Approved American National Standard

ANSI

AISI S919-24

American Iron and Steel Institute

AISI STANDARD

Test Standard for Determining the Flexural Strength and Stiffness of Cold-Formed Steel Nonstructural Members

2024 Edition

AISI S919-24

American Iron and Steel Institute

AISI STANDARD

S919-17

Test Standard for Determining the Flexural Strength and Stiffness of Cold-Formed Steel Nonstructural Members

2024 Edition

Approved by
the AISI Committee on Specifications for the Design of
Cold-Formed Steel Structural Members (or COFS)

DISCLAIMER

The material contained herein has been developed by the American Iron and Steel Institute Committee on Specifications for the Design of Cold-Formed Steel Structural Members. The organization and the Committee have made a diligent effort to present accurate, reliable, and useful information on testing of cold-formed steel members, components or structures. The Committee acknowledges and is grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. With anticipated improvements in understanding of the behavior of cold-formed steel and the continuing development of new technology, this material will become dated. It is anticipated that future editions of this test procedure will update this material as new information becomes available, but this cannot be guaranteed.

The materials set forth herein are for general information only. They are not a substitute for competent professional advice. Application of this information to a specific project should be reviewed by a registered professional engineer. Indeed, in most jurisdictions, such review is required by law. Anyone making use of the information set forth herein does so at their own risk and assumes any and all resulting liability arising therefrom.

1st Printing – March 2018

PREFACE

The American Iron and Steel Institute Committee on Specifications developed this Standard to provide a test method for determining the flexural strength and stiffness of cold-formed steel *nonstructural members*.

This Standard is intended for adoption and use when performance testing of the cold-formed steel member is required.

The Committee acknowledges and is grateful for the contribution of the numerous engineers, researchers, producers and others who have contributed to the body of knowledge on this subject.

This Page is Intentionally Left Blank.

AISI Committee on Specifications for the Design of Cold-Formed Steel Structural Members

R. B. Haws, *Chairman*	Nucor Buildings Group
S. R. Fox, *Vice-Chairman*	Canadian Sheet Steel Building Institute
H. H. Chen, *Secretary*	American Iron and Steel Institute
D. Allen	Super Stud Building Products
P. Bodwell	Verco Decking, Inc.
R. L. Brockenbrough	R. L. Brockenbrough and Associates
J. Buckholt	Computerized Structural Design
J. K. Crews	Unarco Material Handling, Inc.
L. R. Daudet	Simpson Strong-Tie
R. S. Douglas	National Council of Structural Engineers Associations
W. S. Easterling	Virginia Polytechnic Institute and State University
D. Fulton	Triangle Fastener Corporation
R. S. Glauz	RSG Software, Inc.
P. S. Green	Bechtel Power Corporation
W. B. Hall	University of Illinois
G. J. Hancock	University of Sydney
A. J. Harrold	BlueScope Buildings North America
L. Kruth	American Institute of Steel Construction
R. L. Madsen	Supreme Steel Framing System Association
J. A. Mattingly	Consultant
W. McRoy	ICC Evaluation Service, Inc.
C. Moen	NBM Technologies, Inc.
J. R. U. Mujagic	Structural Engineering Consultant
N. A. Rahman	The Steel Network, Inc.
G. Ralph	ClarkDietrich Building Systems
V. E. Sagan	Metal Building Manufacturers Association
T. Samiappan	OMG, Inc.
A. Sarawit	Simpson Gumpetz & Heger
B. W. Schafer	Johns Hopkins University
K. Schroeder	Devco Engineering Inc.
T. Sputo	Steel Deck Institute
R. Ziemian	Structural Stability Research Council

