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INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS, UNIFORM EVALUATION SERVICES

EVALUATION CRITERIA FOR STEEL COMPOSITE, NON-COMPOSITE AND ROOF DECK CONSTRUCTION

EC 007-2013
(Adopted September 2013)

1.0 INTRODUCTION

1.1 Purpose: This Evaluation Criteria establishes the requirements for recognition of cold-formed steel composite, non-composite and roof deck construction in an evaluation report under the 2012 and 2009 *International Building Code*® (IBC). Bases of recognition are IBC Section 104.11 and Chapter 22.

The objective of this criteria is to expand uses of steel decks, since the prescriptive requirements of Chapters 19 and 22 of the IBC need supplemental procedures for establishing the structural capacities of steel decks utilized as components of diaphragms and composite floors.

1.2 Scope: This Evaluation Criteria applies to cold-formed fluted and cellular sheet steel panels attached to cold-formed or hot-rolled steel support framing with welds, screws, power-actuated fasteners (commonly referred to as pins or nails), or other fastening systems suitable for attaching steel deck. Panel side-laps are connected using welds, screws, friction connections (commonly referred to as button punches), penetrating mechanical interference punches or other fastening systems suitable to engage the side-laps of the steel deck.

The criteria provides guidelines to calculate, test and evaluate diaphragm shear capacities, diaphragm flexibility, composite vertical load capacities, section properties and web crippling capacities and includes optional test and acceptance standards for fire-resistance and sound transmission performance.

Evaluation of diaphragm shear capacity for steel deck is limited to the in-plane shear resistance of the steel deck panel or concrete-filled steel deck panel, connection strength of the steel deck to the support framing and connection strength steel deck-to-steel deck (side-lap), acting as the membrane stressed skin of a floor or roof diaphragm assembly. This Evaluation Criteria does not provide for the development of complete horizontal floor or roof diaphragm system as the term diaphragm is used in IBC Section 1602, which would also include support framing, collectors and boundary chords.

2.0 REFERENCED STANDARDS

2.1 General: Referenced standards shall be applied consistent with the provisions of Chapter 35 of the applicable edition of the IBC and as noted herein.

American Concrete Institute

ACI 318-11 Building Code Requirements for Structural Concrete and Commentary (2012 IBC)
ACI 318-08 Building Code Requirements for Structural Concrete and Commentary (2009 IBC)

American Institute of Steel Construction

AISC 360-10 Specification for Structural Steel Buildings (2012 IBC)
AISC 360-05 Specification for Structural Steel Buildings (2009 IBC)

ANSI Accredited Program PRODUCT CERTIFICATION #0675

American Iron and Steel Institute

AISI S100-07/S1-09/S2-10	AISI Standard North American Specification for the Design of Cold-Formed Steel Structural Members with Supplements 1 and 2 (Supplement 2 is optional for the 2009 IBC)
AISI S904-08	Standard Test Methods for Determining the Tensile and Shear Strength of Screws
AISI S905-08	Test Methods for Mechanically Fastened Cold-Formed Steel Connections
AISI S907-08/S1-12	Cantilever Test Method for Cold-Formed Steel Diaphragms
AISI S909-08	Standard Test Method for Determining the Web Crippling Strength of Cold-Formed Steel Beams

American Society of Civil Engineers

ASCE 3-91	Standard for the Structural Design of Composite Slabs
ASCE 7-05	Minimum Design Loads for Buildings and Other Structures (2009 IBC)
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures (2012 IBC)

ASTM International

ASTM A370-09	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM E90-04	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E119-08a	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E492-09	Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

International Code Council

2012 and 2009 IBC	*International Building Code*® (IBC), International Code Council

