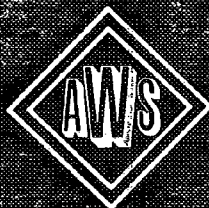


ANSI/AWS C3.2-82
An American National Standard

Standard Method for Evaluating the Strength of Brazed Joints in Shear



AMERICAN WELDING SOCIETY

ANSI/AWS C3.2-82

An American National Standard

Approved by The
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Standard Method for Evaluating the Strength of Brazed Joints in Shear

Supersedes AWS C3.2-63

Prepared by
AWS C3 Committee on Brazing and Soldering

Under the Direction of
Technical Activities Committee

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AWS Board of Directors, June 22, 1982

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Foreword

This standard was established as a result of an extensive test program sponsored by the AWS Committee on Brazing and Soldering. The Committee recognizes the difficulties in assessing the true shear strength of a brazed joint, which is by definition inhomogeneous. Various test specimen designs have been proposed to try to eliminate the effects of stress concentrations or bending moments. The program demonstrated that tests conducted according to this standard yielded data that were consistent and reproducible. The details of the test program are covered in the Committee Report, *Establishment of a Standard Test for Brazed Joints* (AWS C3.1-63).

This standard has been revised to incorporate the International System of Units (SI) and suggestions offered by users of the standard and by members of the C3 Committee. The American Welding Society solicits further comments and suggestions for revision to be used in the preparation of the next edition. Correspondence relating to the standard should be addressed to Secretary, AWS C3 Committee on Brazing and Soldering, American Welding Society, 550 N.W. LeJeune Rd., Miami, Florida 33126.

Introduction

The purpose of this standard is to describe the test method used to obtain reliable data on the strength of brazed joints. Test specimens should therefore be prepared using consistent and proper brazing practices. Interpretation of the test results is the responsibility of the user.

It should be recognized that if the production practices for the brazed product do not follow the test specimen brazing practice, the test specimen joint strengths may not be the same as the product joint strengths.

It is important that the user of this test maintain sufficient documentation of material, braze, and test conditions. This documentation will be required when comparing results with joint strengths obtained by others using this standard method. General use of this standard method may permit a compilation of braze joint strengths and brazing design criteria at some future time.

The following are recommended as references to proper brazing practices and test procedures:

1. AWS *Brazing Manual*, 3rd Edition
2. AWS C3.3-80, *Recommended Practices for Design, Manufacture and Inspection of Critical Brazed Components*
3. ASTM E-8, *Standard Methods of Tension Testing of Metallic Materials*

Both the U.S. customary units and the International System of Units (SI) are used in this edition of the standard. The specified dimensions are intended to provide standard specimens in either system of units. Some of the dimensions, therefore, are not exactly the same. For example, the 1/2 in. diameter hole in the U.S. specimen is given in the SI units as 13 mm rather than 12.7 mm.

Standard Method for Evaluating the Strength of Brazed Joints in Shear

1. Specimen Preparation, Brazing, and Postbrazing Procedures

The procedure for making and brazing the specimens shall be carried out according to the following instructions:

1.1 General Instructions

1.1.1 Base metal sheet nominally 1/8 in. (3 mm) thick shall be used.

1.1.2 For each set of conditions, at least 10 specimens at various overlap distances shall be brazed and tested. The following overlap distances are suggested:

Overlap as ratio of overlap to thickness (T)	Actual overlap	
	in.	mm
0.25	0.031	0.75
0.38	0.047	1.14
0.50	0.062	1.50
0.75	0.094	2.25
1.00	0.125	3.00
1.50	0.187	4.50
2.00	0.25	6.00
4.00	0.50	12.00
6.00	0.75	18.00

Experience has shown that the best test results are obtained when approximately 70% of all the specimens tested fail in the filler metal. The overlap distances should be chosen to achieve this ratio, unless the relative properties of the filler metal and base metal make this impractical. If necessary, braze and test the 0.25 T, 0.50 T, 1.00 T, and 4.00 T specimens first; then determine the overlap distances required in the rest of the test specimens by examining the location of failure in these first four.

