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# Welded High Strength Shaped and Round Steel Tubes for Automobile Structure

汽车结构用高强度异型及圆形焊接钢管

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# Welded High Strength Shaped and Round Steel Tubes for Automobile Structure

## 1 Scope

This Document specifies the classification and code, ordering content, size, shape, weight and allowable deviations, technical requirements, test methods, inspection rules, packaging, markings and quality certificates of the welded high-strength shaped and round steel tubes for automobile structures.

This Document is applicable to the welded high-strength shaped and round welded steel tubes for automobile structures (hereinafter referred to as steel tubes).

## 2 Normative References

The provisions in following documents become the provisions of this Document through reference in 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 Document.

GB/T 222 Permissible Tolerances for Chemical Composition of Steel Products

GB/T 223.9 Iron Steel and Alloy - Determination of Aluminium Content – Chrome Azurol S Photometric Method

GB/T 223.17 Methods for Chemical Analysis of Iron, Steel and Alloy - The Diantipyrylmethane Photometric Method for the Determination of Titanium Content

GB/T 223.26 Iron, Steel and Alloy - Determination of Molybdenum Content - The Thiocyanate Spectrophotometric Method

GB/T 223.40 Iron, Steel and Alloy - Determination of Niobium Content by the Sulphochlorophenol S Spectrophotometric Method

GB/T 223.59 Iron, Steel and Alloy - Determination of Phosphorus Content - Bismuth Phosphomolybdate Blue Spectrophotometric Method and Antimony Phosphomolybdate Blue Spectrophotometric Method

GB/T 223.60 Methods for Chemical Analysis of Iron, Steel and Alloy - The Perchloric Acid Dehydration Gravimetric Method for the Determination of Silicon

GB/T 10561-2005 Steel - Determination of Content of Nonmetallic Inclusions - Micrographic Method Using Standards Diagrams

GB/T 12606-2016 Automated Full Peripheral Flux Leakage Testing of Seamless and Welded (Except Submerged Arc-Welded) Ferromagnetic Steel Tubes for the Detection of Longitudinal and/or Transverse Imperfections

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 20125 Low-Alloy Steel - Determination of Multi-Element Contents - Inductively Coupled Plasma Atomic Emission Spectrometric Method

GB/T 21835 Dimensions and Masses per Unit Length of Welded Steel Pipes

GB/T 30062 Terminology of Steel Pipes and Tubes

# 3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB/T 30062 apply.

# 4 Classification and Code

### 4.1 Naming method of steel grade

Steel grades are named according to the specified minimum upper yield strength values, which are divided into 355, 380, 420, 460, 500, 550, 600, 650, 700.

### 4.2 Classification and code of steel tube precision level

**4.2.1** The steel tubes are classified and coded according to the precision level of the outer diameter (side length) as follows:

a) Ordinary level: PD (P A/B).a;

b) Higher-level: PD (P A/B).b;

c) Advanced level: PD(P A/B).c.

**4.2.2** The steel tubes are classified and coded according to the wall thickness precision

level as follows:

a) Ordinary level: PT.a;

b) Advanced level: PT.c.

**4.2.3** The steel tubes are classified and coded according to the precision level of bending degree are as follows:

a) Ordinary level: PS.a;

b) Higher-level: PS.b;

c) Advanced level: PS.c.

**4.2.4** The steel tubes are classified and coded according to the prevision level of side roughness:

a) Ordinary level: PF.a;

b) Advanced level: PF.c.

# 5 Ordering Content

The contract or order for ordering steel tubes according to this Document shall include the following:

a) The number of this Document;

b) Product name;

c) Steel designation (the designation determined through the negotiation between the supplier and the purchaser on the steel grade);

d) Size specifications (for shaped steel tubes: side length × side length × wall thickness; round steel tubes: nominal outer diameter × nominal wall thickness, in millimetres);

e) The ordered quantity (total weight or total length);

f) Special requirements.

# 6 Size, Shape, Weight and Allowable Deviation

## 6.1 Dimensions and allowable deviation

#### 6.7.1 Delivery weight

Steel tubes are delivered according to actual weight. If it is stated in the contract, the steel tubes can also be delivered according to the theoretical weight.

#### 6.7.2 Calculation of theoretical weight

With the density of steel of 7.85kg/dm$^3$, the calculation of the theoretical weight per unit length of round steel tubes shall comply with the provisions of GB/T 21835; and the theoretical weight per unit length of the shaped steel tubes shall comply with the provisions of GB/T 6726.

#### 6.7.3 Allowable deviation of weight

The allowable deviation between the actual weight and the theoretical weight of the delivered steel tube is ±5%. According to the request of the purchaser, after negotiation between the supplier and the purchaser and indicated in the contract, other allowable deviations of weight can be specified.

## 7 Technical Requirements

### 7.1 Designation and chemical composition of steel

**7.1.1** The steel grade and chemical composition (melting analysis) of the steel shall comply with the provisions of Table 8. The supplier and the purchaser shall determine the steel designation through negotiation on the steel grade when ordering. According to the requirements of the buyer, after negotiation between the supplier and the purchaser and indicated in the contract, steel tubes of other strength grades and/or chemical compositions can be supplied.

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

### 7.6.1 Flattening

**7.6.1.1** The round steel tube shall be subjected to a flattening test. The length of the flattened sample shall be no less than 63.5mm. The weld-seams of the two samples shall be located at 90° and 0° from the direction of force. The sample shall be pressed until the distance between the two plates is 2/3 of the outer diameter of the steel tube. After the test, the sample should not show cracks or clefts.

