



CHINA CLASSIFICATION SOCIETY

**RULES FOR MATERIALS
AND WELDING**

AMENDMENTS

2011

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Beijing

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PART ONE METALLIC MATERIALS

CHAPTER 1 GENERAL

Section 2 TESTING AND SURVEY

New paragraph 1.2.5 is added as follows:

“1.2.5 Non-destructive testing

1.2.5.1 Non-destructive testing personnel are to pass the tests according to CCS Rules for Qualification Approval and Tests of Non-destructive Testing Personnel and relevant standards, and hold a valid “Qualification Certificate of NDT Personnel” issued or accepted by CCS.

1.2.5.2 Non-destructive testing personnel can only engage in the non-destructive testing appropriate to their qualified range of work.

1.2.5.3 Non-destructive testing instruments are to be periodically calibrated according to relevant standards and relevant equipment are to be in good condition and readily available.”

The subsequent paragraphs of this Section are renumbered accordingly.



CHAPTER 3 STEEL PLATES, FLAT BARS AND SECTIONS

Section 1 GENERAL PROVISIONS

The existing paragraph 3.1.3 is replaced by the following:

“3.1.3 Thickness tolerance

3.1.3.1 The responsibility for verification and maintenance of the production within the required tolerances rests with the manufacturer. The Surveyor may require to witness some measurements.

3.1.3.2 The responsibility for storage and maintenance of the delivered product(s) with acceptable level of surface conditions rests with the shipyard before the products are used in fabrication.

3.1.3.3 The nominal thickness is a matter for the shipbuilder and shipowner to mutually agree. The tolerances on thickness of a given product are defined as:

- (1) Minus tolerance is the lower limit of the acceptable range below the nominal thickness.
- (2) Plus tolerance is the upper limit of the acceptable range above the nominal thickness.

3.1.3.4 Unless otherwise specified mutually, thickness is to comply with the following requirements:

- (1) The tolerances on nominal thickness below 5mm are to be in accordance with a recognized standard.
- (2) For steel plates and wide flats intended for hull structures as detailed in Sections 2, 3 and 4 of this Chapter, except for pressure vessels for the transportation of chemicals in bulk or liquefied gases as well as independent tank structures, thickness measurement is to be carried out according to the provisions of 3.1.3.5, and the average thickness is not to be less than the nominal thickness, and the minus tolerance of some measuring points is not to exceed 0.3 mm. If steel plates adopt rolling technology ensuring that the thickness of any measuring point is not less than the nominal thickness, the arithmetic mean need not be calculated.
- (3) For steels for boilers and pressure vessels as detailed in Section 5 of this Chapter as well as steels for independent tanks for the transportation of chemicals in bulk or liquefied gases, unless mutually contracted, the minus tolerance on thickness of products is not to exceed 0.3 mm.
- (4) For steel plates and wide flats intended for machinery as detailed in Section 6 of this Chapter, the under-thickness tolerances are to comply with Table 3.1.3.4(4).

Under-Thickness Tolerances of Steel Plates and Wide Flats for Machinery Use Table 3.1.3.4(4)

Nominal thickness t (mm)	Tolerance (mm)
$5 \leq t < 8$	< 0.4
$8 \leq t < 15$	< 0.5
$15 \leq t < 25$	< 0.6
$25 \leq t < 40$	< 0.8
$t \geq 40$	< 1.0

- (5) For steel plates and wide flats detailed in Sections 7, 8 and 9 of this Chapter and where in the order specifications it is not specified that the nominal thickness is to be taken as the minimum thickness, the under-thickness tolerance is not to exceed 0.3 mm for plate thickness not exceeding 10 mm, and 0.5 mm for plate thickness exceeding 10 mm.

(6) For steels as detailed in Sections 10 and 11 of this Chapter, the thickness tolerance is to comply with the requirements for parent steel.

(7) The plus tolerances on nominal thickness are to be in accordance with a recognized national or international standard.

3.1.3.5 Except that thickness of steel plates for hull structure is to comply with following requirements, the measurement for other steel plates may be in accordance with national or international standards:

(1) Automated method or manual method is applied to the thickness measurements.

(2) Measuring locations of steel plates are to comply with following requirements:

- a. At least two lines among Line 1, Line 2 or Line 3 as shown in Figure 3.1.3.5(2), are to be selected for the thickness measurements and at least three points on each selected line as shown in Figure 3.1.3.5(2) are to be selected for thickness measurement. If more than three points are taken on each line, the number of points is to be equal on each line.

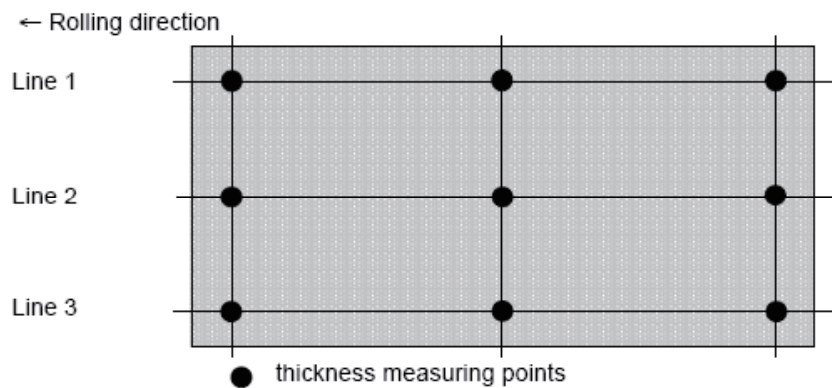


Figure 3.1.3.5(2) Locations of Thickness Measuring Points

- b. For automated methods, the measuring points at sides are to be located not less than 10 mm but not greater than 300 mm from the transverse or longitudinal edges of the product.
- c. For manual methods, the measuring points at sides are to be located not less than 10 mm but not greater than 100 mm from the transverse or longitudinal edges of the product.

The procedure and the records of measurements are to be made available to the Surveyor and copies provided on request.”

A new Section 12 “ROLLED STEEL BARS FOR ANCHOR CHAIN CABLES AND ACCESSORIES” is added as follows:

“Section 12 ROLLED STEEL BARS FOR ANCHOR CHAIN CABLES AND ACCESSORIES

3.12.1 General provisions

3.12.1.1 This Section applies to rolled steel bars for anchor chain cables, offshore mooring chains and accessories.

3.12.1.2 The rolled steel bars for chain cables are to be classified into eight grades, i.e. AM1, AM2 and AM3 for chain steels and OM3, OM3S, OM4, OM4S and OM5 for offshore mooring chain steels, depending on the nominal tensile strength and applicable product types.

3.12.2 Chemical composition

3.12.2.1 For grades AM1, AM2 and AM3 chain steels, the chemical composition is to be in compliance with the requirements of Table 3.12.2.1.

Deoxidation and Chemical Composition of Steel Bars **Table 3.12.2.1**

Grade	Deoxidation method	Chemical composition (%)					
		C	Si	Mn	P	S	Al ^②
AM1	Killed	≤0.20	0.15~0.35	≥0.40	≤0.040	≤0.040	-
AM2 ^①	Killed and fine grain treated	≤0.24	0.15~0.55	≤1.60	≤0.035	≤0.035	≥0.020
AM3	Killed and fine grain treated	Specification acceptable to CCS [®]					

Notes: ① If agreed by CCS, alloying elements may be added.

② It means the total aluminum content. Al may be replaced partly by other grain refining elements.

③ For grade AM3 chain steels, the manufacturer is to provide relevant specification which includes all necessary details, such as chemical composition, deoxidation measures, manufacturing procedures, heat treatment requirements and mechanical properties.

3.12.2.2 The chemical composition of offshore mooring chain steels is to comply with recognized standards, but for grades OM4, OM4S and OM5 chain, the steels are to contain a minimum of 0.20% molybdenum.

3.12.3 Manufacture

3.12.3.1 The rolled steel bars for chain cables, mooring chains and accessories are to be provided by the works approved by CCS, except for steel for Grade 1 chain cable.

3.12.3.2 The steels for chain cables and mooring chains are to be manufactured by basic oxygen, electric furnace or such other process as may be specially approved.

3.12.3.3 All chain steels and mooring chain steels are to be killed and except for grade AM1 chain steels, other chain steels and mooring chain steels are to fine grain treated.

3.12.3.4 Grade OM3S, OM4, OM4S and OM5 mooring chain steels are to be degassed.

3.12.3.5 The rolling reduction ratio of steel for mooring chains is to be at least 5:1. If it is required by the contract, the rolling reduction ratio used in production can be higher. The rolling reduction ratio means the ratio of sectional area of initial steel to finished steel.

3.12.3.6 Except as stipulated in the contract, in general, steel bars for chains are supplied in as-rolled condition.

3.12.4 Chemical composition analysis and metallurgical examination

3.12.4.1 The chain steels and mooring chain steels are to be subject to analysis of the chemical composition of each ladle. The relevant requirements of 3.12.2 of this Section are to be fulfilled.