Steel Deck Institute

ANSI/SDI C-2011	Standard for Composite Steel Floor Deck-Slabs
ANSI/SDI T-CD-2011	Test Standard for Composite Steel Deck-Slabs
ANSI/SDI NC1.0-2006	Standard for Non-Composite Steel Floor Deck (2009 IBC)
ANSI/SDI NC-2010	Standard for Non-Composite Steel Floor Deck (2012 IBC)
ANSI/SDI RD1.0-2006	Standard for Steel Roof Deck (2009 IBC)
ANSI/SDI RD-2010	Standard for Steel Roof Deck (2012 IBC)
CDD2	Composite Steel Deck Design Handbook, 2nd Edition, 1997
DDM03	Diaphragm Design Manual, 3rd Edition with Appendix VI Supplement and Errata

Underwriters Laboratories

UL 263-03	Fire Tests of Building Construction and Materials

United States Army Corp of Engineers

TM 5-809-10	Seismic Design for Buildings, 1982 edition

3.0 DEFINITIONS

3.1 General. Where the following terms appear in this Evaluation Criteria, such terms shall have the meaning as defined in this section.

Acoustical Deck: Deck or cellular deck containing holes. Holes either are in discrete locations or throughout the coil width. Insulation and other components are often but not always installed behind the holes to improve sound absorption.

Cellular Deck: Cold-formed fluted sheet steel panel with a pan sheet or fluted steel panel welded or mechanically attached to the top or bottom of the fluted member.

Composite Deck: Steel deck that is used as a component of a composite deck-slab assembly. Composite deck is designed to bond to the concrete in the assembly and to act as tensile reinforcement

for the composite deck-slab assembly in positive bending. Prior to the concrete curing, the composite deck acts as a form only. Composite deck may be cellular or not cellular.

Composite Deck - Slab: Assembly in which structural normal-weight or lightweight concrete is placed directly on and bonded to the composite deck. The deck acts as the tension reinforcement and the concrete acts as the compression element for positive bending only after the concrete has cured.

Diaphragm Shear Stiffness: In-plane shear stiffness of the steel deck panels or concrete-filled steel deck panels as applicable, and the connections of the steel deck panels to supporting members.

Diaphragm Shear Strength: In-plane shear resistance of steel deck panels or concrete-filled steel deck panels as applicable, and the connections of the steel deck panels to the supporting members.

Non-Composite Deck: Assembly in which structural normal weight or lightweight concrete is placed directly on steel deck or cellular deck but without significant bond. The deck is designed for use only as a form and it is assumed that no composite action is achieved between the concrete and deck.

Roof Deck: Steel deck or cellular deck panel without structural concrete fill.

Steel Deck: Cold-formed multi-web sheet steel panel including cellular versions used for composite, non-composite and roof applications.

4.0 BASIC INFORMATION

4.1 General: Each submittal for product evaluation shall include the information shown in this section.

4.2 Steel Deck: For each profile of steel deck, the following basic information shall be provided:

4.2.1 Deck profile cross section drawings showing dimensions and tolerances.

4.2.2 Detail drawings of embossments, hanger tabs, vent tabs or holes and perforation patterns as applicable to the deck profile.

4.2.3 Deck steel specification(s) and grade(s).

4.2.4 Metallic or paint coatings applied to the steel.

4.2.5 For cellular decks only, drawings illustrating the fastener pattern and descriptions of the fastenings used to connect the fluted sheet steel panel to the pan sheet steel panel together.

4.3 Fasteners: Standards and specifications applicable to the fasteners shall be disclosed to IAPMO UES and the minimum structural properties of the fasteners shall be specified. Fasteners shall be described in detail, including fastener type, material specifications, size, length, head type and point type (where applicable), coatings, limits on the steel connected by the fastener (drill capacity) including the minimum and maximum steel thickness, location and minimum edge distance(s).Drawings showing support fastener patterns shall be provided Where no values are recognized by the IBC or its references, the fasteners shall be recognized in a current evaluation report, a national product standard or shall otherwise be justified to the satisfaction of IAPMO UES in accordance with Section 5.5 or 5.6.4 of this criteria. Fasteners exposed to weather or moisture shall be corrosion-resistant or protected to prevent corrosion, such as stainless steel or galvanized, or covered by corrosion-resistant paint, sealant, or a stainless steel sealing cap. Galvanized steel shall comply with applicable fastener specification. Other metallic coatings shall be permitted to be used on mechanical fasteners if justified to the satisfaction of IAPMO UES.

