



CHINA CLASSIFICATION SOCIETY

# RULES FOR MATERIALS AND WELDING

AMENDMENTS

2020

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**Beijing**

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# PART ONE METALLIC MATERIALS

## CHAPTER 3 STEEL PLATES, FLAT BARS AND SECTIONS

### Section 7 STEELS FOR LOW TEMPERATURE SERVICE

#### 3.7.1 Application

3.7.1.1 This Section applies to carbon-manganese and nickel alloy steels not over 40 mm in thickness, intended for use in the construction of cargo tanks of liquefied gas carriers and the hull structures adjacent to these tanks. Such steels are to comply with the relevant requirements of CCS Rules for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk in addition to the requirement of this Section.

3.7.1.2 Carbon-manganese and nickel alloy steels over 40 mm in thickness are to comply with the relevant recognized standards subject to agreement of CCS ~~be specially considered~~.

**Conditions of supply and mechanical properties of nickel alloy steel Table 3.7.3.2**

Grade	Condition of supply	Proof strength $R_{p0.2}$ min. (N/mm <sup>2</sup> )	Tensile strength $R_m$ (N/mm <sup>2</sup> )	Elongation $A_5$ min. (%)	Charpy V-notch impact tests			Design Temp. min. (°C)	
					Material thickness $t$ (mm)	Test Temp. $T$ (°C)	Average energy of test specimens, min. (J)		
							Long.		Trans.
1.5Ni	Normalized or normalized and tempered or quenched and tempered or TMCP <sup>①</sup>	275	470~640	22	$t \leq 25$ $25 < t \leq 30$ $30 < t \leq 35$ $35 < t \leq 40$	-65 -70 -75 -80	41	27	-60
2.25Ni	Normalized or normalized and tempered or quenched and tempered or TMCP <sup>①</sup>	295	420~570	19	$t \leq 25$ $25 < t \leq 30$ $30 < t \leq 35$ $35 < t \leq 40$	-70 -75 -80 -85			
3.5 Ni	<u>Normalized or normalized and tempered or quenched and tempered</u>	345	440~690	21	$t \leq 25$ $25 < t \leq 30$ $30 < t \leq 35$ $35 < t \leq 40$	-95 -100 -105 -110			-90
5Ni	Normalized or normalized and tempered or quenched and tempered or TMCP <sup>②③</sup>	390	520~710	21	$t \leq 25$ $25 < t \leq 30$ $30 < t \leq 35$ $35 < t \leq 40$	-110 -115 -120 -125			-105
9Ni	Double normalized and tempered or quenched and tempered	490	640~830	19	$t \leq 40$	-196			-165

- ① Nickel steel supplied in TMCP is subject to agreement of CCS.  
 ② Nickel steel with 5% Ni content after being subject to special heat treatment, such as three stage heat treatment (double quenched and tempered), may be used in locations where the minimum temperature is -165°C. However, impact tests are to be carried out at temperature below -196°C.  
 ③ The requirement is applicable to materials not over 40 mm in thickness. For materials over 40 mm in thickness, the energy value of Charpy V-notch impact test is subject to agreement of CCS.  
 ④ The transverse values of impact tests apply to plates and the longitudinal values to sections.

## CHAPTER 5 STEEL FORGINGS

### Section 4 FORGINGS FOR CRANKSHAFTS

5.4.5.2 The number of test specimens for crankshaft forgings is to comply with the following:

(5) For small die crankshaft forgings, batch test may be carried out according to the requirements of 5.1.5.3 of this Chapter; for continuous heat treatment procedure, the batch quantity may be relaxed as appropriate subject to agreement of CCS.

## **CHAPTER 6 STEEL CASTINGS**

### **Section 1 GENERAL PROVISIONS**

6.1.10.13 The manufacturer is to maintain full records detailing the extent and location of repairs made to each casting and details of weld procedures and heat treatments applied for repairs as well as subsequent survey reports. These documents are to be available to the Surveyor and copies provided on request.

