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Hot-rolled steel rails for railway

铁路用热轧钢轨

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Hot-rolled steel rails for railway

1 Scope

This standard specifies the order content, classification, size, shape, quality and tolerance, technical requirements, test methods, inspection rules, signs and quality certificates of steel rails for railway.

This standard applies to 38 kg/m ~ 75 kg/m symmetrical section hot-rolled steel rails and on-line heat-treated steel rails.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB/T 222 Permissible tolerances for chemical composition of steel products

GB/T 223.3 Methods for chemical analysis of iron, steel and alloy - The diantipyryl methane phosphomolybdate gravimetric method for the determination of phosphorus content

GB/T 223.5 Steel and iron - Determination of acid-soluble silicon and total silicon content - Reduced molybdosilicate spectrophotometric method

GB/T 223.9 Iron steel and alloy - Determination of aluminium content - Chrome azurol S photometric method

GB/T 223.11 Iron, steel and alloy - Determination of chromium content - Visual titration or potentiometric titration method

GB/T 223.12 Methods for chemical analysis of iron, steel and alloy - The sodium carbonate separation-diphenyl carbazide photometric method for the determination of chromium content

GB/T 223.14 Methods for chemical analysis of iron, steel and alloy - The N-Benzoy-N-Phenylhydroxylamine extraction photometric method for the determination of vanadium content

GB/T 223.18 Methods for chemical analysis of iron, steel and alloy - The sodium thiosulfate separation iodimetric method for the determination of copper content

GB/T 223.69 Iron, steel and alloy - Determination of carbon contents - Gas-volumetric method after combustion in the pipe furnace

GB/T 223.71 Methods for chemical analysis of iron, steel and alloy the gravimetric method after combustion in the pipe furnace for the determination of carbon content

GB/T 223.72 Iron, steel and alloy - Determination of sulfur content - Gravimetric method

GB/T 223.76 Methods for chemical analysis of iron, steel and alloy - The flame atomic absorption spectrometric method for the determination of vanadium content

GB/T 223.82 Steel and iron - Determination of hydrogen content - Thermal conductivity/infrared method after fusion under inert gas

GB/T 224 Determination of depth of decarburization of steels

GB/T 226 Low-magnification microstructure and defect acid etching test method of steel

GB/T 228.1 Metallic materials - Tensile testing - Part 1: Method of test at room temperature

GB/T 230.1 Metallic materials - Rockwell hardness test - Part 1: Test method

GB/T 231.1 Metallic materials - Brinell hardness test - Part 1: Test method

GB/T 3075 Metallic materials - Fatigue testing - Axial-force-controlled method

GB/T 4161 Metallic materials - Determination of plane-strain fracture toughness

GB/T 4336 Carbon and low-alloy steel - Determination of multi-element contents - Spark discharge atomic emission spectrometric method (routine method)

GB/T 6398 Metallic materials - Fatigue testing - Fatigue crack growth method

GB/T 10561-2005 Steel - Determination of content of nonmetallic inclusions - Micrographic method using standards diagrams

GB/T 11261 Steel and iron - Determination of oxygen content - The pulse heating inert gas fusion-infra-red absorption method

GB/T 13298 Inspection methods of microstructure for metals

GB/T 20066 Steel and iron - Sampling and preparation of samples for the determination of chemical composition

GB/T 20123 Steel and iron - Determination of total carbon and sulfur content

Infrared absorption method after combustion in an induction furnace (routine method)

GB/T 20124 Steel and iron - Determination of nitrogen content - Thermal conductimetric method after fusion in a current of inert gas

GB/T 20125 Low-alloy steel - Determination of multi-element contents - Inductively coupled plasma atomic emission spectrometric method

YB/T 081 Rule for rounding off of numerical values and judgement of testing values for technical standards of metallurgy

YB/T 951 Method of the ultrasonic testing for rails

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Heat

All billets cast from one heat of molten steel until a certain billet is completely poured from the next heat of molten steel (excluding this billet).