Subcommittee 6 – Test-Based Design

L. R. Daudet, *Chairman*	Simpson Strong-Tie
H. H. Chen, *Secretary*	American Iron and Steel Institute
R. S. Douglas	National Council of Structural Engineers Association
D. Fox	TOTAL JOIST By ISPAN Systems
S. R. Fox	Canadian Sheet Steel Building Institute
W. Gould	ICC Evaluation Service, Inc.
P. S. Green	Bechtel Power Corporation
W. B. Hall	University of Illinois
R. B. Haws	Nucor Buildings Group
R. L. Madsen	Supreme Steel Framing System Association
J. R. Martin	Verco Decking, Inc.
C. Moen	NBM Technologies, Inc.
J.R.U. Mujagic	Structural Engineering Consultant
T. M. Murray	Consultant
K. Peterman	University of Massachusetts Amherst
N. A. Rahman	The Steel Network, Inc.
G. Ralph	ClarkDietrich Building Systems
V. E. Sagan	Metal Building Manufacturers Association
T. Samiappan	OMG, Inc.
B. W. Schafer	Johns Hopkins University
M. Schmeida	Gypsum Association
R. Schuster	Consultant
F. Sesma	California Expanded Metal Products
M. Speicher	NIST Engineering Laboratory
T. Sputo	Steel Deck Institute
C. Yu	University of North Texas

AISI S919-24
TEST STANDARD FOR DETERMINING THE FLEXURAL STRENGTH AND STIFFNESS OF COLD-FORMED STEEL NONSTRUCTURAL MEMBERS

1. Scope

1.1 This Standard establishes the test method for determining the nominal flexural strength [resistance] and stiffness of cold-formed steel nonstructural members.

1.2 This Standard can be used to determine the nominal flexural strength [resistance] for both local buckling and distortional buckling failure modes.

1.3 This Standard consists of Sections 1 through 11 inclusive.

> **User Note:**
> This Standard provides an alternative approach to evaluating the flexural strength and stiffness of *nonstructural members*.

2. Referenced Documents

The following documents or portions thereof are referenced within this Standard and shall be considered as part of the requirements of this document.

a. American Iron and Steel Institute (AISI), Washington, DC:
   S100-16, *North American Specification for the Design of Cold Formed Steel Structural Members*
   S220-15, *North American Standard for Cold-Formed Steel Framing – Nonstructural Members*

b. ASTM International (ASTM), West Conshohocken, PA:
   A370-17, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*
   E6-15, *Standard Terminology Relating to Methods of Mechanical Testing*
   IEEE/ASTM SI10-10, *American National Standard for Metric Practice*

3. Terminology

Terms appearing in this Standard shall have the meaning as defined in AISI S100, AISI S220 and ASTM E6 or shall have the ordinary accepted meaning for the context for which they are intended.

4. Units of Symbols and Terms

Any compatible system of measurement units is permitted to be used in this Standard, except where explicitly stated otherwise. The unit systems considered in this Standard shall include U.S. customary units (force in kips and length in inches) and SI units (force in Newtons and length in millimeters) in accordance with IEEE/ASTM SI10.

5. Precision

5.1 Loads shall be recorded to a precision of ±1% of the full range of the measuring device.

> **User Note:**
> The capacity (range) of the load-measuring device should be appropriate to the expected maximum tested load. The use of a measuring device with a calibrated capacity greatly exceeding the anticipated load is inappropriate. A target ratio of the load cell capacity to specimen strength of no greater than three is recommended.
>
> The tests should be conducted on a testing machine that complies with the requirements of ASTM E4-16, *Standard Practices for Force Verification of Testing Machines*.

5.2 Deflections shall be recorded to a precision of 0.001 in. (0.025 mm).

5.3 Devices used to measure loads and deformations shall be maintained in good operating order, used only in the calibrated range.

5.4 Instrument calibration readings taken over the full range anticipated in the test shall be accurate to no less than the precision requirements given in Sections 5.1 and 5.2.

6. Test Apparatus

6.1 It is permitted to use either hydraulic or screw operated testing machines.

6.2 In lieu of a test machine, the load is permitted to be applied by a hydraulic cylinder.

7. Test Specimen

7.1 Singly-symmetric flexural members such as C-sections bending about the axis of symmetry shall be tested in pairs for lateral-torsional stability and in such a manner as to simulate the essential function of the member. When testing a pair of members, the test specimen shall be constructed with two cross-sections of like geometry, dimensions, and material properties.

7.2 Flexural tests shall be carried out to determine the strength based on two potential failure modes: local buckling and distortional buckling. The spacing and construction of the braces on the compression flanges shall be set to allow the member to fail in the desired mode.

7.3 When two singly-symmetric members are connected together, it is permitted to make the connection with discrete bracing such as 1-1/2 × 1-1/2 × 1/8 in. (38 × 38 × 4 mm) angles.

