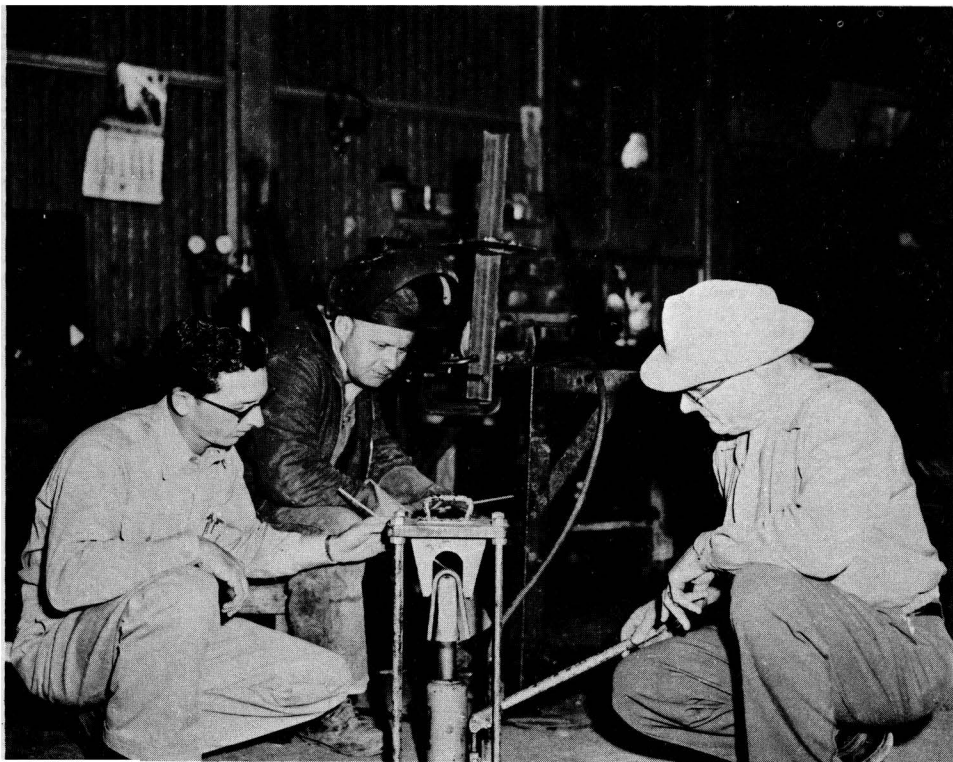


# **CONSTRUCTION**

## **BULLETIN**

**C-6**



**TEXAS HIGHWAY DEPARTMENT**

## FOREWORD

This Bulletin has been prepared by the Bridge Division of the Texas Highway Department for the purpose of furnishing commercial testing laboratories and steel fabricators with the proper procedure to be followed in qualification of welders for manual shielded arc welding.

Fabricators will also use this Bulletin in conjunction with T. H. D. Bulletin C-5 in the qualification of welding procedures.



JANUARY 1961

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## TABLE OF CONTENTS

Section 1	General Provisions	Page
101	Description	1
102	Testing Agencies	1
103	Duration of Welder Qualification	1
104	Retests of Welders	1
105	Test Reports	1
Section 2	Qualification for Structural Welding	
201	Base Metal	2
202	Filler Metal	2
203	Position of Test Welds	2
204	Welder Qualification Tests	3
205	Required Test Specimens	4
206	Bend Tests	5
207	Fillet Weld Test	7
Section 3	Qualification for Welding Reinforcing Steel	
301	Materials	10
302	Tests	10
303	Preparation for Welding	11
304	Number of Specimens	11
305	Testing of Specimens	12
306	Results of Tests	14
307	Certification for Welding Reinforcing Steel	14
Appendix A	Reduced Section Tensile Test	15
	Free Bend Test	16
Appendix B	Removal of Test Specimens from Welded Test Plate	18

## SECTION 1 - GENERAL PROVISIONS

### 101. Description.

Qualification of welders for manual shielded arc welding on Texas Highway Department projects shall conform to the requirements of this bulletin. Procedure qualification tests required under Section 5 of T.H.D. Bulletin C-5 shall be prepared and tested as described herein.

### 102. Testing Agencies.

Tests for welder qualification shall be given by commercial laboratories who have an approved rating with A. S. T. M.