3.2

Sequence

Sequence of molten steel of the same designation in different heats in the tundish.

3.3

On line heat-treatment

The heat treatment process of using the waste heat of rolling to directly carry out accelerated cooling, to obtain fine flaky pearlite structure.

4 Order contents

When ordering, the buyer shall provide the supplier with the following information:

a) Product name;

b) The number of this standard;

c) Rail type and speed grade;

6.3 Rail length and tolerance

6.3.1 Rail length

6.3.1.1 The fixed length of the standard rail is:

- The rail type of 38 kg/m, 43 kg/m: 12.5 m, 25 m;
- The rail type of 50 kg/m, 60 kg/m: 12.5 m, 25 m, 100 m;
- The rail type of 75 kg/m: 25 m, 75 m, 100 m.

6.3.1.2 The length of the curved shortened rail is:

- 12.5 m rail: 12.46 m, 12.42 m, 12.38 m;
- 25 m rail: 24.96 m, 24.92 m, 24.84 m.

6.3.1.3 The short gauge rail length is:

- 12.5 m rails: 9 m, 9.5 m, 11 m, 11.5 m, 12 m;
- 25 m rail: 21 m, 22 m, 23 m, 24 m, 24.5 m;
- 75 m rail: 71 m, 72 m, 73 m, 74 m;
- 100 m rail: 95 m, 96 m, 97 m, 99 m.

The quantity of short rails shall be negotiated by the supplier and purchaser, AND specified in the contract. The quantity of short rails, which have an operating speed less than 200 km/h, shall not exceed 10% of the total order quantity. The quantity of short rails, which have an operating speed of 200 km/h and above, shall not exceed 5% of the total order quantity. In principle, steel rails with holes shall not have short gauge rails. After negotiation between the supplier and the buyer, short gauge rails can also be drilled.

6.3.1.4 The length of curvilinear shortened rails for rails, which have a fixed length of 75 m and 100 m, shall be negotiated between the supplier and the purchaser; the collocation quantity of the short rails shall be indicated in the contract.

6.3.2 Length tolerance

The tolerance of the length of the rail shall comply with the provisions in Table 3.

1) Rails with an operating speed of less than 200 km/h: those located on the rail head tread and the lower surface of the rail bottom shall not be greater than 0.4 mm; there shall be no transverse scratches on the lower surface of the rail bottom; those located on other parts of the rail shall not be greater than 0.5 mm;

2) Rails with an operating speed greater than or equal to 200 km/h: those located on the rail head tread and the lower surface of the rail bottom shall not be greater than 0.3 mm; there shall be no transverse scratches on the lower surface of the rail bottom; those located on other parts of the rail shall not be greater than 0.5 mm.

7.10.2 There shall be no delamination or cracks on the end face of the rail and the surface of the bolt hole; the burrs on the edge shall be removed.

7.10.3 All the raised parts on the rail tread, the lower surface of the rail bottom, within 1 m from the end of the rail that affect the assembly of the joint splint shall be removed (except for the hot-rolled mark).

7.10.4 Rail surface defects can be cleaned by grinding. The cleaning shall be carried out in the longitudinal direction; the cleaning width shall not be less than 5 times the depth. After cleaning, the size of the rail shall meet the requirements in Table 1. The grinding part of the rail shall have a smooth transition AND shall not affect the microstructure.

7.10.5 The rail bottom shall be automatically detected, along the entire length of the rail. All equipment shall be capable of detecting artificial defect sizes of the sizes, which are specified in Table 10. The size tolerance of artificial defects is ±0.1 mm. When using the rail bottom automatic detection technology to detect, the detection range shall be at least 60 mm wider than the center of the rail bottom. The test track with artificial defects shall be calibrated once every 8 hours. When automatic detection equipment cannot be used normally, manual inspection shall be adopted.

7.11 Residual stress on rail bottom

The maximum longitudinal residual tensile stress of the rail bottom shall not be greater than 250 MPa.

