Shape of Tensile Test Specimens for Rolled Steel

Object of Amendment

Guidance for the Survey and Construction of Steel Ships Part K
Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use

Reason for Amendment

Although Part K of the Rules for the Survey and Construction of Steel Ships specifies that flat test specimens are, in principle, to be used for tensile tests, it also specifies round test specimens may be used instead in cases where plate thickness exceeds 40 *mm*. In recent years, the Society has received requests from relevant industry members asking that the use of reduced-thickness flat specimens (hereinafter referred to as "reduced-thickness specimens") be allowed to be used due to insufficient testing machine capacity.

Although the Society's Rules up until now have not included any requirements related to the use of reduced-thickness specimens, it decided to add requirements specifying that reduced-thickness specimens may be used. Such specimens, however, are only allowed to be used on the condition that they are representative of the strength properties of the product itself, and this is to be confirmed by a reviewing its property related to the strength distribution in the thickness direction at manufacturing process approval testing.

Accordingly, relevant requirements are amended to specify the above.

Outline of the Amendment

(1) Specify that reduced-thickness specimens may be used when approved by the Society.
(2) Specify that documents related to reduced–thickness specimens are required to be submitted together with applications for manufacturing process approval testing.

Effective Date and application

Effective date of this amendment is [the date of establishment].

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

ID:DH24-14

Amended-Original Requirements Comparison Table (Shape of Tensile Test Specimens for Rolled Steel)

Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part K MATERIALS** **K3 ROLLED STEELS** **K3.1 Rolled Steels for Hull** **K3.1.7 Selection of Test Specimens** When the capacity of the available testing machine is insufficient to allow the use of flat test specimens taken from samples, testing may be carried out using specimens of reduced thickness in the thickness direction of the product in cases where approved by the Society. **K3.2 Rolled Steel Plates for Boilers** **K3.2.7 Selection of Test Specimens** When the capacity of the available testing machine is insufficient to allow the use of flat test specimens taken from samples, testing may be carried out using specimens of reduced thickness in the thickness direction of the product in cases where approved by the Society.	**GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part K MATERIALS** **K3 ROLLED STEELS** **K3.1 Rolled Steels for Hull** **(Newly added)** **K3.2 Rolled Steel Plates for Boilers** **(Newly added)**	

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Amended	Original	Remarks
K3.3 Rolled Steel Plates for Pressure Vessels **K3.3.7 Selection of Test Specimens** **1** In **3.3.7-2(2), Part K of the Rules**, "deemed necessary by the Society" means the case where the steel plates are used for spherical tanks or end plates, etc. of cylindrical tanks to contain cold liquefied gas at normal temperature. In such a case, the specified values of the impact tests are to be in accordance with **Table K3.13, Part K of the Rules**. **2** When the capacity of the available testing machine is insufficient to allow the use of flat test specimens taken from samples, testing may be carried out using specimens of reduced thickness in the thickness direction of the product in cases where approved by the Society. **K3.8 High Strength Rolled Steels for Offshore Structures** **K3.8.7 Selection of Test Specimens** When the capacity of the available testing machine is insufficient to allow the use of flat test specimens taken from samples, testing may be carried out using specimens of reduced thickness in the thickness direction of the product in cases where approved by the Society.	**K3.3 Rolled Steel Plates for Pressure Vessels** **K3.3.7 Selection of Test Specimens** In **3.3.7-2(2), Part K of the Rules**, "deemed necessary by the Society" means the case where the steel plates are used for spherical tanks or end plates, etc. of cylindrical tanks to contain cold liquefied gas at normal temperature. In such a case, the specified values of the impact tests are to be in accordance with **Table K3.13, Part K of the Rules**. (Newly added) **K3.8 High Strength Rolled Steels for Offshore Structures** **(Newly added)**	

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Part 1 METALLIC MATERIALS **Chapter 1 APPROVAL OF MANUFACTURING PROCESS OF ROLLED STEELS** **1.4 Approval Test** **1.4.3 Details of Test** **1** Approval tests for each of rolled steels are to be performed for each test item indicated with a ○ mark in **Table 1.1-2** and the test procedure and judgement standard are to be accordance with **Table 1.1-3**. However, when deemed necessary by the Society, Society may request the increase of test piece, addition of test item (except the test item indicated in **Table 1.1-2** which is included the test related to hot workability, fatigue test, weld cracking test, *CTOD* tests of welded joints etc.) and submission of proper technical information. **2** In case of the test is not able to carry out at the works, the test is to carry out at proper test organization after obtaining the approval of the Society. **3** For approval of the manufacturing process of the rolling bars for offshore chains, in the case of initial approval and/or changes in any approved conditions, the approval test specified in **2.4, Part 2** is to be carried out in addition to the test specified in this Chapter. **4** In case of following **(1)** through **(3)**, Society considers these content and may omit the part or all of the approval tests. (1) Changes in the approval contents specified in **1.5.4**.	**Part 1 METALLIC MATERIALS** **Chapter 1 APPROVAL OF MANUFACTURING PROCESS OF ROLLED STEELS** **1.4 Approval Test** **1.4.3 Details of Test** **1** Approval tests for each of rolled steels are to be performed for each test item indicated with a ○ mark in **Table 1.1-2** and the test procedure and judgement standard are to be accordance with **Table 1.1-3**. However, when deemed necessary by the Society, Society may request the increase of test piece, addition of test item (except the test item indicated in **Table 1.1-2** which is included the test related to hot workability, fatigue test, weld cracking test, *CTOD* tests of welded joints etc.) and submission of proper technical information. **2** In case of the test is not able to carry out at the works, the test is to carry out at proper test organization after obtaining the approval of the Society. **3** For approval of the manufacturing process of the rolling bars for offshore chains, in the case of initial approval and/or changes in any approved conditions, the approval test specified in **2.4, Part 2** is to be carried out in addition to the test specified in this Chapter. **4** In case of following **(1)** through **(3)**, Society considers these content and may omit the part or all of the approval tests. (1) Changes in the approval contents specified in **1.5.4**.	

