
**Steel for the reinforcement and
prestressing of concrete — Test
methods —**

Part 2:
Welded fabric and lattice girders

*Aciers pour l'armature et la précontrainte du béton — Méthodes
d'essai —*

Partie 2: Treillis soudés et treillis raidisseurs

STANDARDSISO.COM : Click to view the full PDF of ISO 15630-2:2019



STANDARDSISO.COM : Click to view the full PDF of ISO 15630-2:2019



COPYRIGHT PROTECTED DOCUMENT

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	v
Introduction.....	vi
1 Scope.....	1
2 Normative references.....	1
3 Terms, definitions and symbols.....	1
4 General provisions concerning test pieces.....	2
5 Tensile test.....	3
5.1 Test piece.....	3
5.2 Test equipment.....	3
5.3 Test procedure.....	3
6 Bend test on welded intersection of welded fabric.....	5
6.1 Test piece.....	5
6.2 Test equipment.....	5
6.3 Test procedure.....	5
6.4 Interpretation of test results.....	6
7 Shear test.....	6
7.1 Determination of the weld shear force of welded fabric (F_s).....	6
7.1.1 Test piece.....	6
7.1.2 Test equipment.....	6
7.1.3 Test procedure.....	10
7.2 Lattice girders.....	11
7.2.1 Shear test on weld points.....	11
7.2.2 Shear test on clamped joints.....	12
7.2.3 Test apparatus.....	15
7.2.4 Test piece.....	15
7.2.5 Test procedure.....	15
8 Axial force fatigue test of welded fabric.....	16
8.1 Principle of test.....	16
8.2 Test piece.....	16
8.3 Test equipment.....	16
8.4 Test procedure.....	17
8.4.1 Provisions concerning the test piece.....	17
8.4.2 Upper force (F_{up}) and force range (F_r).....	17
8.4.3 Stability of force and frequency.....	17
8.4.4 Counting of force cycles.....	17
8.4.5 Frequency.....	17
8.4.6 Temperature.....	17
8.4.7 Validity of the test.....	17
9 Chemical analysis.....	17
10 Measurement of the geometrical characteristics.....	18
10.1 Welded fabric.....	18
10.1.1 Test piece.....	18
10.1.2 Test equipment.....	18
10.1.3 Test procedure.....	18
10.2 Lattice girders.....	18
10.2.1 Test piece.....	18
10.2.2 Test equipment.....	18
10.2.3 Measuring procedure.....	18
11 Specialized tests.....	18
11.1 Tensile test at elevated temperature.....	18

11.1.1	General.....	18
11.1.2	Test piece.....	18
11.1.3	Test equipment.....	19
11.1.4	Test procedure.....	19
11.2	Tensile test at low temperature.....	19
11.2.1	General.....	19
11.2.2	Test piece.....	19
11.2.3	Test equipment.....	19
11.2.4	Test procedure.....	19
11.3	Cyclic inelastic load test.....	19
11.3.1	Principle of the test.....	19
11.3.2	Test piece.....	20
11.3.3	Test equipment.....	20
11.3.4	Test procedure.....	20
12	Test report.....	21
Annex A (informative) Options for agreement between the parties involved.....		22
Bibliography.....		23

STANDARDSISO.COM : Click to view the full PDF of ISO 15630-2:2019

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 17, *Steel*, Subcommittee SC 16, *Steels for the reinforcement and prestressing of concrete*.

This third edition cancels and replaces the second edition (ISO 15630-2:2010), which has been technically revised. Changes have been introduced in the title (the addition of lattice girders), the Introduction and [Clauses 1, 2](#) and [4, 5.3](#), [Clause 8](#) (only the title), [8.3](#), [8.4.5](#) and [8.4.6](#). In [Clauses 7](#) and [10](#), the titles have been slightly simplified and the clauses have been subdivided to cover both welded fabric and lattice girders. A new [Clause 11](#) has been added for “specialized” tests. The Bibliography has been updated and the dated references have been replaced by undated references.

A list of all parts in the ISO 15360 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The aim of ISO 15630 (all parts) is to provide all relevant test methods for reinforcing and prestressing steels in one standard series.

This document covers standard test methods (see [Clauses 5 to 10](#)), as well as specialized test methods (gathered in [Clause 11](#)) that are not commonly used in routine testing and that should only be considered where relevant (or specified) in the applicable product standard.

Reference is made to International Standards on the testing of metals, in general, as they are applicable. Complementary provisions have been given if needed.

STANDARDSISO.COM : Click to view the full PDF of ISO 15630-2:2019

Steel for the reinforcement and prestressing of concrete — Test methods —

Part 2: Welded fabric and lattice girders

1 Scope

This document specifies chemical and mechanical test methods and measurement methods of geometrical characteristics applicable to welded fabric and lattice girders for the reinforcement of concrete.

NOTE In some countries, the expression “welded wire reinforcement” is used in place of “welded (wire) fabric”.

For those tests not specified in this document (e.g. bend test, rib/indentation geometry, mass per metre), ISO 15630-1 is applicable.

This document does not cover the sampling conditions that are dealt with in the product standards.

A list of options for agreement between the parties involved is provided in [Annex A](#).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4965-1, *Metallic materials — Dynamic force calibration for uniaxial fatigue testing — Part 1: Testing systems*

ISO 4965-2, *Metallic materials — Dynamic force calibration for uniaxial fatigue testing — Part 2: Dynamic calibration device (DCD) instrumentation*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

ISO 16020, *Steel for the reinforcement and prestressing of concrete — Vocabulary*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 16020 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

For the purposes of this document, the following symbols apply.

Symbol	Unit	Description	Reference
A	%	Percentage elongation after fracture	5.1 , 5.3
A_g	%	Percentage plastic extension at maximum force (F_m)	5.3
A_{gt}	%	Percentage total extension at maximum force (F_m)	Clause 5
A_r	%	Percentage uniform elongation after fracture	5.3
d	mm	Nominal diameter of the bar or wire	5.3 , 7.2 , 8.2 , 8.4.7 , Table 1 , 11.3.4.8
D	mm	Diameter of the mandrel of the bending device in the bend test on a welded intersection	Figure 2 , 6.3
f	Hz	Frequency of force cycles in the axial force fatigue test	8.1 , 8.4.3 , Table 1
F_m	N	Maximum force in the tensile test	5.3
F_r	N	Force range in the axial force fatigue test	Figure 9 , 8.3 , 8.4.2 , 8.4.3
F_s	N	Weld shear force of welded fabric	7.1
F_{up}	N	Upper force in the axial force fatigue test	Figure 9 , 8.3 , 8.4.2 , 8.4.3
F_w	N	Weld shear force of lattice girders	7.2.5
r_1	mm	Distance between the grips and the gauge length for the manual measurement of A_{gt}	5.3
r_2	mm	Distance between the fracture and the gauge length for the manual measurement of A_{gt}	5.3
R_{eH}	MPa	Upper yield strength	5.3
R_m	MPa	Tensile strength	5.3
$R_{p0,2}$	MPa	0,2 % proof strength, plastic extension	5.2 , 5.3
S_n	mm ²	Nominal cross-sectional area of the bar or wire	8.4.2
γ	°	Angle of bend in the bend test on a welded intersection	6.3
$2\sigma_a$	MPa	Stress range in the axial force fatigue test	8.4.2
σ_{max}	MPa	Maximum stress in the axial force fatigue test	8.4.2

NOTE 1 MPa = 1 N/mm².

