



**SLOVENSKI STANDARD**  
**oSIST prEN ISO 15630-3:2024**  
**01-maj-2024**

---

**Jeklo za armiranje in prednapenjanje betona - Metode preskušanja - 3. del: Jeklo za prednapenjanje (ISO/DIS 15630-3:2024)**

Steel for the reinforcement and prestressing of concrete - Test methods - Part 3: Prestressing steel (ISO/DIS 15630-3:2024)

Stahl für die Bewehrung und das Vorspannen von Beton - Prüfverfahren - Teil 3: Spann Stahl (ISO/DIS 15630-3:2024)

Aciers pour l'armature et la précontrainte du béton - Méthodes d'essai - Partie 3: Aciers de précontrainte (ISO/DIS 15630-3:2024)

**Ta slovenski standard je istoveten z: prEN ISO 15630-3**

[oSIST prEN ISO 15630-3:2024](https://standards.sist.net/catalog/standards/sist/41e220-6d00-4140-a58c-3acab0e0e370/osist-pr-en-iso-15630-3-2024)

**ICS:**

77.140.15      Jekla za armiranje betona      Steels for reinforcement of concrete

**oSIST prEN ISO 15630-3:2024**

**en,fr,de**





# DRAFT International Standard

## ISO/DIS 15630-3

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

#### Part 3: Prestressing steel

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

*Partie 3: Aciers de précontrainte*

ICS: 77.140.15

<https://standards.iteh.ai/catalog/standards/sist/de41e2e0-6d60-41a8-a50e-3acabdbede96/osist-pren-iso-15630-3-2024>

This document is circulated as received from the committee secretariat.

**ISO/CEN PARALLEL PROCESSING**

Reference number  
ISO/DIS 15630-3:2024(en)

ISO/TC 17/SC 16

Secretariat: **SN**

Voting begins on:  
**2024-02-26**

Voting terminates on:  
**2024-05-20**

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENTS AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

© ISO 2024

## ISO/DIS 15630-3:2024(en)

# iTeh Standards (<https://standards.iteh.ai>) Document Preview

[oSIST prEN ISO 15630-3:2024](https://standards.iteh.ai/catalog/standards/sist/de41e2e0-6d60-41a8-a50e-3acabdbede96/osist-pren-iso-15630-3-2024)

<https://standards.iteh.ai/catalog/standards/sist/de41e2e0-6d60-41a8-a50e-3acabdbede96/osist-pren-iso-15630-3-2024>



### **COPYRIGHT PROTECTED DOCUMENT**

© ISO 2024

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  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

© ISO 2024 – All rights reserved

## ISO/DIS 15630-3:2023(en)

## Contents

	Page
<b>Foreword</b> .....	<b>vi</b>
<b>Introduction</b> .....	<b>vii</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms, definitions and symbols</b> .....	<b>1</b>
<b>4 General provisions concerning test pieces</b> .....	<b>3</b>
<b>5 Tensile test</b> .....	<b>4</b>
5.1 Test piece.....	4
5.2 Test equipment.....	4
5.3 Test procedure.....	4
5.3.1 General.....	4
5.3.2 Determination of the modulus of elasticity.....	5
<b>6 Bend test</b> .....	<b>6</b>
6.1 Test piece.....	6
6.2 Test equipment.....	6
6.3 Test procedure.....	6
6.4 Interpretation of test results.....	6
<b>7 Reverse bend test</b> .....	<b>7</b>
7.1 Test piece.....	7
7.2 Test equipment.....	7
7.3 Test procedure.....	8
<b>8 Wrapping test</b> .....	<b>8</b>
8.1 Test piece.....	8
8.2 Test equipment.....	8
8.3 Test procedure.....	8
<b>9 Isothermal stress relaxation test</b> .....	<b>8</b>
9.1 Principle of test.....	8
9.2 Test piece.....	9
9.3 Test equipment.....	9
9.3.1 Frame.....	9
9.3.2 Force-measuring device.....	10
9.3.3 Length-measuring device (extensometer).....	10
9.3.4 Anchoring device.....	10
9.3.5 Loading device.....	10
9.4 Test procedure.....	10
9.4.1 Provisions concerning the test piece.....	10
9.4.2 Application of force.....	10
9.4.3 Initial force.....	11
9.4.4 Force during the test.....	11
9.4.5 Maintenance of strain.....	11
9.4.6 Temperature.....	12
9.4.7 Frequency of force recording.....	12
9.4.8 Frequency of strain recording.....	12
9.4.9 Duration of the test.....	12
<b>10 Axial force fatigue test</b> .....	<b>12</b>
10.1 Principle of test.....	12
10.2 Test piece.....	13
10.3 Test equipment.....	13
10.4 Test procedure.....	13
10.4.1 Provisions concerning the test piece.....	13
10.4.2 Stability of force and frequency.....	13

