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W-08 ROLLED STEEL BARS FOR ANCHOR CHAIN CABLES AND ACCESSORIES

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Foreword:

This Guide is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

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Comments or suggestions can be sent by email to ps@ccs.org.cn .

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ROLLED STEEL BARS FOR ANCHOR CHAIN CABLES AND ACCESSORIES

1 Application

1.1 This Guideline applies to the works approval and inspection of rolled steel bars both for anchor chain cables and accessories onboard ships and for mooring chain cables and accessories onboard offshore installations and accessories, which are manufactured in accordance with the requirements of CCS Rules for Classification of Sea-Going Steel Ships and CCS Rules for Materials and Welding. Reference may be made to rolled steel bars for other purposes (such as directly used for manufacturing marine shafting).

Rolled steel bars for anchor chain cables, mooring chain cables and accessories as well as hot rolled steel bars directly used for manufacturing (only mechanically processing) marine shafting are to be manufactured by works approved by CCS.

1.2 This Guideline applies to the works approval and inspection of anchor chain steels, which are manufactured by electric arc furnace (RP, HP, or UHP), direct current furnace, top and bottom blown converter including secondary refining (LF, VD, CAS, RH), cast in moulds or made by a continuous casting process to be square or rectangular materials, and delivered in the condition of AR or CR.

2 Normative references

2.1 CCS Rules for Classification of Sea-Going Steel Ships;

2.2 CCS Rules for Materials and Welding;

2.3 relevant national and international standards;

2.4 technical specifications or descriptions of order, where necessary.

3 Classification of rolled steel bars

3.1 Rolled bars for anchor chain cables and accessories are classified into eight grades according to the nominal tensile strength and applicable product type, i.e. AM1, AM2 and AM3 for steels which are used for marine anchor chain cables, OM3, OM3S, OM4, OM4S and OM5 which are used for steels for offshore mooring chain cables.

3.2 The classification of rolled steel bars for other purposes may be carried out according to

relevant standards.

4 Plans and documents

4.1 A manufacturer intending for approval by CCS is to submit an application to CCS for works approval.

4.2 The documents as specified in 3.2.1 of PART ONE of the Guidelines are to be submitted to CCS for information.

4.3 The type test program is to be submitted to CCS for approval.

5 Type test

5.1 Determination of the Type test program

Prior to type test, CCS and the applicant are to determine the type test program through negotiation. The program may be proposed by the applicant and examined and approved by CCS, or proposed by CCS and confirmed by the applicant. The program is to include:

- (1) The type, specification and delivery condition of the products for approval (indicating the deoxidation, grain refining elements and delivery condition for each steel grade);
- (2) Steel grade, specification, number and heat treatment of the selected products for test;
- (3) The test items and the standards or rules adopted;
- (4) Sampling scheme and descriptions;
- (5) Place of test and qualification of the laboratory (if applicable, the qualification of the subcontractor and the agreement).

5.2 Selection of typical samples

The typical samples for type test are to be selected according to the following requirements:

- (1) The typical samples are to be taken for type test from the largest products of rolled steel bars for each grade. The products with the maximum specification are to be selected respectively for continuous casting and mould casting. Where electric furnace and converter are for smelting, the products with the maximum specification are to be selected accordingly. CCS may require additional approval test for the smallest or medium products as the case may

be.

- (2) Depending on the resources of the manufacturer, the sampling process may be confirmed by tracking sampling or production process or by tracing relevant information through production control computer.
- (3) The materials (billets, ingots) for rolled steel bars for test are to be designated by the Surveyor. The test samples are to be taken from the top and bottom of the bars.
- (4) In application for materials approval, the materials may be rolled into finished products for mechanical property test depending on the agreement with the supplier.
- (5) Sampling for hydrogen brittleness test of OM3S, OM4, OM4S and OM5 steel bars is to be carried out according to the requirements of CCS Rules for Materials and Welding.

5.3 Type test items and requirements

5.3.1 The type test items and requirements are as follows:

- (1) Chemical composition analysis: compositions of ladle sample and finished products to be analyzed respectively. The elements to be analyzed are C, Si, Mn, P, S, Cr, Ni, Mo, Cu, Al, Nb, V, Ti and other added ones (Al not required for AM1).
- (2) Tensile test: to determine the upper yield strength R_{eH} , tensile strength R_m and elongation A . The test specimens are to be taken from the bars in longitudinal direction at a position of $1/6$ diameter from the surface or as close as possible to this position. Yield strength of material is generally not more than 0.92.

(3) Bend test

- ① the test specimens: for diameter not exceeding 40 mm, to be taken as a cylindrical bar with full cross-section or a cylindrical bar of 25 mm in diameter with one rolled surface; for diameter exceeding 40 mm, to be taken from the bars in longitudinal direction with center line at a position of $1/6$ diameter from the surface or as close as possible to this position;
- ② bending angle of 180° : $d = a$ for AM1, $d = 1.5a$ for AM2 and AM3; for diameter not less than 25 mm (uncut test specimens), $d = 2a$ for AM1, $d = 2.5a$ for AM2 and AM3.