4.4 Concrete: Properties of concrete used in the deck assemblies shall be reported in accordance with the applicable design and test standards. Minimum information to be reported shall be the density and minimum compressive strength of the concrete.

4.5 Accessories: For each accessory type, a drawing shall be provided with basic information including geometry, dimensions and tolerances. Detail drawings of the embossments, stiffeners, holes and perforation patterns shall be provided as applicable. Specifications(s) and grade(s) of the materials(s) shall be provided. Metallic or paint coatings applied shall be described as applicable.

4.6 Acoustical Deck Assemblies: For each acoustical deck, a cross section profile shall be provided identifying the type of deck and perforation pattern. The acoustical deck type, size of acoustic materials, type and thickness of acoustic material, type of concrete fill for composite deck or non-composite deck, and cover board or insulation board placed on top of steel roof deck shall be described. Standards and specifications applicable to acoustic materials and cover board or insulation on top of deck used shall be

provided. For rock wool, mineral wool, fiberglass and similar acoustic batt materials, the density of the batts shall be provided.

4.7 Engineering Reports: Engineering reports demonstrating the product capacities in accordance with the design and test standards shall be submitted. Reports shall include calculations, installation/assembly diagrams, recommendations and limitations in sufficient detail to demonstrate that the deck complies with the design and test requirements of this Evaluation Criteria to the satisfaction of IAPMO UES. Reports shall be signed and sealed by a registered design professional.

4.8 Test Reports: Test reports shall contain all information and results required by the applicable test standard. Testing laboratories shall be accredited for the applicable testing procedures in accordance with ISO/IEC 17025 by a recognized accreditation body conforming to ISO/IEC 17011. Testing at a non-accredited laboratory shall be permitted by IAPMO UES, provided the testing is conducted under the supervision of an accredited laboratory and the supervising laboratory issues the test report.

5.0 TESTING AND PERFORMANCE REQUIREMENTS

5.1 Roof Deck: Steel roof deck panels shall be designed to comply with the requirements of ANSI/SDI RD1.0 (2009 IBC) or ANSI/SDI RD-2010 (2012 IBC or 2009 IBC) and the provisions contained in this Evaluation Criteria.

5.2 Non-Composite Deck: Non-composite deck panels shall be designed in accordance with the requirements of ANSI/SDI NC1.0 (2009 IBC) or ANSI/SDI NC-2010 (2012 IBC or 2009 IBC) and the provisions contained in this Evaluation Criteria.

5.3 Composite Deck and Composite Deck-Slabs: Composite deck and composite deck-slabs shall be designed in accordance with ANSI/SDI C-2011 and the provisions contained in this Evaluation Criteria. Alternatively, capacities of composite deck slabs may be determined in accordance with ASCE 3 or SDI CDD2.

5.4 Cellular Decks: Cellular decks shall be designed in accordance with Section 5.1, 5.2 or 5.3 of this criteria as applicable based on the application of the cellular deck. To develop the full gross and effective section properties, the components of the cellular deck shall be interconnected with welds, screws, bolts, rivets, or other mechanical fastening systems sufficient to develop the shear flow at the interface of the components of the cellular deck. Welds, screws, bolts, rivets, and other mechanical fastening systems shall comply with the requirements of AISI S100.

5.5 Diaphragm Shear Strength and Stiffness: Diaphragm shear strength and diaphragm shear stiffness shall be determined by analytical calculations or by testing as referenced in Section 6.3 of this criteria.