4 General provisions concerning test pieces

Unless otherwise agreed or specified in the product standard, the test pieces shall be taken from the welded fabric or lattice girders in the as-delivered condition.

In the case of a curved test piece, the test piece shall be straightened prior to any testing by a bend operation with a minimum amount of plastic deformation.

NOTE 1 The straightness of the test piece is critical for the tensile test at room temperature, the tensile test at low temperature, the axial force fatigue test and the cyclic inelastic load test.

The means of straightening the test piece (manual, machine) shall be indicated in the test report.

For routine tests conducted by the manufacturers of reinforcing steels, the test information, including the test piece condition and method of straightening, should be described within internal documentation.

For the determination of the mechanical properties in the tensile test at room temperature, the tensile test at low temperature, the axial force fatigue test and the cyclic inelastic load test, the test piece may be artificially aged, depending on the requirements of the relevant product standard.

If ageing is specified but the product standard does not specify the ageing treatment, the following conditions should be applied: heating the test piece to 100 °C, maintaining at this temperature ± 10 °C for a period between 60 min and 75 min and then cooling in still air to the ambient temperature.

NOTE 2 Depending on the conditions (number of test pieces, diameter of test pieces, type of heating device), different heating times can be required for the test piece to reach the temperature of 100 °C. Unless otherwise proven, a minimum heating time of 40 min can be assumed for the test pieces to reach the oven/bath operating temperature.

If an ageing treatment is applied to the test piece, the conditions of the ageing treatment shall be stated in the test report.

The test piece shall include at least one welded intersection in the free length.

Cross wires or bars, and the wire or bar not to be tested in a twin-wire or twin-bar sample, shall be cut off before the test without damaging the wire or bar to be tested or the weld under test.

5 Tensile test

5.1 Test piece

In addition to the general provisions given in [Clause 4](#), the free length of the test piece shall be sufficient for the determination of the percentage elongation after fracture or the percentage total extension at maximum force in accordance with [5.3](#).

If the percentage elongation after fracture (A) is determined manually, the test piece shall be marked in accordance with ISO 6892-1.

If the percentage total extension at maximum force (A_{gt}) is determined by the manual method, equidistant marks shall be made on the free length of the test piece (see ISO 6892-1). The distance between the marks shall be 20 mm, 10 mm or 5 mm, depending on the bar or wire nominal diameter.

5.2 Test equipment

The testing machine shall be verified and calibrated in accordance with ISO 7500-1 and shall be at least of class 1.

If an extensometer is used, it shall be of class 1 in accordance with ISO 9513 for the determination of $R_{p0,2}$; for the determination of A_{gt} , a class 2 extensometer (see ISO 9513) may be used.

Any extensometer used for the determination of the percentage total extension at maximum force (A_{gt}) shall have a gauge length of at least 100 mm. The gauge length shall be indicated in the test report.

5.3 Test procedure

The tensile test shall be performed in accordance with ISO 6892-1. For the determination of $R_{p0,2}$, if the straight portion of the force-extension diagram is limited or not clearly defined, one of the following methods shall be applied:

- the procedure recommended in ISO 6892-1;
- the straight portion of the force-extension diagram shall be considered as the line joining the points corresponding to $0,2F_m$ and $0,5F_m$.

F_m may be predefined as the force corresponding to the nominal tensile strength given in the applicable product standard.

For stainless steels, other values than the ones mentioned above, applicable to carbon steels, may be replaced by the appropriate values given in the product standard or agreed between the parties involved.

In case of dispute, the second procedure shall be applied.

The test may be considered invalid if the slope of this line differs by more than 10 % from the theoretical value of the modulus of elasticity.

For the calculation of tensile properties (R_{eH} or $R_{p0,2}$, R_m), the nominal cross-sectional area shall be used, unless otherwise specified in the relevant product standard.

Where fracture occurs in the grips or at a distance from the grips of less than 20 mm or d (whichever is the greater), the test may be considered as invalid.

For the calculation of elongation properties, the gauge length shall include at least one welded intersection, unless otherwise specified in the relevant product standard. However, the subsequent specified restrictions regarding the position of the gauge length (distances r_1 and r_2) have higher priority and overrule this requirement.

For the determination of percentage elongation after fracture (A), the original gauge length shall be five times the nominal diameter (d), unless otherwise specified in the relevant product standard. In case of dispute, A shall be determined manually.

The percentage total extension at maximum force (A_{gt}) shall be determined either by using an extensometer or by the manual method described in this document.

If A_{gt} is measured by using an extensometer, ISO 6892-1 shall be applied with the following modification. A_{gt} shall be recorded before the force has dropped more than 0,2 % from its maximum value.

NOTE This provision is aimed at avoiding different values with different methods (manual vs. extensometer). It is recognized that the use of extensometers tends to give on average a lower value of A_{gt} than the one measured manually.

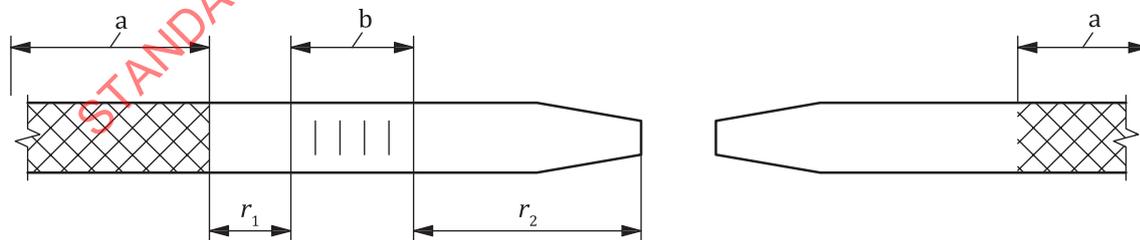
If A_{gt} is determined by the manual method after fracture, A_{gt} shall be calculated from [Formula \(1\)](#):

$$A_{gt} = A_r + R_m / 2\ 000 \tag{1}$$

where A_r is the percentage uniform elongation after fracture.

The measurement of A_r shall be made, as the measurement of A (see ISO 6892-1), on the longer of the two fractured parts of the test piece on a gauge length of 100 mm, as close as possible to the fracture but at a distance, r_2 , of at least 50 mm or $2d$ (whichever is the greater) away from the fracture and including a welded intersection, if possible. This measurement may be considered as invalid if the distance, r_1 , between the grips and the gauge length is less than 20 mm or d (whichever is the greater). See [Figure 1](#).

In case of dispute, the manual method shall apply.



- a Grip length.
- b Gauge length 100 mm.

Figure 1 — Measurement of A_{gt} by the manual method

6 Bend test on welded intersection of welded fabric

6.1 Test piece

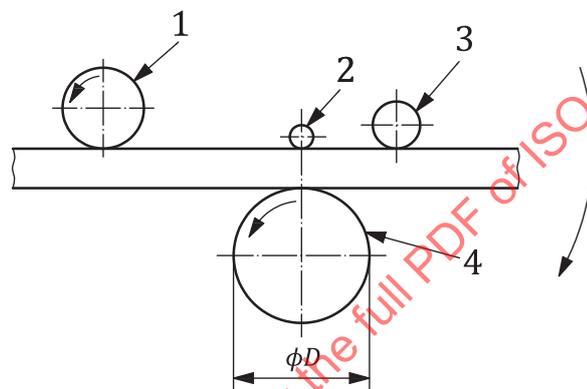
The general provisions given in [Clause 4](#) apply.

