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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 5068-2019

Axles steel for railway locomotives and wagons

铁路机车、车辆车轴用钢

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1 Scope

China's national standard for the steel from which railway locomotive and wagon axles are made. A railway axle is the single component whose failure is least survivable: it carries the vehicle's weight through a rotating bending load that reverses on every revolution, which is the classic fatigue duty, and it is expected to last decades and hundreds of millions of cycles. There is no redundancy - an axle that breaks derails the vehicle and quite possibly the train - and the failures that have occurred have usually traced back not to design but to an inclusion or a segregation in the steel, a defect a few millimetres across from which a crack started. That is why the material specification is exacting in ways a strength requirement alone would not convey: cleanliness, internal soundness, freedom from segregation, and full ultrasonic inspection. The standard covers high-quality carbon and alloy structural steel in square and round bar for axle manufacture, with the classification, coding, dimensions, tolerances, requirements, test methods and inspection rules.

This standard specifies the classification, code, size, shape, weight and allowable deviation, technical requirements, test methods, inspection rules, packaging, markings, quality certificates of axles steel for railway locomotive and wagons. This standard is applicable to the high-quality carbon structural steel and alloy structural steel square steel and round steel (hereinafter referred to as axle billet) for the manufacture of axles for railway locomotive and wagons.

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 223.5 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 aluminum 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-benzoyl-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 determination of carbon content

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

GB/T 223.74 Methods for chemical analysis of iron, steel and alloy - The combustion gravimetric/gas-volumetric method for the determination of combined carbon content

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 226 Test method for macrostructure and defect of steel by etching

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

GB/T 229 Metallic materials - Charpy pendulum impact test method

3 Classification and code

3.1 Classification Axle billets are classified into two types according to their uses: axle billets for railway locomotives and axle billets for wagons.

3.2 Code Code of axle billet for locomotive: JZ (JZ is the Chinese Pinyin prefix for the locomotive axle); Code of the axle billet for wagon: LZ (LZ is the Chinese Pinyin prefix for the wagon axle).

4.1 Size and allowable deviation

4.1.1 The cross-section size and allowable deviation of square steel shall meet the requirements of Table 1.

4.1.2 The cross-section size and allowable deviation of round steel shall meet the requirements of Table 2.

4.1.3 The fixed-length or multiple-length of the axle billet shall be determined by the agreement between the supplier and the buyer and shall be indicated in the contract. The allowable deviation between fixed-length and multiple-length is 0 mm ~ 80 mm.

4.1.4 Forged steel shall be used for square steel with side length not less than 320 mm; rolled or forged steel shall be used for square steel with side length below 320 mm.

4.1.5 Axle billets of other specifications and deviations can be supplied upon agreement between the supplier and the buyer and indicated in the contract.

5.1.3 Upon agreement between the supplier and the buyer and indicated in the contract, axle billets of other designations and chemical compositions can be supplied.

5.2 Smelting and rolling, forging

5.2.1 The steel billets for the manufacture of axles shall be smelted in an electric arc furnace or a converter; meanwhile subjected to external refining and vacuum degassing treatment.

5.2.2 The billets after hot rolling or forging shall be stacked for cooling or put in pits for slow cooling and annealing.

5.2.3 The rolling ratio from ingot to axle billet shall not be less than 6:1; the forging ratio shall not be less than 3:1; the rolling ratio or forging ratio from continuous casting billet to axle billet shall not be less than 3:1. For LZ50, the rolling ratio or forging ratio of continuous casting billet to axle is not less than 3:1.

5.3 Delivery status Axle billets are delivered in hot rolled or forged state. When the buyer has special needs, it shall be indicated in the contract.

5.4 Macrostructure There shall be no visible white spots, cracks, residual shrinkage holes, delamination, under-skin blisters, internal blisters, inclusions (non-metallic and dissimilar metals), peeling, intergranular cracks, bright strip, etc., on the horizontal acid-leached macrostructure test piece of the axle steel billet. The grade of acid-leached macrostructure shall meet the requirements of Table 5. Table 5 -- The grade of acid-leaching macrostructure

5.5 Non-metallic inclusions The inspection of non-metallic inclusions in the axle billet shall be evaluated according to the method A in GB/T 10561-2005; the inspection results shall meet the requirements of Table 6. Table 9 -- Mechanical properties

5.7 Grain size

5.7.1 Sampling position The grain size specimen shall be taken from the undeformed large end of the tensile specimen or sampled at the position of the tensile specimen, as shown in Figure A.1 and Figure A.2, from the heat-treated sample billet.

5.7.2 Grain size of high-quality carbon structural steel The specimen made of the undeformed large end or sample billet of the tensile sample after a normalizing heat treatment shall have a grain size grade of 5 or finer.

5.7.3 Grain size of alloy structural steel According to the requirements of GB/T 6394, the austenite grain size of the axle billet shall be tested. The grain grade shall be 6 or finer, meanwhile the difference between the highest and the lowest grades shall not exceed 3.

5.8 Ultrasonic flaw detection According to the requirements of the buyer, the axle billets for wagons can be ultrasonically tested after negotiation between the supplier and the buyer and indicated in the contract. Locomotive axle billets shall be tested by ultrasonic flaw detection one by one in case of exit-factory. Ultrasonic testing and evaluation shall be carried out according to GB/T 7736. For locomotive axle billet, the defect equivalent value is $\leq \phi$

3.2 mm; for wagon axle billet, the defect equivalent value shall be based on the requirements of the buyer. The quality certificate indicates that the flaw detection is qualified.

5.9 Surface quality (if the heat treatment performance is unqualified, it is allowed to readjust the heat treatment once to inspect the mechanical properties; the billet is judged as qualified if the inspection is qualified). In addition, select two A-segment axle billets from the remaining batch of axle billets for the re-inspection of the unqualified item (white dots are not allowed to re-inspect). If the re-inspection result is qualified, the remaining axle billets of the batch are qualified. When one of the indicators in the re-inspection result (including any index required by the test of this item) is unqualified, all A-segment axle billets of the batch are judged as unqualified. In this case, samples can be taken from the non-marked end of any two A-segment billets or the marked end of the B-segment billet for the full item test. When one specimen fails, the batch of axle billets is judged as unqualified; when the test results are all qualified, all axle billets except the A-segment axle billets are qualified. For continuous casting axle billets, if one of the test results does not meet the requirements of the technical conditions of this standard, this axle billet is scrapped (if the heat treatment performance is unqualified, it is allowed to readjust the heat treatment once to check the mechanical properties. After the inspection is qualified, the billet is judged to be qualified).