3.12.4.2 For offshore chain steels, a metallographic sample from each ladle is to be taken to examine austenitic grain according to recognized standard. The austenitic grain size is to be 6 or finer.

3.12.4.3 For steels of grade OM4S and OM5, the following information is to be supplied by the manufacturer:

(1) Each heat is to be examined for non-metallic inclusions. The level of micro inclusions is to be quantified and assessed; to be sure inclusion levels are acceptable for the final product.

(2) A sample from each heat is to be macro etched according to recognized standard to be sure there is no injurious segregation or porosity.

(3) A sample from each heat is to be subject to jominy hardenability test according to recognized standard. The test is to be recorded in the report.

3.12.5 Mechanical tests

3.12.5.1 Steel bars are to be presented for testing in batches not exceeding 50t from the same heat and of the same diameter. A test sample having a suitable length is to be taken at random from each batch of steel bars for testing, and be subjected to the heat treatment provided for the finished chain cables.

3.12.5.2 A tensile specimen is to be taken from the test sample. Except for grade 1 chain steels, a set of three Charpy V-notch impact specimens are to be taken from the same test sample. The tensile and impact specimens are to be taken from the sample in the longitudinal direction at a position of 1/6 diameter from the surface or as close as possible to this position, as shown in Figure 3.12.5.2. The preparation and dimensions of specimens are to comply with the relevant requirements of Chapter 2 of this PART. The cross-sectional area of the tensile specimen is not to be less than 150 mm². The tensile specimen in full cross section may also be taken.

The tensile and impact tests and retests are to be carried out in compliance with the relevant requirements of Chapter 2 of this PART and the results are to comply with the requirements of Table 3.12.5.2.

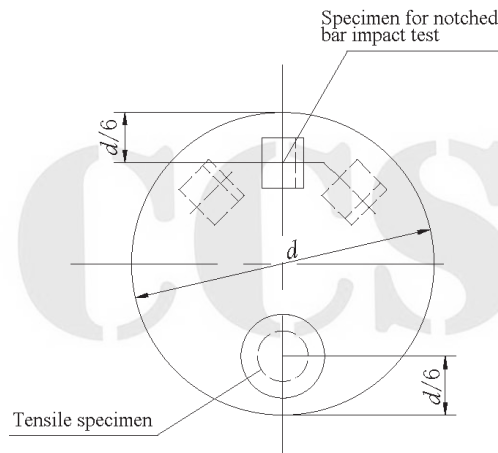


Figure 3.12.5.2

Mechanical Properties of Material for Chain Cables, Mooring Cables and Accessories

Table 3.12.5.2

Grade	Yield strength R_{eH} (N/mm ²)	Tensile strength R_m (N/mm ²)	Elongation A_5 (%)	Reduction of area Z (%)	Charpy V-notch impact test	
					Test temperature (°C)	Impact energy (J)
AM1	Not required	370~490	≥25	Not required	Not required	Not required
AM2	≥295	490~690	≥22	Not required	0	≥27 ^①
AM3	≥410	≥690	≥17	40	0(-20) ^②	≥60(35)
OM3	≥410	≥690 ^③	≥17	50	0(-20) ^②	≥60(40)
OM3S	≥490	≥770 ^③	≥15	50	0(-20) ^②	≥65(45)
OM4	≥580	≥860 ^③	≥12	50	-20	≥50
OM4S ^④	≥700	≥960 ^③	≥12	50	-20	≥56
OM5 ^④	≥760	≥1000 ^③	≥12	50	-20	≥58

- Notes: ① The impact test for Grade AM2 steel may be waived if the steel is supplied in a heat treatment condition.
 ② In general, the temperature of impact test for Grades AM3, OM3 and OM3S steel is 0°C. Where it is required by the purchaser, -20°C may be regarded as a supply condition.
 ③ Aim value of yield to tensile ratio: 0.92 max.
 ④ Aim maximum hardness for OM4S is 330HBW and OM5 340HBW.

3.12.5.3 Each heat of Grade OM3S, OM4, OM4S and OM5 steel bars is to be tested for hydrogen embrittlement.

(1) In case of continuous casting, test samples representing both the beginning and the end of the charge are to be taken. In case of ingot casting, test samples representing two different ingots are to be taken.

(2) Two (2) tensile test specimens are to be taken from the central region of bar material which has been subjected to the heat treatment cycle intended to be used in production. A specimen with a diameter of 20 mm is preferred (consideration will be given to a diameter of 14 mm).

(3) One of the specimens is to be tested within a maximum of 3 h after machining (for a 14 mm diameter specimen, the time limit is 1.5 h). Where this is not possible, the specimen is to be immediately cooled to -60°C after machining and kept at that temperature for a maximum period of 5 days. The second specimen is to be tested after baking at 250°C for 4 h, alternatively 2 h for 14 mm diameter specimen.

(4) A slow strain rate $< 0.0003 \text{ s}^{-1}$ must be used during the entire test, until fracture occurs (This is approximately 10 min for the 20 mm diameter specimen).

(5) Tensile strength, elongation and reduction of area are to be reported. The acceptance requirement for the test is:

$$Z_1/Z_2 \geq 0.85$$

where: Z_1 = Reduction of area without baking;

Z_2 = Reduction of area after baking.

If the requirement $Z_1/Z_2 \geq 0.85$ is not achieved, the bar material may be subjected to a hydrogen degassing treatment after agreement with CCS. New tests are to be performed after degassing.

3.12.5.4 Unless it can be proved that the failure is caused by improper heat treatment and another heat treatment may be carried out, if the test is not satisfactory, the represented material is to be rejected.

3.12.6 Surface quality and tolerances

3.12.6.1 The steel bar is to be free from defects that might impair proper workability and use. Surface defects may be repaired by grinding, provided that the admissible tolerance is not exceeded.

3.12.6.2 Unless otherwise specified in the contract, the tolerances of diameter and roundness of steel bars directly used for welding chain cables and mooring chains are to be in compliance with the requirements of Table 3.12.6.2. The roundness is to be taken by measuring the maximum and minimum diameters at a cross section. The tolerance on roundness is the difference between them.

Tolerance of Diameter and Roundness for Steel Bars **Table 3.12.6.2**

Nominal diameter (mm)	<25	25~35	36~50	51~80	81~100	101~120	121~160	161~210
Tolerance on diameter (mm)	-0~+1.0	-0~+1.2	-0~+1.6	-0~+2.0	-0~+2.6	-0~+3.0	-0~+4.0	-0~+5.0
Tolerance on roundness (mm)	0.6	0.8	1.1	1.5	1.95	2.25	3.00	4.00

3.12.7 Non-destructive examination

3.12.7.1 100 percent of bar material intended for either chain or fittings is to be subjected to ultrasonic examination at an appropriate stage of the manufacture. The bars are to be free of pipe, cracks and flakes.

3.12.7.2 100 percent of the bar material is to be examined by magnetic particle or eddy current methods. The bars are to be free of injurious surface imperfections such as seams, laps and rolled-in mill scale. Provided that their depth is not greater than 1% of the bar diameter, longitudinal discontinuities may be removed by grinding and blending to a smooth contour.

3.12.7.3 Non-destructive examination is to be performed in accordance with recognized Standards. Non-destructive examination procedures, together with rejection/acceptance criteria are to be submitted to CCS.

3.12.7.4 The frequency of NDE may be reduced at the discretion of CCS provided it is verified by statistical means that the required quality is consistently achieved.

3.12.8 Marking and certification

3.12.8.1 Each accepted bar is to be stamped with designation on one of the end surfaces according to the requirements of 3.1.7 of this Chapter. Steel bars having diameters of up to and including 40 mm and combined into bundles, may be marked on permanently affixed labels.

3.12.8.2 All satisfactory bars are to be furnished with an approved product certificate issued by CCS Surveyor. In addition to contents required by 3.1.7.3 of this Chapter, for Grades OM4S and OM5 mooring chain bars, the certificate is to include information on results of hydrogen embrittlement test, non-destructive examination, austenitic grain size, non-metallic inclusions and hardenability.”



CHAPTER 10 EQUIPMENT

Section 2 MARINE ANCHOR CHAIN CABLES AND ACCESSORIES

The existing section is replaced by the following:

“Section 2 MARINE ANCHOR CHAIN CABLES AND ACCESSORIES

10.2.1 Application

10.2.1.1 The requirements of this Section apply to the manufacture and testing of the marine stud link chain cables and accessories made of rolled and forged steels.

10.2.1.2 Marine chain cables specified in this Section include common links, enlarged links, end links, Kenter shackles, joining shackles, end shackles, swivels and swivel shackles.

10.2.1.3 If the studless link chain cables are used, they are to be manufactured and tested in accordance with the relevant standards acceptable to CCS.

10.2.1.4 Chain cables are to be classified into three grades, i.e. 1, 2 and 3, depending on the nominal tensile strength.

