S11 Longitudinal strength standard

(1989)

S1. Application

This requirement applies only to ships of length 90 m and greater in unrestricted service. For ships having one or more of the following characteristics, special additional considerations will be given by each Classification Society.

(i)	Proportion	$L/B \leqq 5$, $B/D \geqq 2{,}5$
(ii)	Length	$L \geqq 500$ m
(iii)	Block coefficient	$Cb < 0{,}6$
(iv)	Large deck opening	
(v)	Ships with large flare	
(vi)	Carriage of heated cargoes	
(vii)	Unusual type or design	

S2. Loads

S2.1 Still water bending moment and shear force

S2.1.1 General

Still water bending moments, *Ms* (kN-m), and still water shear forces, *Fs* (kN), are to be calculated at each section along the ship length for design load conditions and ballast conditions as specified in S2.1.2.
For these calculations, downward loads are assumed to be taken as positive values, and are to be integrated in the forward direction from the aft end of *L*. The sign conventions of *Ms* and *Fs* are as shown in Fig.1.

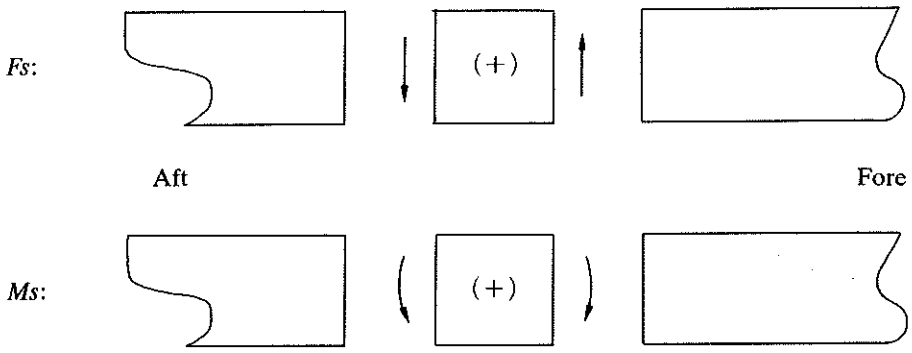


Fig.1 Sign Conventions of *Ms* and *Fs*

S11 cont'd

S2.1.2 Load conditions

In general, the following load conditions, based on amount of bunker, fresh water and stores at departure and arrival, are to be considered for the *Ms* and *Fs* calculations.

General cargo ships, container ships, roll-on/roll-off and refrigerated cargo carriers, bulk carriers, ore carriers:
- Homogeneous loading conditions at maximum draught
- Ballast conditions
- Special loading conditions e.g., container or light load conditions at less than the maximum draught, heavy cargo, empty holds or mon-homogeneous cargo conditions, deck cargo conditions, etc., where applicable.

Oil tankers:
- Homogeneous loading conditions (excluding dry and clean ballast tanks) and ballast or part-loaded conditions
- Any specified non-uniform distribution of loading
- Mid-voyage conditions relating to tank cleaning or other operations where these differ significantly from the ballast conditions.

Chemical tankers:
- Conditions as specified for oil tankers
- Conditions for high density or segregated cargo.

Liquefied gas carriers:
- Homogeneous loading conditions for all approved cargoes
- Ballast conditions
- Cargo condition where one or more tanks are empty or partially filled or where more than one type of cargo having significantly different densities is carried.

Combination Carriers:
- Conditions as specified for oil tankers and cargo ships.

S2.2 Wave loads

S2.2.1 Wave bending moment

The wave bending moments, *Mw*, at each section along the ship length are given by the following formulae:

$Mw\ (+) = +\ 190\ M\ C\ L^2\ B\ Cb \times 10^{-3}$ (kN − m) ··· For positive moment
$Mw\ (-) = -\ 110\ M\ C\ L^2\ B\ (Cb + 0{,}7) \times 10^{-3}$ (kN − m) ··· For negative moment

where, M = Distribution factor given in Fig.2

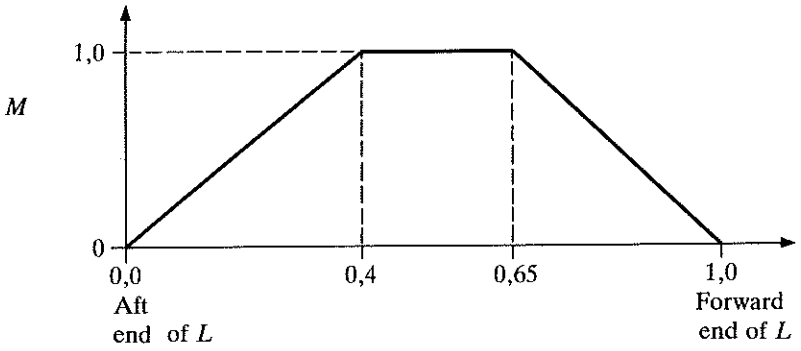
$$C = 10{,}75 - \left[\frac{300 - L}{100}\right]^{1.5} \quad \text{for } 90 \leqq L \leqq 300$$

$$\text{or } 10{,}75 \quad \text{for } 300 < L < 350$$

$$\text{or } 10{,}75 - \left[\frac{L - 300}{150}\right]^{1.5} \quad \text{for } 350 \leqq L \leqq 500$$

L = Length of the ships in meters, difined by the IACS Requirement S2
B = Greatest moulded breadth in meters
Cb = Block coefficient, defined by the IACS Requirement S2, but not to be taken less than 0,6 ▶

S11
cont'd



Distance from the aft end of L in terms of L

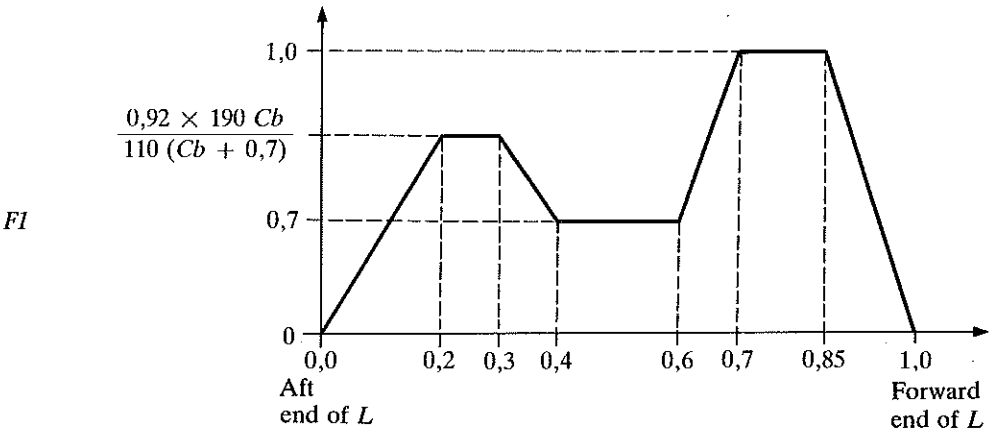
Fig.2 Distribution factor M

S2.2.2 Wave shear force

The wave shear forces, Fw, at each section along the length of the ship are given by the following formulae:

$$Fw\ (+) = +\ 30\ F1\ C\ L\ B\ (Cb + 0{,}7) \times 10^{-2}\ \text{(kN)} \cdots \text{For positive shear force}$$
$$Fw\ (-) = -\ 30\ F2\ C\ L\ B\ (Cb + 0{,}7) \times 10^{-2}\ \text{(kN)} \cdots \text{For negative shear force}$$

Where, $F1$, $F2$ = Distribution factor given in Figs.3 and 4
C, L, B, Cb = As specified in S2.2.1



