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Specification of manufacturing for transmission line tower

输电线路铁塔制造技术条件

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Specification of manufacturing for transmission line tower

1 Scope

This standard specifies the materials, technical requirements, inspection, packaging, marking, transportation, storage in the manufacturing process of transmission line towers (hereinafter referred to as "towers").

This standard applies to the manufacturing of angle steel towers for transmission lines. It can be used as a reference for the manufacturing of power microwave towers, power communication towers and similar steel structures.

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 41 Hexagon nuts, style 1 - Product grade C

GB/T 95 Plain washers - Product grade C

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

GB/T 470 Zinc ingots

GB/T 699 Quality carbon structure steels

GB/T 700 Carbon structural steels

GB/T 702 Hot-rolled steel bars - Dimensions, shape, weight and tolerances

GB/T 706 Hot rolled section steel

GB/T 709 Dimension shape weight and tolerances for hot-rolled steel plates and sheets

GB/T 805 Tight nuts

GB/T 985.1 Recommended joint preparation for gas welding, manual metal arc welding, gas-shield arc welding and beam welding

When the design needs to be modified, the consent of the design organization shall be obtained and the design change document shall be signed.

4.2 Matters not specified in this standard shall comply with the provisions of the relevant current national standards.

4.3 When new technologies, new processes and new materials are used, they shall be tested and verified to be qualified.

4.4 The production process of the tower shall comply with the provisions of the environment, safety, occupational health.

5 Materials

5.1 Steel

5.1.1 The specifications and grades of steel used in the manufacture of the tower shall be selected according to the design requirements; its various quality indicators shall comply with the provisions of GB/T 699, GB/T 700, GB/T 702, GB/T 706, GB/T 709, GB/T 1591, GB/T 3274, GB/T 3524, GB/T 5313. It shall have an exit-factory quality certificate and be used after passing the random inspection. The sampling batch and quantity of steel shall meet the requirements of the relevant standards. The quality of imported steel shall comply with the provisions of the design and contract.

5.1.2 Steel materials shall have traceability marks. If the original traceability marks are split during the manufacturing process, the marks shall be transplanted before the materials are split.

5.1.3 The dimensions, shapes, weights, allowable deviations of hot-rolled steel plates and strips shall comply with the N-type deviation requirements of GB/T 709, when there are no special requirements in the design or contract.

5.1.4 The curvature of angle steel with a side width greater than 200 mm shall not be greater than 2 mm/m; the total curvature shall not be greater than 0.2% of the total length.

5.1.5 There shall be no cracks, folds, scars, inclusions, double skin on the surface of steel materials; when there is rust, pitting or scratches on the surface, the depth shall not be greater than 1/2 of the negative allowable deviation value of the steel thickness; the cumulative error shall be within the negative allowable deviation range.

5.1.6 Section steel shall not have burrs greater than 5 mm. The surface defects of steel sections are allowed to be removed, but they shall not be removed laterally. The removed area shall be smooth and without edges and corners. The removal width shall not be less than 5 times the removal depth. The size deviation of the steel section after

removal shall not exceed the negative allowable deviation agreed in the contract.

5.2 Welding materials

5.2.1 The quality of welding materials such as welding rods, welding wires, fluxes shall comply with the provisions of GB/T 5117, GB/T 5118, GB/T 5293, GB/T 8110, GB/T 10045, GB/T 12470, GB/T 17493.

5.2.2 The coating on the surface of the welding rod shall not fall off or be damp. The surface of the welding wire shall be smooth and flat; there shall be no burrs, scratches, rust, oxide scale or other impurities that have adverse effects on welding performance and welding equipment operation performance.

5.2.3 The welding gas shall meet the requirements of GB/T 6052 and HG/T 3728.

5.2.4 Before the first use of each welding material, the mechanical properties test of the deposited metal shall be carried out.

5.2.5 The management of welding materials shall comply with the provisions of JB/T 3223.

5.3 Fasteners

5.3.1 The specifications, grades, anti-corrosion forms of fasteners used in the tower shall be selected according to the requirements of the design documents; the product quality shall comply with the provisions of GB/T 41, GB/T 95, GB/T 805, GB/T 3098.1, GB/T 3098.2, GB/T 5780, GB/T 6170.