Fabricating shops with the proper facilities for administering the tests may do so under the supervision of the Materials and Tests Division.

### 103. Duration of Welder Qualification.

1. Permanent unless qualified process is not used for six months.
2. Until work shows doubt of ability.

### 104. Retests of Welders

1. Immediately after failure - two of each joint failed.
2. After retraining - one of each joint failed.

### 105. Test Reports.

Commercial laboratories shall furnish two copies of all test reports to the Bridge Division, Texas Highway Department, Austin 14, Texas. The address to which the client wishes his Highway Department certification papers sent shall be included.

## SECTION 2 - QUALIFICATION FOR STRUCTURAL WELDING

### 201. Base Metal.

Base metal for welder qualification shall be A7, A373, A36 or A441. Qualification on any of the above listed steels will qualify for welding any of them.

### 202. Filler Metal.

1. Manual shielded metal arc - electrodes shall conform to ASTM-A233 and shall be grouped as follows:

<u>Group</u>	<u>Electrode</u>
F1	E6020, E6030, E6024, E6027, E6028
F2	E6012, E6013, E6014
F3	E6010, E6011
F4	E6015, E6016
F5	E6018

Qualification with an electrode of any group number will qualify for welding with other electrodes in that group and with any electrode having a lower group number.

Group F3, F4, or F5 electrodes must be used for Basic Qualification Test and Supplemental Limited Thickness Test.

The welder shall be tested with the largest size electrode he will use during fabrication or construction.

For welding on A36 or A441 steel the welder must be tested and certified for use of Group F4 or F5 electrodes.

### 203. Position of Test Welds.

The welder must be certified in the position or positions in which he expects to weld. Test plates shall be positioned as shown in Figure 1. Positions for which welder is qualified shall be in accordance with Table 1.

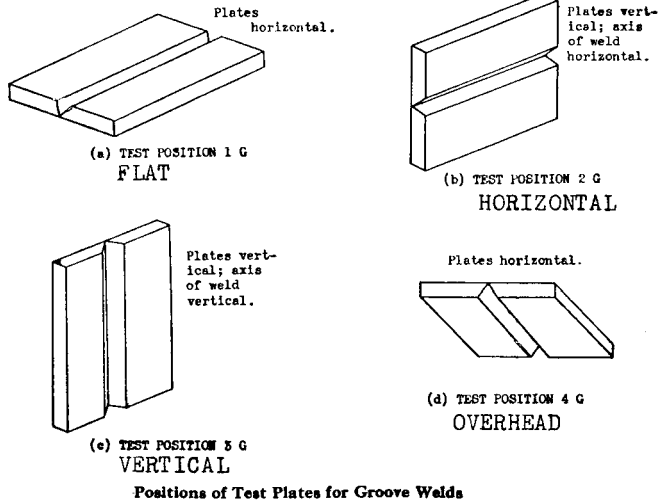


Figure 1

204. Welder Qualification Tests.

Tests shall consist of one test plate per test.

Positions, type weld, and thickness of material for which a welder is certified shall be in accordance with Table 1.

Table 1

Test Position	Positions & Type Welds Qualified	
	Basic Test & Limited Thickness Test*	Supplemental Fillet Test
Flat	Flat Butt; Flat & Horiz. Fillet	Flat Fillet
Horizontal**	Flat & Horiz. Butt; Flat & Horiz. Fillet	Flat & Horiz. Fillet
Vertical	Flat & Vert. Butt; Flat, Vert. & Horiz. Fillet	Flat, Vertical & Horiz. Fillet
Overhead	Flat & Overhead Butt; Flat, Overhead & Horiz. Fillet	Flat, Overhead & Horiz. Fillet

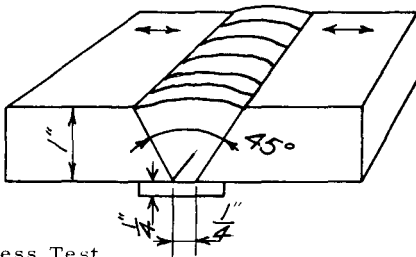
\*On butt welds, qualification by the limited thickness test is for material not over 3/4" thick.

\*\*The welder shall prepare and space the plates which he is to use in making the test for horizontal butt welds.

Joint details for each test shall be as shown herein:  
 Arrows indicate direction of rolling.