Distance from the aft end of L in terms of L

Fig.3 Distribution factor $F1$

S11
cont'd

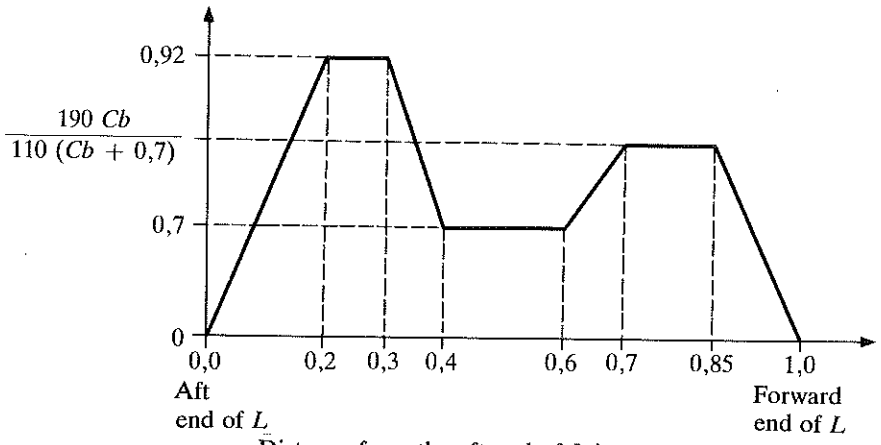


Fig.2 Distribution factor *M*

S3. Bending strength

S3.1 Bending strength amidships

S3.1.1 Section modulus

(i) Hull section modulus, Z, calculated in accordance with IACS Requirment S5, is not to be less than the values given by the following formula in way of 0,4 L midships for the still water bending moments Ms given in S2.1.1 and the wave bending moments Mw given in S2.2.1, respectively:

$$\frac{|Ms + Mw|}{\sigma} \times 10^3 \qquad (cm^3)$$

where, $\sigma = 175/k$ (N/mm²)
$k = 1{,}0$ for ordinary hull structural steel
$k < 1{,}0$ for higher tensile steel according to IACS Requirement S4.

(ii) In any case, the longitudinal strength of the ship is to be in compliance with the IACS Requirement S7.

S3.1.2 Moment of inertia

Moment of inertia of hull section at the midship point is to be in compliance with the IACS Requirement S4.

S3.2 Bending strength outside amidships.

The required bending strength outside 0,4 L amidships is to be determined at the discretion of each Classification Society.

S4. Shearing strength

S4.1 General

The thickness requirements given in S4.2 or S4.3 apply unless smaller values are proved satisfactory by a method of direct stress calculation approved by each Classification Society, where the calculated shear stress is not to exceed $110/k$ (N/mm²) ▶

S11
cont'd

S4.2 Shearing strength for ships without effective longitudinal bulkheads

(i) The thickness of side shell is not to be less than the values given by the following formula for the still water shear forces *Fs* given in S2.1.1 and the wave shear forces *Fw* given in S2.2.2, respectively:

$$t = \frac{0{,}5 \mid Fs + Fw \mid}{\tau} \frac{S}{I} \times 10^2 \quad \text{(mm)}$$

where, I = Moment of inertia in cm^4 about the horizontal neutral axis at the section under consideration

S = First moment in cm^3, about the neutral axis, of the area of the effective longitudinal members between the vertical level at which the shear stress is being determind and the vertical extremity of effective longitudinal members, taken at the section under consideration

$\tau = 110/k$ (N/mm^2)

k = As specified in S3.1.1 (i)

(ii) The value of *Fs* may be corrected for the direct transmission of forces to the transverse bulkheads at the discretion of each Classification Society.

S4.3 Shearing strength for ships with two effective longitudinal bulkheads

(i) The thickness of side shell and longitudinal bulkheads are not to be less than the values given by the following formulae:

For side shell:

$$t = \frac{\mid (0{,}5 - \phi)\,(Fs + Fw) + \triangle Fsh \mid}{\tau} \frac{S}{I} \times 10^2 \quad \text{(mm)}$$

For longitudinal bulkheads:

$$t = \frac{\mid \phi\,(Fs + Fw) + \triangle Fbl \mid}{\tau} \frac{S}{I} \times 10^2 \quad \text{(mm)}$$

Where, ϕ = ratio of shear force shared by the longitudinal bulkhead to the total shear force, and given by each Classification Society

$\triangle Fsh$, $\triangle Fbl$ = shear force acting upon the side shell plating and longitudinal bulkhead plating, respectively, due to local loads, and given by each Classification Society, subject to the sign convention specified in S2.1.1.

S, I, τ = As specified in S4.2 (i) ◀◀