Shear Area of Frames for Polar Class Ships

Object of Amendment

Rules for the Survey and Construction of Steel Ships Part I

Reason for Amendment

Requirements for the structures of polar class ships are specified in IACS Unified Requirements (UR) I2, and these requirements have been incorporated into Chapter 3, Annex 1, Part I of the Rules for the Survey and Construction of Steel Ships.

Although UR I2 did not originally specify that the sectional areas of attached plates are to be considered when determining the shear area of a frame, IACS subsequently discussed the matter internally, and it was agreed that such sectional areas should be included in the shear areas of frames. As a result, IACS amended the UR and adopted relevant requirements as UR I2 (Rev. 5) in June 2025.

Accordingly, relevant requirements are amended based on UR I2 (Rev.5).

Outline of Amendment

Revises the formula for determining the shear area of frames so as to include the sectional areas of attached plates.

Effective Date and Application

This amendment applies to ships for which the date of contract for construction is on or after 1 January 2027.

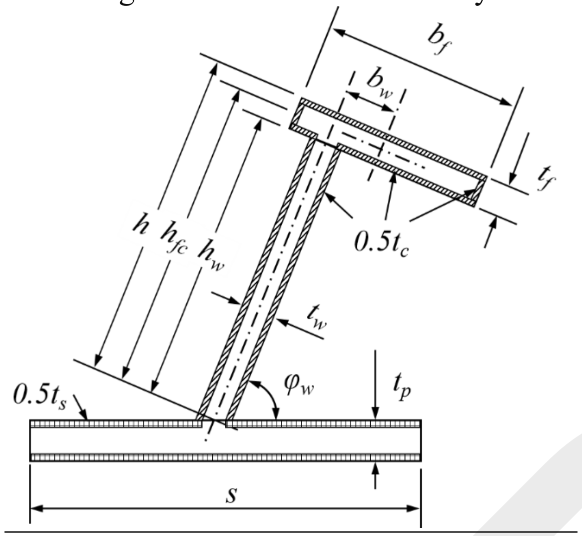
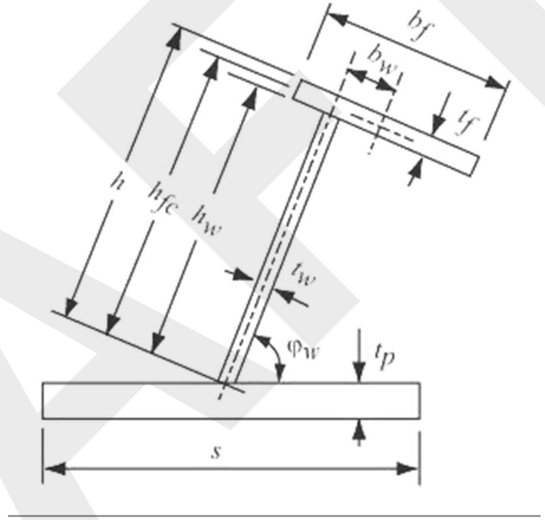
ID:DH25-10

Amended-Original Requirements Comparison Table (Shear Area of Frames for Polar Class Ships)

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS	**RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS**	
Part I SHIPS OPERATING IN POLAR WATERS, POLAR CLASS SHIPS AND ICE CLASS SHIPS	**Part I SHIPS OPERATING IN POLAR WATERS, POLAR CLASS SHIPS AND ICE CLASS SHIPS**	
ANNEX 1 SPECIAL REQUIREMENTS FOR THE MATERIALS, HULL STRUCTURES, EQUIPMENT AND MACHINERY OF POLAR CLASS SHIPS	**ANNEX 1 SPECIAL REQUIREMENTS FOR THE MATERIALS, HULL STRUCTURES, EQUIPMENT AND MACHINERY OF POLAR CLASS SHIPS**	
Chapter 3 HULL STRUCTURE	**Chapter 3 HULL STRUCTURE**	
3.4 Local Strength	**3.4 Local Strength**	
3.4.2 Framing - General	**3.4.2 Framing - General**	
7 The actual net effective shear area, A_w, of a transverse or longitudinal local frame is given by: $A_w = \frac{(h - 0.5t_c + t_{pn} + 0.5t_s) t_{wn} \sin\varphi_w}{100}$ (cm^2) where h : height of stiffener (mm), see **Fig. 3.4.2-1** t_{pn} : fitted net shell plate thickness (mm) (is to comply with t_{net} as required by **3.4.1-2**) t_s : corrosion and abrasion deduction (mm) to be subtracted from the shell plate thickness, see	**7** The actual net effective shear area, A_w, of a transverse or longitudinal local frame is given by: $A_w = \frac{h t_{wn} \sin\varphi_w}{100}$ (cm^2) where h : height of stiffener (mm), see **Fig. 3.4.2-1**	IACS UR I2 (Rev.5)

