
**Non-alloy steel wire rod for
conversion to wire —**

**Part 1:
General requirements**

*Fil-machine en acier non allié destiné à la fabrication de fils —
Partie 1: Exigences générales*

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

This third edition cancels and replaces the second edition (ISO 16120-1:2011), which has been technically revised.

The main changes compared to the previous edition are:

- core segregation, surface discontinuity and mechanical damage have been added to the terms and definitions;
- determination of cementite network in high-carbon steel wire rod ([9.5.8](#) and [Annex E](#)) added.

A list of all parts in the ISO 16120 series can be found on the ISO website.

Non-alloy steel wire rod for conversion to wire —

Part 1: General requirements

1 Scope

The ISO 16120 series is applicable to wire rod of non-alloy steel intended for wire drawing and/or cold rolling. The cross-section can be circular, oval, square, rectangular, hexagonal, octagonal, half-round or another shape, generally with at least 5 mm nominal dimension, and with a smooth surface.

This document specifies general requirements for non-alloy steel wire rod for conversion to wire. It is not applicable to products for which standards exist or are in development, for example:

- steel wire rod intended for heat treatment;
- free-cutting steel wire rod;
- steel wire rod for cold heading and cold extrusion;
- steel wire rod intended for the production of electrodes and products for welding;
- steel wire rod for welded fabric for reinforcement for concrete;
- steel wire rod for ball and roller bearings (see ISO 683-17);
- steel wire rod for wire for high fatigue strength mechanical springs, such as valve springs.

In addition to the requirements of this document, the general technical delivery requirements specified in ISO 404 apply.

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 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 404:2013, *Steel and steel products — General technical delivery requirements*

ISO 3887, *Steels — Determination of depth of decarburization*

ISO 4885, *Ferrous products — Heat treatments — Vocabulary*

ISO 4948-1, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 4948-2, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics*

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

ISO 6929, *Steel products — Vocabulary*

ISO/TR 9769, *Steel and iron — Review of available methods of analysis*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 16120-2:2017, *Non-alloy steel wire rod for conversion to wire — Part 2: Specific requirements for general-purpose wire rod*

ISO 16120-3:2011, *Non-alloy steel wire rod for conversion to wire — Part 3: Specific requirements for rimmed and rimmed substitute, low-carbon steel wire rod*

ISO 16120-4:2017, *Non-alloy steel wire rod for conversion to wire — Part 4: Specific requirements for wire rod for special applications*

ISO 16124, *Steel wire rod — Dimensions and tolerances*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 377, ISO 404, ISO 4885, ISO 4948-1, ISO 4948-2 and ISO 6929 and the following apply.

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

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

3.1

rod

hot-rolled finished product hot-wound into irregular coils

Note 1 to entry: Rod used for wire-drawing purposes in coil form is generally termed wire rod.

3.2

heat analysis

chemical analysis representative of the heat, by a method determined at the steelmaker's discretion

[SOURCE: ISO 404:2013, 3.11, modified.]

3.3

product analysis

chemical analysis carried out on a sample of the product taken after the final hot rolling operation

[SOURCE: ISO 404:2013, 3.12, modified.]

3.4

resolvable pearlite

two-phased structure in which ferrite and iron carbide lamellae can be clearly observed under optical microscopy in certain conditions

3.5

core segregation

local variation in chemical composition that is noticeable over a cross-section of wire rod (3.1) by macrographic examination and that concerns primarily the segregation resulting from a solidification process in continuous casting

Note 1 to entry: It is for this reason that an examination, specifically for carbon core segregation, will reveal the presence of segregation.

Note 2 to entry: A different technique is used to assess grain boundary cementite (which may be detrimental to further processing), the formation of which is related to carbon segregation and the cooling rate after wire rod rolling. However, grain boundary cementite should not be confused with core segregation.

3.6**surface discontinuity**

measurable discontinuity in the surface of the wire *rod* (3.1), introduced at some point during the manufacturing process

3.7**mechanical damage**

discernible contact which the wire *rod* (3.1) encounters after the rolling and coiling operation, i.e. during subsequent handling of the coil, and which marks the surface

Note 1 to entry: The contact can be introduced by abrasion or impact and can occur between coils or between the coil and any other material capable of inducing damage (concrete, steel or other materials).

Note 2 to entry: See [Annex C](#).

4 Classification

The classification of the steel grades covered by this document is indicated in ISO 16120-2, ISO 16120-3 and ISO 16120-4 for the corresponding steel grades.

5 Ordering information to be supplied by the purchaser

The following information shall be supplied by the purchaser at the time of enquiry and order, to enable the supplier to comply satisfactorily with the requirements of the ISO 16120 series:

- a) quantity to be delivered;
- b) cross-section and product type (e.g. round wire rod, square wire rod, hexagonal wire rod, etc.);
- c) nominal dimensions of the wire rod and tolerance class in accordance with ISO 16124 (if another tolerance class such as T1 is required);
- d) reference to the relevant part of ISO 16120, i.e. ISO 16120-2;
- e) steel grade, including any variations, and/or the addition of other elements, as permitted by ISO 16120-2 and ISO 16120-4;

(For steels according to ISO 16120-2 and ISO 16120-4, wire rod can also be ordered by the mean tensile strength; see ISO 16120-2:2017, Clause 3 and 4.6 and ISO 16120-4:2017, Clause 3 and 4.8. When ordering to tensile strength, it is necessary also to indicate the required tolerances on tensile strength ranges — Option A or Option B.)

