welding)*

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. 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 not greater than 77 mm;
b) a nominal flute spacing not greater than 406 mm; and
c) side laps to interconnect adjacent units.

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 Manufacturer 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 Manufacturer 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 steel 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 **Manufacturer** means a manufacturer of composite steel deck.

3.8 **Span** of composite steel deck means the lesser of:
- a) the centre to centre distance of structural supports; or
- b) the clear distance between edges of structural 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. The **Minimum Thickness** shall not be less than 95% of the Design Thickness as permitted by CAN/CSA-S136.

4. SHEET STEEL REQUIREMENTS

4.1 **Material**

Sheet steel used for composite steel deck shall conform to one of the following material 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 95% of the specified design thickness as permitted by CAN/CSA-S136.

4.4 **Metallic Coatings**

Unless conditions require the use of a heavier metallic coating, the minimum zinc coating designation shall be ZF75 (zinc-iron alloy coating) or Z275 (zinc coating) for ASTM A653/A653M material, and AZM150 (55% aluminum-zinc alloy coating) for ASTM A792/A792M material.

5. FABRICATION

5.1 **General**

Composite steel deck shall be fabricated in accordance with the applicable requirements of CAN/CSA-S136. 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 or width.

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, such 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 steel wire rope and a choker type sling or multi-lift 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 All composite steel deck sheets, 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 removed from 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 including touch-up to the underside of top chords or flanges of supporting steel members where discolouration due to welding has occurred.

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 the 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 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*, minimum Grade 230 with a minimum metallic coating designation of ZF75 (zinc-iron alloy coating) or Z275 (zinc coating); or,

(b) ASTM A792/A792M Steel Sheet, 55% *Aluminum-Zinc Alloy-Coated by the Hot-Dip Process*, minimum Grade 230 with a minimum metallic coating designation of AZM150.

The base steel design thickness shall be 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.

Note: 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. The building structural design documents shall include the type and spacing of the fasteners connecting the steel deck to the supporting structure.

7.5.2 The composite steel deck Erector shall submit ___ copies of erection drawings for review. 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 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 Manufacturer.

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 CAN/CSA-S136.

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 four structural supports (three spans).

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 CAN/CSA-S136, 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 dead loads due to wet concrete and steel deck, combined with 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 and support reactions for one, two and three equal spans. In addition to bending moment, the web crippling capacity of the deck needs to be checked.

NOTE: The uniform construction live load of 1 kPa is considered adequate for typical construction applications that consist of concrete transport and placement by hose and finishing using hand tools. The designer typically has little or no control over means-and-methods of construction, and it should be brought to the attention of the contractor that bulk dumping of concrete using buckets, chutes, or handcarts, or the use of heavier motorized finishing equipment such as power screeds, may require design of the deck as a form using a uniform construction live load of 2.4 kPa or greater.

7.7.2 **Deflections:** Calculated deflections shall be based on the uniform dead load due to wet concrete and steel deck. The maximum midspan deflection shall be limited to L/180 or 20 mm whichever is smaller. Deflections shall be calculated as follows:
For a single span:

$$\Delta = \frac{5\ W1\ L^4}{384EI} Y_p$$

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 service load deflection, mm
W1 = uniform dead load due to wet concrete and steel deck, kPa
L = span, mm
E = modulus of elasticity of steel, (203 000 MPa)
I = moment of inertia of the composite steel deck at midspan, when supporting the service load, W1, with top flange of the deck in compression, mm^4/m of width
Y_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. The designer is urged to check the deflection of the total system. Typical load tables are based on uniform slab thickness. If the designer wants to include additional concrete loading on the deck because of frame deflection, the additional load should be shown on the design drawings or stated in the deck section of the contract documents.

7.8 **Erection of Composite Steel Deck**

7.8.1 All erection work, including field welding or mechanical fasteners, shall be the responsibility of the Erector and such erection work shall be carried out by trained erection crews, all in accordance with the Manufacturer's and these specifications. Erectors shall be qualified in accordance with CSA Standard W47.1 *Certification of Companies for Fusion Welding of Steel.* Welders shall be qualified for deck welding by the Canadian Welding Bureau.

7.8.2 Composite steel deck units 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 can 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 as specified in the building structural design documents. The maximum spacing of fastenings shall be 406 mm along bearing supports. Where arc spot welds are used they shall have a 20 mm nominal top diameter.

