ABSTRACT

American Society of Civil Engineers Standard for the Structural Design of Composite Slabs, ASCE Standard Practice for Construction and Inspection of Composite Slabs (ASCE 3-91 and ASCE 9-91 respectively) presents standards for the structural design and testing of composite slabs and for good construction practice and inspection procedures. In addition, commentaries on both standards are included. The “Standard for the Structural Design of Composite Slabs” (ASCE 3-91) and its “Commentary” cover such topics as loads, construction stage, strength design, service load design, test procedures, and test results evaluation. The “Standard Practice for the Construction and Inspection of Composite Slabs” (ASCE 9-91) and its “Commentary” discuss such topics as damage control, connections, concrete placement, shore removal, holes and hole reinforcement. These standards are written in such a form that they may be adopted by reference in a general building code.

Library of Congress Cataloging-in-Publication Data


p.cm.—(ASCE standard)
Includes bibliographical references and index.
SBN 0-87262-954-6
In April 1980, the Board of Direction approved ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by the Society. All such standards are developed by a consensus standards process managed by the Management Group F (MGF), Codes and Standards. The consensus process includes balloting by the balanced standards committee made up of Society members and non-members, balloting by the membership of ASCE as a whole and balloting by the public. All standards are updated or reaffirmed by the same process at intervals not exceeding five years.

The following standards have been issued:

ANSI/ASCE 1-88 N-725 Guidelines for Design and Analysis of Nuclear Safety Related Earth Structures
ANSI/ASCE 2-91 Measurement of Oxygen Transfer in Clean Water
ANSI/ASCE 3-91 Standard for the Structural Design of Composite Slabs and ANSI/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs
ASCE 4-86 Seismic Analysis of Safety-Related Nuclear Structures

Building Code Requirements for Masonry Structures (ACI530-92/ASCE5-92/TMS402-92) and Specifications for Masonry Structures (ACI530.1-92/ASCE6-92/TMS602-92)
ANSI/ASCE 7-93 Minimum Design Loads for Buildings and Other Structures
ANSI/ASCE 8-90 Standard Specification for the Design of Cold-Formed Stainless Steel Structural Members
ANSI/ASCE 9-91 listed with ASCE 3-91
ANSI/ASCE 10-90 Design of Latticed Steel Transmission Structures
ANSI/ASCE 11-90 Guideline for Structural Condition Assessment of Existing Buildings
ANSI/ASCE 12-92 Guideline for the Design of Urban Subsurface Drainage
ASCE 13-93 Standard Guidelines for Installation of Urban Subsurface Drainage
ASCE 14-93 Standard Guidelines for Operation and Maintenance of Urban Subsurface Drainage
ASCE 15-93 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)
FOREWORD

The material presented in this Standard has been prepared in accordance with recognized engineering principles. This Standard should not be used without first securing competent advice with respect to its suitability for any given application. The publication of the material contained herein is not intended as a representation or warranty on the part of the American Society of Civil Engineers, or of any other person named herein, that this information is suitable for any general or particular use or promises freedom from infringement of any patent or patents. Anyone making use of this information assumes all liability from such use. The appendices contained in this document are intended by the Steel Deck with Concrete Standards Committee to be included with the parent Standard document unless specifically exempted by building code authorities. This standards document is written in such a form that it may be adopted by reference in a general building code.
This page intentionally left blank
ACKNOWLEDGEMENTS

The American Society of Civil Engineers (ASCE) acknowledges the efforts of the Steel Deck with Concrete Standards Committee of the Management Group F on Codes and Standards. This Committee comprises individuals from many backgrounds including: consulting engineering, research, cold-formed steel industry, education, and government.

The previous work of the Composite Steel Deck Committee of the American Iron and Steel Institute is gratefully acknowledged. The preparation of the many revisions of this and the prior ASCE 3-84 Standard for ASCE by Max L. Porter, Ph.D., P.E. is acknowledged. In addition, the Commentaries were authored by Max L. Porter with support by the Committee.