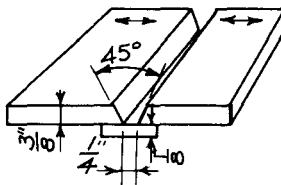
1. Basic Qualification Test

Joint detail - 1" plate  
 45° incl. angle groove  
 1/4" root opening, backed



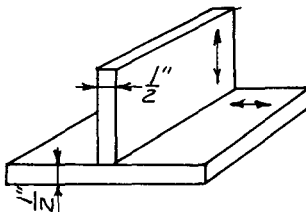
2. Supplemental Limited Thickness Test

3/8" plate  
 45° incl. angle groove  
 1/4" root opening - backed



3. Supplemental Fillet Welding Test

1/2" plate  
 Tee joint  
 5/16 weld



205. Required Test Specimens

The number and type of test specimens required for each Qualification Test shall be as shown in Table 2.

Table 2

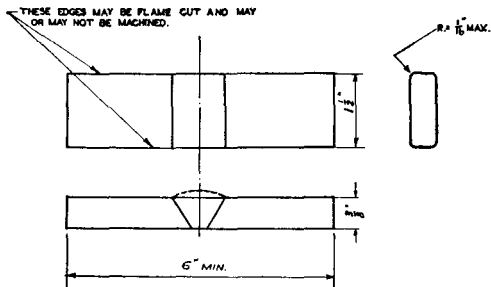
Qualification Test	Type and Number of Test Specimens Required				
	Root Bend	Face Bend	Side Bend	Fracture	Macro Etch
Basic Test			2		
Limited Thickness Test	1	1			
Fillet Welding Test				1	2



206. Bend Tests for Basic Qualification Test and Limited Thickness Test

1. Preparation of Bend Test Specimens

- a. Face and Root Bend Specimens shall be removed from testplate at approximate locations shown in Figure 14 and shall be prepared as shown in Figure 2. If the thickness of the specimen is greater than 3/8 inch the surface opposite that which is to be tested may be machined so that the thickness of the finished specimen will be 3/8 inch.

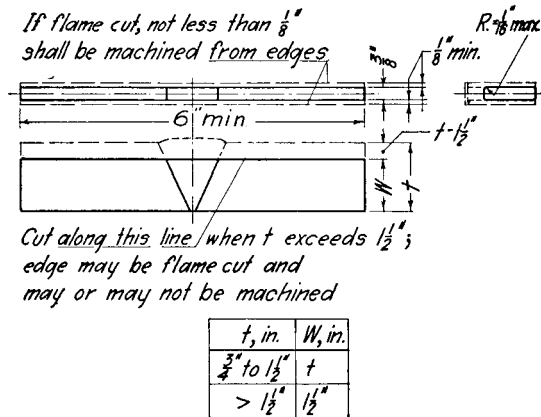


**NOTE:** WELD REINFORCEMENT AND BACKING STRIP, IF ANY, SHALL BE REMOVED FLUSH WITH THE SURFACE OF THE SPECIMEN. IF A RECESSED STRIP IS USED THIS SURFACE OF THE SPECIMEN MAY BE MACHINED TO A DEPTH NOT EXCEEDING THE DEPTH OF THE RECESS TO REMOVE THE STRIP, EXCEPT THAT IN SUCH CASES THE THICKNESS OF THE FINISHED SPECIMEN SHALL BE THAT SPECIFIED ABOVE.

Face- and Root-Bend Specimens

Figure 2

- b. Side Bend Specimens shall be removed from test plate at approximate locations shown in Figure 13 and prepared as shown in Figure 3.



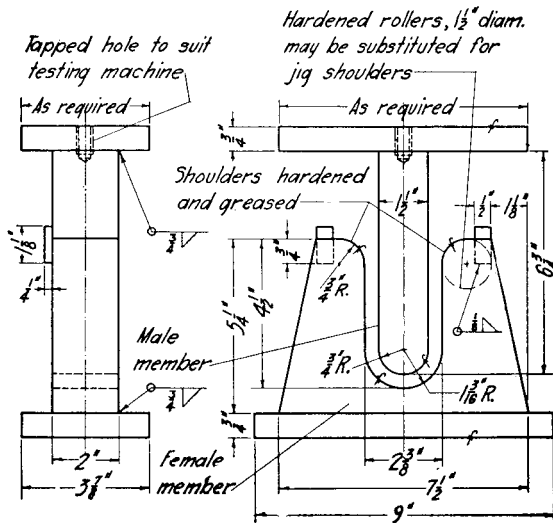
Side-Bend Specimen

Figure 3

## 2. Method of Testing for Face, Root and Side Bend Specimens

Each specimen shall be bent in a jig having the contour shown in Fig. 4 and otherwise substantially in accordance with that figure. Any convenient means may be used for moving the male member with relation to the female member.

