Baoshan Iron and Steel Co., Ltd. Enterprise Standards

Q/BQB 670—2023 replaces Q/BQB 670—2019

High Hard Protective Steel Plate

High Hardness Steel Sheets and Plates for Protection

Posted on 2023-04-09 2023-07-01 Implementation

Baoshan Iron and Steel Co., Ltd.released

Preface

This document is drafted in accordance with the provisions of GB/T 1.1—2020 'Guidelines for Standardization Work Part 1: Structure and drafting rules of standardization documents'.

This document is formulated according to Baosteel product development and actual production.

This document replaces Q/BQB 670—2019 'High-hardness Protective Steel Plate'. Compared with Q/BQB 670-2019, the main technical changes are as follows, excluding structural adjustments and editorial modifications:

—— Include the year of GB/T 228.1 in the normative reference documents.

—— Chapter 3, Terms and Definitions, was added;

—— The grade P6500 and its corresponding requirements are added.

This document is proposed by the Manufacturing Management Department of Baoshan Iron & Steel Co., Ltd.

This document is under the jurisdiction of the Manufacturing Management Department of Baoshan Iron & Steel Co., Ltd.

This document is drafted by the Manufacturing Management Department of Baoshan Iron & Steel Co., Ltd.

The main drafter of this document is Huang Jinhua.

The release history of this document and its superseded versions is as follows: Q/BQB 670-2019.

High Hard Protective Steel Plate

1 Scope

This document specifies the size, shape, technical requirements, testing and inspection, marking and inspection documents of high-hardness protective steel plate.

This document is applicable to the high-hardness protective single-rolled steel plate produced by Baoshan Iron & Steel Co., Ltd. and the steel plate cut from hot-rolled steel strip.

2 Normative Reference Document

The contents of the following documents shall constitute the essential provisions of this document through their normative references. For references with dates, only the version corresponding to that date shall apply to this document; for references without dates, the latest version (including all amendments) shall apply to this document.

GB/T 222—2006 allowable deviation of chemical composition of finished steel

GB/T 223 Methods for chemical analysis of iron and steel (applicable parts)

GB/T 228.1—2021 Metallic Materials—Tensile Test—Part 1: Test Method at Room Temperature

GB/T 229. Method for impact test of metal materials by Charpy pendulum

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

GB/T 232 Method for testing bending of metallic materials

General provisions for packaging, marking and quality certificates of steel plates and steel strips

GB/T 2970 Ultrasonic Testing Method for Thick Plate Steel

GB/T 2975—2018 Steel and steel products Sampling position and sample preparation for mechanical properties test

GB/T 4336 Carbon steel and medium-low alloy steel Determination of multi-element content Spark discharge atomic emission spectrometry (conventional method) GB/T 8170 Rules for numerical rounding and representation and determination of limit values

GB/T 20066 Sampling and sample preparation for chemical composition determination of steel and iron

GB/T 20123 Steel Determination of total carbon and sulfur content by infrared absorption after combustion in high-frequency induction furnace (conventional method)

GB/T 20125 Low-alloy steel Determination of multi-element content Inductively coupled plasma atomic emission spectrometry

General Provisions for Packaging, Marking and Inspection Documents of Hot Strip Steel Plates and Steel Strips Q/BQB 300

Q/BQB 301 Dimension, Shape, Weight and Allowable Deviation of Hot Strip Steel Plate and Strip

Q/BQB 600 General Technical Requirements for Thick Steel Plates

3 Terms and Definitions

There are no terms and definitions to be defined in this document.

4 Classification and Code

4.1 Brand Name Representation

The steel grade is composed of the initial letter 'B' representing Baosteel, the initial letter 'P' for protection, or 'ARMOR' for armor, along with the average Brinell hardness or a hardness code. For example, the grade B900FD combines the initial 'B' of Baosteel, the specified minimum tensile strength (in MPa), and the initial 'F' denoting bulletproof application.