This Standard was formulated through the consensus process by balloting in compliance with procedures of ASCE’s Management Group F on Codes and Standards. Those individuals who serve on the Steel Deck with Concrete Standards Committee are:

Prodyot K. Basu
C. Dale Buckner
Theron Z. Chastain
Sing L. Chu
Donald J. Clark
Calvin R. Clauer
Harry J. Collins, III
Michel Crisinel
W. Samuel Easterling
Edward R. Estes, Jr.
James M. Fisher
Jules O. A. Gagnon, Jr.

Charles R. Gray
J. David Harmon
Richard B. Heagler, Secretary
Thomas J. Jones
Larry D. Luttrell
Thomas J. McCabe
Virgil Morton
D. C. O’Leary
Miley R. Parrish
Mark Patrick

Clarkson W. Pinkham
Max L. Porter, Chairman
Robert M. Preddy
Satinder Pal Singh Puri
James J. Rongoe
Robert A. Samela
Walter E. Schultz
Reinhold M. Schuster
Louis C. Tartaglione
Ronald E. Witthohn
This page intentionally left blank
# ASCE Standard for the Structural Design of Composite Slabs

## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>STANDARDS</td>
<td>iii</td>
</tr>
<tr>
<td>FOREWORD</td>
<td>v</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>vii</td>
</tr>
<tr>
<td>CONTENTS</td>
<td>ix</td>
</tr>
<tr>
<td>NOTATION</td>
<td>xiii</td>
</tr>
<tr>
<td><strong>CHAPTER 1 - GENERAL</strong></td>
<td></td>
</tr>
<tr>
<td>1.1 - Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1.1 - Composite slabs</td>
<td>1</td>
</tr>
<tr>
<td>1.1.2 - Objective and scope</td>
<td>1</td>
</tr>
<tr>
<td>1.1.3 - Inch-pound units</td>
<td>1</td>
</tr>
<tr>
<td>1.2 - Materials</td>
<td>1</td>
</tr>
<tr>
<td>1.2.1 - Steel deck</td>
<td>1</td>
</tr>
<tr>
<td>1.2.2 - Concrete</td>
<td>1</td>
</tr>
<tr>
<td>1.3 - Slab limitations</td>
<td>2</td>
</tr>
<tr>
<td>1.3.1 - Span-to-depth ratios</td>
<td>2</td>
</tr>
<tr>
<td>1.3.2 - Slab depth and concrete cover</td>
<td>2</td>
</tr>
<tr>
<td>1.4 - Tolerances and minimum sizes</td>
<td>2</td>
</tr>
<tr>
<td>1.4.1 - Tolerances</td>
<td>2</td>
</tr>
<tr>
<td>1.4.2 - Dimensions</td>
<td>2</td>
</tr>
<tr>
<td><strong>CHAPTER 2 - DESIGN CRITERIA</strong></td>
<td>2</td>
</tr>
<tr>
<td>2.1 - Loads</td>
<td>2</td>
</tr>
<tr>
<td>2.2 - Construction stage</td>
<td>2</td>
</tr>
<tr>
<td>2.2.1 - General</td>
<td>2</td>
</tr>
<tr>
<td>2.2.2 - Section properties</td>
<td>2</td>
</tr>
<tr>
<td>2.2.3 - Construction live loads</td>
<td>2</td>
</tr>
<tr>
<td>2.2.4 - Allowable stresses</td>
<td>2</td>
</tr>
<tr>
<td>2.2.5 - Calculated stresses</td>
<td>2</td>
</tr>
<tr>
<td>2.2.6 - Dead load deflection</td>
<td>2</td>
</tr>
<tr>
<td>2.3 - Composite section</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1 - Strength design</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1.1 - General</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1.2 - Load factors</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1.3 - Strength reduction factors, $\phi$</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1.4 - Continuity over supports</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1.5 - Strength relationships</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1.5.1 - Shear-bond strength</td>