- f) type of inspection and inspection document in accordance with ISO 10474 (or in accordance with other regional standards, e.g. EN 10204);
- g) surface condition (where different from the as-rolled condition);
- h) dimensions and mass of coils;
- i) where applicable, indication of the type of descaling (chemical cleaning or mechanical);
- j) where applicable, the amount of microalloying elements (see ISO 16120-2 and ISO 16120-4);
- k) where applicable, class B for the depth of decarburization (see ISO 16120-4);

NOTE If nothing is mentioned in the order, class A will be delivered;

- l) where applicable, the microstructure (see ISO 16120-4:2017, 4.11);
- m) where applicable, suitability for galvanizing;
- n) where applicable, suitability for direct drawing;

- o) where applicable, the quality system (see [7.2](#));
- p) where applicable, the method of binding and labelling.

Items g) to p) are options. If the purchaser does not indicate a wish to implement any of these options, the supplier shall supply the product in accordance with the basic specifications of items a) to f).

Examples 1 and 2 provide two ordering examples.

EXAMPLE 1 For grades ordered according to chemical composition, 100 tonnes of round wire rod, nominal diameter of 12 mm with dimensional tolerances according to ISO 16124, class T1, steel grades ISO 16120-2 – C52D in the as-rolled condition with an inspection document 3.1 according to ISO 10474.

100 t round wire rod ISO 16124-12,0T1

ISO 16120-2 – C52D

ISO 10474 inspection document [3.1](#)

EXAMPLE 2 For grades ordered according to tensile strength, 200 tonnes of round wire rod, nominal diameter of 5,5 mm with dimensional tolerances according to ISO 16124, class T1, steel grades ISO 16120-4 – C##D2 with tensile strength 1 020 MPa, tensile strength tolerance Option A, in the as-rolled condition with an inspection document 3.1 according to ISO 10474.

200 t round wire rod ISO 16124-5, 5T1

ISO 16120-4 – C##D2-1020A

ISO 10474 inspection document [3.1](#)

NOTE The symbol “##” means “to be left blank” since the carbon content is at the discretion of the supplying mill, and the supplying mill indicates the exact number of ## based on the grade designation until shipment. See ISO 16120-2:2017, Table 1 and ISO 16120-4:2017, Table 1 respectively, for the grade designation.

6 Production process

At the request of the purchaser at the time of enquiry and ordering, the steel making and manufacturing process shall be made known to the purchaser. Those processes that are specifically agreed upon shall not be changed without the prior agreement of the purchaser.

7 Requirements

7.1 General

Suppliers are responsible, using the means they think fit, for inspecting their product in accordance with various quality criteria specified. In view of the practical difficulties in inspecting a coil of wire rod along its entire length, it cannot be proved that no value greater than the specified limits is to be found in the coil as a whole. Statistical evaluation of performances applicable to all coils may be agreed between the purchaser and the manufacturer at the time of ordering.

7.2 Quality system

If agreed between the supplier and purchaser at the time of enquiry and order, the wire rod supplied shall be produced under a mutually acceptable quality system.

7.3 Method of delivery

Wire rod shall be delivered by heat or part of a heat. Unless otherwise specified, the number of heats per delivery should be minimized as far as possible.

7.4 Delivery condition

Wire rod shall be supplied in the as-rolled state, in coils of one continuous length with non-aligned turns, but capable of being unwound in a regular manner during subsequent processing.

The coils shall be cut back at both ends to provide a product of uniform shape and properties.

8 Dimensions, mass and tolerances

The dimensions, mass and tolerances of the wire rod shall be in accordance with the requirements of ISO 16124.

9 Inspection

9.1 Inspection and inspection documents

Inspection and inspection documents shall be in accordance with ISO 404 and ISO 10474.

9.2 Extension of inspection

If the order is accompanied by a request for an inspection certificate or an inspection report, the inspection shall be carried out in accordance with [Table 1](#). If the order requires an inspection document [3.1](#) or [3.2](#), the purchaser shall supply to the manufacturer the name and address of the organization or person nominated to carry out the inspection.

Table 1 — Extension of inspection

Subject of test	General-purpose wire rod (ISO 16120-2)	Rimmed and rimmed substitute, low-carbon wire rod (ISO 16120-3)	Wire rod for special applications (ISO 16120-4)
Surface discontinuities	0	0	0
Decarburization	—	—	0
Non-metallic inclusions	—	0	0
Core segregation	0	—	0
Product analysis	0	0	0
Tensile strength	0	0	0
Microstructure	—	—	0 ^a
^a See Annex D . — is not carried out. 0 is carried out only if part of the options agreed at the time of ordering.			

9.3 Acceptance unit, number of samples and test pieces

Unless otherwise agreed, the acceptance unit is composed of wire rod of the same cross-sectional dimension, originating from the same heat, and rolled in the same continuous lot.

If specific inspection is required, the number of samples and test pieces given in [Table 2](#) shall apply. For wire rod for special applications, a higher frequency of sampling may be agreed. If non-specific inspection is required, the performance statistics or suitable data may be used.