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(2) The manufacturing process and the test result have been approved by the other society and the manufacturer has a data showing actual manufacturing records within the specific period. (chemical composition, mechanical properties and thickness or dimension expressed in the form of histogram or statistics) (3) Where the rolled steel manufacturer uses slabs from multiple slab manufacturers or changes the slab manufacturer, and the following **(a)** or **(b)** applies. (a) The rolled steel manufacturer has already been approved for the manufacturing process using other semi-finished products characterized by the same thickness, steel grade, grain refining and micro-alloying elements, steel making and casting process. (b) The semi-finished product manufacturer has been approved for the complete manufacturing process with the same conditions (steelmaking, casting, rolling and heat treatment) for the same type of steel. **5** For the corrosion resistant steel for cargo oil tanks specified in **3.13, Part K of the Rules for the Survey and Construction of Steel Ships**, the Society may require additional tests in the following cases: (1) When the Society determines that since the chemical composition range is set by the theoretically analysis of each element based on existing data, the number of corrosion resistance test for cargo oil tanks is too few to adequately confirm the validity of the chemical composition range; (2) When the Society determines that the data of the corrosion resistance test result obtained for setting	(2) The manufacturing process and the test result have been approved by the other society and the manufacturer has a data showing actual manufacturing records within the specific period. (chemical composition, mechanical properties and thickness or dimension expressed in the form of histogram or statistics) (3) Where the rolled steel manufacturer uses slabs from multiple slab manufacturers or changes the slab manufacturer, and the following **(a)** or **(b)** applies. (a) The rolled steel manufacturer has already been approved for the manufacturing process using other semi-finished products characterized by the same thickness, steel grade, grain refining and micro-alloying elements, steel making and casting process. (b) The semi-finished product manufacturer has been approved for the complete manufacturing process with the same conditions (steelmaking, casting, rolling and heat treatment) for the same type of steel. **5** For the corrosion resistant steel for cargo oil tanks specified in **3.13, Part K of the Rules for the Survey and Construction of Steel Ships**, the Society may require additional tests in the following cases: (1) When the Society determines that since the chemical composition range is set by the theoretically analysis of each element based on existing data, the number of corrosion resistance test for cargo oil tanks is too few to adequately confirm the validity of the chemical composition range; (2) When the Society determines that the data of the corrosion resistance test result obtained for setting	

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the chemical composition range varies too widely; (3) When the Society determines that the validity of the corrosion resistance test result for setting the chemical composition range is insufficient, or has some flaws; (4) When the Surveyor has not attended the corrosion resistance tests for setting the chemical composition range, and the Society determines that additional testing is necessary in order to confirm the validity of the test result data; and (5) Others as deemed necessary by the Society. **6** For the steels considered to have the brittle crack arrest properties specified in **3.12, Part K of the Rules for the Survey and Construction of Steel Ships**, if the manufacturing process is similar to manufacturing control standards of chemical composition and rolling conditions for which the applicant has already been approved and is same as the deoxidation practice, grain refining and micro-alloying elements, heat treatment, steel making process, steel casting process, temperature gradient *ESSO* tests or double tension tests, chemical analyses, tensile tests and Charpy impact tests may be performed as approval tests according to this chapter. *CAT* evaluation tests may be applied instead of temperature gradient *ESSO* tests or double tension tests. In addition, where small-scale tests are used for product testing, these test methods are to be approved by the Society in accordance with **Annex 1.1**.	the chemical composition range varies too widely; (3) When the Society determines that the validity of the corrosion resistance test result for setting the chemical composition range is insufficient, or has some flaws; (4) When the Surveyor has not attended the corrosion resistance tests for setting the chemical composition range, and the Society determines that additional testing is necessary in order to confirm the validity of the test result data; and (5) Others as deemed necessary by the Society. **6** For the steels considered to have the brittle crack arrest properties specified in **3.12, Part K of the Rules for the Survey and Construction of Steel Ships**, if the manufacturing process is similar to manufacturing control standards of chemical composition and rolling conditions for which the applicant has already been approved and is same as the deoxidation practice, grain refining and micro-alloying elements, heat treatment, steel making process, steel casting process, temperature gradient *ESSO* tests or double tension tests, chemical analyses, tensile tests and Charpy impact tests may be performed as approval tests according to this chapter. *CAT* evaluation tests may be applied instead of temperature gradient *ESSO* tests or double tension tests. In addition, where small-scale tests are used for product testing, these test methods are to be approved by the Society in accordance with **Annex 1.1**.	