For steel deck with and without concrete fill, calculations for diaphragm shear and diaphragm shear stiffness shall be conducted in accordance with the DDM03, including supplemental information in Appendix VI and errata. For fasteners not included in DDM03, provisions of the AISI-S100 may be used to calculate shear capacities when supplemented by testing to determine fastener strength and stiffness . Testing shall be conducted in accordance with Section 6.6 of this criteria for fasteners that are outside the scope of DDM03. For general design of buildings, shear strength and stiffness tables shall be based on a three-span deck condition as recommended in DDM03.

As an alternative, allowable diaphragm shear strength and stiffness may be calculated in accordance with Section 5-6 of TM 5-809-10. For the conversion of allowable diaphragm shear to nominal diaphragm shear in TM 5-809-10, Equation 5-8 shall be multiplied by a safety factor of 3.0 and Equation 5-9 shall be multiplied by a safety factor of 2.0.

When large-scale testing is conducted in accordance with Section 6.3 of this criteria to modify or extend the application limits of an existing design model, diaphragm shear strength and diaphragm stiffness may be calculated per the modified or extended model.

For composite steel deck-slabs with structural concrete fill that is attached to supporting members with welded stud shear connectors, calculation of diaphragm shear strength shall be permitted to be based on the provisions of ACI 318 for the shear capacity of the concrete above the deck and AISC 360 for the shear capacity of the stud shear connectors.

5.6 Vertical Load Capacities:

5.6.1 Deck Panels: Vertical load capacities for roof deck, non-composite deck, and composite deck acting as a form shall be determined in accordance with provisions of this section and the respective standards referenced in Sections 5.1, 5.2, or 5.3 of this criteria.

Vertical uniform load capacities for decks to resist gravity and wind loads shall be based on a rational analysis, analyzing the steel deck as a beam. For uniformly distributed loads, a combination of gross and effective moment of inertia shall be permitted to be used for determining deflection as follows:

Simple span:

$$I_{uniform} = \frac{2I_{effn} + I_g}{3}$$

Multiple span:

$$I_{uniform} = \frac{2I_{effn} + I_g}{3}$$

or

$$I_{uniform} = \frac{2I_{effi} + I_g}{3}$$

Where:

$I_{uniform}$ = Hybrid moment of inertia under uniformly distributed loads, in^4 (mm^4)

I_{effn} = Effective moment of inertia, normal orientation, in^4 (mm^4)

I_{effi} = Effective moment of inertia, inverted orientation, in^4 (mm^4)

I_g = Gross moment of inertia, in^4 (mm^4)

Determination of vertical line load or point load capacities shall be based on a rational analysis, analyzing the steel deck as a beam. It is acceptable to specify a load distribution device, such as a steel plate or bar that will distribute the load perpendicular to the deck flutes. Tributary width of the deck shall not be more than one flute beyond the length of the point or line load distribution perpendicular to the deck unless testing demonstrates otherwise. Web crippling at the line or point load shall be considered where applicable.

5.6.2 Composite Deck and Composite Deck-Slabs: Vertical load capacities for concrete-filled composite deck-slabs shall be determined in accordance with the standards referenced in Section 5.3 of this criteria.

5.6.3 Web Crippling: Web crippling for steel decks shall be determined in accordance with the provisions of AISI S100. As an alternative, testing in accordance with Section 6.5 of this criteria shall be permitted to be used to determine web crippling capacities of any panel. For decks with R/t, N/t or N/h ratios that exceed limitations specified in AISI S100, or modified elements, such as perforations, separate tests are mandatory to determine applicable end reactions and interior reactions. The testing shall establish the minimum and maximum bearing widths. Where multiple thicknesses occur in the deck profile, testing conducted in accordance with Section 6.5 of this criteria shall establish the minimum and maximum thicknesses.

5.6.4 Fasteners: Tension strength of fasteners used to resist vertical loads applied to the deck away from the supporting members such as wind uplift, shall be calculated in accordance with AISI S100. As an alternative, testing shall be permitted to be performed in accordance with Section 6.6 of this criterion. Evaluation of combined tension and shear loading is outside the scope of this criteria.

