

Welding Bend Test

1 Purpose

In the welding bend test the crack arrest behavior of a material shall be checked. For this purpose, a welding bead shall be laid on a test plate of this material. Then the test plate shall be subjected to bending stress. In doing this, it shall be checked if an incipient crack occurring in the weld metal is arrested by the heat affected zone or the base metal when bending without interruption.

In case of plates the specimen axis may also be vertical to the main rolling direction at the discretion of the manufacturer (transverse specimen).

In case of arbitration longitudinal specimens shall be used.

2 Scope of application

This Steel and Iron Test Sheet shall apply to the welding bend test of weldable structural steels with minimum yield strength values between 235 and 355 N/mm² in product thicknesses equal to or greater than 30 mm. For plates the product thickness shall be the nominal thickness, for profile steels the product thickness shall be the flange thickness, for other products the product thickness shall be the thickness of the specimen taking point.

6. Specimen preparation

6.1 Mechanical machining

The long sides of the specimens shall be machined mechanically; the edges shall be chamfered or rounded.

Protruding parts such as remains of webs in case of profile steel shall be machined off so that a plane-parallel specimen with the biggest possible thickness is formed. However, one rolled surface must be left.

In case of products with thicknesses > 50 mm the specimen shall be worked off to a thickness of 50 mm. However, one rolled surface must be left. At the discretion of the steel manufacturer specimens with a thickness of more than 50 mm may also be used. The other requirements of the Steel and Iron Test Sheet remain unaffected. In case of arbitration specimens with a thickness of 50 mm shall be used.

3 Test unit

Test unit shall be the products of one heat, one product type and similar heat treatment, separated into product thicknesses of ≤ 50 mm and > 50 mm.

On the rolled surface side a groove shall be made according to *Figure 1*.

4 Scope of testing

Each test unit shall be subjected to a welding bend test.

The test of a test unit consisting of products with thicknesses ≤ 50 mm may be dropped if the test of a test unit of the same heat, product type and heat treatment consisting of products with thicknesses > 50 mm is performed.

6.2 Welding

The groove as per point 6.1 shall be filled with weld metal in flat position according to *Figure 1* and 'Table 1.

Welding must be performed in such a way that cracks occur in the welding bead or in the heat affected zone when bending. This will normally be the case if the following requirements are met:

5 Taking a specimen

The test piece for making the specimen with the dimensions as per *Table 1* shall be taken from one end of a product as delivered, if possible next to the test pieces for the mechanical tests according to the applicable technical delivery condition.

In case of profile steel the test piece must include the rim of the flange.

- Welding method: manual arc welding
- Electrode type: RR as per DIN EN 499 or filler metal with lower ductility
- Electrode diameter: 5 mm

- Specimen temperature at the beginning of welding room temperature
- Welding current: mean value as specified by the manufacturer of welding electrodes
- Weld reinforcement: about 1 mm
- Length of welding bead: according to Table 1

In the main bending area of the specimen the welding bead shall be welded in one go without interruption.

The welding bead shall not be machined off.

6.3 Condition of base metal

The base metal shall be tested as delivered.

When taking and preparing the specimen, it must be ensured that the base metal is neither subject to mechanical nor to thermal influences outside the influence area of the welding bead.

7 Test procedure

The welding bend test shall be performed at room temperature. The specimen shall be placed in the bending jig according to *Figure 2* in such a way that the welding bead lies in the tension zone. Then it shall be bent to a bending angle of at least 60° in one go without interruption.

The test will be finished if either

- the specimen shows a fracture or
- a bending angle equal to or greater than 60° measured on the unloaded specimen has been reached.

8 Test procedure

The welding bend test will be *successful* if at least one incipient crack occurring in the weld metal has been arrested by the heat affected zone or the base metal.

The welding bend test will *not* be *successful* if the specimen shows a fracture before reaching a bending angle of 60°.

Specimens of not thermomechanically rolled steels will be considered as fractured if the distance between the center of welding bead and one crack end is greater than 80 mm.

Specimens of thermomechanically rolled steels will be considered as fractured if the crack has reached the edge of the specimen.¹⁾

The welding bend test will be *invalid* if, until reaching a bending angle of 60°, the weld metal does not show an incipient crack that has extended to the fusion line.

9 Repeat test

If the welding bend test of a properly prepared and tested welding bend specimen has *not* been *successful*, it can be proceeded as follows:

- either
the product from which the specimen was taken shall be excluded from the test unit, The welding bend test shall then be performed on a specimen each from two other products of the test unit. Both specimens must meet the requirements.
- or
the manufacturer can subject the products of the test unit to a heat treatment appropriate to the condition as delivered and repeat the test.

If the welding bend test of a properly prepared and tested welding bend specimen is *invalid*, a new welding bend test shall be performed on another test piece of the same product or on another product of the same test unit. For this purpose, it is useful to employ a harder welding electrode.

