



AMERICAN NATIONAL STANDARDS INSTITUTE/ STEEL DECK INSTITUTE

C1.0 - 2006 Standard for

Composite Steel Floor Deck



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1. General

1.1 Scope:

- A. This specification for Composite Steel Deck shall govern the materials, design, and erection of cold formed steel deck which acts as a permanent form and as positive reinforcement for a structural concrete slab.
- B. Commentary shall not be considered part of the mandatory document.

1.2 Reference Codes, Standards and Documents:

- A. Codes and Standards:
For purposes of this Standard, comply with applicable provisions of the following Codes and Standards:
 - 1. American Iron and Steel Institute (AISI) Standard-North American Specification for the Design of Cold-Formed Steel Structural Members, 2001 Edition with Supplement 2004
 - 2. American Welding Society-ANSI/AWS D1.3 Structural Welding Code/Sheet Steel-98 Structural Welding Code-Sheet Steel
 - 3. American Society for Testing and Materials (ASTM) A653 (A653M)-06, A924 (A924M)-06, A1008 (A1008M)-06, A820 (A820M)-06, C1399 (C1399M)-04, Test Method E2322-03, ASTM Subcommittee CO9.42
 - 4. American Concrete Institute (ACI) Building Code Requirements for Reinforced Concrete – ACI 318-05
 - 5. American Society of Civil Engineering (ASCE)-SEI/ASCE7-05
 - 6. American Institute of Steel Construction (AISC)-Specification for Structural Steel Buildings, 13th Edition

- 7. Underwriters Laboratories (UL) Fire Resistance Directory-
<http://www.ul.com/database>
2006

Commentary: Many fire related assemblies that use composite floor decks are available. In the Underwriters Laboratories *Fire Resistance Directory*, the composite deck constructions show hourly ratings for restrained and unrestrained assemblies. ASTM E119 provides information in appendix X3 called "Guide for Determining Conditions of Restraint for Floor and Roof Assemblies and for Individual Beams".

- B. Reference Documents:
Refer to the following documents:

- 1. SDI Composite Deck Design Handbook-CDD2-1997
- 2. SDI Manual of Construction with Steel Deck-MOC2-2006
- 3. SDI Standard Practice Details-SPD2-2001
- 4. SDI Diaphragm Design Manual-DDMO3-2004

2. Products

2.1 Material:

- A. Sheet steel for galvanized deck shall conform to ASTM A653 (A653M) Structural Quality, with a minimum yield strength of 33 ksi (230 MPa).
- B. Sheet steel for uncoated or phosphatized top/painted bottom deck shall conform to ASTM A1008 (A1008M) with a minimum yield strength of 33 ksi (230 MPa). Other structural sheet steels or high strength low alloy steels are acceptable, and shall be selected from the *North American Specification for the Design of Cold-Formed Steel Structural Members*.

- C. Sheet steel for accessories shall conform to ASTM A653 (A653M)-minimum yield strength of 33 ksi (230 MPa). Structural Quality for structural accessories, ASTM A653 (A653M) Commercial Quality for non-structural accessories, or ASTM A1008 (A1008M) for either structural or non-structural accessories. Other structural sheet steels or high strength low alloy steels are acceptable, and shall be selected from the *North American Specification for the Design of Cold-Formed Steel Structural Members*.

- D. The deck type (profile) and thickness (gauge) shall be as shown on the plans.

Commentary: Most composite steel floor deck is manufactured from steel conforming to ASTM Designation A1008 (A1008M), Grades 33 and 40, or from A653 (A653M), Structural Sheet Steel. When specifying alternative steels, certain restrictions apply (See *North American Specification for the Design of Cold-Formed Steel Structural Members* Section A 2-3.2). 2.1A refers to the use of galvanized deck while 2.1B refers to the use of uncoated or phosphatized top/painted underside deck. In most cases the designer will choose one finish or the other. However, both types of finish may be used on a job, in which case the designer must indicate on the plans and project specifications the areas in which each is used. (Refer to Section 2.3 and the commentary of these specifications). In section 2.1D, the deck type is the particular profile of deck chosen by the designer.