For specimens being tested for local buckling, the maximum spacing (clear distance) of these braces on the compression flange shall be 6 in. (150 mm) in the shear span and 3 in. (75 mm) in the center span region as detailed in Figure 1, Test Assembly 1.

> **User Note:**
> Depending on the profile geometry, it may be necessary to reduce the spacing of the braces on the compression flange in the shear span to avoid a distortional buckling failure.

For specimens being tested for distortional buckling, a brace shall be provided at mid-span in the center span. Shear span bracing shall remain the same as Test Assembly 1. The center span shall be the larger of 4 times the distortional buckling half-wavelength or 36 in. (905 mm) as detailed in Figure 2, Test Assembly 2. The distortional buckling half-wavelength (L_{crd}) is permitted to be determined in accordance with AISI S100 Section 2.3.3.3.

The spacing of the braces on the tension flange shall be 12 in. (305 mm).

7.4 Bearing stiffeners or stiffening plates shall be required at each end bearing location and under the points of load application. These stiffeners shall be attached to the web of the member to transfer the point loads into the member without web crippling.

7.5 If the test specimen has punchouts in the web, one of these punchouts shall be located in the constant moment region, as shown in Figures 1 and 2.

7.6 The mechanical properties of the test specimens, including yield stress, tensile strength, percent elongation, and uncoated base steel thickness shall be determined from standard tensile tests conducted in accordance with ASTM A370. A minimum of three (3) samples from the slit coil used to make the test specimens, or from the actual test specimens, shall be submitted for mechanical testing.

7.7 The measured base steel thickness of the material used to fabricate the test specimens shall not vary from the design thickness by more than ±5%.

8. Test Setup

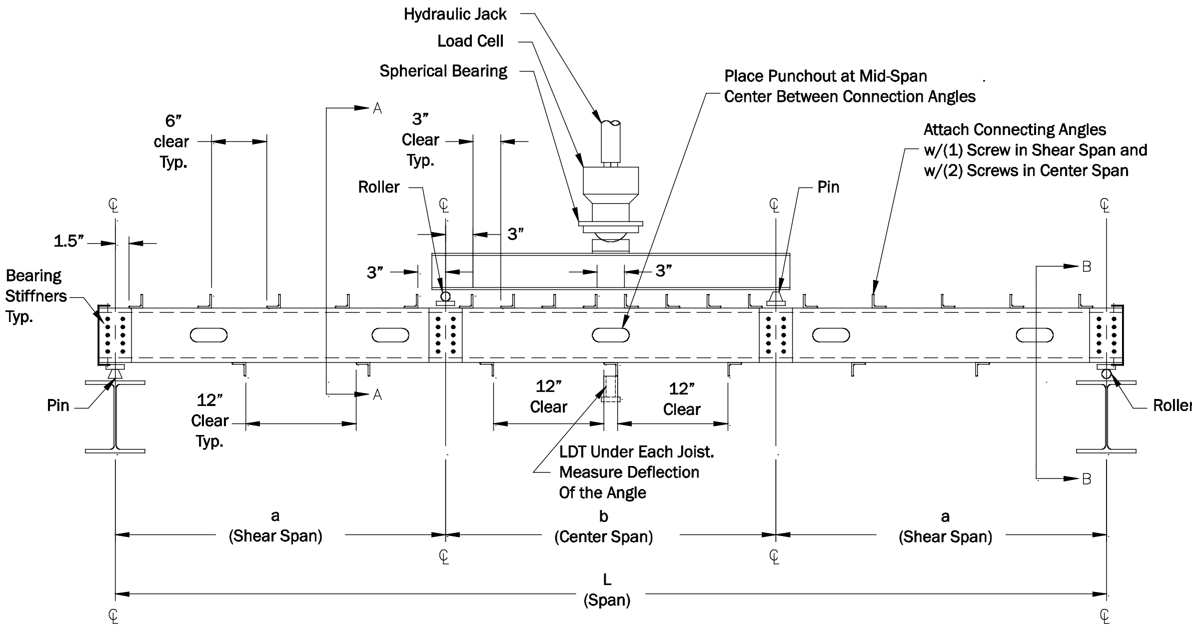
8.1 The load shall be applied equally at two points on the member span with a constant moment region with zero shear in the center span where flexural failure can occur.