## **CHAPTER 9 OTHER NON-FERROUS MATERIALS**

### **Section 1 COPPER ALLOY PROPELLERS**

9.1.7.2 Each satisfactorily inspected propeller casting is to be provided with a certificate~~a marine product certificate or equivalent document~~ containing the following details:

## CHAPTER 10 EQUIPMENT

### Section 1 ANCHORS

10.1.6.2 The tests are to be applied to anchors of mass which are as far as possible representative of the full range of sizes proposed. Normally the following requirements are to be complied with:

(1) For approval and/or acceptance for a range of HHP anchor sizes, tests at sea are to be carried out for at least two anchor sizes. The mass of the maximum size approved is not to be more than 10 times the mass of the largest size tested ~~The larger of the two anchors tested is to have a mass not less than one-tenth of that of the largest anchor for which approval is sought,~~ and the smaller of the two anchors is to have a mass not less than one-tenth of that of the large anchor.

## PART TWO NON-METALLIC MATERIALS

### CHAPTER 2 PLASTICS MATERIALS

#### Section 2 RAW MATERIALS

##### 2.2.3 Reinforcements

2.2.3.1 Reinforcements are in general fibrous substances or fabrics, and are to be free from imperfections or defects such as impurities, contamination and rot. They are to be well compatible with the polymers and resins which are to be reinforced and be stored strictly according to the manufacturer's recommendations in dry, ventilated and dust-free places with a relatively stable temperature.

2.2.3.2 The manufacturer is to provide data to the following items, as applicable, for each type of reinforcements used and recognized standards are to be satisfied:

- (1) reinforcement type;
- (2) fibre type for each direction;
- (3) linear density of fibres or yarns ( $kT$ tex value);
- (4) fibre finish and/or treatment;
- (5) density of the fibre material;
- (6) tensile strength at break and elongation at break of fibers, rovings or fabrics;
- (7) content of combustible matters;
- (8) moisture content;
- (9) type and content of wetting agent and/or treating agent;
- (10) weave type;
- (11) weight per unit area of fabric or felt;
- (12) width, thickness of fabric or felt;
- (13) compatibility (suitable for which polymer or resin);
- (14) other necessary items.

2.2.3.3 In the case of a multi-ply reinforcement comprising felt, cloth and fabric, detailed data of its structural composition are to be listed: e.g. density, type, repeat frequency and orientation of yarns/threads.

2.2.3.4 Tests of the mechanical properties are to be made, as necessary, on laminate samples containing the reinforcement (rovings may be rod-shaped in accordance with a relevant standard). The samples are to be prepared as follows, using the curing system recommended by the manufacturer:

- (1) A CCS approved resin (polymer) of suitable type is to be used.
- (2) A minimum of three layers of the reinforcement is to be laid with parallel ply to give a laminate not less than 4 mm thick.
- (3) The weights of resin and reinforcement used are to be recorded together with the measured thickness of the laminate, including the measured weight per unit area of the reinforcement used.
- (4) For glass reinforcements, the nominal glass fiber content is as follows:

**Nominal Fiber Content by Mass**

**Table 2.2.3.4(4)**

	Open mould (%)	Vacuum bag (%)
Chopped strand mat (CSM)	30	36
Roving and woven roving (WR)	48	58
Roving mat combination (Mat + Cloth)	46-18 <i>R</i>	56-22 <i>R</i>
Multidirectional fabric (3-directional and 4 directional)	50	60
Unidirectional fabric	55	66

Note: *R* = total weight of mat in roving mat combination/(total weight of mat and cloth in roving mat combination)

The total nominal glass fiber content *G* of a laminate can be calculated using the following formula:

$$G = \frac{W}{\frac{W_1}{G_1} + \frac{W_2}{G_2} + \dots + \frac{W_n}{G_n}}$$

where:  $W_1, W_2, \dots, W_n$  are respectively the total weight of various reinforcements per unit area of a laminate, in g;  
 $W = W_1 + W_2 + \dots + W_n$  are total weight of reinforcements per unit area of a laminate, in g;  
 $G_1, G_2, \dots, G_n$  are respectively the nominal glass fiber content of various reinforcements per unit area of a laminate, to be obtained from Table 2.2.3.4(4).