Table 2 — Acceptance unit, number of samples and test pieces

Type of requirement	Number of samples and test pieces
Product analysis	Three, from three different coils originating from the same heat, but not necessarily rolled in the same continuous lot ^a
Permissible depth of surface discontinuities Permissible depth of decarburization Non-metallic inclusions Tensile strength Microstructure	One per 20 t with a minimum of three and a maximum of five per acceptance unit ^a
Core segregation	10 ^b
Cementite network	At least 10 samples
^a Another number of samples to be examined may be agreed upon between the supplier and purchaser at the time of ordering, depending upon the process capability.	
^b The number of samples to be examined may be agreed upon between the supplier and the purchaser, with preferably a minimum of 10.	

9.4 Sampling and preparation of samples and test pieces

9.4.1 Chemical composition

Where it has been agreed to verify the chemical composition of the product, sampling and preparation of samples for heat analysis shall be carried out in accordance with ISO 14284.

9.4.2 Tensile strength

If it is agreed to perform the tensile test, samples shall be taken and prepared in accordance with ISO 377.

9.4.3 Decarburization, surface discontinuities, non-metallic inclusions, core segregation and microstructure

For testing for decarburization, surface discontinuities, non-metallic inclusions, core segregation and microstructure, the required number of test pieces shall be taken from one end of individual cropped coils (see 7.4).

9.5 Test methods

9.5.1 Chemical composition

The methods for heat analysis shall be in accordance with ISO/TR 9769. The methods to be applied for the verification of the product analysis shall be agreed upon at the time of ordering. In case of dispute about analytical methods, the chemical composition shall be determined in accordance with a reference method.

9.5.2 Tensile strength

The tensile test shall be carried out on wire rod in the as-rolled condition in accordance with ISO 6892-1.

9.5.3 Surface discontinuities

The method to be used for revealing and measuring surface discontinuities shall be chosen by the supplier, as described in Annex B.

9.5.4 Decarburization

Testing for decarburization shall be carried out on the wire rod in the as-rolled condition, in accordance with ISO 3887. Decarburization is inspected by microscope, preferably at a magnification of 200 ×, on a transverse metallographic test piece that has been suitably etched.

The depth of decarburization of the sample is considered as being the average of eight measurements at the ends of four diameters (or diagonals) located at 45° to each other, starting from the zone of maximum decarburization and avoiding starting from a defective zone. In the calculation of the above average value, any measuring point of the seven remaining situated in a local surface discontinuity shall not be taken into account in the calculation. The depth of decarburization is measured normal to the surface of the test piece.

9.5.5 Non-metallic inclusions

The tests shall be carried out on the wire rod in the as-rolled condition and in accordance with ISO 16120-3:2011, 5.5 and ISO 16120-4:2017, 4.6.

9.5.6 Core segregation

The method for determining the core segregation shall be macrographic examination on a transverse section of the sample, as specified in [Annex A](#).

9.5.7 Microstructure

The tests shall be carried out on the wire rod in the as-rolled condition. The method for determining the microstructure shall be carried out as specified in [Annex D](#).

9.5.8 Determination of cementite network in high-carbon steel wire rod

The method for the determination of cementite network in high-carbon steel wire rod shall be carried out as specified in [Annex E](#).

9.6 Retest

Retests of wire rod and their criteria should be as specified in ISO 404.

10 Marking

Each coil in each consignment shall be marked with the following information:

- a) dimensions of the cross-section of the wire rod;
- b) steel grade;
- c) heat number;
- d) the name and, if applicable, the symbol of the supplying mill;
- e) any subsequently agreed information (e.g. coil weight).

Unless otherwise agreed upon, the marking shall withstand pickling. The durability of the labels utilized for marking shall be agreed upon at the time of ordering.

11 Disputes

In case of dispute, the sampling conditions and test methods used to evaluate the dispute characteristics shall be those described in the relevant International Standard, or in ISO 404:2013, 8.3.3 and 8.3.4.

Annex A (normative)

Determination of core segregation

A.1 Overview

This annex is applicable for wire rod made from continuously cast steel with a carbon content of at least 0,4 % and defined in this document. The method described in [A.2](#) and [A.3](#) is a macrographic method aimed at determining and evaluating the core segregation present in continuously cast high-carbon wire rod by revealing the carbon segregation.

A.2 Principle

Chemical heterogeneity is revealed by chemical etching of a cross-section of the wire rod using a nital solution.

The images observed by macrographic examination are compared with the pictures shown in the reference chart and are classified accordingly.

A.3 Preparation of samples

A.3.1 Cutting

The surface to be examined is a transverse section from each sample to be examined. This is obtained by gradually cutting at low speed. At all times, excessive heating shall be avoided by means of appropriate cooling.

A.3.2 Polishing

The specimen is polished stepwise by using graduated emeries and finishing with fine diamond paste of grain size 1 μm .

After polishing to a mirror finish, the specimen is carefully washed with water and dried using alcohol.

A.3.3 Etching

The nital solution is a solution of 2 ml of nitric acid ($\rho_{20} = 1,33 \text{ g/ml}$) in 100 ml of ethanol.

The polished surface is etched at ambient temperature in the nital solution for a minimum of 10 s until the surface is etched clearly.