## ISO/DIS 15630-3:2023(en)

10.4.3	Counting of force cycles .....	14
10.4.4	Frequency .....	14
10.4.5	Temperature .....	14
10.4.6	Validity of the test .....	14
<b>11</b>	<b>Stress corrosion test in a solution of thiocyanate .....</b>	<b>14</b>
11.1	Principle of test .....	14
11.2	Sample and test piece .....	14
11.3	Test equipment .....	14
11.3.1	Frame .....	14
11.3.2	Force-measuring device .....	14
11.3.3	Time-measuring device .....	15
11.3.4	Test cell containing the test solution .....	15
11.3.5	Test solution .....	15
11.4	Test procedure .....	15
11.4.1	Provisions concerning the test pieces .....	15
11.4.2	Application and maintenance of force .....	16
11.4.3	Filling of the test cell .....	16
11.4.4	Temperature during the test .....	16
11.4.5	Termination of the test .....	16
11.4.6	Determination of median lifetime to fracture .....	16
<b>12</b>	<b>Deflected tensile test .....</b>	<b>16</b>
12.1	Principle of test .....	16
12.2	Sample and test pieces .....	17
12.3	Test equipment .....	17
12.3.1	General description .....	17
12.3.2	Dimensions .....	17
12.3.3	Anchorage .....	18
12.3.4	Mandrel .....	18
12.3.5	Loading device .....	19
12.4	Test procedure .....	19
<b>13</b>	<b>Chemical analysis .....</b>	<b>20</b>
<b>14</b>	<b>Measurement of the geometrical characteristics .....</b>	<b>20</b>
14.1	Test piece .....	20
14.2	Test equipment .....	20
14.3	Test procedures .....	20
14.3.1	Rib measurements .....	20
14.3.2	Indentation measurements .....	21
14.3.3	Lay length of strand ( <i>P</i> ) .....	22
14.3.4	Straightness .....	22
<b>15</b>	<b>Determination of the relative rib area (<math>f_R</math>) .....</b>	<b>22</b>
15.1	General .....	22
15.2	Calculation of $f_R$ .....	23
15.2.1	Relative rib area .....	23
15.2.2	Simplified formulae .....	23
15.2.3	Formula used for the calculation of $f_R$ .....	24
<b>16</b>	<b>Determination of deviation from nominal mass per metre .....</b>	<b>24</b>
16.1	Test piece .....	24
16.2	Accuracy of measurement .....	25
16.3	Test procedure .....	25
<b>17</b>	<b>Test report .....</b>	<b>25</b>
<b>Annex A (informative) Options for agreement between the parties involved .....</b>		<b>26</b>
<b>Annex B (informative) Stress corrosion test in thiocyanate solution with galvanostatic current .....</b>		<b>27</b>
<b>Annex C (informative) Stress corrosion test in distilled water .....</b>		<b>33</b>

**iTeh Standards**  
**(<https://standards.iteh.ai>)**  
**Document Preview**

[oSIST prEN ISO 15630-3:2024](https://standards.iteh.ai/catalog/standards/sist/de41e2e0-6d60-41a8-a50e-3acabdbede96/osist-pren-iso-15630-3-2024)

<https://standards.iteh.ai/catalog/standards/sist/de41e2e0-6d60-41a8-a50e-3acabdbede96/osist-pren-iso-15630-3-2024>

## ISO/DIS 15630-3:2023(en)

### 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](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO [had/had not] received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

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](http://www.iso.org/iso/foreword.html).

