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European Destructive Testing Technician (EDTT)

Tensile Tests of Welded Joints with Butt Welds,
Cruciform Joints, Overlap Joints and Joints with
Fillet Welds

[Name of the Event & Date]



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Introduction

The purpose of destructive testing of welded joints is to determine the conformity of the required material characteristics with the requirements of the relevant standards of the subject regulations, construction documents and technical acceptance conditions.



Introduction

Purpose of mechanical testing of welding joints

- Qualification (acceptance) of welding technology.
- Testing of the welding consumables and their recognition.
- Quality control of the execution of the provisions in question, construction documentation and welded joints (technological tests, e.g. fracture test).
- Other.



Examples of where destructive testing are required

Qualification of welding technologies

ISO 15614-1:2017

Specification and qualification of welding procedures for metallic materials
— Welding procedure test — Part 1: Arc and gas welding of steels and arc
welding of nickel and nickel alloys



Examples of where destructive testing are required

Qualification of welding technologies

ISO 15614-1

For level 1

Test piece	Type of test	Extent of testing
Butt joint with full penetration	Visual testing	100 %
	Transverse tensile test	2 specimens
	Transverse bend test	4 specimens
Fillet welds	Visual testing	100 %
	Macroscopic examination	2 specimens



Examples of where destructive testing are required

Qualification of welding technologies

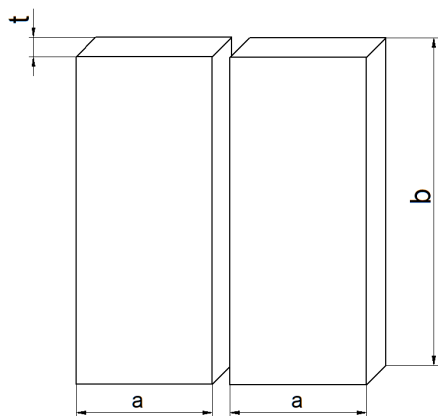
ISO 15614-1

For level 2

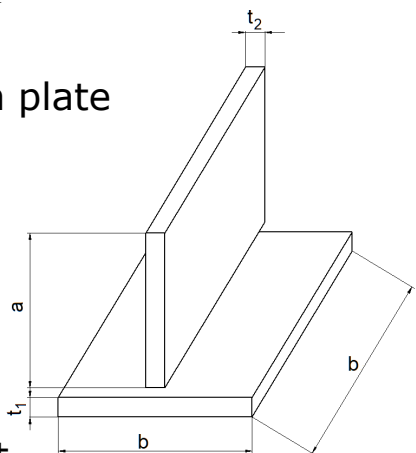
Test piece	Type of test	Extent of testing
Butt joint with full penetration	Visual testing	100 %
	Radiographic or ultrasonic testing	100 %
	Surface crack detection	100 %
	Transverse tensile test	2 specimens
	Transverse bend test	4 specimens
	Impact test	2 sets
	Hardness test	required
	Macroscopic examination	1 specimen
T-joint with full penetration	Visual testing	100 %
	Radiographic or ultrasonic testing	100 %
Branch connection with full penetration	Surface crack detection	100 %
	Hardness test	required
	Macroscopic examination	2 specimens
Fillet welds	Visual testing	100 %
	Surface crack detection	100 %
	Hardness test	required
	Macroscopic examination	2 specimens