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Approval test item		Selected location of test samples (1) (2)	Length direction of test specimen (3) (4)	Testing method	Acceptance criteria	Notes		
Base metal test	Chemical analysis	Top	—	*JIS G* 0320, *JIS G* 0321 or equivalent method. Ladle analysis and product analysis are to be performed for elements specified in **Part K of the Rules**, and other elements as deemed necessary. In cases where a carbon equivalent or cold cracking susceptibility value is to be satisfied, the value is to be specified.	Chemical composition by ladle analysis is to comply with the requirements in **Chapter 3, Part K of the Rules**.	・ The sample is to be selected from tensile test specimens. ・ Excessive differences in the chemical compositions between ladle analysis and product analysis are not to be accepted. ・ Analysis is to be carried out for grain refining and micro-alloying elements (including *Zr*, *Cr*, or rare earth metals) ・ In the case of rolled steels for hulls, analysis is to be carried out for *As*, *Sn*, *B* and *Sb*. (for *B* and *Sb* in the case of steel making by electric furnace or open hearth furnace) ・ In the case of high strength rolled steels for offshore structures, if applicable, analysis is to be carried out for *As*, *Sn*, *B*, *Sb*, *Bi*, *Pb* and *H*, and nitrogen binding elements are also to be included.		
	Sulphur print	Top	Transverse	*JIS G* 0560, *ISO* 4968 or equivalent method. Sulphur prints are to be taken from plate edges which are perpendicular to the axis of the ingot or slab. These sulphur prints are to be approximately 600 *mm* long taken from the centre of the edge selected, i.e. on the ingot centreline, and are to include the full plate thickness.	Bias etc. deemed to have negative effects are not to be present.	-		
	Microscopic examination for non-metallic inclusions	Top	Parallel	*JIS G* 0555, *ISO* 4967 or equivalent method.	To be as deemed appropriate by the Society.	-		
		Bottom	Parallel					
	Macro-structure	Top	Transverse	*JIS G* 0553, *ISO* 4969 or equivalent method.		・ For continuous casting billets before rolling, macrostructure tests may be omitted for bottom portions.		
		Bottom	Transverse					
	Micro-structure	Top	—	Microscopic photographs		-		

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		Bottom	—	(approx. 100x) of base metal, joining part and cladding metal are to be taken.			
Base metal test	Austenite grain size Ferrite grain size	Top	—	*JIS G* 0551, *ISO* 643, *ASTM E* 112 or equivalent method. Magnification of microscopic photographs are to be, as a rule, 100x. The grain size is required for each microscopic photograph. In the case of austenite grain sizes which cannot be measured, pre-austenite grain size is to be determined.	For decisions other than those specified according to **Chapter 3**, **Part K of the Rules**, to be as appropriate by the Society.	・ In case of steels over 40 *mm* in thickness, tests are to be carried out on the surface, the position 1/4 of thickness and the middle of the thickness. ・ In the case of ferrite grain size numbers over 10, microscopic photographs (500x) are to be taken. ・ In the case of high strength rolled steels for offshore structures, microscopic photographs (x100 and 500x) are to be taken.	
	Hardness test	Top	—	In accordance with the requirements in **Part K of the Rules**. Hardness distribution in the thickness direction is to be measured in the case of stainless clad steel.	For decisions other than those specified according to **Chapter 3**, **Part K of the Rules**, to be as appropriate by the Society.	-	

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	Tensile test	Top	Transverse	In accordance with the requirements in **Part K of the Rules**.	To meet the requirements in **Chapter 3**, **Part K of the Rules**.	• In the case of hot coils, test samples are also to be selected from the middle of the length direction specified in **1.4.2-1**. • In the case of high strength rolled steels for offshore structures, test specimens are to be taken with their longitudinal axis parallel and transverse to the final direction of rolling from top and bottom • In cases where deemed necessary by Society, additional test specimens are taken with their longitudinal axis parallel to the final direction of rolling • In the case of round tensile test specimens of bars taken from steels over 40 *mm* in thickness, test specimens are to be taken from 1/4 and 1/2 of thickness. • In the case of high strength rolled steels for offshore structures, reduction of area and yield to tensile ratio are to be reported for reference. • When the capacity of the available testing machine is insufficient, tests may be carried out using specimens of reduced thickness in the thickness direction of the product in cases where such specimens are deemed appropriate by the Society in consideration of the type of heat treatment to be applied. In such cases, additional tests (tensile tests using the specimen of reduced thickness, hardness tests, micro-structures, etc.) may be required, and the thickness of the specimen to be used is to be stated in the approval test plan.	
EFFECTIVE DATE AND APPLICATION **1.** The effective date of the amendments is [the date of establishment].							