5.3.2 High-strength bolts of grade 8.8 and above shall have a certificate of strength and plasticity test.

5.3.3 The thickness of the zinc coating of fasteners shall comply with the provisions of GB/T 13912.

5.4 Zinc ingots

The quality requirements, test methods, inspection rules and markings, packaging, transportation and storage of zinc ingots shall comply with the provisions of GB/T 470.

obvious concave and convex surface defects; there shall be no cracks or gaps on the edges.

6.2.3 The steel stamp shall not be pressed on the hole making, bending, milling, welding parts.

6.3 Forming (bending, flattening, opening and closing angles)

6.3.1 For bending and opening & closing angles of parts, cold deformation at room temperature or uniform hot deformation can be used; hot deformation shall be used for flattening. Carbon structural steel shall not be cold deformed when the ambient temperature is below -16 °C; low alloy structural steel shall not be cold deformed when the ambient temperature is below -12 °C. The minimum radius of curvature for cold bending of steel plates is 2 times the plate thickness.

6.3.2 After bending the parts, the edges of the bends shall be smoothly transitioned; there shall be no cracks, obvious wrinkles, concave surfaces and damage on the surface. The depth of scratches shall not be greater than 0.5 mm.

6.3.3 After bending the parts, the thinnest part of the angle steel edge shall not be less than 70% of the original nominal thickness.

6.3.4 When bending the notch of the parts, the quality grade of the weld at the notch shall not be lower than the grade-II weld requirements, meanwhile the welding shall not affect the installation. When filling the gap with material, the material and thickness shall be the same as that of the original part.

6.3.5 After the part is flattened, a reasonable gap shall be left at the flattened part to ensure the quality of galvanizing.

6.3.6 The allowable deviation of bending, flattening, opening & closing angles shall comply with the provisions of Table 3.

not exceed 8 m/s; for gas shielded arc welding, it should not exceed 2 m/s. If it exceeds the above range, effective measures shall be taken to ensure that the welding arc area is not affected.

b) Welding is strictly prohibited when the welding area is in one of the following conditions:

- Relative humidity is greater than 90%;

- The surface of the weldment is wet or exposed to rain, ice or snow;

- The welding working conditions do not meet the relevant provisions of GB/T 9448.

c) When the welding environment temperature is lower than 0 °C but not lower than -10 °C, heating or protective measures shall be taken, to ensure that the temperature of the parent material in the range of not less than 2 times the plate thickness and not less than 100 mm in all directions of the joint welding; it shall be not less than 20 °C or the specified minimum preheating temperature, whichever is higher; it shall not be lower than this temperature during the welding process.

d) When the welding environment temperature is lower than -10 °C, a process assessment test shall be carried out under the corresponding welding environment; welding shall be carried out only after the assessment is qualified. If it does not meet the above provisions, welding is strictly prohibited.

6.6.3.4 Metal materials shall not be embedded in the weld gap.

6.6.3.5 After the first and second level welds are welded, the welder number shall be stamped at a conspicuous position 50 mm from the weld toe. If the element is welded by only one welder, the welder number shall be stamped at a conspicuous position of the element; it shall be clearly visible after galvanizing.

6.6.3.6 Welds that need to be polished shall ensure the effective penetration of the weld.

6.6.4 Welding groove

6.6.4.1 The form and size of the welding groove shall comply with the relevant provisions of GB/T 985.1 and GB/T 985.2. The form and size of the groove with special requirements for the drawings shall be determined, based on the drawings and combined with the welding procedure qualification.

6.6.4.2 The welding groove shall be processed by mechanical methods first. When flame cutting is used, the weld groove shall be flat, free of burrs, cracks, gas cutting nodules, interlayers or other defects.

7 Inspection

7.1 Certificate of conformity

Products shall be inspected and accepted before leaving the factory and a product certificate of conformity shall be issued.