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

This fourth edition cancels and replaces the third edition (ISO 15630-3:2019), which has been technically revised.

The main changes are as follows:

- addition of the informative [Annex B](#) which specifies a stress corrosion test in thiocyanate solution with galvanostatic current;
- addition of the informative [Annex C](#) which specifies a stress corrosion test in distilled water.

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](http://www.iso.org/members.html).



**ISO/DIS 15630-3:2023(en)****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, as well as specialized test methods 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.

**iTeh Standards**  
**(<https://standards.itih.ai>)**  
**Document Preview**

[oSIST prEN ISO 15630-3:2024](https://standards.itih.ai/catalog/standards/sist/de41e2e0-6d60-41a8-a50e-3acabdbede96/osist-pren-iso-15630-3-2024)

<https://standards.itih.ai/catalog/standards/sist/de41e2e0-6d60-41a8-a50e-3acabdbede96/osist-pren-iso-15630-3-2024>



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

## Part 3: Prestressing steel

### 1 Scope

This document specifies test methods applicable to prestressing steel (bar, wire or strand) for concrete.

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 4957, *Tool steels*

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 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

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 7801, *Metallic materials — Wire — Reverse bend test*

ISO 7802, *Metallic materials — Wire — Wrapping test*

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 <https://www.electropedia.org/>

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

## ISO/DIS 15630-3:2023(en)

Symbol	Unit	Description	Reference
$a_m$	mm	Rib height at the mid-point	<a href="#">14.3</a> , <a href="#">15.2</a>
$a_{max}$	mm	Maximum height of rib or depth of indentation	<a href="#">14.3</a>
$a_{s,i}$	mm	Average height of a portion $i$ of a rib subdivided into $p$ parts of length $\Delta l$	<a href="#">15.2</a>
$a_{1/4}$	mm	Rib height at the quarter-point	<a href="#">14.3</a> , <a href="#">15.2</a>
$a_{3/4}$	mm	Rib height at the three-quarters point	<a href="#">14.3</a> , <a href="#">15.2</a>
$A$	%	Percentage elongation after fracture	<a href="#">5.1</a> , <a href="#">5.3</a>
$A_{gt}$	%	Percentage total extension at maximum force	<a href="#">Clause 5</a>
$A_r$	%	Percentage uniform elongation after fracture	<a href="#">5.3</a>
$b$	mm	Width of transverse rib at the mid-point	<a href="#">14.3.1.6</a>
$c$	mm	Rib or indentation spacing	<a href="#">14.3</a>
$C$	mm	Groove width at nominal diameter of the mandrel, $d_a$ , used for the deflected tensile test	<a href="#">12.3.4</a>
$d$	mm	Nominal diameter of the bar, wire or strand	<a href="#">5.3.1</a> , <a href="#">7.2</a> , <a href="#">Table 3</a> , <a href="#">10.4.6</a> , <a href="#">Table 4</a>
$d_a$	mm	Nominal diameter of the mandrel used for the deflected tensile test	<a href="#">12.3.4</a>
$d_b$	mm	Diameter to be obtained after placing two gauge cylinders in the groove of the mandrel used for the deflected tensile test	<a href="#">12.3.4</a>
$d_e$	mm	Diameter of the gauge cylinder used for the deflected tensile test	<a href="#">12.3.4</a>
$d_g$	mm	Diameter of guide hole	<a href="#">7.2</a>
$d_i$	mm	Inner diameter of the groove of the mandrel used for the deflected tensile test	<a href="#">12.3.4</a>
$D$	%	Average coefficient of reduction of the maximum force in the deflected tensile test	<a href="#">12.2</a> , <a href="#">12.4</a>
$D_c$	mm	Inner diameter of the test cell in the stress corrosion test	<a href="#">11.3.4</a>
$D_i$	%	Individual percentage of reduction of the maximum force in the deflected tensile test	<a href="#">12.4</a>
$D_m$	mm	Diameter of the mandrel of the bending device in the bend test	<a href="#">Figure 2</a>
$e$	mm	Average gap between two adjacent ribs or indentation rows	<a href="#">14.3.1.4</a> , <a href="#">14.3.2.5</a>
$E$	MPa	Modulus of elasticity	<a href="#">5.2</a> , <a href="#">5.3</a>
$f$	Hz	Frequency of force cycles in the axial force fatigue test	<a href="#">10.1</a> , <a href="#">10.4.2</a>
$f_R$	—	Relative rib area	<a href="#">Clause 15</a>
$F_{a,i}$	N	Individual breaking force in the deflected tensile test	<a href="#">12.4</a>
$F_m$	N	Maximum force in the tensile test	<a href="#">5.3</a>
$\bar{F}_m$	N	Mean value of the maximum force	<a href="#">9.2</a> , <a href="#">11.2</a> , <a href="#">12.2</a> , <a href="#">12.4</a>
$F_{p0,1}$	N	0,1 % proof force, plastic extension	<a href="#">5.2</a> , <a href="#">5.3</a>
$F_{p0,2}$	N	0,2 % proof force, plastic extension	<a href="#">5.2</a> , <a href="#">5.3</a>
$F_r$	N	Force range in the axial force fatigue test	<a href="#">Figure 6</a> , <a href="#">10.3</a> , <a href="#">10.4.2</a>
$F_{rt}$	N	Residual force in the test piece at time $t$ in the isothermal stress relaxation test	<a href="#">9.1</a>
$\Delta F_{rt}$	N	Force loss in the test piece at time $t$ in the isothermal stress relaxation test	<a href="#">9.1</a>
$F_R$	mm <sup>2</sup>	Area of longitudinal section of one rib	<a href="#">15.2</a>
$F_{up}$	N	Upper force in the axial force fatigue test	<a href="#">Figure 6</a> , <a href="#">10.3</a> , <a href="#">10.4.2</a>
$F_0$	N	Initial force in the isothermal stress relaxation test and the stress corrosion test	<a href="#">9.1</a> , <a href="#">9.2</a> , <a href="#">9.3</a> , <a href="#">9.4</a> , <a href="#">11.1</a> , <a href="#">11.2</a> , <a href="#">11.4.2</a>
$G$	mm	Depth of the groove of the mandrel used for the deflected tensile test	<a href="#">12.3.4</a>