For welded fabric with single wires or bars in both directions, the larger wire or bar shall be subjected to bending.

For welded fabric with twin wires or bars, one of the twin wires or bars shall be subjected to bending.

6.2 Test equipment

6.2.1 A bending device, the principle of which is shown in [Figure 2](#), shall be used.



Key

- 1 support
- 2 crossing wire
- 3 carrier
- 4 mandrel

Figure 2 — Principle of a bending device

NOTE [Figure 2](#) shows a configuration where the mandrel and support rotate and the carrier is locked. It is also possible that the carrier rotates and the support or mandrel is locked.

6.2.2 The bend test may also be performed by using a device with supports and a mandrel (e.g. see ISO 7438).

6.3 Test procedure

The bend test shall be performed at a temperature between 10 °C and 35 °C, unless otherwise agreed by the parties involved.

For testing at a low temperature, if the agreement between the parties involved does not specify all the testing conditions, a deviation of ± 2 °C on the agreed temperature should be applied. The test piece should be immersed in the cooling medium for a sufficient time to ensure that the required temperature is reached throughout the test piece (for example, at least 10 min in a liquid medium or at least 30 min in a gaseous medium). The bend test should start within 5 s from removal from the medium. The transfer device should be designed and used in such a way that the temperature of the test piece is maintained within the temperature range.

The test piece shall be bent over a mandrel so that the weld will be in the centre of the bent portion of the test piece and in the zone under tension.

The angle of bend (γ) and the diameter of the mandrel (D) shall be in accordance with the relevant product standard.

6.4 Interpretation of test results

The interpretation of the bend test results shall be made in accordance with the requirements in the relevant product standard.

If these requirements are not specified, the absence of cracks visible to a person with normal or corrected vision is considered as evidence that the test piece has withstood the bend test.

A superficial ductile tear may occur at the base of the ribs or indentations and shall be not considered to be a failure. The tear may be considered superficial when the depth of the tear is not greater than the width of the tear.

7 Shear test

7.1 Determination of the weld shear force of welded fabric (F_s)

7.1.1 Test piece

The general provisions given in [Clause 4](#) shall apply.

For welded fabric with single wires or bars in both directions, the larger wire or bar shall be used as the pulling wire or bar.

For welded fabric with twin wires or bars, one of the twin wires or bars shall be the pulling wire or bar.

Test pieces previously subjected to tensile testing may be used for the weld shear test, provided that the necking at the fracture is away from the weld zone.

7.1.2 Test equipment

The tensile testing machine shall be verified in accordance with ISO 7500-1 and shall be of class 1 or better.

The holder for the support of the test piece shall be of one of the following three types.

- Type a: the cross wire or bar is simply supported by a smooth steel plate, with a slot for the pulling wire or bar. Neither the deflection of the pulling wire or bar nor the rotation of the cross wire or bar is prevented [see [Figure 3 a](#)];
- Type b: in addition to the provisions applicable to type a holders, the deflection of the tail of the pulling wire or bar is prevented, but not the rotation of the cross wire or bar. The tail of the pulling wire or bar should be supported at a distance in the range of 30 mm to 50 mm from the support surface. The tail support shall allow small movements in the direction of the wire or bar. The side movement of the cross wire or bar, due to the reaction from the tail support, is prevented by a stopper, adjustable according to the size of the test piece. No initial compression of the joint is allowed [see [Figure 3 b](#)];
- Type c: in addition to the provisions applicable to type b holders, the rotation of the cross wire or bar is prevented. The cross wire or bar is firmly tightened between jaws with a suitable surface structure. The jaws will also prevent any side movement of the cross wire or bar [see [Figure 3 c](#)].

For all types of holder, the distance between the support and the pulling wire or bar shall be as small as possible but there shall be no friction between the support and the pulling wire or bar.

Unless otherwise specified in the product standard, a holder of type c shall be used in case of dispute.

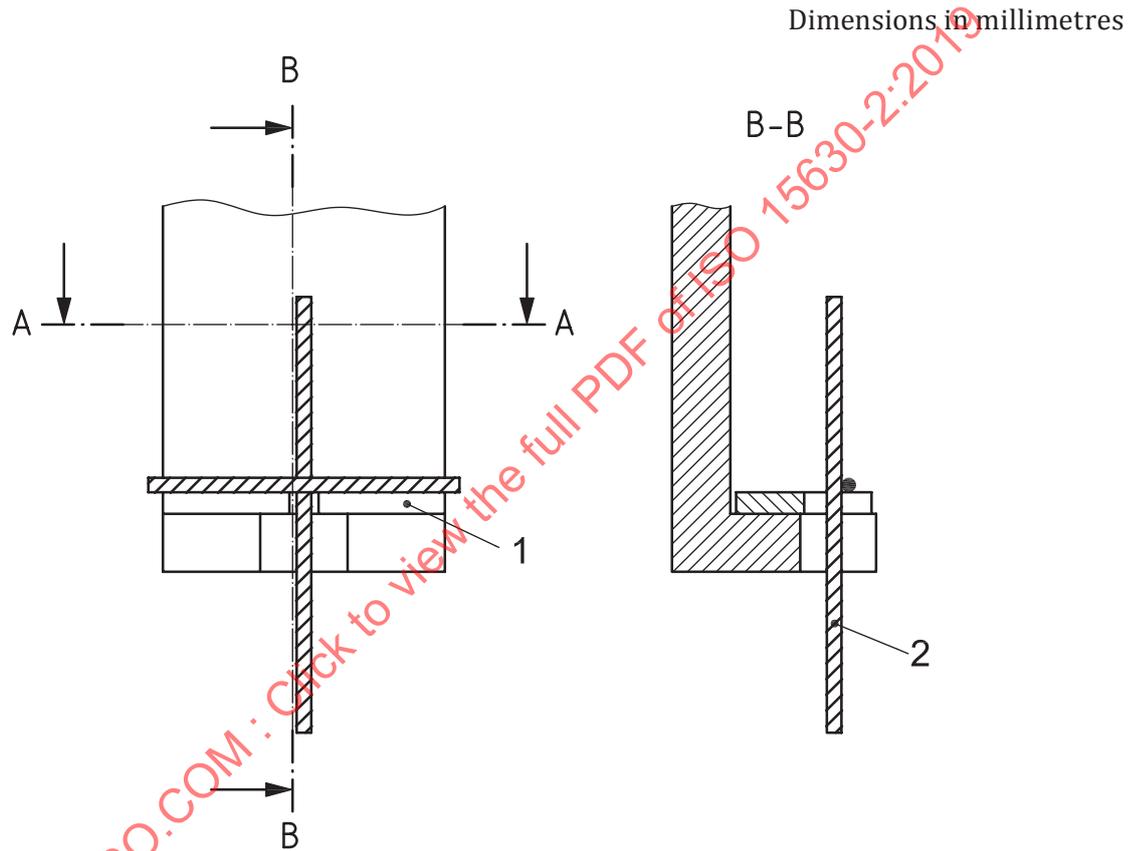
The type of holder that is used shall be stated in the test report.

The support conditions with holders of type c more closely represent the support conditions of fabric in concrete.

It is recommended that the distance between the support and the pulling wire or bar be no greater than 0,5 mm for $d \leq 9$ mm and 1 mm for $d > 9$ mm.