**7.6.1.2** Shaped steel tubes shall be subjected to flattening test. The length of the flattened sample shall be no less than 63.5mm, and the test method shall comply with the provisions of Appendix C. The sample shall be pressed until the distance between the two plates is 2/3 of the vertical height (*C*) or the diagonal height (*D*). After the test, the sample shall not show cracks or clefts.

### 7.6.2 Bending

For round steel tubes with an outer diameter no greater than 60.3mm, a bending test can be taken to replace the flattening test. There shall be no filler during the bending test, the radius of the bending centre (bending die) is 6 times the outer diameter of the steel tube; the bending angle is 90°; and the weld-seam is located at the maximum tensile deformation of the bending. After the test, the sample shall not show cracks or clefts.

### 7.6.3 Flaring

According to the request of the purchaser, after negotiation between the supplier and the purchaser, and indicated in the contract, the round steel tube shall be subjected to the flaring test. The top centre taper of the flaring test is one of 30°, 45° or 60°; and the flaring rate of the outer diameter of the sample shall be 6%. After the test, the sample shall not show cracks or clefts.

### 7.7 Non-destructive testing

**7.7.1** Round steel tubes shall be subjected to non-destructive testing according to one of the following methods:

a) Carry out ultrasonic testing according to the provisions of GB/T 5777-2019, and the acceptance level is U4;

b) Carry out eddy current testing according to the provisions off GB/T 7735-2016, and the acceptance level is E4H or E4.

**7.7.2** According to the request of the purchaser, after negotiation between the supplier and the purchaser, and indicated in the contract, the shaped steel tube shall be subjected to the magnetic flux leakage test. During the magnetic flux leakage test, the acceptance level shall comply with the provisions of F4 in GB/T 12606-2016.

### 7.8 Surface quality

#### 7.8.1 Surface defects

There shall be no visible cracks, scars, folding, delamination, lap welding and other defects on the inner and outer surfaces of the steel tube. These deficiencies shall be completely removed; the depth of removal shall not exceed the lower deviation of the wall thickness; and the actual wall thickness of the removal location shall be no less than the minimum allowable wall thickness.

#### 7.8.2 Weld-seam

**7.8.2.1** The burrs on the outer weld seam of the steel tube shall be removed and flattened.

**7.8.2.2** According to the request of the purchaser, after negotiation between the supplier and the purchaser, and specified in the contract, round steel tubes with an outer diameter greater than 25mm or shaped steel tubes with a circumference greater than 100mm can be delivered without internal burrs.

**7.8.2.3** When steel tubes are delivered with internal burrs removed, the reinforcement of the inner weld-seams shall comply with the provisions of Table 11; and after removing the inner weld-seam, the remaining wall thickness of the steel tubes shall be no less than the minimum allowable wall thickness. When the purchaser does not specify the reinforcement precision level of the inner weld-seam of the steel tube in the contract, it shall comply with the provisions of the ordinary level.

**Table 11 Reinforcement of Inner Weld-Seam** Unit: mm

| Precision level | Ordinary level | Advanced level |
|---|---|---|
| Reinforcement of inner weld-seam | $^{+0.4}_{-0.1}$ | $^{+0.2}_{-0.05}$ |

## 8 Test Methods

**8.1** Sampling for chemical composition analysis of steel tubes shall comply with the rules of GB/T 20066. The chemical composition analysis usually complies with the provisions in GB/T 4336, GB/T 20123, GB/T 20125 or other general methods; and the arbitration shall comply with GB/T 223.9, GB/T 223.17, GB/T 223.26, GB/T 223.40, GB/T 223.59, GB/T 223.60, GB/T 223.63, GB/T 223.76, GB/T 223.78, GB/T 223.85, GB/T 223.86, GB/T 20125.

**8.2** The size and shape of steel tubes shall be measured one by one with measuring tools that meet the accuracy requirements. The outer diameter of the steel tube shall be measured at least 50mm away from the tube end. The method of measuring the torsion value shall comply with the provisions of Appendix B.

# Appendix B

## (Normative)

## Determination of Torsion Value of the Shaped Steel Tube

### B.1 Torsion value

Due to manufacturing reasons, the steel tube rotates into a spiral around its longitudinal axis and produces a torsion angle. The maximum deviation distance per unit length is called the torsion value, and the unit is millimetres per meter (mm/m).

### B.2 Principle

If the steel tube is twisted, within a unit length, one end of its side will deviate from the plane formed by the other three end points, and this deviation distance is the torsion value.

### B.3 Measurement procedures

Take two steel plates whose side length is greater than that of the steel tube under test; and fix them on a standard flat plate with a parallel spacing of 1m, which is taken as a simple measuring tool for measuring the torsion value of the steel tube. When measuring, cover the measuring tool on the surface of the steel tube to be measured (the direction of the measuring tool is consistent with the direction of the steel tube); so that one end of the measuring tool is close to the steel tube plane. If there is torsion, the other end of the measuring tool forms an angle with the steel tube plane; use a feeler gauge to measure the maximum distance *H* of this angle, the value of which is the torsion value of the steel tube. The angle *α* can also be measured with a protractor, and the torsion value *H* is calculated according to Formula (B.1). The schematic diagram of the torsion value determination is shown in Figure B.1.

$$H = \sin\alpha (A - 2R) \qquad \cdots\cdots (B.1)$$

Where:

*H* – torsion value, in mm/m;

*α* – torsion angle per meter, in °;

*A* – side length of the steel tube, in mm;

*R* – outer arc radius, in mm.

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