After etching, the surface is dried using alcohol.

A.3.4 Evaluation of the segregation

The etched surface is observed with a binocular microscope using illumination under a small angle with such a magnification as to obtain approximately the same dimension as in the reference chart.

The pictures in the chart are limit references for each class concerned.

Actual pictures are compared, positioned and graded within the reference chart. They are assigned the class of the reference picture equal to or worse than the picture under observation.

A.3.5 Classes of the segregation

The reference chart presents five classes of segregation; see [Figure A.1](#):

- Class 1: without segregation zone;
- Class 2: core segregation with slight contrast (medium-grey);
- Class 3: core segregation with medium contrast (dark grey);
- Class 4: core segregation with pronounced contrast (small black core);
- Class 5: core segregation with heavy contrast (big black core).

A.3.6 Evaluation of the test results

It is generally accepted that a large number of results are required for a statistically significant evaluation of the core segregation of a heat or a shipment. The core segregation evident on an individual sample is only of limited value. For this reason, and to limit the number of tests to an economically acceptable level, it is advisable to use the determination of the segregation as part of a quality system.

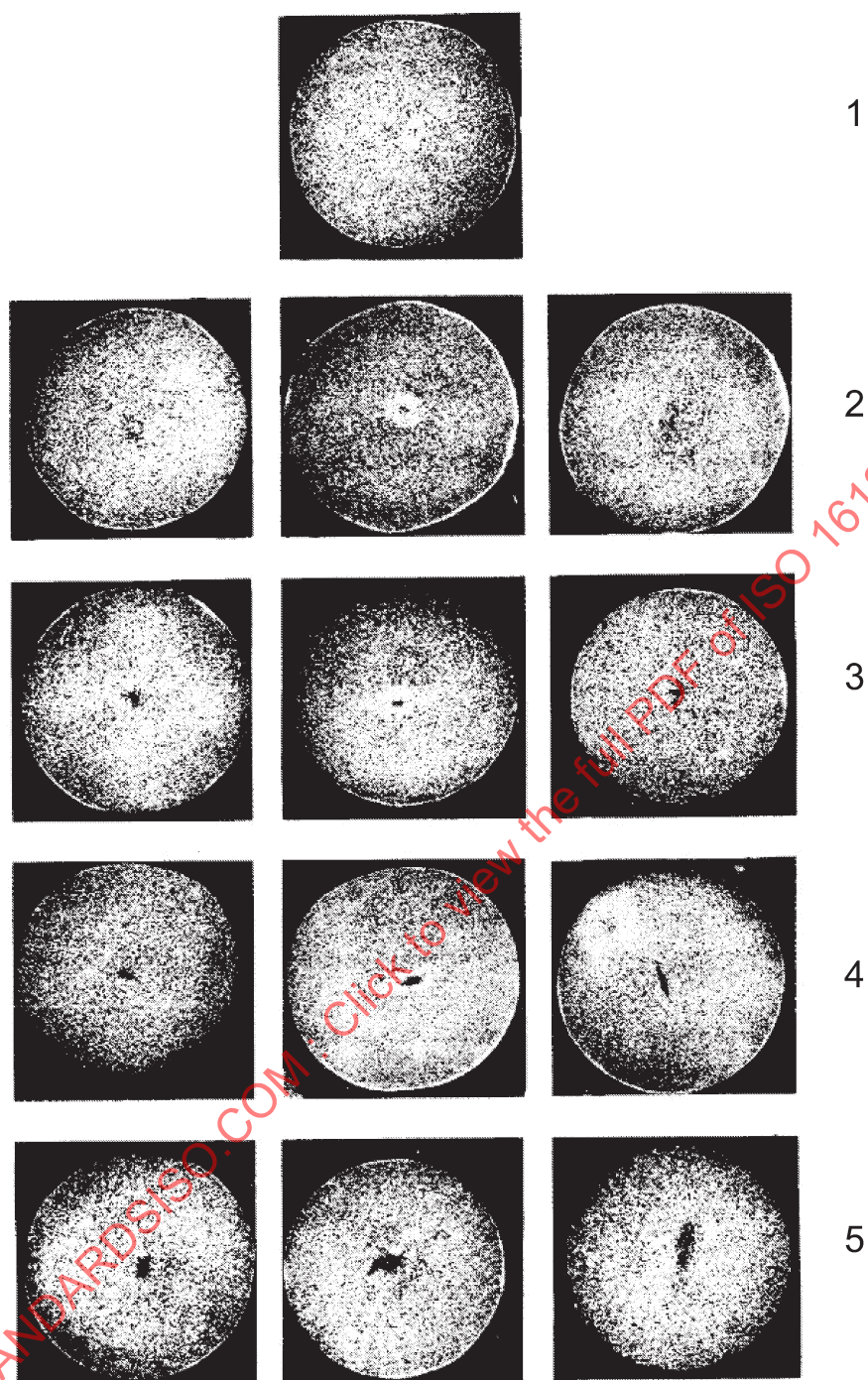


Figure A.1 — Reference chart for core segregation comparison

Annex B (informative)

Measurement of surface discontinuities

B.1 Overview

This annex is applicable for all grades of wire rod specified in ISO 16120-2, ISO 16120-3, and ISO 16120-4. The method described is a micrographic method aimed at determining and evaluating the magnitude of surface discontinuities as described in [B.2](#) and [B.3](#).