4.2 The grade, nominal thickness, delivery condition, product category and application of steel plate are shown in Table 1.

Table 1

Card number [a]	Normal thickness mm	Condition of delivery	Product category [b]	Use
BP300、B900FD	2.0～12.0	tempering	Hot rolled and heat treated steel plate	Protective steel plates, used for various vehicles, structures, and protective frameworks requiring excellent protective performance.
BP440、BP500、BP500T（P6500）、BP600	2.0～12.0	Quenching + tempering		
BARMOR500（BARMOR 04）	4.5～60.0	Quenching + tempering	Thick plate, hot rolled and heat treated steel plate	
BARMOR600（BARMOR 06）	4.5～30.0			

[a] The order can be made according to the brand name in the bracket.

[b] Hot-rolled steel plate is the steel plate which is cut from hot-rolled steel strip and then treated by heat treatment.

5 Order Information

5.1 The Following Information Must Be Provided by the User When Placing an Order:

a) Document number and brand name;

b) category of the product；

c) Specifications and dimensional accuracy;

d) boundary situation；

e) weight；

f) use；

g) Check file type

h) ballistic performance requirement

i) Other (such as special requirements).

5.2 Omission in Contract of Order

Unless otherwise specified in this document, the steel plate shall be delivered with standard dimensional accuracy unless dimensional accuracy is specified. The steel plate shall be delivered with untrimmed edges unless edge condition is specified.

6 Size, Shape, Weight, and Allowable Deviations

6.1 The thickness tolerance of steel plate shall comply with Table 2.

6.2 Other dimensions, shape, weight and allowable deviation of hot-rolled and heat-treated steel plate should comply with the provisions of Q / BQB 301.

6.3 The other dimensions, shape, weight and allowable deviation of the plate shall comply with the provisions of Q/BQB 600.

6.4 If the buyer requests it, delivery may be made with other dimensional tolerances upon mutual agreement between the supplier and the buyer and stipulated in the contract.

Table 2

Nominal thickness [b] mm	Allowable thickness deviation at specified widths	
	≤1600	>1600
≤6.0	+0.50 0	+0.60 0
>6.0～12.0	+0.70 0	+1.00 0
>12.0～16.0	+1.00 0	+1.10 0
>16.0～30.0	+0.90 -0.20	+1.00 -0.20
>30.0～40.0	+1.10 -0.30	+1.30 -0.30
>40.0～60.0	+1.30 -0.30	+1.50 -0.30

7 Technical Requirement

7.1 Grade and Chemical Composition

7.1.1 The grade and chemical composition (melting analysis) of steel shall comply with the requirements specified in Table 3.

Table 3

The name of a shop	Chemical composition [a] (mass fraction)%										
	C ≤	Si ≤	Mn ≤	P ≤	S ≤	Alt ≥	Cr ≤	Ni ≤	Ti ≤	Mo ≤	B ≤
BP300 B900FD	0.22	0.50	2.00	0.020	0.015	0.015	0.50	0.50	-	-	0.005
BP440	0.35	0.50	1.85	0.020	0.015	0.015	1.00	0.50	-	-	0.005
BP500 BP500T （P6500）	0.45	1.00	1.85	0.020	0.015	0.015	1.20	0.80	-	-	0.005
BP600	0.50	1.00	1.85	0.020	0.015	0.015	1.20	0.80	-	-	0.005
BARMOR500 (BARMOR 04)	0.35	1.00	1.60	0.010	0.006	0.015	1.00	3.20	0.06	0.80	0.005
BARMOR600 (BARMOR 06)	0.45	1.80	1.60	0.010	0.006	0.015	1.50	3.20	0.06	0.80	0.005

[a] In order to improve the properties of steel plate, other micro-alloying elements can be added as needed.

7.1.2 The allowable deviation of chemical composition of finished steel should comply with the provisions of GB / T 222.

7.2 Smelting Process

The steel used in the steel plate is the oxygen converter or electric furnace smelting and refining of the calm steel.