Examples of where destructive testing are required

Qualification of welding technologies

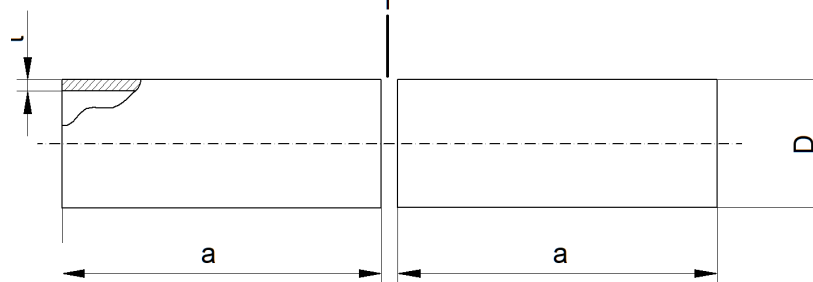


Test piece for a butt joint in plate with full penetration



Test piece for a T-joint

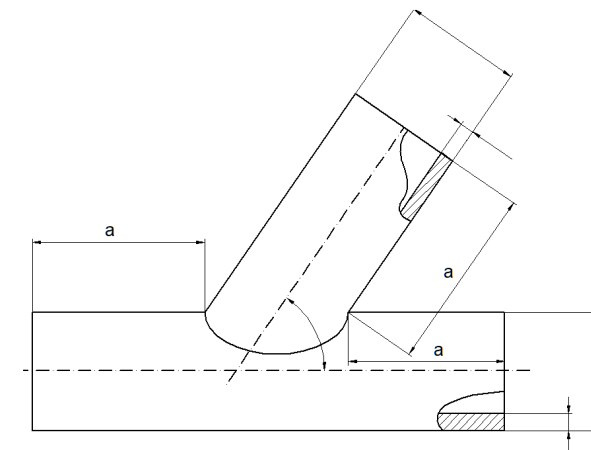
ISO 15614-1



Test piece for a butt joint in pipe with full penetration

Oznaczenia:

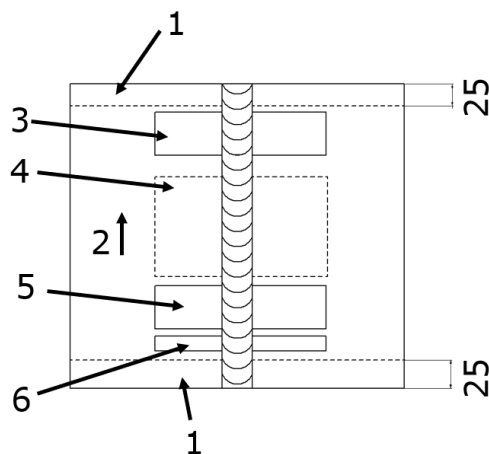
- 1 – joint preparation and fit-up as detailed in the preliminary welding procedure specification (pWPS),
- a – min. 150 mm
- b – min 350 mm
- D – outside pipe diameter



Test piece for a branch connections

- D_1 – outside diameter of main pipe,
- D_2 – outside diameter of branch pipe
- t – material thickness
- t_1 – main pipe material thickness,
- t_1 – branch pipe material thickness.
- α – branch angle

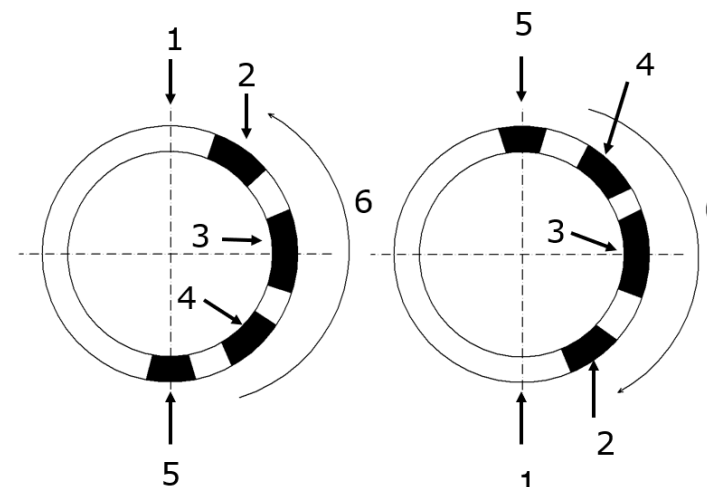
Examples of where destructive testing are required Qualification of welding technologies



