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**Flat bottom (Vignole) railway rails  
43 kg/m and above**

*Rails Vignole de masse supérieure ou égale à 43 kg/m*



Reference number  
ISO 5003:2016(E)



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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](http://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](http://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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: [Foreword — Supplementary information](#).

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 15, *Railway rails, rail fasteners, wheels and wheelsets*.

This second edition cancels and replaces the first edition (ISO 5003:1980), which has been technically revised.



# Flat bottom (Vignole) railway rails 43kg/m and above

## 1 Scope

This International Standard specifies the terms and definitions, information to be supplied by the purchaser, tolerances for dimensions, length, technical requirements, inspection rules, identification, certification, and a quality assurance system for as-rolled and heat-treated steel rails for railways.

This International Standard specifies flat bottom (vignole) railway rails with linear mass of 43 kg/m and above, for conventional and high-speed railway track usage.

There are 19 pearlitic steel grades specified, covering a 200 HBW to 400 HBW hardness range and including “non-heat-treated” carbon manganese steels, “non-heat-treated” alloy steels, “heat-treated” carbon manganese, and “heat-treated” low alloy steels.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1099, *Metallic materials — Fatigue testing — Axial force-controlled method*

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

ISO 4967, *Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams*

ISO 4968:1979, *Steel — Macrographic examination by sulfur print (Baumann method)*

ISO 4969:2015, *Steel — Etching method for macroscopic examination*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

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

ISO 12108, *Metallic materials — Fatigue testing — Fatigue crack growth method*

ASTM E45, *Standard test methods for determining the inclusion content of steel*

ASTM E399, *Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness  $K_{Ic}$  of Metallic Materials*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

#### **heat**

liquid steel melt tapped out of a converter or electric arc furnace which includes, after continuous casting, a given number of blooms relating to the weight of the heat and the extension of the mixing zone

Note 1 to entry: In the case of sequence casting, the blooms belonging to the mixing zone should be clearly defined.

### 3.2

#### **sequence**

any number of heats, of the same steel grade, which undergo continuous casting in tundishes

Note 1 to entry: Tundishes can be used in parallel, if the caster has many strands.

### 3.3

#### **heat-treated rail**

rail that has undergone accelerated cooling from austenitizing temperature during the metallurgical transformation period

### 3.4

#### **off-line heat-treated rail**

all rolled rail that has undergone re-austenitization for heat treatment purposes

### 3.5

#### **online heat-treated rail**

heat-treated rail that has not undergone re-austenitization after rolling

### 3.6

#### **rolling process**

process between the blooms leaving the heating furnace and exiting the finishing pass

### 3.7

#### **isothermal treatment process**

process whereby blooms are held for a period of time at an elevated temperature for reducing the hydrogen content

Note 1 to entry: For maximum efficiency, this is as near to (but below) the pearlite to austenite transformation temperature as is practically possible.

Note 2 to entry: This process is sometimes referred to as “sub-critical” diffusion annealing.

### 3.8

#### **rail running surface**

curved surface of the rail head

Note 1 to entry: It may also refer to any area between both gauge corners (transition points of the head inclination and the first head radius).

## **4 Information to be supplied by the purchaser**

The purchaser shall provide the supplier with the following information at the time of enquiry or order:

- a) the rail profile (by submitting a drawing) and the profile tolerances as defined for the dimensions listed in [Table 3](#);
- b) the steel grade (see [7.2](#) and [Annex A](#));
- c) the straightness class “A” or “B” of rail (see [Table 5](#));
- d) the non-metallic inclusion determination method and if applicable: the class “1” or “2” of rail (see [Table 13](#));
- e) the determination of the macrostructure (see [5.10](#));
- f) the lengths of rail (see [Table 4](#) and [6.3](#));
- g) undrilled or drilled rail ends to take fish bolts, and location and dimensions of holes when required (see [Table 4](#));
- h) paint code requirements (see [9.4.4](#)).

## 5 Test methods

### 5.1 Test items, testing frequency and test methods

Test items, sampling position, sampling numbers and test methods shall be as given in [Table 1](#) and [Table 2](#).