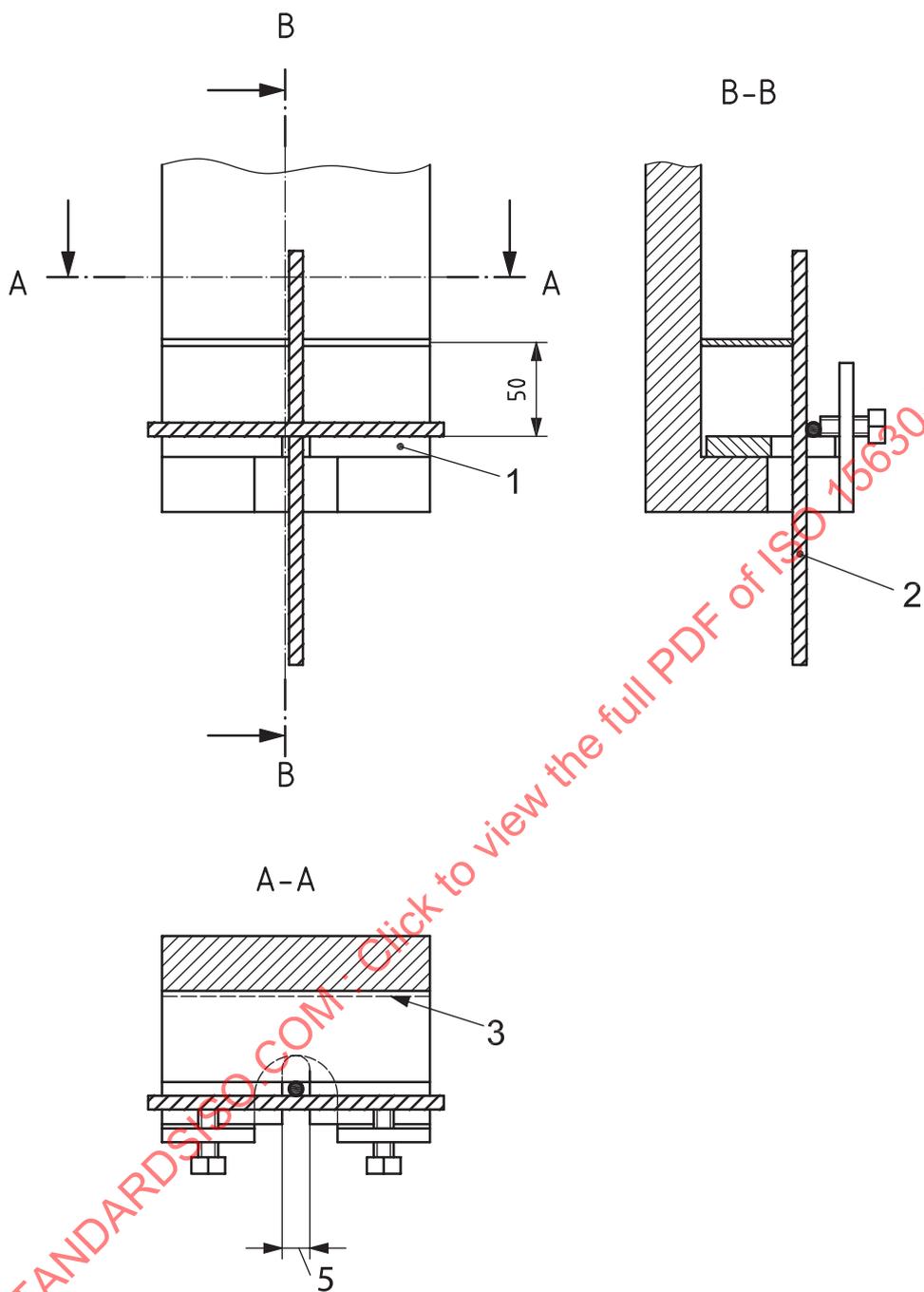
NOTE 1 The choice of the type of holder and support provisions thereof will affect the test results. Type a and type b holders lead to values significantly lower than the reference values, which can be obtained only with type c holders.

NOTE 2 [Figures 3](#) a), b) and c) show examples of holders of type a, b and c, respectively.



