

S33 Requirements for Use of Extremely Thick Steel Plates in Container Ships

(Jan 2013)
(Rev.1
Sept 2015)
(Rev.2
Dec 2019)
(Rev.3
Feb 2020)

1. Application

1.1 General

1.1.1 This UR is to be complied with for container ships incorporating extremely thick steel plates having steel grade and thickness in accordance with 1.2 and 1.3 respectively.

1.1.2 This UR identifies when measures for the prevention of brittle fracture of extremely thick steel plates are required for longitudinal structural members.

1.1.3 This UR defines the following methods to apply to the extremely thick plates of container ships for preventing the crack initiation and propagation:

- Non-Destructive Testing (NDT) during construction detailed in 2,
- Periodic NDT after delivery detailed in 3,
- Brittle crack arrest design detailed in 4.

The application of the measures specified in 2, 3 and 4 is to be in accordance with Annex 1.

1.1.4 This UR gives the basic concepts for application of extremely thick steel plates to longitudinal structural members in the upper deck region.

1.1.5 For the application of this UR, the upper deck region means the upper deck plating, hatch side coaming plating, hatch coaming top plating and their attached longitudinals.

1.2 Steel Grade

1.2.1 This UR is to be applied when any of YP36, YP40 and YP47 steel plates are used for the longitudinal structural members in the upper deck region.

Note: YP36 YP40 and YP47 refers to the minimum specified yield strength of steel 355, 390 and 460 N/mm², respectively as defined in UR W11 and W31.

Notes:

1. This UR is to be applied by IACS Societies to ships contracted for construction on or after 1 January 2014.
2. Revision 1 of this UR is to be applied by IACS Societies to ships contracted for construction on or after 1 January 2017.
3. The “contracted for construction” date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of “contract for construction”, refer to IACS Procedural Requirement (PR) No. 29.
4. Revision 2 of this UR is to be applied by IACS Societies to ships contracted for construction on or after 1 January 2021.
5. Revision 3 of this UR is to be applied by IACS Societies to ships contracted for construction on or after 1 July 2021.

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1.2.2 In case YP47 steel plates are used for longitudinal structural members in the upper deck region, the steel plates are to be of EH47 grade as specified in UR W31.

1.3 Thickness

1.3.1 For steel plates with thickness of over 50 mm and not greater than 100 mm, the measures for prevention of brittle crack initiation and propagation specified in 2, 3 and 4 are to be taken.

1.3.2 For steel plates with thickness exceeding 100 mm, appropriate measures for prevention of brittle crack initiation and propagation are to be taken in accordance with the Classification Society's procedures.

1.4 Hull structures (for the purpose of design)**1.4.1 Material factor k**

The material factors of YP36 and YP40 steels are defined in UR S4.

The material factor of YP47 steel for the assessment of hull girder strength is to be taken as $k = 0.62$.

1.4.2 Fatigue assessment

The fatigue assessment of the longitudinal structural members is to be performed in accordance with the Classification Society's procedures.

1.4.3 Details of construction design

Special consideration is to be paid to the construction details where extremely thick steel plates are applied to structural members such as connections between outfitting and hull structures. Connections details are to be in accordance with the Classification Society's requirements.

2. Non-Destructive Testing during construction (Measure No.1 of Annex 1)

Where non-destructive testing (NDT) during construction is required in Annex 1, the NDT is to be in accordance with 2.1 and 2.2. Enhanced NDT as specified in 4.3.1(e) is to be carried out in accordance with an appropriate standard.

2.1 General

2.1.1 Ultrasonic testing (UT) in accordance with UR W33 is to be carried out on all block-to-block butt joints of all upper flange longitudinal structural members in the cargo hold region. Upper flange longitudinal structural members include the topmost strakes of the inner hull/bulkhead, the sheer strake, main deck, coaming plate, coaming top plate, and all attached longitudinal stiffeners. These members are defined in Fig.1.

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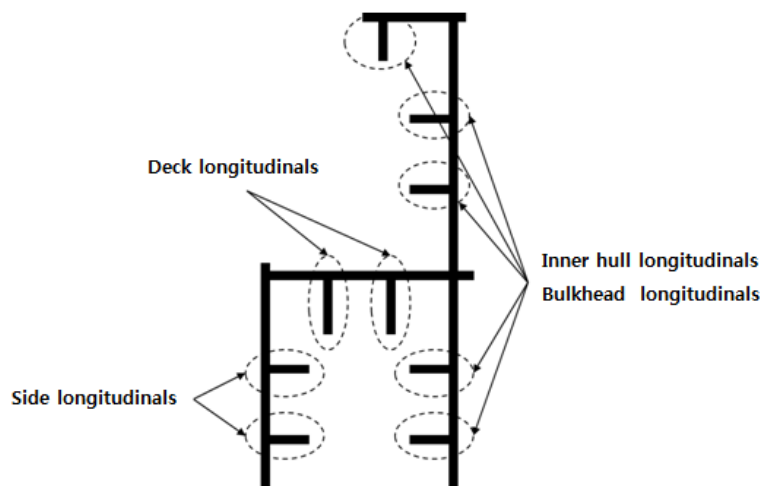


Fig.1 Upper Flange Longitudinal Structural Members

2.2 Acceptance criteria of UT

2.2.1 Acceptance criteria of UT are to be in accordance with UR W33.

2.2.2 The acceptance criteria may be adjusted under consideration of the appertaining brittle crack initiation prevention procedure and where this is more severe than that found in UR W33, the UT procedure is to be amended accordingly to a more severe sensitivity.