1.1.3 All specimens shall be made as uniformly and as accurately as possible.

1.2 Specific Instructions

1.2.1 Specimen blanks for brazing shall nominally be 5 x 1-1/8 in. (130 x 30 mm) rectangles. They shall be of the same material as the parts they represent, both in alloy and surface condition.

1.2.2 The specimen blanks shall be prepared as shown in Fig. 1.

1.2.3 The mating surfaces shall be prepared for brazing by a procedure suitable to the test blank material and braze process to be used. This may include, but not be limited to, grit blasting, etching, abrading, plating, or solvent cleaning of the surfaces to be joined (see Fig. 1, surface S). Nonmetallic grit such as glass beads, sand, or alumina should not be used.

1.2.4 When a flux is used, specifications or other descriptive information, including lot or batch number, shall be included on the test data sheets.

1.2.5 The configuration and recommended tolerances for the assembly of the shear test specimens prior to brazing are shown in Fig. 2. The specimens may be assembled by tack welding using a suitable welding method, or may be held by a suitable fixture during brazing. In either case, alignment must be held closely in all directions. The joint clearance should be the optimum recommended for the filler metal being tested unless the objective of the test is to determine the effect of clearance variation on joint strength. The *AWS Brazing Manual*, 3rd Edition, Table 6.1, page 78 gives clearance recommendations for the various classes of filler metals and brazing processes. To aid the assembly of the specimen blanks, a fixture similar to that shown in Fig. 3 may be used. The joint clearance may be established and maintained by inserting spacers between the specimen blanks along the edges of the joint area. The spacers must be metallurgically compatible with the base metal and filler metal being tested. Selection of one of the base metals as the spacer

1.4 Postbrazing Procedure

1.4.1 After brazing, fillets on all specimens shall be filed, ground, or machined to 0.015 in. (0.5 mm) maximum radius. No undercutting of parent metal is permissible.

1.4.2 Hardness measurements are suggested to monitor the effect and consistency of the braze and, if applicable, the heat treatment on the properties of the base metal.

1.4.3 The specimens shall be machined to the configuration and tolerances given in Fig. 4.

overlap distance, width, and thickness (A, W, and T, respectively on Fig. 4). Joint thickness should be determined. Direct measurement can be made using a metallographic cross-section. Estimated thickness can be determined via thickness measurements using the following formula:

$$T_{\text{joint}} = T_{\text{total}} - (T_1 + T_2)$$

T_{total} = Total specimen thickness after braze and T_1 and T_2 are the original thicknesses of the base metal.

3.2 All specimens shall be tension tested. The breaking load and the location of failure, whether through the filler metal or through the base metal, shall be noted.

2. Recording of Data

For each specimen, details of the specimen preparation and brazing operations shall be accurately recorded on a data sheet such as the one shown in Fig. 5.

3. Mechanical Testing

Tension testing shall be performed in accordance with ASTM E-8, *Standard Methods of Tension Testing of Metallic Materials* and the applicable ASTM standard for specific base metals.

3.1 Prior to testing, all specimens shall be measured for

4. Processing and Presentation of Data

4.1 For each specimen, compute the average unit shear stress in the filler metal at failure and the average unit tensile stress in the base metal at failure as follows (see Fig. 4):