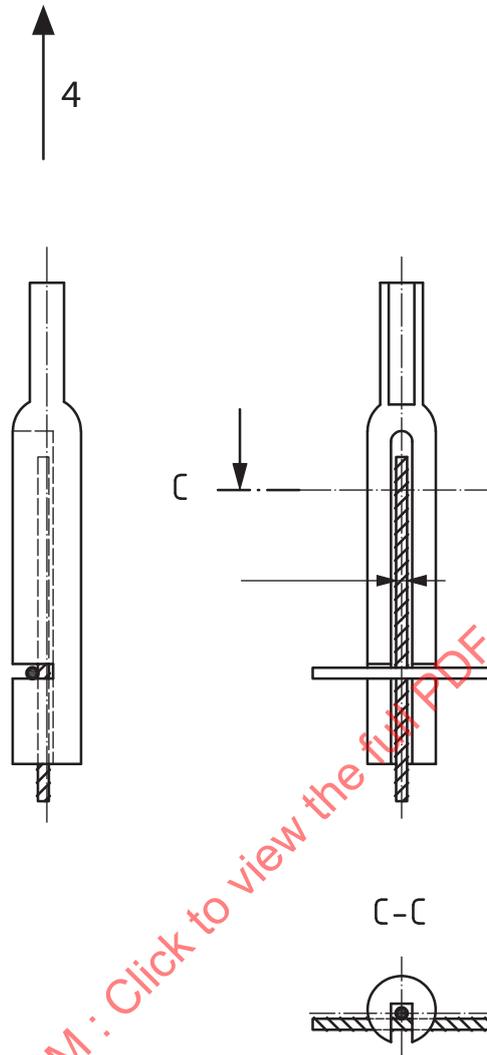
a) Example of holder of type a

Dimensions in millimetres



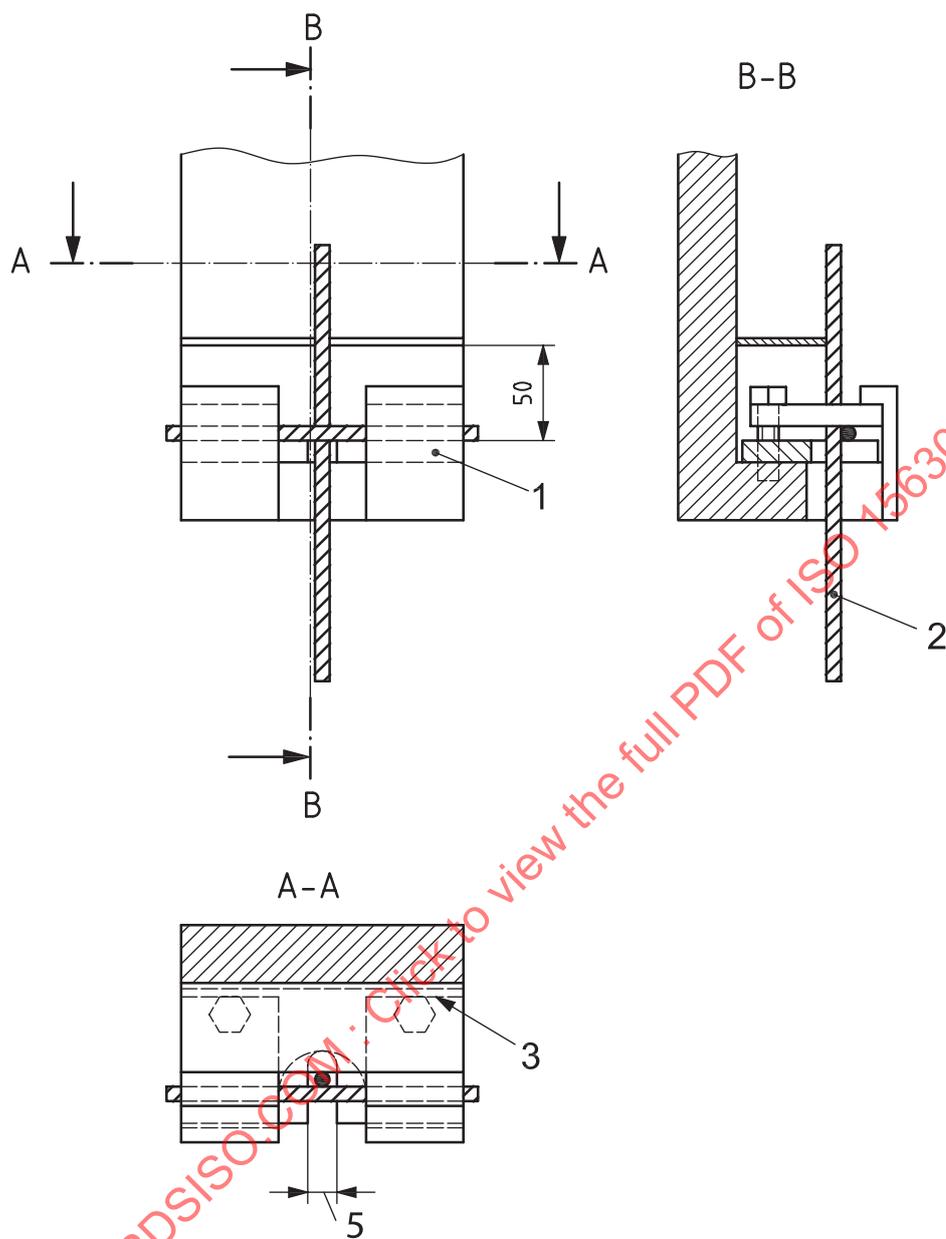
b) Example of holder of type b

Dimensions in millimetres



b) Example of holder of type b (continued)

Dimensions in millimetres



c) Example of holder of type c

Key

- 1 slot-adjusting plate
- 2 pulling bar
- 3 torsion spring
- 4 direction of pull
- 5 width of slot

Figure 3 — Examples of holders of type a, b and c

7.1.3 Test procedure

The test piece shall be placed on the holder.

The tensile force shall be applied to the pulling wire or bar with a stress rate between 6 MPa/s and 60 MPa/s.

The maximum force, in newtons, during the test shall be recorded.

7.2 Lattice girders

7.2.1 Shear test on weld points

7.2.1.1 General

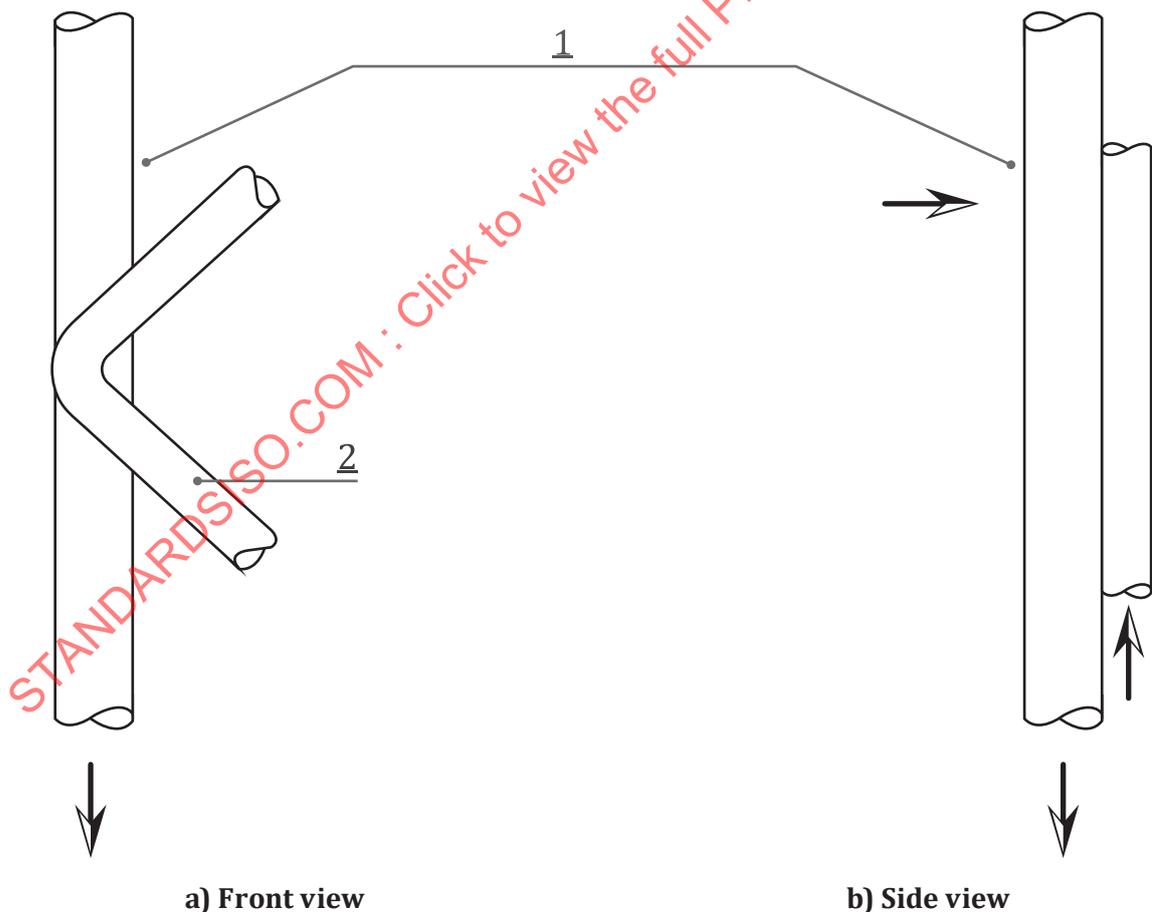
The same test method shall be used for type testing and factory production control.

7.2.1.2 Principle of the test methods

The strength of welds can be determined by either of two methods. The choice of method shall be at the discretion of the manufacturer.

7.2.1.3 Method 1

The principle of method 1 is a tensile test, which is applied on a chord of the lattice girder as shown in [Figure 4](#). In this test, the diagonal of the lattice girder is restrained.