2.2 Tolerance:

- A. Uncoated thickness shall not be less than 95% of the design thickness as listed in Table 2.2.1:



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Table 2.2.1

Gage No.	Design Thickness		Minimum Thickness	
	in.	mm.	in.	mm.
22	0.0295	0.75	0.028	0.71
21	0.0329	0.84	0.031	0.79
20	0.0358	0.91	0.034	0.86
19	0.0418	1.06	0.040	1.01
18	0.0474	1.20	0.045	1.14
17	0.0538	1.37	0.051	1.30
16	0.0598	1.52	0.057	1.44

- B. Panel length shall be within plus or minus 1/2 inch (12 mm) of specified length.
- C. Panel cover width shall be no greater than minus 3/8 inch (10 mm), plus 3/4 inch (20 mm).
- D. Panel camber and/or sweep shall be no greater than 1/4 inch in 10 foot length (6 mm in 3 m).
- E. Panel end out of square shall not be greater than 1/8 inch per foot of panel width (10 mm per m).

2.3 Finish:

- A. Galvanizing shall conform to ASTM A653 (A653M).
- B. Uncoated or phosphatized topside with painted underside shall be applied to steel sheet conforming to ASTM A1008 (A1008M).
- C. The finish on the steel composite deck shall be suitable for the environment of the structure.

Commentary: The finish on the steel composite deck shall be as specified by the designer and be suitable for the environment of the structure. Since the composite deck is the positive bending reinforcement for the slab, it must be designed to last the life of the structure. A galvanized finish equal to ASTM A653 (A653M)-G30 minimum is recommended. When composite deck with a phosphatized top and painted bottom is used, the primer coat is intended to protect the steel for only a short period of exposure in ordinary atmospheric conditions and shall be

considered an impermanent and provisional coating.

2.4 Design:

A. Deck as a form

1. The section properties for the steel floor deck unit (as a form in bending) shall be computed in accordance with the *North American Specification for the Design of Cold-Formed Steel Structural Members*.
2. Allowable Stress Design (ASD): Bending stress shall not exceed 0.60 times the yield strength, nor exceed 36 ksi (250MPa) under the combined loads of wet concrete, deck weight, and the following construction live loads: 20 pounds per square foot (1 kPa) uniform load or 150 pound concentrated load on a 1'-0" (300 mm) wide section of deck (2.2 kN per m). The interaction of shear and bending shall be considered in the calculations. (See Figure 1-Attachment C1)
3. Load and Resistance Factor Design (LRFD): The load combinations for construction are as shown in Attachment C1. Load factors shall be in accordance with ASCE 7 (See Section 1.2.A.5). The resistance factors and nominal resistances shall be in accordance with *North American Specification for the Design of Cold-Formed Steel Structural Members*.

Commentary: The loading shown in Figure 1 of Attachment C1 is representative of the sequential loading of wet concrete on the deck. The 150 pound load (per foot of width) is the result of distributing a 300 pound (1.33 kN) man over a 2 foot (600 mm) width. Experience has shown this to be a conservative distribution. The metric equivalent of the 150 pound load is 2.2 kN per meter of width. For single span deck conditions, the ability to control the concrete placement

may be restricted and an amplification factor of 1.5 is applied to the concrete load to address this condition; however, in order to keep this 50% load increase within a reasonable limit, the increase is not to exceed 30 psf (1.44 kPa). In LRFD, a load factor for construction of 1.4 is applied to this load. Whenever possible, the deck shall be multi-span and not require shoring during concrete placement.

4. Deck Deflection: Calculated deflections of the deck, as a form, shall be based on the load of the wet concrete as determined by the design slab thickness and the weight of the steel deck, uniformly loaded on all spans, and shall be limited to 1/180 of the clear span or 3/4 inch (20 mm), whichever is smaller. Calculated deflections shall be relative to supporting members.

Commentary: The deflection calculations do not take into account construction loads because these are considered temporary loads. The deck is designed to always be in the elastic range so removal of temporary loads should allow the deck to recover. The structural steel also deflects under the loading of the wet concrete.