Location of test specimens for butt joint in plate

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Discard 25 mm, 2. Welding direction 3. Area for: <ul style="list-style-type: none"> - 1 tensile specimen - bend test specimen 4. Area for: <ul style="list-style-type: none"> - impact and additional test specimens if required | <ol style="list-style-type: none"> 5. Area for: <ul style="list-style-type: none"> - 1 tensile specimen - bend test specimen 6. Area for: <ul style="list-style-type: none"> - 1 macro test specimen - 1 hardness test specimen |
|---|---|

ISO 15614-1

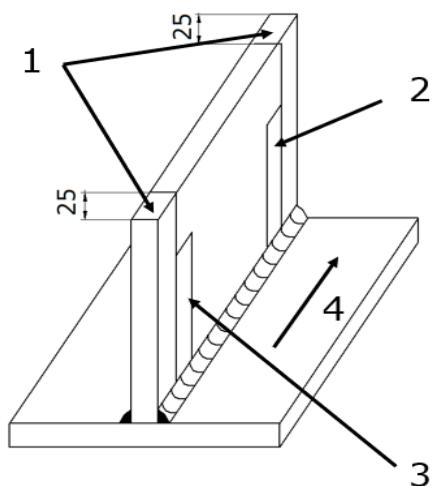


Location of test specimens for butt joint in pipe

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. End of weld, 2. Area for: <ul style="list-style-type: none"> - 1 tensile specimen - bend test specimen 3. Area for: <ul style="list-style-type: none"> - impact and additional test specimens if required | <ol style="list-style-type: none"> 4. Area for: <ul style="list-style-type: none"> - 1 tensile specimen - bend test specimen 5. Area for: <ul style="list-style-type: none"> - 1 macro test specimen - 1 hardness test specimen (taken from the start of weld) 6. Weld direction |
|---|---|

Examples of where destructive testing are required

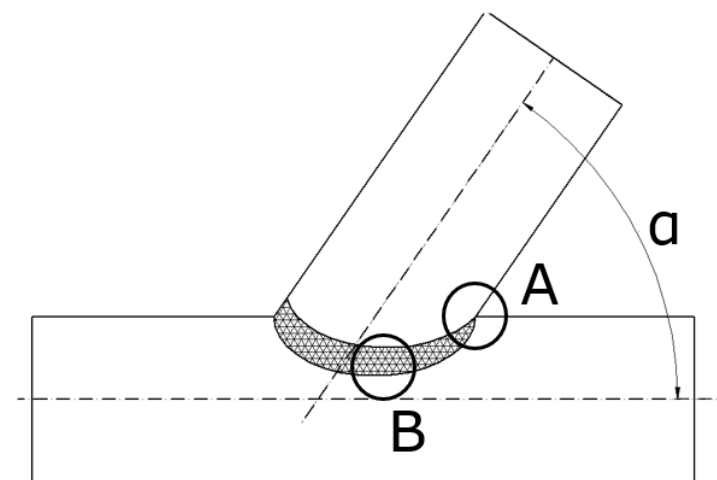
Qualification of welding technologies



Location of test specimens in a T-joint

1. Discard 25 mm,
2. Macro test specimen
3. Macro and hardness test specimen
4. Welding direction

ISO 15614-1



Location of test specimens for a branch connection on pipe

- A – macro and hardness test specimen to be taken
- B – macro test specimen to be taken
- α – branch angle



Examples of where destructive testing are required

Qualification of welders

ISO 9606-1:2017

Qualification testing of welders — Fusion welding — Part 1: Steels

Test method	Butt weld (in plate or pipe)	Fillet weld and branch joint
Visual testing acc. to ISO 17637	mandatory	mandatory
Radiographic testing acc. to ISO 17638	mandatory	not mandatory
Bend test acc. to ISO 5173	mandatory	not mandatory
Fracture test acc. to ISO 9017	mandatory	mandatory



Transverse tensile test of welded joints

ISO 4136:2022

Destructive tests on welds in metallic materials — Transverse tensile test

This document specifies the sizes of test specimen and the procedure for carrying out transverse tensile tests in order to determine the tensile strength and the location of fracture of a welded butt joint.