Key

- 1 chord
- 2 diagonal

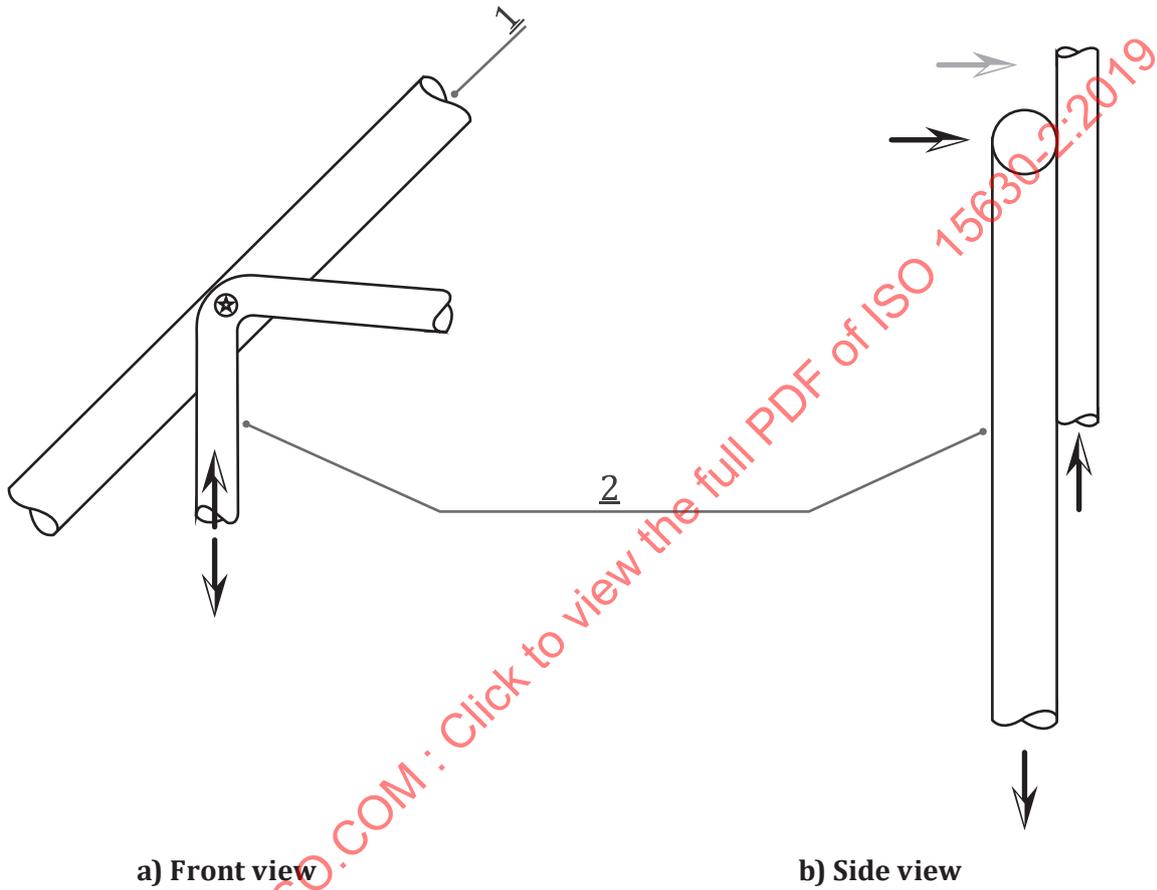
Figure 4 — Principle of shear test method 1

7.2.1.4 Method 2

The principle of method 2 is a tensile test, which is applied on the diagonal of the lattice girder as shown in Figure 5. In this test, the chord of the lattice girder is restrained.

Tests according to either method shall be performed in such a way as to avoid a rotation of the test pieces [compare Figures 4 b) and 5 b)].

In cases where the chord is a steel strip, testing the weld point between steel strip and diagonal should be performed using an appropriate device.



- Key**
 1 chord
 2 diagonal

Figure 5 — Principle of shear test method 2

7.2.2 Shear test on clamped joints

7.2.2.1 General

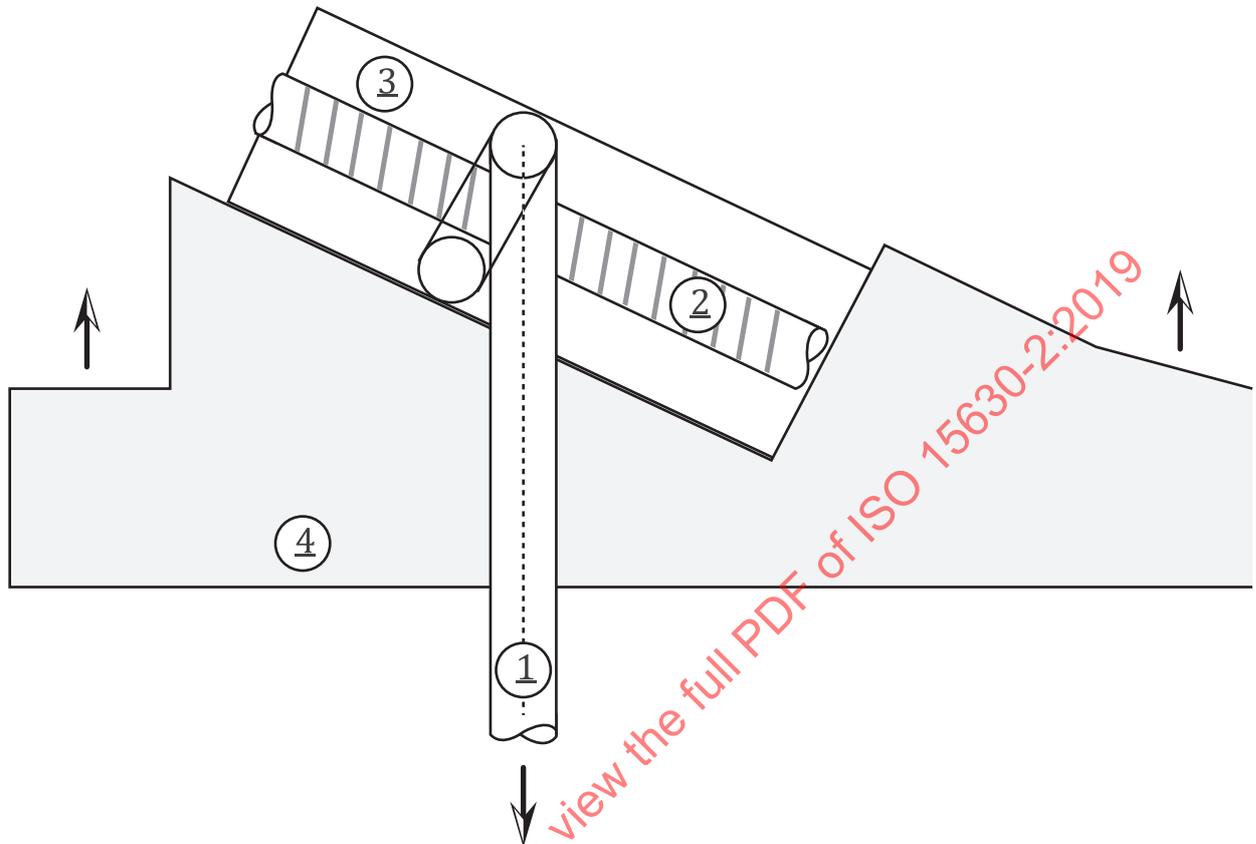
Different test methods for type testing and the factory production control apply. In cases of dispute, the test method according to Figure 6 shall be used.

7.2.2.2 Principle of the test method for type testing

The test shall be performed similarly to a tensile test which is applied on the diagonal with a joint embedded into concrete (see Figure 6).

The strength class should be as low as C20/25 to cover the worst case.