(5) For carbon fiber reinforcements, the fire content is to be controlled within 60±5% by weight. For reinforcement types other than glass fiber and carbon fiber, a fibre volume-weight fraction recommended by the manufacturer may be used.

2.2.3.5 Glass fiber rovings intended for filament winding may be regarded as unidirectional reinforcements and in this case, tests with glass fibre content of 70±5% by weight are recommended.

2.2.3.6 The properties of glass fiber laminate samples prepared according to 2.2.3.4 are to be tested for the following items, as applicable, the test results of which are to comply with the relevant recognized standards:

- (1) resin or fiber content;
- (2) density;
- (3) water absorption;
- (4) hardness (Shore hardness, Rockwell hardness, Brinell hardness for thermoplastics, or Barcol hardness for thermosetting plastics);
- (5) temperature of deflection under load (Martin heat endurance, Vicat softening point or temperature of deflection);
- (6) tensile strength, modulus, elongation;
- (7) compressive strength, modulus;

- (8) flexural strength, modulus;
- (9) interlaminar shear strength (for laminates);
- (10) impact strength.

2.2.3.7 For approval of glass fiber woven roving, felt and cloth, the flexural strength is to be tested in wet condition, with test samples being boiled in distilled water for 2 h prior to the test.

2.2.3.8 Test specimens are to be taken to the orientation of the glass fiber reinforcement in the laminate. In general, gun roving and chopped strand mat may be taken in any direction, unidirectional material at 0° direction, woven roving and woven cloth at 0° and 90°, multi-ply combined reinforcement at 0°, 45°, 90° or -45° as necessary.

2.2.3.9 For PAN-based and pitch-based carbon fiber fabrics with the largest strand not greater than 48K, laminates are to be prepared according to the requirements in 2.2.3.4, and to be tested according to the items required in Table 2.2.3.9. The test results are not to be lower than that as required in Table 2.2.3.9.

**Performance requirements for carbon fiber laminates** **Table 2.2.3.9**

	<u>Tensile strength (MPa)</u>	<u>Tensile modulus (GPa)</u>	<u>Compressive strength (MPa)</u>	<u>Bending strength (MPa)</u>	<u>Interlaminar shear strength (MPa)</u>
	<u>ISO 527</u>	<u>ISO 527</u>	<u>ISO14126</u>	<u>ISO14125</u>	<u>ISO14130</u>
<u>Unidirectional</u>	<u>1100</u>	<u>100</u>	<u>765</u>	<u>900</u>	<u>25 for vinyl ester resin;</u> <u>48 for epoxy resin</u>
<u>Biaxial</u>	<u>600</u>	<u>55</u>	<u>430</u>	<u>500</u>	
<u>Triaxial</u> <sup>①</sup>	<u>550</u>	<u>45</u>	<u>350</u>	<u>400</u>	
<u>Quadraxial</u>	<u>500</u>	<u>42</u>	<u>350</u>	<u>370</u>	
Note:① The direction of the test is 0°.					
② Sizing agent of the fiber being tested is to match the resin intended to be used.					

# PART THREE WELDING

## CHAPTER 1 GENERAL

### Section 2 TESTING

(1) Bend tests of structural steels are to comply with the requirements of Table 1.2.4.2(1).