It applies to metallic materials in all types of products joined by any welding process.

Unless otherwise stated for specific clauses in this International Standard, the general rules of ISO 6892-1 and ISO 6892-2 shall apply.



Transverse tensile test of welded joints

Preparation of test specimen

ISO 4136

Location

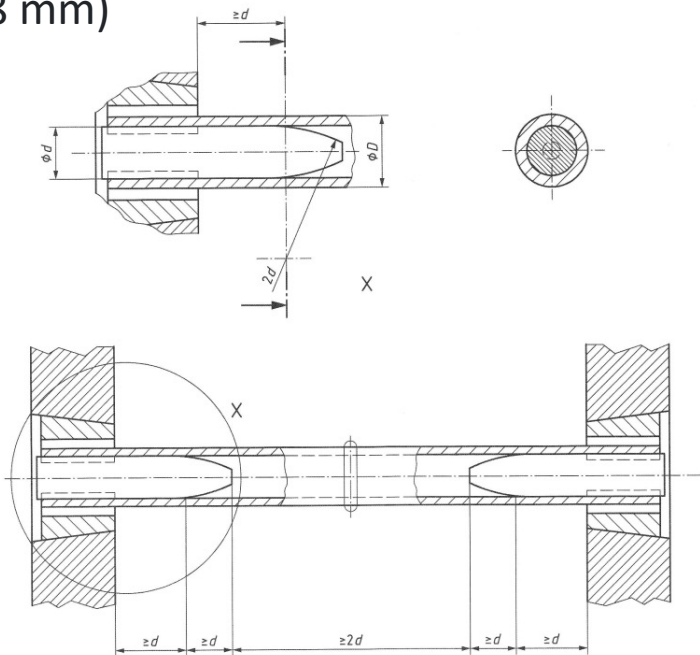
The test specimens shall be taken transversely from the welded joint in such a way that, after machining, the weld axis remains in the middle of the parallel length of the test specimen.

For small diameter pipes, the test may be carried out on whole pipe ($D < 18$ mm)

Transverse tensile test of welded joints

Preparation of test specimen

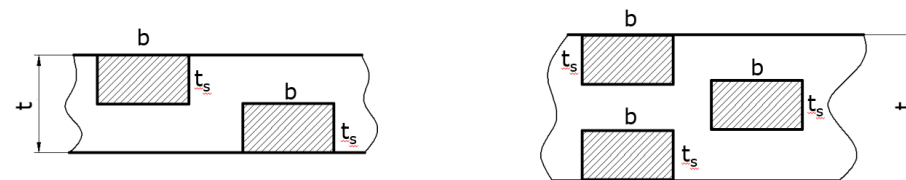
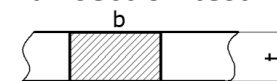
Tensile test specimen for full section pipe
($D < 18 \text{ mm}$)



ISO 4136

In general the thickness of the test specimen, shall be equal to the thickness of the parent metal near the welded joint. When a relevant application requires testing of the full thickness $> 30 \text{ mm}$, several test specimens may be taken to cover the full thickness of the joint. In such cases, the location of the test specimen in the welded joint thickness shall be identified.