B.2 Principle

Surface discontinuities are revealed by examination, using a microscope, of a polished section of the wire rod. The polished section may be etched.

B.3 Preparation of samples

B.3.1 Cutting

The surface to be examined is a transverse section.

B.3.2 Polishing

The specimen is polished stepwise using graduated emeries, finishing with the fine diamond paste.

After polishing to a mirror finish, the specimen is carefully washed with water, cleaned with alcohol and dried.

B.3.3 Etching

The specimen may be examined in the etched or unetched condition. If etched, a nital etchant, which is a solution of 2 ml of nitric acid ($\rho_{20} = 1,33 \text{ g/ml}$) in 100 ml of ethanol, is used. The polished surface is etched at ambient temperature in the etching solution for a minimum of 10 s or until the surface is etched clearly.

After etching, the surface is cleaned using alcohol and dried.

B.3.4 Evaluation of the depth of the surface discontinuity

The surface is observed with an optical microscope at a magnification appropriate to the rod diameter and depth of discontinuity. The whole circumference of the specimen shall be examined.

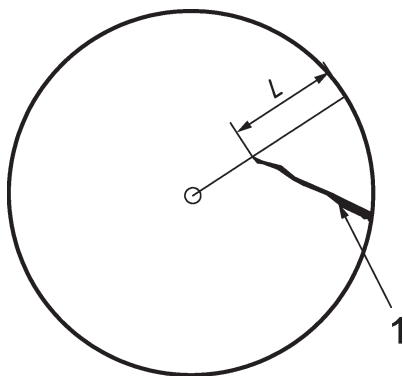
B.3.5 Reporting of results

The results may be reported in two ways, "radial depth" or "actual length":

Radial depth is defined as the distance between the surface of the wire rod and the end point of the discontinuity, measured along a radius, as shown in [Figure B.1](#).

Actual length is defined as the distance from the point at which the discontinuity breaks the surface to its end point; see [Figure B.2](#). In cases where the discontinuity is nonlinear, an approximation method

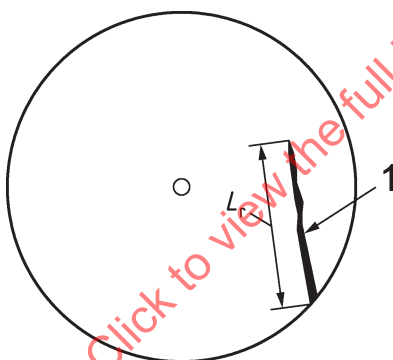
is used by notionally dividing the discontinuity into a number of linear portions, then summing the individual lengths; see [Figure B.3](#).



Key

- 1 discontinuity
- L radial depth

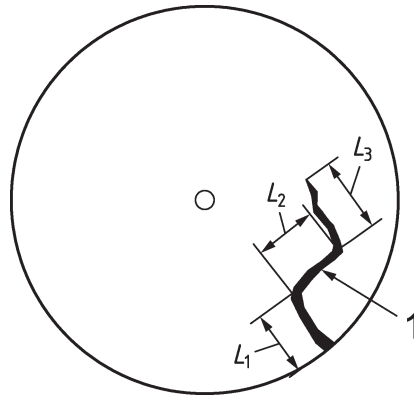
Figure B.1 — Measurement of surface discontinuities: Case 1



Key

- 1 discontinuity
- L_r actual length

Figure B.2 — Measurement of surface discontinuities: Case 2

**Key**

1 discontinuity

 L_r actual lengthNOTE $L_r = L_1 + L_2 + L_3$ **Figure B.3 — Measurement of surface discontinuities: Case 3**

Annex C (informative)

Mechanical damage

C.1 Overview

This annex is intended to provide information concerning the types and appearance of mechanical damage on wire rod, which, if sufficiently severe, can result in failure either during drawing or during subsequent processing.

C.2 Illustrations of mechanical damage and the consequences

C.2.1 Types of damage and probable causes

There are three types of damage, which are shown in [Figures C.1](#) to [C.3](#).