**Requirements for Bend Tests of Structural Steels** **Table 1.2.4.2(1)**

Purpose of test	Specified yield strength of test material (N/mm <sup>2</sup> )	Diameter <i>d</i> of former	Bending angle $\alpha$
For approval of welding consumables	$R_{eH} \leq 400$	$3t$	120°
	$400 < R_{eH} \leq 500$	$4t$	
	$500 < R_{eH} \leq 690$	$5t$	
	<u><math>690 &lt; R_{eH} &lt; 890</math></u>	<u><math>6t</math></u>	
	<u><math>890 &lt; R_{eH} &lt; 960</math></u>	<u><math>7t</math></u>	
For approval of welding procedures	$R_{eH} \leq 400$	$4t$	180°
	$400 < R_{eH} \leq 500$	$5t$	
	$500 < R_{eH} \leq 690$	$6t$	
	<u><math>690 &lt; R_{eH} &lt; 890</math></u>	<u><math>7t</math></u>	
	<u><math>890 &lt; R_{eH} &lt; 960</math></u>	<u><math>8t</math></u>	

Notes: ① *t* is the thickness of the specimen.

② For approval test of welding procedures for boilers and pressure vessels, the former diameter is to comply with Table 7.2.3.4 of this PART.

## CHAPTER 2 WELDING CONSUMABLES

### Section 2 MECHANICAL PROPERTIES OF WELDING CONSUMABLES

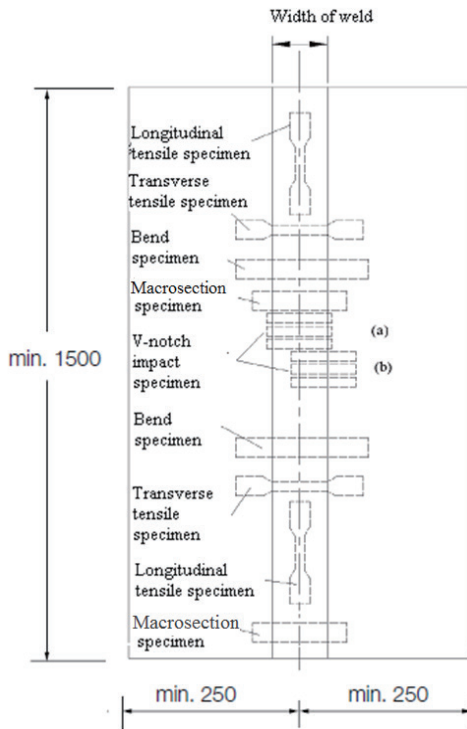
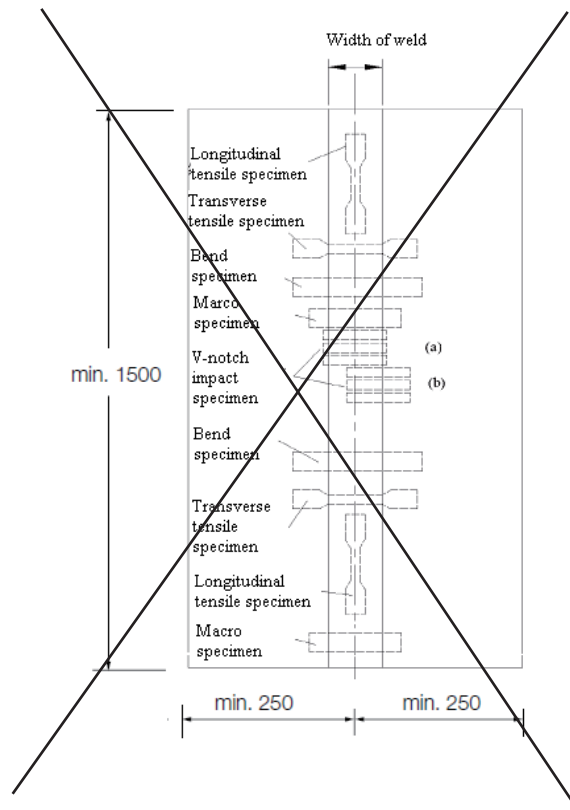
**Mechanical Properties of Consumables for Welding Structural Steels Table 2.2.2.3**