5.7 Fire-Resistance (Optional): Fire- resistance ratings shall be determined by tests in accordance with Section 6.7 of this criteria except fire resistance designs issued by approved agencies complying with IBC Section 1703.1 as determined by IAPMO UES are permitted in accordance with IBC Section 703.3.1.

5.8 Sound Transmission (Optional): Sound transmission performance of acoustical deck assemblies shall be determined by testing in accordance with Section 6.8 of this criteria.

6.0 TEST METHODS

6.1 Product Sampling: Sampling of the steel deck for tests under this Evaluation Criteria shall be in accordance with the applicable test standard. In the absence of specified sampling, the sampling methods shall be approved by IAPMO UES.

6.2 Material Properties: All steel used for testing shall have mill traceability certifications that clearly identify the grade designation, actual base metal thickness, yield strength, tensile strength and elongation. In absence of any of the required information, each coil of steel used for panel samples shall be tested in accordance with ASTM A370.

6.3 Diaphragm Shear Strength and Diaphragm Shear Stiffness: Diaphragm testing shall comply with the requirements of AISI S100, AISI S907 and this Evaluation Criteria. The test assemblies shall be as intended for end use unless sufficient evidence is submitted and approved by IAPMO UES for a variance. Boundary elements shall be designed such that the boundary elements do not fail before the diaphragm fails.

Large scale testing shall be used to establish the diaphragm shear strength and stiffness of a specific assembly when general analytic design equations for diaphragm shear strength and stiffness are outside the scope of DDM03 or TM 5-809-10. Large scale testing shall be performed in accordance with AISI S100 using AISI S907.

Small scale testing shall be used to develop shear strength and stiffness properties of fasteners. Testing shall be performed in accordance with the requirements of Section 6.6 of this criteria. Shear strength and stiffness values for fasteners developed through small scale testing may be used in combination with the methods in DDM03 to develop diaphragm shear and stiffness values for steel roof deck (with or without structural concrete fills), non-composite floor deck, composite deck, and composite deck-slabs.

Provisions for analyzing the test data within the test standard shall be acceptable for both large scale and small scale tests. As an alternative, analytic design equations to describe a range of tested assemblies are permitted to be developed. Provisions of AISI S100 Section F1, Tests for Determining Structural Performance, are permitted for development of safety and resistance factors for the analytical method that describes the test results.

Tests shall comply with the requirements for the minimum number of tests and diversity of tests in accordance with the test standard. Where such requirements are not stated, provisions in Section A1.2 and Chapter F of AISI S100 shall be applied. Statistical data for determination of resistance factors shall be the most conservative for the connector type(s) used in the test assemblies. Target reliability index, β_o shall be in accordance with AISI S100 Section D5 and Commentary, which is 2.5 for wind and 3.5 for all other load effects. The professional factor, P_m, shall be the average of the ratio of the test results to the calculated design values predicted by the theoretical design equations (P_m = AVE (P_{test}/P_{calc})). Resistance and safety factors developed from this analysis shall be compared to with Table D5 of AISI S100. If the resistance and safety factors are higher than those in AISI S100 Table D5, then the higher resistance factors shall be used in conjunction with the products tested. Likewise, if the safety factor developed from this analysis is lower than those in AISI S100 Table D5, then the lower safety factor shall be used in conjunction with the products tested.

In all testing, the requirements for evaluation of steel yield and tensile strength shall be considered in accordance with Section F1.1 (b) of AISI S100.

6.4 Composite Deck-Slab Testing: Testing of vertical load capacities as required by ANSI/SDI C-2011 shall be in accordance with ANSI/SDI T-CD-2011. As an alternative, testing in accordance with ASCE 3 shall be permitted.

6.5 Web Crippling: If required testing for web crippling shall be performed in accordance with AISI S100 using AISI S909.

6.6 Mechanical Fasteners: Testing of mechanical fasteners shall be performed in accordance with test methods AISI S904 and AISI S905. Test results are calibrated according to AISI S100.