Figure C.1 — Damage caused by contact with other coils and other metal material

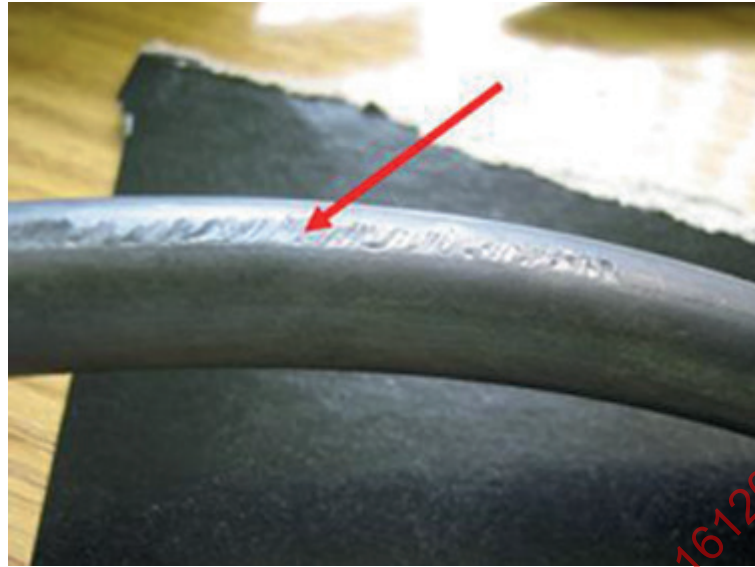


Figure C.2 — Damage caused by abrasive contact with concrete floor

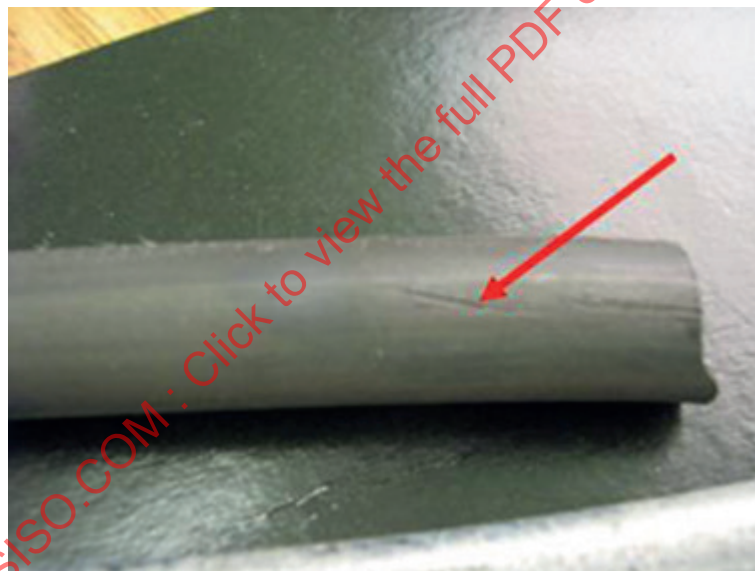


Figure C.3 — Damage caused by contact with other coils or other metallic materials during stacking

C.2.2 Consequences of mechanical damage

[Figure C.4](#) shows an area of mechanical damage on the rod surface (indicated by an arrow) that has acted as the initiation point for a fracture which has occurred. [Figures C.5](#) and [C.6](#) are photomicrographs (at magnifications of 18 × and 118 ×, respectively) showing that the mechanical damage can be associated with frictional martensite, the result of abrasive contact between the wire rod surface and a harder material.



Figure C.4 — Mechanical damage on the rod surface (indicated by the arrow)

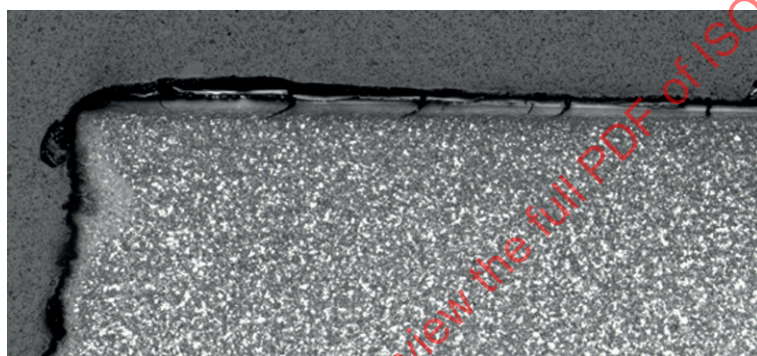


Figure C.5 — Photomicrograph (magnification $18\times$) of mechanical damage

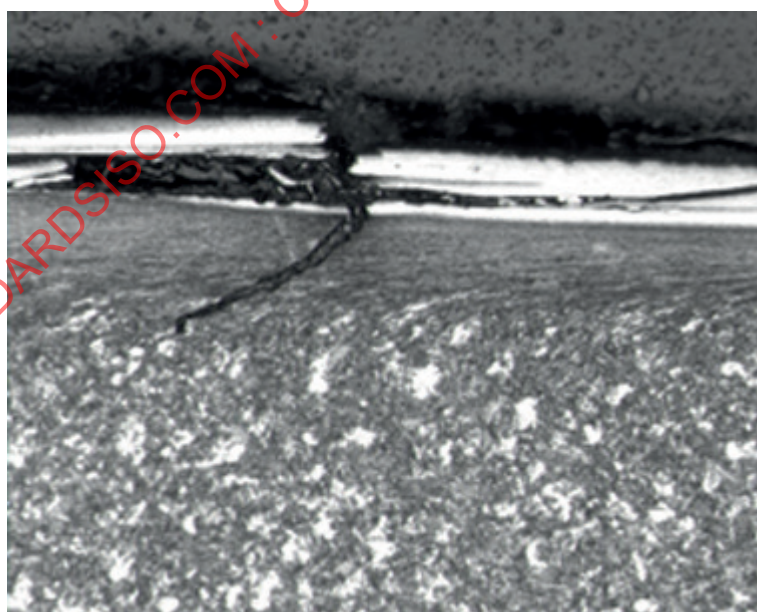


Figure C.6 — Photomicrograph (magnification $118\times$) of mechanical damage

C.3 Avoidance of mechanical damage

C.3.1 General

The measures in C.3.2 to C.3.4 are normally adopted to avoid mechanical damage during the various stages of processing after the rod is discharged from the production line.