<td>5</td>
</tr>
<tr>
<td>2.3.1.5.2 - Flexural strength</td>
<td>6</td>
</tr>
<tr>
<td>2.3.2 - Service load design</td>
<td>6</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2.3.2.1 - Section properties for deflection calculations</td>
<td>6</td>
</tr>
<tr>
<td>2.3.2.2 - Deflection limitations</td>
<td>7</td>
</tr>
<tr>
<td>2.3.3 - Special design considerations</td>
<td>7</td>
</tr>
<tr>
<td>2.3.3.1 - Control of shrinkage and temperature effects</td>
<td>7</td>
</tr>
<tr>
<td>2.3.3.2 - Punching shear</td>
<td>7</td>
</tr>
<tr>
<td>2.3.3.3 - Two-way action</td>
<td>7</td>
</tr>
<tr>
<td>2.3.3.4 - Repeated or vibratory loading</td>
<td>9</td>
</tr>
<tr>
<td>CHAPTER 3 - PERFORMANCE TESTS</td>
<td>9</td>
</tr>
<tr>
<td>3.1 - Introduction</td>
<td>9</td>
</tr>
<tr>
<td>3.2 - Testing of composite slab elements</td>
<td>9</td>
</tr>
<tr>
<td>3.2.1 - Specimen preparation</td>
<td>9</td>
</tr>
<tr>
<td>3.2.1.1 - General</td>
<td>9</td>
</tr>
<tr>
<td>3.2.1.2 - Dimensions of composite specimens</td>
<td>9</td>
</tr>
<tr>
<td>3.2.2 - Test procedure</td>
<td>9</td>
</tr>
<tr>
<td>3.2.2.1 - Loading of specimens</td>
<td>9</td>
</tr>
<tr>
<td>3.2.2.2 - Instrumentation</td>
<td>10</td>
</tr>
<tr>
<td>3.2.2.3 - Recording of data</td>
<td>10</td>
</tr>
<tr>
<td>3.2.3 - Scope of tests</td>
<td>11</td>
</tr>
<tr>
<td>3.2.3.1 - Shear-bond tests</td>
<td>11</td>
</tr>
<tr>
<td>3.2.3.2 - Flexural tests</td>
<td>12</td>
</tr>
<tr>
<td>3.2.4 - Test result evaluation</td>
<td>12</td>
</tr>
<tr>
<td>3.2.4.1 - General</td>
<td>12</td>
</tr>
<tr>
<td>3.2.4.2 - Shear-bond</td>
<td>12</td>
</tr>
<tr>
<td>3.2.4.3 - Flexure</td>
<td>13</td>
</tr>
<tr>
<td>3.2.4.4 - Design dimensions of the steel deck</td>
<td>13</td>
</tr>
<tr>
<td>3.3 - Existing tests</td>
<td>13</td>
</tr>
<tr>
<td>3.4 - Performance tests</td>
<td>13</td>
</tr>
<tr>
<td>3.4.1 - General</td>
<td>13</td>
</tr>
<tr>
<td>3.4.2 - Acceptance test</td>
<td>13</td>
</tr>
<tr>
<td>APPLICABLE DOCUMENTS</td>
<td>14</td>
</tr>
<tr>
<td>APPENDIX A - SI UNITS</td>
<td>15</td>
</tr>
<tr>
<td>APPENDIX B - SECTION PROPERTIES FOR CALCULATING</td>
<td>16</td>
</tr>
<tr>
<td>DEFLECTIONS OF COMPOSITE SLABS</td>
<td></td>
</tr>
<tr>
<td>B.1 - Transformed composite neutral axis</td>
<td>16</td>
</tr>
<tr>
<td>B.2 - Moment of inertia of cracked section</td>
<td>16</td>
</tr>
<tr>
<td>B.3 - Moment of inertia of uncracked section</td>
<td>16</td>
</tr>
<tr>
<td>B.4 - Moment of inertia of composite section</td>
<td>16</td>
</tr>
<tr>
<td>APPENDIX C - DECK MEASUREMENTS</td>
<td>16</td>
</tr>
<tr>
<td>C.0 - Notation</td>
<td>16</td>
</tr>
<tr>
<td>C.1 - General</td>
<td>16</td>
</tr>
<tr>
<td>C.2 - Measurements</td>
<td>17</td>
</tr>
<tr>
<td>C.2.1 - Embossments</td>
<td>17</td>
</tr>
<tr>
<td>C.2.2 - Measuring devices</td>
<td>17</td>
</tr>
<tr>
<td>C.2.3 - Dimensions to be recorded for straight embossments</td>
<td>17</td>
</tr>
<tr>
<td>C.2.4 - Dimensions to be recorded for curved embossments</td>
<td>17</td>
</tr>
</tbody>
</table>
APPENDIX D - AN ALTERNATE METHOD FOR CALCULATING FLEXURAL CAPACITY OF COMPOSITE SLABS