Full section test

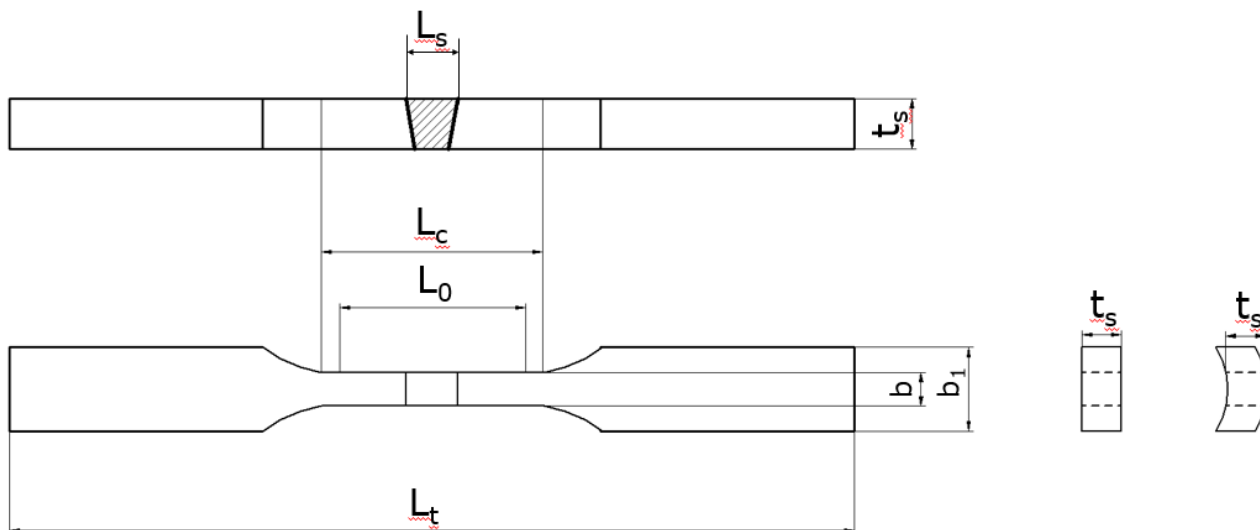


Multi specimen test

Transverse tensile test of welded joints

Preparation of test specimen

ISO 4136

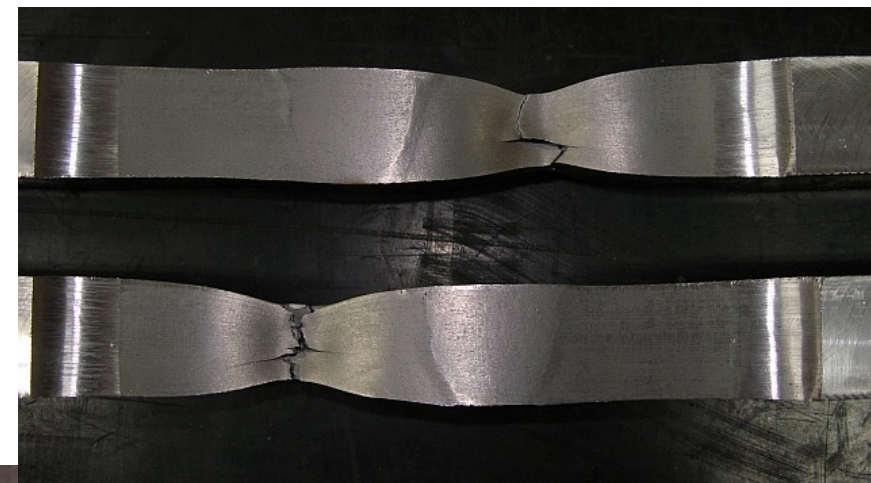


Denomination	Symbol	Wymiary
Total length of the specimen	L_t	Tusuit particular testing machine
Width of shoulder	b_1	$b+12$
Width of the paralel length	Plates	12 dla $a \leq 2$ 25 dla $a > 2$
	Pipes	6 dla $D \leq 50$ 12 dla $50 < D \leq 168,3$ 25 dla $D > 168,3$
Parallel length ^{a, b}	L_c	$\geq L_s + 60$
Radius at shoulder	r	≥ 25
^a For pressure welding and beam welding (process groups 2, 4 i 5 acc. with ISO 4063:2009), $L_s = 0$ ^b For some other metallic materials (e.g. aluminium, copper and their alloys) $L_c \geq L_s + 100$ may be necessary		



Transverse tensile test of welded joints

Samples of test specimen





Tensile test on cruciform and lapped joints

ISO 9018:2015

Destructive tests on welds in metallic materials — Tensile test on cruciform and lapped joints

Standard specifies the sizes of test pieces and test specimens, and the procedure for carrying out tensile tests, for determining the tensile strength and location of fractures in welded joints with transverse stressed fillet welds.

