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## **Wide and Heavy Plates for Offshore Line Pipe**

海底管线用宽厚钢板

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# Wide and Heavy Plates for Offshore Line Pipe

## 1 Scope

This Standard specifies the designation expression method, ordering contents, size, shape, weight, technical requirements, test methods, inspection rules, package, marking and quality certificate of hot-rolled wide and heavy plates for offshore line pipe.

This Standard is applicable to the wide and heavy plates for offshore line pipe (hereinafter referred to as steel plate) with thickness of 6mm~45mm.

## 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) are applicable to this document.

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

GB/T 223.11 Iron, Steel and Alloy - Determination of Chromium Content - Visual Titration or Potentiometric Titration Method

GB/T 223.14 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 223.16 Methods for Chemical Analysis of Iron, Steel and Alloy - The Chromotropic Acid Photometric Method for the Determination of Titanium Content

GB/T 223.18 Methods for Chemical Analysis of Iron, Steel and Alloy - The Sodium Thiosulfate Separation Iodometric Method for the Determination of Copper Content

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

GB/T 223.37 Methods for Chemical Analysis of Iron, Steel and Alloy - the Indophenol Blue Photometric Method for the Determination of Nitrogen Content after Distillation Separation

Steel and Medium and Low Alloy Steel

GB/T 4340.1 Metallic Materials - Vickers Hardness Test - Part 1: Test Method

GB/T 6394 Metal - Methods for Estimating the Average Grain Size

GB/T 8170 Rules of Rounding off for Numerical Values & Expression and Judgement of Limiting Values

GB/T 8363 Test Method for Drop-Weight Tear Tests of Steel Products

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

GB/T 12778 Metallic Materials - Determination of Charpy Impact Fracture Surface

GB/T 13298 Metal - Inspection Method of Microstructure

GB/T 13299 Steel - Determination of Microstructure

GB/T 14977 General Requirement for Surface Condition of Hot-Rolled Steel Plates

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 20126 Unalloyed Steel - Determination of Low Carbon Content - Part 2: Infrared Absorption Method after Combustion in an Induction Furnace (with Preheating)

GB/T 21143 Metallic Materials - Unified Method of Test for Determination of Quasi-static Fracture Toughness

### 3 Expression Method of Designation

The steel designation consists of English initial letter "L" representing the "Line pipe", minimum total extension strength specified for the steel pipe, English initial letter "M" representing the hot "Mechanical" rolling, and English initial letter "O" representing "Offshore". At the same time the X series designations frequently used at home and

$$A_{50\text{ mm}} = 1\,940 \times S_0^{0.2} / R_m^{0.9} \times 100\% \quad \dots\dots\dots (2)$$

Where:

$A_{50\text{ mm}}$  – the minimum elongation after break with original gauge length of 50mm;

$S_0$  – the original cross-sectional area of the tensile specimen is in square millimeters ( $\text{mm}^2$ ); for a full-thickness rectangular specimen, take whichever is smaller between  $485\text{mm}^2$  and specimen cross-sectional area (nominal thickness  $\times$  specimen width); rounded off to near the  $10\text{mm}^2$ .

$R_m$  – specified minimum tensile strength, in MPa.

#### 6.5.4 Charpy (V-notch) impact test

**6.5.4.1** If the purchaser has special requirements for the Charpy (V-notch) impact test, the test temperature, the specific value of impact energy absorption, and shear section rate shall be determining through the negotiation between the supplier and the purchaser.

**6.5.4.2** The Charpy (V-notch) impact test for the steel plate with thickness less than 12mm shall adopt the specimen with small size;  $>8\text{mm} \sim <12\text{mm}$  steel plate specimen size shall be  $10\text{mm} \times 7.5\text{mm} \times 55\text{mm}$ ; its impact absorption energy shall be no less than 75% of the value specified in Table 3.  $6\text{mm} \sim 8\text{mm}$  steel plate specimen size shall be  $10\text{mm} \times 5\text{mm} \times 55\text{mm}$ ; its impact absorption energy shall be no less than 50% value specified in Table 3; however, the shear section rate shall always conform to the provisions of Table 3.