D.1 - Introduction ................................................. 17
D.2 - Calculated bending strength ........................................ 17
  D.2.1 - General .................................................. 17
  D.2.2 - Shear force transfer ........................................ 19
    D.2.2.1 - Type I decks ......................................... 19
    D.2.2.2 - Type II decks ......................................... 19
    D.2.2.3 - Type III decks ......................................... 19
  D.2.3 - Limitations ............................................... 19
D.3 - Confirmation tests .............................................. 19
D.4 - Design equations ............................................... 22

LIST OF FIGURES

  2.1 Loading diagrams for moments ..................................... 3
  2.2 Loading diagrams for support reactions .......................... 4
  2.3 Loading diagrams for deflections ................................ 4
  3.1 Typical test assembly ......................................... 10
  3.2 Typical shear-bond plot showing the reduced regression line for m and k ........................................... 12
B.1 Composite section ............................................... 16
C.1 Deck measurements ............................................... 18
D.1 Deck sections .................................................. 20
D.2 Embossments details .............................................. 21

LIST OF TABLES

  2.1 Shoring factors ............................................... 6
  2.2 Maximum allowable deflections under service loads ............... 8
  3.1 Limiting values of depths and shear spans ....................... 9
A.1 SI conversion factors ........................................... 15

COMMENTARY ......................................................... 23

INDEX .............................................................. 87
NOTATION

\[ a = \text{depth of equivalent rectangular stress block,} \quad A_{ei}/0.85 \frac{f_{ce}b}{t} \text{ in.} \]

\[ A_s = \text{cross-sectional area of steel deck, or area of negative moment reinforcing steel where used as tension reinforcement, sq. in. per ft. of width} \]

\[ A' = \text{area of that portion of steel deck which is in compression, sq. in. per ft. of width} \]

\[ A'' = \text{area of that portion of steel deck which is in tension, sq. in. per ft. of width} \]

\[ b = \text{unit width of slab, 12 in. (305 mm)} \]

\[ B = \text{width of slab, ft.} \]

\[ b_d = \text{width of composite test slab, ft.} \]

\[ B_b = \text{width of bottom flange measured at intersection of inside tangents, in.} \]

\[ B_t = \text{width of top flange measured at intersection of inside tangents, in.} \]

\[ c_m = \text{moment coefficient, dependent upon whether the slab is simply supported or continuous, and on distribution of loads} \]

\[ C = \text{compressive force on cross section due to flexure, lbs.} \]

\[ C_s = \text{cell spacing, in.} \]

\[ d = \text{effective slab depth, distance from extreme concrete compression fiber to centroidal axis of the full cross section of steel deck, in.} \]

\[ d_d = \text{overall depth of steel deck profile, in.} \]

\[ D_w = \text{developed width of web measured to inside tangent on flanges, including end arcs, in.} \]

\[ e_1 = \text{distance from C-resultant force to top of steel deck, in.} \]

\[ e_2 = \text{distance from C-resultant force to mid-height of deck web, in.} \]

\[ e_3 = \text{distance from C-resultant force to bottom of steel deck, in.} \]

\[ E = \text{earthquake load perpendicular to slab, psf} \]

\[ E_s = \text{modulus of elasticity of concrete, psi} \]

\[ E_s = \text{modulus of elasticity of steel deck, 29,500,000 psi (203 000 MPa)} \]

\[ f = \text{allowable stress, psi} \]

\[ f_b = \text{bending stress for elastic computation, psi} \]

\[ f_r = \text{modulus of rupture of concrete, psi} \]

\[ f_u = \text{specified tensile strength of steel, psi} \]

\[ f_s = \text{measured tensile strength of steel, according to ASTM A370 [4], psi} \]

\[ f_y = \text{specified or design yield point or yield strength of steel, psi} \]

\[ f_{sy} = \text{measured yield strength of steel, according to ASTM A370 [4], psi} \]