NOTE 1 MPa = 1 N/mm<sup>2</sup>.

## ISO/DIS 15630-3:2023(en)

Symbol	Unit	Description	Reference
$h$	mm	Distance from the top tangential plane of cylindrical supports to the bottom face of the guide	<a href="#">7.2</a>
$h_b$	mm	Bow height in the plane of the bow	<a href="#">14.3.4</a>
$l$	mm	Length of indentation	<a href="#">14.3.2.4</a>
$L_t$	mm	Length of the test piece in the stress corrosion test	<a href="#">11.2</a>
$L_0$	mm	Gauge length (without force on the test piece) in the isothermal stress relaxation test Length of the test piece in contact with the solution in the stress corrosion test	<a href="#">9.1</a> , <a href="#">9.3</a> , <a href="#">9.4</a> <a href="#">11.2</a> , <a href="#">11.3.4</a> , <a href="#">11.4.1</a> , <a href="#">11.4.3</a> , <a href="#">11.4.5</a>
$L_1$	mm	Length of the passive side in the deflected tensile test	<a href="#">12.3.2</a>
$L_2$	mm	Length of the active side in the deflected tensile test	<a href="#">12.3.2</a>
$m, n$	—	Coefficients or numbers	<a href="#">9.4.9</a> , <a href="#">14.3</a> , <a href="#">15.2</a>
$P$	mm	Lay length of a strand	<a href="#">14.3.3</a>
$r$	mm	Radius of cylindrical supports	<a href="#">7.2</a>
$R$	mm	Radius at the base of the mandrel used for the deflected tensile test	<a href="#">12.3.4</a>
$r_1$	mm	Distance between the grips and the gauge length for the manual measurement of $A_{gt}$	<a href="#">5.3</a>
$r_2$	mm	Distance between the fracture and the gauge length for the manual measurement of $A_{gt}$	<a href="#">5.3</a>
$R_a$	$\mu\text{m}$	Surface roughness of the mandrel used for the deflected tensile test	<a href="#">12.3.4</a>
$S_n$	$\text{mm}^2$	Nominal cross-sectional area of the test piece	<a href="#">5.3.2</a>
$t_a$	h	Maximum agreed time for the stress corrosion test	<a href="#">11.4.5</a>
$t_{f,i}$	h	Individual lifetime to fracture in the stress corrosion test	<a href="#">11.4.5</a>
$t_{f,m}$	h	Median lifetime to fracture in the stress corrosion test	<a href="#">11.4.6</a>
$t_0$	s	Starting time in the isothermal stress relaxation test and in the stress corrosion test	<a href="#">9.4.2</a> , <a href="#">11.4</a>
$y$	mm	Distance from a plane, defined by the axes of the cylindrical supports, to the nearest point of contact with the test piece	<a href="#">Figure 3</a>
$V_0$	$\text{mm}^3$	Volume of test solution to fill the test cell in the stress corrosion test	<a href="#">11.4.3</a>
$Z$	%	Percentage reduction of area	<a href="#">5.3.1</a>
$\alpha$	$^\circ$	Angle of deviation in the deflected tensile test	<a href="#">12.3.2</a>
$\beta$	$^\circ$	Rib or indentation angle to the bar or wire axis	<a href="#">14.3</a>
$\varepsilon_{xF_m}$	—	Value of the strain for a force equal to $x F_m$	<a href="#">5.3.2</a>
$\rho$	%	Relaxation	<a href="#">9.4.9</a>
$\Sigma e_i$	mm	Part of the circumference without indentation or rib	<a href="#">14.3.1.4</a> , <a href="#">14.3.2.5</a> , <a href="#">15.2</a>