**6.5.4.3** The strain aging test shall be carried out according to the requirements of GB/T 229. Deformation shall be carried out along the direction perpendicular to the rolling direction on a large test piece. The deformation amount is the maximum deformation amount of the base metal in actual pipe making process, or is determined through the negotiation between the supplier and the purchaser. It is aged at  $250^\circ\text{C}$  for 1h; then take the specimen for the Charpy (V-notch) impact test along the direction perpendicular to the rolling direction on such test piece; perform the curve test between the shear section rate and energy-absorbing ductile-brittle transition of the Charpy (V-notch) impact test. The test temperature is at  $-60^\circ\text{C}$ ,  $-40^\circ\text{C}$ ,  $-20^\circ\text{C}$ ,  $-10^\circ\text{C}$ ,  $0^\circ\text{C}$ ,  $20^\circ\text{C}$ ; the impact absorption energy at  $-20^\circ\text{C}$  is no less than 50% of the actual impact absorption energy under the unaged condition; and is no less than the impact absorption energy requirements of Table 3.

#### 6.5.5 Drop-Weight Tear Test

The drop-weight tear test (DWTT) of the steel plate shall be in principle based on the full-thickness specimen. If the thickness of the steel plate is greater than 19mm, thinner specimen can be adopted after the negotiation between the supplier and the purchaser.

specified in GB/T 10561-2005.

**Table 5 – Levels of Non-Metallic Inclusions**

| A    |        | B    |        | C    |        | D    |        |
|------|--------|------|--------|------|--------|------|--------|
| Fine | Coarse | Fine | Coarse | Fine | Coarse | Fine | Coarse |
| ≤2.0 | ≤2.0   | ≤2.0 | ≤2.0   | ≤2.0 | ≤2.0   | ≤2.0 | ≤2.0   |

**6.8.2** The banded structure of the steel plate shall be no greater than Level-3.

## 6.9 Surface quality

**6.9.1** The supplier shall keep the surface of the steel plate clean, where there shall be free of the grease and corrosive substances.

**6.9.2** The surface of the steel plate shall be free of bubbles, crusting, cracks, folds, heavy skin, inclusions, and sharp defects such as indentation and scratching of the oxide scale with thickness exceeding half tolerance.

**6.9.3** The surface of the steel plate may have the thin layer of iron oxide scale, rust and inconspicuous surface roughness, scratches, indentations and other local defects caused by the falling of the iron oxide scale, all of which do not affect the surface quality inspection; however, their depths shall be no greater than half thickness tolerance; and the minimum thickness of the steel plate shall be ensured.

**6.9.4** The defects on the surface of steel plate are not allowed for repair-welding. The grinding treatment is allowed; however, the minimum thickness of the steel plate shall be ensured. The grinding treatment shall be smooth, leaving no edges and corners.

## 6.10 Ultrasonic test

The steel plate shall be ultrasonically tested one by one according to the provisions of GB/T 2970; its acceptance level shall be indicated in the contract. After the consultation between the supplier and the purchaser, and indicated in the contract, other ultrasonic testing standards may also be used.

## 6.11 Special requirements

After the consultation between the supplier and the purchaser, indicated in the contract, the purchaser can propose other special technical requirements (such as requirements for chemical composition, drop-weight tear test performance, grain aging, impact absorption energy and shear area, test temperature, anti-HIC performance) against the steel plate.

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|    |                 |            |                        |                            |
|----|-----------------|------------|------------------------|----------------------------|
|    |                 |            | horizontal, GB/T 21143 |                            |
| 13 | Size and shape  | One by one | ---                    | Appropriate measuring tool |
| 14 | Surface quality | One by one | ---                    | Visual examination         |

## 8 Inspection Rules

**8.1** The inspection and acceptance of the steel plates shall be carried out by the quality inspection department of the supplier.

**8.2** The steel plates shall be checked and accepted in batches. Each batch consists of the steel plates with the same designation, the same furnace number, the same thickness specification and the same delivery state; the weight of each batch shall not exceed 60t.

**8.3** The sampling quantity, sampling department and sampling method of the steel plate shall conform to the provisions of Table 6.

**8.4** If a test result representing a batch of steel plates is unqualified, the manufacturer may take another 2 pieces of steel plates from the same batch; each steel plate shall be conducted reinspection on the unqualified item. If both the reinspection results are qualified, then such batch of steel plates can be accepted excepted for steel plate that is unqualified in the initial test. If anyone steel plate is unqualified in the reinspection, then the manufacturer may choose to reject the entire batch; or inspect the rest untested steel plates one by one in such batch.

**8.5** The inspection results shall be rounded off as per the rounding-off comparison method; the rounding-off rules shall conform to the provisions of GB/T 8170.

## 9 Package, Marking and Quality Certificate

The package, marking and quality certificate of the steel plates shall conform to the provisions of GB/T 247. If the purchaser has special requirements for package, it shall be indicated in the contract.

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