10.2.2 Chain cables

10.2.2.1 The rolled steel bars used for chain cables are to be in accordance with the relevant requirements of Section 12, Chapter 3, PART ONE of the Rules.

10.2.2.2 Unless otherwise specified as follows, the manufacture and testing of the forged steel for accessories are to comply with the relevant requirements of Section 1, Chapter 5 of this PART:

(1) The chemical composition is to comply with the specifications acceptable to CCS. The steel manufacturer is to determine and certify the chemical composition for each heat.

(2) Billets for forging chain cables are to be sampled for mechanical test in accordance with the requirements of 10.2.3 in this Section.

10.2.2.3 The studs are to be made of material corresponding to steel for the chain cables such as rolled or forged steels with low carbon content. The use of other materials, e.g. grey or nodular cast iron is not permitted.

10.2.2.4 The brand, steel grade and abbreviated symbol of the heat are to be clearly marked at the end of material by the manufacturer. Steel bars having diameters of up to and including 40 mm and combined into bundles, may be marked on permanently affixed labels.

10.2.3 Manufacture of chain cables and accessories

10.2.3.1 The works manufacturing chain cables and accessories are to be approved by CCS.

10.2.3.2 The chain cables and accessories are to be manufactured in accordance with recognized standards. Typical designs of chain links, shackles, swivels are given in Figures. 10.2.3.2(1) to (7). The numbers in the Figures represent multiples of the diameter d of links. A length of chain cable is to comprise an odd number of links. Where the type of accessories or the welding process used is other than those required above, the whole set of drawings giving details of dimensions, manufacturing process and heat treatment are to be submitted to CCS for approval.

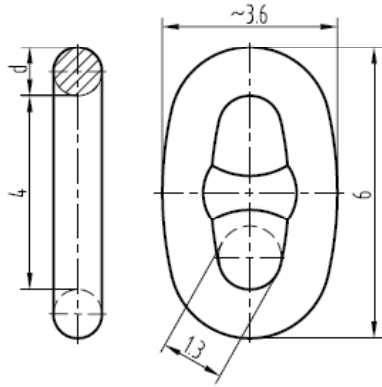


Figure 10.2.3.2(1) Common link

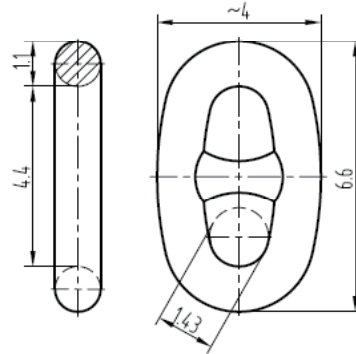


Figure 10.2.3.2(2) Enlarged link

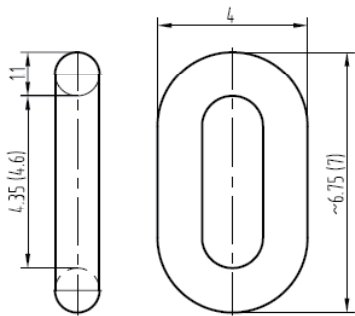


Figure 10.2.3.2(3) End link

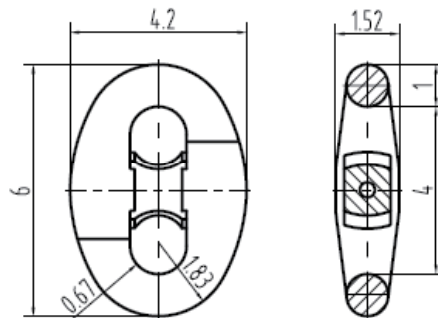


Figure 10.2.3.2(4) Kenter shackle

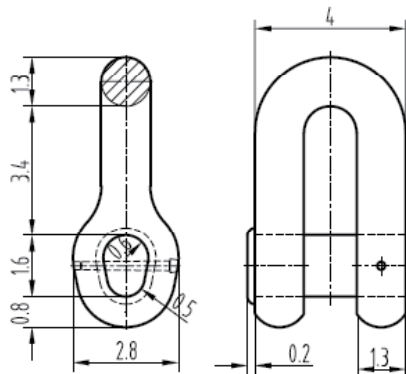


Figure 10.2.3.2(5) Joining shackle

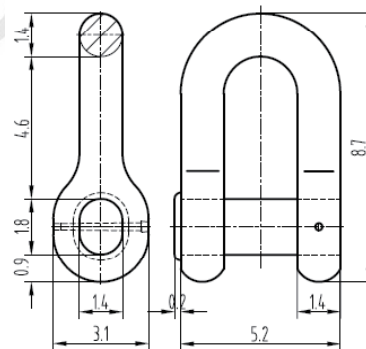


Figure 10.2.3.2(6) End shackle

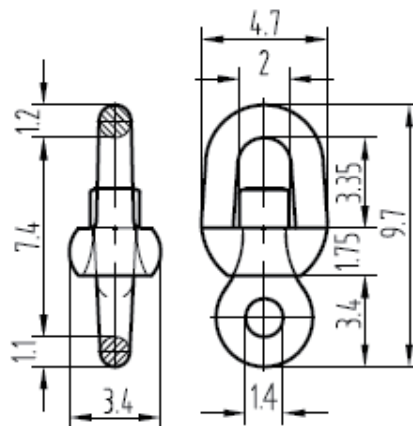


Figure 10.2.3.2(7) Swivel

10.2.3.3 Stud link chain cables are to preferably be manufactured by flash butt welding. Pressure butt welding may also be adopted for Grades 1 and 2 studless chain cables provided that the nominal diameter of the chain cable does not exceed 26 mm.

10.2.3.4 Accessories such as shackles, swivels and swivel shackles are to be forged in steel of at least Grade 2. Where a welding process is adopted for these parts, it is to be specially approved by CCS.

10.2.3.5 The welding of studs is to comply with the requirements as follows:

- (1) The studs are to be welded at one end only, i.e., opposite to the weld of the link. The stud ends are to fit the inside of the link without appreciable gap.
- (2) The welds, preferably in the horizontal position, are to be executed by qualified welders using suitable welding consumables.
- (3) All welds are to be carried out before the final heat treatment of the chain cable.
- (4) The welds are to be free from defects liable to impair the proper use of the chain. Undercuts, end craters and similar defects are to be ground off.
- (5) A procedure test for the welding of chain studs may be required.

10.2.4 Quality of the surface

10.2.4.1 All individual parts of chain cables and accessories are to have a clean surface consistent with the method of manufacture and be free from cracks, notches and other defects impairing the performance of the product. The flashes produced by drop forging or upsetting are to be properly removed.

10.2.4.2 Minor surface defects may be removed by grinding. However, the diameter of link after grinding is to meet the required dimensional tolerances (see 10.2.5 of this Section) and to leave a gentle transition to the surrounding surface. Remote from the crown, local grinding up to 5% of the nominal link diameter may be permitted.

10.2.4.3 Where the links are to be weld repaired, the procedure is to be submitted to CCS for approval. Weld repair at link crown is not permitted.

10.2.5 Dimensions and tolerances

10.2.5.1 The dimensions of chain cables and accessories are to comply with the relevant recognized standards.

10.2.5.2 The following tolerance are applicable to links:

- (1) Diameter measured at the crown is to be taken twice at the same location, one in the plane of the link and another perpendicular to the plane of the link, then the mean value is taken, tolerance between it and nominal diameter d is to be in compliance with the requirements of Table 10.2.5.2(1) and the cross-sectional area must have no negative tolerance.

Allowable Tolerance of Diameter at Crown Table 10.2.6.2(1)

Nominal diameter (mm)	$d \leq 40$	$40 < d \leq 84$	$84 < d \leq 122$	$d > 122$
Allowable tolerance (mm)	$-1 \sim +0.05d$	$-2 \sim +0.05d$	$-3 \sim +0.05d$	$-4 \sim +0.05d$

- (2) Diameter measured at locations other than the crown is to have no negative tolerance. The plus tolerance may be up to 5% of the nominal diameter. The plus tolerance of the diameter at the flash-butt weld is to comply with the requirements of approval specification.

(3) The allowable tolerance on assembly measured over a length of 5 links is to be of 0% to +2.5% (measured with the chain under tension after proof load test).

(4) All other dimensions are to be subjected to a manufacturing tolerance of 2.5%, provided that all of the final link parts of the chain cable fit together properly.

(5) Studs are to be located in the links centrally, and at right angle to the sides of the links. The following tolerances are acceptable provided that the stud fits snugly and its ends lie practically flush against the inside of the link. The tolerances are to be measured in accordance with Figure 10.2.5.2(5):

- 1) maximum off-centre distance $X = (A - a) / 2$ is 10% of the nominal diameter;
- 2) maximum deviation from the 90° position $\alpha \leq 4^\circ$.