7.2 Inspection items

Inspection items include: steel quality (including steel appearance, dimensions, physical properties and chemical composition), part and component dimensions (including cutting length, perpendicularity of cut surface, perpendicularity of angle steel end, root cleaning, back shoveling, corner cutting, opening & closing angle, hole shape, hole position, bending, deflection, marking, etc.), zinc layer quality (including zinc layer appearance, thickness, adhesion, uniformity), welded parts assembly quality, weld quality (including weld appearance, dimensions and internal quality), trial assembly (including component placement rate, concentric hole penetration rate, control size).

7.3 Inspection requirements and methods

7.3.1 Inspection personnel

Product inspection personnel shall pass the special basic theory and operation skills training examination and hold a certificate to work.

7.3.2 Non-destructive testing personnel

Relevant personnel engaged in non-destructive testing of welds shall be qualified by the professional assessment agency authorized by the state; their corresponding grade certificates shall be valid; they shall engage in non-destructive testing and auditing according to the qualified assessment items and authority.

7.3.3 Inspection equipment and measuring tools

The accuracy or measuring range of the inspection equipment and measuring tools shall meet the requirements of Table 16, pass the metrological verification (calibration), be used within the validity period.

7.3.4.2 Weld quality inspection of welded parts

The external quality of the weld is inspected with a magnifying glass and a weld inspection ruler. The internal quality inspection of the weld should be carried out by ultrasonic testing. When ultrasonic testing cannot determine the defects, radiographic testing shall be used.

7.3.4.3 Quality inspection of galvanized layer

Visual inspection is used for appearance inspection. The uniformity of the galvanized layer is tested by the copper sulfate test method (see Appendix A); the adhesion is tested by the drop hammer test method (see Appendix B); the thickness of the galvanized layer is tested by the metal coating thickness gauge test method (see Appendix C). In case of disputes, the dissolution weighing test method (see Appendix D) is used to test the adhesion of the galvanized layer as an arbitration test method.

7.3.4.4 Quality inspection of trial assembly

The position of the components is visually inspected; the through-hole rate of the concentric holes is tested by a hole tester 0.3 mm larger than the nominal diameter of the bolt; other dimensions are tested by a steel tape measure.

7.3.4.5 Inspection of steel dimensions

The width of the angle steel is measured at three points on each side in the length direction with a vernier caliper; the arithmetic mean is taken. The thickness of the angle steel is measured at three points on each side with a vernier caliper; the arithmetic mean is taken. The thickness of the steel plate is measured at three points, the arithmetic mean is taken. During the test, the test points shall be evenly distributed; the distance from the edge shall not be less than 10 mm.

7.4 Sampling plan and judgment principle

7.4.1 Sampling principle

7.4.1.1 Unless otherwise specified, the general inspection level of GB/T 2828.1 is adopted (quality level see Table 17).

7.4.1.2 Sampling scheme for steel quality, component dimensional quality, welded parts and weld quality: The tower products with voltage levels of 660 kV and below adopt the normal inspection one-time sampling scheme of GB/T 2828.1; the tower products with voltage levels of 750 kV and above adopt the strict inspection one-time sampling scheme of GB/T 2828.1.

7.4.1.3 The zinc layer and trial assembly quality adopt the one-time sampling scheme of GB/T 2829 discrimination level I.

if one of the items in Class B is not less than the rejection number (Re), the product shall be judged as unqualified.

8 Packaging, marking, transportation, storage

8.1 Packaging

8.1.1 Angle steel packaging

8.1.1.1 The packaging length, number of bundles and weight of angle steel shall be convenient for packaging, transportation, marking.

8.1.1.2 Bent angle steel, angle steel welded parts, etc. that cannot be included in the bundle can be packaged separately.

8.1.1.3 The bundling method can be a clamp composed of angle steel or channel steel and long rod bolts, or a steel belt bundling form; the packaging shall be treated with anti-corrosion.

8.1.1.4 The ends of the angle steel bundles shall be neat, with clear layers and basically the same thickness.

8.1.2 Connection plate packaging

The connection plate packaging should be fastened by long bolts and a lifting point shall be set.