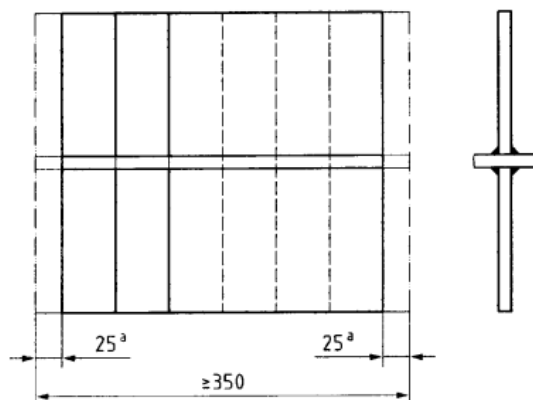
It is applicable to metallic materials with welded cruciform and lapped joints on plates, where the term plate - alone or in combination - refers to plates, sheets, extruded bars or other solid sections.

Tensile test on cruciform and lapped joints

ISO 9018

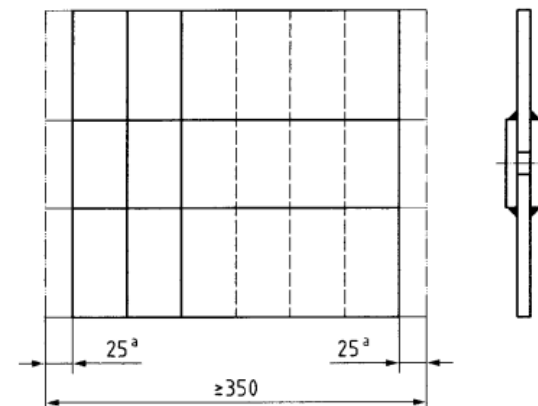
The test pieces shall be prepared and welded in accordance with the relevant application standard.

Location of specimen from a cruciform connection



^a End pieces are to be discarded.

Location of specimen from a lapped connection



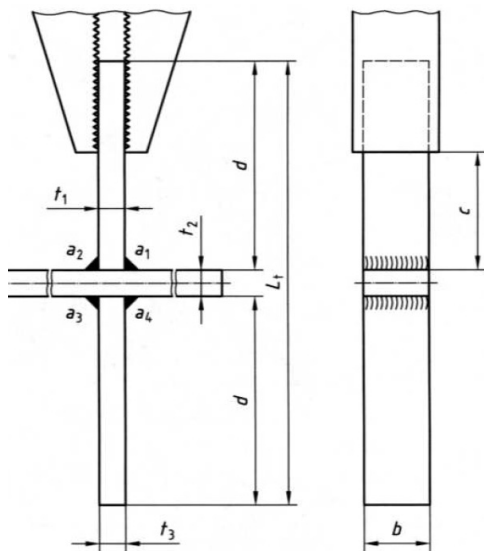
Dimensions in millimetres

^a End pieces are to be discarded.

Tensile test on cruciform and lapped joints

ISO 9018

The dimension of the test specimens shall be in accordance with below figures. The weld axis shall remain perpendicular to the longitudinal direction of the specimen.



t – production test: thickness of product procedure test: $t_1 = t_2 = t_3$

a – procedure test:

according to requirement of application
standard or, if not given

$$a \approx 0,5 \times t_1$$

$$a_1 \approx a_2 \approx a_3 \approx a_4$$

$$d \geq 150$$

$$30 \leq b \leq 50; 3t \leq b \leq 50$$

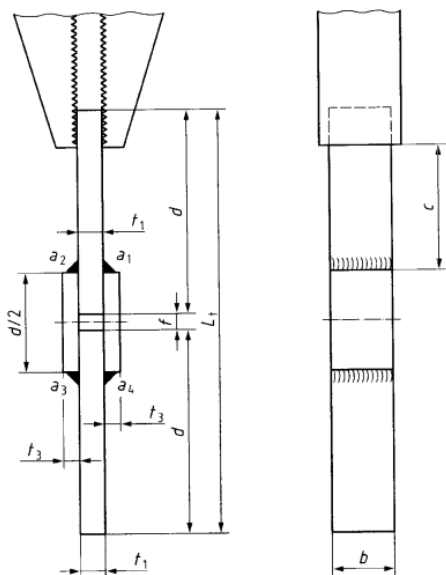
$$c \geq 2b$$

$$L_t = 2 \times d + t_2$$

Tensile test on cruciform and lapped joints

ISO 9018

The dimension of the test specimens shall be in accordance with below figures. The weld axis shall remain perpendicular to the longitudinal direction of the specimen.



t – production test: thickness of product procedure test: $t_1 = t_2$

a – procedure test:

according to requirement of application
standard or, if not given

$$a \approx 0,5 \times t_1$$

$$a_1 \approx a_2 \approx a_3 \approx a_4$$

$$d \geq 150$$

$$30 \leq b \leq 50; 3t \leq b \leq 50$$

$$c \geq 2b$$

$$L_t = 2 \times d + t_2$$



Tensile test on cruciform and lapped joints

ISO 9018

Method of testing

The test specimen shall be loaded gradually and continuously in a direction perpendicular to the weld axis until rupture occurs.

After testing, the following shall be measured and/or the result/information recorded:

- the test temperature T ,
- The fracture surfaces shall be examined and the existence of any imperfections, including their type, size and amount shall be recorded. If fish eyes are present, their location shall be recorded. Only central regions of fish eyes shall be considered as imperfections.

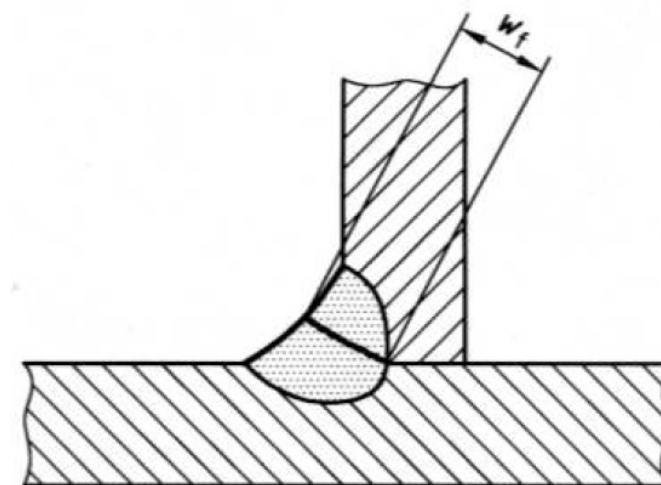
Tensile test on cruciform and lapped joints

ISO 9018

Method of testing

- The average width of the fracture Surface w_f , shall be determined by measuring at several points across the fracture at a spacing of approximately $3 \times a$ and dividing by the total number of measurements,
- The tensile strength R_m , calculated as the ratio of the maximum load F_m sustained by the test specimen during testing and the fracture area A_f expressed in MPa.

If the plate delaminates, the test should be considered as being void.





Longitudinal tensile test on weld metal in fusion welded joints

ISO 5178:2019

Destructive tests on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints

This document specifies the sizes of test specimens and the test procedure for carrying out longitudinal tensile tests on cylindrical test specimens in order to determine the mechanical properties of weld metal in a fusion welded joint.

This document applies to metallic materials in all forms of product with joints made by any fusion welding process, having joint sizes that are sufficient to obtain cylindrical test specimens with dimensions in accordance with ISO 6892-1.

Unless specified otherwise for specific points in this document, the general principles of ISO 6892-1 apply.