Amended	Original	Remarks
2.3.2 t_{wn} : net web thickness (mm), $t_{wn} = t_w - t_c$ t_w : as built web thickness (mm), see **Fig. 3.4.2-1** t_c : corrosion deduction (mm) to be subtracted from the web and flange thickness (as specified by other Parts , but not less than t_s as required by **2.3.3**). φ_w : smallest angle (deg) between shell plate and stiffener web, measured at the mid-span of the stiffener, see **Fig. 3.4.2-1**. The angle φ_w may be taken as 90 *degrees* provided the smallest angle is not less than 75 *degrees*. **8** The actual net effective plastic section modulus of a transverse or longitudinal local frame is given by following **(1)** or **(2)**. (1) When the cross-sectional area of the attached plate flange exceeds the cross-sectional area of the local frame, the actual net effective plastic section modulus, Z_p, is given by: $Z_p = \frac{A_{pn} t_{pn}}{20} + \frac{h_w^2 t_{wn} \sin\varphi_w}{2000} + \frac{A_{fn}(h_{fc}\sin\varphi_w - b_w \cos\varphi_w)}{10}$ (cm^3) where h, t_{wn}, t_c, <u>t_{pn}</u> and φ_w : as given in **-7** above A_{pn} : net cross-sectional area (cm^2) of the local frame h_w : height (mm) of local frame web, see **Fig. 3.4.2-1** A_{fn} : net cross-sectional area (cm^2) of local frame flange h_{fc} : height (mm) of local frame measured to centre of the flange area, see **Fig. 3.4.2-1**	t_{wn} : net web thickness (mm), $t_{wn} = t_w - t_c$ t_w : as built web thickness (mm), see **Fig. 3.4.2-1** t_c : corrosion deduction (mm) to be subtracted from the web and flange thickness (as specified by other Parts , but not less than t_s as required by **2.3.3**). φ_w : smallest angle (deg) between shell plate and stiffener web, measured at the mid-span of the stiffener, see **Fig. 3.4.2-1**. The angle φ_w may be taken as 90 *degrees* provided the smallest angle is not less than 75 *degrees*. **8** The actual net effective plastic section modulus of a transverse or longitudinal local frame is given by following **(1)** or **(2)**. (1) When the cross-sectional area of the attached plate flange exceeds the cross-sectional area of the local frame, the actual net effective plastic section modulus, Z_p, is given by: $Z_p = \frac{A_{pn} t_{pn}}{20} + \frac{h_w^2 t_{wn} \sin\varphi_w}{2000} + \frac{A_{fn}(h_{fc}\sin\varphi_w - b_w \cos\varphi_w)}{10}$ (cm^3) where h, t_{wn}, t_c and φ_w : as given in **-7** above A_{pn} : net cross-sectional area (cm^2) of the local frame <u>t_{pn} : fitted net shell plate thickness (mm) (is to comply with t_{net} as required by **3.4.1-2**)</u> h_w : height (mm) of local frame web, see **Fig. 3.4.2-1** A_{fn} : net cross-sectional area (cm^2) of local frame flange h_{fc} : height (mm) of local frame measured to centre of the flange area, see **Fig. 3.4.2-1**	IACS UR I2 (Rev.5) Transfers the definition of t_{pn} to 3.4.2-7.

Amended-Original Requirements Comparison Table (Shear Area of Frames for Polar Class Ships)

Amended	Original	Remarks
b_w : distance (mm) from mid thickness plane of local frame web to the centre of the flange area, see **Fig. 3.4.2-1** (2) (Omitted) Fig. 3.4.2-1 Stiffener Geometry  **3.4.3 Framing - Local Frames in Bottom Structures and Transverse Local Frames in Side Structures** **3** The actual net effective plastic section modulus of the plate/stiffener combination Z_p as defined in **3.4.2-8** is to be not less than Z_{pt} determined as follows: $Z_{pt} = \frac{100^3 \times LL \times YsAF \times PPF_t \frac{P_{avg}}{1000} aA_1}{4\sigma_y}$ (cm^3) where AF, PPF_t, P_{avg}, LL, b, s, a and σ_y are as given	b_w : distance (mm) from mid thickness plane of local frame web to the centre of the flange area, see **Fig. 3.4.2-1** (2) (Omitted) Fig. 3.4.2-1 Stiffener Geometry  **3.4.3 Framing - Local Frames in Bottom Structures and Transverse Local Frames in Side Structures** **3** The actual net effective plastic section modulus of the plate/stiffener combination Z_p as defined in **3.4.2-8** is to be not less than Z_{pt} determined as follows: $Z_{pt} = \frac{100^3 \times LL \times YsAF \times PPF_t \frac{P_{avg}}{1000} aA_1}{4\sigma_y}$ (cm^3) where AF, PPF_t, P_{avg}, LL, b, s, a and σ_y are as given	 IACS UR I2 (Rev.5)