7.8.5 Side laps of adjacent units shall be fastened at intervals not exceeding 600 mm on centre. Closer spacing may be required for diaphragm action, as determined by the building structural designer. For thicknesses 0.91 mm and greater, side laps may be welded using 25 mm long seam welds.

Note: Side lap weld connections on material thinner than 0.91 mm are permitted by CSA-S136, but not recommended due to the difficulty in making quality welds in thin material.

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 leveled. 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 Manufacturer.

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.

If the bundles are to be covered, avoid impermeable material such as plastic and ensure that adequate ventilation is provided to prevent condensation.

7.11.2 Moisture can cause wet staining of deck material and usually occurs in one 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 55% aluminum-zinc alloy coated sheet) to red rust. On material where wet staining has occurred, it should be noted that a nominal amount of staining is not detrimental to the functioning of the product and is considered acceptable. Primer that may be required to cover wet staining discolouration is not the responsibility of the deck supplier.

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

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

7.12 **Cleanup**

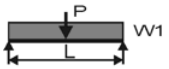
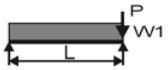
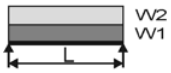
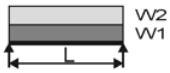
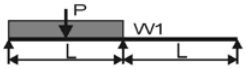
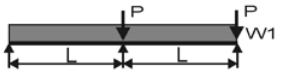
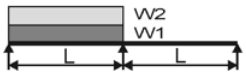
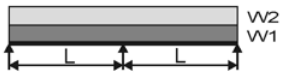
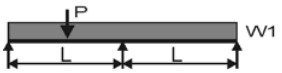
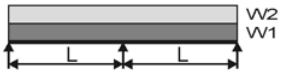
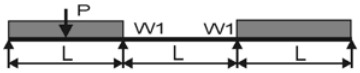
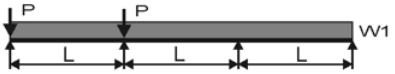
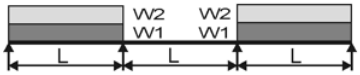
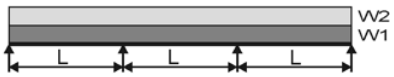
7.12.1 Remove all debris of this trade and leave work ready for other trades.

In Figure 1:

L = deck span, m
M = factored positive moment, kN.m/m width
M' = factored negative moment, kN.m/m width
P = minimum transverse construction line load = 2 kN/m
R_e = factored end support reaction, kN/m width
R_i = factored interior support reaction, kN/m width
W1 = uniform dead load due to concrete slab and steel deck, kPa
W2 = minimum construction live load = 1 kPa
α_L = load factor for construction live load = 1.50
α_D = load factor for construction dead load = 1.25

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

Figure 1: Loading Diagrams

Factored Moments (kN.m/m of deck)	Factored Support Reactions (kN/m of deck)
 $M = 0.125\alpha_D W1L^2 + 0.25\alpha_L PL$	 $R_e = 0.500\alpha_D W1L + \alpha_L P$
 $M = 0.125[\alpha_D W1 + \alpha_L W2]L^2$	 $R_e = 0.500[\alpha_D W1 + \alpha_L W2]L$
 $M = 0.096\alpha_D W1L^2 + 0.203\alpha_L PL$	 $R_e = 0.375\alpha_D W1L + \alpha_L P$ $R_i = 1.25\alpha_D W1L + \alpha_L P$
 $M = 0.096[\alpha_D W1 + \alpha_L W2]L^2$	 $R_e = 0.375[\alpha_D W1 + \alpha_L W2]L$ $R_i = 1.25[\alpha_D W1 + \alpha_L W2]L$
 $M' = 0.125\alpha_D W1L^2 + 0.094\alpha_L PL$	
 $M' = 0.125[\alpha_D W1 + \alpha_L W2]L^2$	
 $M = 0.101\alpha_D W1L^2 + 0.200\alpha_L PL$	 $R_e = 0.4\alpha_D W1L + \alpha_L P$ $R_i = 1.1\alpha_D W1L + \alpha_L P$
 $M = 0.101[\alpha_D W1 + \alpha_L W2]L^2$	 $R_e = 0.4[\alpha_D W1 + \alpha_L W2]L$ $R_i = 1.1[\alpha_D W1 + \alpha_L W2]L$
 $M' = 0.117\alpha_D W1L^2 + 0.100\alpha_L PL$	
 $M' = 0.117[\alpha_D W1 + \alpha_L W2]L^2$	