8.1.3 Packaging requirements

It shall be firm to ensure that the bundle does not loosen during transportation.

8.2 Marking

In addition to meeting the contract requirements, the marking shall also be identified in a conspicuous position on the bundle, indicating the project name, tower type, nominal height, tower number, bundle number, manufacturer name; the marking content shall also meet the requirements of the transportation department.

8.3 Transportation and storage

During loading, unloading, transportation and storage, the packaging must not be damaged to cause deformation of the product or damage to the galvanized layer.

Appendix A

(Normative)

Hot-dip galvanizing layer uniformity test - Copper sulfate test method

A.1 Preparation and dosage of copper sulfate solution

A.1.1 Preparation of copper sulfate solution: Add 36 g of copper sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) to 100 mL of distilled water; heat to dissolve and then cool to room temperature; add 1 g of copper hydroxide or basic copper carbonate [$Cu(OH)_2$ or $Cu_2CO_3(OH)_2$] per liter of solution and stir evenly; let stand for more than 24 h; filter or suck out the clear solution above for use.

The density of copper sulfate solution at 18 °C shall be 1.18 g/cm^3; otherwise, it shall be adjusted with copper sulfate solution or distilled water.

A.1.2 Dosage of copper sulfate solution: Not less than 8 mL/cm^2 based on the surface area of the specimen.

A.1.3 The prepared copper sulfate solution can also be used for multiple tests, but not more than 15 times.

A.2 Specimen preparation

A.2.1 Specimen size

The specimen test area shall not be less than 100 cm^2.

A.2.2 Specimen collection

First, remove 5 cm from each end of the sample; then take 3 specimens in total from both ends and the middle of the sample. The surface of the plating shall not be damaged during specimen processing.

A.3 Test conditions

A.3.1 The container used for the test shall not react chemically with the copper sulfate solution; it shall have sufficient volume to immerse the specimen in the solution. The outer edge of the specimen shall be no less than 25 mm from the container wall.

A.3.2 The temperature of the copper sulfate solution during the test shall be (18 ± 2) °C.

A.4 Test procedure

A.4.1 Specimen surface treatment: Wipe the prepared specimen with organic solvents such as carbon tetrachloride and benzene; rinse with running water; wipe dry with a clean cloth; paint or paraffin on the exposed base metal of the test piece before the test.

Appendix D

(Normative)

Hot-dip galvanized layer adhesion test -- Dissolution weighing test method

D.1 Preparation and dosage of dissolving solution

D.1.1 Preparation of dissolving solution: Dissolve 3.5 g of hexamethylenetetramine (urotropine) in 500 mL concentrated hydrochloric acid, which has a density of 1.19 g/cm^3; dilute to 1000 mL with distilled water.

D.1.2 Dosage of dissolving solution: Not less than 10 mL/cm^2 based on the surface area of the specimen.

D.2 Preparation of specimen

D.2.1 Specimen size

The test area of the specimen shall not be less than 100 cm^2.

D.2.2 Specimen collection

First remove 5 cm from each end of the test piece. Then take 3 specimens from both ends and the middle of the test piece. The surface of the plating shall not be damaged during specimen processing.

D.3 Test conditions

D.3.1 The test container shall not react chemically with the dissolving solution; it shall have sufficient volume to completely immerse the specimen in the dissolving solution.

D.3.2 The temperature of the dissolving solution during the test shall not be higher than 38 °C.

D.4 Test procedure

D.4.1 Surface treatment of the specimen and weighing before dissolution: Wipe the prepared specimen with organic solvents such as carbon tetrachloride and benzene; rinse with running water; wipe dry with a clean cloth; then wash the specimen with ethanol; dry it thoroughly and weigh it before dissolution (accurate to 1% of the weight of the zinc plating of the specimen).

D.4.2 Dissolution of the specimen and weighing after dissolution: Immerse the specimen with a treated surface in the dissolving solution; observe the hydrogen evolution reaction on the surface of the specimen; when the hydrogen evolution is smooth and unchanged, it is taken as the end point of the coating dissolution process. Take out the specimen and rinse it with running water; use a hard brush to remove the

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