The specimen shall be placed on the female member of the jig with the weld at midspan. Face-bend specimens shall be placed with the face of the weld directed toward the gap; root-bend specimens shall be placed with the root of the weld directed toward the gap; side-bend specimens shall be placed with that side showing the greater defects, if any, directed toward the gap. The two members of the jig shall be forced together until the curvature of the specimen is such that a 1/32-in. diameter wire cannot be passed between the curved portion of the male member and the specimen. The specimen shall then be removed from the jig.



Guided-Bend Test Jig

Figure 4

3. Test Results Required for Face, Root and Side Bend Tests.

The convex surface of the specimen shall be examined for the appearance of cracks or other open defects. Any specimen in which a crack or other open defect is present after the bending, exceeding 1/8 in. measured in any direction, shall be considered as having failed. Cracks occurring on the corners of the specimen during testing shall not be considered.

207. Fillet Weld Test

1. Preparation of test joint and test specimens shall be as shown in Figure 5.
2. Fracture Test
  - a. Method of Testing

The stem of the 6" section shall be loaded laterally in such a way that the root of the weld is in tension. The load shall be steadily increased until the specimen fractures or bends upon itself.

b. Test Results Required

A specimen shall not fracture, or if fractured, shall not contain defects in excess of the following limits:

- (1) Cracks, overlaps, undercuts, lack of penetration, and incomplete fusion - None.
- (2) Inclusions (slag, porosity or other deleterious material) that are  $1/16$ " or less in their greatest dimension shall be allowed if dispersed in such a manner that the sum of the greatest dimensions of the inclusions in any linear inch of weld shall not exceed  $1/4$ ".
- (3) Inclusions (slag, porosity, or other deleterious material) less than  $3/16$ " in their greatest dimension shall be allowed if the minimum clearance between edges of inclusions is  $1-1/2$ " and the sum of their greatest dimensions does not exceed  $3/8$ " in the 6" long specimen.

3. Macro Etch Test

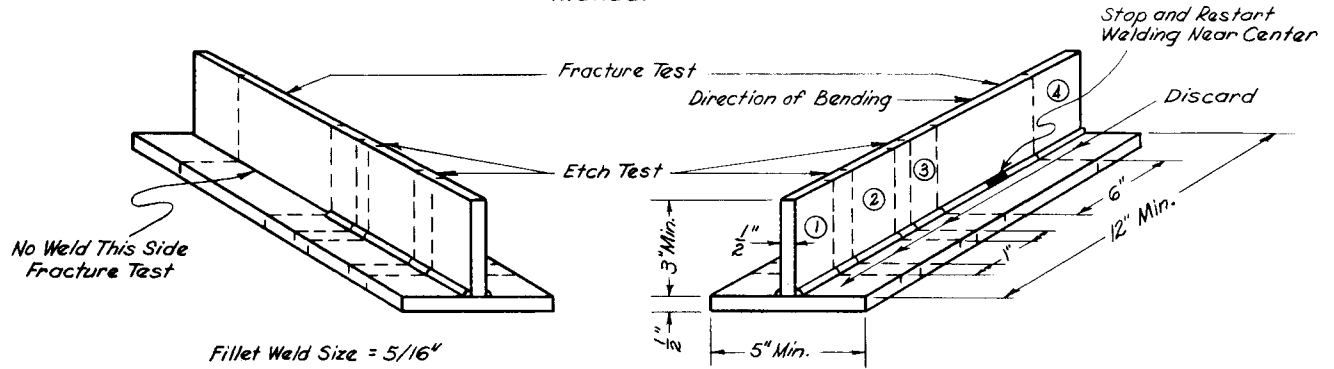
a. Preparation of Specimen

The ends of specimen shall be smooth before etching. Etching shall be with a suitable solution to give a clear definition of the weld.

b. Test Results Required

The welds shall show fusion to the root but not necessarily beyond root and be free from cracks. Convexity or concavity of welds shall not exceed  $1/16$ ". Both legs of weld shall be equal to within  $1/16$ ".