$$\text{Average unit shear stress} = \frac{\text{Breaking load}}{A \times W}$$

$$\text{Average unit tensile stress} = \frac{\text{Breaking load}}{W \times T}$$

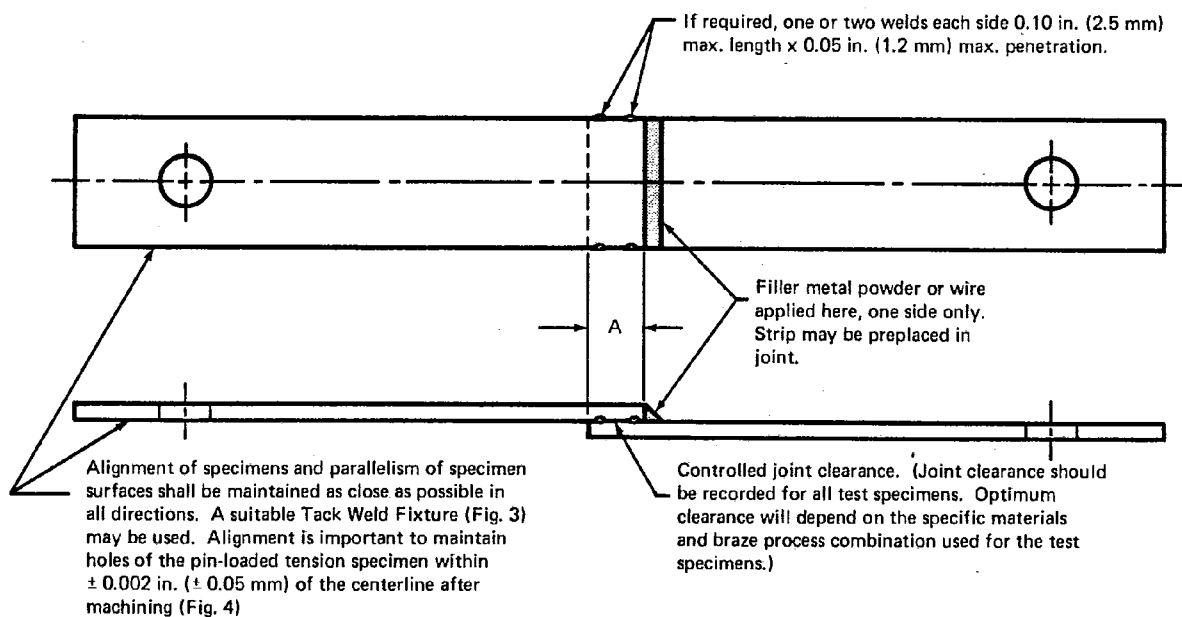


Fig. 2 — Assembly of single-lap shear test specimen and application of filler metal