The designer is urged to check the deflection of the total system, especially if composite beams and girders are being used. 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 job specifications.

5. Minimum Bearing: Minimum interior bearing lengths shall be determined in accordance with the web crippling provisions of the *North American Specification for the Design of Cold-Formed Steel Structural Members*; a uniform

loading case of wet concrete, plus the weight of the steel deck, plus 20 psf (1 kPa) construction load shall be used. (See Figure 3-Attachment C1)

Commentary: Experience has shown that 1-1/2 inches (38 mm) of bearing is sufficient for composite floor decks. If less than 1-1/2 inches (38 mm) of end bearing is available, or if high support reactions are expected, the design professional should check the deck web crippling capacity. The deck must be adequately attached to the structure to prevent slip off.

6. Diaphragm Shear Capacity: Diaphragms without concrete shall be designed in accordance with the SDI *Diaphragm Design Manual*, or from tests conducted by an independent professional engineer.

Commentary: Calculations of diaphragm strength and stiffness should be made using the SDI *Diaphragm Design Manual*. If testing is used as the means for determining the diaphragm strength and stiffness, then it should follow the AISI TS 7-02 test protocol.

B. Deck and Concrete as a Composite Slab:

1. General: The "SDI Method" (refer to SDI *Composite Deck Design Handbook*) shall be limited to galvanized or topside uncoated steel decks with embossments. The embossment patterns shall be typical of the manufactured steel deck with the depth of the embossment not less than 90% of the tested embossment depth. (Refer to Attachment C4 for further limitations).

The composite slab shall be designed as a reinforced concrete slab with the steel deck acting as the positive

reinforcement. The deck must be suitable to develop composite interaction. Justification of this requires full scale testing as per ASTM E2322, or calculations based upon testing.

- Allowable Strength Design (ASD) shall be permitted as an alternate design method. (See SDI *Composite Deck Design Handbook*.)
- Standard reinforced concrete design procedures shall be used to determine ultimate load capacity. The allowable superimposed load shall then be determined by deducting the weight of the slab and the deck. Attachment C4, *Strength and Serviceability Determination of Composite Deck Slab* shall be used for strength determination.

Commentary: High concentrated loads, diaphragm loads, etc. require additional analysis. Horizontal load capacities can be determined by referring to the SDI *Diaphragm Design Manual*. Concentrated loads can be analyzed by the methods shown in the SDI *Composite Deck Design Handbook*. Most published live load tables are based on simple span analysis of the composite system; that is, the slab is assumed to crack over each support.

2. Load Determination: Using standard reinforced concrete design procedures, the allowable superimposed load shall be found by using appropriate load and resistance design factors (LRFD) and applicable reduction factors based on the presence, absence, or spacing of shear studs on beams perpendicular to the deck. (Refer to Attachment C4 and C5)

Commentary: By using the reference analysis techniques or test results, the deck manufacturer determines the live loads that can be applied to the composite deck slab combination. The results are usually published as uniform load tables. For most applications, the deck thickness and profile is selected so that shoring is not required; the live load capacity of the composite system is usually more than adequate for the superimposed live loads. In calculating the section properties of the deck, the AISI provisions may require that compression zones in the deck be reduced to an "effective width," but as tensile reinforcement, the total area of the cross section may be used. (See attachment C5)

Coatings other than those tested may be investigated, and if there is evidence that their performance is better than that of the tested product, additional testing may not be required.

3. Concrete: Concrete design shall be in accordance with the ACI *Building Code Requirements for Reinforced Concrete*. Minimum compressive strength (f'_c) shall be a minimum of 3 ksi (20 MPa) or as required for fire ratings or durability. Admixtures containing chloride salts shall not be used.

Commentary: Load tables are generally calculated by using a concrete strength of 3 ksi (20 MPa). Composite slab capacities are not greatly affected by variations in concrete compressive strength; but, if the strength falls below 3 ksi (20 MPa) it would be advisable to check shear stud strengths. Fire rating requirements may dictate the minimum concrete strength. The use of admixtures containing chloride salts is not allowed because the salts will corrode the steel deck.