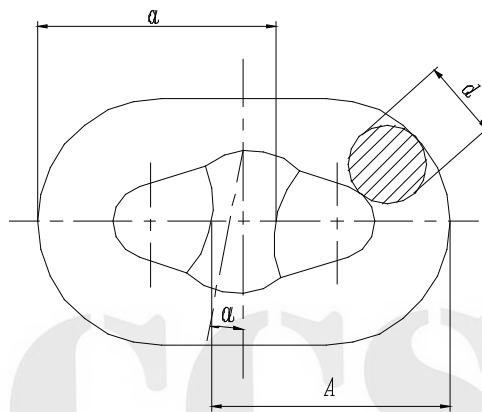


Figure 10.2.5.2(5)

The studs of enlarged links at each end of any length may be located off-centre so as to facilitate the insertion of the joining shackle.

10.2.5.3 The following tolerances are applicable to accessories:

nominal diameter: 0% to +5%;
other diameters: 2.5%.

10.2.6 Heat treatment of finished chain cables and accessories

10.2.6.1 According to the grade of steel, chain cables and accessories are to be supplied in one of the conditions specified in Table 10.2.6.1. The heat treatment is to be performed before the proof load test, breaking load test and all mechanical testing.

Condition of Supply of Chain Cables and Accessories **Table 10.2.6.1**

Grade	Chain cables	Accessories
1	As welded or normalized	Not applicable
2	As welded or normalized ^①	Normalized
3	Normalized, normalized and tempered or quenched and tempered	Normalized, normalized and tempered or quenched and tempered

Note: ① Grade 2 chain cables made by forging are to be supplied in the normalized condition.

10.2.7 Testing of finished chain cables

10.2.7.1 All finished chain cables are to be subjected to proof load test and breaking load test in accordance with recognized standards in the presence of the Surveyor. For this purpose, the chain cables are to be free from paint and anti-corrosion media. Where the manufacturer has a procedure to record proof loads and the Surveyor is satisfied with the adequacy of the recording system, he need not witness all proof load tests. The Surveyor is, however, to satisfy himself that the testing machines are calibrated and maintained in a satisfactory condition.

10.2.7.2 Proof load test: Each length of chain cable (27.5 m) is to be subjected to a proof load test at the proof load appropriate to the particular chain cables as shown in Table 10.2.7.2 using an approved testing machine. After unloading, each length of chain cable including the dimensions is to be examined. All links are to be free from significant defects, and the permanent stretch in a length of chain cable is not to exceed 5% of the original length.

Proof and Break Test Loads of Chain Cables **Table 10.2.7.2**

Test load	1	2	3
Proof load (kN)	$0.00686d^2(44 - 0.08d)$	$0.00981d^2(44 - 0.08d)$	$0.01373d^2(44 - 0.08d)$
Breaking load (kN)	$0.00981d^2(44 - 0.08d)$	$0.01373d^2(44 - 0.08d)$	$0.01961d^2(44 - 0.08d)$

10.2.7.3 For the braking load test, one sample comprising at least of three links is to be taken from every four lengths or fraction of chain cables and tested at the breaking loads given by Table 10.2.7.2. During test, breaking load is to be maintained for at least 30s. The links concerned are to be made in a single manufacturing cycle together with the chain cable and welded and heat treated together with it. Only after this may they be separated from the chain cable in the presence of the Surveyor.

Where the tensile loading capacity of the testing machine is insufficient to apply the breaking load for chain cables of large diameter, another equivalent testing method is to be agreed.

Where the specimen is not broken after the specified load is applied, it is regarded that the specimen has passed the test.

10.2.7.4 Retest: Where a breaking load test fails to meet the requirements, an additional specimen may be taken from the same length of chain cable and tested. The test is to be considered successful if the requirements are then satisfied.

Where the retest fails, the length of chain cable concerned is to be rejected. If the manufacturer so wishes, the remaining three lengths belonging to the batch test quantity may then be individually subjected to test at the breaking load. Where one such test fails to meet the requirements, the entire batch is to be rejected.

Where a proof load test fails, the defective link(s) is(are) to be replaced by new links which have been locally heat treated, the proof load test is to be repeated. In addition, an investigation is to be made to identify the cause of the failure.

10.2.7.5 For Grades 2 and 3 chain cables, specimens for mechanical test are to be taken from every four lengths. For forged chain cables, the specimens are to be taken not more than four lengths in accordance with the heat and heat treatment charge. According to the requirements of Table 10.2.7.5, one tensile specimen and two sets of three Charpy V-notch impact test specimens are to be taken. One tensile specimen and one set of three impact test specimens are to be taken from the base material of link opposite to the weldment, another set of three impact test specimens having their notch located in the weld is to be prepared. In order to take the specimens, an additional link (or several links where the links are small) is to be provided in a length of chain cable, which will not be a specimen for the breaking test. The specimen link is to be manufactured and heat treated together with the length of chain cable.

Number of Mechanical Specimens for Finished Chain Cables and Accessories Table 10.2.7.5

Grade	Manufacturing method	Condition of supply	Number of specimens		
			Tensile test for base metal	Charpy V-notch impact test	
				Base metal	Weldment
1	Flash-butt welded	As welded, normalized	Not required	Not required	Not required
2	Flash-butt welded	As welded	1	3	3
		Normalized	Not required	Not required	Not required
	Forged	Normalized	1	3 ^①	Not applicable
3	Flash-butt welded	Normalized, normalized and tempered, quenched and tempered	1	3	3
	Forged	Normalized, normalized and tempered, quenched and tempered	1	3	Not applicable

Note: ① This only applies to accessories.

10.2.7.6 The mechanical test is to be carried out in the presence of the Surveyor. The mechanical properties are to comply with the requirements of Table 10.2.8.4 in this Section.

10.2.7.7 Where the mechanical properties of a links in a length are not satisfactory, samples are to be taken again for retest in accordance with the requirements of 1.2.3, Chapter 2 of this PART.

10.2.7.8 Where the retest is not satisfactory, samples are to be taken again after heat treatment. Where the retest still fails, that length is to be rejected.

10.2.8 Testing of accessories

10.2.8.1 Proof load test: All the accessories are to be subjected to the proof load test at the proof load specified for the corresponding chain cable in Table 10.2.7.2 of this Section.

10.2.8.2 Breaking load test: From each manufacturing batch (the same cast, diameter and heat treatment) of 25 units or less of shackles, swivels, swivel shackles, enlarged links and end links and from each manufacturing batch of 50 units or less of Kenter shackle, one unit is to be subjected to the breaking load test at break load specified in Table 10.2.7.2. Parts tested in this way may not be put to further use.

Enlarged links and end links need not be tested provided that they are manufactured and heat treated together with the chain cable.

10.2.8.3 The breaking test may be waived if:

- (1) the breaking load has been demonstrated on the occasion of the approval testing of parts of the same design;
- (2) the mechanical properties and impact energy of each manufacturing batch have been proved, and
- (3) the accessories have been subjected to suitable non-destructive testing.

10.2.8.4 For test sampling, forged accessories with the similar dimensions originating from the same heat of steel and the same heat treatment charge are to be combined into one test unit. At least one sample is to be taken for mechanical test after heat treatment in accordance with the requirements of 10.2.7.5 in this Section. Test results and retest requirements are to comply with Table 10.2.8.4.

Mechanical Properties of Finished Chain Cables and Accessories Table 10.2.8.4

Grade	Yield strength R_{eH} (N/mm ²)	Tensile strength R_m (N/mm ²)	Elongation A_5 (%)	Reduction of area Z (%)	Charpy V-notch impact test		
					Test temperature (°C)	Impact energy (J)	
						Base metal	Weldment
2	≥295	490~690	≥22	Not required	0	≥27	≥27
3	≥410	≥690	≥17	≥40	0(-20) ^①	≥60(35)	≥50(27)

Note: ① In general, the impact test temperature of Grade 3 finished chain cables is 0°C. Where it is required by the purchaser, -20°C may be regarded as a supply condition.

10.2.9 Marking and certification

10.2.9.1 The chain cables and accessories accepted by CCS are to be stamped with the following marks on both ends of each length of chain cable as shown in Figure 10.2.9.1:

- (1) Chain cable grade;
- (2) Certificate number;
- (3) CCS.

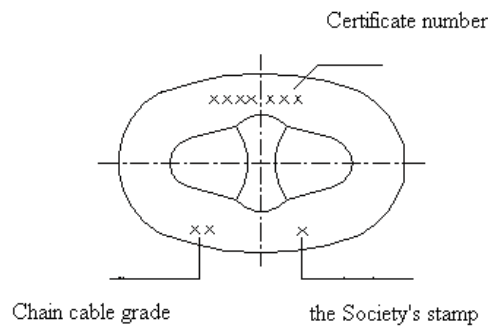


Figure 10.2.9.1

The certificate number may be abbreviated or other equivalent marking, and is to be stated in relevant certificates.