Grade of welding consumables		1,2,3	1Y 2Y 3Y 4Y <sup>①</sup>	2Y40 3Y40 4Y40 5Y40	3Y42 4Y42 5Y42	3Y46 4Y46 5Y46	3Y50 4Y50 5Y50	3Y55 4Y55 5Y55	3Y62 4Y62 5Y62	3Y69 4Y69 5Y69	3Y89 4Y89 5Y89	3Y96 4Y96 5Y96	1.5Ni	3.5Ni	5Ni	9Ni	
Deposited metal test	Yield strength <sup>⑦</sup> $R_{eff}$ (N/mm <sup>2</sup> )	≥305	≥375	≥400	≥420	≥460	≥500	≥550	≥620	≥690	≥890	≥960	≥375				
	Tensile strength <sup>⑧</sup> $R_m$ (N/mm <sup>2</sup> )	400~560	490~660	510~690	520~680	540~720	590~770	640~820	700~890	770~940	940~1100	980~1150	≥460	≥420	≥500	≥600	
	Elongation $A$ (%)	≥22		≥20		≥18			≥17	≥14	≥13	≥22	≥25				
	Charpy V-notch impact test	Test temp. (°C)	②										-80	-100	-120	-196	
	Average impact energy <sup>⑥</sup> (J)	≥47 <sup>③</sup>		≥47		≥50	≥55	≥62	≥69	≥69	≥69	≥69					
Butt Butt weld test	Transverse tensile strength (N/mm <sup>2</sup> )	≥400	≥490	≥510	≥520	≥540	≥590	≥640	≥700	≥770	940	980	≥490	≥450	≥540	≥640	
	Charpy V-notch impact test	Test temp. (°C)	②										-80	-100	-120	-196	
		Average impact energy <sup>⑥</sup> (J)	≥47 <sup>④</sup>		≥47		≥50	≥55	≥62	≥69	≥69	≥69	≥69				
	Bend test	After testing, the test specimens are not to reveal any open defects in any direction greater than 3 mm <sup>⑤</sup>															

- Notes: ① Manual arc welding electrodes are to comply with Grade 2Y and above.
- ② The temperature of impact test for welding consumables of Grade 1 and Grade 1Y is to be 20°C; for those of Grades 2, 2Y, 2Y40 to be 0°C; for those of Grades 3, 3Y, 3Y40, 3Y42, 3Y46, 3Y50, 3Y55, 3Y62, 3Y69, 3Y89, 3Y96 to be -20°C; for those of Grades 4Y, 4Y40, 4Y42, 4Y46, 4Y50, 4Y55, 4Y62, 4Y69, 4Y89, 4Y96 to be -40°C; for those of Grades 5Y40, 5Y42, 5Y46, 5Y50, 5Y55, 5Y62, 5Y69, 5Y89, 5Y96 to be -60°C. for those of impact grade F is not applicable for 890 N/mm<sup>2</sup> and 960 N/mm<sup>2</sup> yield strength levels, and especially considered by CCS. Acceptance values of impact tests for welding consumables of Grades 5Y89, 5Y96 are to be specially considered by CCS.
- ③ The average impact energy of deposited metal test of submerged arc automatic welding is not to be less than 34 J for welding consumables with  $R_{eff} < 400$  N/mm<sup>2</sup>; not to be less than 39 J for those with  $R_{eff} \geq 400$  N/mm<sup>2</sup>.
- ④ The average impact energy of butt joints of vertical welding and submerged arc automatic welding is not to be less than 34 J for welding consumables with  $R_{eff} < 400$  N/mm<sup>2</sup>; not to be less than 39 J for those with  $R_{eff} \geq 400$  N/mm<sup>2</sup>.
- ⑤ Except for 5Ni and 9Ni steel specimens to be bend tested with a former of diameter four times the plate thickness, the diameter of former is to comply with the requirements of 1.2.4.2 of this PART.
- ⑥ Energy values from individual impact test specimens are not to be less than 70% of the specified values.
- ⑦ In case of no marked yield stress, the proof stress  $R_{p0.2}$  is to be reported.
- ⑧ Where the tensile strength exceeds the specified maximum value, special consideration is to be given by CCS.