7.3 Condition of Delivery

The steel plate is delivered in quenched and tempered or tempered state.

7.4 Mechanics and Process Performance

7.4.1 The mechanical and process properties of the steel plate shall comply with the requirements specified in Table 4 and Table 5.

Table 4

The name of a shop	Tensile test [a] $L_0=5.65\sqrt{S_0}$			Brinell hardness [b] HBW (Nominal thickness ≥4mm)	90°Bending test [c](a= sample thickness, b= sample width, D= diameter of bending press head)
	Yield strength $R_{p0.2}$ MPa	Tensile strength Rm MPa	Post-break elongation A %		
BP300 B900FD	≥700	≥900	≥10	-	D=3a
BP440	≥1100	≥1250	≥8	420～480	-
BP500	≥1250	≥1450	≥6	470～540	-
BP500T （P6500）	≥1250	≥1450	≥8	470～540	D=8a
BP600	≥1450	≥1750	≥6	570～640	-

[a] The specified values of tensile test are applicable to transverse specimens.

[b] The Brinell hardness value is the average of three test results. The specified Brinell hardness value applies to steel plates with a nominal thickness of not less than 4mm. The specified [c] bending test value applies to transverse specimens with a bending specimen width of b≥20 mm, and b=20mm in arbitration.

Table 5

The name of a shop	Normal thickness	Brinell hardness [a] HBW	Impact test [b]	
			temperature ℃	Impact absorption energy KV_2 J
BARMOR500 (BARMOR 04)	≤30	460～540	-40	≥40
	>30.0～60.0	440～540		≥32
BARMOR600 (BARMOR 06)	≤30	540～630	-40	≥20

[a] The Brinell hardness value was the average of three test results.

[b] The impact test is taken from the transverse sample, and the impact sample is the standard sample.

7.4.2 After bending test, the outer surface of the specimen shall not have visible cracks.

7.4.3 The impact absorption energy is the average value of test results from three specimens, allowing one specimen's result to be below the specified value, but not less than 70% of the specified value.

7.4.4 Impact testing is only applicable to products with a thickness of 6mm or more. For products with a thickness of 12mm or more, a standard sample measuring 10mm×10mm×55mm shall be used, and the test results must meet the specified values in the table. For steel plates with a thickness between 6mm and 12mm, small-sized samples measuring 7.5mm×10mm×55mm or 5mm×10mm×55mm shall be used, and the test results must be at least 75% or 50% of the specified values in the table, respectively.

7.4.5 The impact test results shall be calculated as the arithmetic mean of three samples per batch, with one sample permitted to fall below the specified value, provided that no sample falls below 70% of the specified value. If this condition is not met, three additional samples shall be taken from the same batch for retesting. In such cases, the arithmetic mean of the six samples (before and after retesting) must not be lower than the specified value. Two samples may be allowed to fall below the specified value, but only one sample may be below 70% of the specified value.

7.5 Impact Resistance

The anti-impact performance of steel plate is agreed by the supplier and the customer in the contract.

Note: The bullet resistance performance has been tested for some nominal thicknesses of each grade. For order details, please consult the manufacturer for the document 'Typical Thickness Q/BQB 670—2023 Bullet Resistance Performance of High Hardness Protective Steel Plates'.

7.6 Supersonic Inspection

As per the requirements of the purchaser, and upon mutual agreement between the supplier and the purchaser with explicit stipulation in the contract, the thick plates may undergo ultrasonic inspection sheet by sheet. The ultrasonic inspection method shall comply with the provisions of GB/T 2970, and the qualification level shall be specified in the contract.

7.7 Surface Quality

7.7.1 The steel plate surface must be free from any harmful defects such as cracks, bubbles, scars, folds, or inclusions. No delamination is permitted. If such defects are found, they may be cleaned to a depth calculated from the actual dimensions of the steel plate, which shall not exceed half the thickness tolerance of the steel plate and must ensure the minimum thickness of the steel plate. The cleaned areas must be smooth and free of sharp edges.