6.7 Fire-Resistance: Fire-resistance testing shall be in accordance with ASTM E119 or UL 263.

6.8 Sound Transmission Testing: Sound transmission testing shall be conducted in accordance with the following standards: ASTM E90 to determine the sound transmission coefficient (STC); and ASTM E492 for the Impact Insulation Class (IIC).

7.0 QUALITY CONTROL

7.1 Inspections: IAPMO UES approved inspections of manufacturing facilities are required for these products. Welded cellular steel decks require inspections conducted by an approved inspection agency. The approved inspection agency shall be accredited in accordance with ISO/IEC 17020 by a recognized accreditation body conforming to ISO/IEC 17011.

7.2 Quality Assurance: Quality documentation complying with IAPMO UES Minimum Requirements for Listee's Quality Assurance System (IAPMO UES 010) shall be submitted.

8.0 EVALUATION REPORT RECOGNITION

8.1 Product Identification: Evaluation reports shall include information on mandatory visible product identification labels for each bundle of panels. Labels shall include the manufacturer's name and address, IAPMO UES evaluation report number, deck type, steel specification and base metal thickness and gage.

8.2 Section Properties. Mandatory items listed in Table 1, Section Properties, shall be included and the optional items may be included in the evaluation report. Other items shall be permitted to be included as determined appropriate by IAPMO UES.

8.3 Deflection Equations. Table 2, Diaphragm Shear Web Deflection Equations, shall be included in the evaluation report to aid designers in determining the shear deflection based on the shear stiffness of the steel deck.

8.4 Diaphragm Design. Evaluation reports shall contain the following or equivalent statements:

When steel deck panels are used as the stressed skin shear carrying element of a horizontal or sloped diaphragm as defined in Section 1602 of the IBC, the diaphragm length and width shall be limited by one of the following: engineering mechanics; applied loads; shear capacity of the diaphragm; diaphragm shear deflection limited by the requirements of ASCE 7 in Sections 12.8.6 entitled, "Story Drift Determination"; or Section 12.12 entitled, "Drift and Deformation".

Shear deflection shall be based on the shear stiffness for the steel deck diaphragm and equations of mechanics. Common shear deflection equations as shown in Table 2 may be used.

8.5 Openings, Holes or Penetrations Through Steel Deck: The registered design professional may submit design calculations and opening details to the building official for approval based on the principles of mechanics for openings, holes or penetrations. Proprietary penetrations, holes, and openings shall be permitted and listed in the report if testing or calculations are submitted to the satisfaction of IAPMO UES.

8.6 Fatigue Loads: Evaluation reports shall indicate that the steel deck shall not be used in conditions subject to loads that are predominately cyclic in nature unless a licensed design professional submits substantiating calculations to the Building Official in accordance with AISI S100 Chapter G.

8.7 Supporting Members Materials: Evaluation reports shall require that supporting steel members shall be of materials complying with the requirements of AISC 360 or AISI S100.

8.8 Fire-Resistance Ratings: Evaluation reports with fire-resistance ratings shall provide guidelines for classification as a restrained or unrestrained assembly. If no fire-resistance rating evidence is submitted, then the evaluation report shall indicate that use within fire-resistive assemblies is beyond the scope of the report.

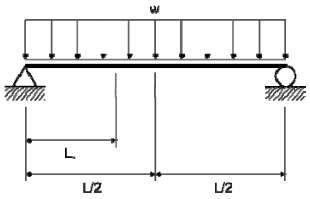
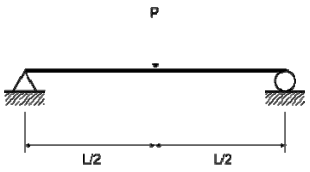
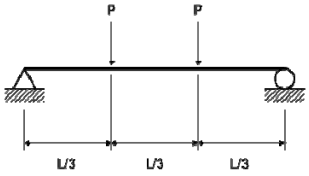
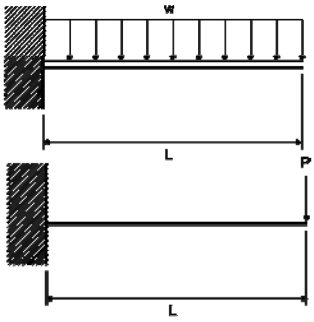
8.9 Sound Transmission Performance: Evaluation reports with tested values for sound transmission coefficient (STC) or Impact Insulation Class (IIC) shall include those values and specify the testing standard used to establish them. When no acoustical performance evidence is submitted, then the evaluation report shall indicate that acoustic performance is beyond the scope of the report.