(4) Charpy V-notch impact test

- ① The test is to determine the energy with a set of three test specimens, and the individual value and average value of energy to be provided. Impact test is not required for grade 1 steel.
- ② The temperature requirements for impact test: normal temperature, 0°C and -20°C for AM2, normal temperature, 0°C, -20°C and -40°C for AM3, OM3 and OM3S, normal temperature, 0°C, -20°C, -40°C and -60°C for OM4, OM4S and OM5.
- ③ The test specimens are to be taken from the bars in longitudinal direction with center line at a position of 1/6 diameter from the surface or as close as possible to this position, and for diameter not less than 60 mm, additional specimens are to be taken on the core.
- ④ The fracture photos and side expansion value are to be provided.
- (5) Hardness test: Steels for each grade are to be subject to hardness test. Specimens may be prepared individually or apply residual samples (parts without deformation) of tensile and impact tests. Hardness of OM4S steel is not to be greater than 330HBW, and hardness of OM5 steel is not to be greater than 340HBW
- (6) Sulphur prints: sulphur prints to be taken with full cross-section (or 1/2) of the material; for bars, sulphur prints to be taken with a full cross-section or a longitudinal section through axis (length of specimen/diameter ≥ 1.2). The photos of sulphur prints are to be provided.
- (7) Hydrogen brittleness test of OM3S, OM4, OM4S and OM5 round steel bars: test requirements and methods and result assessment are to comply with CCS Rules for Materials and Welding.
- (8) Macrostructure: the requirements for position and length of the specimen for the materials and finished products are the same as those for sulphur prints.
- (9) Microstructure and grain size: microstructure ($\times 100$ magnification) to be prepared in longitudinal direction at a position of 1/6 diameter from the surface or as close as possible to this position to determine actual grain size (or $\times 500$ magnification as the case may be).
- (10) Welding property test: rolled steel bars for anchor chain cables and mooring chain cables are to be subject to welding property test in an initial approval. The sampling material is to be welded by actual production technology of those chain cables, and the welds (after heat treatment) are to be subject to mechanical property tests (tensile, impact, hardness) and technological test (bend), in which, the hardness test is to determine the maximum hardness and hardness distribution in heat affected zones of welding.

(11) Visual and dimensional examination: at least 5 pieces of bars are to be selected for examination. The diameter, roundness, the curvature per meter and the total curvature are to be examined for each piece. The diameter tolerance and roundness tolerance are to comply with the requirements of CCS Rules for Materials and Welding.

(12) Non-destructive test:

- ① Steels for all mooring chain cables and accessories are to be subject to ultrasonic test at appropriate stage of manufacturing process. Round steel bars are to be free from gas hole, crack or folding.
- ② Steels for all offshore mooring chain cables are to be subject to surface inspection by magnetic particle, eddy current or equivalent methods.
- ③ Non-destructive test is to be carried out according to recognized standards. Non-destructive test technology and acceptance criteria are to be submitted to CCS for information.

(13) Other test items as deemed necessary by CCS (isothermal transformation curve for austenite, tower type test, quenching degree test etc.).

5.3.2 For steel mills where the materials are purchased, the material suppliers are to be approved by CCS and subject to sulphur prints/macrostructure examination, chemical composition analysis, visual and dimensional examination. Qualified materials are sent to mills to make steel bars and subject to test according to the above-mentioned requirements. The material suppliers may be approved only after all satisfactory tests.

6 Unit/batch inspection

6.1 After works approval by CCS, the rolled steel bars as manufactured according to the approved conditions (including equipment, process, etc.) are to be applied by the manufacturer for unit/batch inspection by CCS, which can be used only after satisfactory inspection.

6.2 The detailed requirements for unit/batch inspection after approval are to be notified in written form to the works when CCS issues a certificate of works approval.

6.3 The unit/batch inspection is to be carried out according to the approved test program. The test program is to contain the test items for witness, review and on-site examination. The items are at least to include:

- (1) Visual and dimensional examination;
- (2) Review of the result of chemical analysis;
- (3) Mechanical property test;
- (4) Austenitic grain size examination(for offshore mooring chain rolled steel bars)
- (5) Nondestructive test(for offshore mooring chain rolled steel bars)
- (6) Hydrogen embrittlement test(for OM3S,OM4,OM4S and OM5 for offshore mooring chain rolled steel bars)
- (7) Macro acid corrosion examination(for OM4S and OM5 for offshore mooring chain rolled steel bars)
- (8) Non-metallic inclusion examination(for OM4S and OM5 for offshore mooring chain rolled steel bars)
- (9) Quenching degree test(for OM4S and OM5 for offshore mooring chain rolled steel bars)
- (10) Other test items as deemed necessary by CCS.

6.4 After satisfactory inspection of products, CCS Surveyor is to issue a certificate of marine products or endorse the manufacturer's quality certificate.

6.5 The quality certificate is to contain at least: acceptance criteria (rules, standard, technical agreements, etc.), cast number/batch number, steel grade, specification, mass, number, delivery condition, chemical composition, mechanical properties, description of identifications. For OM4S and OM5 rolled steel bars for mooring chain cables, results of hydrogen brittleness test and non-destructive test as well as results of austenitic micro grain size, non-metallic intrusions and hardenability test are also to be listed. The space for stamp and endorsement by CCS Surveyor is to be reserved.

6.6 The format of the manufacturer's quality certificate is to be approved by CCS.