\[ f'_{ct} = \text{compressive test cylinder strength of concrete at time of slab testing, psi} \]

\[ f'_{el} = \text{lower usage compressive strength of concrete, used to determine } V_{el}, \text{ psi} \]

\[ f'_{e2} = \text{laboratory test strength of concrete corresponding to } V_{e2}, \text{ psi} \]

\[ h = \text{nominal out-to-out depth of slab, in.} \]

\[ h_c = \text{depth of concrete above top corrugation of steel deck, in.} \]

\[ h_t = \text{out-to-out depth of slab at top corrugation of steel deck, in.} \]

\[ I_c = \text{moment of inertia of composite section based on cracked section, in.}^4 \text{ per ft. of width} \]

\[ I_d = \text{moment of inertia of composite section considered effective for deflection computations, in.}^4 \text{ per ft. of width} \]

\[ I_{e1} = \text{moment of inertia of full steel deck section only taken about the composite cracked section neutral axis, in.}^4 \text{ per ft. of width} \]

\[ I_e = \text{effective moment of inertia, in.}^4 \text{ per ft. of width} \]

\[ I_s = \text{moment of inertia of steel deck based on effective width [1], in.}^4 \text{ per ft. of width} \]

\[ I_{sf} = \text{moment of inertia of steel deck based on full cross sectional deck area, in.}^4 \text{ per ft. of width} \]

\[ I_u = \text{moment of inertia of composite section based on uncracked section, in.}^4 \text{ per ft. of width} \]

\[ k = \text{ordinate intercept of reduced experimental shear-bond line} \]

\[ k_u = \text{ratio defining position of neutral axis at failure} \]

\[ k_1 = \text{ordinate intercept of shear-bond line} \]

\[ K = \text{bond force transfer property, } K_i/(K_i + K_2) \]

\[ K_o = \text{test average for } M/M_0 \text{ values} \]

\[ K_1 = \left[ \frac{d_d/7.8}{10^3} \right]^{0.5} \]

\[ K_2 = \text{mechanical bond factor, from Eq. (D-12) or (D-15)} \]

\[ K_3 = \text{slab width factor, from Eq. (D-10)} \]

\[ e_c = \text{length of embossment, in.} \]

\[ e_i = \text{length of span or shored span, ft.} \]

\[ e_f = \text{length of shear span, ft.} \]

\[ e_1 = \text{length of span or shored span, in.} \]

\[ e_i = \text{length of shear span, in., for uniform load, } e_i = e_i/4 \text{ in.} \]

\[ e_i = \text{distance between inflection points in any particular span of a continuous slab, in.} \]

\[ e_{ef} = \text{length of clear span, ft.} \]

---

1 Unit width of slab in SI units shall be consistent with SI units for other terms.
\( \ell_o \) = slab overhang at supports, in.

\( m \) = slope of reduced experimental shear-bond line

\( m_l \) = slope of shear-bond line

\( M \) = moment due to concrete dead load, steel deck load, and construction live load, ft-lbs. per ft. of width

\( M_s \) = applied moment, ft-lbs. per ft. of width

\( M_{cr} \) = calculated bending moment at cracking, ft-lbs. per ft. of width

\( M_{sl} \) = calculated bending moment at first yield, ft-lbs. per cell width \( C_g \)

\( M_n \) = nominal moment strength, ft-lbs. per ft. of width

\( M_o \) = tested moment strength, ft-lbs. per ft. of width

\( M_i \) = bending moment induced by shoring removal, ft-lbs. per ft. of width

\( M_t \) = \( K(M_u)/C_s \), bending moment, modified for bond limitations, ft-lbs. per ft. of width

\( M_u \) = factored moment, ft-lbs. per ft. of width

\( N \) = number of cells in test slab width

\( n \) = modular ratio, \( E_g/E_c \)

\( N_v \) = number of vertical elements in embossment pattern lengths

\( N_h \) = number of horizontal elements in embossment pattern lengths

\( P_e \) = maximum applied experimental slab load at failure obtained from laboratory tests (includes weight of loading system but not weight of slab), lbs.

\( P_{te} \) = concentrated construction live load on a per ft. width of deck, 150 lbs. (2.2 kN/m)

\( p_h \) = height of embossment, in.