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td>in 3.4.3-2.
$Y = 1 - 0.5\ (LL\ /\ a)$
A_1 : taken equal to the greater of following (a) and (b)
(a) When ice load acting at the mid-span of the local frame
$$A_1 = \frac{1}{1 + \frac{j}{2} + \frac{k_w j\left(\sqrt{1 - {a_1}^2} - 1\right)}{2}}$$
(b) When ice load acting near a support
$$A_1 = \frac{1 - \frac{1}{2a_1 Y}}{0.275 + 1.44{k_z}^{0.7}}$$
j = 1 for a local frame with one simple support outside the ice-strengthened areas
j = 2 for a local frame without any simple supports
$a_1 = A_t / A_w$
A_t : Minimum shear area (cm^2) of the local frame as given in 3.4.3-2
A_w: Effective net shear area (cm^2) of the local frame (calculated according to 3.4.2-7)
$k_w = 1\ /\ (1 + 2A_{fn}\ /\ A_w)$ with A_{fn} as given in 3.4.2-8
k_z : Section modulus ratio
$k_z = z_p\ /\ Z_p$ in general
k_z = 0.0 when the frame is arranged with end bracket
z_p : Sum of individual plastic section</td><td>in 3.4.3-2.
$Y = 1 - 0.5\ (LL\ /\ a)$
A_1 : taken equal to the greater of following (a) and (b)
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$$A_1 = \frac{1}{1 + \frac{j}{2} + \frac{k_w j\left(\sqrt{1 - {a_1}^2} - 1\right)}{2}}$$
(b) When ice load acting near a support
$$A_1 = \frac{1 - \frac{1}{2a_1 Y}}{0.275 + 1.44{k_z}^{0.7}}$$
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</table>

Amended	Original	Remarks
modulus (cm^3) of flange and shell plate as fitted $z_p = (b_{fn}\, t_{fn}^2 / 4 + b_{eff}\, t_{pn}^2 / 4) / 1000$ b_{fn} : Net flange breadth (mm) $b_{fn} = b_f - t_c$ (t_c as given in **3.4.2-7**) b_f : Flange breadth (mm), see **Fig. 3.4.2-1** t_{fn} : net flange thickness (mm) $t_{fn} = t_f - t_c$ (t_c as given in **3.4.2-7**) t_f : As-built flange thickness (mm), see **Fig. 3.4.2-1** t_{pn} : The fitted net shell plate thickness (mm), not to be less than t_{net} as given in **3.4.1**. b_{eff} : Effective width (mm) of shell plate flange $b_{eff} = 500\, s$ Z_p : Net effective plastic section modulus (cm^3) of the local frame (calculated according to **3.4.2-8**)	modulus (cm^3) of flange and shell plate as fitted $z_p = (b_f\, t_{fn}^2 / 4 + b_{eff}\, t_{pn}^2 / 4) / 1000$ b_f : Flange breadth (mm), see **Fig. 3.4.2-1** t_{fn} : net flange thickness (mm) $t_{fn} = t_f - t_c$ (t_c as given in **3.4.2-7**) t_f : As-built flange thickness (mm), see **Fig. 3.4.2-1** t_{pn} : The fitted net shell plate thickness (mm), not to be less than t_{net} as given in **3.4.1**. b_{eff} : Effective width (mm) of shell plate flange $b_{eff} = 500\, s$ Z_p : Net effective plastic section modulus (cm^3) of the local frame (calculated according to **3.4.2-8**)	IACS UR I2 (Rev.5) Revises symbols and terms.

EFFECTIVE DATE AND APPLICATION

1. The effective date of the amendments is 1 January 2027.

2. Notwithstanding the amendments, the current requirements apply to ships for which the date of contract for construction* is before the effective date.

* "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.
2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
   For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved

Amended-Original Requirements Comparison Table (Shear Area of Frames for Polar Class Ships)

<table>
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<tr><td colspan="2">plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
(1) such alterations do not affect matters related to classification, or
(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.
3. If a contract for construction is later amended to include additional vessels or additional options, the date of “contract for construction” for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a “new contract” to which 1. and 2. above apply.
4. If a contract for construction is amended to change the ship type, the date of “contract for construction” of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:
This Procedural Requirement applies from 1 July 2009.</td><td></td></tr>
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