3. Periodic NDT after delivery (Measure No.2 of Annex 1)

Where periodic NDT after delivery is required, the NDT is to be in accordance with 3.1, 3.2 and 3.3.

3.1 General

3.1.1 The procedure of the NDT is to be in accordance with UR W33, irrespective of the applicability clause for new building in paragraph 1.1 of UR W33.

3.2 Timing of UT

3.2.1 Where UT is carried out, the frequency of survey is to be in accordance with the Classification Society requirements.

3.3 Acceptance criteria of UT

3.3.1 Where UT is carried out, acceptance criteria of UT are to be in accordance with UR W33, irrespective of the applicability clause for new building in paragraph 1.1 of UR W33.

4. Brittle crack arrest design (Measures No.3, 4 and 5 of Annex 1)

4.1 General

4.1.1 The brittle crack arrest steel method detailed in 4 may be used when the measures No.3, 4 and 5 of Annex 1 are applied and the steel grade material of the upper deck is not

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higher than YP40. Otherwise other means for preventing the crack initiation and propagation shall be agreed with the Classification Society.

4.1.2 Measures for prevention of brittle crack propagation, are to be taken within the cargo hold region. A brittle crack arrest design means a design using these measures.

4.1.3 The measures given in section 4 generally apply to the block-to-block joints but it should be noted that cracks can initiate and propagate away from such joints. Therefore, appropriate measures should also be considered for the cases specified in 4.2.1 (b) (ii).

4.1.4 Brittle crack arrest steels are defined in UR W31.

4.2 Functional requirements of brittle crack arrest design

4.2.1 The purpose of the brittle crack arrest design is to arrest propagation of a crack at a proper position and to prevent large scale fracture of the hull girder.

- (a) The locations of most concern for brittle crack initiation and propagation are the block-to-block butt weld joints either on hatch side coaming or on upper deck plating. Other locations in block fabrication where joints are aligned may also present higher opportunity for crack initiation and propagation along butt weld joints.
- (b) Both of the following cases are to be considered:
 - (i) where the brittle crack runs straight along the butt joint, and
 - (ii) where the brittle crack initiates in the butt joint but deviates away from the weld and into the plate, or where the brittle crack initiates from any other weld (see the figure below for definition of other welds) and propagates into the plate.

“Other weld” includes the following (refer to Fig.2):

1. Fillet weld between hatch side coaming plating, including top plating, and longitudinals;
2. Fillet weld between hatch side coaming plating, including top plating and longitudinals, and attachments. (e.g., Fillet weld between hatch side top plating and hatch cover pad plating.);
3. Fillet weld between hatch side coaming top plating and hatch side coaming plating;
4. Fillet weld between hatch side coaming plating and upper deck plating;
5. Fillet weld between upper deck plating and inner hull/bulkheads;
6. Fillet weld between upper deck plating and longitudinal; and
7. Fillet weld between sheer strakes and upper deck plating.

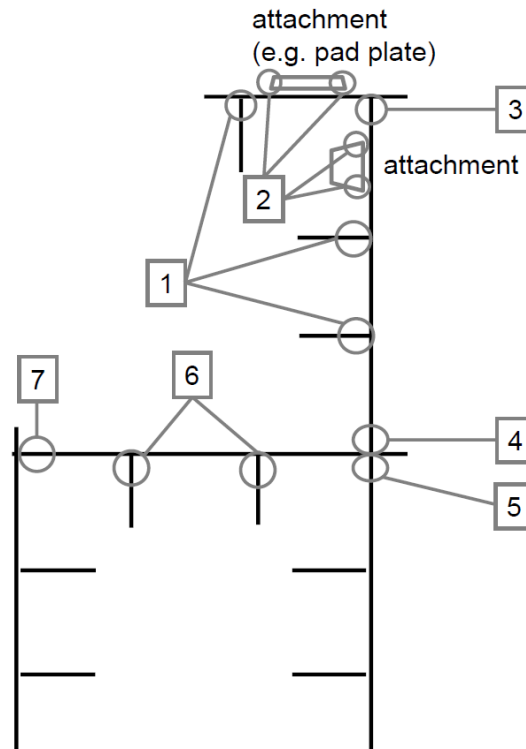


Fig.2 Other Weld Areas

4.3 Concept examples of brittle crack arrest design

4.3.1 The followings are considered acceptable examples of measures that can be used on a brittle crack arrest-design to prevent brittle crack propagations. The detail design arrangements are to be submitted to the Classification Society for their approval. Other measures may be considered and accepted for review by the Classification Society.