10.2.9.2 Chain cables and accessories which meet the requirements are to be certified by CCS at least for the following items:

- (1) Grade;
- (2) Chemical composition (including total aluminum content);
- (3) Traceable heat number;
- (4) Diameter and weight of chain cables and accessories and length of chain cables;
- (5) Proof load and breaking load;
- (6) Heat treatment procedure;
- (7) Marks on chain cables or accessories;
- (8) Mechanical properties of chain cables or accessories (where applicable)."

Section 3 OFFSHORE MOORING CHAINS AND ACCESSORIES

The existing section is replaced by the following:

“Section 3 OFFSHORE MOORING CHAINS AND ACCESSORIES

10.3.1 Application

10.3.1.1 The requirements of this Section apply to the manufacture and testing of offshore mooring chains and accessories intended to be used for application such as: mooring of mobile offshore units, mooring of floating production units, mooring of offshore loading systems and mooring of gravity based structures during fabrication.

10.3.1.2 Mooring equipment covered are common stud and studless links, connecting common links (splice links), enlarged links, end links, detachable connecting links (shackles), end shackles, swivels and swivel shackles.

10.3.1.3 Studless link chain is normally deployed only once, being intended for long-term permanent mooring systems with pre-determined design life.

10.3.1.4 Chafing chain for single point mooring arrangements are to be manufactured according to the requirements of this Section.

10.3.2 Chain grades

10.3.2.1 Depending on the nominal tensile strength of the steels used for manufacture, chains are to be subdivided into five grades, i.e.: OM3, OM3S, OM4, OM4S and OM5.

10.3.2.2 Manufacturers propriety specifications for OM4S and OM5 may vary subject to design conditions and the acceptance of CCS.

10.3.3 Material

10.3.3.1 The rolled steel bars intended for welded mooring chains and accessories are to comply with the relevant requirements of Section 10, Chapter 3, PART ONE of the Rules.

10.3.3.2 Except for following stipulations, forged steels used for the manufacture of accessories are to comply with the requirements of Section 1, Chapter 5 of this PART:

(1) The chemical composition of forged steels is to be determined by the manufacturers and is to comply with approved specifications and the submitted test reports approved by CCS.

(2) Forged steels are to be presented for testing in batches, the material in each batch is to be heat treated in the same furnace and with diameter not more than 25mm, and sampled for mechanical test. The mechanical properties are not to be lower than the relevant requirements for steel bars in Section 10, Chapter 3 of this PART.

(3) The austenitic grain size is to be 6 or finer.

(4) All forged steels are to be subject to ultrasonic non-destructive examination with approved standard during appropriate forging stage.

10.3.3.3 Forged steels for Grades OM4S and OM5 accessories are to comply with following requirements:

(1) Steel for forgings is to be vacuum degassed.

(2) In addition to routine steel information, the following information is to be supplied by the steel manufacturer to the mooring accessory manufacturer and the results included in the accessory documentation: non-metallic inclusions, segregation or porosity, jominy hardenability and ultrasonic examination.

10.3.3.4 The studs are to be made of steel corresponding to that of the chain and the technical specifications are to be submitted to CCS for approval. In general, the carbon content is not to exceed 0.25% or carbon equivalent is not to exceed 0.58% if the studs are to be welded in place.

10.3.4 Design of mooring chain

10.3.4.1 Drawings accompanied by design calculations, giving detailed design of mooring chain and accessories made by or supplied through the chain manufacturer are to be submitted to CCS for approval. Typical designs are given in figure 10.2.3.2. For studless chain, the shape and proportions are to comply with the requirements of 10.3.8.6(5). New or non-standard designs of chain links or fittings may require a fatigue analysis and possible performance, fatigue or corrosion fatigue testing.

10.3.4.2 In addition, for stud link chain, drawings showing the detailed design of the stud are to be submitted to CCS for information. The stud is to give an impression in the chain link which is sufficiently deep to secure the position of the stud, but the combined effect of shape and depth of the impression are not to cause any harmful notch effect or stress concentration in the chain link.

10.3.4.3 Machining of Kenter shackles is to result in fillet radius min. 3 percent of nominal diameter.

10.3.5 Manufacture of mooring chains

10.3.5.1 The mooring chain manufacturer is to purchase steel bars for mooring chains from the works approved by CCS.

10.3.5.2 Offshore mooring chains are to be manufactured in continuous lengths by flash butt welding and are to be heat treated in a continuous furnace; batch heat treatment is not permitted. Records of bar heating, flash welding and heat treatment are to be made available for inspection by the Surveyor.

10.3.5.3 The use of joining shackles to replace defective links is subject to the written approval of the end purchaser in terms of the number and type permitted. The use of connecting common links is restricted to 3 links in each 100m of chain.

10.3.5.4 Bar heating is to comply with following provisions:

(1) For electric resistance heating, the heating phase is to be controlled by an optical heat sensor. The controller is to be checked at least once every 8 h and records made.

(2) For furnace heating, the heat is to be controlled and the temperature continuously recorded using thermocouples in close proximity to the bars. The controls are to be checked at least once every 8 h and records made.

10.3.5.5 The welding parameters for platen motion, current as a function of time and hydraulic pressure are to be controlled during flash welding of each link. The controls are to be checked at least every 4 h and records are to be made.

10.3.5.6 Heat treatment of mooring chains is to comply with following requirements:

(1) Chain is to be austenitized, above the upper transformation temperature, at a combination of temperature and time within the limits established.

(2) When applicable, chain is to be tempered at a combination of temperature and time within the limits established. Cooling after tempering is to be appropriate to avoid temper embrittlement.

(3) Temperature and time or temperature and chain speed is to be controlled and continuously recorded.

10.3.6 Fitting of studs

10.3.6.1 A welded stud may be accepted for grade OM3 and OM3S mooring chains. Welding of studs in grade OM4, OM4S and OM5 mooring chains is not permitted unless specially approved by CCS.

10.3.6.2 Where studs are welded into the links, this is to be completed before the mooring chain is heat treated.

10.3.6.3 The stud ends must be a good fit inside the link and the weld is to be confined to the stud end opposite to the flash butt weld. The full periphery of the stud end is to be welded unless otherwise approved.

10.3.6.4 Welding of studs both ends is not permitted unless specially approved.

10.3.6.5 The welds are to be made by qualified welders using an approved procedure and low hydrogen approved consumables.

10.3.6.6 The size of the fillet weld is to comply with the requirements of Figure 10.3.6.6.

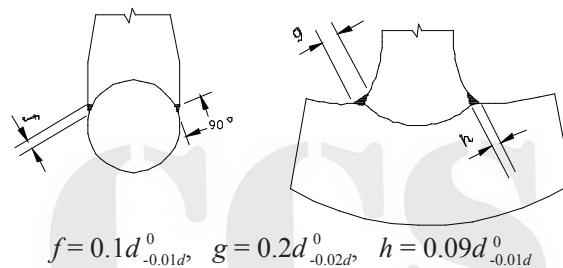


Figure 10.3.6.6

10.3.6.7 The welds are to be of good quality and free from defects such as cracks, lack of fusion, gross porosity and undercuts exceeding 1 mm.

10.3.6.8 All stud welds are to be visually examined. At least 10 per cent of all stud welds within each length of chain are to be examined by dye penetrant or magnetic particles after proof testing. If cracks or lack of fusion are found, all stud welds in that length are to be examined.

10.3.7 Connecting common links (splice links)

10.3.7.1 Single links to substitute for test links or defective links without the necessity for reheat treatment of the whole length are to be made in accordance with an approved procedure. Separate approvals are required for each grade of chain and the tests are to be made on the maximum size of chain for which approval is sought.

10.3.7.2 Manufacture and heat treatment of connecting common link is not to affect the properties of the adjoining links. The temperature reached by these links is nowhere to exceed 250°C.

10.3.7.3 Each link is to be subjected to the appropriate proof load and non-destructive examination as detailed in Tables 10.3.8.5, 10.3.8.9 and 10.3.8.10. A second link is to be made identical to the connecting common link; the link is to be tested and inspected in accordance with the requirements of 10.3.8.8 to 10.3.8.10.

10.3.7.4 Each connecting common link is to be marked either; on the stud for stud link chain or, on the outer straight length on the side opposite the flash butt weld for studless chain. This marking is to be in accordance with the requirements of 10.3.10.1 plus a unique number for the link. The adjoining links are also to be marked on the studs or straight length as above.

10.3.8 Testing and inspection of mooring chains

10.3.8.1 This section applies to but is not limited to finished mooring chain such as common stud and studless links, end links, enlarged end links and connecting common links (splice links).

10.3.8.2 Prior to testing and inspection, the chain is to be free from scale, paint or other coating by sand blasting, shot blasting or other suitable means.

10.3.8.3 Mooring chains are to have a clean surface consistent with the method of manufacture and be free from cracks, notches and other defects impairing the performance of the mooring chain. The dimensions of mooring chains and accessories are to comply with the relevant standards accepted by CCS or approved special design requirements.