WELDER QUALIFICATION  
FILLET WELD TEST  
Manual



PREPARATION OF TEST SPECIMENS

Specimens may be sawed, machined, or flame cut from welded test joint.  
The ends of etched specimen shall be smooth for etching.

Figure 5

SECTION 3 - QUALIFICATION FOR WELDING REINFORCING STEEL

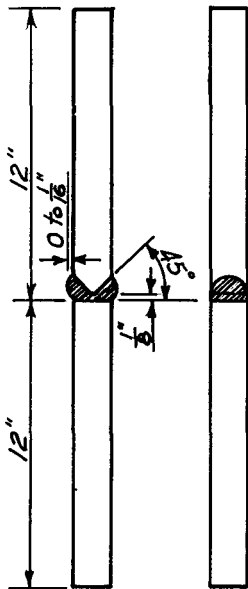
301. Materials

The tests shall be made using hard grade, open hearth new billet steel as specified in Paragraph 2 of Item 440, "Reinforcing Steel" of the Standard Specifications. The testing agency shall provide the proper bars for the tests and shall certify that hard grade bars are used.

302. Tests

Splice details for each test shall be as shown in Fig. 6 & 7.

1. Basic Qualification Test - Basic Test for welding reinforcing steel shall be a butt weld made in the horizontal position as shown in Figure 6.



No. 9 Bars

*Butt weld in horizontal position.*

Figure 6

## 2. Supplemental Lap Weld Test

Supplemental lap weld test for welding reinforcing steel shall be a lap weld made in the horizontal position as shown in Figure 7.

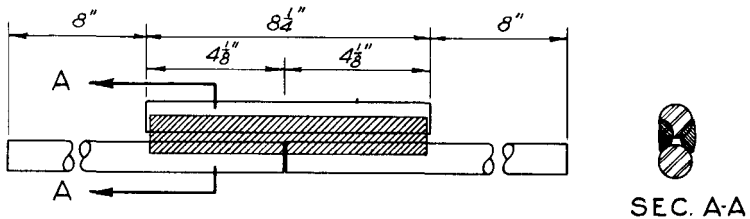


Figure 7

### 303. Preparation for Welding

For the butt splices the applicant shall, by use of the cutting torch and other tools which will be available in the field, prepare the bar ends to the bevels and to the cleanliness required for sound work.

Field conditions shall be simulated in fitting and tacking the butt splices. The bars for the lap splices shall be wired together by the testing agency in a manner similar to that used in ordinary reinforced concrete construction. (The welding arc will melt and release the wires and there is no need for tacking). The welder shall satisfy himself regarding the cleanliness of the bars before he begins welding.

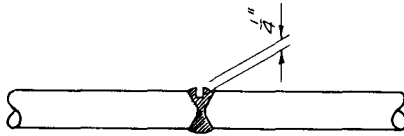
### 304. Number of Specimens

Two test specimens will be required for each test.

305. Testing of Specimens

1. Basic Test for Reinforcing Steel

- a. One specimen shall be subject to tension test to failure.
- b. One specimen shall be saw-notched for a nick-break test as is shown in Fig. 8 and shall be broken and visually examined for soundness.



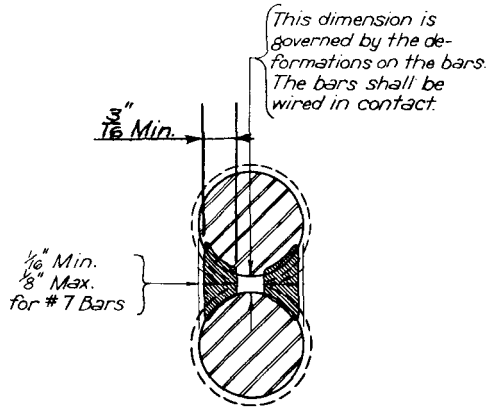
*Specimen prepared for  
nick-break test.*

Figure 8



2. Supplemental Lap Weld Test

- a. Both specimens shall be subject to tension tests to failure.  
Note - When pulling lap weld specimens to determine tensile strength a jig must be used to prevent distortion due to secondary stresses. The jig may be of the design and detail preferred by the testing agency but must prevent change in geometry of the specimen as it is being pulled.
- b. After making the tension test to failure of each lap splice specimen it shall be visually examined and then sawed through an average section of the unbroken portion. A check will then be made and recorded of the dimensions indicated on Fig. 9.