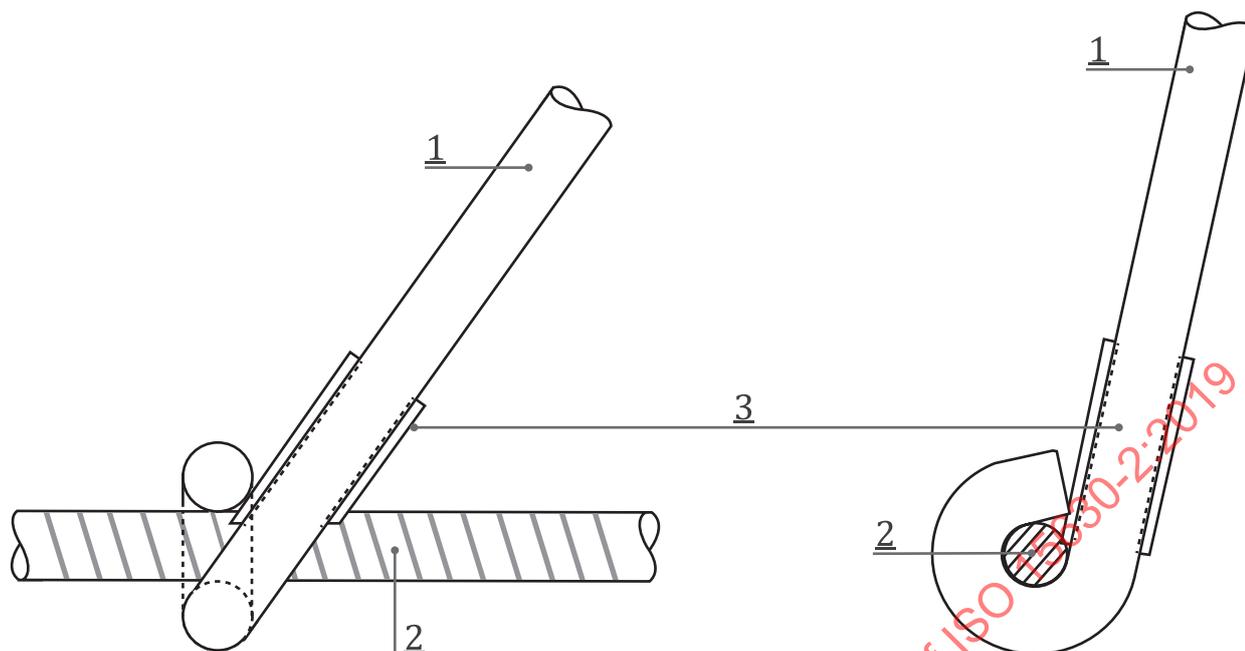
The bond of the diagonal to the concrete should be prevented (see [Figure 7](#)).



Key

- 1 diagonal
- 2 lower chord
- 3 concrete
- 4 steel

Figure 6 — Principle of shear test on clamped joints embedded in concrete



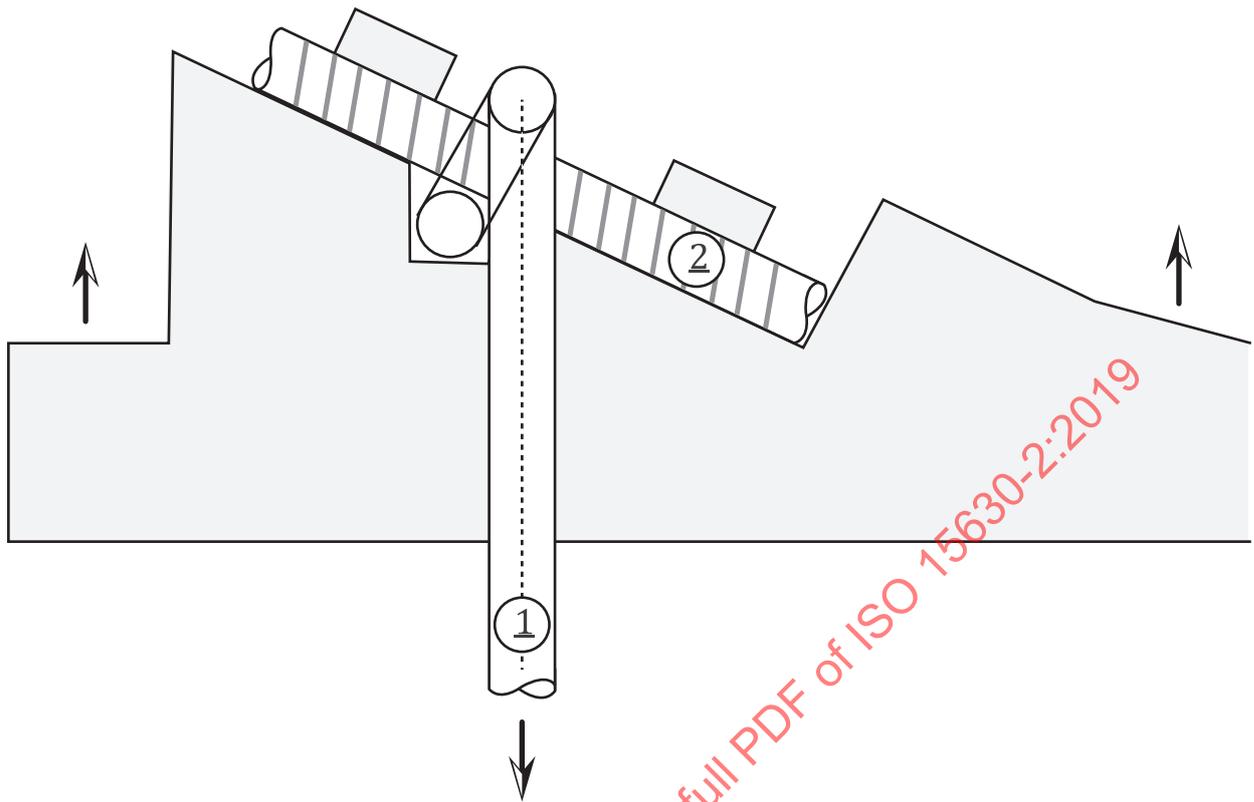
Key

- 1 diagonal
- 2 lower chord
- 3 tube to prevent bond

Figure 7 — Test specimen for the shear test according to [Figure 6](#)

7.2.2.3 Principle of the test method for factory production control

A tensile force is applied to the diagonal. The lower chord is fixed in a device to avoid rotation of the chord (see [Figure 8](#)).

**Key**

- 1 diagonal
- 2 lower chord

Figure 8 — Shear test method on clamped joints for factory production control

7.2.3 Test apparatus**7.2.3.1 Tensile testing machine**

A tensile testing machine of class 1 or 0,5 in accordance with ISO 7500-1 shall be used.

7.2.3.2 Holder

A special holder shall be used to support either the diagonal (method 1) or the chord (method 2). The holder shall be fixed in the upper jaws of the tensile testing machine.

In the case of method 1, the holder shall prevent the bending of the test piece during testing.

In the case of method 2, the holder shall prevent the rotation of the test piece during testing.

7.2.4 Test piece

The test piece shall be cut from the lattice girder without damaging the weld point.

7.2.5 Test procedure

The test piece shall be placed in the holder either before or after the holder is placed on the tensile testing machine.

The tensile force is applied on the free length of the test piece.

The stressing rate shall be the same as for tensile tests in the elastic range.