10.3.8.4 All mooring chains are to be subjected to proof load tests, break load tests and mechanical tests after final heat treatment in the presence of the Surveyor. Where the manufacturer has a procedure to record proof loads and the Surveyor is satisfied with the adequacy of the recording system, he need not witness all proof load tests. The Surveyor is, however, to satisfy himself that the testing machines are calibrated and maintained in a satisfactory condition.

10.3.8.5 Mooring chains are to be subject to proof and break test in accordance with following requirements:

(1) The entire length of mooring chain is to withstand the proof load specified in Table 10.3.8.5(1) without fracture and is not to crack in the flash weld and without obvious stud loosening. Where plastic straining is used to set studs, the applied load is not to be greater than that qualified in approval tests and is to be recorded in the test report.

Proof and Break Test Loads, Weight and Length over 5 Links Table 10.3.8.5(1)

With stud	OM3	OM3S	OM4	OM4S	OM5
Proof test load (kN)	0.0148K	0.0180K	0.0216K	0.0240K	0.0251K
Break test load (kN)	0.0223K	0.0249K	0.0274K	0.0304K	0.0320K
Studless	OM3	OM3S	OM4	OM4S	OM5
Proof test load (kN)	0.0148K	0.0174K	0.0192K	0.0213K	0.0223K
Break test load (kN)	0.0223K	0.0249K	0.0274K	0.0304K	0.0320K
Mooring chain weight (kg/m)	Chain with stud $0.0219d^2$		Studless chain is to be weight calculated according to the design		
Length L over 5 links	$22d \leq L \leq 22.55d$				

where: $k = d^2(44 - 0.08d)$

d — nominal diameter of mooring chain, in mm.

(2) A break test specimen consisting of at least 3 links is to be either taken from the mooring chain or produced at the same time and in the same manner as the mooring chain. The test frequency is to be based on tests at sampling intervals according to Table 10.3.8.5(2) provided that every cast is represented. Each specimen is to be capable of withstanding the break load specified in Table 10.3.8.5(1) without fracture and is not to crack in the flash weld. It will be considered acceptable if the specimen is loaded to the specified value and maintained at that load for 30s.

Sampling Frequency of Break Tests Table 10.3.8.5(2)

Nominal chain diameter (mm)	≤ 48	49 ~ 60	61 ~ 73	74 ~ 85	86 ~ 98	99 ~ 111	112 ~ 124
Maximum sampling interval (m)	91	110	131	152	175	198	222
Nominal chain diameter (mm)	125 ~ 137	138 ~ 149	150 ~ 162	163 ~ 175	176 ~ 186	187 ~ 199	200 ~ 210
Maximum sampling interval (m)	250	274	297	322	346	3709	395

(3) For chain diameters over 100 mm, alternative break-test proposals to the above break test will be considered whereby a one link specimen is used. Alternatives are to be approved by CCS, every heat is to be represented, the test frequency is to be in accordance with Table 10.3.8.5(2), and it is to be demonstrated and proven that the alternative test represents an equivalent load application to the three link test.

(4) If the loading capacity of the testing machine is insufficient, another equivalent method is to be agreed with CCS.

10.3.8.6 After proof load testing, measurements are to be taken on at least 5 per cent of the links in accordance with following requirements. The shape and proportion of links are to comply with recognized standards or specially approved design requirements as well as following tolerance requirements:

(1) The maximum and minimum dimensions measured at link crown are to comply with the tolerance requirements in Table 10.3.8.6(1), but the cross-sectional area must have no negative tolerance.

Allowable Tolerance of Diameter at Crown Table 10.3.8.6(1)

Nominal chain diameter d (mm)	≤ 40	$40 < d \leq 84$	$84 < d \leq 122$	$122 < d \leq 152$	$152 < d \leq 184$	$184 < d \leq 210$
Negative tolerance (mm)	1	2	3	4	6	7.5
Plus tolerance (mm)	0.05d					

(2) Diameter measured at locations other than the crown is to have no negative tolerance. The plus tolerance may be up to 5% of the nominal diameter. The plus tolerance of the diameter at the flash-butt weld is to comply with the requirements of technical specifications approved by CCS.

(3) The allowable tolerance on assembly measured over a length of 5 links is to be 0% to +2.5% (measured with the chain loaded to 10% of the minimum proof load).

(4) Except for the provisions in Table 10.3.8.6(5), all other dimensions are to be subjected to a manufacturing tolerance of 2.5%, provided that all of the final link parts of the mooring chain fit together properly.

(5) The tolerance of common links is to comply with the relevant requirements of Table 10.3.8.6(5). The inside and outside bending diameters of links are to be even.

(6) For stud links, studs are to be located in the links centrally, and at right angle to the sides of the links. The following tolerances in Table 10.3.8.6(5) are acceptable provided that the stud fits snugly and its ends lie practically flush against the inside of the link.

Dimensions and tolerances of common links Table 10.3.8.6(5)

Designation	Description	Stud link			Studless link		
		Nominal dimension	Minus tolerance	Plus tolerance	Nominal dimension of	Minus tolerance	Plus tolerance
A	Link length	$6d$	$0.15d$	$0.15d$	$6d$	$0.15d$	$0.15d$
B	Link half length	$a^*/2$	$0.1d$	$0.1d$	Not applicable	—	—
C	Link width	$3.6d$	$0.09d$	$0.09d$	$3.35d$	$0.09d$	$0.09d$
E	Stud angular misalignment	0°	4°	4°	Not applicable	—	—
R	Inner radius	$0.65d$	0	—	$0.60d$	0	—

Notes: ① d = Nominal diameter of mooring chain, a^* = Actual link length.

② Other dimension ratios are subject to special approval by CCS.

10.3.8.7 After proof testing, the entire mooring chain is to be checked for the length, five links at a time. By the check the first five links are to be measured. From the next set of five links, at least two links from the previous five links set are to be included. This procedure is to be followed for the entire chain length. The measurements are to be taken preferably while the chain is loaded to 5% to 10% of the minimum proof load. The links held in the end blocks may be excluded from this measurement.

10.3.8.8 According to the test frequency and sampling provisions in Table 10.3.8.5(2), links of samples detached from finished, heat treated mooring chain are to be sectioned for determination of mechanical properties:

(1) One tensile specimen and three sets of three Charpy V-notch impact test specimens are to be taken for testing. The sampling locations are as shown in Figure 10.3.8.8(1) and comply with following stipulations:

The tensile specimen is to be taken in the side opposite the flash weld;

First set of three impact specimens is to be taken across the flash weld with the notch centered in the middle;

Second set of three impact specimens is to be taken across the unwelded side;

Third set of three impact specimens is to be taken from the bend region.

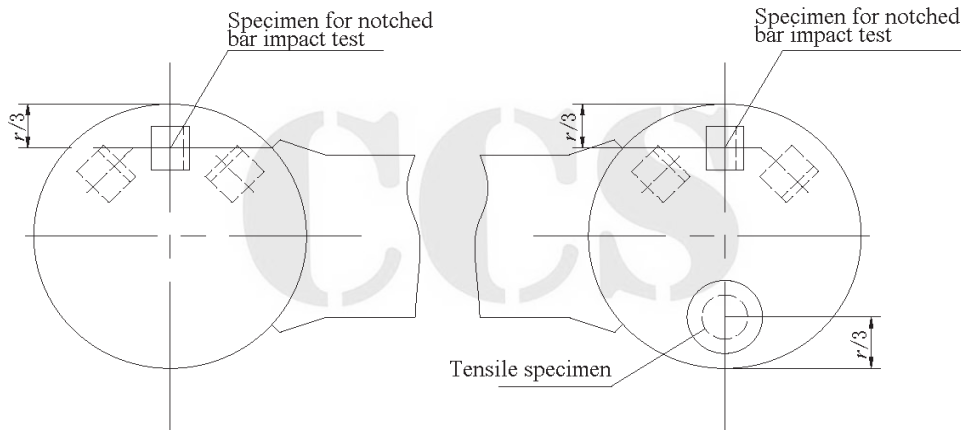


Figure 10.3.8.8(1)

(2) The frequency of impact testing in the bend may be reduced at the discretion of CCS provided it is verified by statistical means that the required toughness is consistently achieved.

(3) The test results are to comply with the requirements of Table 10.3.8.8(3).

Mechanical Properties of Mooring Chains and Accessories Table 10.3.8.8(3)

Grade	Yield strength $R_{p0.2}$ (N/mm ²)	Tensile strength R_m (N/mm ²)	Elongation A_5 (%)	Reduction of area Z (%)	Charpy V-notch impact test		
					Test temperature (°C)	Impact energy (J)	
						Base metal	Weld metal
OM3	≥410	≥690 ^②	≥17	50	0(-20) ^①	≥60(40)	≥50(30)
OM3S	≥490	≥770 ^②	≥15	50	0(-20) ^①	≥65(45)	≥53(33)
OM4	≥580	≥860 ^②	≥12	50	-20	≥50	≥36
OM4S ^③	≥700	≥960 ^②	≥12	50	-20	≥56	≥40
OM5 ^③	≥760	≥1000 ^②	≥12	50	-20	≥58	≥42

Notes: ① In general, the temperature of impact test for Grade OM3 and OM3S chain is 0°C. Where it is required by the purchaser, -20°C may be regarded as a supply condition.