*Minimum dimensions for welds in lap splices.*

Figure 9

306. Results of Tests

A tension test specimen shall be considered satisfactory if it develops the minimum tensile requirements as set up by the A. S. T. M. for intermediate grade, open hearth new billet steel, (70,000#/sq. inch.).

1. Basic Test

- a. Minimum breaking load for tension specimen, No. 9 bars, shall be 70,000 lbs.
- b. Nick-break test shall show complete penetration and no inclusions or gas pockets.

2. Supplemental Lap Weld Test

- a. Minimum breaking load for tension specimens No. 7 bars shall be 42,070 lbs.
- b. Examination of the specimen after sawing shall show complete fusion. Dimensions shall conform to requirements of Figure 9.

307. Certification for Welding Reinforcing Steel

1. Basic Test

A welder who passes the basic test shall be certified for welding butt and lap joints in all positions and on all size bars.

2. Supplemental Lap Weld Test

A welder who passes the lap weld test shall be certified for welding lap splices in all positions on bars No. 7 and smaller.

## **APPENDIX A**

**Reduced Section Tensile Test and Free  
Bent Test for Procedure Qualification**

## REDUCED SECTION TENSILE TEST

The specimen shall be prepared as shown in Figure 10. Thickness of test plate shall be that which is to be used in the work but need not exceed 1-1/2 inches. Before testing, the least width and corresponding thickness of the reduced section shall be measured in inches. The specimen shall be ruptured under tensile load and the maximum load in pounds shall be determined. The cross-sectional area shall be obtained as follows; cross-sectional area = width x thickness. The tensile strength in pounds per sq. in. shall be obtained by dividing the maximum load by the cross-sectional area.

Yield point shall be determined by Drop of the Beam or Halt of the Pointer Method in accordance with ASTM E-8.

For structural carbon steel of the A7 and A373 classifications, tensile strength and yield point shall be as follows:

Tensile Strength (Range)	62,000 to 80,000 psi
Yield Point (Min.)	45,000 psi

For structural low alloy steel A441 and high yield carbon steel A36, tensile strength and yield point shall be as follows:

Tensile Strength (Range)	70,000 to 90,000 psi
Yield Point (Min.)	55,000 psi

Test specimens shall be machined so that the reduced section being tested includes only the weld metal and the fusion zone of the parent metal.

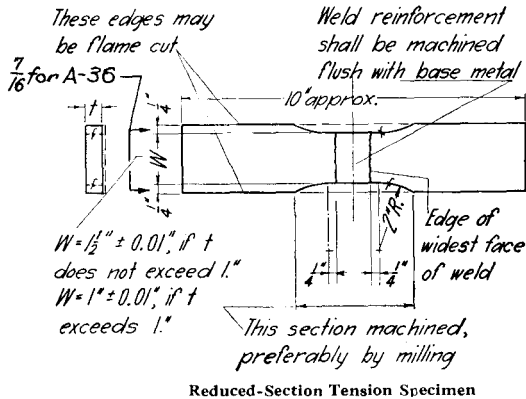


Figure 10

## FREE BEND TEST

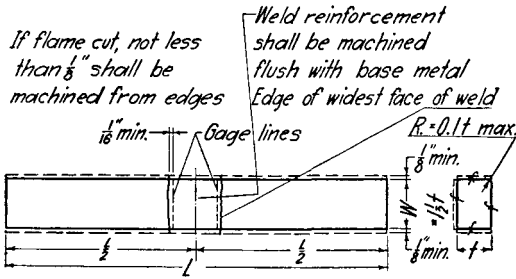
The gage lines indicated in Fig. 11 shall be lightly scribed on the face of the weld. The gage length (distance between gage lines) shall be approximately  $1/8'$  less than the width of the face of the weld, and shall be measured in inches to the nearest 0.01 inch.

Each specimen may be bent initially by the use of a fixture complying with the requirements of Figure 12. The surface of the specimen containing the gage lines shall be directed toward the supports. The weld shall be at midspan of both the supports and the loading block. Alternatively, the initial bend may be made by holding each specimen in the jaws of a vise with one-third the length of the specimen projecting from the jaws, then bending the specimen away from the gage lines through an angle of from  $30$  to  $45^\circ$  by blows of a hammer. The other end of the specimen shall be bent in the same way. In order that the final bend shall be centered on the weld, the initial bends shall be symmetrical with respect to the weld, and both ends shall be bent through the same angle. The initial bend may also be started at the weld by placing the specimen in the guided-bend test jig shown in Figure 4.