7.12 Fatigue performance

When the total strain amplitude is 1350 με, the fatigue life of each specimen (that is, the number of cycles when the specimen is completely broken) shall be greater than 5

8.3 Microstructural examination

Sampling at the rail head for microstructure inspection, see Figure 5 for the sampling location. The magnification is 500 times under the metallographic microscope; the test is carried out according to the method specified in GB/T 13298.

8.4 Inspection of decarburized layer

Measure the depth of the continuous closed ferrite network, at any part of the surface layer of the rail head, as specified in Figure 2 (see Figure 3). The test shall be carried out according to the method of GB/T 224.

8.5 Inspection of hydrogen, oxygen, nitrogen content

8.5.1 Hydrogen content

8.5.1.1 The hydrogen content of molten steel is determined according to the partial pressure value of hydrogen in the steel; it is measured by a wire-immersion probe system. At least two specimens shall be taken from the first heat of molten steel poured in a new tundish; one specimen shall be taken from each of the remaining heats. The first specimen from the first heat of a sequence shall be taken from the tundish at the time when the hydrogen content is highest. When the hydrogen content in the molten steel is not more than 2.5×10^{-4}%, the hydrogen content of the rail may be exempted from inspection; when the hydrogen content in the molten steel is greater than 2.5×10^{-4}%, the sequence billet shall be subject to retarded cooling, then the hydrogen content

Rails shall be accepted in batches. Each batch consists of rails, which are rolled from billets as continuously poured by several furnaces of molten steel of the same designation and model.

9.4 Re-inspection and judgment

9.4.1 Chemical composition

If the chemical composition and hydrogen content are unqualified, re-inspection shall not be performed. When the oxygen and nitrogen elements are unqualified, re-inspection shall be carried out, for each batch of steel. The rails of qualified furnaces can be accepted after re-inspection; the rails of unqualified furnaces shall not be accepted.

9.4.2 Tensile test

If the result of the initial inspection is unqualified, a re-inspection sample shall be taken from the other two rails of the same furnace for re-inspection. One of the re-inspection samples shall be taken from the rail, which is rolled in the same casting stream, as the initial inspection sample; the other re-inspection sample shall be sampled from the rails, which are rolled in other casting stream. When the inspection results of the two re-inspection samples conform to the provisions of this standard, this furnace of rail shall be accepted.

If the inspection results of the two re-inspection samples do not meet the requirements of this standard, samples shall be taken again for re-inspection. That is to say, if the two inspection results of the rail of same casting stream are unqualified, the rail of same casting stream shall not be accepted. If the first inspection fails, the unqualified rail shall continue to be sampled and inspected, according to the above sampling method on the casting stream where the unqualified rail is located and the rail rolled by other casting streams, until it is qualified.

9.4.3 Decarburized layer, non-metallic inclusions

9.4.3.1 Decarburized layer

If the preliminary inspection fails, a specimen shall be taken from two adjacent rails of the same batch, for re-inspection. When the inspection results of the two specimens are all qualified, the remaining rails of this batch of rails can be inspected and accepted. If the result of the re-inspection test is unqualified, continue to take samples from adjacent rails for re-inspection, until it is qualified. Rails between two retest specimens shall not be accepted.

9.4.3.2 Non-metallic inclusions

If the initial inspection fails, a re-inspection sample shall be taken from the other two rails of the same furnace for re-inspection. The two specimens for re-inspection shall

be taken respectively from the same casting stream, as the initial-inspection sample and the rails rolled by another casting stream. If the re-inspection results of the two re-inspection samples are both qualified, the whole batch of steel rails is qualified. If the inspection result of one of the specimens is unqualified, the unqualified rail shall continue to be sampled from the casting stream and the rolled rails, from other casting stream, until it is qualified. If the two inspection results of the rail of same casting stream are unqualified, the rail of same casting stream shall not be accepted.