② Aim value of yield to tensile ratio: 0.92 max.

③ Aim maximum hardness for OM4S is 330HBW and OM5 340HBW.

10.3.8.9 After proof testing, all surfaces of every link are to be visually examined. Burrs, irregularities and rough edges are to be contour ground. Links are to be free from mill defects, surface cracks, dents and cuts, especially in the vicinity where gripped by clamping dies during flash welding. Studs are to be securely fastened.

10.3.8.10 Magnetic particles are to be employed to examine the following positions. Procedures and equipment in accordance with those approved are to be used:

- (1) the flash welded area including the area gripped by the clamping dies;
- (2) 10% of links are to be tested on all accessible surfaces.

Link surfaces and the surface at the flash weld are to be free from cracks, lack of fusion and gross porosity.

10.3.8.11 Ultrasonics are to be employed to examine the flash weld fusion. Procedures and equipment in accordance with those approved are to be used. On-site calibration standards for chain configurations are to be approved by CCS. The flash weld is to be free from defects causing ultrasonic back reflections equal to or greater than the calibration standards.

10.3.9 Retest, rejection and repair criteria

10.3.9.1 If the length over 5 links is short, the mooring chain may be stretched by loading above the proof test load specified provided that the applied load is not greater than that approved and that only random lengths of the chain need stretching. If the length exceeds the specified tolerance, the over length chain links are to be cut out and 10.3.9.2 is to apply. The stretched links are to be recorded in the report.

10.3.9.2 If single links are found to be defective or to not meet other applicable requirements, defective links may be cut out and a connecting common link inserted in their place. The individual heat treatment and inspection procedure of connecting common links is subject to CCS's approval. Other methods for repair are subject to the written approval of CCS and the end purchaser.

10.3.9.3 If a crack, cut or defect in the flash weld is found by visual or magnetic particle examination, it is to be ground down no more than 5% of the link diameter in depth and streamlined to provide no sharp contours. The final dimensions must still conform to the agreed standard.

10.3.9.4 If indications of interior flash weld defects in reference to the accepted calibration standards are detected during ultrasonic examination, those links are to be cut out and replaced in accordance with the requirements of 10.3.9.2.

10.3.9.5 If link diameter, length, width and stud alignment do not conform to the required dimensions, these are to be compared to the dimensions of 40 more links; 20 on each side of the affected link. If a single particular dimension fails to meet the required dimensional tolerance in more than 2 of the sample links, all links are to be examined, and unsatisfactory links are to be cut out and replaced in accordance with the requirements of 10.3.9.2.

10.3.9.6 If a break load test fails, a thorough examination with the Surveyor informed in a timely manner is to be carried out to identify the cause of failure. Two additional break test specimens representing the same sampling length of mooring chain are to be subjected to the break load test. Based upon satisfactory results of the additional tests and the results of the failure investigation, it will be decided what lengths of mooring chain can be accepted. Failure of either or both additional tests will result in rejection of the sampling length of mooring chain represented and satisfactory chains with same length are to be used.

10.3.9.7 If a link fails during proof load testing, a thorough examination with the Surveyor informed in a timely manner is to be carried out to identify the probable cause of failure of the proof test. In addition to the above failure investigation, a break test specimen is to be taken from each side of the one failed link, and subjected to the break test. Based upon satisfactory results of both break tests and the results of the failure investigation, it will be decided what length of mooring chain can be considered for acceptance. Failure of either or both break tests will result in rejection of the same proof loaded length. In the event that two or more links in the proof loaded length fail, that length is to be rejected. The above failure investigation is to be carried out especially with regard to the presence in other lengths of factors or conditions thought to be causal to failure.

10.3.9.8 Re-test requirements for tensile and impact tests are to be in accordance with the provisions of Section 2, Chapter 1 of this PART. Failure to meet the specified requirements of either or both additional tests will result in rejection of the sampling length of mooring chain represented.

10.3.10 Marking, certification and document

10.3.10.1 The mooring chain having been satisfactorily surveyed by CCS is to be marked at the following places:

- (1) each end;
- (2) intervals not exceeding 100 m;
- (3) connecting common links;
- (4) Links next to shackles or connecting common links.

All marked links are to be stated on the certificate, and the marking is to make it possible to recognize the leading and tail end of the chain. In addition to the above required marking, the first and last common link of each individual charge used in the continuous length is to be adequately and traceably marked. The marking is to be permanent and legible throughout the expected lifetime of the chain.

10.3.10.2 The chain is to be marked on the studs as follows:

- (1) chain grade;
- (2) certificate number;
- (3) CCS stamp.

The certificate number may be exchanged against an abbreviation or equivalent. If so, this is to be stated in the certificate.

10.3.10.3 The mooring chain certificate is to contain information on number and location of connecting common links. The certificate number and replacement link number may be exchanged against an abbreviation or equivalent. If so, this is to be stated in the certificate.

10.3.10.4 A complete chain inspection and testing report in booklet form is to be provided by the chain manufacturer for each continuous chain length. This booklet is to include all dimensional checks, test and inspection reports, NDT reports, process records, photographs as well as any non-conformity, corrective action and repair work. In addition, certificates for materials, the location and number of replacement links are to be included.

Individual certificates are to be issued for each continuous single length of chain. All accompanying documents, appendices and reports are to carry reference to the original certificate number.

The manufacturer will be responsible for storing, in a safe and retrievable manner, all documentation produced for a period of at least 10 years.

10.3.11 Testing and inspection of accessories

10.3.11.1 This section applies to but is not limited to mooring equipment accessories such as Kenter shackles, end shackles, swivels and swivel shackles.

10.3.11.2 All accessories are to be subjected to proof load tests, sample break load tests and sample mechanical tests after final heat treatment in the presence of a Surveyor. Where the manufacturer has a procedure to record proof loads and the Surveyor is satisfied with the adequacy of the recording system, he need not witness all proof load tests. The Surveyor is to satisfy himself that the testing machines are calibrated and maintained in a satisfactory condition. Prior to testing and inspection the chain accessories are to be free from scale, paint or other coating.

10.3.11.3 All accessories are to be subjected to the proof load specified for the corresponding link chain.

10.3.11.4 At least one accessory out of every batch or every 25 accessories, whichever is less, is to be tested to the break test load prescribed for the grade and size of mooring chain for which they are intended. A batch is defined as accessories that originate from the same heat treatment charge and the same heat of steel.

For individually produced accessories or accessories produced in small batches (less than 5), other alternative testing methods may be used subject to agreement of CCS.

The accessories which have been subjected to the break load test are to be destroyed and not used as part of an outfit.

10.3.11.5 At least one accessory (of the same type, size and nominal strength) out of 25 is to be checked for dimensions after proof load testing. The manufacturer is to provide a statement indicating compliance with the purchaser's requirements.

10.3.11.6 The following tolerances are applicable to accessories:

nominal diameter: 0% to +5%;

other dimensions: $\pm 2.5\%$.

These tolerances do not apply to machined surfaces.

10.3.11.7 Accessories are to be subjected to mechanical testing. Mechanical tests are to be taken from proof loaded full size accessories that have been heat treated with the production accessories they represent. The use of separate representative coupons is not permitted except for accessories with complex geometries.

10.3.11.8 Test location of forged shackles. Forged shackle bodies and forged Kenter shackles are to have a set of three impact tests and a tensile test taken from the crown of the shackle. Tensile tests on smaller diameter shackles can be taken from the straight part of the shackle, where the geometry does not permit a tensile specimen from the crown. The tensile properties and impact values are to meet the requirements of Table 10.3.8.8(3) in the locations specified in Figure 10.3.8.8(1), with the Charpy pieces on the outside radius. The sampling locations of other accessories with complex geometries are to be agreed with CCS.

10.3.11.9 For individually produced accessories or accessories produced in small batches (less than 5), alternative testing can be proposed. Each proposal for alternative testing is to be detailed by the manufacturer in a written procedure and submitted to CCS.

10.3.11.10 Mechanical tests of pins are to be taken as per Figure 10.3.8.8(1) from the mid length of a sacrificial pin of the same diameter as the final pin. For oval pins, the diameter taken is to represent the smaller dimension. Mechanical tests may be taken from an extended pin of the same diameter as the final pin that incorporates a test prolongation and a heat treatment buffer prolongation, where equivalence with mid length test values have been established. The length of the buffer is to be at least equal to 1 pin diameter dimension which is removed after the heat treatment cycle is finished. The test coupon can then be removed from the pin. The buffer and test are to come from the same end of the pin as per Figure 10.3.11.10.