10 Test report

The test report shall include:

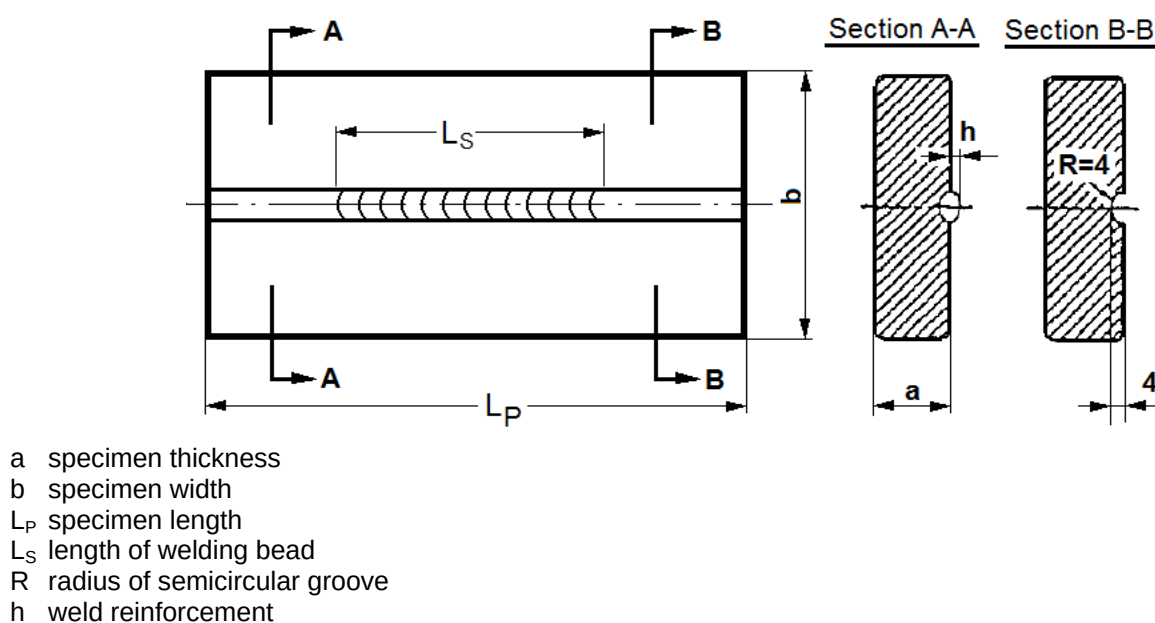
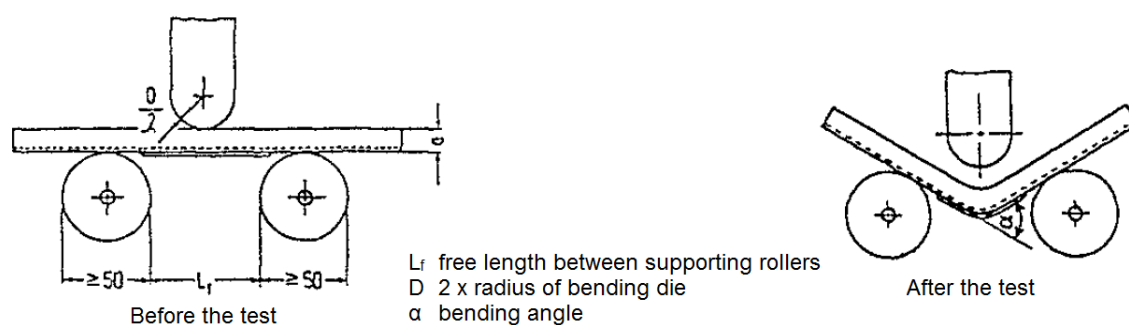
- all data which are required in order to assign the test result to the test unit.
- product thickness and specimen dimensions
- the confirmation that the weld metal shows at least one incipient crack that has propagated to the fusion line.
- the test result (successful, not successful, invalid)

¹⁾ For passing the welding bend test it is of essential importance that the stable incipient crack propagating throughout the surface of the specimen during bending does not reach the critical length at which a low-ductility fracture of the residual cross-section spontaneously occurs. For steels of conventional manufacturing method it cannot be excluded with certainty according to the present state of knowledge that, in case of crack lengths of more than 80 mm, a spontaneous low-ductility fracture will be caused, however the specimen will not fall apart into two halves. The particularly fine-grained structure of thermo-mechanically rolled steels causes such a ductile behavior that even an incipient crack of almost 100 mm length has not yet reached the critical length at which such failure of the specimen is to be expected.

Table 1 Specimen dimensions, length of welding bead and details of testing equipment

Nominal thickness Flange thickness of product or Thickness at specimen taking point mm	Specimen dimensions			Groove radius R mm	Length of welding bead L _S min. mm	Testing equipment	
	Length	Width	Thickness			2 x radius of bending die D mm	Roller spacing L _f mm
	L _P	b	a				
	mm	mm	mm				
≥ 30 to ≤ 35	410	200	Biggest possible thickness	4	175	105	190
> 35 to ≤ 40	440	200		4	190	120	220
> 40 to ≤ 45	470	200		4	220	135	250
> 45 to ≤ 50	500	200		4	220	150	280
> 50	500	200	50 ¹⁾	4	220	150	280

¹⁾ See point 6.1

**Figure 1 Welding bend specimen****Figure 2 Bending device with bending die and supporting rollers**