\( p_s \) = embossment intensity factor, \( 12 \ell_s/s \)

\( s \) = center-to-center spacing of shear devices, in.; or in Appendix D, the length of repeating embossment pattern, in.

\( S \) = effective section modulus for either positive or negative bending, in.\(^3/ft.\) of width

\( S_e \) = section modulus of concrete, in.\(^3\)

\( t \) = thickness of steel deck exclusive of coating, in.

\( T_B \) = component of tensile force resisted by bottom horizontal elements of steel deck in general strain analysis, lbs. per ft. of width

\( T_l \) = deck element tension forces with \( i = 1 \) to 3, lbs.

\( T_T \) = component of tensile force resisted by top horizontal elements of steel deck in general strain analysis, lbs. per ft. of width

\( T_w \) = component of tensile force resisted by web elements of steel deck in general strain analysis location of resultant force is assumed to be at mid-depth of web elements, lbs. per ft. of width

\( V_e \) = maximum experimental shear at failure obtained from laboratory tests (not including weight of slab), lbs. per ft. of width

\( V_{es} \) = shear-bond capacity corresponding to a lower usage compressive strength of concrete, lbs. per ft. of width

\( V_{e2} \) = shear-bond capacity from laboratory test compressive strength of concrete, lbs. per ft. of width

\( V_n \) = nominal shear-bond strength, lbs. per ft. of width

\( V_u \) = factored shear force, lbs. per ft. of width

\( W \) = wind load perpendicular to slab, psf

\( w \) = average width of embossment, in.

\( W_a \) = computed uniform dead load, \( (W_{dc} + W_{sd} + W_{ud}) \), psf

\( W_{dc} \) = concrete dead load including additional weight of concrete due to deck deflection, psf

\( W_{sd} \) = steel deck dead load, psf

\( W_{ad} \) = superimposed uniform dead load, (additional dead load applied to slab exclusive of \( W_{ud} \)), psf

\( W_{te} \) = superimposed uniform live load, specified by general building code, but not greater than \( W_{te} \) or \( W_{tr} \), psf

\( W_{tc} \) = uniform construction live load, 20 psf (1.0 kN/m\(^2\))

\( W_{tf} \) = permissible superimposed uniform live load for flexure, psf

\( W_{ts} \) = permissible superimposed uniform live load for shear-bond, psf

\( W_r \) = average rib width, \( (C_a - B_t + B_b)/2 \), in.

\( W_{rf} \) = roof live loads (see 4.11 of ASCE 7 [3]), snow loads, or rain loads, except ponding, psf

\( W_s \) = weight of slab, \( (W_{dc} + W_{sd}) \), psf

\( W_{sw} \) = snow load, psf

\( W_u \) = uniformly distributed factored load, psf

\( W_{uf} \) = permissible superimposed uniform load for flexure, exclusive of \( W_r \), psf

\( W_{uf} \) = permissible superimposed uniform load for shear-bond, exclusive of \( W_r \), psf

\( X \) = abscissa value for shear-bond determination

\( y_{cc} \) = distance from neutral axis of composite section to top of slab, in.
\( y_a \) = distance from neutral axis of composite section to centroidal axis of steel deck, in.

\( y_{gb} \) = distance from centroidal axis of steel deck to bottom of steel deck, in.

\( Y \) = ordinate value for shear-bond determination
= \( V_e/bd \sqrt{f_{c}} \)

\( \alpha \) = coefficient for modifying \( I_c \) for deflection calculations

\( \beta_1 \) = 0.85 for concrete with \( f'_{c} \leq 4000 \text{ psi} \) (28 MPa) and is reduced at a rate of 0.05 for each 1000 psi (7 MPa) of strength above 4000 psi (28 MPa), but \( \beta_1 \) shall not be taken less than 0.65

\( \gamma \) = coefficient for proportion of dead load added upon removal of shore

\( \Delta \) = maximum deflection, in.

\( \Delta_i \) = iterative total deflection based on \( \Delta \) to account for ponding or for the additional concrete due to the deflection of the steel during casting, ft.

\( \Delta_1 \) = maximum single span deflection, in.

