



AISI S902-13



AISI STANDARD

Stub-Column Test Method for Effective Area of Cold-Formed Steel Columns

2013 Edition

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

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PREFACE

The American Iron and Steel Institute Committee on Specifications developed this standard to provide test methods for determining the effective cross-sectional area of cold-formed steel columns.

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.

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Stub-Column Test Method for Effective Area of Cold-Formed Steel Columns

1. Scope

1.1 This test method provides methodology to determine the effective cross-sectional area of cold-formed steel columns.

1.2 This test method provides requirements for testing, and equations to determine, the effective area of a cold-formed steel column section at ultimate load, A_{euN} , and the load- or stress-dependent effective area, A_e .

1.3 The test method provides a means to observe, measure, and account for *local buckling* deformations when the appearance of a column section under stress must be determined.

1.4 The determination of A_e is conducted by either of the following methods:

- (1) The basic method provided in Sections 5 through 11, or
- (2) An alternative method provided in Appendix A.

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:

S100-12, *North American Specification for the Design of Cold-Formed Steel Structural Members*

- b. ASTM International (ASTM), West Conshohocken, PA:

A370-12a, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

E6-09be1, *Standard Terminology Relating to Methods of Mechanical Testing*

IEEE/ASTM-SI10-10, *American National Standard for Metric Practice*

3. Terminology

Where the following terms appear in this standard, they shall have the meaning as defined herein. Terms not defined in Section 3 of this standard, AISI S100 or ASTM E6 shall have the ordinary accepted meaning for the context for which they are intended.

Elements. Straight or curved portions of the cross-section of a column or *stub-column*.

Local Buckling. The *local buckling* mode of a flat element of a column cross-section, which influences the overall column-buckling behavior.

Overall Buckling. Buckling of a column as a function of its overall length.

Stub-Column. An axial compression member of the same cross-section and material as the column for which the strength needs to be determined, but short enough to preclude overall column buckling, if possible.

4. Symbols

- A = Gross cross-sectional area of a column without holes or perforation, or the minimum cross-sectional area of a column with holes or perforation
 A_a = Average of all gross cross-sectional areas of the *stub-columns* without holes or perforations in a test unit, or the average minimum cross-sectional areas of the *stub-columns* with holes or perforations in a test unit
 A_e = Effective cross-sectional area of a *stub-column* at a load less than the ultimate test load, or the effective area of a full-length column
 A_{ei} = Effective cross-sectional area of a *stub-column* at load P_i
 A_{eu} = Effective cross-sectional area of a *stub-column* at ultimate load
 A_{eua} = Average effective cross-sectional area of a test unit of *stub-columns* at the ultimate axial load
 A_{euN} = Nominal effective cross-sectional area at ultimate load adjusted to the nominal thickness and the minimum specified yield stress
 A_{eu1} = Effective cross-sectional area of a *stub-column* with parameters of Test Unit 1 at ultimate load
 A_{eu2} = Effective cross-sectional area of a *stub-column* with parameters of Test Unit 2 at ultimate load
 A_N = Nominal gross cross-sectional area of a *stub-column*
 A_1 = Minimum gross cross-sectional area of a *stub-column* with parameters of Test Unit 1 at ultimate load
 A_2 = Minimum gross cross-sectional area of a *stub-column* with parameters of Test Unit 2 at ultimate load
 D = Axial shortening of a *stub-column* at load P
 D_i = Axial shortening of a *stub-column* at load P_i
 D_u = Axial shortening of a *stub-column* at load P_u
 f = Average axial stress assumed to be uniformly distributed over the effective cross-sectional area, A_e
 f_i = Average axial stress assumed to be uniformly distributed over the effective cross-sectional area, A_{ei} at load P_i
 f_o = Average axial stress assumed to be uniformly distributed over the effective cross-sectional area, A_e , above which the section is not fully effective
 F_n = Nominal ultimate stress, assumed to be uniformly distributed over the effective cross-section of a column as calculated from Section C4 of AISI S100, at which flexural, torsional, torsional-flexural, distortional, or *local buckling*, and/or yielding, can occur
 F_u = Ultimate stress, assumed to be uniformly distributed, at which local failure occurs in a tested *stub-column*
 F_y = Minimum specified elastic limit or yield stress of column or *stub-column* material
 F_{ya} = Average elastic limit or yield stress of the sheet steel for a given test unit
 F_{yi} = Individual elastic limit or yield stress of the sheet-steel specimens in a test unit
 F_{yN} = Minimum specified elastic limit or yield stress of column or *stub-column* material
 i = Load-displacement reading number for a particular *stub-column* test (load

- displacement D_i at load P_i)
- j = Total number of load-displacement readings taken for a particular *stub-column* test
- L = Length of the *stub-column* test specimen
- L_p = Pitch of a repeating pattern of perforations along the longitudinal column axis
- n = Ratio of the effective cross-sectional area at the ultimate load to the full cross-sectional area, A_{eu}/A
- P = Applied axial compression force (column load)
- P_i = Applied load at load increment i
- P_N = Nominal failure load of a column
- P_u = Ultimate *stub-column* load at which local failure occurs
- P_{ua} = Average of all ultimate *stub-column* loads within a test unit
- r = Minimum radius of gyration of the cross-sectional area, A
- t = Nominal base-steel thickness exclusive of coating
- t_a = Average of all base-steel thicknesses within a test unit, exclusive of coating
- t_N = Nominal base-steel thickness within a test unit, exclusive of coating
- W = Greatest overall width of the cross-section, including corner(s)

5. 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.

6. Test Fixture

6.1 Linear displacement devices for measuring lateral displacements shall have a 0.001 in. (0.0254 mm) least-reading capability.

6.2 Measuring devices for determination of the actual geometry of a test specimen shall have a 0.001 in. (0.0254 mm) least-reading capability.

6.3 If axial shortening is recorded, the measuring device shall have a 0.0001 in. (0.00254 mm) least-reading capability.

User Note:

It is recommended that ASTM E4-10, *Standard Practices for Force Verification of Testing Machines*, be used as applicable.

7. Test Unit

7.1 A test unit shall include a minimum of three identical *stub-column* specimens and a minimum of two corresponding sheet-type tensile specimens.

7.2 The specimens within a unit shall represent one type of cold-formed steel section with the same specified geometrical, physical, and chemical properties. The specimens are permitted to be taken from the same column or from different production runs, provided the source of the specimens is properly identified and recorded.