2.2.2.4 Welding consumables with grade Y89 are considered suitable for welding steels in the same strength level only. Welding consumables with grade Y96 are also considered suitable for welding steels in the one strength level below that for which they have been approved. For grade Y89 and Y96 in Table 2.2.2.3 of this PART, where the design requirements permit undermatching weld joint, then welding consumables within the scope of this chapter can be considered subject to CCS' discretion and Manufacturer's recommendations. (effective from 1 January 2020)

**Section 6 CONSUMABLES FOR USE IN ELECTRO-SLAG OR  
ELECTRO-GAS VERTICAL WELDING**



**Figure 2.6.2.3(1)**

# CHAPTER 3 APPROVAL OF WELDING PROCEDURES

## Section 1 GENERAL PROVISIONS

3.1.4.4 The application of a welding procedure specification to aluminum alloys is to comply with the following requirements:

(1) Welding procedures to be approved for aluminum alloys may be grouped as follows according to the chemical composition of their parent metal:

Group B: aluminum-magnesium alloys with  $4\% \leq \text{Mg} \leq 7\%$  (alloys ~~5059, 5083, 5086, 5383, 5456~~ and ~~5A01, 5086, 5083, 5383, 5456, 5A01, 5059~~)

## Section 2 WELDING PROCEDURE APPROVAL TESTS FOR BUTT WELDS

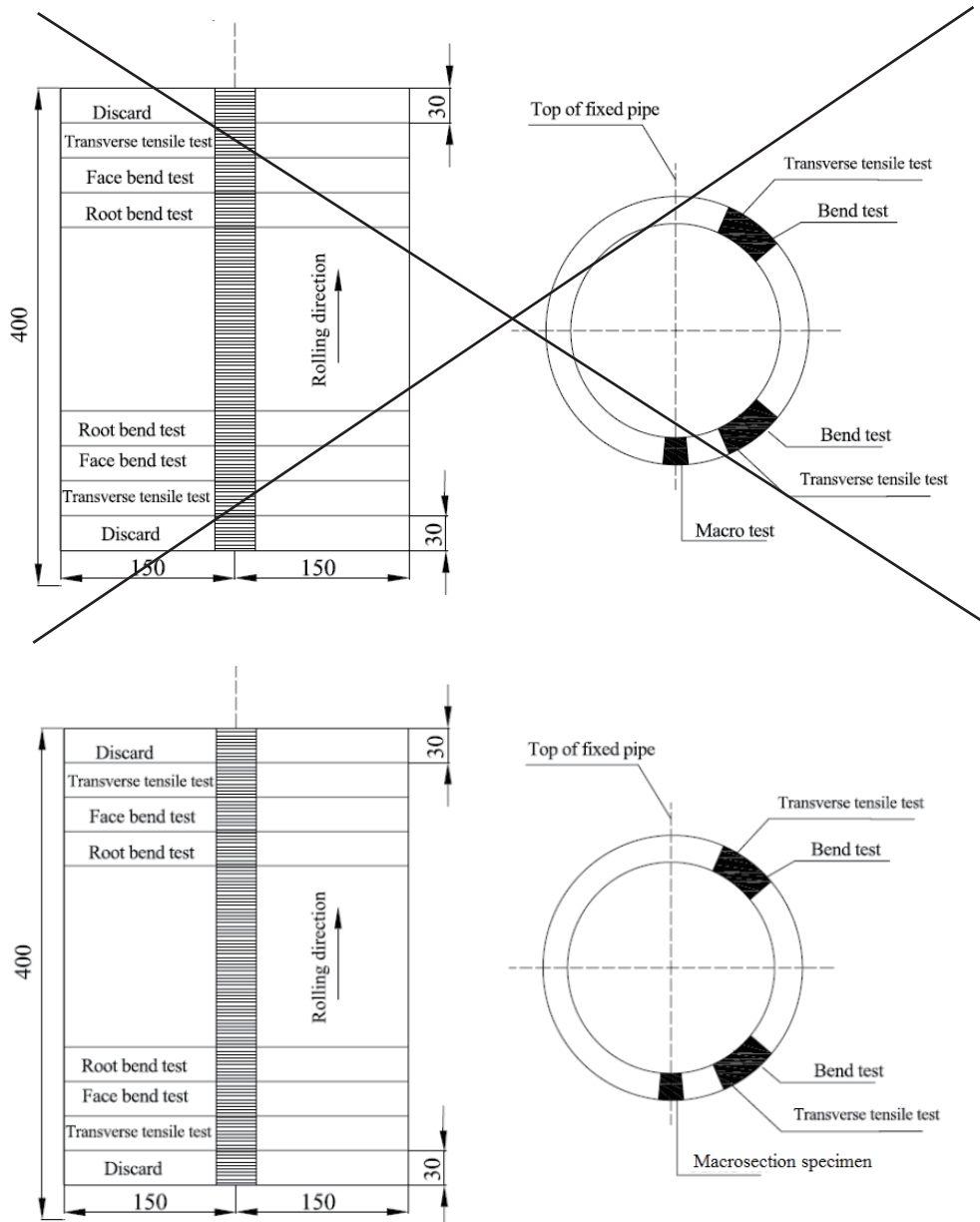
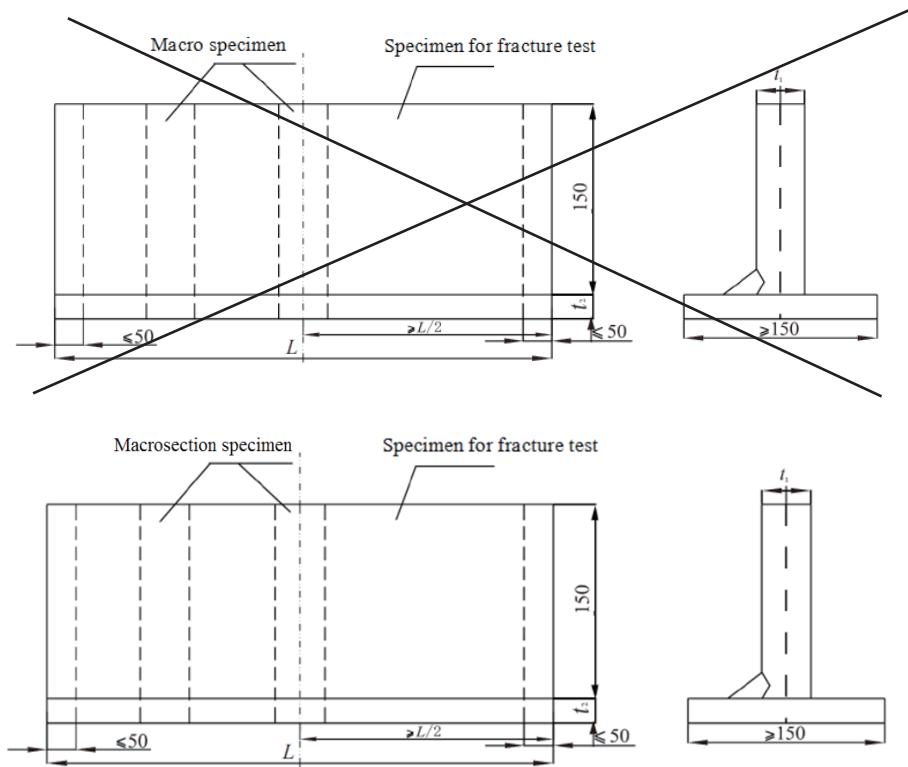