Compressive forces shall be applied to the ends of the specimen, continuously decreasing the distance between the ends. (Any convenient means such as a vise or a testing machine may be used for the final bend.) When either a crack or other open defect exceeding  $1/16$  in. in any direction appears on the convex face of the specimen, the load shall immediately be removed. If no crack appears, the specimen shall be bent double. Cracks occurring on the corners of the specimen during testing shall not be considered.

The elongation shall be determined by measuring the minimum distance between the gage lines, along the convex surface of the weld, to the nearest 0.01 inch and subtracting the initial gage length. The per cent elongation shall be obtained by dividing the elongation by the initial gage length and multiplying by 100. Elongation shall be not less than the following:

A7 & A373 Steel - 25%  
A441 & A36 Steel - 22%



Dimensions

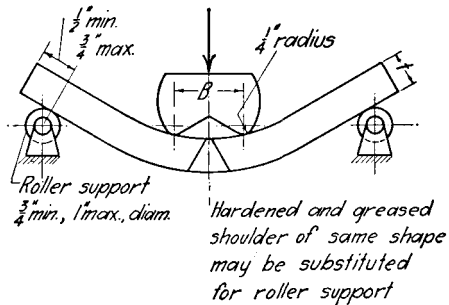
$t$ , in.	$\frac{3}{8}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$
$W$ , in.	$\frac{3}{16}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{1}{4}$	3	$3\frac{3}{4}$
$L$ min., in.	8	11	12	$13\frac{1}{2}$	15	18	21
$B^*$ min., in.	$1\frac{1}{4}$	2	2	2	2	2	3

\*SEE FIG. 12

NOTE 1: THE LENGTH  $L$  IS SUGGESTIVE ONLY, NOT MANDATORY.

NOTE 2: IF DESIRED, THE EDGES OF THE SPECIMEN MAY BE PREPARED BY MACHINE FLAME CUTTING, FOLLOWED BY ROUNDING OF THE CORNERS WITH A FILE, THROUGH THIS MAY BE A MORE SEVERE TEST.

Figure 11 - Free Bend Specimen

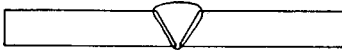


Note. For dimension  $B$  see Figure 11

Figure 12 - Initial Bend for Free-Bend Specimens

APPENDIX B  
Order of Removal of Test Specimens  
from Weld Test Plate

<i>DISCARD</i>		<i>THIS PIECE</i>
<i>SIDE BEND</i>		<i>SPECIMEN</i>
<i>REDUCED SECTION</i>		<i>TENSILE SPECIMEN</i>
<i>SIDE BEND</i>		<i>SPECIMEN</i>
<i>FREE BEND</i>		<i>SPECIMEN</i>
<i>SIDE BEND</i>		<i>SPECIMEN</i>
<i>REDUCED SECTION</i>		<i>TENSILE SPECIMEN</i>
<i>SIDE BEND</i>		<i>SPECIMEN</i>
<i>FREE BEND</i>		<i>SPECIMEN</i>
<i>DISCARD</i>		<i>THIS PIECE</i>



Order of Removal of Test Specimens from Welded Test Plate  
(Plate Thickness 3/4" and Over)

Figure 13

<i>DISCARD</i>		<i>THIS PIECE</i>
<i>REDUCED SECTION</i>		<i>TENSILE SPECIMEN</i>
<i>ROOT BEND</i>		<i>SPECIMEN</i>
<i>FREE BEND</i>		<i>SPECIMEN</i>
<i>FACE BEND</i>		<i>SPECIMEN</i>
<i>ROOT BEND</i>		<i>SPECIMEN</i>
<i>FREE BEND</i>		<i>SPECIMEN</i>
<i>FACE BEND</i>		<i>SPECIMEN</i>
<i>REDUCED SECTION</i>		<i>TENSILE SPECIMEN</i>
<i>DISCARD</i>		<i>THIS PIECE</i>



Order of Removal of Test Specimens from Welded Test Plate  
(Plate Thickness less than 3/4")

Figure 14