9.4.4 Macrostructure

9.4.4.1 Rail white spots shall not be re-inspected.

9.4.4.2 When the macrostructure preliminary inspection does not meet the requirements of this standard, one specimen shall be taken, each from the front and rear sides of the preliminary inspection sampling location of the same casting stream, for re-inspection. At least one of the two re-inspection samples, are taken from the same rail of casting stream as the initial inspection sample; the rail between the two re-inspection positions shall not be accepted. If the re-inspection results of the two re-inspection samples meet the requirements, the remaining rails of the batch can be accepted. If a re-inspection sample is unqualified, continue sampling and re-inspection, until it is qualified.

9.4.4.3 When the macrostructure defect is difficult to identify, it can be further inspected at a higher magnification.

9.4.5 Microstructure

When the inspection results do not meet the requirements, re-inspect samples from two adjacent rails in the same batch. If the test results of the two specimens meet the requirements, the batch can be accepted (except for the rails that failed the preliminary inspection). If one of the specimen inspection results is unqualified, it shall continue to take samples from adjacent rails for re-inspection, until it is qualified. The rail between the two re-inspection specimens shall not be accepted.

9.5 Numerical rounding off

The rounding off of the test results of mechanical properties shall be carried out, in accordance with the provisions of GB/T 228.1. The rounding of values of other test results shall be carried out, in accordance with the provisions of YB/T 081.

10 Mark and quality certificate

10.1 Mark

10.1.1 On the rail waist on one side of each rail, the following clear and raised marks shall be rolled out, at least every 4 m intervals: the character height is 20 mm ~ 28 mm, the raised height is 0.3 mm ~ 1.5 mm:

a) The sign of the manufacturer;

b) Rail type;

c) Steel designation;

d) Speed grade (rails whose operating speed is not less than 200 km/h are marked with "G"; rails whose operating speed is less than 200 km/h are not marked);

e) Manufacturing year (the last two digits of the rolling year), month.

10.1.2 Rails, that do not meet the requirements of operating speed greater than or equal to 200 km/h BUT meet the requirements of operating speed less than 200 km/h, can be reduced to use as rails, whose operating speed is less than 200 km/h; however, a hot-rolled mark on each end of the rail "G" shall be removed by grinding.

10.1.3 On the other side of each rail, at a distance not less than 0.6 m from the rail end AND an interval of not more than 15 m, use a hot embossing machine (not cold embossing) to emboss the following clear signs in sequence. The embossing characters shall have a straight or arc-shaped surface; the characters shall be 10 mm ~ 16 mm high, 0.3 mm ~ 1.5 mm deep, 1 mm ~ 1.5 mm wide; the sides shall be inclined; the letters and numbers shall be 10° from the vertical and have an arc corner; the heat embossing mark consists of the following 13 digits and letters:

- The 1st digit: The characteristic symbol of the steel plant, consisting of 1 English capital letter, such as: P means Panzhihua Iron and Steel; A means Anshan Iron and Steel; B means Baotou Steel; W means Wuhan Iron and Steel; H means Handan Iron and Steel;

- The 2nd ~ 3rd digits indicate the year of steelmaking, consisting of 2 digits of Arabic numerals, such as: 09 indicates 2009; 10 indicates 2010, and so on;

- The 4th ~ 9th digits represent the serial number of the converter, composed of 6 Arabic numerals, which is compiled by the steel mill;

- The 10th digit indicates the sequence stream number, which is composed of 1 Arabic numeral: 1 ~ 5 for a 5-stream sequence machine, 1 ~ 6 for a 6-stream sequence machine;

- The 11th ~ 12th digits indicate the sequence billet number, consisting of 2 Arabic numerals;

- The 13th digit indicates the rail sequence number, consisting of 1 English capital letter: A, B, C, D.

10.1.4 If the hot-printed mark is missed or changed, the mark shall be sprayed on the rail waist, for at least 2 places for rails less than or equal to 25 m, OR at least 1 place

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