> **User Note:**
> A typical test setup for determining the nominal flexural strength [resistance] is illustrated in Figures 1 and 2.

8.2 The length of the shear span, a, and the center span, b, shall be at least 36 in. (914 mm).

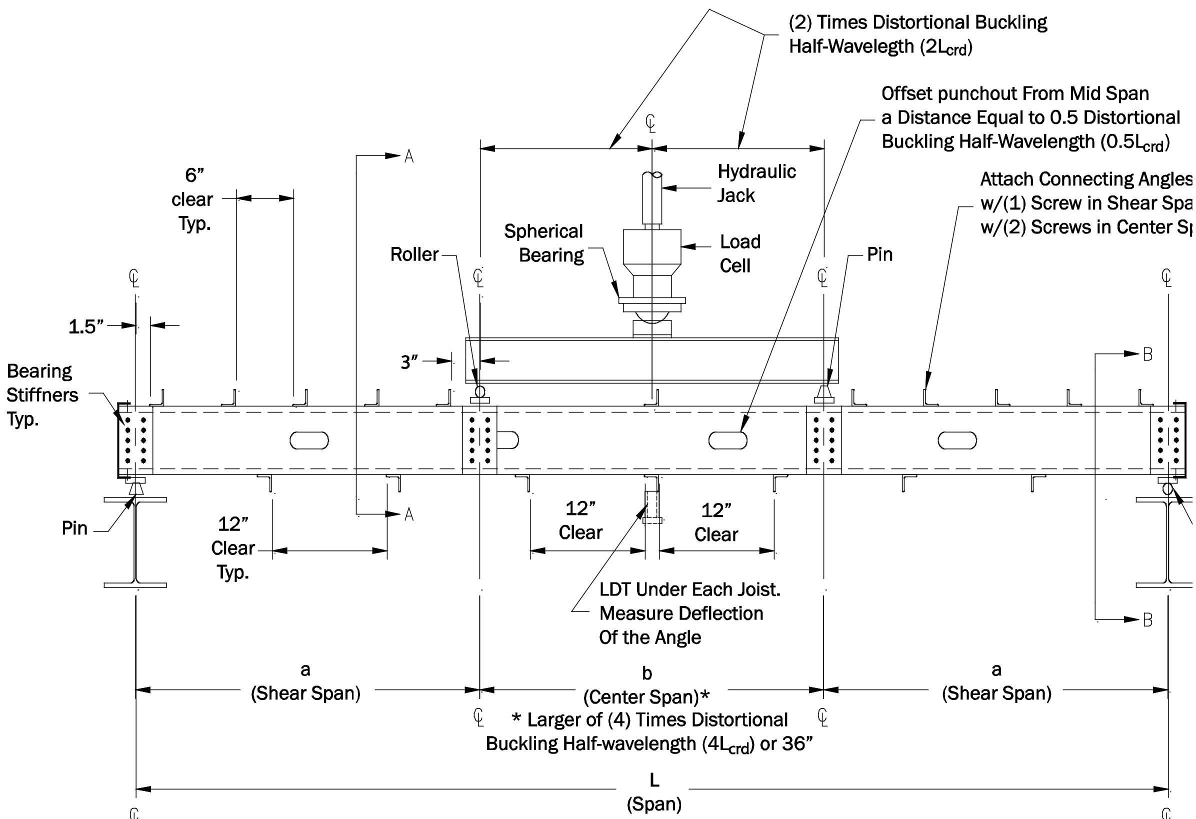
8.3 Combinations of pins and rollers shall be used at alternating support and load points to allow the member to deflect as a simply-supported member under load.

8.4 External bracing is permitted to be used to restrain the section from lateral-torsional buckling (LTB). These members shall be anchored to resist any lateral forces that develop. Discrete blocking shall be provided at regular intervals between the lateral support members and the test specimen. To act as the guiding surfaces, these blocks shall have enough length to maintain contact with the test specimen through the limits of its deflection. If additional members are included to restrain lateral-torsional buckling of the test assembly, any surface in contact with the test specimen shall be a low-friction material such as high density polyethylene. Alternatively, the blocks shall be lubricated to reduce frictional resistance.