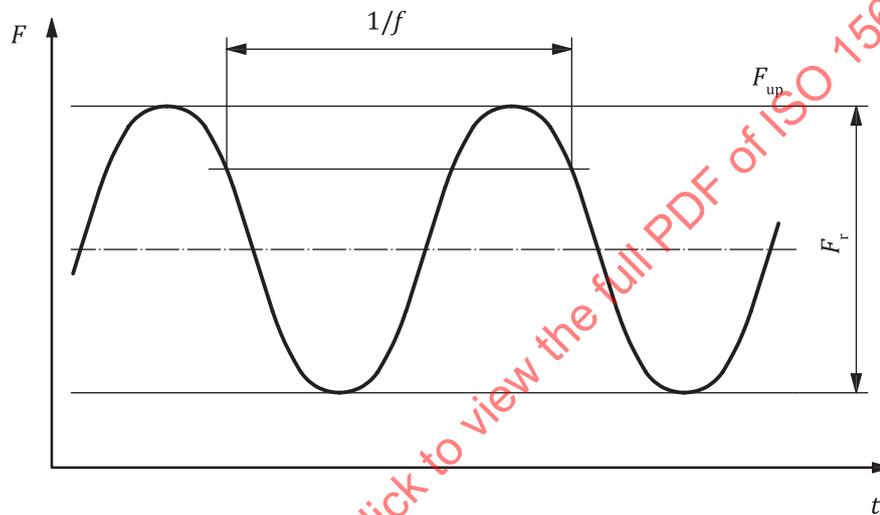
The maximum force (F_w) and the location of the fracture shall be recorded.

For the evaluation of the test results for the shear force, the number of weld points that have been loaded and failed in the same moment shall be recorded.

8 Axial force fatigue test of welded fabric

8.1 Principle of test

The axial force fatigue test consists of submitting the test piece to an axial tensile force, which varies cyclically according to a sinusoidal wave-form of constant frequency (f) in the elastic range (see [Figure 9](#)). The test shall be performed until failure of the test piece or until reaching, without failure, the number of force cycles specified in the relevant product standard.



Key

F_{up} upper value of F

F_r range of F per cycle

$1/f$ one cycle

F force

t time

Figure 9 — Force cycle diagram

8.2 Test piece

The general provisions given in [Clause 4](#) apply.

The surface of the free length between the grips shall not be subjected to any surface treatment of any kind. The free length shall be at least 140 mm or $14d$, whichever is the greater.

8.3 Test equipment

The fatigue-testing machine shall be calibrated in accordance with either ISO 4965-1 and ISO 4965-2, or ISO 7500-1. The relative error of accuracy shall be less than or equal to $\pm 1\%$. The fatigue-testing machine shall be capable of maintaining the upper force (F_{up}) within $\pm 2\%$ of the specified value, and the force range (F_r) within $\pm 4\%$ of the specified value.

8.4 Test procedure

8.4.1 Provisions concerning the test piece

The test piece shall be gripped in the test equipment in such a way that force is transmitted axially and free of any bending moment along the test piece.

8.4.2 Upper force (F_{up}) and force range (F_{r})

The upper force (F_{up}) and the force range (F_{r}) shall be as specified in the relevant product standard.

NOTE F_{up} and F_{r} can be deduced from the maximum stress (σ_{max}) and the stress range ($2\sigma_{\text{a}}$) given in the relevant product standard as shown by [Formulae \(2\)](#) and [\(3\)](#):

$$F_{\text{up}} = \sigma_{\text{max}} \cdot S_{\text{n}} \quad (2)$$

$$F_{\text{r}} = 2\sigma_{\text{a}} \cdot S_{\text{n}} \quad (3)$$

where S_{n} is the nominal cross-sectional area of the bar or wire.

8.4.3 Stability of force and frequency

The test shall be performed under conditions of stable upper force (F_{up}), force range (F_{r}) and frequency (f). There shall be no planned interruptions in the cyclic loading throughout the test. However, it shall be permissible to continue a test which is accidentally interrupted. Any interruption shall be reported; an interrupted test may be considered as invalid.

8.4.4 Counting of force cycles

The number of force cycles shall be counted inclusively from the first full force-range cycle.

8.4.5 Frequency

The frequency of force cycles shall be stable during the test and also during the series of tests with identical testing conditions. The frequency shall be between 1 Hz and 200 Hz.

8.4.6 Temperature

The temperature of the test piece shall not exceed 40 °C throughout the test. The temperature of the testing laboratory shall be between 10 °C and 35 °C, unless otherwise specified.

8.4.7 Validity of the test

If failure occurs in the grips or within a distance of $2d$ of the grips, or initiates at an exceptional feature of the test piece, the test may be considered as invalid.

9 Chemical analysis

In general, the chemical composition is determined by spectrometric methods.

In case of dispute about analytical methods, the chemical composition shall be determined by an appropriate reference method specified in one of the relevant International Standards.

NOTE A list of the relevant International Standards for the determination of the chemical composition is given in the Bibliography.

10 Measurement of the geometrical characteristics

10.1 Welded fabric

10.1.1 Test piece

The test piece shall consist of a sheet of fabric in the as-delivered condition.

10.1.2 Test equipment

The wire or bar spacing, and the length and width of the sheet, shall be measured with an instrument with an accuracy of 1 mm or better.

10.1.3 Test procedure

The sheet of fabric shall be laid on a flat surface.

The length and width shall be determined as the overall dimensions of the sheet.

10.2 Lattice girders

10.2.1 Test piece

The test piece shall be a lattice girder in the as-delivered condition.

10.2.2 Test equipment

The height, width and length of the lattice girder shall be measured with an instrument of an accuracy of 1 mm or better.

10.2.3 Measuring procedure

The lattice girder shall be laid on a flat surface. To measure the design height of lattice girder with an overhang of the diagonals, it is permissible to lay the lower chords of the girder onto the perpendicular bars.

The height and width shall be determined at the mid-length position of the lattice girder.

For the determination of the pitch, the distance over at least three pitches shall be measured and the average value calculated.

11 Specialized tests

11.1 Tensile test at elevated temperature

11.1.1 General

The test is performed at a temperature higher than 35 °C, which means at temperatures higher than room temperature as specified in ISO 6892-1.

11.1.2 Test piece

See [5.1](#).

11.1.3 Test equipment

See [5.2](#).

11.1.4 Test procedure

The tensile test shall be performed in accordance with ISO 6892-2. For the determination of the properties, see [5.3](#).

11.2 Tensile test at low temperature

11.2.1 General

The tensile test at low temperature covers the range between +10 °C and -196 °C.

11.2.2 Test piece

See [5.1](#).

11.2.3 Test equipment

See [5.2](#).

11.2.4 Test procedure

The tensile test shall be performed in accordance with ISO 6892-3. For the determination of the properties, see [5.3](#).

11.3 Cyclic inelastic load test

11.3.1 Principle of the test

The cyclic inelastic load test consists of subjecting the test piece to five complete symmetrical cycles of hysteresis under the conditions given in [Table 1](#) and [Figure 10](#). The test shall be terminated upon failure of the test piece before reaching the specified number of cycles, or on completion of the specified number of cycles without failure.

Table 1 — Testing conditions for cyclic inelastic load testing and specification of load cycles

Nominal diameter <i>d</i> mm	Free length between the grips	Tension strain %	Compression strain %	Number of complete hys- teresis symmetrical cycles (cyclic load strength)	Frequency <i>f</i> Hz
All	10 <i>d</i> ± 5 %	2,5 ± 0,1	-2,5 ± 0,1	5	< 3