\( \Delta_2 \) = maximum double span deflection, in.

\( \Delta_3 \) = maximum triple span deflection, in.

\( \epsilon_{B1}, \epsilon_{B2}, \epsilon_{B3}, \epsilon_{B4} \) = strain in bottom fiber of steel deck for general strain analysis, microinches per in.

\( \epsilon_{C} \) = maximum compressive strain in the concrete, taken as 0.003 in./in. (0.003 mm/mm)

\( \epsilon_{C2}, \epsilon_{C3}, \epsilon_{C4} \) = strain at top fiber of concrete for general strain analysis, microinches per in.

\( \epsilon_{T1}, \epsilon_{T2}, \epsilon_{T3}, \epsilon_{T4} \) = strain at top fiber of steel deck for general strain analysis, microinches per in.

\( \epsilon_{W1}, \epsilon_{W2}, \epsilon_{W3}, \epsilon_{W4} \) = strain in web sections of steel deck taken at mid-depth of web elements for general strain analysis, microinches per in.

\( \theta \) = web angle, degrees

\( \lambda \) = multiplier for additional long-time deflection

\( \rho \) = reinforcement ratio of steel deck area to effective concrete area, \( A_p/bd \)

\( \rho_b \) = reinforcement ratio producing balanced strain conditions

\( \phi \) = strength reduction factor
This page intentionally left blank
CHAPTER 1 - GENERAL

1.1 - Introduction

1.1.1 - Composite slabs. Composite slab construction is defined as a system comprising of normal weight or lightweight structural concrete placed permanently over cold-formed steel deck in which the steel deck performs the dual role of acting as a form for the concrete during construction and as positive reinforcement for the slab during service.

Steel decks, either shored or unshored, shall provide adequate strength and stiffness to support wet concrete and construction live loads as defined in Section 2.2.3. Composite behavior results when the steel deck has some reliable mechanical means of providing positive interlocking between the deck and the concrete. These connecting means shall provide resistance to separation of the steel deck and the concrete. Where manufacturers’ decks provide for variable spacing of the shear devices, this must be accounted for in the design and test procedures.

1.1.2 - Objective and scope. This Standard presents provisions applicable to composite slabs, relating to:

(a) structural design, and
(b) testing.

Standard performance tests shall be conducted to evaluate the load-carrying capacity of composite slabs, wherein the steel deck manufacturer shall be responsible for conducting, under supervision of a registered professional engineer and an independent testing agency, slab tests as required in Chapter 3 of this document. Steel deck section properties shall be calculated according to the AISI Specification for the Design of Cold-Formed Steel Structural Members [1] unless otherwise required herein. The ACI Building Code Requirements for Reinforced Concrete, ACI 318 [2] shall be used for the design of composite slabs, unless modified herein. Both shored and unshored installations are considered.

The appendices contained in this design standard shall be included as part of this mandatory document unless specifically exempted by the building code authorities.

1.1.3 - Inch-pound units. Equations appearing in this Standard are compatible with the following Inch-Pound units. However any consistent measurement units such as SI units may be used.

(a) Force: lbs.
(b) Span length: in. or ft.
(c) Shear span length: in. or ft.
(d) Dimensions of cross section: in.
(e) Moment: ft.-lbs.

SI units or equations as given in parentheses in this Standard and Appendix A are for information only and are not part of the Standard.

1.2 - Materials

1.2.1 - Steel deck. Grades of steel used in fabricating steel deck units shall be as described in Section A3 of the AISI Specification for the Design of Cold-Formed Steel Structural Members [1]. The deck coating shall be appropriate to the environment of the structure and shall be specified by the designer.

1.2.2 - Concrete. Materials for concrete, including admixtures and reinforcing, shall comply with Chapter 3 of ACI 318, except as modified herein [2]. Minimum specified compressive strength of concrete, $f'_c$, shall be 2500 psi (17 MPa) [2]. Structural concrete shall be in accordance with ACI 318 [2].

1 For standard practices of construction and inspection, see ASCE 9 Standard Practice for Construction and Inspection of Composite Slabs (See REFERENCES in Commentary)
2 Numbers in brackets denote APPLICABLE DOCUMENTS listed after Chapter 3.