8.10 Special Inspection: Evaluation reports shall indicate that special inspection is required in accordance with IBC Section 1705.2.2 for steel deck and welding and 1705.3 for concrete.

TABLE 1: SECTION PROPERTIES

Mandatory	Optional	Item
		Code Reference
	X	Nominal, allowable or factored moment or shear strengths
		Properties
X		Cross section diagram(s) of panels and basic dimensions
X		Fastener attachment pattern diagram(s)
X		Perforation pattern(s), if applicable
		Fasteners
X		Nominal, allowable or factored shear capacities and stiffness
	X	Nominal, allowable or factored withdrawal capacities
	X	Nominal, allowable or factored pull-over capacities
		Properties
X		Design base metal thickness per gage callout
X		Grade(s) of steel, yield and tensile strengths
	X	Average weight per unit area
	X	Gross cross section area
	X	Gross moment of inertia
	X	Distance to neutral axis
	X	Gross positive section modulus
	X	Gross negative section Modulus
	X	Effective area
	X	Effective positive moment of inertia
	X	Distance to neutral axis for positive bending
X		Effective positive section modulus
	X	Effective negative moment of inertia
	X	Distance to neutral axis for negative bending
X		Effective negative section modulus
	X	Positive hybrid moment of inertia for uniform load deflection
	X	Negative hybrid moment of inertia for uniform load deflection
X		Lesser of positive or negative hybrid moment of inertia for uniform load deflection
		Diaphragm
X		Nominal, allowable or factored diaphragm shear strengths. If nominal strengths are reported, safety factors and resistance factors also shall be provided, based on the referenced standard or from calibration of the test data per Section 6.3 of this criteria. The safety factors shall be greater than or equal to and the resistance factors shall be less than or equal to the values in Table D5 of AISI S100.
X		Diaphragm flexibility factor or stiffness factor
		Web crippling
X		Web crippling for end and interior supports
	X	Web crippling for other conditions
		Out-Of-Plane Capacities
	X	Distributed load tables for strength and deflection
	X	Point load tables for strength and deflection

TABLE 2: DIAPHRAGM SHEAR WEB DEFLECTION EQUATIONS

Type of Loading	Loading Condition	Shear Deflection	
Simple Beam at Center	Uniform Load, w	$\Delta_w = \frac{wL^2}{8bG'}$	
Simple Beam at L_1	Uniform Load, w	$\Delta_w = \frac{q_{ave}L_1}{G'}$	
Simple Beam at center	Point Load, P	$\Delta_w = \frac{PL}{4bG'}$	
Simple Beam at 1/3 points	Point Loads, P	$\Delta_w = \frac{PL}{3bG'}$	
Cantilever Beam at End	Uniform Load, w	$\Delta_w = \frac{WL^2}{2bG'}$	
Cantilever Beam at End	Point Load, P	$\Delta_w = \frac{PL}{bG'}$	
Relationship between flexibility factor and stiffness factor		$f = \frac{1000}{G'}$	

b = Depth of diaphragm (ft)
f = Flexibility factor (micro in/lbs)
G' = Stiffness factor (kips/in)
L = Diaphragm Length (ft)
L_1 = Distance to point were deflection is calculated (ft)
P = Concentrated load (lbs)
q_{ave} = Average diaphragm shear (lbs/ft)
w = Uniform load (lbs/ft)
Δ_w = Web deflection (in.)