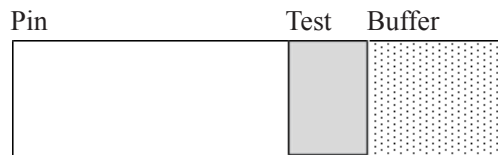


Figure 10.3.11.10 Buffer and test piece location

10.3.11.11 After proof load testing, non-destructive examination is to be carried out according to following requirements:

- (1) All chain accessories are to be subjected to a close visual examination. Special attention is to be paid to machined surfaces and high stress regions. All non-machined surfaces are to be sand or shot blasted to permit a thorough examination. All accessories are to be checked by magnetic particles or dye penetrant.
- (2) Non-destructive examination is to be carried out according to approved standards or procedures. Relevant acceptance standards are to be submitted to CCS for approval.

The manufacturer is to provide a statement that non-destructive examination has been carried out with satisfactory results. This statement is to include a brief reference to the techniques and to the operator's qualification.

10.3.11.12 In the event of a failure of any test, the entire batch represented is to be rejected unless the cause of failure has been determined and it can be demonstrated to the Surveyor's satisfaction that the condition causing the failure is not present in any of the remaining accessories.

10.3.12 Accessory marking, certification and document

10.3.12.1 Each accessory satisfactorily surveyed by CCS is to be marked with mooring chain grade.

10.3.12.2 The Certificate number may be exchanged against an abbreviation or equivalent. If so, this is to be stated in the certificate.

10.3.12.3 A complete accessory inspection and testing report in booklet form is to be provided by the manufacturer for each order. This booklet is to include all dimensional checks, test and inspection reports, NDT reports, process records as well as any non-conformity, corrective action and repair work.

10.3.12.4 Each type of accessory is to be covered by separate certificates. All accompanying documents, appendices and reports are to carry reference to the original certificate number. The manufacturer will be responsible for storing, in a safe and retrievable manner, all documentation produced for a period of at least 10 years."

PART TWO NON-METALLIC MATERIALS

CHAPTER 2 PLASTIC MATERIALS

Section 2 RAW MATERIALS

The heading of the existing paragraph 2.2.7, “Resin castings for machinery chocking” is replaced by “Machinery chocking compounds (resin chocks)”.

In existing paragraph 2.2.7.1, “resin castings” is replaced by “resin chocks”.

The existing paragraph 2.2.7.3 is replaced by “The resin chocks for approval are to be casted according to the minimum exotherm value under practical conditions and be subject to the following approval tests.”.

The first sentence of existing paragraph 2.2.7.5 is replaced by “The following properties are to be determined on cured chock materials.”

The existing subparagraph 2.2.7.5(6) is replaced by “(6) water absorption (immersed in artificial sea water and distilled water for 7 days);”.

The existing subparagraph 2.2.7.5(7) is replaced by “(7) oil absorption (immersed in diesel oil and lubricating oil for 7 days);”.

The existing paragraph 2.2.7.7 is replaced by the following:

“2.2.7.7 The working conditions of resin chocks intended for approval are a static load caused by equipment weight not greater than 0.7 N/mm² and maximum static load undertaken by resin chocks (equipment weight plus bolt fastening force) not greater than 4.5 N/mm² and temperature not greater than 80°C. The requirements for properties of the castings are given in Table 2.2.7.7.

Requirements for Properties of Resin Chock Castings **Table 2.2.7.7**

Compressive strength N/mm ²	Compressive modulus of elasticity N/mm ²	Barcol hardness	Heat deflection temperature °C	Flammability	Water absorption %	Oil absorption %
≥120	≥5000	≥35	≥80	Self-extinguishing	≤0.9	≤0.9

”

In the existing paragraph 2.2.7.8, a new sentence “The tensile strength is not to be less than 34 MPa.” is added at the end of the paragraph.

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CHAPTER 7 FIBER ROPES

Section 2 MARINE FIBER ROPES

In the existing paragraph 7.2.2.1, “HMPE” is replaced by “UHMWPE”.

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PART THREE WELDING

CHAPTER 5 WELDING AND RIVETING OF HULL STRUCTURES

Section 3 INSPECTION AND REPAIRING OF WELDS

The existing paragraph 5.3.2 is replaced by the following:

“5.3.2 Inspection

5.3.2.1 On completion of welding of hull structures, visual inspection is to be carried out on all the finished welds. The surfaces of the welds are to be uniform and sound, with a smooth transition to the parent metal, and are to be free from excessive reinforcements and defects such as cracks, lack of fusion and incomplete root penetration of single side welding. Surface pores and undercuts are to be within admissible extents.

5.3.2.2 The internal quality of welds is to be examined by non-destructive detection methods such as radiographic examination, ultrasonic detection or other suitable methods. Some welds are to be subject to additional magnetic particle or dye penetrant examination if necessary. The method, procedures and acceptance standards of non-destructive testing are to be approved by CCS.

5.3.2.3 The location and extent of welds to be examined by non-destructive testing are to be agreed with between the Builder and CCS Surveyor. The number for non-destructive testing may be increased by the Surveyor if necessary.

5.3.2.4 The number (n) of radiographic examination for the welds in the strength deck and shell within $0.6L$ amidships may be calculated by the following formula:

$$n = 0.25 (i + 0.1W_T + 0.1W_L)$$

where: n — the number of radiographic examination for the welds;

i — amount of intersections of butt welds within $0.6L$ amidships;

W_T — whole length of transverse welds within $0.6L$ amidships, in m;

W_L — whole length of longitudinal welds joining the blocks within $0.6L$ amidships, in m.

The density of radiographs is to be decreased in number with the decrease of material grade. For material grades, reference is made to the definition in Chapter 1, PART TWO of CCS Rules for Classification of Sea-Going Steel Ships.

Where radiographic examination is carried out at an intersection, the length of the film is to be paralleled to the direction of the transverse welds.

5.3.2.5 The number of radiographic examination for the welds in the strength deck and shell outside $0.6L$ amidships may be 10% to 20% of the number stipulated in 5.3.2.4, and ultrasonic examination of a suitable number may be allowed.

The examination density of critical areas (such as shaft wrapper plate, stem and stern frame area, bow wave impact area and ice strengthened area) is to be greater than that of other areas.

5.3.2.6 Butt welds of longitudinal at bottom, side and deck are to be non-destructive examined as follows:

within $0.4L$ amidships — one in ten;

outside $0.4L$ amidships — one in twenty.

5.3.2.7 In addition to the hull structural areas specified in 5.3.2.4 to 5.3.2.6, the welds in the following essential areas of hull structures are also to be random examined by non-destructive testing in an appropriate manner:

- (1) The fillet welds for which the Rules require full penetration, such as:
 - a. connection of bulkhead to deck, bottom plate, upper or lower stool shelf plate;
 - b. connection of main engine foundation girders to top plate;
 - c. rudder horns and shaft brackets to shell structure;
 - d. rudder side plating to cast rudder stock connecting areas;
 - e. full penetration welds of crane pedestals (posts);
 - f. welds of stiffening pieces of strength decks, sheer strakes and bottom plates having an opening of over 300 mm in diameter within $0.6L$ amidships.
- (2) Butt connection of inner bottom, other continuous deck and bulkhead as well as continuous longitudinal.
- (3) Butt connection of longitudinal continuous hatch coaming (including the top plate) more than $0.15L$ in length, of container ship or other ships.
- (4) Welds of critical locations determined according to direct calculation of structural strength or fatigue strength assessment.
- (5) Other strength welds which are deemed important, subject to high stress or may have significant impact after failure.

5.3.2.8 In addition to the requirements of 5.3.2.3 to 5.3.2.7, non-destructive examination is to be carried out on the following locations of cargo tanks carrying dangerous chemicals in bulk:

- (1) All crossing of butts and seams of cargo tank bulkhead plating.
- (2) Cargo tank boundary welds are to be crack detected for a minimum of 10% of the total length of the welds.
- (3) Where side, bottom longitudinal and longitudinal bulkhead horizontal stiffeners stop at transverse bulkheads, in addition to the requirements of (2), at least 10% of the bulkhead boundary connection is to be crack detected.
- (4) Where longitudinal and longitudinal bulkhead horizontal stiffeners are continuous through transverse bulkheads, in addition to the requirements of (2), at least 30% of the bottom and shipside boundaries and 20% of the longitudinal bulkhead boundaries are to be crack detected.
- (5) Where transverse framing members are continuous through the cargo tank longitudinal bulkheads, a minimum of 10% of the boundary connection is to be crack detected.

5.3.2.9 Where non-destructive examination reveals unacceptable defects in the welds and there is the possibility for such defects to develop, additional examinations are to be made along the direction of possible extension of the defective welded seam (one end or both ends) until a sound weld is obtained.

5.3.2.10 During actual examination, if it is found that less than 80% is satisfactory and doubt exists to weld quality of certain location, examination number is to be increased at the discretion of the surveyor.

5.3.2.11 The positions and results of non-destructive examination are to be recorded in the reports, which are to be submitted to CCS Surveyor for consideration.”