7.7.2 Other defects are allowed, but the depth of the defects should not exceed half of the allowable tolerance of the steel plate thickness, and the thickness of the defects should not be less than the minimum allowable thickness of the steel plate.

7.8 Special Requirements

7.8.1 If requested by the buyer, the supplier may, upon mutual agreement and contractual stipulation, impose impact test requirements on the grades specified in Table 4.

7.8.2 If requested by the buyer, the tensile test for the grades listed in Table 5 may be conducted upon mutual agreement between the supplier and the buyer, as stipulated in the contract. However, the test results are for reference only.

7.8.3 If the purchaser requests, the supplier may, upon mutual agreement and contractual stipulation, mandate bending tests for grades not specified for such tests.

8 Inspection and Testing

8.1 The appearance of steel plate was examined by naked eye.

8.2 The size and shape of steel plate should be measured with appropriate measuring tools.

8.3 The inspection items, sample quantity, sampling method, test method, and sampling direction for each batch of steel plates shall comply with the provisions in Table 6.

8.4 sampling rate

8.4.1 The sampling frequency of chemical composition analysis is according to the furnace for chemical composition melting analysis.

8.4.2 Sampling Frequency of Mechanical and Process Performance

Each batch should be composed of the same heat treatment parent plate or the same heat treatment system of the same parent coil.

8.4.3 The rules of batch grouping can be determined by the negotiation between the supplier and the customer.

Table 6

Order number	Inspecting item	Number of samples, units	Sampling method [b]	Experimental method
1	Chemical analysis [a]	1 (Per furnace)	GB/T 20066	GB/T 223, GB/T 4336, GB/T 20123, GB/T 20125 or General Method
2	Tension test	1/lot	GB/T 2975-2018	GB/T 228.1—2021 Method B [c]
3	Hardness test	1 per (measure 3 points)/lot	The sampling position is at 1/4 of the steel plate width, and the measurement should be performed on the surface of the steel plate after removing 0.3mm to 2mm in thickness.	GB/T 231.1
4	Blow-test	1 Group (3) / Lot	GB/T 2975-2018 Thickness ≤40mm, Figure A11 a) (near surface); Thickness>40mm, Figure A11 b) (1/4t)	GB/T 229
5	Bend test	1/lot	GB/T 2975-2018	GB/T 232
6	Impact resistance [d]	–	–	–
7	Ultrasonic inspection (negotiated)	One by one	–	GB/T 2970

[a] The test method used in arbitration was GB/T 223.

[b] When sampling cannot be performed at the specified location, the sampling site should be as close as possible to the target location.

[c] To improve the reproducibility of the measurement results, it is recommended to use the beam displacement rate control method. The beam displacement rate for yield strength measurement is 0.00083× L_c(mm/s) or 0.05× L_c(mm/min). After yield strength measurement, the beam displacement rate is 0.0067× L_c(mm/s) or 0.4× L_c(mm/min).

[d] Impact resistance performance, as a guaranteed item, is typically not tested by the supplier. If the purchaser requests testing, it shall be agreed upon through mutual consultation between both parties and specified in the contract.

8.5 Review

8.5.1 If the hardness test results do not meet the specified requirements, a second sample shall be taken from the same steel plate for retest. If the retest results are qualified, the entire batch is deemed acceptable.

8.5.2 The reinspection of other test items shall comply with the provisions of GB/T 17505.

9 Packaging, Marking and Inspection Documents

9.1 The packaging, labeling, and inspection documentation for hot-rolled and heat-treated steel plates must comply with the requirements of Q/BQB 300.

9.2 The marking and inspection documents of the thick plate shall comply with the provisions of Q/BQB 600.

10 Rounding

The numerical evaluation adopts the rounding value comparison method, and the numerical rounding should comply with the provisions of GB/T 8170.