4/STANDARD METHOD FOR EVALUATING THE STRENGTH OF BRAZED JOINTS IN SHEAR

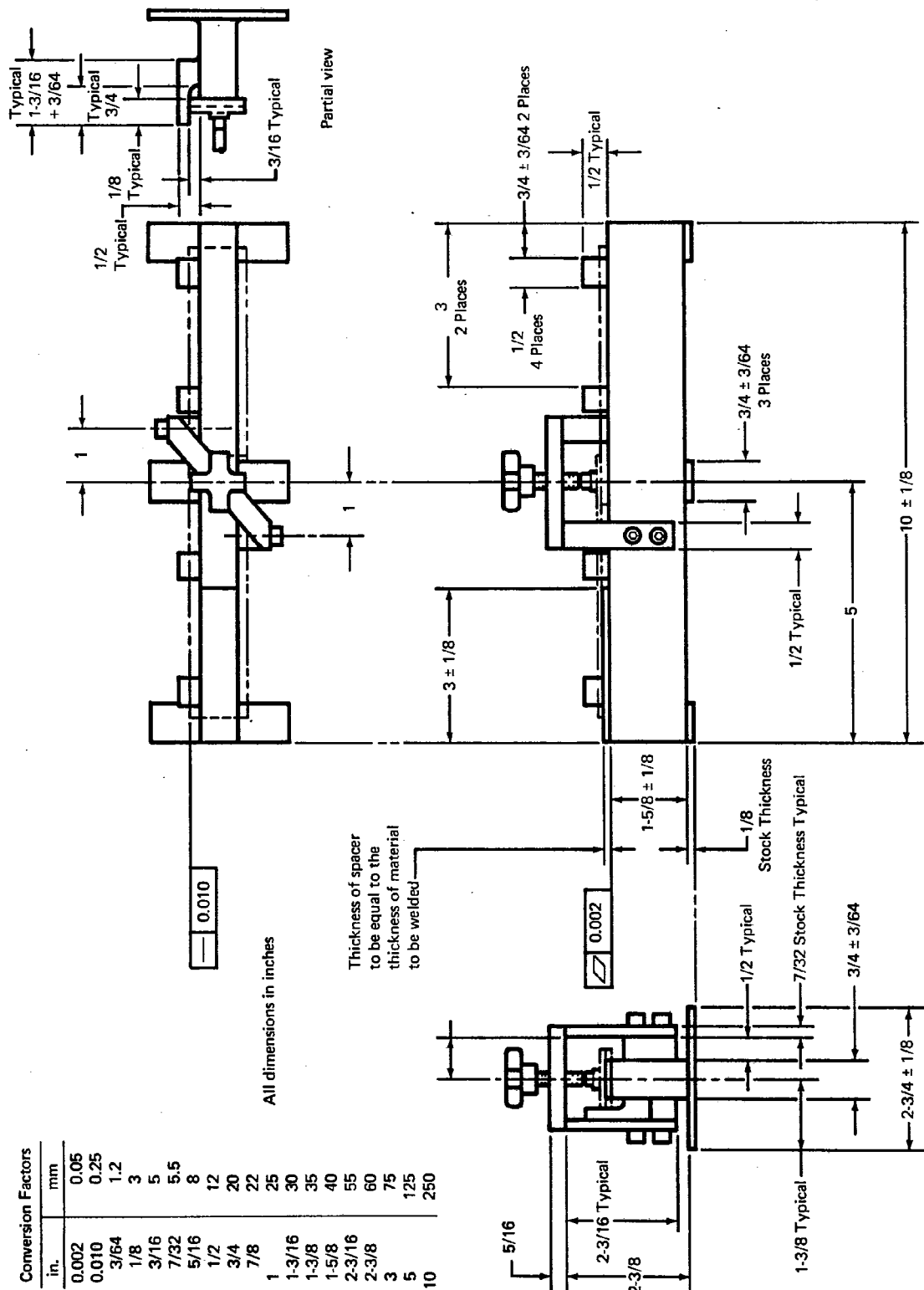
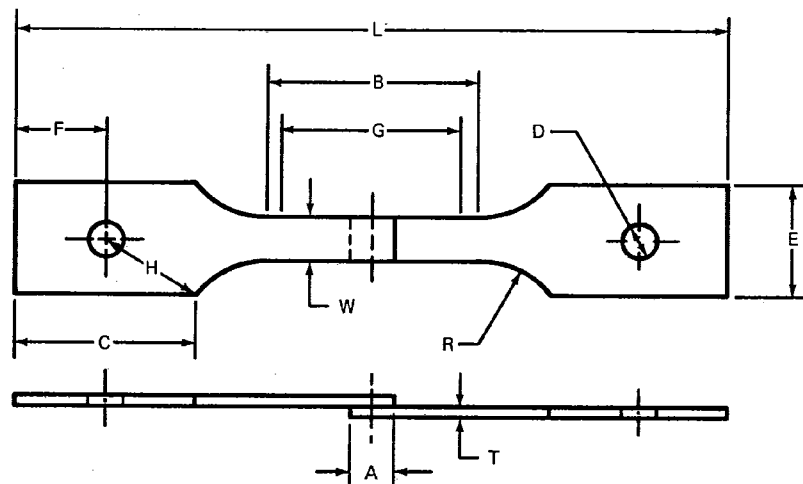


Fig. 3 — Tack weld fixture for shear test specimen



Description	Dimensions	
	in.	mm
G - gage length	2.000 ± 0.005	50.0 ± 0.10
W - width	0.500 ± 0.010	12.5 ± 0.25
T - thickness (nom.)	1/8	3
R - radius of fillet, min.	1/2	13
L - overall length, min.	8	200
B - length of reduced section, min.	2-1/4	60
C - length of grip section, min.	2	50
E - width of grip section approx.	1-1/4	32
D - diameter of hole for pin	1/2	13
F - edge distance from pin, approx.	1	25
A - joint overlap	as specified	as specified
H - distance from hole to fillet, min.	1/2	13
Location of holes relative to centerline within.	± 0.002	± 0.05 min.

Fig. 4 — Pin loaded single-lap shear test specimen

4.2 Plots of average unit shear stress in the filler metal and average unit tensile stress in the base metal as functions of overlap distance shall be prepared as in Fig. 6. Overlap distance shall be represented by two scales as shown; one in terms of overlap distance, and the other in terms of ratio of overlap distance to sheet thickness. The shear stress values shall be plotted as circles, and the tensile stress values as triangles. The location of failure is designated by whether or not the symbols are filled; open symbols represent failure through the filler metal, and the filled symbols represent failure through the base metal.