Longitudinal tensile test on weld metal in fusion welded joints

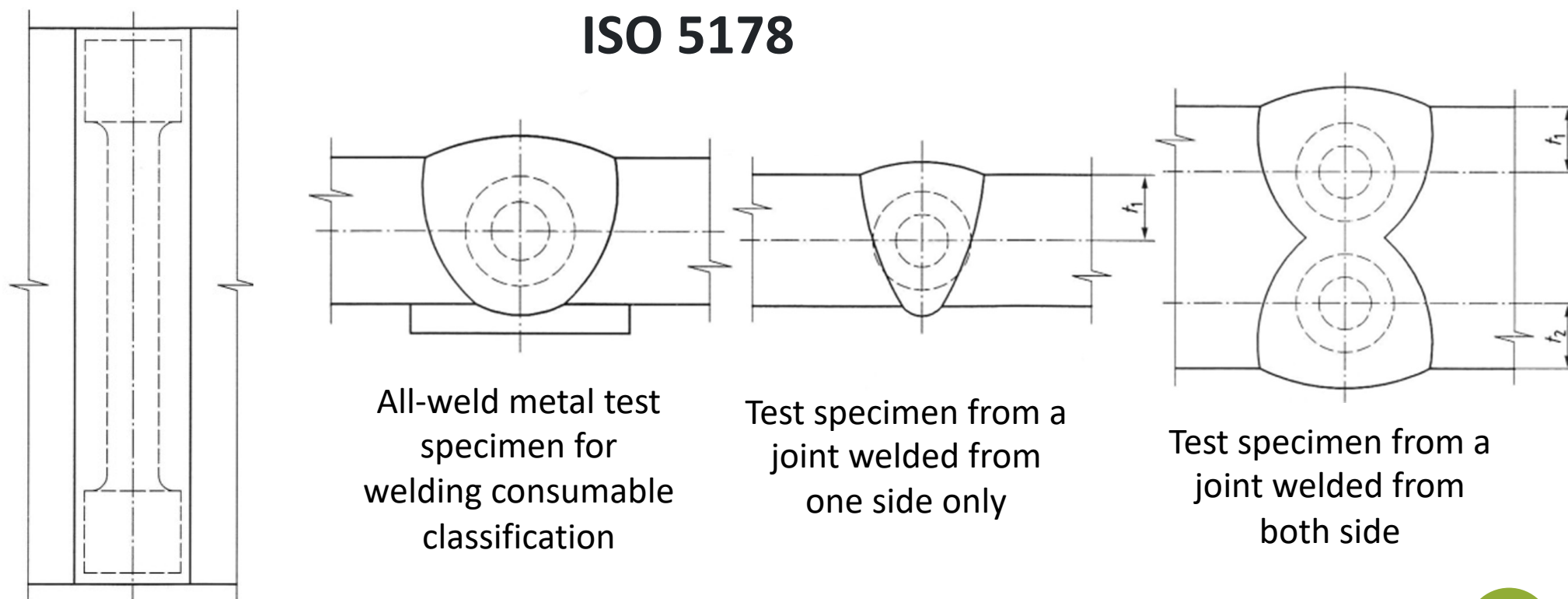
ISO 5178

Location

The test specimen shall be taken longitudinally from the welded joint of the manufactured product or from the test piece.

To enable correct positioning of the test specimen in the joint, the cross-section at both ends of the test specimen can be macroetched

Longitudinal tensile test on weld metal in fusion welded joints





Longitudinal tensile test on weld metal in fusion welded joints

ISO 5178

Dimensions

Each test specimen shall have a circular cross-section and dimensions, expressed as a function of the diameter, d_0 of the parallel length shall conform to ISO 6892-1

It shall have a normal diameter d_0 of 10 mm. If this is not possible, the diameter shall be as large as possible but not less than 4 mm.

The gripped ends of the test specimens shall be compatible with tensile testing machine used.



Longitudinal tensile test on weld metal in fusion welded joints

ISO 5178

Examination of fracture surfaces

After rupture of the test specimen, the fracture surfaces shall be examined and the existence of any imperfections that can have adversely affected the test shall be recorded, including their type, size and quantity.

If fish eyes are present, they shall be recorded and only central regions shall be considered as imperfections.



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Any Questions?



Thank You!

[Name & contact email]



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