Brittle crack arrest design for 4.2.1(b) (ii):

- (a) Brittle crack arrest steel is to be used for the upper deck plating along the cargo hold region in a way suitable to arrest a brittle crack initiating from the coaming and propagating into the structure below.

Brittle crack arrest design for 4.2.1(b) (i):

- (b) Where the block to block butt welds of the hatch side coaming and those of the upper deck are shifted, this shift is to be greater than or equal to 300mm. Brittle crack arrest steel is to be provided for the hatch side coaming plating.
- (c) Where crack arrest holes are provided in way of the block-to-block butt welds at the region where hatch side coaming weld meets the deck weld, the fatigue strength of the lower end of the butt weld is to be assessed. Additional countermeasures are to be taken for the possibility that a running brittle crack may deviate from the weld line into upper deck or hatch side coaming. These countermeasures are to include the application of brittle crack arrest steel in hatch side coaming plating.
- (d) Where arrest insert plates of brittle crack arrest steel or weld metal inserts with high crack arrest toughness properties are provided in way of the block-to-block butt welds at the region where hatch side coaming weld meets the deck weld, additional

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countermeasures are to be taken for the possibility that a running brittle crack may deviate from the weld line into upper deck or hatch side coaming. These countermeasures are to include the application of brittle crack arrest steel in hatch side coaming plating.

- (e) The application of enhanced NDT particularly time of flight diffraction (TOFD) technique using stricter defect acceptance in lieu of standard UT technique specified in 2 can be an alternative to (b), (c) and (d).

4.4 Selection of brittle crack arrest steels

4.4.1 The brittle crack arrest steels fitted in the upper deck region of container ships are to comply with Table 1 where suffixes BCA1 and BCA2 are defined in UR W31.

4.4.2 The brittle crack arrest steel property is to be selected for each individual structural member with thickness above 50 mm according to Table 1.

Table 1: Brittle crack arrest steel requirement in function of structural members and thickness

Structural Members plating (*)	Thickness (mm)	Brittle crack arrest steel requirement
Upper deck	$50 < t \leq 100$	Steel grade YP36 or 40 with suffix BCA1
Hatch coaming side	$50 < t \leq 80$	Steel grade YP 40 or 47 with suffix BCA1
	$80 < t \leq 100$	Steel grade YP 40 or 47 with suffix BCA2
(*) Excluding their attached longitudinals		

4.4.3 When brittle crack arrest steels as specified in Table 1 are used, the weld joints between the hatch coaming side and the upper deck are to be partial penetration weld details approved by the Classification Society.

In the vicinity of ship block joints, alternative weld details may be used for the deck and hatch coaming side connection provided additional means for preventing the crack propagation are implemented and agreed by the Classification Society in this connection area.

Annex 1
Measures for Extremely Thick Steel Plates

The thickness and the yield strength shown in the following table apply to the hatch coaming top plating and side plating, and are the controlling parameters for the application of the countermeasures given in S33.4.3.1. These controlling parameters are not applicable for the upper deck.

If the as built thickness of the hatch coaming top plating and side plating is below the values contained in the table, countermeasures are not necessary regardless of the thickness and yield strength of the upper deck plating.

Yield Strength (kgf/mm ²)	Thickness (mm)	Option	Measures			
			1	2	3+4	5
36	50 < t ≤ 85	-	N.A.	N.A.	N.A.	N.A.
	85 < t ≤ 100	-	X	N.A.	N.A.	N.A.
40	50 < t ≤ 85	-	X	N.A.	N.A.	N.A.
	85 < t ≤ 100	A	X	N.A.	X	X
		B	X *	N.A. **	N.A.	X
47 (FCAW)	50 < t ≤ 100	A	X	N.A.	X	X
		B	X *	N.A. **	N.A.	X
47 (EGW)	50 < t ≤ 100	-	X	N.A.	X	X
<p>“X” means “To be applied” “N.A.” means “Need not to be applied” “A”, “B”: selectable options *: See 4.3.1 (e) of UR S33. **: may be required at the discretion of the Classification Society</p>						

Measures:

1. NDT other than visual inspection on all target block joints (during construction): See S33.2.
2. Periodic NDT other than visual inspection on all target block joints (after delivery): See S33.3.

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3. Brittle crack arrest design against straight propagation of brittle crack along weldline to be taken (during construction): See S33.4.3.1 (b), (c) and (d).
4. Brittle crack arrest design against deviation of brittle crack from weldline (during construction): See S33.4.3.1 (a).
5. Brittle crack arrest design against propagation of cracks from other welds such as fillets and attachment welds, as defined in S33.4.2.1 (b), (during construction): See S33.4.3.1 (a).

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