4.3 An optional treatment is to determine the equations of the curves of an average unit shear stress and average unit tensile stress versus overlap distance (see

Fig. 6). To do this, assume an exponential function for the shear stress of the form:

$$S_s \text{ (Average unit shear stress)} = aA^n$$

The log of this equation is:

$$\log S_s = X \log A + \log a$$

A is overlap

n is slope

a is S_s at $A = 1$

Charting data on a log plot will result in a straight line which can be used to determine n and a. For S_s , assume two linear relationships. One will fit data for low overlaps (Line 1 of Fig. 6); the other will fit Line 2 of Fig. 6.

6/STANDARD METHOD FOR EVALUATING THE STRENGTH OF BRAZED JOINTS IN SHEAR

Base metal _____ Date _____

Base metal condition and hardness before brazing _____

Filler metal _____

Surface preparation method _____

Joint clearance: Before brazing _____ After brazing _____

Hardness after brazing _____

Furnace-brazed specimens

Type of furnace _____

Type of retort (bell, tube, muffle) _____ Size _____

Seal geometry and type of seal _____

Flow rate (retort vol. per hr) _____

Atmosphere _____ Dew point _____ Where taken _____

Vacuum: Pressure _____ Rate of decay, microns/min _____

Brazing temperature _____ How measured _____

Heating time, minutes solidus to liquidus _____ Liquidus to braze temp _____

Time at temperature _____

Cooling time: Minutes _____ Brazing temp to solidus _____

Torch-brazed specimens

Type of flux _____ Oxygen Fuel Gas _____

Type, size of torch _____ Tip size _____

Length of flame _____ Oxidizing or reducing flame _____

Approximate brazing time _____ Regulator settings _____

Other heating methods. Describe and give pertinent details _____

Postbrazing heat treatment. Describe and give hardness after heat treatment _____

Remarks _____

Company _____ Engineer _____

Fig. 5 — Typical data sheet for details of single-lap specimen preparation and brazing

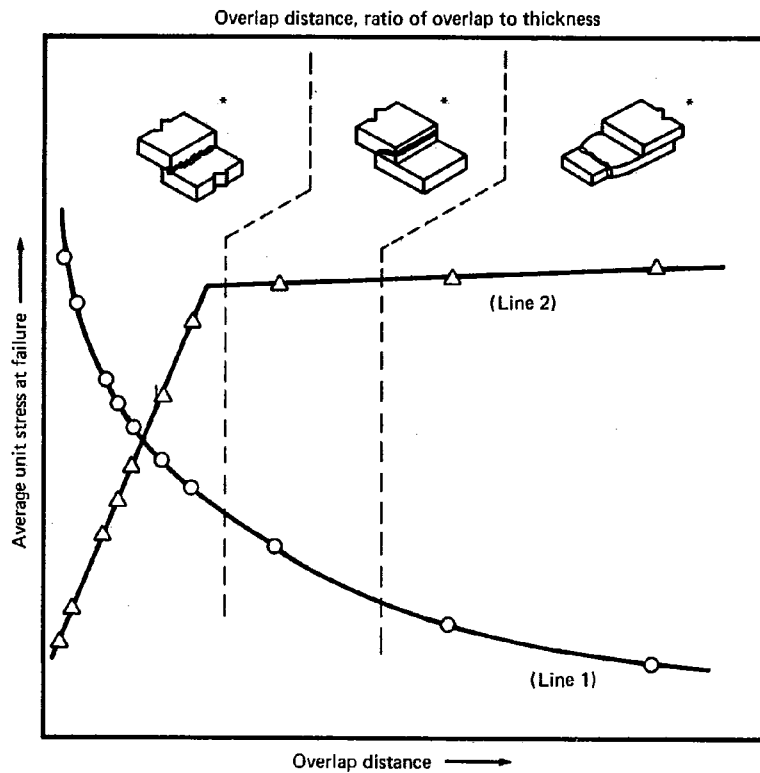


Fig. 6 — Average unit shear stress (circles) and average unit tensile stress (triangles) as functions of overlap distance. (Open symbols represent failure in the filler metal; filled symbols represent failure in the base metal.) Starred (*) illustrations show types of failures.