**Table 1 — Testing frequency for acceptance testing**

Test items	As-rolled rails	Heat-treated rails	Relevant subclause
Chemical composition	One per heat	One per heat	<a href="#">5.2</a>
Hydrogen	One per heat (two tests from first heat in sequence)	One per heat (two tests from first heat in sequence)	<a href="#">5.3</a>
Total oxygen	One per sequence <sup>a</sup>	One per sequence <sup>a</sup>	<a href="#">5.4</a>
Tensile	One per heat <sup>a,b,d</sup>	One per heat <sup>a,c</sup>	<a href="#">5.5</a>
Hardness	One per heat <sup>a,b</sup>	One per heat <sup>a,c</sup>	<a href="#">5.6</a>
Microstructure	Not required for grades HR200, HR220, HR235 and HR260A. One per 1 000 tons or part thereof for grades HR260B, HR280, HR310A, HR310B, HR320, HR325 <sup>a,b</sup>	One per 100 tons of heat-treated rail <sup>a,c</sup>	<a href="#">5.7</a>
Decarburization	One per 1 000 tons or part thereof <sup>a,b</sup>	One per 500 tons or part thereof <sup>a,c</sup>	<a href="#">5.8</a>
Non-metallic inclusions	One per sequence <sup>b</sup>	One per sequence <sup>b</sup> or <sup>c</sup>	<a href="#">5.9</a>
Macrostructure	One per 500 tons or part thereof <sup>a,b</sup>	One per 500 tons or part thereof <sup>a,b</sup> or <sup>c</sup>	<a href="#">5.10</a>
Dimension	Whole length	Whole length	<a href="#">6.1</a>
Straightness	Whole length	Whole length	<a href="#">6.2</a>
Surface quality	Whole length	Whole length	<a href="#">7.9</a>
Ultrasonic test	Whole length	Whole length	<a href="#">5.11</a>
<sup>a</sup> Samples shall be taken at random. When different rail grades are casted in the same sequence, the samples shall be taken outside the mixing zone. <sup>b</sup> Samples shall be cut after rolling. <sup>c</sup> Samples shall be cut after heat-treating for heat-treated rails. <sup>d</sup> One calculation per heat and one testing per 2 000 tons if agreed between purchaser and manufacturer			

**Table 2 — Testing frequency for periodic tests**

Test items	As-rolled rails and Heat-treated rails	Relevant subclause
Residual stress	Tests shall be done for all grades at least once every 5 years or after any relevant change in the production process. The manufacturer shall only carry out testing on a 60 kg/m profile or the heaviest section produced.	<a href="#">5.12</a>
Fracture toughness ( $K_{IC}$ )		<a href="#">5.13</a>
Fatigue crack growth rate		<a href="#">5.14</a>
Fatigue test		<a href="#">5.15</a>
Longitudinal hardness test	Heat-treated rails	<a href="#">5.16</a>

### 5.2 Chemical composition

The chemical composition shall be determined on the liquid.

When the solid chemical composition is to be checked as a requirement of the purchaser, this shall be carried out at the position of the tensile test piece shown in [Figure 1](#).

### 5.3 Hydrogen content

The hydrogen content of the liquid steel shall be measured by determining the pressure of hydrogen in the steel using an online immersion probe system or the method agreed between the purchaser and manufacturer.

At least two liquid samples shall be taken from the first heat of any sequence using a new tundish and one from each of the remaining heats and analysed for hydrogen content (see [Table 1](#)). The first sample from the first heat in a sequence shall be taken from the tundish at the time of the maximum hydrogen concentration.

When testing of rails is required rail samples shall be taken at the hot saw at a frequency of one per heat at random. However on the first heat in a sequence, the rail sample shall be from the last part of a first bloom teemed on any strand. Hydrogen determination shall be carried out on samples taken from the centre of the rail head, and determined by automatic machine.

### 5.4 Total oxygen content

The total oxygen content can be determined in the liquid or solid.

If the total oxygen content is determined from the solid rail head, the testing positions are shown in [Figure 2](#).

### 5.5 Tensile test

Test samples shall be taken from the rail head as shown in [Figure 1](#).

The tensile properties shall be determined in accordance with ISO 6892-1 by using a round tensile test piece with the dimensions as follows:

- diameter 10 mm;
- gauge length 50 mm.

In the case of dispute, the tensile test pieces shall be maintained at a temperature of 200 °C for 6 h before testing.

For as-rolled rails, the tensile strength and elongation may be determined as agreed between the purchaser and manufacturer by a correlation to the chemical composition based on the statistical data analysis. The method to be applied is shown in [Annex B](#).

### 5.6 Hardness

#### 5.6.1 General requirements

Brinell hardness tests (HBW) shall be carried out in accordance with ISO 6506-1. The method used is at the discretion of the manufacturer.

In case of dispute, the test shall be done using HBW 2,5/187,5.

#### 5.6.2 Surface hardness

The surface hardness shall be tested at position RS as shown in [Figure 3](#).