NOTE 1 MPa = 1 N/mm<sup>2</sup>.

#### 4 General provisions concerning test pieces

Unless otherwise agreed or specified in the product standard, the samples shall be taken from the finished product before packaging.

Special care should be taken when samples are taken from the packaged product (e.g. coil or bundle) in order to avoid plastic deformation, which could change the properties of the samples used to provide the test pieces.

Specific complementary provisions concerning the test pieces are indicated in the relevant clauses of this document, if needed.

## ISO/DIS 15630-3:2023(en)

### 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 total extension at maximum force ( $A_{gt}$ ) in accordance with [5.3.1](#).

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 for a bar or wire, 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 test piece diameter.

#### 5.2 Test equipment

The test equipment 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  $E$ ,  $F_{p0,1}$  or  $F_{p0,2}$ ; for the determination of  $A_{gt}$ , a class 2 extensometer (see ISO 9513) may be used.

Grips shall be such as to avoid breaks in or very near the grips.

#### 5.3 Test procedure

##### 5.3.1 General

The tensile test for the determination of the modulus of elasticity ( $E$ ), 0,1 % and 0,2 % proof force ( $F_{p0,1}$  and  $F_{p0,2}$ ), maximum force ( $F_m$ ), percentage total extension at maximum force ( $A_{gt}$ ) and/or percentage elongation after fracture ( $A$ ) and percentage reduction of area ( $Z$ ) shall be performed in accordance with ISO 6892-1.

An extensometer shall be used for the determination of the modulus of elasticity ( $E$ ), 0,1 % and 0,2 % proof force ( $F_{p0,1}$  and  $F_{p0,2}$ ) and percentage total extension at maximum force ( $A_{gt}$ ). The extensometer gauge length shall be as specified in the relevant product standard.

Accurate values of  $A_{gt}$  can only be obtained with an extensometer. If it is not possible to leave the extensometer on the test piece to fracture or until the maximum force has been passed, the extension may be measured as follows.

- Continue loading until the extensometer records an extension just greater than the extension corresponding to  $F_{p0,2}$ , at which the extensometer is removed; the distance between the testing machine crossheads is noted. The loading is continued until fracture occurs. The final distance between the crossheads is noted.
- The difference between the crosshead measurements is calculated as a percentage of the original distance between the cross-heads and this value is added to the percentage obtained by the extensometer.

For wire and bars, it is also permissible to determine  $A_{gt}$  by the manual method. If  $A_{gt}$  is determined by the manual method after fracture,  $A_{gt}$  shall be calculated from [Formula \(1\)](#):

$$A_{gt} = A_r + R_m / 2000 \quad (1)$$

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. 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](#).