Figure 3.2.4.2

**Section 3 WELDING PROCEDURE APPROVAL TESTS FOR FILLET WELDS**



**Figure 3.3.3.2**

## CHAPTER 7 WELDING OF PRESSURE SHELLS

### Section 5 INSPECTIONS AND REPAIRING

7.5.2.4 For boilers and common pressure vessels, the gauge of the designed form is to have a chord length equal to 1/4 of the nominal inside diameter of the shell. The deviation  $X$  and the overall out-of-roundness  $\Delta\phi$  are to comply with the requirements of Table 7.5.2.4.

**Out-of-Roundness Deviation of Boilers and Common Pressure Vessels Table 7.5.2.4**

Nominal inside diameter of pressure shell $D_i$ (mm)	Allowable out-of-roundness $\Delta\phi$ (mm)	Maximum deviation from designed form $X$ (mm)
$D_i \leq 300$	$\leq 0.01D_i$	1.2
$300 < D_i \leq 460$		1.6
$460 < D_i \leq 600$		2.4
$600 < D_i \leq 900$		3.2
$900 < D_i \leq 1220$		4.0
$1220 < D_i \leq 1520$		4.8
$1520 < D_i \leq 1900$		5.6
$1900 < D_i \leq 2300$	$\leq 19$	6.4
$2300 < D_i \leq 2670$		7.2
$2670 < D_i \leq 3950$		8.0
$3950 < D_i \leq 4650$	$\leq 19$	$0.002D_i$
$D_i > 4650$	$\leq 0.004D_i$	$0.002D_i$

## CHAPTER 9 WELDING OF PRESSURE PIPES

### Section 3 INSPECTION OF WELDING QUALITY

#### 9.3.1 General requirements

9.3.1.1 Visual inspection, non-destructive testing and hydraulic pressure test are to be carried out after the welding of pipes.

9.3.1.2 The hydraulic tests are to be carried out in accordance with the requirements of Section 5, Chapter 2 of PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

#### 9.3.2 Visual inspection

9.3.2.1 The surface of welds is to be free from cracks, overlaps, pores, undercuts, unfilled cavities and depressions. In case of the above defects, repairs by welding are to be performed.

#### 9.3.3 Non-destructive testing

9.3.3.1 All butt joints of Class I pipes having an external diameter greater than 75 mm are to be subjected to radiographic or gammagraphic examination.

9.3.3.2 10% of butt joints of Class II pipes having an external diameter greater than 100 mm and Class I pipes having an external diameter equal to or less than 75 mm are to be subjected to radiographic or gammagraphic examination.

9.3.3.3 An approved ultrasonic testing procedure may be accepted in lieu of radiographic testing where the conditions are such that a comparable level of welding quality is assured.

9.3.3.4 Fillet welds on flange pipe connections of Class I pipes are to be examined by the magnetic particle method or by other appropriate non-destructive methods. The quantity of examination is to comply with the provisions in 9.3.3.1 and 9.3.3.2. For pipes of other classes, magnetic particle examination or equivalent non-destructive testing may be required for fillet welds depending upon the material, wall thickness and outside diameter of pipes and the nature of the medium being carried.

9.3.3.5 Ultrasonic examination in addition to the above non-destructive testing may be required in special cases.

9.3.3.6 Radiographic, gammagraphic and ultrasonic examinations are to be performed by Grade II operators certified by CCS, using an appropriate procedure. If necessary, complete details of the radiographic, gammagraphic and ultrasonic procedures are to be submitted for examination.

9.3.3.7 Magnetic particle examination is to be performed with suitable equipment and procedures, using a magnetic flux output sufficient for defect detection. If necessary, the equipment is to be checked against standard samples.

9.3.3.8 The welds are to meet an acceptable standard. Unacceptable defects are to be removed and repaired as required.