C.3.2 Transposition of coils (i.e. lifting, loading and unloading)

The contact surface between the carrying device (C-hook or pole truck) and the coil should be made of soft steel or fitted with an inlay of aluminium or another “soft” material.

Lifting of coils should be vertical, to avoid dragging against the ground, steelwork or other coils.

Slings should be of fabric or another non-metallic material. If the use of chain or rope is unavoidable, it should be coated or sleeved with plastic or another non-harmful material.

C.3.3 Coil storage

Coils should be stored on wood, rubber matting, or another softer material. “Soft” spacers (made of hardboard or cardboard) should be placed between coils.

Where coils are stacked on top of each other in layers, “soft” spacers should be used between layers.

For those grades of wire rod where the surface quality is especially sensitive, single-layer storage should be used.

C.3.4 Transportation

Trucks and wagons should ideally be fitted with purpose-designed carriers (normally termed “wells” or “cradles”) to prevent movement of the coil during transportation and to prevent contact with other coils.

As a minimum, the floor of the truck/wagon/vessel should be of wood or another non-harmful material, or protected with the same.

“Soft” spacers should be placed vertically between coils to prevent coil-to-coil abrasive damage. (Movement of coils during transportation can result in considerable abrasive damage if such a measure is not adopted.)

Where coils have to be strapped into a fixed position to ensure safe transportation, strapping material should be softer than the steel (e.g. fabric).

Annex D (normative)

Determination of percentage of resolvable pearlite in high-carbon steel wire rod

D.1 Overview

This annex is applicable to wire rod made from unalloyed continuously cast steel with a carbon content greater than 0,65 %.

Where the purchaser and the supplier have agreed to specify the percentage of resolvable pearlite, this annex describes the procedure for the microscopic revealing and assessing of resolvable pearlite.

“Resolvable pearlite” is defined as the percentage of pearlite showing a clearly distinguishable lamellar structure at a magnification of 500:1 and with a numerical aperture of at least 0,8. The visible lamellae can be very broad up to fairly tight but always with clearly visible ferrite between the carbide lamellae.

D.2 Principle

Resolvable pearlite is revealed by chemical etching of a polished section of the wire rod using an appropriate etchant.

The surface to be examined can be a longitudinal or transversal section of the wire rod in the as-rolled or patented condition. In addition to a suitable magnification, a suitable size of the examined area shall also be ensured in order to assess a sufficient number of grains; see [D.4](#).

D.3 Preparation of samples and etching

The specimens should be prepared metallographically using a well-conceived method, starting with sectioning without mechanical deformation, followed by an appropriate sequence of grinding and polishing steps aiming at a mirror-like, undeformed surface.

After the last polishing (usually with diamond paste), the specimen is carefully washed with water, cleaned with ethanol and finally dried.

For the revealing of the pearlite, the following etchants are recommended:

- a) a nital etchant, which is a solution of 2 ml of nitric acid ($\rho_{20} = 1,33$ g/ml) in 100 ml ethanol;
- b) a picral etchant, which is a saturated solution of picric acid in ethanol.

The recommended etching time is from 10 s to 15 s.

After the etching process, the specimen is again carefully washed with water, cleaned with ethanol and finally dried.

A preparation leading to the same result is also allowed.

D.4 Evaluation of the percentage of resolvable pearlite

The etched surface is observed with an optical microscope using the following conditions:

- magnification at 500:1;

- numerical aperture of at least 0,8;
- sample area with a diameter of at least $D = 0,2$ mm (corresponding to the scale length of the platform micrometre at a magnification of 500:1);
- typically, a white light source (another effective light source may be used, including green light).

For a manual assessment of the resolvable pearlite, four measuring points (O1, O2, O3, O4) are defined, displaced by 90° and arranged in the middle between the core and the wire surface ($1/2$ radius of the section) (see [Figure D.1](#)), and the percentage of resolvable pearlite is examined visually for each of these measuring points (see [Figure D.2](#)).

(An examination by an automatic image analysis is principally possible if it leads to the same result. The examination must be carried out under the same conditions described above for the manual method and in the half radius of the section.)

In case of a dispute, the manual method shall be followed.

D.5 Reporting of results

If the assessment of the four measuring points leads to different values, only the maximum value will be reported. The other values should be reported only if agreed at the time of enquiry and order. If by agreement the average values shall be reported, these values should be rounded up. Examples of indication are given in [Table D.1](#).