Note:
Unit conversion: 1" = 25.4 mm.
Lateral suppport members and lateral torsional buckling (LTB) blocking are shown in Figure 3 Sections A-A and B-B.

Figure 1 Test Assembly 1, Local Buckling Test



Note:
Unit conversion: 1" = 25.4 mm.
Lateral suppport members and lateral torsional buckling (LTB) blocking are shown in Figure 3 Sections A-A and B-B.

Figure 2 Test Assembly 2, Distortional Buckling Test

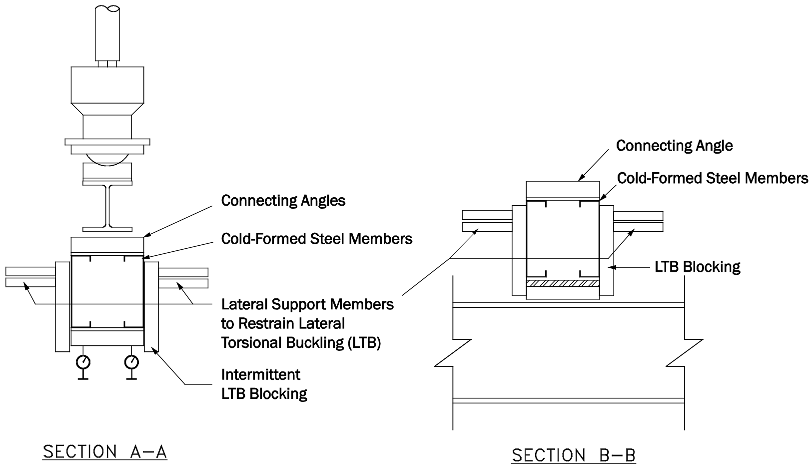


Figure 3 Section Views of Test Assemblies 1 and 2

9. Test Procedure

9.1 The test load shall be applied to produce a deflection at a maximum uniform rate of 0.10 in. (2.5 mm) per minute.

9.2 The mid-span deflection shall be measured for each member. The total load shall be measured, including both the applied load and dead load (i.e., bearing plates, stiffeners, bracing angles, etc.)

9.4 An initial load, or preload, is permitted to be applied to seat the assembly. This preload shall not exceed 10% of the estimated ultimate load. The preload shall be removed and the sensors zeroed before beginning the test.

9.5 Deflection readings shall be taken to permit determining the load-deflection behavior.

9.6 The nominal flexural strength [resistance] of the member shall be determined based on the test specimen shear span and the maximum recorded load that the assembly carries during the test. For a double member assembly, the load per member shall be taken as half of the total load.

10. Data Evaluation

10.1 Evaluation of the test results and the determination of the available strength (i.e., allowable strength or design strength [resistance] or both) shall be made in accordance with the procedures described in Section K2 of AISI S100. For the purposes of this provision, an assembly with a pair of specimens shall be considered a single test.

10.2 No test result shall be eliminated unless a rationale for its exclusion can be given.

10.3 The load determined by testing shall be adjusted to account for differences between the mechanical properties of the test specimens (base steel thickness and yield stress) and the corresponding design values.

11. Report

11.1 The test report shall include a description of the tested specimens, including a drawing detailing all dimensions.

11.2 The test report shall include the measured steel physical properties of the tested specimens.

11.3 The test report shall include a detailed drawing of the test setup, depicting location and direction of load application, location of displacement instrumentation and their point of reference. Additionally, photographs shall supplement the detailed drawings of the test setup.

11.4 The test report shall include load-versus-deformation values or curves, as plotted directly, or as reprinted from data acquisition systems.

11.5 The test report shall include a description of the test method, loading procedure, and rate of loading.

11.6 The mid-span deflection shall be reported for various load levels allowing the calculation of the member stiffness.

11.7 The test report shall include individual and average maximum test load values observed, description of the nature, type and location of failure exhibited by each specimen tested, and a description of the general behavior of the test fixture during load application. Additionally, photographs shall supplement the description of the failure mode(s).

American
Iron and Steel
Institute

25 Massachusetts Avenue NW
Suite 800
Washington, DC 20001
www.steel.org

The New Steel

American
Iron and Steel
Institute

25 Massachusetts Avenue NW
Suite 800
Washington, DC 20001
www.steel.org

The New Steel®

AISI S919-17E