Table D.1 — Examples of indication

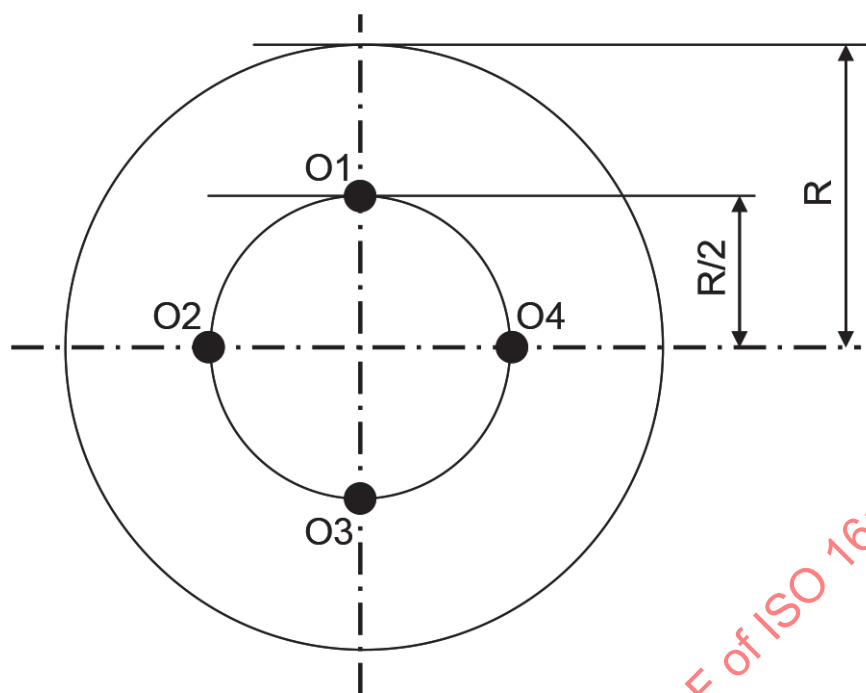
No.	Measuring point				Average value	Report ^a
	O1	O2	O3	O4		
1	5	5	10	20	10	20
2	10	10	5	5	7,5	10
3	5	5	5	5	5	5
4	10	15	10	15	12,5	15
5	5	5	5	10	6,25	10

^a If agreed at the time of enquiry and order, other values shall be also be reported. The average values should be rounded up.

If requested by the purchaser, the percentage of resolvable pearlite shall be reported in the certificate.

The reporting of the results shall include:

- percentage of resolvable pearlite (indication as described above);
- etchant;
- magnification;
- numerical aperture of the objective lens;
- method (manual or automatic image analysis);
- if an automatic image analysis, the method used.



Key

R radius of sample area

Figure D.1 — Schematic diagram of measuring points for the manual examination of resolvable pearlite

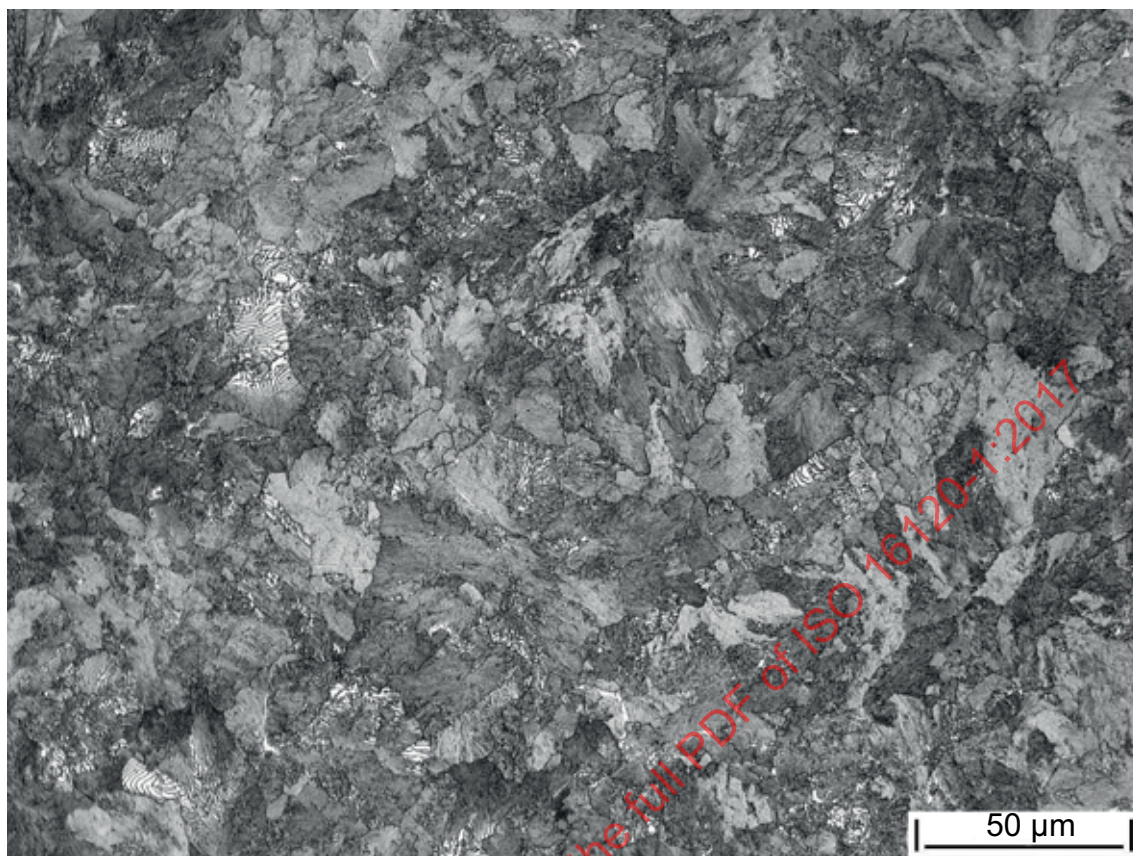


Figure D.2 — Pearlitic structure with largely unresolvable pearlite and small areas of resolvable pearlite (500 ×)